10th International Scientific Conference

Energy and Climate Change

PROCEEDINGS

organized by

Energy Policy and Development Centre (KEPA)

National and Kapodistrian University of Athens

2017

Editor

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Green Energy Investments
2nd Forum

11 October 2017, Athens, Greece

Under the auspices of Ukrainian Chairmanship

PROMITHEASnet 10TH International Scientific Conference on Energy and Climate Change

academic impact
Sharing a Culture of Intellectual Social Responsibility

AGENDA

Venue: Kostis Palamas building, Academias 48 & Sina 1 str.

09:00 Registration

09:30 SESSION 1: GREEN ENERGY INVESTMENT POLICIES

CHAIR **Amb. Traian CHEBELEU**

Deputy Secretary General, Permanent International Secretariat of the Black Sea Economic Cooperation organization (BSEC-PERMIS)

Prof. Dimitrios MAVRAKIS

Director of Energy Policy and Development Centre (KEPA), National and Kapodistrian University of Athens (NKUA)

WELCOME

Prof. Dimitrios MAVRAKIS

Coordinator of PROMITHEASnet

OPENING

Mr. Ramu DAMODARAN video message

Chief of United Nations Academic Impact (UNAI)

KEYNOTE SPEAKER

Amb. Michael CHRISTIDES

Secretary General BSEC – PERMIS

POLICY STATEMENTS

Mrs. Hanna TISCHENKO

BSEC Chairmanship-in-Office, Embassy of Ukraine to the Hellenic Republic

Amb. of Japan Mr. Yasuhiro SHIMIZU

Embassy of Japan to the Hellenic Republic

Amb. of Romania Mr. Lucian FATU

Ambassador at the Embassy of Romania to the Hellenic Republic

Amb. of Moldova Mr. Anatol VANGHELI

Embassy of Moldova to the Hellenic Republic

Dr. Miltiadis MAKRYGIANNIS

Parliamentary Assembly of the Black Sea Economic Cooperation organization (PABSEC)

Prof. Dimitrios MAVRAKIS

Director of KEPA, National and Kapodistrian University of Athens

Green Energy Investments
2nd Forum
11 October 2017, Athens, Greece

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PROMITHEASNET 10TH INTERNATIONAL SCIENTIFIC CONFERENCE ON ENERGY AND CLIMATE CHANGE

academic impact
Sharing a Culture of Intellectual Social Responsibility

11:30 *Coffee break*

12:00 **SESSION 2: GREEN ENERGY INVESTMENTS**

CHAIR **Amb. Traian CHEBELEU**
Deputy Secretary General BSEC – PERMIS
Prof. Dimitrios MAVRAKIS
Director of KEPA, NKUA

SPEAKERS

Mr. Libor KRKOSKA
Head of Resident Office in Cyprus, European Bank of Reconstruction and Development (EBRD)

Mr. Mircea COJOCARU
Head of Environment & Social Sustainability, Black Sea Trade and Development Bank (BSTDB)

Ms. Ioanna SAMPRAKOU
Advisor to Deputy Minister of Economy and Development (Strategic investments & PPP – Energy / Infrastructures/ ICT) and MoRepresentatives board of technical Chamber of Greece

National Bank of Greece

Dr. Spyros KIARTZIS
Director Alternative Energy Sources & New Technologies, Hellenic Petroleum

Mr. George CHATZOPOULOS
Consultant strategy & business development, Public Natural Gas Supply Corporation, DEPA

Ms. Alkisti FLOROU
EU Affairs and Projects Advisor, Network of Sustainable Greek Islands (DAFNI)

Mr. Constantinos STAMBOLIS
Executive director, Institute of Energy for S.E. Europe (IENE)

Mr. Konstantinos THEOFYLAKTOS
Hellenic Association For Cogeneration Of Heat & Power

Mr. Ioannis TSIPOURIDIS
General Manager at R.E.D. Pro Consultants - Renewable Energy Development Professionals in Greece

CLOSING REMARKS

Amb. Traian CHEBELEU
Deputy Secretary General BSEC – PERMIS

14:30 **End of 2nd Green Energy Investments Forum**

Scientific Conference on Energy and Climate Change

12 OCTOBER 2017, Athens, Greece

Under the auspices of Ukrainian Chairmanship

PROMITHEASNET 10TH INTERNATIONAL SCIENTIFIC CONFERENCE ON ENERGY AND CLIMATE CHANGE

academic impact

Sharing a Culture of Intellectual Social Responsibility

AGENDA

Venue: Kostis Palamas building, Academias 48 & Sina 1 str.

09:00 Registration

09:30 SESSION 1: ENERGY - CLIMATE CHANGE POLICIES

CHAIR **Prof. Krzysztof WARMUZINSKI**

Institute of Chemical Engineering, Polish Academy of Sciences, Poland

Prof. Evaggelos DIALYNAS

National Technical University of Athens, Greece

KEYNOTE SPEAKER

Current trends in CO_2 capture

by Prof. Krzysztof WARMUZINSKI, Poland

SPEAKERS

Impact of CO_2 on mechanical properties of sandstone during sequestration for climate change mitigation

Mr. Georgios DIMADIS, Aristotle University of Thessaloniki , Greece

Tax incentives for conservation of land and forests – reviewing Australian and Canadian experience

Dr. Evgeny GUGLYUVATYY, Southern Cross University, Australia

A Model for Natural Gas Consumption Forecast

Milica IVIĆ, University of Belgrade, Serbia

Nature, Energy and Citizenship

Prof. Thor Oivind JENSEN, University of Bergen, Norway

Application of HERON Decision Support Tool for the Greek case (Transport)

Dr. Popi KONIDARI, Energy Policy and Development Centre, NKUA, Greece

Implementing carbon free ferry technology on West Coast Norway

Prof. Tom SKAUGE, Western Norway University of Applied Sciences , Norway

12:00 *Coffee break*

Scientific Conference on Energy and Climate Change

12 October 2017, Athens, Greece

Under the auspices of Ukrainian Chairmanship

PROMITHEASNET 10TH INTERNATIONAL SCIENTIFIC CONFERENCE ON ENERGY AND CLIMATE CHANGE

12:30 SESSION 2: ENERGY - CLIMATE CHANGE - RENEWABLE ENERGY SOURCES

CHAIR
Prof. Thor Oivind JENSEN
University of Bergen, Norway
Prof. Milton TYPAS
National and Kapodistrian University of Athens, Greece

KEYNOTE SPEAKER
Prof. Nikolas KALOYANOV, Technical University of Sofia , Bulgaria

SPEAKERS

Hydro power and the environment: From power vs nature to sustainable energy
Dr. Ole Andreas BREKKE, Norway

Simulation of an absorption solar cooling system for Batna, Algeria
Prof. Mounir AKSAS, Faculty of Material Sciences - University of Batna, Algeria

Supporting global and European climate and energy policy-making through the nexus approach
Dr. Dora FAZEKAS, Cambridge Econometrics, United Kingdom

Comparative analysis among preferable EE scenarios
Aliki-Nefeli MAVRAKI, Energy Policy and Development Centre, NKUA, Greece

Incorporating behavioral barriers into energy efficiency scenarios for Greece
Dr. Popi KONIDARI, Energy Policy and Development Centre, NKUA, Greece

14:00 End of Scientific Conference on Energy and Climate Change

Projects and Funding Opportunities on Energy and Climate Change

Under the auspices of Ukrainian Chairmanship

BROKERAGE EVENT

13 October 2017, Athens, Greece

PROMITHEASNET 10TH INTERNATIONAL SCIENTIFIC CONFERENCE ON ENERGY AND CLIMATE CHANGE

Sharing a Culture of Intellectual Social Responsibility

AGENDA

Venue: Kostis Palamas building, Academias 48 & Sina 1 str.

09:00 Registration

09:30 **SESSION 1: PROJECTS**

CHAIR **Prof. Dejan IVEZIC**
University of Belgrade, Faculty of Mining and Geology, Serbia
Prof. Nikolas KALOYANOV
Technical University of Sofia, Bulgaria

SPEAKERS

Urban resilience and adaptation to climate change
Prof. Eleni MIRIVILI, Athens Chief Resilience Officer (100RC), City of Athens Council-member (Climate Change Portfolio)

HERON – Forward-looking socio-economic research on Energy Efficiency in EU countries, H2020 project
Ms. Eleni-Danai MAVRAKI, Energy Policy and Development Centre, NKUA, Greece

MOTIVATE – Promoting citizens' active involvement in the development of Sustainable Travel Plans in Med Cities with Seasonal Demand, INTERREG Med projects
Ms. Alexia SPYRIDONIDOU, Sustainable Mobility Expert, Aegean Energy & Environment Agency, Greece

FIT-to-NZEB – Innovative training schemes for retrofitting to nZEB-levels, H2020 project
Mr. Stefanos PALLANTZAS, Hellenic Institute of Passive Building, Greece

ACE: E2 project: Adoption, Compliance Enforcement for Energy Efficiency in Commercial Buildings in India
Mr. Konstantinos THEOFYLAKTOS, Project team leader

New challenges for the building energy efficiency in Bulgaria – results of two R&D projects at the Technical University-Sofia
Prof. Nikolas KALOYANOV, Technical Univerity of Sofia, Bulgaria

WiseGRID & SMILE – Demonstration of smart grid, storage and system integration technologies with increasing share of renewables: distribution system, H2020 projects
Ms. Alkisti FLOROU, Aegean Energy & Environment Agency, Greece

STEPPING – Supporting The EPC Public Procurement IN Going-beyond, INTERREG Med project
Ms. Alkisti FLOROU, Aegean Energy & Environment Agency, Greece

Projects and Funding Opportunities on Energy and Climate Change

Under the auspices of Ukrainian Chairmanship

BROKERAGE EVENT

13 October 2017, Athens, Greece

PROMITHEASNET 10TH INTERNATIONAL SCIENTIFIC CONFERENCE ON ENERGY AND CLIMATE CHANGE

11:45 *Coffee break*

12:00 SESSION 2: FUNDING OPPORTUNITIES

CHAIR Prof. Dejan IVEZIC, University of Belgrade, Faculty of Mining and Geology, Serbia
Prof. Nikolas KALOYANOV, Technical University of Sofia, Bulgaria

SPEAKERS

H2020 – Energy: new calls
Ms. Christiana SIAMPEKOU, National Contact point, National Documentation Centre, Greece

H2020 – Climate action and Environment: new calls
Ms. Katerina PAPADOULI, National Contact Point, PRAXI Network, Greece

LIFE 2014 – 2020 for ENVIRONMENT
Mr. Dimitrios HOMATIDIS, Environment & Resource Efficiency Officer, Greek LIFE Task Force

LIFE 2014 – 2020: for Climate Action
Mr. Dimitrios NIAVIS, National Contact point, Hellenic Ministry of Environment and Energy

Research and Innovation Strategies and Implementation for Smart Specialization (RIS3) in the Greek Energy Sector
Dr. Kyriakos PANOPOULOS, Coordinator of the Energy Platform for Smart Specialization, General Secretariat for Research and Technology, Greece

13:30 COOPERATION OPPORTUNITIES – THEMATICAL DISCUSSION

FACILITATOR
Prof. Dejan IVEZIC, University of Belgrade, Faculty of Mining and Geology, Serbia

CLOSING REMARKS
Prof. Dimitrios MAVRAKIS, Coordinator of PROMITHEASnet, Energy Policy and Development Centre, NKUA, Greece

14:30 End of projects & funding opportunities on Energy and Climate Change brokerage event

List of participants

A/A	Title	First Name	Last Name	Organization
1	Mr.	Panagiotis	Agrapidis	Organization Strategic Systems, Hellas
2	Prof.	Mounir	Aksas	University of Batna, Algeria
3	Mrs.	Loukia	Amygdalou	Embassy of Austria in Hellenic Republic
4	Mr.	Dimitris	Antoniou	European Bank of Reconstruction and Development (EBRD), Hellas
5	Dr.	Roman	Berenblyum	International Research Institute of Stavanger, Norway
6	Mr.	Alexey	Bechenkov	Embassy of Russia in Hellenic Republic
7	Mrs.	Angeliki	Boura	Ministry of Foreign Affairs, Hellas
8	Dr.	Ole Andreas	Brekke	Western Norway University of Applied Sciences
9	Mr.	Ivan	Chalakov	Embassy of Bulgaria in Hellenic Republic
10	Mr.	Georgios	Chatzopoulos	Public Gas Corporation S.A. (DEPA), Hellas
11	Mrs.	Cristina	Ceban	Embassy of Moldova in Hellenic Republic
12	Amb.	Traian	Chebeleu	Black Sea Economic Cooperation-PERMIS
13	Amb.	Michael	Christides	Black Sea Economic Cooperation-PERMIS
14	Mr.	Mircea	Cojocaru	Black Sea Trade and Development Bank (BSTDB)
15	Mr.	Marios	Danakos	Thymio Papayannis and Associates Inc., Hellas
16	Mr.	Georgios	Dimadis	Aristotle University of Thessaloniki, Hellas
17	Amb.	Lucian	Fătu	Romanian Embassy in Hellenic Republic
18	Dr.	Dora	Fazekas	Cambridge Econometrics, United Kingdom
19	Mrs.	Alkisti	Florou	DAFNI Network of Sustainable Aegean & Ionian Islands, Hellas
20	Mrs.	Anastasia	Frilingou	National Technical University of Athens, Hellas
21	Mrs.	Tereza	Fokianou	Flow Energy, Hellas
22	Mr.	Rogalev	Gennady	The Russian Centre of Science and Culture in Athens, Hellas
23	Prof.	Kyriakos	Georgiou	National and Kapodistrian University of Athens, Department of Biology

24	Dr.	Evgeny	Guglyuvatyy	Southern Cross University, Australia
25	Mr.	Dimitris	Homatidis	Ministry of Environment and Energy, Hellas
26	Prof.	Dejan	Ivezic	University of Belgrade, Serbia
27	Mrs.	Milica	Ivić	University of Belgrade, Serbia
28	Prof.	Thor Øivind	Jensen	University of Bergen, Norway
29	Prof.	Nikola	Kaloyanov	Technical University of Sofia, Bulgaria
30	Prof.	Constantinos	Karagiannopoulos	National Technical University of Athens, Hellas
31	Mr.	Ioannis	Kardasis	National Bank of Greece, Hellas
32	Mrs.	Dimitra	Katsini	National Bank of Greece, Hellas
33	Dr.	Spyros	Kiartzis	Hellenic Petroleum, Hellas
34	Mrs.	Charis	Kollia	National Bank of Greece, Hellas
35	Dr.	Popi	Konidari	National and Kapodistrian University of Athens Energy Policy and Development Centre (KEPA)
36	Mr.	Sergey	Kondrashin	Embassy of Russia in Hellenic Republic
37	Mr.	Libor	Krkoska	European Bank of Reconstruction and Development (EBRD), Hellas
38	Mrs.	Ekaterine	Lortkipanidze	Embassy of Georgia in Hellenic Republic
39	Dr.	Miltiadis	Makrygiannis	Parliamentary Assembly of the Black Sea Economic Cooperation - PABSEC, Turkey
40	Prof.	Haji	Malikov	Geotechnological Problems from Oil, Gas & Chemistry, Azerbaijan
41	Mr.	Kostantinos	Maniatopoulos	F. Director General - Energy E.C.
42	Mr.	Aimilios	Margaritis	Prendre Holdings Ltd, Hellas
43	Mrs.	Anastasia	Marinoudi	Ecozen, Hellas
44	Ms.	Aliki-Nefeli	Mavraki	National and Kapodistrian University of Athens Energy Policy and Development Centre (KEPA)
45	Ms.	Eleni-Danai	Mavraki	National and Kapodistrian University of Athens Energy Policy and Development Centre (KEPA)
46	Prof.	Dimitrios	Mavrakis	National and Kapodistrian University of Athens Energy Policy and Development Centre (KEPA)
47	Mrs.	Sotirios	Mikros	University of Patras, Hellas
48	Prof.	Eleni	Mirivili	Municipality of Athens, Hellas
49	Dr.	Anders	Nermoen	University of Stavanger, Norway
50	Mr.	Dimitris	Niavis	Ministry of Environment and Energy, Hellas

51	Mr.	Ioannis	Ntroukas	EPA Attikis, Hellas
52	Mr.	Stefanos	Pallantzas	Hellenic Institute of Passive Building (EIPAK)
53	Dr.	Kyriakos	Panopoulos	General Secretariat of Research and Technology (GSRT), Hellas
54	Mrs.	Eleni	Papadopoulou	A-Energy, Hellas
55	Mrs.	Katerina	Papadouli	PRAXI Network, Hellas
56	Mr.	Ioannis	Pappas	Ministry of Foreign Affairs, Hellas
57	Mrs.	Jenny	Passari	National and Kapodistrian University of Athens Energy Policy and Development Centre (KEPA)
58	Mr.	Dan	Pericleanu	Romanian Embassy in Hellenic Republic
59	Mr.	Ioannis	Pispirigos	TRIM – Digital & Print Publications, Hellas
60	Mrs.	Ioanna	Sambrakou	Ministry of Infrastructures, Transports and Networks, Hellas
61	Mr.	Antonios	Serepas	National School of Public Administration, Hellas
62	Mrs.	Christiana	Siambekou	National Documentation Centre (EKT/NHRF), Hellas
63	Prof.	Tom	Skauge	Western Norway University of Applied Sciences
64	Mr.	Panteley	Spassov	Embassy of Bulgaria in Hellenic Republic
65	Mrs.	Alexia	Spyridonidou	DAFNI Network of Sustainable Aegean & Ionian Islands, Hellas
66	Mr.	Costis	Stambolis	Institute of Energy for SE Europe (IENE)
67	Mr.	Nikolaos	Stratigeas	ANAPLASI Consulting Engineers S.A., Hellas
68	Mr.	Kostantinos	Theofilaktos	Hellenic Association for Cogeneration of Heat & Power (HACHP), Hellas
69	Mrs.	Hanna	Tischenko	Embassy of Ukraine in Hellenic Republic
70	Mr.	Panagiotis	Trifa	University of Patras, Hellas
71	Mr.	Michael	Tsereklas	Public Power Corporation S.A, Hellas
72	Dr.	Ioannis	Tsipouridis	R.E.D. Pro Consultants - Renewable Energy Development Professionals in Greece
73	Prof.	Milton A.	Typas	National and Kapodistrian University of Athens, Department of Biology
74	Amb.	Anatol	Vangheli	Embassy of Moldova in Hellenic Republic
75	Prof.	Krzysztof	Warmuzinski	Institute of Chemical Engineerging, Poland
76	Mrs.	Antonia	Zafeiri	European Commission Representation in Greece
77	Mr.	Jason	Zafeiriadis	Renewable Energy Development Professionals (REDPro), Hellas

DAY 1: 2nd Green Energy Investments Forum

Session 1: Policy statements

Welcome address by Prof. Dimitrios MAVRAKIS

Director of KEPA, National and Kapodistrian University of Athens, Hellas

Your Excellences,

Distinguished guests and colleagues,

It is great pleasure and honor for me and my colleagues of KEPA to welcome you in the 10th Annual International Scientific Conference on Energy and Climate Change and the 2nd Green Energy Investment Forum that is organized by the "PROMITHEASnet" and the "BSEC-Green Energy Network".

Both networks are coordinated by the Energy Policy and Development Centre of the National and Kapodistrian University of Athens and operate under the auspices of the Black Sea Economic Cooperation Organization and of the United Nations Academic Impact initiative.

For more than twenty years, we promote regional cooperation among academic institutions, policy makers and market stakeholders on the crucial and demanding issues of Energy and Climate Change.

For almost fourteen years, in close cooperation with partners from the European Union, the Black Sea and Central Asia, we implement competitive scientific programmes, mainly financed by the European Commission, while all these years the Black Sea Economic Cooperation Organization plays a decisive role as facilitator and supporter to our efforts to communicate with policymakers, market stakeholders and academic communities of its Member States.

Apart of this annual scientific event, that recently was enhanced with the Green Investment Forum, we organize numerous international activities, such as seminars, workshops, tele and web-seminars and ad-hoc training skype sessions, in cooperation with partners from EU, the "PROMITHEASnet" and the "BSEC – Green Energy Network".

It is worth mentioning that the "BSEC – Green Energy Network" has been developed as the outcome of the close cooperation of KEPA with the Permanent International Secretariat of BSEC and the Working Group on Energy of the BSEC-MS, on issues related to Green Energy. Finally we are members of the United Nations Academic Impact Initiative.

Further to our web pages, we edit and circulate, on regular basis, a worldwide disseminated newsletter, a bilingual scientific journal, a two-annual Energy View of the BSEC countries volume and ad-hoc scientific editions.

In addition, our staff participates in knowledge transfer procedures to policy and decision makers in our region, concerning the development and evaluation of climate change and energy efficiency scenarios.

Closing this short welcome allow me to express my sincere gratitude to our financial sponsors the National Bank of Greece, the Hellenic Petroleum, and the Public Gas Corporation (DEPA) and to all of you that honor us with your participation, especially those coming from abroad to present and discuss their results of their scientific research.

Finally, allow me to sincerely thank the Secretary-General *Amb. Michael Christides,* and the Deputy Secretary-General *Amb. Traian Chebeleu* of PERMIS for their continuous support and encouragement to our efforts in the combat against Climate Change and the promotion of the Sustainable Economic Development in the Member States of BSEC.

Once more I welcome you and I wish you a fruitful and enjoyable stay in Athens.

Thank you

Video – message from Mr. Ramu DAMODARAN

Chief of United Nations Academic Impact,

Secretary of the United Nations Committee on Information

My Greetings and good wishes to all of you at this tenth scientific conference on Energy Policy and Development being organized by the National and Kapodistrian University in Athens.

Your conference this October comes at a particular opportune time, right after the general debate in the Nations General Assembly, but even as the individual committees and delegates are working to fashion in detail the agenda, the possibilities and the promise for the United Nations over the next year's.

Speaking on change, just a few months ago our Secretary-General António Guterres said that the facts that we have to accept are that climate change is undeniable, climate action is unstoppable and climate solutions are unmatchable.

It is you, the participants in this conference, backed by the solid academic research that you have done before coming here and which will continue to do once you leave this conference, that can best assure those solutions.

We are also blessed at this time by realizing recognition within the energy industry that it is of its own interests not to be combative about climate change and not to regent measures that now must be taken to preclude climate change and energy depravation affecting our planet in years ahead.

They do so because they realize that in an increasingly energy efficient world where clean and sustainable energy is becoming the norm; it is of their own interests to move with the tide and to anticipate the changes that are about to come and accommodate them in their current behaviour, practices and planning.

They do so because they are investors and those who show them up both financially and politically are aware of climate change and are absolutely keen that it will be factored into what industry is doing now. And above all they are keen because the work force they are going to drop on, the work force which increasingly will become comprised of people born in the last part of the twentieth century and the beginning of the present century, who are committed to the idea of a sustainable planet and want to work in an occupation and in an industry, that encourages that.

So, we have in many ways a remarkable combination of circumstances that work all very well for between energy and climate change perspectives that this conference addresses. What is now left to you is to make sure that the worth and burden of your academic research and academic proof casts its weight upon the business models and the profitable models and the sustainable models that energy industry wishes to adopt.

If you are able to do so and if you are able to take your research beyond the laboratory into what the United Nations truly is, a forum for every activity and every occupation that humanity has chosen to adopt and practice, then you will have made this conference well worth of success and we in the United Nations Academic Impact will be proud of you.

Thank you for all that you are doing and will continue to do and my best wishes to you in this conference.

Opening by Amb. Michael CHRISTIDES

Secretary General BSEC-PERMIS

Ladies and Gentlemen,

Welcome to the "*2nd Green Investment Forum*", organized by KEPA in its capacity of Coordinator of the "*BSEC Green Energy Network*", in cooperation with BSEC PERMIS; the aim of the event is to bring together governmental officials responsible for the promotion of Green Energy, representatives of the banking sector, the business communities and of NGOs active in the development and use of Green Energy in the BSEC Region.

The Forum offers an excellent opportunity to participants, especially to the representatives of governmental institutions in the BSEC Member States, to present their Green Energy policies and investment plans and, at the same time, to the international development banks to present their green policy instruments and programs for the BSEC Region. Thus, this Forum can contribute to accelerating the dissemination of relevant information for the market forces and could complement information regarding access to the already running investment funds in the area of Green Energy, like the Green Climate Fund.

Needless to underline that one of the sectors of cooperation to which our Organization attaches great importance is that of Energy. Understandably so, if one considers the significance of the Black Sea region in what concerns the production, transport and distribution of energy to the world markets.

As you know, a vital component of the overall Energy question is energy efficiency, energy conservation and alternative / renewable sources of energy; all of them are issues very much on the forefront of the agendas of BSEC Member States.

Thus, one of the priorities of our Organization is to support the efforts of the Member States for ensuring sustainable energy, including the elaboration of a BSEC Green Energy Strategy, with the view to promote renewable energy sources, energy efficiency and environmentally friendly technologies.

In this regard, one of the most important developments is the establishment of the *BSEC Green Energy Network*, which started to function in 2015 under the coordination of KEPA and the supervision of BSEC. This Network is an important tool for exchanging information and for sharing know-how and good practices among our Member States, which have set for themselves, in the strategic document guiding the activities of the Organization (i.e. the *BSEC Economic Agenda 2012*), the task of taking gradual steps to materialize the vision of transforming the BSEC Region into a model for clean energy by the year 2050.

The importance of this Green Energy Investment Forum stems from the fact that the BSEC Member States have to reduce their reliance on fossil fuels, save more energy and use more renewable sources. Generally speaking, investment in renewable energy is growing. It is true that this sector is still relatively young and challenged by high costs, while oil and gas are still available at convenient prices and, thus, they will continue to be an important part of the energy mix in the foresee-able future.

At the same time, in the light of the results of COP 21, de-carbonization requires massive efforts involving governments, business and banking sectors, NGOs; all of them should work together for ensuring a comprehensive change and for having energy from renewable sources take a steadily increasing part of the energy mix of our Member States.

Consequently, a BSEC Green Energy Investment Forum to discuss these and other related issues can stimulate and facilitate action in these directions.

We are optimistic that this initiative of KEPA will be followed by similar Fora on a regular, periodic basis in various BSEC Member States, a development that could be of great help for identifying and implementing national and regional projects and for encouraging green energy investment opportunities in the BSEC Member -States.

The efforts we are undertaking in this direction have a distinct importance in enabling the BSEC Member States to combat climate change effectively and boost the transition towards resilient, low-carbon economies, whilst promoting fair and sustainable development.

With these thoughts and remarks allow me to wish you all fruitful deliberations during the event, for the benefit of all concerned.

Thank you for your kind attention.

Opening by Amb. Lucian FĂTU

Ambassador of Romania in Hellenic Republic

Dear Secretary-General,

Dear Deputy Secretary-General,

Dear Professor Mavrakis,

Distinguished participants,

As always, I am honored to address the International Scientific Conference organized by KEPA Athens University, and grateful for the invitation. It is a pleasure and a privilege.

Energy and climate change are ongoing topical issues on the BSEC agenda, with the aim to harness national Government and NGO actions around the Black Sea and add the value of regional cooperation and BSEC expertise.

In 2016, the Paris Agreement marked a turning point in the battle against climate change. World leaders from across the globe united for the first time in history to legally ratify action against pollution through the United Nations Framework Convention.

However, President Trump’s decision to withdraw the US from the Paris Agreement in June created a fresh impetus for climate action among EU countries. Directly after his announcement, during the European Council, all EU heads of state and government confirmed their commitment to swiftly and fully implementing the Paris Agreement. Now comes the first test of these commitments: the negotiations on one of the EU’s cornerstone measures for implementing the Paris Agreement, the Effort Sharing Regulation, which sets targets for member states to reduce emissions from transport, waste, agriculture, buildings and small industry.

Two days from now, EU Environment Ministers will meet to decide on the revision of this policy for 2021-2030. The Effort Sharing Regulation covers over 60% of the EU’s greenhouse gas emissions, setting binding national emission reduction targets for the EU member states for sectors such as transport, buildings, waste and agriculture.

I want to mention that Romania welcomes the commitment and determination of EU Member States for the ratification of the Paris Agreement. The formulation and the coordinated implementing of the strategies on sustainable development and climate changes, on a national level, correspond to Romania's commitment as EU and UN member state, as well as to Romania's goal of actively contributing to implementing the Paris Agreement mechanisms.

I would like to emphasize that Romania is among the countries with high potential for renewable energy, and this resource is a real opportunity for economic recovery. According to the objectives, Renewable energy sources will provide 60% of the medium - term electricity production. In Romania, the cumulated area (over 490,000 hectares of degraded land) can be used for the establishment of “energy crops”. Also, for a period of at least 25 years, tens of thousands of jobs can be created, with professions and professional specializations in training activities, exploitation and processing biomass, respectively, production, distribution and supply of energy, especially in the rural areas. Biomass-based projects are supported at no cost to the environment for the production of electric and thermal energy.

Redefining energy policies so that Romania becomes a regional energy hub is among the main priorities of our Government. In the 2020-2030 Energy Strategy objectives of the development framework there must be a 40% drop in greenhouse gas emissions - compared to 1990 level, min. 27% in the demand for energy from renewable sources; energy efficiency - min. 27% compared to the status quo scenario; increasing interconnection of the power and energy systems to 15%. On medium and long term, until 2035 and thereafter, a change is required in the paradigm on how to produce, distribute and use the energy, adapted to a global energy mix that priorities renewable energy, coal and clean gas, hydrogen fuel, nuclear fission - fourth generation and nuclear fusion.

Promoting the production of electricity from renewable energy sources represents an imperative for Romania and the European Union justified by environmental protection, increasing energy independence from imports through the diversification of sources of energy supply, and for the economic and social cohesion reasons.

I would like to wish you all fruitful exchanges and productive networking.

Thank you.

Opening by Amb. Anatol VANGHELI

Ambassador of the Republic of Moldova to Hellenic Republic

Dear Secretary General of the Black Sea Economic Cooperation Organization, Michael Christides,

Dear Deputy Secretary General of the Permanent International Secretariat of the Black Sea Economic Cooperation Organization, Traian Chebeleu,

Dear Professor Dimitrios Mavrakis,

Dear organizers of the event: Black Sea Economic Cooperation Organization and the United Nations Academic Impact Initiative,

Dear participants,

Excellences Ambassadors, Representatives of state and academic institutions,

Ladies and gentlemen, good morning

Let me start by thanking you for the invitation to participate to such an important event for our time and for offering me the opportunity to bring to your attention the current situation of the use of Green energy in the Republic of Moldova. It is clear for everyone that, promoting the use of green energy has multiple importance. The mainly one, it is environment friendly and contributes to the sustainable development, including reducing the carbon pollution and has a much lower impact on the environment. For Moldova, it is considered an important tool to strengthen the country's energy security, reducing the import of energy from fossil sources. Therefore, the renewable energy and the energy efficiency are between the main objectives of the RM Energy Strategy until 2030. That said, it is to underline that in recent years, RM is making progress in this field. The production of green energy has increased significantly, from 4% in 2010 to 15% nowadays (from the total use), mostly from the processing of biomass.

To this end, the efforts of the RM are focused, both, at legislative and executive levels with main objectives to further develop the use of new and renewable energy resources, in order also to contribute to the environmental sustainability and combating climate change, common objectives with those pursued by the European Energy Community to which RM is part of it.

In this regard, two main strategies have been approved: 1) Energy Strategy until 2030 (y.2013) and 2) The Moldova 2020 National Development Strategy (2012). In order to ensure the legislative and normative framework in this field, the process of elaboration and promotion of normative acts continues. In this respect, the law (no.10 of 26.02.2016) on the promotion of energy from renewable sources have been passed and will be applied starting March 2018. It should be noticed that the mentioned law was worked out in correspondence with the European requirements. It transposes the provisions of European Directive 2009/28 EC, of 23 April 2009 on the promotion of the use of energy from renewable sources. This element changed the state's approach to renewable energy investments, providing investors with the necessary guaranties. The new investment support scheme in this field are market-based instruments that promote competition among the investors - capacity auctions, and also includes a support scheme targeted at small (local) investors. Recently, on September 28, 2017 the National Agency for Energy Regulation approved the Regulation on Guarantees of Origin for Electricity Produced from Renewable Energy Sources and the Methodology for determining tariffs and fixed prices for electricity from renewable energy sources produced by the eligible companies. There have been elaborated also 11 drafts on eco-design requirements applicable to energy-related products and the draft of the Government Decision regarding the certification of low capacity renewable energy resources installations.

Implementing energy efficiency projects and capitalizing on renewable energy sources is a priority for RM. In this respect, the Energy Efficiency Fund approved for financing 19 energy efficiency projects for public sector objectives in 2015. Therefore, in order to ensure the continuity of project financing in the field of energy efficiency and the capitalization of renewable energy sources, Energy Efficiency Fund signed 66 grant contracts. For the development of energy and environment efficiency projects, on 14.05.2015 was ratified the Agreement on Contribution between the Government of the RM and the European Bank for Reconstruction and Development regarding the participation of our country in the Eastern European Energy Efficiency and Environment Efficiency Partnership Fund (E5P). Other important and current projects in the field of energy from new and renewable energy sources, promoting also energy efficiency measures are:

1. Currently there are calls for proposals of projects in the field of public institutions, supported by the Energy Efficiency Fund of the RM and in the public field, prepared by the Energy Efficiency Fund in cooperation with the GEF-UNDP project “ESCo-Moldova” (ESCo- Energy Services Companies);
2. The Energy and Biomass Project in Moldova, Phase II: contributes to increasing the consumption of energy from renewable sources predominantly in public institutions and households in rural communities. It has expanded for the period of 2015-2017, funded by the EU and co-funded by UNDP (9,41 million EUR). The Project will expand its activities in the transnistrian region and small towns.
3. ESCo Moldova - Transforming the Market for Urban Energy Efficiency through the Introduction of Energy Services Companies: aims to create a functional, sustainable and efficient ESCo market by converting engineering companies into energy service companies, in order also to reduce CO_2 emissions (for the period of 2015-2018, with a budget of 1,19 million EUR supported by the EU);
4. Sustainable urban demonstration projects. These initiatives are implemented by local NGOs and municipalities and for the period of 2014-2018 are financed with a budget of 2 million EUR. This project offers a 50-60% grant from the EU and with the other part contributes the municipalities.
5. Financing for Energy Efficiency Line and Moldova’s Residential Energy Efficiency Finance Facility. First consists in providing credits with the grant component for increasing energy efficiency and capitalizing renewable sources in the industrial sector, for the period of 2009-2017 with an about 46,7 million EUR budget. The second, is in residential sector, for the period of 2012-2017, with a budget of 40,2 million EUR. Both are supported by the European Bank for Reconstruction and Development (EBRD).
6. Potential projects that will be supported by the National Regional Development Fund. It aimed to mobilize from the state budget around 1 billion MDL for infrastructure projects in the 2017-2020 years.
7. E5P Projects in Moldova - The Eastern European Partnership for Energy Efficiency and Environment Fund (E5P) provided financial resources to the RM in the form of a grant (30 million EUR), which in turn, make it possible to attract another 120 million EUR, financial support in the form of preferential credits for the implementation of public building rehabilitation projects, in the field of public transport, street lighting, centralized heat supply, etc.

Ladies and Gentlemen,

One of the main source to develop this sector are foreign donors and investors. It is worth to mention the project Energy and Biomass which is financed by EU and implemented by UNDP with a total sum of 21 mln euro. Another program which is supported by BERD started in 2009 with a sum of 42 mln euros for a large number of projects in my country. I would like to use this opportunity to express our deep appreciation to all our partners and investors and to underline that their support for future projects is vital to the development of the green energy in Moldova.

As one of the priorities of the BSEC Organization is to support the efforts of the 12 Member States for ensuring sustainable energy, we believe that BSEC member states could encourage as well mobilize funding by facilitating regional cooperation initiatives in this sector, including through the granting of preferential credits/ loans/ financial guarantees. Therefore, I use this opportunity to invite those interested to invest in this filed in RM which importance is raising continuously.

Finally, I would like to thank you for your attention and I hope that today Forum will provide a platform to exchange views, positive experience and best practices of BSEC member states and will offer new incentives to the development and use of Green Energy in our countries.

Opening by Mr. Miltiadis MAKRYGIANNIS

Deputy Secretary General, Parliamentary Assembly of the BSEC-PABSEC

Ladies and Gentlemen,

Distinguished participants,

Firstly, I would like to congratulate the Energy Policy and Development Center for its initiative to organize the 2nd "Green Investment Forum", in the context of the 10th International Scientific Conference on "Energy and Climate Change".

Allow me also to express our gratitude to Professor Mavrakis for his efforts to maintain active and strong the cooperation between the Parliamentary Assembly of the Black Sea Economic Cooperation and the KEPA.

The Black Sea region is one of the main suppliers of energy to the world markets. Therefore, energy plays an important role in the economic development of this region. The development of infrastructure aimed at increasing oil and gas transportation and transit routes confirms the strategic importance of the Black Sea region in the field of energy and also as a link connecting Europe and Asia. The Black Sea region is an integral part of the global energy market and is of strategic importance in the future development of energy relations.

Natural, climatic and geographic conditions in the BSEC region, as well as the existing potential of fuel and energy resources of the countries in the region, including the available resources of fossil fuels and renewable energy sources, outline the priorities in the development and utilisation of various types of new and renewable energy sources.

The Parliamentary Assembly of BSEC has always been placing emphasis to the issue of energy efficiency, green energy, environmental protection and green investments. PABSEC has debated many times on energy issues and environmental challenges and has adopted several Reports and Recommendations. The latest was just a few months ago titled "Development of New and Renewable Sources of Energy in the BSEC Member States". These documents outline the basic strategy of our Parliamentary Assembly on this issue.

Over recent years, the parliamentarians of the BSEC member states actively pursue the development of new energy policy that aims to ensure the energy security, the welfare and security of all citizens and the effective functioning and development of the economy, continued energy access at affordable prices with due account to the environmental challenges, and address the issues of sustainable development.

The countries of the Black Sea region are introducing new technologies and largely investing in the development of the alternative energy market. The challenges faced by the Black Sea region drive it towards the single comprehensive approach to the formation of regulatory and legislative support to the energy policy. Furthermore, the development of alternative energy in the region contributes positively to regional economies and local energy security.

The role of the parliaments is especially important in order to forge the laws, guidelines, frameworks and incentives that will allow efficient implementation of national and international engagement on the challenge of green development and global climate change.

Parliaments' role is also important in order to improve legislation regulating the internal energy markets with a view to providing and creating a fully effective, competitive and stable common energy market in the region and to adopt necessary regulations or laws aiming at the measures on ensuring security of energy supply and consumption in the BSEC member states.

In the Recommendations adopted by the Parliamentary Assembly of the Black Sea Economic Cooperation it is underlined the need to enhance national policies and strategies to increase the use of new and renewable sources of energy and carbon reduction technologies, including cleaner fossil fuel technologies and attribute special attention to the sustainable use of traditional energy sources and the expansion of alternative national capacities to meet growing energy needs. Parliaments and Governments of the BSEC member states are recommended to continue the formation of legal, financial and regulatory frameworks to strengthen investor confidence, as well to share regulatory skills and best practices in the field of new and renewable sources of energy, to accelerate the process of improving the legislative framework in the context of the formation of a favourable investment climate for the development of renewable energy sources and to encourage scientific research and development along with investments by private sector in priority renewable energy projects.

Cooperation at the trans-national, regional and local levels is of significant essence for efficient and effective address to the issue of green development. BSEC states along with the international organisations and civil society are challenged to engage in a constructive dialogue which produces tangible results. Black Sea countries are endowed with an invaluable natural heritage, but fragile enough to be threatened by numerous environmental challenges. In order to overcome inefficiency and fragmentation there is a need for “greening” the Black Sea through environmental governance. This strategic policy implies the incorporation of the horizontal environmental perspective into all sectoral policies, with a view to achieving legal compliance, efficiency, legitimacy, and networking.

Once again, on behalf of the International Secretariat of the Parliamentary Assembly of the Black Sea Economic Cooperation, I thank you for the invitation and I wish success to your works.

Opening by Prof. Dimitrios MAVRAKIS

Director of KEPA, National and Kapodistrian University of Athens, Hellas

Thank you, your Excellency,

As I have mentioned at the opening, the current 2nd Green Energy Investment Forum has emerged as a consequence of our efforts to increase the momentum among the BSEC –Member States on the issues of Climate Change and Sustainable Development and contribute to the acceleration of the green transformation of their economies.

We have started with the promotion, in cooperation with the Permanent International Secretariat of BSEC, of the organization of Green Energy Investment Fora, in the BSEC – Member States during their bi-annual rotating chairmanships in office of the Organization.

We expect that this will provide a space where policy makers, regional market stakeholders and investors will have the opportunity to be informed about national green investment policies and for the emerging funding opportunities released by the various international sources.

We target to bring together policy makers, market forces, scientists, multilateral, regional and commercial banks that are motivated by the principles of green investing and sustainable development for the broad region of the Black Sea.

Having an over ten year's negative experience, I have to accept that this is not an easy task since we have to overcome strong and well established barriers, especially those related with the negative behavioral patterns demonstrated by both policy makers, local bankers and ordinary people that are ignorant of the existing opportunities and mainly the magnitude of the threat for their wellbeing.

How to convince people to develop and implement policies that they do not understand?

How to expect ordinary people to change their well established behavioral patterns if the necessary knowledge cannot reach them?

Policy makers and decision makers tend to behave as if they have plenty of time before they will take and implement green and efficient policies, not to mention that some of them even refuse the reality with irrational arguments.

But the reality is that the greenhouse gasses we emit will stay in the atmosphere for decades, centuries or even millennia and that is why it is so important to cap emissions as soon as possible.

Ironically, the gas that accounts for the greatest proportion of global warming, carbon dioxide (CO_2) is the hardest to pin down. According to the Intergovernmental Panel on Climate Change (IPCC) about 50% of a CO_2 increase will be removed from the atmosphere within 30 years and a further 30% will be removed with a few centuries

With the CO_2 concentration having increased to 407.25ppm in July 2017, from the 404.50ppm of July 2016, the comparison with the level of the 280ppm that was during the past 10.000 years up to mid-18th century shows the occurring change due to human activities, particularly due to the burning of fossil fuels and deforestation. These changes are better understood if we take into account that one part per million by volume CO_2 in the atmosphere contains approximately 2.13 Gt of Carbon.

The emerging negative implications of these GHG emissions on the climate has driven the world leaders during the 20th Conference of the Parties, the COP 20, of UNFCCC in Lima in 2014 to conclude with the clear statement on the need to keep the increase of the atmospheric temperature below the 2°C, even 1.5°C, comparing to the pre-industrial era.

Following this statement, COP21 in December 2015 has concluded with the Paris Agreement that was set in force one year later in November 2016. It is based on the originally submitted by the participating parties Intended Nationally Determined Contributions (INDCs) for reductions in greenhouse gas emissions that were transformed to National Determined Contributions (NDC) by the 168 members that have ratified the agreement.

Finally, as of October 2017, 195 states and the European Union have signed the Agreement with the exception of Syria and the United States of America that intents on leaving. Nicaragua that did not initially sign the Agreement due to objections that the conditions imposed on developed countries were not sufficient, in September 2017 announced that it would reverse course and sign the agreement.

However, these NDCs are not binding as a matter of international law and furthermore, there is no mechanism to force a country to set a target by a specific date and no enforcement if a set target is not met.

In addition, most of the signatories from developing and underdeveloped economies define as a prerequisite to comply with their contributions their support with external technical and financing assistance.

Although the agreement was lauded by many policy makers and the media, the United Nations Environment Programme, in the Emissions Gap Report 2016, states that "the emissions gap for 2030 is 12 to 14 $GtCO_{2e}$ compared with 2°C scenarios, while for 1.5°C the gap is three $GtCO_{2e}$ larger. Even if fully implemented, the unconditional Intended Nationally Determined Contributions are only consistent with staying below an increase in temperature of 3.2°C by 2100 and 3.0°C if conditional Intended Nationally Determined Contributions are included".

With no doubt, this is an optimistic approach taking into account that undertaken "contributions" are not mandatory for the signatories nor they are fully supported by the necessary funding mechanisms.

Consequently the opening statement of UNEP in the aforementioned report that "the strengthened long-term objectives of the Paris Agreement require even stronger actions that previously identified, calling for accelerated efforts pre-2020, as well increasing the ambition of the Nationally Determined Contributions" should be translated as an urgent invitation for accelerated action towards the implementation and improvement of the initially declared intentions of the signatory countries.

Responding to this reality, the 2nd Green Energy Investment Forum attempts to further facilitate the economies of the BSEC – MS in their efforts to take the advantages of existing international mechanisms for knowledge transfer and green investment attraction.

The Permanent International Secretariat of BSEC in cooperation with the Black Sea Trade and Development Bank and the "BSEC – Green Energy Network" can be the facilitators for the BSEC – MS in their efforts to increase their access to international financial mechanisms, especially those that are under the UNFCCC.

As we are all aware, there are two main operating entities of the Financial Mechanism, the Global Environment Facility (GEF) and the Green Climate Fund (GCF) and three specialized funds the GEF, which also hosts the Least Developed Countries Fund and the Special Climate Change Fund.

Parties also created the Adaptation Fund (AF) under the Kyoto Protocol, which channels the financing for adaptation to developing countries.

Among them the Green Climate Fund seems to be the most promising mechanism for mitigation and adaptation programmes for the BSEC – MS, with developing economies, due to the established network of National Designated Authorities in each beneficiary country and the capacity to finance the establishment of these authorities and provide the necessary financing assistant for their preliminary studies, through the USD 15 million "Readiness and preparatory support programme"

The clearly defined accreditation procedures for the entities interested to be involved in the relevant programmes and the necessity the beneficiary countries to secure the ownership of their programmes makes the whole process quite attractive for them while the fiduciary standards of the fund define an attractive basis for leveraging initial amounts approved by GCF.

The Fund finances low-emission (mitigation) and climate resilient (adaptation) projects and programmes developed by the public and private sectors to contribute to the sustainable development goals of the beneficiary countries.

Projects or programmes should aim either to reduce emissions from transport, energy generation and access, forest and land use and buildings, cities, industries and appliances or increase the resilience of health, food and water security, livelihoods of people and communities, ecosystems and ecosystem services, infrastructure and built environment.

GCF classifies projects and programmes according to their size in four categories: 1) Micro (XS) USD 0-10 million, 2) Small (S) USD 10-50 million, 3) Medium (M) USD 50-250 million, 4) Large (L) >250 million, while is the largest dedicated climate fund globally with a budget overcoming the USD 10 billion and with the perspective to reach the USD 100billion a year 2020.

In this concept, seven out of the twelve member states of the BSEC are eligible to GCF financing for all the set objectives.

Having spent some time analyzing their national mitigation and adaptation forward looking policies in combination with their submitted INDCs it becomes that the most preferable and beneficiary sector to start their cooperation with the GCF is the improvement of their energy efficiency in the various sectors of their economy. Such a target can be more attractive if combined with their policies to combat the energy poverty that concerns considerable parts of their population.

With fossil fuels playing a dominant role in energy consumption in the BSEC - MS in the foreseen future the improvement of energy efficiency, especially in the sector of buildings can contribute not only to mitigate GHG emissions but also to the Sustainable Economic Development of these economies and the improvement of the livelihood of less developed parts of their societies.

Further to that and without ignoring the existing behavioral barriers demonstrated by both the policy makers and the end-users we consider, as network, that programmes that aim to retrofit and transform buildings to Nearly Zero Energy Buildings with the addition of the smartness dimension will not only contribute achieving the GCF targets but through the necessary knowledge and technology transfer the accomplishment of such aim will contribute to the sustainable development of the region, as a whole.

As network, we have started preliminary contacts between our partners and their policy making authorities in four of the aforementioned beneficiaries BSEC – MS. Although we have to accept that we have not received the expected reaction we remain optimist that we will finally succeed to mobilize them.

We remain optimist that we will convince BSTDB to be accredited to GCF and the NDAs in the BSEC – MS to become more cooperative. We hope that multilateral Banks such as the EBRD and the EIB will increase their level of cooperation with GCF for programmes in the BSEC – MS. EIB and GCF have signed recently (28 Spt. 2017) an Accreditation Master Agreement allowing them to work together to finance climate action in developing countries.

We will be happy to cooperate and facilitate them in implementing relevant programmes in the BSEC region taking into account that our networks include not only experts from our region but also from the whole European Union.

Your Excellencies,

Distinguished Ladies and Gentlemen,

My aim was to attract your attention to the issue that Climate Change and Sustainable Development are the key challenges of the 21st Century and despite the increasing efforts to combat them we are delaying to take and implement the appropriate policies and measures.

We face the triple challenge, which is to make and implement effective mitigation and adaptation policies and at the same time to secure equitable and resource efficient economic development for our societies.

This is a global challenge for rich and poor, developed and developing countries, educated and uneducated people. We have to remember that it will be a non-reversible situation, once as humanity we will lose the control over it.

It is in our hand to change attitude and become more effective in this combat.

Thank you

Session 2: Green Energy Investments

Green Economy Financing

by

Mr. Libor KRKOSKA,

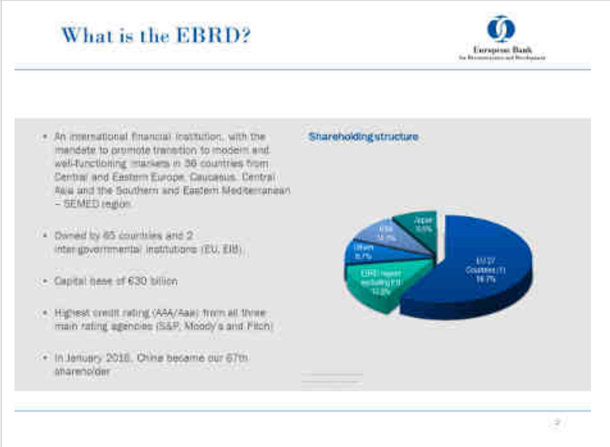
Head of Office,

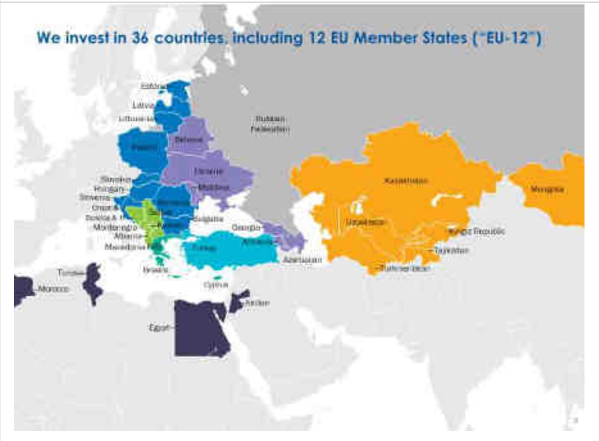
European Bank for Reconstruction and Development (EBRD),
Cyprus

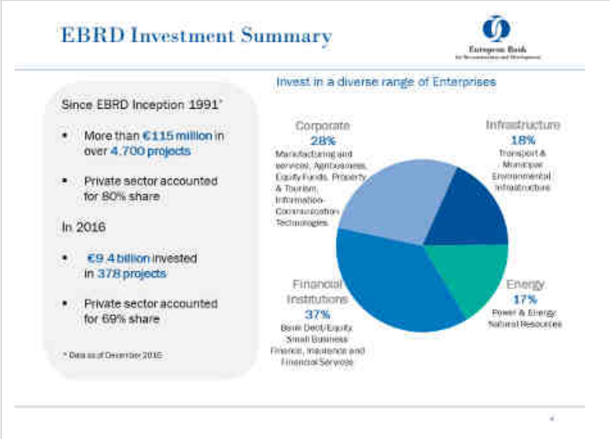
Abstract

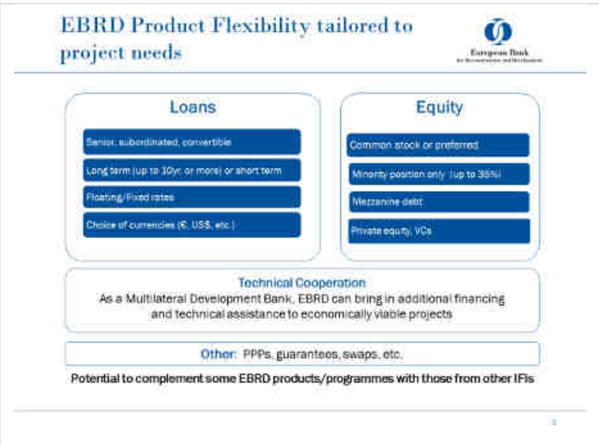
Green economy financing is one of the core activities of the European Bank for Reconstruction and Development (EBRD), a multilateral financial institution owned by 65 countries and 2 intergovernmental institutions with the mandate to promote transition to modern and well-functioning markets in 36 countries from Central and Eastern Europe, Caucasus, Central Asia and the South Eastern Mediterranean region. EBRD has established Energy Efficiency Banking team more than 20 years ago, in 1994, and increased the share of green economy financing to more than a third of the total annual investments of over Euro 9 billion in recent years. The scope of green economy transition projects has expanded over the years to include not only energy efficiency and renewable energy but also sustainable use of water and other resources as well as environmental protection. To date, more than 1,300 projects benefited from EBRD green economy financing worth more than Euro 23 billion and helping to reduce CO_2 emissions by 85 million tonnes per year. EBRD's green financing business model covers project financing, policy dialogue and technical assistance, helping to blend concessional finance, strengthen the institutional and regulatory frameworks and help develop sustainable energy lending in all the countries of operations.

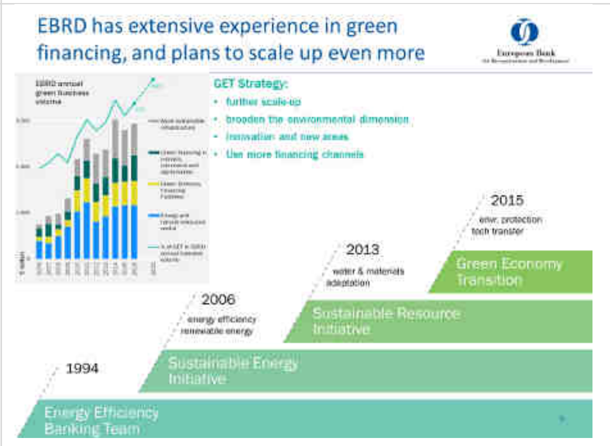

Green Economy Financing
Libor Krkoska, EBRD, October 2017
European Bank

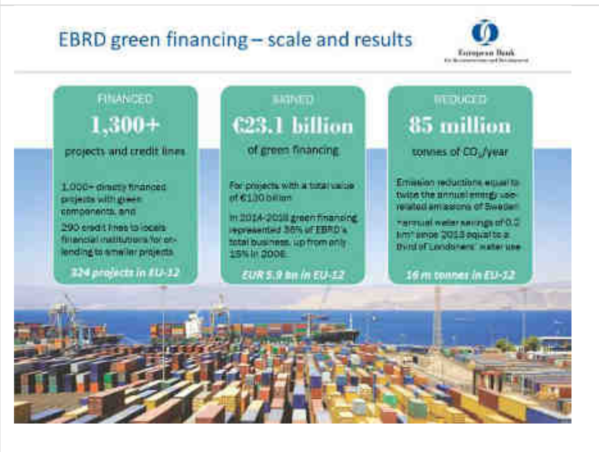

What is the EBRD?
An international financial institution, with the mandate to promote transition to modern and well-functioning markets in 36 countries from Central and Eastern Europe, Caucasus, Central Asia and the Southern and Eastern Mediterranean – SEMED region
Owned by 65 countries and 2 inter-governmental institutions (EU, EIB)
Capital base of €30 billion
Highest credit rating (AAA/Aaa) from all three main rating agencies (S&P, Moody's and Fitch)
In January 2016, China became our 67th shareholder
Shareholding structure

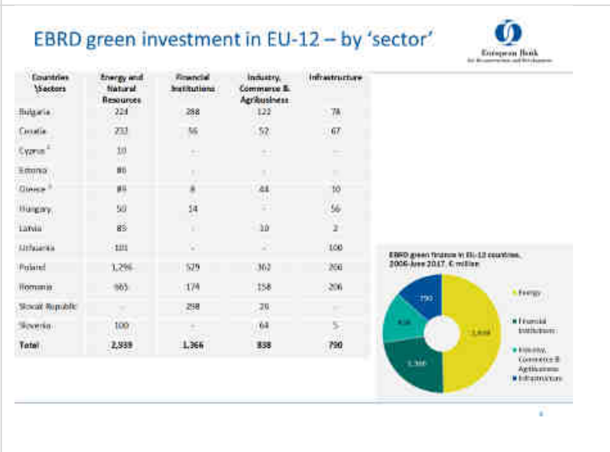

We invest in 36 countries, including 12 EU Member States ("EU-12")

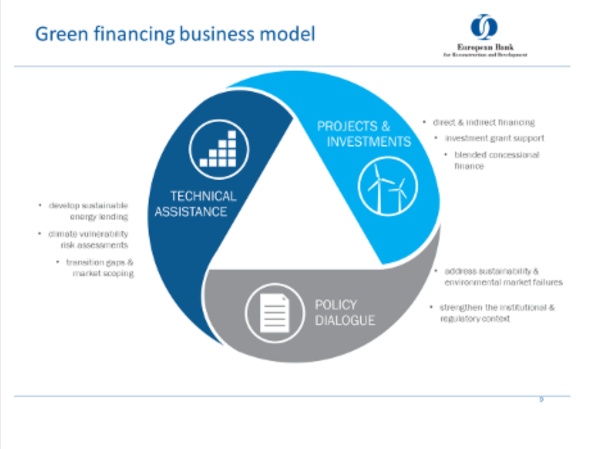

EBRD Investment Summary
Invest in a diverse range of Enterprises
Since EBRD Inception 1991*
More than €115 million in over 4,700 projects
Private sector accounted for 80% share
In 2016
€9.4 billion invested in 378 projects
Private sector accounted for 69% share
* Data as of December 2016
Corporate 28%
Infrastructure 18%
Financial Institutions 37%
Energy 17%

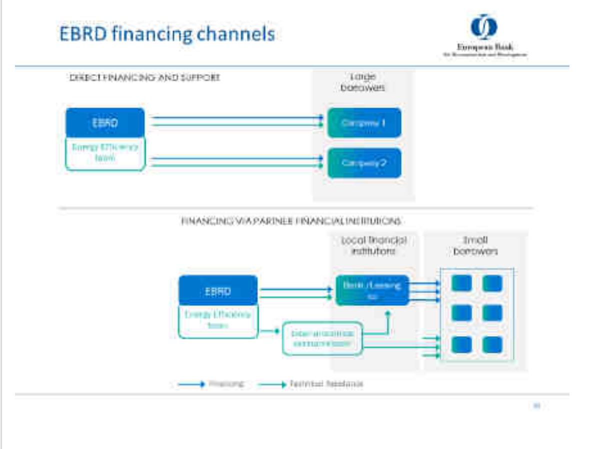

EBRD Product Flexibility tailored to project needs
Loans
Senior, subordinated, convertible
Long term (up to 10yr or more) or short term
Floating/Fixed rates
Choice of currencies (€, US$, etc.)
Equity
Common stock or preferred
Minority position only (up to 35%)
Mezzanine debt
Private equity, VCs
Technical Cooperation
As a Multilateral Development Bank, EBRD can bring in additional financing and technical assistance to economically viable projects
Other: PPPs, guarantees, swaps, etc.
Potential to complement some EBRD products/programmes with those from other IFIs


EBRD has extensive experience in green financing, and plans to scale up even more
GET Strategy:
further scale-up
broaden the environmental dimension
innovation and new areas
Use more financing channels
2015
2013
2006
1994
Green Economy Transition
Sustainable Resource Initiative
Sustainable Energy Initiative
Energy Efficiency Banking Team


EBRD green financing – scale and results
FINANCED
1,300+
projects and credit lines
SIGNED
€23.1 billion
of green financing
REDUCED
85 million
tonnes of CO2/year
324 projects in EU-12
EUR 5.9 bn in EU-12
16 m tonnes in EU-12

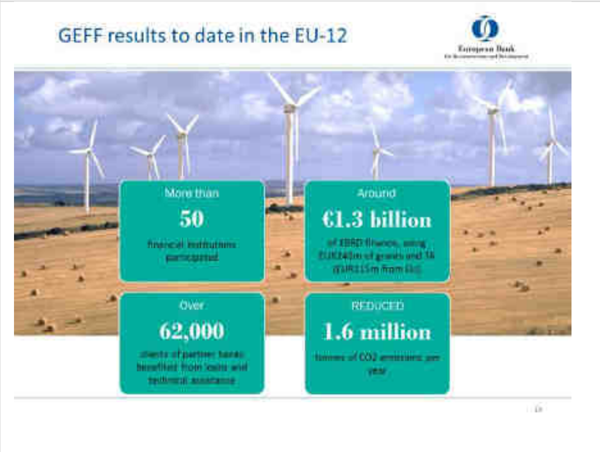

EBRD green investment in EU-12 – by 'sector'
Countries \Sectors | Energy and Natural Resources | Financial Institutions | Industry, Commerce & Agribusiness | Infrastructure
Bulgaria | 224 | 288 | 122 | 78
Croatia | 232 | 56 | 52 | 67
Cyprus | 10 | - | - | -
Estonia | 86 | - | - | -
Greece | 89 | 8 | 44 | 10
Hungary | 50 | 14 | - | 56
Latvia | 85 | - | 10 | 2
Lithuania | 101 | - | - | 100
Poland | 1,296 | 529 | 362 | 206
Romania | 965 | 174 | 158 | 206
Slovak Republic | - | 298 | 20 | -
Slovenia | 100 | - | 64 | 5
Total | 2,939 | 1,366 | 838 | 790

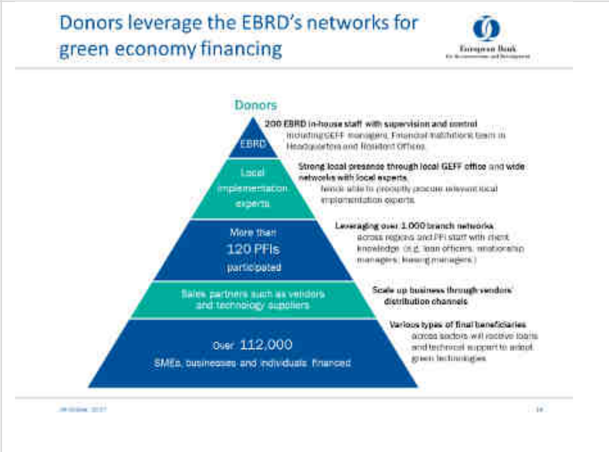

Green financing business model
PROJECTS & INVESTMENTS
TECHNICAL ASSISTANCE
POLICY DIALOGUE
direct & indirect financing
investment grant support
blended concessional finance
develop sustainable energy lending
climate vulnerability risk assessments
transition gaps & market scoping
address sustainability & environmental market failures
strengthen the institutional & regulatory context


EBRD financing channels
DIRECT FINANCING AND SUPPORT
Large borrowers
EBRD
Company 1
Company 2
FINANCING VIA PARTNER FINANCIAL INSTITUTIONS
Local financial institutions
Small borrowers
EBRD

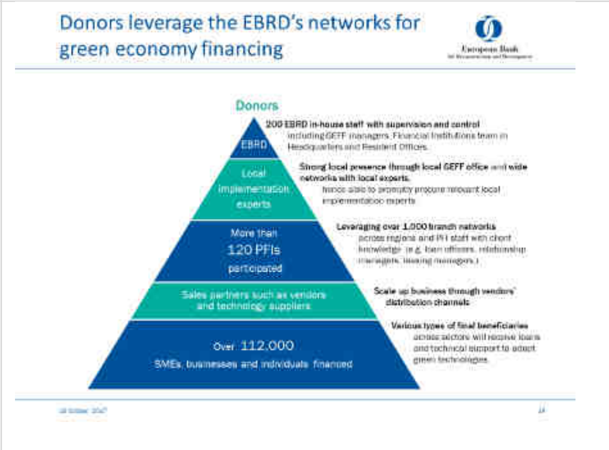

Green Economy Financing Facility (GEFF)
GEFF
European Bank for Reconstruction and Development
GEFFs are a good example of products that blend both public and private finance.
Through GEFFs the EBRD extends credit lines to local financial institutions seeking to develop sustainable energy and resource financing as a permanent area of business.
Local financial institutions on-lend funds to small and medium-sized businesses, corporate and residential borrowers.
Finance is provided for energy efficiency and small-scale renewable energy, water and waste efficiency projects.
GEFFs establish project implementation teams who support local financial institutions and their clients.
GEFFs are effective in reaching a wide range of small and medium-sized business and residential clients.
EBRD
Borrowers


GEFF Investment areas
Industrial and commercial sector:
Residential sector:
Municipal sector:


GEFF results to date in the EU-12
More than
50
financial institutions participated
Around
€1.3 billion
Over
62,000
REDUCED
1.6 million
tonnes of CO2 emissions per year


Donors leverage the EBRD's networks for green economy financing
Donors
EBRD
Local implementation experts
More than
120 PFIs
participated
Sales partners such as vendors and technology suppliers
Over 112,000
SMEs, businesses and individuals financed


Example: GEFFs in Romania: Sustainable energy in the commercial and industrial sectors
PROGRAMME
STRUCTURE OF FACILITIES
RESULTS AND IMPACT
PROJECT EXAMPLE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EBRD
Local implementation experts
More than
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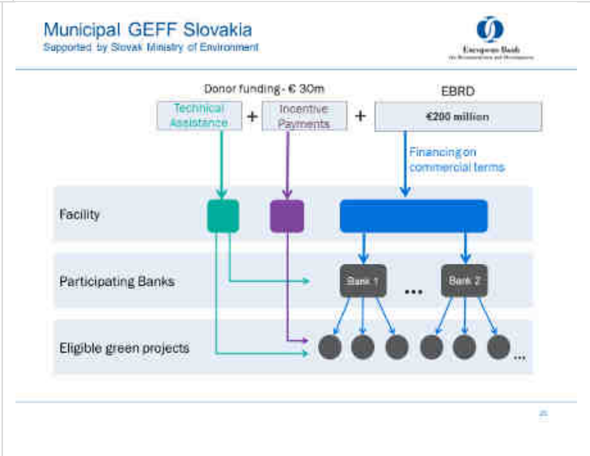
participated
Sales partners such as vendors and technology suppliers
Over 112,000
SMEs, businesses and individuals financed


Green Buildings
Healthcare
Hotels & Lodging
Residential buildings
Office & Commercial buildings
Public buildings
Retail & Logistics
€15 billion of GET enabled green buildings investments, with EBRD's contribution of € 2 billion.
More than 25 million m² of floor area of green buildings was financed by EBRD.
71,000 GWh of energy savings are expected from EBRD's Green Buildings Investments over life-time (15-25 years) with emission savings of 335 million tonnes of CO₂e.
Dedicated credit lines (Financing Facilities) through local financial intermediaries (any buildings)
Larger scale PPP framework programs (greenfield and brownfield public buildings)
Sustainable property funds (commercial and private residential buildings)
Sustainable retail (commercial buildings)
Structured financing: EPC/ ESCOs/ Forfaiting (residential, public buildings)
Labelled green property bonds (commercial/public buildings)


Hines Poland Sustainable Income Fund
THE CLIENT
Hines is a privately owned global real estate investment firm with locations in 185 cities in 19 countries. Hines has a commitment to sustainability.
THE PROJECT
EBRD helped develop and invested in this Fund – it is the 1st Green Property Fund in the EBRD region.
Investing in commercial property in Poland, the Fund will create value through active asset management, including systematic introduction of sustainability measures and sustainability certification.
FINANCIAL STRUCTURE
EBRD equity investment EUR 50 million
Fund Value at final closing EUR 155 million
TECHNICAL ASSISTANCE
Support in setting up green lease policies
Identifying cost-effective sustainability measures within the Sustainability Management Plan for selected assets
INTEGRATING SUSTAINABILITY MEASURES IN MANAGED ASSETS
building infrastructure upgrades and improvements
professional facility management with strong focus on energy/water saving and waste reduction
Tenant engagement through green lease policies and dedicated Building Management Committees
Sustainability policies embedded in Fund mgmt. with qualitative and quantitative targets
LEED/ BREEAM certification
Sustainability performance will be linked to the Management Company's remuneration.

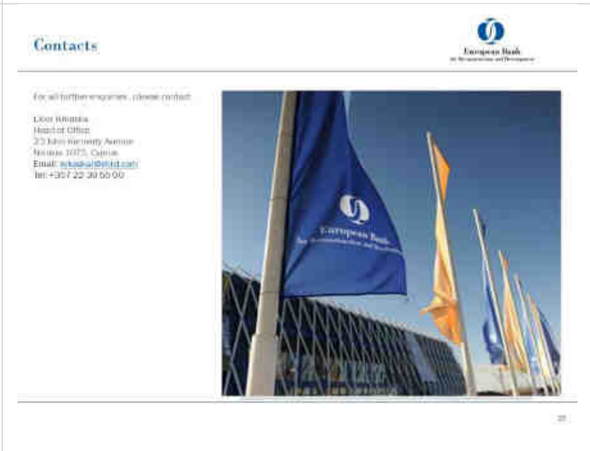

Supporting ESCOs in Latvia using innovative forfaiting mechanism
THE PROBLEM
ESCOs are typically paid back through energy bills over a number of years
This can however leave them short of cash with which to do more projects
Typical bank debt helps only partially as it is short-term, borrowing capacity is reached quickly
THE INNOVATION
A fund specifically set up to purchase the receivables
Receivables are from projects where the ESCO has begun to receive its payments from end-client
Through the sale the ESCO has the cash needed to invest in further projects
The ESCO is provided a fee to cover its maintenance and guarantee obligations under its contract with the end-client
THE EBRD'S ROLE
Helped develop the financing structure
Intend to provide debt financing to the fund purchasing the receivables
FI
EBRD
ESCO
LABEEF
Apartment Building Management Company
Agent Bank (Citadele Bank)


Municipal GEFF Slovakia
Supported by Slovak Ministry of Environment
Donor funding - € 30m
EBRD
Technical Assistance
Incentive Payments
€200 million
Financing on commercial terms
Facility
Participating Banks
Bank 1
Bank 2
Eligible green projects


EBRD in Cyprus –Renewable Energy Projects
EUR 6.25 million in non-recourse debt financing to CYPV Energy Ltd, LGEG Photovoltaic Ltd and LGEG Solar Power Ltd for the construction, development and operation of three solar photovoltaic parks of total capacity 7.4MWp located in the areas of Frenaros, Nisou and Dhali.
EUR 4.1 million in non-recourse debt financing to TPM Abitenergy Ltd and Conbetter Ltd for the construction, development and operation of two solar photovoltaic parks of total capacity 4.5MWp located in the areas of Paliometocho and Malounta.
EBRD supports renewable energy projects tapping the island's huge potential in the sector and contributing towards Cyprus' 2020 target for power generation from sustainable sources.
Benchmark transactions for non-recourse financing in the Renewable Energy sector.


EBRD in Greece –Renewable Energy Projects
Terna Energy
Signed in November 2016
TERNA ENERGY
GEK TERNA GROUP
Client Description
Terna Energy, owned by GEK Terna Group, is one of the largest and most respected renewable energy companies active in Greece. It directly owns and operates 110 MW of renewable energy projects while another 557 MW are indirectly owned through SPVs located in Greece, Bulgaria, Poland and the USA
Project Size
Senior secured €60 million Greek bond loan
EBRD Finance
€50 million senior secured loan alongside a €10 million parallel loan to be provided by a Greek commercial bank
Use of Proceeds
The proceeds to finance the development, construction and operation of renewable energy power plants in Greece, which will support Greece in achieving the target to reach 40% of electricity consumption from renewable sources by 2020


The EBRD on the ground in Greece
EBRD established its local presence in Athens in September 2015 and opened its office in March 2016
The regional office in Athens includes a multidisciplinary team of local and international bankers
Support from sector and product teams in EBRD headquarters in London
EBRD Regional Office in Athens


Contacts

BSTDB Activities for green energy investments

by

Mr. Mircea COJOCARU,

Head of Environmental and Social Sustainability Office, Black Sea Trade and Development Bank (BSTDB)

Abstract

BSTDB acknowledges that climate change affects directly the natural environment, human health and wellbeing, businesses and national economies. Thus, it affects development and the ability of national economies to sustain growth and alleviate poverty. The Members States of BSTDB are vulnerable to climate change, and the Bank's effort to decrease their vulnerability to date has been mainly through financing operations that reduce emissions, apply energy efficiency, cleaner production, and use of renewable energy sources. Over the years the Bank support in this respect amounted at over 300 mln EUR. While such operations had unquestionably a positive impact and was in line with mandate fulfillment, the Bank believes it can achieve much more in addressing climate change at both strategic and operational level.

In this respect BSTDB recognizes that it needs to systematically incorporate climate issues into its financing decisions, it needs to mobilize more capital to help shift national economies to low carbon model, and it needs to build capacities to help its Member States build climate resilience and adaptation. At present, the Bank is developing its first Climate Change Strategy that would allow BSTDB to provide more targeted support to the private and public sectors in combating climate change, building resilience and adaptation, and decreasing their vulnerability to the effects of changing climate.

BSTDB is an international financial institution established by the Governments of Albania, Armenia, Azerbaijan, Bulgaria, Georgia, Greece, Moldova, Romania, Russia, Turkey, and Ukraine. We started operating in June 1999 and we have an authorized capital of €3.45 billion. Our main goal is supporting economic development and regional cooperation in the Black Sea Region through trade and project finance in public and private enterprises in our Member Countries.

The current knowledge of the global climate suggests that the change in the atmospheric composition due to increasing anthropogenic greenhouse gas emissions is the fundamental cause of climate change. This is a global phenomenon characterized by more apparent shifts in temperature, rising sea level, and more extreme weather events. Climate change affects directly the natural environment, human health and wellbeing, businesses and national economies. Climate change also accelerates deterioration of man-made capital including buildings, infrastructure, and machinery and increases costs while reducing benefits from using this capital. Thus, climate change becomes a developmental issue as it affects the ability of national economies to sustain growth and alleviate poverty.

The Development Financial Institutions can play an important role in addressing this issue. Many Banks systematically incorporate climate issues into their financing decisions, and mobilize capital to help shift national economies to low carbon models. The Banks can also bring important capacity building to help countries build climate resilience and adaptation, and to decrease vulnerability to climate change. The general approach in addressing this issue is through improving institutional policies, updating due diligence practices, using new tools in identifying and assessing more accurately the climate impacts on the financial performance of investments. But also by supporting the clients in building capacity to formulate adaptation strategies that would increase their resilience and adaptation to the changing and more variable climate. At the same time by decreasing their vulnerability to effects of climate change.

We, at BSTDB, recognize that this is a serious global challenge and our Member States are vulnerable due to various reasons, including due historic underinvestment and aging infrastructure that is less able to withstand climate change. We have committed at the policy level to contribute to addressing this issue. Thus, we support operations that reduce emissions, apply energy efficiency, cleaner production, and use renewable energy sources. Over the years the Bank had supported operations with strong emission reduction component and renewables, which at present amount at more than 300 mln EUR. Perhaps a modest figure. While such operations had a positive impact and were fully in line with our mandate, we believe we can achieve much more in addressing climate change at both strategic and operational level.

In this respect we recognize that we need to systematically incorporate climate into our financing decisions. We need to mobilize more capital to help our Member States shift their economies to low carbon models. and

We need to build capacities. At present, the Bank is developing its first Climate Change Strategy with the goal to provide more targeted support to the public and private sectors to:

- combat climate change
- build resilience and adaptation,
- and decreasing their vulnerability to the effects of the changing climate.

We, at BSTDB very much welcomed the Paris Agreement on Climate Change adopted at COP21, and as response to the call for the non-party stakeholders, such as financial institutions, to support climate actions have applied to the Secretariat of the United Nations Framework Convention on Climate Change to be granted the Observer Status to COP. We were happy to receive the positive resolution of the Secretariat, and the delegation of the Bank which will be headed by President Delikanli will for the first time attend the upcoming COP23 in Bonn. This shows commitment, and we will take more actions to further address the issue of Climate Change, and will join forces with other institutions, financial and non-financial, to bring our contribution to the global efforts of combating this phenomenon.

How technology is innovating the oil and gas sector

by

Dr. Spyros KIARTZIS

Manager New Technologies & Alternative Energy Sources

Hellenic Petroleum, Hellas

Abstract

Oil and Gas markets have changed radically over the past 5 years since demand is complicated and supply is challenged. Energy markets are evolving while policy and regulations are dominating and geopolitical frameworks are rethought. The challenge to move away from fossil fuels is not so easy neither that quick. The alternative of electric vehicles is likely attractive for some light duty applications but long haul will need low carbon fuels. Advanced biofuels can be the answer although technology barriers postpone biofuel evolution and biomass sources are under question. Biorefinery is oil industry's next step. Hellenic Petroleum is investing in Renewable Energy Sources and expands in biofuels. Hellenic Petroleum is developing renewable electricity to diversify Group's energy portfolio also offsetting part of CO_2 emissions due to refining and power generation. The Group is also supporting new technologies in energy and transport through R&D projects with various academic institutions and pilot applications of alternative technologies. Our vision is clean energy and sustainable transport in order to evolve to an innovative, reliable and competitive energy supplier in the future.

HELLENIC PETROLEUM

How Technology is Innovating the Oil and Gas Sector

Dr. Spyros Kiartzis
Manager New Technologies & Alternative Energy Sources

10th International Scientific Conference on "Energy and Climate Change",
Athens, 11 October 2017

Contents

• Current transport challenges
• The future of transport
• Hellenic Petroleum overview
• Investing in new technologies in energy and transport

1

Oil and Gas markets have changed radically over the past 4 years

- **Demand is complicated**
  - Request for new fuels and energy products
  - Product demand is more important than crude demand
  - Price elasticity increase as subsidies are removed
- **Supply is challenged**
  - The shale oil and gas new reality
  - Investment financing limitations – capital shortage
  - Supply driven investments are slow to respond
- **Energy markets are evolving**
  - Consumer - oriented world
  - Hedging energy markets – a new price setting mechanism
- **Policy and regulations are dominating**
  - Low carbon footprint policies and climate debate
  - Environmental regulations imbalance the market
  - Create unequal cost burdens
- **Geopolitical frameworks are rethought**
  - Pipelines chess game
  - Economies in stress forced to structural reforms
  - The "energy-water-food" nexus

Policy limitations step up actions

- **COP21 meeting: The Paris Agreement (Dec. 2015)**
  - Transformation will need to be implemented in all economies to reduce energy demand and the use of fossil fuels.
  - In EU, the drive for efficiency will reduce the general demand trajectory for oil.

- **The EU Action Plan for the Circular Economy (Dec. 2015)**
  - Transition to a more circular economy, is an essential contribution to the EU's efforts to develop a sustainable, low carbon and competitive economy.
  - The bioeconomy hence provides alternatives to fossil-based products and energy.

- **European Strategy for Low-Emission Mobility (July 2016)**
  - Low-emission mobility is an essential component of the broader shift to the low-carbon, circular economy needed for Europe to stay competitive and be able to cater to the mobility needs of people and goods.
  - The Commission already indicated that food-based biofuels have a limited role in decarbonizing the transport sector and should not receive public support after 2020. Food-based biofuels will gradually phase out and be replaced by more advanced biofuels.

Moving away from fossil fuels?

Not so easy, not that quick!

- ✓ Low-cost renewables are required
- ✓ Volatility in CO_2 markets
- ✓ Infrastructure bottleneck (the chicken – egg dilemma)
- ✓ Not enough money for investments
- ✓ Technology issues to be resolved

New challenges for energy players

- ✓ Balancing the fuel mix
- ✓ Reliability of fuel quality
- ✓ Knowledge capture
- ✓ Technology integration
- ✓ Identifying new energy sources
- ✓ New business models to capture value

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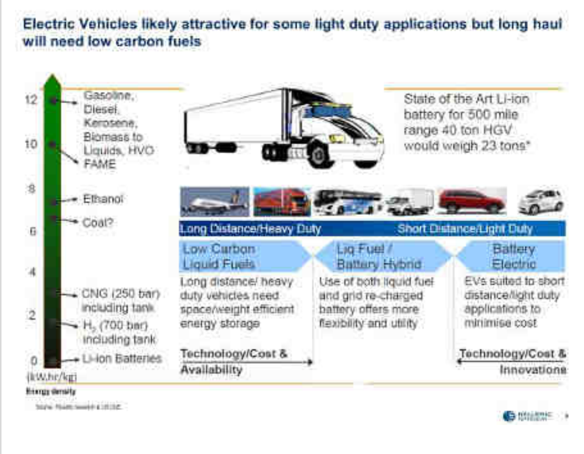
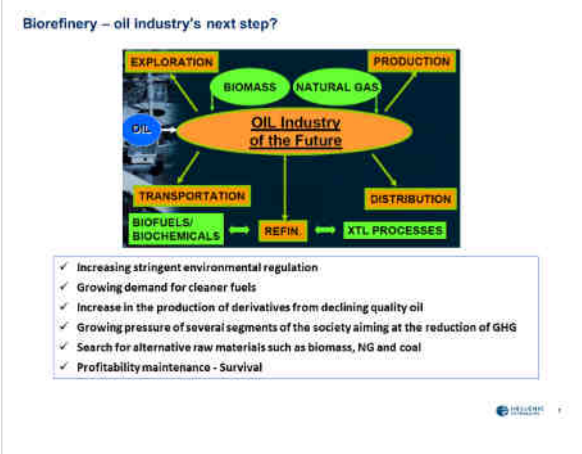
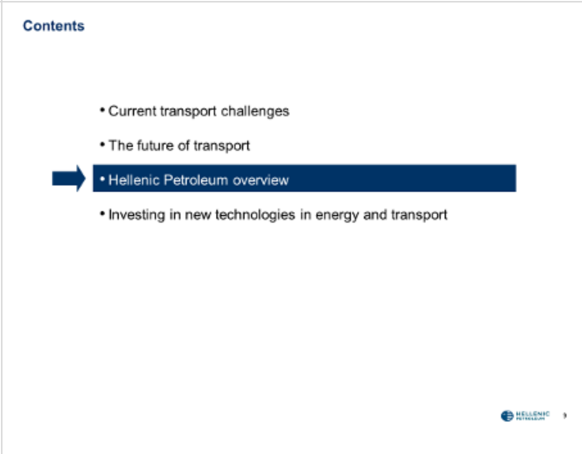

Electric Vehicles likely attractive for some light duty applications but long haul will need low carbon fuels
12
10
8
6
4
2
0
(kW.hr/kg)
Energy density
Gasoline, Diesel, Kerosene, Biomass to Liquids, HVO FAME
Ethanol
Coal?
CNG (250 bar) including tank
H_2 (700 bar) including tank
Li-ion Batteries
State of the Art Li-ion battery for 500 mile range 40 ton HGV would weigh 23 tons*
Long Distance/Heavy Duty
Short Distance/Light Duty
Low Carbon Liquid Fuels
Long distance/ heavy duty vehicles need space/weight efficient energy storage
Liq Fuel / Battery Hybrid
Use of both liquid fuel and grid re-charged battery offers more flexibility and utility
Battery Electric
EVs suited to short distance/light duty applications to minimise cost
Technology/Cost & Availability
Technology/Cost & Innovations


Biorefinery – oil industry's next step?
EXPLORATION
PRODUCTION
BIOMASS
NATURAL GAS
OIL
OIL Industry of the Future
TRANSPORTATION
DISTRIBUTION
BIOFUELS/ BIOCHEMICALS
REFIN.
XTL PROCESSES
✓ Increasing stringent environmental regulation
✓ Growing demand for cleaner fuels
✓ Increase in the production of derivatives from declining quality oil
✓ Growing pressure of several segments of the society aiming at the reduction of GHG
✓ Search for alternative raw materials such as biomass, NG and coal
✓ Profitability maintenance - Survival


Advanced biofuels: Misconceptions and Reality
• Cheap oil halts renewables
➢ Capital markets are thirsty for new sections to invest
➢ Renewables attract money due to shrinking investments in the oil sector
• Biofuels is an energy security issue
➢ One single energy carrier can not meet all needs
➢ Can serve all modes of transport (road, rail, marine, air)
• Climate change debate
➢ Policies impact heavily biofuel industry and profitability
➢ Stable and predictable policy framework is required to enable long-term investment planning
• Technology barriers postpone biofuel evolution
➢ Technology revolution and breakthroughs
➢ A variety of alternative processing routes are available
• The biomass quest crossroad
➢ Many alternative feedstocks
➢ In the end of the day it is a commodity market


Contents
• Current transport challenges
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Current position
Leading domestic market position; major middle distillates and naphtha/gasoline exporter in the East Med market
Group operational footprint and Sales
MONTENEGRO
SERBIA
BULGARIA
FYROM
GREECE
CYPRUS


Assets overview
Core business around downstream assets with activities across the energy value chain
DESCRIPTION
METRICS
Exploration & Production
• Exploration assets in Greece
• 50% (operator) in W. Patraikos Gulf
• Exploration rights in 2 more areas
Refining, Supply & Trading
• Complex (recently upgraded) refining system:
– Aspropyrgos (FCC: 148kbpd)
– Elefsina (HDC: 100kbpd)
– Thessaloniki (HS: 93kbpd)
• Pipeline fed refinery/terminal in FYROM
• Capacity: 16MT
• NCI: 9.6
• Market share: 65%
• Tankage: 7m M³
Petrochemicals
• Basel technology PP production (integrated with refining) and trading
• > 60% exports in the Med basin
• Capacity (PP): 220 kt
Domestic Marketing
• Leading position in all market channels (Retail, Commercial, Aviation, Bunkering) through EKO and HF (BP branded network)
• c.1,700 petrol stations
• 30% market share
• Sales volumes: 3.5MT
International Marketing
• Strong position in Cyprus, Montenegro, Serbia, Bulgaria, FYROM
• Advantage on supply chain/vertical integration
• c.290 petrol stations
• Sales volumes 1.2MT
Power & Gas
• ELPEDISON: Second largest IPP in Greece (JV with Edison/EdF)
• Capacity: 810 MW (CCGT)
• DEPA/DESFA GROUP: 35% in Greece's incumbent NatGas supply company (DESFA in sale process)
• Volumes (2016): 3.0bcm

Contents

- Current transport challenges
- The future of transport
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Investing in Renewable Energy Sources

- Developing renewable electricity to diversify Group's energy portfolio. Also offsetting part of CO_2 emissions due to refining and power generation.
  - Wind and PV assets in operation
  - Developing a 200 MW portfolio (in various maturity stages)
- Expanding in biofuels
  - 2nd and 3rd generation biofuels

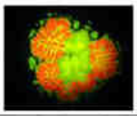
Supporting new technologies in energy and transport

- Supporting R&D projects with various academic institutions:
  - ✓ "Sustain-Diesel": hybrid diesel from used cooking oils
  - ✓ "Sustainable use of marine microalgae for the production of biofuels and high-added value biochemicals": 3rd gen biofuels
- Pilot applications of alternative technologies in transport
  - ✓ Electric vehicle charging points in selected petrol stations
- Corporate Venture Capital - under consideration

Participating in R&D projects …

Sustain-Diesel

Hydrosol Plant project - FCH JU



Sustainable use of marine microalgae for the production of biofuels and high added value bio chemicals

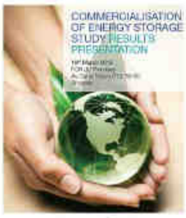
CAPITA
GREEN MEOH

Green MEOH project - CAPITA

CHORUS
Clean Energy cluster

Innovation Clusters

… and European Union initiatives



Our vision: Sustainable transport & Clean energy

- Gaining know-how in future energy technologies
- Developing new business
- Converting R&D outputs in production

Evolving to an innovative, reliable and competitive energy supplier in the future

Hellenic Petroleum: Energy for life

Fisikon: The power of nature for mobility needs

Investing in the development of an alternative vehicle fuel in Greece

by

Mr. George CHATZOPOULOS,

Consultant strategy & business development,

Public Natural Gas Supply Corporation, DEPA, Hellas

Abstract

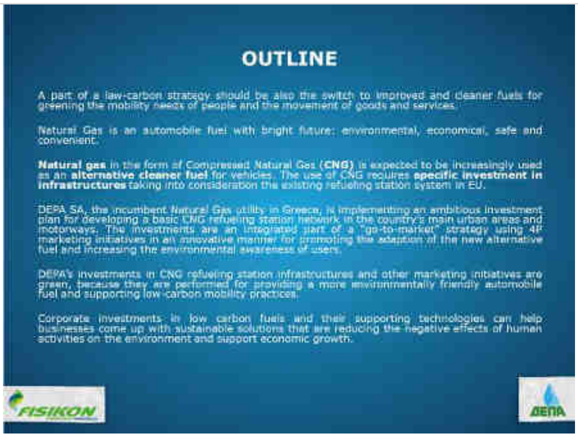
Mobility in the 21st century should be environmentally friendly, safe, highly efficient and economical. The use of Compressed Natural Gas (CNG) as vehicle fuel attains all of the above goals.

DEPA SA is implementing an ambitious investment plan for developing a network of CNG refueling stations at main urban areas and main motorways in Greece.

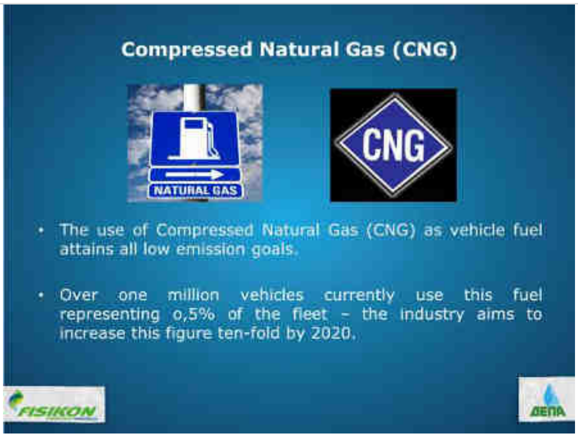
CNG is launched to the Greek market with the brand name «FISIKON».

The presentation will focus on all elements making the particular investment "green", and will give details about the objectives of the investment plan and the activities of the dedicated marketing strategy for developing a new alternative vehicle fuel.

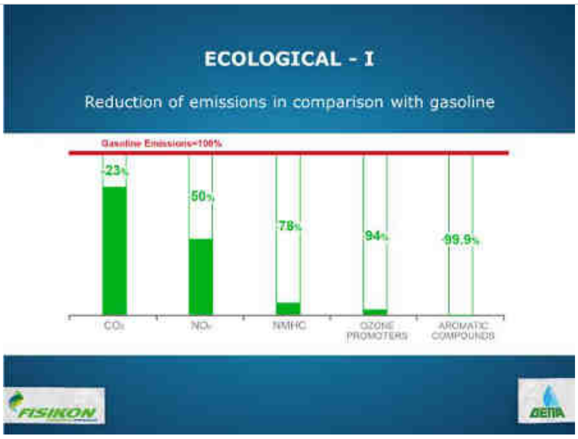

FISIKON: THE POWER OF NATURE FOR MOBILITY NEEDS
FISIKON
Investing in the development of an alternative vehicle fuel in Greece
CHATZOPOULOS GEORGIOS
October 2017
Towards Low-Carbon Mobility
ΔΕΠΑ

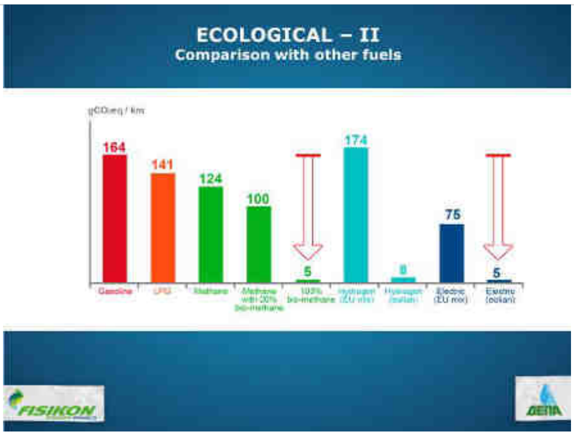

OUTLINE
A part of a law-carbon strategy should be also the switch to improved and cleaner fuels for greening the mobility needs of people and the movement of goods and services.
Natural Gas is an automobile fuel with bright future: environmental, economical, safe and convenient.
Natural gas in the form of Compressed Natural Gas (CNG) is expected to be increasingly used as an alternative cleaner fuel for vehicles. The use of CNG requires specific investment in infrastructures taking into consideration the existing refueling station system in EU.
DEPA SA, the incumbent Natural Gas utility in Greece, is implementing an ambitious investment plan for developing a basic CNG refueling station network in the country's main urban areas and motorways. The investments are an integrated part of a "go-to-market" strategy using 4P marketing initiatives in an innovative manner for promoting the adaption of the new alternative fuel and increasing the environmental awareness of users.
DEPA's investments in CNG refueling station infrastructures and other marketing initiatives are green, because they are performed for providing a more environmentally friendly automobile fuel and supporting low-carbon mobility practices.
Corporate investments in low carbon fuels and their supporting technologies can help businesses come up with sustainable solutions that are reducing the negative effects of human activities on the environment and support economic growth.
FISIKON
ΔΕΠΑ

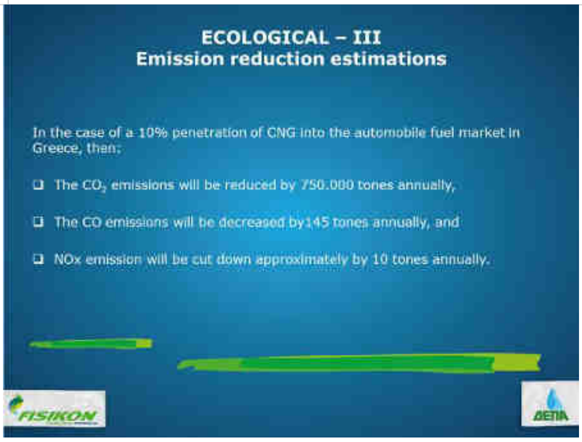

Moving towards zero-emissions vehicles
• Mobility in the 21st century should be environmentally friendly, safe, highly efficient and economical.
• Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities.
Alternative Fuel
• Low-emission alternative fuels to diesel and gasoline can contribute to the gradual decarbonization of transport in Europe and Greece catering the mobility needs of people and goods.
FISIKON
ΔΕΠΑ

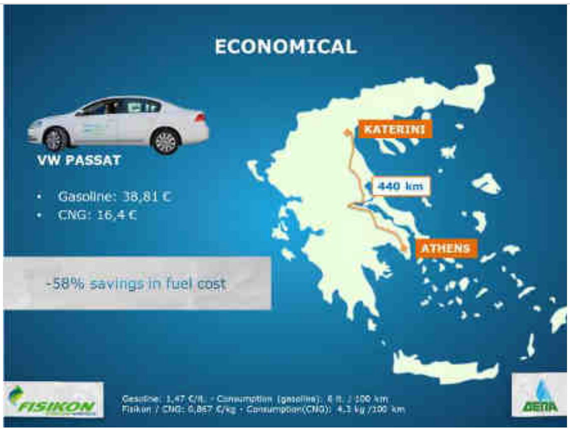

Compressed Natural Gas (CNG)
NATURAL GAS
CNG
• The use of Compressed Natural Gas (CNG) as vehicle fuel attains all low emission goals.
• Over one million vehicles currently use this fuel representing 0,5% of the fleet – the industry aims to increase this figure ten-fold by 2020.
FISIKON
ΔΕΠΑ


FUEL / CNG FEATURES
AVAILABLE
PRACTICAL
HIGH QUALITY
ECOLOGICAL
ECONOMICAL
SAFE
AFFORDABLE
MATURE TECHNOLOGY
FISIKON
ΔΕΠΑ


ECOLOGICAL - I
Reduction of emissions in comparison with gasoline
Gasoline Emissions=100%
-23%
-50%
-78%
-94%
-99.9%
CO2
NOx
NMHC
OZONE PROMOTERS
AROMATIC COMPOUNDS
FISIKON
ΔΕΠΑ

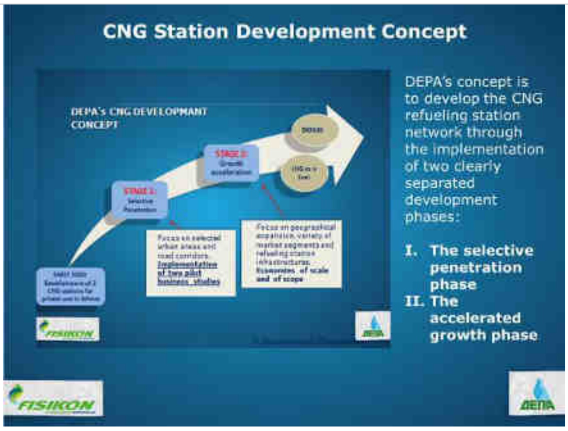

ECOLOGICAL – II
Comparison with other fuels
164
141
124
100
5
174
8
75
5
Gasoline
LPG
Methane
FISIKON
ΔΕΠΑ

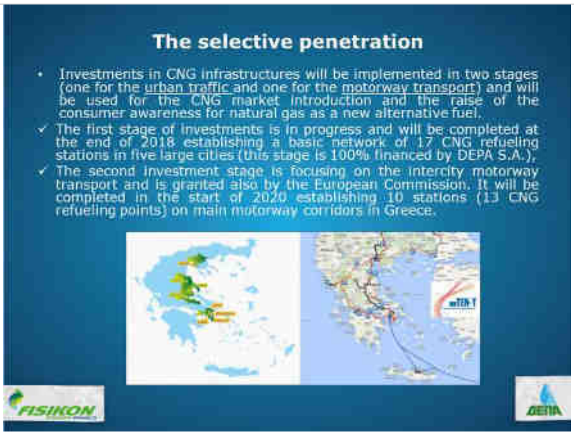

ECOLOGICAL – III
Emission reduction estimations
In the case of a 10% penetration of CNG into the automobile fuel market in Greece, then:
The CO2 emissions will be reduced by 750.000 tones annually,
The CO emissions will be decreased by145 tones annually, and
NOx emission will be cut down approximately by 10 tones annually.
FISIKON
ΔΕΠΑ

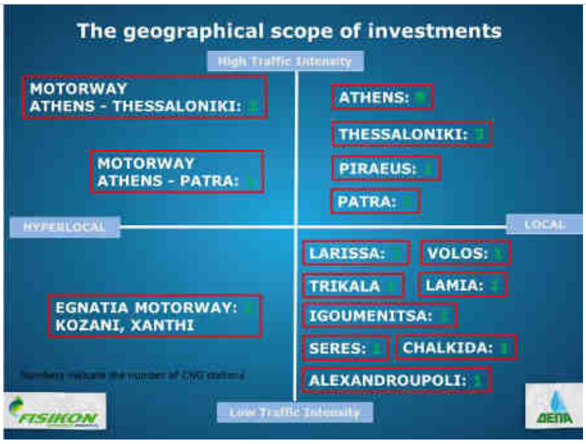

ECONOMICAL
VW PASSAT
Gasoline: 38,81 €
CNG: 16,4 €
-58% savings in fuel cost
KATERINI
440 km
ATHENS
FISIKON
ΔΕΠΑ


Roll-out of CNG infrastructures
In order to achieve mass acceptance and deployment of Natural Gas Vehicles (NGVs), refueling infrastructures need to become widely available throughout Europe.
The Public Gas Corporation (DEPA S.A.) is implementing an ambitious investment plan for developing a network of CNG refueling stations at large urban areas and main motorways in Greece.
CNG is launched to the Greek market with the brand name «FISIKON».
FISIKON
ΔΕΠΑ


Motives and objectives
MOTIVES:
I. The transportation fuel market has a size of 12 billion Euros in Greece (2016);
II. Favor business environment for natural gas applications in the transport sector: The EU policy for alternative fuels aims to ensure that publically accessible CNG refueling points with common standards are available Europe-wide with maximum distance of 150 km by 2020.
The main corporate objectives for the investments are:
To grow and diversify the company's business in a new promising sector, and
To lead the development of alternative transportation fuels and "blue - green corridor" concepts in Southern East Europe (SEE).
FISIKON
ΔΕΠΑ


CNG Station Development Concept
DEPA's CNG DEVELOPMENT CONCEPT
DEPA's concept is to develop the CNG refueling station network through the implementation of two clearly separated development phases:
I. The selective penetration phase
II. The accelerated growth phase
FISIKON
ΔΕΠΑ


The selective penetration
Investments in CNG infrastructures will be implemented in two stages (one for the urban traffic and one for the motorway transport) and will be used for the CNG market introduction and the raise of the consumer awareness for natural gas as a new alternative fuel.
The first stage of investments is in progress and will be completed at the end of 2018 establishing a basic network of 17 CNG refueling stations in five large cities (this stage is 100% financed by DEPA S.A.),
The second investment stage is focusing on the intercity motorway transport and is granted also by the European Commission. It will be completed in the start of 2020 establishing 10 stations (13 CNG refueling points) on main motorway corridors in Greece.
FISIKON
ΔΕΠΑ


The geographical scope of investments
High Traffic Intensity
MOTORWAY ATHENS - THESSALONIKI:
MOTORWAY ATHENS - PATRA:
ATHENS:
THESSALONIKI:
PIRAEUS:
PATRA:
HYPERLOCAL
LOCAL
LARISSA:
VOLOS:
TRIKALA
LAMIA:
IGOUMENITSA:
EGNATIA MOTORWAY: KOZANI, XANTHI
SERES:
CHALKIDA:
ALEXANDROUPOLI:
Low Traffic Intensity
FISIKON
ΔΕΠΑ


Other (green) marketing activities
The "Supply" Site of the CNG market
The "Demand" Site of the CNG market
PLACE: Green Investments in Infrastructures.
CNG refueling points at existing petrol stations reducing resource consumption
PRODUCT: "Greener" Fuel.
PRICE: Low price with perception of extra product value.
PROMOTION: Is addressed to the relationship between fuel and biophysical environment
FISIKON
ΔΕΠΑ


Defining the "green" in DEPA's investments
"Green investment" is a very board term.
Macroeconomic definition (=> more broad and generic, focussing on the fixed assets)
DEPA's investments in CNG refueling infrastructures are necessary for reducing GHG and other pollutant emissions, without reducing the transport activities of other sectors in the economy.
Micro-Level definition (focussing on the product / CNG, relative to the other conventional fuels in the transport sector)
DEPA's fuel (CNG) is low carbon, more climate resilient, less toxic, safer.
FISIKON
ΔΕΠΑ


Investments activating Innovation
Because they are applying scientific and engineering knowledge to the conception and development of natural gas as a fuel for on-road transport operations, facilitating and supporting:
The promotion of new refueling- and vehicle technologies with socio-economical benefits,
The driving of global standards,
and
A change process in the economic system towards the promotion of alternative fuels
FISIKON
ΔΕΠΑ


FISIKON
Macroeconomic Benefits
The shift towards low-emission mobility is:
Offering opportunities for new business development,
Bolstering the competitiveness of the transport industry
Boosting growth in the vehicle business
Providing New jobs with new skills
Bringing savings on oil import bills
ΔΕΠΑ


Examples for the value of green investments towards low emission mobility:
Alternative fuels will create 700.000 additional Jobs by 2025 in EU.
NGV sector in Italy:
Turnover: 1,7 bill. €,
20.000 employees,
over 1.100 refueling stations,
5.000 dedicated Workshops,
50 SMEs with worldwide activities.
FISIKON
ΔΕΠΑ


DEPA SA
DEPA S.A. was founded in 1988 with the main mission to introduce Natural Gas to Greece.
DEPA Group is the incumbent natural gas utility in Greece, responsible for the wholesale, trading, distribution and supply natural gas. The group is currently 65% owned by the Greek State and 35% by Hellenic Petroleum S.A.
DEPA S.A. – 2016:
200 highly specialized employees;
Revenue: 862 million Euros;
EBITDA: 46 million Euros;
After Tax Profit: 106 million Euros
FISIKON
ΔΕΠΑ


DEPA's STRENGTHS
Competitive supply mix, including mid-long term contracts at advantageous prices.
Scale, which allows flexibility on the commercial side and supports the strong value proposition to large and medium sized customers.
Strong position in international developments, through active participation in concrete projects in the region.
Active role in shaping new developments in natural gas in the domestic market, e.g. CNG refueling stations for natural gas fueled vehicles (NGVs), small scale LNG & CNG.
A strong management team and well diversified and integrated human resources with long experience in the sector and in depth understanding of the evolution of gas market.
Proven track of records in planning, developing, permitting, building and operating safely natural gas infrastructures.
FISIKON
ΔΕΠΑ


FISIKON
DRIVING WITH THE POWER OF NATURE
THANK YOU FOR YOUR ATTENTION
ΔΕΠΑ

Smart Islands Initiative

by

Ms. Alkisti FLOROU,

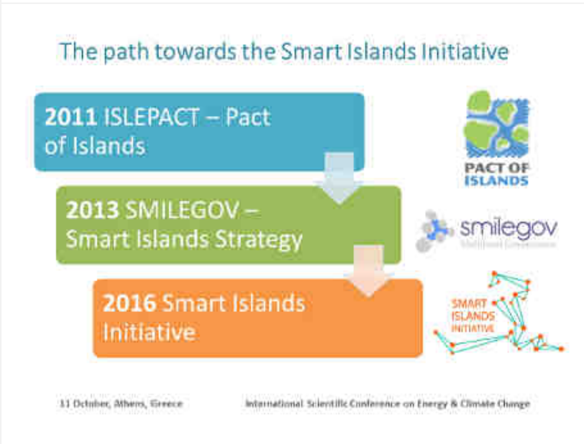
EU Affairs and Projects Advisor, Network of Sustainable Greek islands (DAFNI)

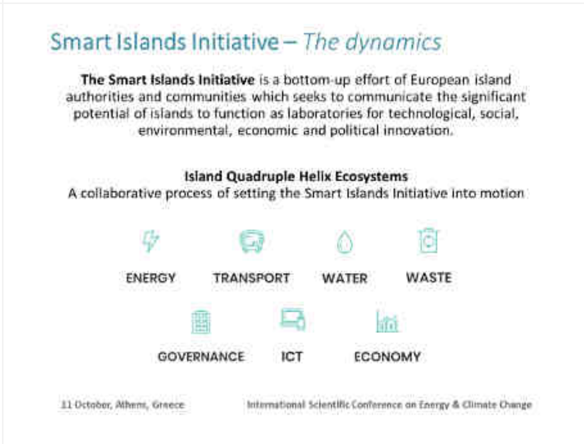
Abstract

The Network of Sustainable Greek Islands – DAFNI Network coordinates the Smart Islands Initiative. The Initiative represents a bottom-up effort of EU island local and regional authorities to highlight islands' potential to develop sustainably, by hosting integrated solutions that maximise synergies between key infrastructures, i.e. energy, transport, waste, water. The knowledge produced on optimal resource and infrastructure management can be then transferred to mountainous, rural and generally geographically isolated areas but also scaled-up in cities, helping Europe become a smart, sustainable and inclusive economy. The Initiative was launched during the 1st Smart Islands Forum, held in Athens in June 2016, with the participation of over 40 EU island representatives. It was officially presented among over 100 EU stakeholders in March 2017 during the "Smart Islands – Creating New Pathways for EU islands" event, co-hosted by 12 MEPs, where 33 representatives of over 200 islands from 15 EU countries signed the Smart Islands Declaration, cornerstone document of the Smart Islands Initiative!


DAFNI
Network of Sustainable Greek Islands
SMART ISLANDS INITIATIVE
Smart Islands Initiative
An initiative of European island local and regional authorities and actors
International Scientific Conference
"Energy and Climate Change"
11-12-13 October2017
Athens, Greece
Alkisti Florou
DAFNI Network of Sustainable Greek Islands
Coordinator of Smart Islands Initiative
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


The DAFNI network
DAFNI
• DAFNI is a network of island local and regional authorities
• DAFNI is a non profit organisation
• DAFNI has 40 Municipal and 4 Regional members
• DAFNI promotes sustainable development in Greek islands through integrated actions in the fields of energy, environment and culture
• DAFNI is founding member of the Pact of Islands initiative promoting sustainability in European islands through local energy planning
• DAFNI is the coordinator of the Smart Islands Initiative promoting islands as ideas areas for innovative projects in the fields of energy, environment, transport and mobility
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


The path towards the Smart Islands Initiative
2011 ISLEPACT – Pact of Islands
PACT OF ISLANDS
2013 SMILEGOV – Smart Islands Strategy
smilegov
2016 Smart Islands Initiative
SMART ISLANDS INITIATIVE
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


Smart Islands Initiative – The dynamics
The Smart Islands Initiative is a bottom-up effort of European island authorities and communities which seeks to communicate the significant potential of islands to function as laboratories for technological, social, environmental, economic and political innovation.
Island Quadruple Helix Ecosystems
A collaborative process of setting the Smart Islands Initiative into motion
ENERGY
TRANSPORT
WATER
WASTE
GOVERNANCE
ICT
ECONOMY
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


Smart Islands Initiative – Declaration signing ceremony
In 28 March 2017 12 MEPs hosted in the European Parliament
33 Local and Regional island authorities from 15 Member States signing
on behalf of more than 200 EU islands
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


Smart Islands Initiative – The way forward
The Smart Islands Declaration
A Motion for Resolution will follow the signing of the Declaration to be adopted by the European Parliament
The Smart Islands Initiative Pillars
1. The Smart Islands Forum – An annual collaborative, networking and knowledge-sharing space for island public administration and community representatives
2. The Smart Islands Conference – An annual gathering of stakeholders to exchange views and propose measures for putting the Smart Islands Declaration into effect, organized back-to-back with the Forum
3. The Smart Islands Platform – A body catalysing collaboration between the public, private and academic sectors for the deployment of pilot innovative projects on islands
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change


Thank you
For more information
policy@Dafni.net.gr
info@smartislandsinitiative.eu
SMART ISLANDS INITIATIVE
11 October, Athens, Greece
International Scientific Conference on Energy & Climate Change

Green Energy Investment Prospects in SE

by

Mr. Costis STAMBOLIS,

Executive Director,

Institute of Energy for S.E. Europe (IENE), Greece

Abstract

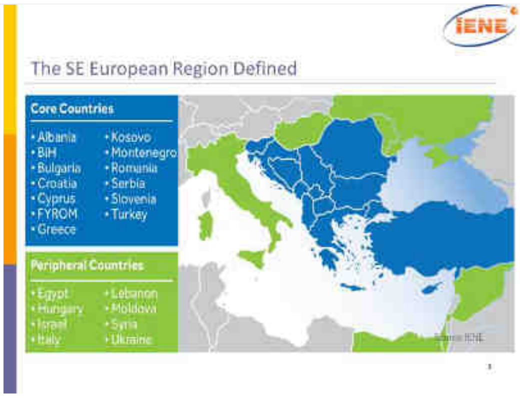
The presentation concerned the description of the global renewable energy sources (RES) investment trends, before defining the SE European region and presenting its key economic and energy data, such as real GDP growth and the region's current and past energy mix. A presentation on the current RES situation, on a country-by-country basis was then made, followed, by a broad discussion on the future of renewables in SE Europe, explaining also the reasons as to why further RES growth is hindered.

Projections about the regional energy mix, RES's contribution in the SE European gross final energy consumption and net RES generation capacity were also briefly analysed. In addition, the energy investment outlook of SE Europe over 2016-2025 was presented, highlighting the two scenarios (a **reference** one with an average real GDP growth of 1% and an **optimistic** one with an average real GDP growth of 3% and maximum investments) where the investment outlook was based on.

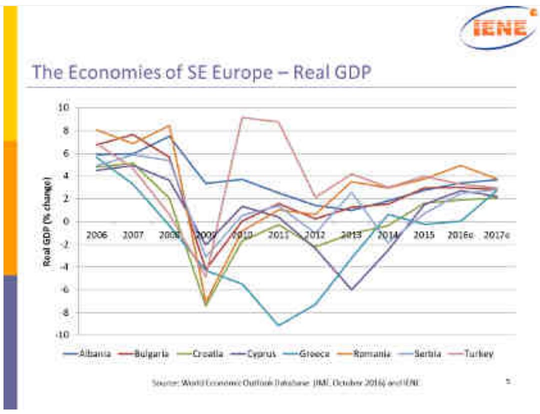
In both scenarios anticipated investments in all areas of the energy sector appear substantial. Investment prospects for energy related basic infrastructure and energy projects across the board (i.e. electricity, natural gas, RES, thermal power plants, oil and gas explorations, energy efficiency) look positive over the next decade. There appears to be marginal improvement in anticipated and planned projects from now on until 2025, compared to the projection made in 2011 for the period 2011-2020, with total estimated funding in the region of €273 billion in the reference scenario and €333 billion in the optimistic one. In particular, in the reference scenario, the investment prospects per RES sector in SE Europe over 2016-2025 stand at a total of about €61 billion.

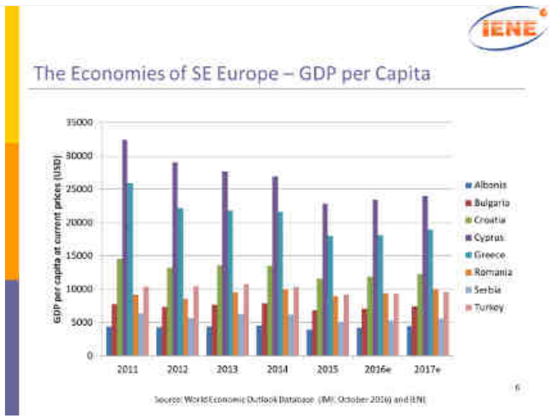

"Green Energy Investment Prospects in SE Europe"
2nd Green Energy Investments Forum
10th International Scientific Conference on Energy and Climate Change
Organised by PROMITHEASnet,
Energy and Climate Change Policy Centre (KEPA), University of Athens
Athens, October 11, 2017
A Presentation by Mr. Costis Stambolis,
Executive Director
Institute of Energy for S.E. Europe (IENE), Athens
INSTITUTE OF ENERGY
FOR SOUTH EAST EUROPE
IENE

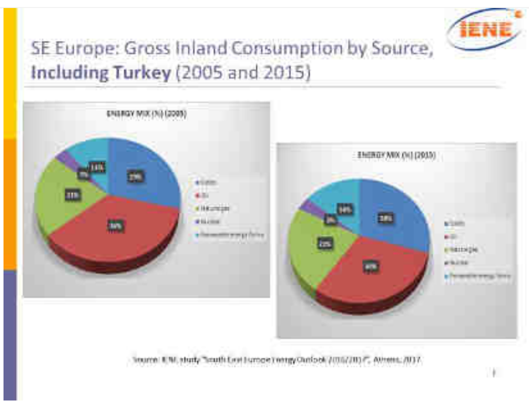

IENE
Presentation Outline
1. The SE European Region Defined
2. The Economies of SE Europe
3. SE Europe: Gross Inland Consumption by Source (2005 and 2015)
4. Current RES Situation per country in SE Europe
5. RES growth in SE Europe is Hindered
6. RES Growth in Selected SEE Countries
7. RES Development for Power Generation in SE Europe
8. Regional Energy Mix: What Lies Ahead?
9. SE Europe: Net RES Generation Capacity in 2015, 2025 and 2035
10. SE Europe: Gross Inland Consumption (2005-2050)
11. SE Europe: RES in Gross Final Energy Consumption (2005-2050)
12. SEE Energy Investment Outlook 2016-2025
13. Investment Prospects per RES sector in SE Europe (2016-2025)
14. Sources of Finance vs Country Risk
2

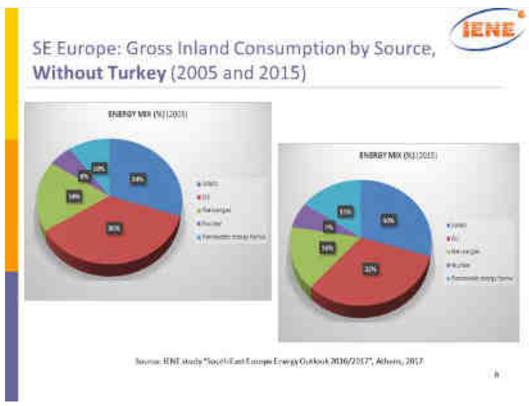

IENE
The SE European Region Defined
Core Countries
• Albania • Kosovo
• BiH • Montenegro
• Bulgaria • Romania
• Croatia • Serbia
• Cyprus • Slovenia
• FYROM • Turkey
• Greece
Peripheral Countries
• Egypt • Lebanon
• Hungary • Moldova
• Israel • Syria
• Italy • Ukraine
3


IENE
INSTITUTE OF ENERGY FOR SE EUROPE
South East Europe
Energy Outlook 2016/17
IENE
4


IENE
The Economies of SE Europe – Real GDP
Real GDP (% change)
10
8
6
4
2
0
-2
-4
-6
-8
-10
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016e 2017e
Albania Bulgaria Croatia Cyprus Greece Romania Serbia Turkey
Source: World Economic Outlook Database (IMF, October 2016) and IENE
5


IENE
The Economies of SE Europe – GDP per Capita
GDP per capita at current prices (USD)
35000
30000
25000
20000
15000
10000
5000
0
2011 2012 2013 2014 2015 2016e 2017e
Albania
Bulgaria
Croatia
Cyprus
Greece
Romania
Serbia
Turkey
Source: World Economic Outlook Database (IMF, October 2016) and IENE
6


IENE
SE Europe: Gross Inland Consumption by Source, Including Turkey (2005 and 2015)
ENERGY MIX (%) (2005)
ENERGY MIX (%) (2015)
Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017
7


IENE
SE Europe: Gross Inland Consumption by Source, Without Turkey (2005 and 2015)
ENERGY MIX (%) (2005)
ENERGY MIX (%) (2015)
Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017
8

SE Europe - Current Situation

The SE European region is characterized by distinctly different (in terms of structure and operation) and frequently segregated energy markets in various stages of development:

- The **EU member states (Greece, Romania, Cyprus, Bulgaria, Croatia and Slovenia)** have implemented several steps toward the smooth adaptation of EU energy and environmental policies and directives
- The **West Balkan countries (Serbia, Bosnia & Herzegovina, Montenegro, Kosovo, FYROM)** are in a transition process within the Energy Community framework.
- **Turkey:** With a rapidly growing economy, Turkey has become one of the fastest growing energy markets in the world. Projections show that demand growth trend will continue.

West Balkans (I)

Albania

- Albania passed the Law on Promotion of the Use of Energy from Renewable Sources
- The main support scheme for energy generated from renewable energy sources in Albania has been a feed-in tariff which has been applied only to small hydro power plants with the capacity of less than 10 MW
- Renewable energy has not been given priority in regards to grid connection.

Bosnia & Herzegovina - Growing renewables share in energy mix

- Ten new small hydropower and five solar plants in the Republic of Srpska to be completed by the end of 2017
- The Republic of Srpska should build two wind farms in Herzegovina, the southern region of BiH
- Construction of the wind farm Hrgud, with the installed capacity of 48 MW
- Wind farm, Trusina, will be built in the municipality of Nevesinje. Its installed capacity will be 50 MW
- A concession contract for the construction of 8 more turbines within the Plocno wind farm, with a combined capacity of 48 MW
- The target for wind energy is very conservatively capped at 350 MW until 2019

West Balkans (II)

Croatia - Renewable Energy Future in Question

- To maintain the status quo and postpone until 2018 the implementation of the Law on Renewable Energy Sources
- Retroactive introduction of excise taxes on renewable energy
- Croatia increased in September the incentive fees aimed at stimulating the production of renewable energy, in turn slightly raising electricity bills for consumers. The fee - a fixed price for energy consumed - will be raised to 0.11 kuna from 0.04 kuna per kilowatt-hour.
- Croatia together with Bulgaria and Romania met in 2015 its target share of energy from renewable sources in gross final consumption of energy
- Since 2007, when the renewables support scheme was introduced, Croatia added more than 600 MW in green energy capacity.

FYRO Macedonia

- Support schemes for various technologies have been adopted
- The targets on capacities imposed for several types of renewable sources until 2020 have to be revised
- Steps have been taken to remove some of the barriers related to administrative procedures
- Deadlines have been shortened and unnecessary procedural steps have been abolished
- No clear mechanisms for coordination of the different authorities

West Balkans (III)

Kosovo - more effort should be made

- Kosovo should make more investments in the energy sector, and add further generation capacity from both thermal and renewable energy sources, in order to become able to plan the decommissioning of the country's two coal power plants
- The energy reforms recently implemented by the local government are not sufficient to improve the country's troubled power market
- Kosovo is expected to add 240 MW of power generation capacity from renewables, of which only 10 MW is for solar PV, while wind and biomass will account for 150 MW and 14 MW, respectively. Solar had only a few hundred kW connected to the grid as of the end of 2015

Montenegro - RES, become political issue

- Government increased the tariff subsidy for electricity from renewable energy sources and high efficiency cogeneration from 0,12 to 0,47 eurocents per kWh
- The tariff is paid by citizens through their electricity bills
- Electricity bills in 2017 will stay on the level of 2016
- France's Akuo Energy and Austria's Ivicom plan to start the operation of the 72 MW Krnovo wind farm
- The national target of 33 percent of energy from renewables has already been reached. Montenegro already reached its EU 2020 target.

Serbia - focus on wind energy

- Made some progress in upgrading its renewable energy framework
- Serbia is not on track to meet its 2020 targets of 22%.
- Serbia currently is building wind farms with a combined installed capacity of 483 MW
- The first wind farms with a combined capacity of 17 MW have already started operating in Serbia

East Balkans – Greece – Cyprus

Cyprus

- The government of Cyprus is planning to establish the renewable energy agency that will draft and implement a national renewable action plan
- Cyprus' 2020 target is 13 percent share of energy generated from renewable energy sources in gross final energy consumption, including electricity, heating, cooling and transport. The share of RES in total consumption reached 10.5% in 2016.
- From the beginning of 2017, the tariff subsidy on electricity bills doubled, from 0.5 to 1 eurocent per kWh
- The RES fund owes to the Electricity Authority of Cyprus EUR 15 million. The fund's expected revenues for 2017 stand at EUR 50.67 million

Greece - New renewable energy law provides feed-in premiums and introduces tender schemes for PV

- A new RES law (L.4414/2016) was voted by the Greek Parliament in August 2016.
- The new policy framework abandons the feed-in tariff (FIT) policy in favour of a feed-in premium scheme for systems over 500 kWp
- The feed-in premium will be valid for 20 years. The new law does not apply to Greece's non-interconnected islands.
- Greece Records Second Best Year in Wind Power Installations in 2016
- New RES projects calculated to total 1.2 to 1.5 billion euros between the 2016-2020 period. The proposals include tenders and licensing of wind farms and photovoltaic panels totaling 1.300 MW.

Net Metering

- Greek government has signed in May 2017 the virtual net metering provisions into the law.
- The country's electricity market is changing rapidly and electricity bills will most possibly increase further. Private investors with transparent investment plans will be far more efficient to adopt net metering PV.
- According to LAGIE, the country did not install new solar PV capacity in 2016.

East Balkans, Romania – Bulgaria

Romania

- Romania has left the ranking of the 40 most attractive markets in the world for renewable energy investments
- The Romanian power system seems to need to digest the massive injection of uncontrollable production capacities put into operation before December 31, 2016
- Romania Removes 12-Month Expiry Date for Green Certificates
- Romania Introduces New State Aid Scheme to Support Geothermal Development

Bulgaria

- Bulgaria is among the European countries that have announced the achievement of the objectives of the "Europe 2020" strategy on renewable energy
- The sector is said to be in crisis and unsustainable
- Retroactive measures against renewable energy operators have been taken
- Bulgarian electricity grid operator ESO said a total of 1,506 MW of new capacity is planned to be completed in Bulgaria by 2026
- One of Europe's biggest solar parks with an installed capacity of 180 MW is expected to be implemented by 2022 in Devnya, a town in Varna Province, Northeastern Bulgaria
- Renewable energy output is expected to increase to 7,379,800 MWh in 2026, from 5,884,800 MWh in 2017.

Turkey – RES Tops Energy Agenda

- Turkey's renewable energy market has been expanding rapidly since the Renewable Energy Law was enacted in 2005
- By developing a structured system for renewable energy investment, Turkey is allowing investors to bypass the usual risks.
- Over the past two years, $1.9 billion have been invested in the country's energy sector. As many as 30 percent of these funds are invested in the development of renewable energy sources.
- The Turkish Ministry of Energy and Natural Resources (MENRA), the state aims to increase wind generation to 10,000 MW and solar generation to 3,000 MW by 2020.
- In October 2016, a regulation on renewable energy zones (REZs) was introduced (a reverse auction). This allowed structured investments in green power sources, supported by an incentive scheme for licensed renewable energy generation. REZs are expected to overcome the existing financing difficulties facing renewable energy projects
- A strong RES growth is expected in Turkey. According to the Turkish 'National Renewable Energy Action Plan' the target for renewable energy generation capacity was set to 61GW by 2023, mostly in the forms of hydro, wind and solar generation. Turkey plans to have 34GW of hydro generation capacity; 20GW of wind; 5GW of solar; and 1GW in both geothermal and biomass generating capacity by 2023. Geothermal energy will play a small part too, increasing to 600 MW within a decade. These goals would require a sevenfold increase in non-hydro renewables output in less than a decade. The country also aims to be meeting 10% of the energy needs of its transport sector through renewable energy by 2023.

Further RES Growth in SE Europe Hindered (I)

For a number of reasons, RES growth in SE Europe could not be sustained and has been flat over the last three years:

- **Greece** and **Bulgaria** introduced exceptionally high FiTs without a proper financial analysis and cash flow projections showing the impact that RES would have on the national accounts and electricity market operation over a long time period.
- This rapid and unplanned buildup of RES based on high FiTs had a dramatic impact on the electric system leading to large financial deficits for the market operator with big payments delays to producers.
- **Bulgaria** currently has an overcapacity problem and is exporting electricity to Turkey, Greece and the rest of the Balkans, meaning there is little motivation for investment in yet more RES generation capacity.
- **Romania** decided to slash incentives for renewable electricity generation following a dramatic boom in the sector between 2010 and 2013. Bucharest's generous "green certificate" incentive scheme attracted numerous international investors from Europe and Asia, in addition to local companies.
- **Greece** has two main support mechanisms for renewable energy: a feed-in tariff and investment subsidies. The actual impact of such measures has been limited, not because of the lack of incentives, but largely due to lengthy administrative processes. The latest legislation addresses those challenges and might significantly improve market development.

Further RES Growth in SE Europe Hindered (II)

- The cutbacks have raised questions about whether countries in the region will meet medium- and long-term renewables targets. The above abrupt changes to incentive schemes have discouraged many investors and it is uncertain whether they can be lured back.
- A strong RES growth is expected in **Turkey**. According to the Turkish 'National Renewable Energy Action Plan' the target for renewable energy generation capacity was set to 61GW by 2023; mostly in the forms of hydro, wind and solar generation. Turkey plans to have 34GW of hydro generation capacity; 20GW of wind; 5GW of solar; and 1GW in both geothermal and biomass generating capacity by 2023. Geothermal energy will play a small part too, increasing to 600 MW within a decade. These goals would require a sevenfold increase in non-hydro renewables output in less than a decade. The country also aims to be meeting 10% of the energy needs of its transport sector through renewable energy by 2023.

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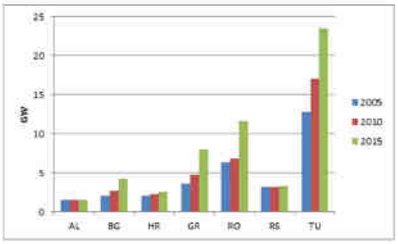
RES Growth in Selected SEE Countries



Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

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RES Development for Power Generation in SE Europe (2015)

Country	Wind (MW)	PV (MW) Hydro	Small+ Large (MW)	Deep Geothermal	Biomass RES (MW)	Total Power Capacity	Total RES Capacity (MW)	Installed
Albania	0.0	0.0	1.800	0.0	0.0	1.800	1.878	96%
Bosnia & Herzegovina	0.0	0.0	2.058	0.0	0.0	2.058	4.021	51%
Bulgaria	691.0	1.020	3.400	0.0	1.8	5.113	15.650	33%
Croatia	422.7	32.2	2.187	0.0	0.0	2.631	4.995	52%
Cyprus	157.0	64.8	0.0	0.0	9.7	231.5	1.740	13%
FYROM	37.0	0.0	581.0	0.0	0.0	618.0	1.967	31%
Greece	2.150	2.600	3.435	0.0	46.0	8.221	17.762	46%
Montenegro	0.0	0.0	660	0.0	0.0	660.0	886	74%
Romania	3.129	1.312	6.232	0.05	70.0	10.743	24.637	43%
Serbia & Kosovo	20.0	5.0	2.910	0.0	0.0	2.935	8.710	34%
Slovenia	3.4	257.0	1.270	0.0	0.0	1.530	4.183	36%
Turkey	4.718	54.8	23.583	600.0 (2016)	130.0	29.164	72.060	40%
Total	11.328	5.346	48.194	600.05	257,5	65.704,5	158.499	41%

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

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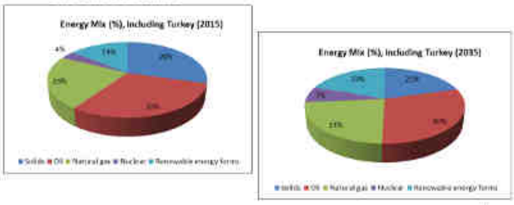
Regional Energy Mix: What Lies Ahead?

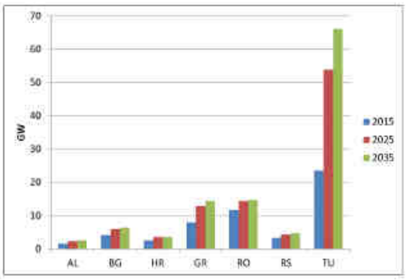
- The region's changing energy mix (Comparison between 2015 and 2035)
  - Substantial changes are foreseen over next 20 years with lower use of coal (lignite), stable contribution of gas and oil, more RES penetration and higher use of nuclear power.



Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

20

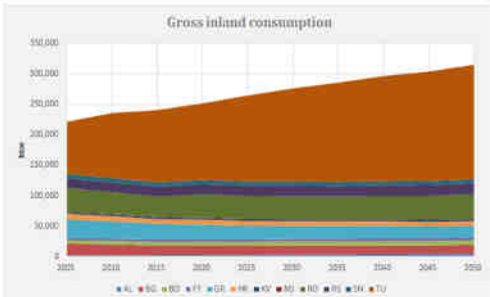
SE Europe: Net RES Generation Capacity in 2015, 2025 and 2035



Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

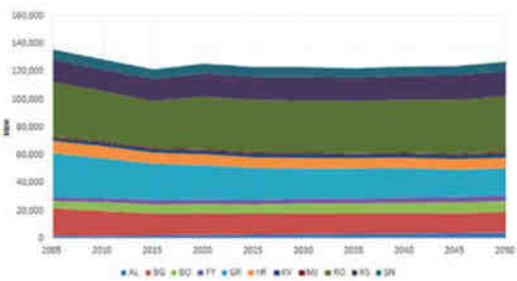
21

SE Europe: Gross Inland Consumption, including Turkey (2005-2050)



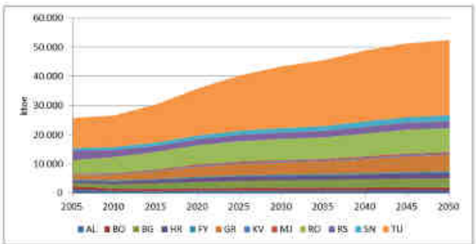
Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

SE Europe: Gross Inland Consumption, without Turkey (2005-2050)



Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

SE Europe: RES in Gross Final Energy Consumption*, including Turkey (2005-2050)

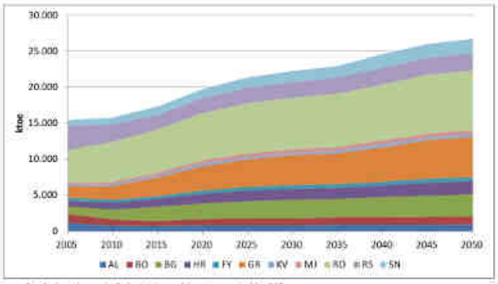


*including the part of electricity and heat generated by RES

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

24

SE Europe: RES in Gross Final Energy Consumption*, **without Turkey** (2005-2050)



*including the part of electricity and heat generated by RES

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

SEE Energy Investment Outlook 2016-2025

- The **investment prospects** in the energy sector of SE Europe over the next 10 years can only be described as **positive**.
- In terms of planned investments, a group of **five countries (i.e. Turkey, Bulgaria, Romania, Serbia, Greece)** appear to be moving **much faster than others** in attracting the needed investment for a variety of energy projects, while progress in the rest of the countries is moving more slowly.
- The region as a whole can be considered as presenting **attractive business opportunities in almost all branches of the energy sector**. The present analysis shows that investment in the energy sector will be spread as follows between countries and interregional projects. This analysis involves **two scenarios:**
  - An **optimistic one** (with an average real GDP growth of 3% over 2016-2025 and maximum investments) and
  - A **reference one** (with an average real GDP growth of 1% over 2016-2025 and substantial part of investments).

Findings of SEE Energy Investment Outlook 2016-2025 per country

SEE Countries	Scenario A: Total Investments (in million euros)	Scenario B: Total Investments (in million euros)
Albania	7,460	8,258
Bosnia & Herzegovina	8,722	10,060
Bulgaria	11,050	12,863
Croatia	8,525	9,178
Cyprus	7,350	8,759
FYROM	3,400	4,373
Greece	25,500	30,192
Kosovo	2,603	3,377
Montenegro	2,400	3,653
Romania	20,630	22,716
Serbia	11,260	13,527
Slovenia	3,185	4,891
Turkey	124,935	141,623
TOTAL	**234,822**	**273,280**

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

Findings of SEE Energy Investment Outlook 2016-2025 per sector

Sector	Total Investment (in million euros) Scenario A	Scenario B
Oil Upstream (Research, Exploration and Production)	25,450	32,288
Oil Downstream/Midstream (incl. liquid biofuels)	13,340	18,767
Electricity		
Thermal Plants	119,473	146,369
Nuclear Plants		
Lignite Mine Development		
Grids – Upgrade and Expansion		
HV Transmission Lines		
Gas		
Main and branch gas pipelines	16,550	26,460
Gas Storage		
Town grids		
LNG Terminals and Liquefaction plants		
RES (Wind, PV, Biomass, Mini Hydro, Geothermal)	40,009	49,406
TOTAL	**234,822**	**273,280**
Intraregional Mega Projects		
Oil Pipelines	-	1,000
Gas Pipelines	33,350	51,361
Electricity Interconnectors	4,700	7,150
Grand Total	**272,872**	**332,791**

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

Investment Prospects per RES sector in SE Europe over 2016-2025 (in Million Euros) (Reference Scenario)

	Hydro	Wind	PV	CSP	Biomass (including liquid biofuels)	Geothermal	Total
Albania	3,120	250	250	-	260	-	**3,880**
BiH	2,190	632	935	-	160	-	**3,917**
Bulgaria	380	300	200	-	120	-	**1,000**
Croatia	750	500	50	-	60	85	**1,445**
Cyprus	-	250	350	200	300	-	**1,100**
FYROM	1,150	90	10	-	20	-	**1,270**
Greece	500	5,500	2,000	200	700	300	**9,200**
Kosovo	300	190	10	-	45	-	**545**
Montenegro	720	160	30	-	100	-	**1,010**
Romania	1,900	640	150	-	280	-	**2,970**
Serbia	1,340	665	150	-	30	10	**2,195**
Slovenia	325	50	70	-	15	-	**460**
Turkey	11,350	10,500	6,000, including CSP	-	3,200	1,200	**32,250**
Total	**24,025**	**19,727**	**10,205**	**400**	**5,290**	**1,595**	**61,242**

Sources of Finance vs Country Risk (I)

- The **main sources of finance** for planned energy infrastructure projects in SE Europe include:
  - Government/own resources
  - International Financial Institutions (IFIs)
    - European Commission
    - European Bank for Reconstruction and Development (EBRD)
    - European Investment Bank (EIB)
    - World Bank
    - German government-owned development bank KfW
    - European Western Balkans Joint Fund (EWBJF)
    - International Development Association (IDA)
  - Commercial banks/private investors
  - Financial facilities for investments in energy efficiency and renewable energy

Sources of Finance vs Country Risk (II)

- However, the implementation of a set of planned energy projects in SE Europe may be hindered by the **high Country Risk** of several SEE countries and the **increased cost of capital**.

Country	Moody's ratings	S&P ratings	Fitch ratings
Albania		B1 (August 2016)	B+ (February 2016) n.a.
Bosnia and Herzegovina	B3 (February 2016)	B (November 2011)	n.a.
Bulgaria	Baa2 (June 2015)	BB+ (December 2014)	BBB- (December 2016)
Croatia	Ba2 (March 2016)	BB (January 2016)	BB (July 2016)
Cyprus	B1 (November 2016)	BB (September 2016)	BB- (October 2016)
FYROM	n.a.	BB- (May 2013)	BB (August 2016)
Greece	Caa3 (October 2016)	B- (January 2016)	CCC (September 2016)
Montenegro	B1 (May 2016)	B+ (November 2014)	n.a.
Romania	Baa3 (December 2015)	BBB- (May 2014)	BBB- (July 2016)
Serbia	n.a.	BB- (August 2012)	BB- (December 2016)
Slovenia	Baa3 (September 2016)	A (June 2016)	A- (September 2016)
Turkey	Ba1 (September 2016)	BB (July 2016)	BBB- (August 2015)

Source: IENE study "South East Europe Energy Outlook 2016/2017", Athens, 2017

INSTITUTE OF ENERGY FOR SOUTH-EAST EUROPE

Thank you for your attention

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The role of cogeneration in a green economy in Greece

by

Mr. Costas G. THEOFYLAKTOS,

President,

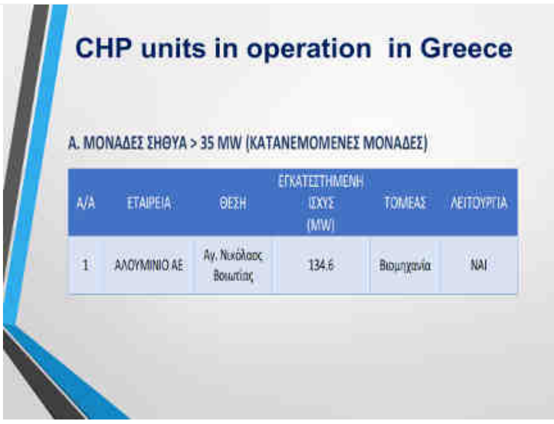
Hellenic Association for Cogeneration of Heat and Power, HACHP

Abstract

The presentation is dealing with the critical role of Cogeneration of Heat and Power for a Green Greek Economy, by achieving the targets set by the EU Energy Efficiency Directive, EED, 2012/27/EE.

It gives a short presentation of the history of CHP units operated in Greece in the last 30 years the current situation of micro- small- and large CHP units operating in all sectors in Greece.

It, also, presents the today's situation for investing in CHP n Greece, the opportunities and barriers.



Α/Α	ΕΤΑΙΡΕΙΑ	ΘΕΣΗ	ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ (MW)	ΤΟΜΕΑΣ	ΛΕΙΤΟΥΡΓΙΑ
1	ΑΛΟΥΜΙΝΙΟ ΑΕ	Αγ. Νικόλαος Βοιωτίας	134.6	Βιομηχανία	ΝΑΙ

Α/Α	ΕΤΑΙΡΕΙΑ	ΘΕΣΗ	ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ (MW)	ΤΟΜΕΑΣ	ΛΕΙΤΟΥΡΓΙΑ
2	ΘΕΡΜΗ ΣΕΡΡΩΝ	Σέρρες	16.00	Τηλεθέρμανση	ΝΑΙ
3	ΔΕΣΦΑ	Τερματικός Σταθμός ΥΦΑ	13.00	Βιομηχανία	ΝΑΙ
5	ΕΥΔΑΠ	ΚΕΛ Ν. ΨΥΤΤΑΛΕΙΑΣ	12.90	Βιομηχανία	ΝΑΙ
6	WONDERPLANT	Γηπεδοδάπεδος Πετρούσας Ν. Δράμας	8.00	Αγροτικός	ΝΑΙ
7	ΕΛΛΗΝΙΚΑ ΠΕΤΡΕΛΑΙΑ ΑΕ	Βιομ/κες Εγκ/σεις Ν. Θεσ/νίκης	5.50	Βιομηχανία	ΝΑΙ
8	ΑΓΡΟΤΕΧ ΕΝΕΡΓΕΙΑΚΗ ΑΕ	Αλεξάνδρεια Ν. Ημαθίας	4.97	Αγροτικός	ΝΑΙ
9	ΘΕΡΜΟΚΗΠΙΑ ΔΡΑΜΑΣ ΑΕ	Βότρυς Ν. Δράμας	4.80	Αγροτικός	ΝΑΙ
10	ΕΘΝΙΚΟ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝ/ΜΙΟ ΑΘΗΝΩΝ	Πανεπιστημιούπολη Αθήνα	2.72	Τριτογενής	ΟΧΙ

Α/Α	ΕΤΑΙΡΕΙΑ	ΘΕΣΗ	ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ (kW)	ΤΟΜΕΑΣ	ΛΕΙΤΟΥΡΓΙΑ
1	ΚΛΙΝΙΚΗ ΓΕΝΕΣΙΣ	Θεσσαλονίκη	730	Τριτογενής	ΝΑΙ
2	Ναυτικό Νοσοκομείο	Αθήνα	560	Τριτογενής	ΝΑΙ
3	Μαιευτήριο ΜΗΤΕΡΑ	Αθήνα	515	Τριτογενής	ΝΑΙ ΟΧΙ
4	ΕΚΠΑΙΔΕΥΤΗΡΙΑ ΔΟΥΚΑ	Αττική	340	Τριτογενής	ΝΑΙ
5	ΜΠΡΑΪΤ ΕΙΔΙΚΟΣ ΦΩΤΙΣΜΟΣ ΑΕ	Μενίδι Αττικής	130	Βιομηχανία	ΝΑΙ
6	ΠΑΠ ΧΟΤΕΛΣ ΚΟΡΠ ΑΕ	Ξενοδοχείο ASTORIA Ν. Χαλκιδικής	70	Τριτογενής	ΝΑΙ

Α/Α	ΕΤΑΙΡΕΙΑ	ΘΕΣΗ	ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ (kW)	ΤΟΜΕΑΣ	ΛΕΙΤΟΥΡΓΙΑ
1	TOP KRAFT BAKERY PRODUCTION	Θεσσαλονίκη	4.5	Βιομηχανία	ΝΑΙ
2	ΙΔΙΩΤΙΚΗ ΚΑΤΟΙΚΙΑ	Θεσσαλονίκη	4.5	Οικιακός	ΝΑΙ
3	PHILLIPOS XENIA HOTEL	Σέρρες	4.5	Τριτογενής	ΝΑΙ
4	HOTEL MANTHOS	Πήλιο	4.5	Τριτογενής	ΝΑΙ
5	ORESTIAS KASTORIA HOTEL	Θεσσαλονίκη	4.5	Τριτογενής	ΝΑΙ
6	Πολυκατοικία	Θεσσαλονίκη	4.5	Οικιακός	ΝΑΙ

CHP units in operation in Greece

Δ. ΜΟΝΑΔΕΣ ΠΟΛΥ ΜΙΚΡΗΣ ΣΗΘΥΑ (<50 kW)

A/A	ΕΤΑΙΡΕΙΑ	ΘΕΣΗ	ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ (kW)	ΤΟΜΕΑΣ	ΛΕΙΤΟΥΡΓΙΑ
1	TOP KRAFT BAKERY PRODUCTION	Θεσσαλονίκη	4.5	Βιομηχανία	ΝΑΙ
2	ΙΔΙΩΤΙΚΗ ΚΑΤΟΙΚΙΑ	Θεσσαλονίκη	4.5	Οικιακός	ΝΑΙ
3	PHILLIPOS XENIA HOTEL	Σέρρες	4.5	Τριτογενής	ΝΑΙ
4	HOTEL MANTHOΣ	Πήλιο	4.5	Τριτογενής	ΝΑΙ
5	ORESTIAS KASTORIA HOTEL	Θεσσαλονίκη	4.5	Τριτογενής	ΝΑΙ
6	Πολυκατοικία	Θεσσαλονίκη	4.5	Οικιακός	ΝΑΙ

Green Energy Investment Perspectives

by

Dr. Ioannis TSIPOURIDIS,

General Manager at R.E.D. Pro Consultants – Renewable Energy Development Professionals in Greece

Abstract

The dire necessity to proceed speedily to an uprooting energy transition from fossil fuels to clean energy generation is dictated by the dramatic manifestations of climate change around the globe, caused by the rise in the average earth surface temperature, the result of continuously increasing GHG concentrations in the atmosphere.

Science has decreed the action to be taken and technology has provided the tools. Now it's up to politicians, the markets and the global economy to rise to the challenge and move away from an energy system based on polluting fossil fuels and into the era of a zero carbon economy. The presentation provides information on how the economy and the markets have already reacted positively by directing investments to clean technologies, which in turn contribute, in conjunction with technological improvements, to a reduction of the new technologies cost.

As a result, new technologies are competing favorably with the old polluting energy sources which hang on to existence by one and only characteristic: that they are still comparatively cheap since their external pollution cost has not been incorporated into their selling price. And even so clean energy sources fair better.

The presentation also covers funding opportunities offered by the new Green Climate Fund, the newest funding tool offered by the global community under the auspices of UNFCCC. Finally, it touches upon the perennial failure of the Greek political system to appreciate the economic and social benefits for the country, hidden in the renewable energy sources found in abundance in Greece.


2nd Green Energy Investments Forum
Dr. Ioannis Tsipouridis
General Manager R.E.D. Pro Consultants
Former Chairman of Board & C.E.O
Hellenic Wind Energy Association
The PROMITHEAS Network
10th International Conference
"Energy and Climate Change",
11-13 October 2017, Athens


Contents.
✓Green Energy investment perspectives
✓Green Climate Fund
✓Perspectives of green investing in Greece
✓100% RES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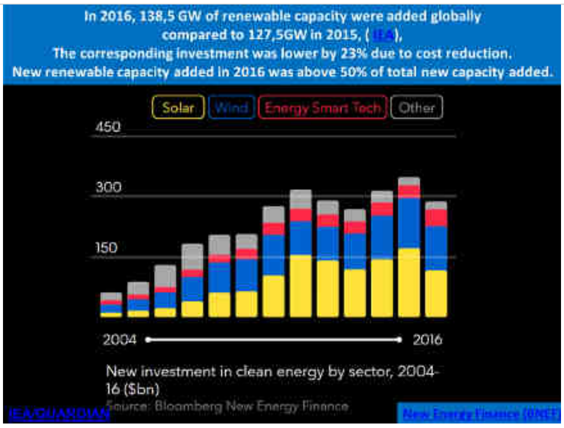
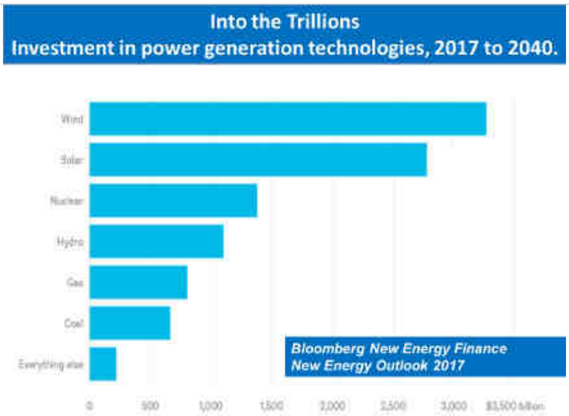
✓Green Energy investment perspectives
✓Green Climate Fund
✓Perspectives of green investing in Greece
✓100% RES

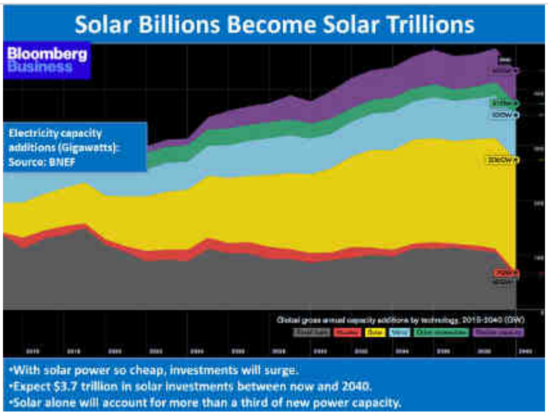

Bloomberg New Energy Finance
New Energy Outlook 2017

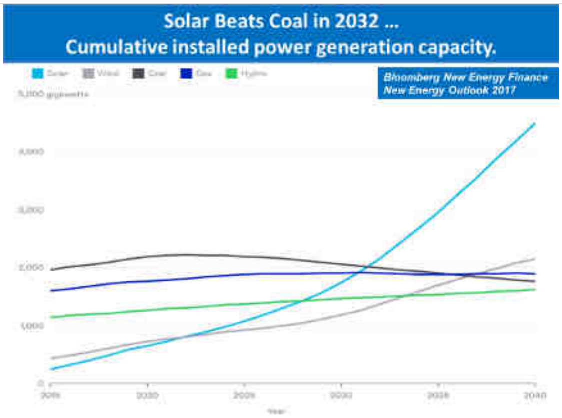

The Bloomberg report:
The renewable-energy boom is here.
Trillions of dollars will be invested over the next 25 years, driving some of the most profound changes yet in how humans get their electricity.
About $8 trillion, or two thirds of the world's spending on new power capacity over the next 25 years, will go toward renewables!!!!v
Thanks to rapidly falling costs for solar and wind power, and a growing role for batteries (incl. electric vehicle batteries), in balancing supply and demand.
Bloomberg Business
New forecast by Bloomberg New Energy Finance.

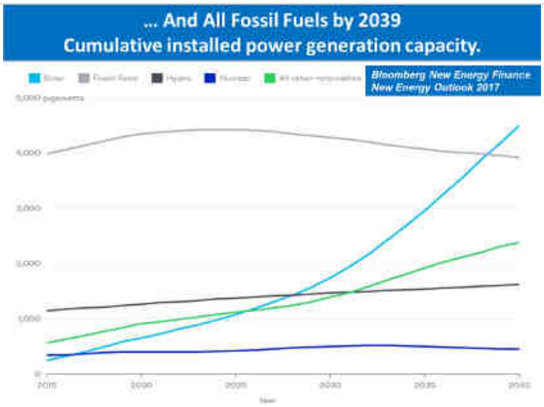

In 2016, 138,5 GW of renewable capacity were added globally compared to 127,5GW in 2015, (IEA),
The corresponding investment was lower by 23% due to cost reduction.
New renewable capacity added in 2016 was above 50% of total new capacity added.
Solar
Wind
Energy Smart Tech
Other
450
300
150
2004
2016
New investment in clean energy by sector, 2004-16 ($bn)
Source: Bloomberg New Energy Finance


Rapidly falling costs for solar and wind power
➢Solar is already at least as cheap as coal in
➢Germany, Australia, the U.S., Spain and Italy.
➢The levelized cost of electricity from solar is set to drop another 66% by 2040.
➢By 2021, it will be cheaper than coal in
➢China, India, Mexico, the U.K. and Brazil as well.
➢Onshore wind costs fall fast, and offshore falls faster
➢Onshore wind levelized costs will fall 47% by 2040, thanks to cheaper, more efficient turbines and advanced OPEX regimes.
➢In the same period, offshore wind costs will slide a whopping 71%, helped by experience, competition, and economies of scale.

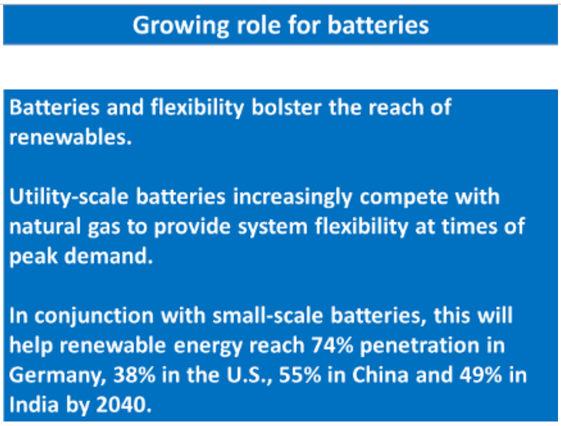

Into the Trillions
Investment in power generation technologies, 2017 to 2040.
Wind
Solar
Nuclear
Hydro
Gas
Coal
Everything else
Bloomberg New Energy Finance
New Energy Outlook 2017
0
500
1,000
1,500
2,000
2,500
3,000
$3,500 billion

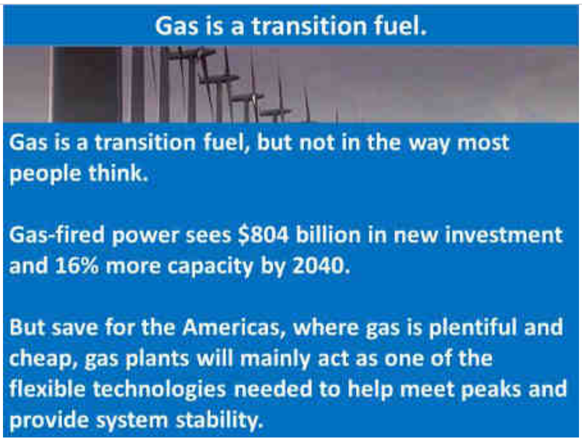

Solar Billions Become Solar Trillions
Bloomberg Business
Electricity capacity additions (Gigawatts): Source: BNEF
•With solar power so cheap, investments will surge.
•Expect $3.7 trillion in solar investments between now and 2040.
•Solar alone will account for more than a third of new power capacity.


Solar Beats Coal in 2032 …
Cumulative installed power generation capacity.
Bloomberg New Energy Finance
New Energy Outlook 2017

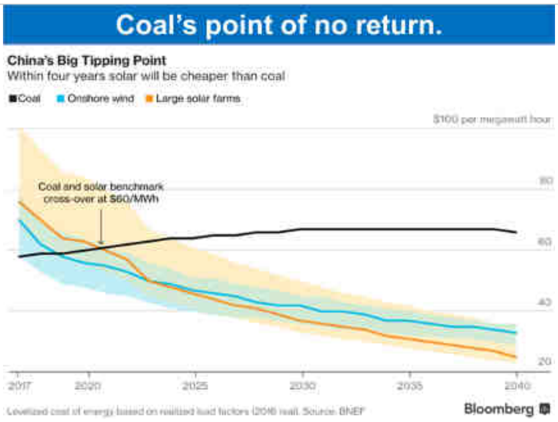

… And All Fossil Fuels by 2039
Cumulative installed power generation capacity.
Bloomberg New Energy Finance
New Energy Outlook 2017

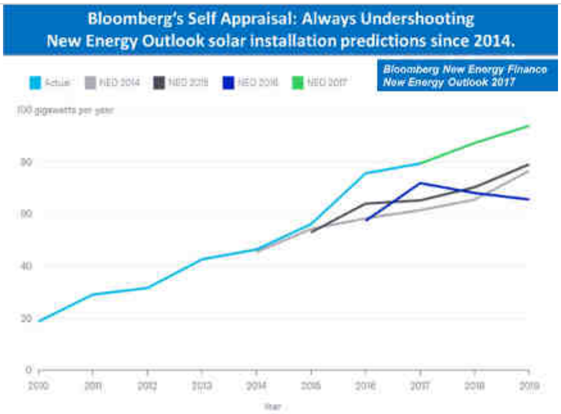

Homeowners' love of solar grows.
By 2040, rooftop PV will account for as much as 24% of electricity in Australia, 20% in Brazil, 15% in Germany, 12% in Japan, and 5% in the U.S. and India.
This, combined with the growth of large-scale renewables, reduces the need for existing large-scale coal and gas plants.


Growing role for batteries
Batteries and flexibility bolster the reach of renewables.
Utility-scale batteries increasingly compete with natural gas to provide system flexibility at times of peak demand.
In conjunction with small-scale batteries, this will help renewable energy reach 74% penetration in Germany, 38% in the U.S., 55% in China and 49% in India by 2040.

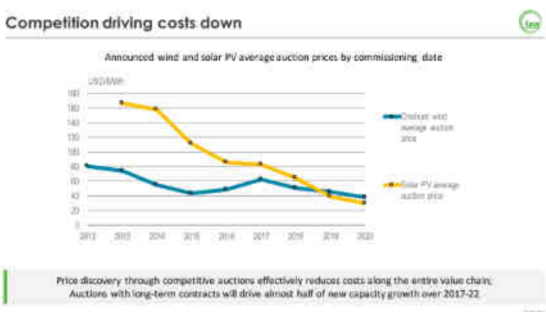

Gas is a transition fuel.
Gas is a transition fuel, but not in the way most people think.
Gas-fired power sees $804 billion in new investment and 16% more capacity by 2040.
But save for the Americas, where gas is plentiful and cheap, gas plants will mainly act as one of the flexible technologies needed to help meet peaks and provide system stability.


Coal's point of no return.
Sluggish demand, cheap renewables and coal-gas fuel switching slash coal use by 87% in Europe and 45% in the U.S. by 2040, while coal generation continues to grow in China but reaches peak in 2026.
A mere 18% of planned new coal power plants will ever get built. That means 369GW of projects stand to be cancelled.


Coal's point of no return.
China's Big Tipping Point
Within four years solar will be cheaper than coal
Coal
Onshore wind
Large solar farms
$100 per megawatt hour
Coal and solar benchmark cross-over at $60/MWh
Bloomberg



I.E.A. RENEWABLES REPORT OCTOBER 2017.



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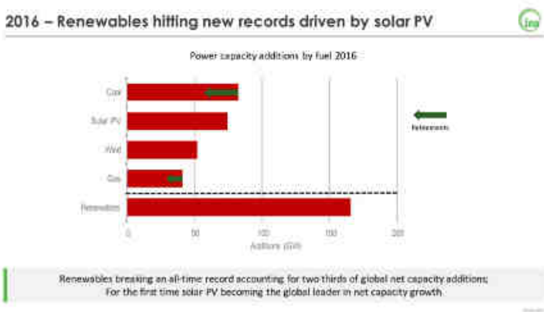

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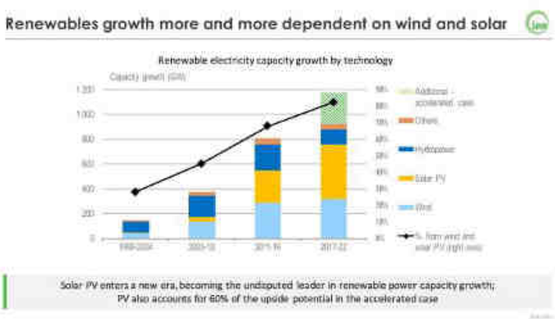
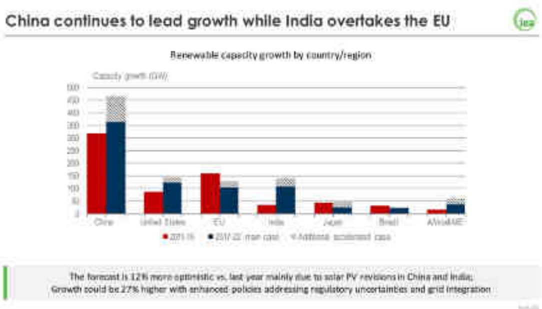
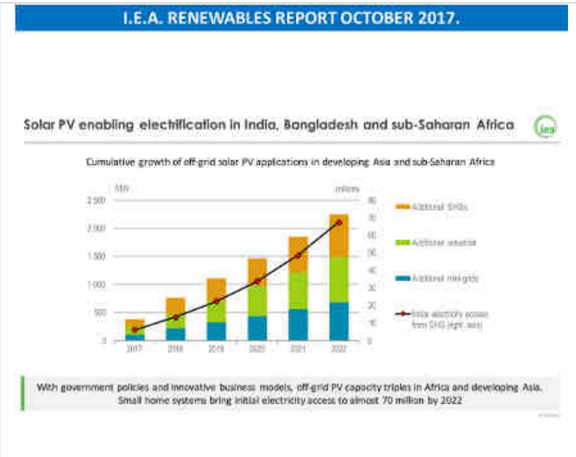
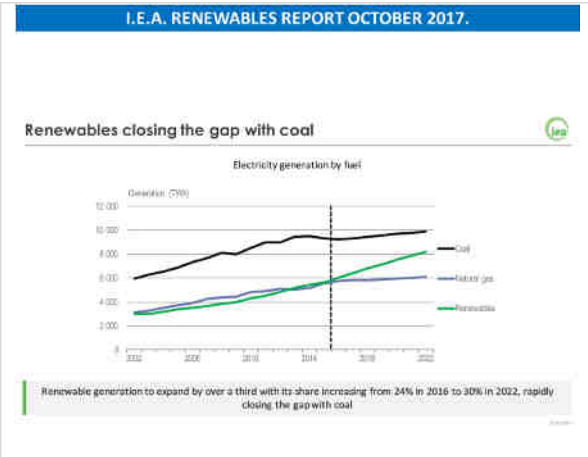
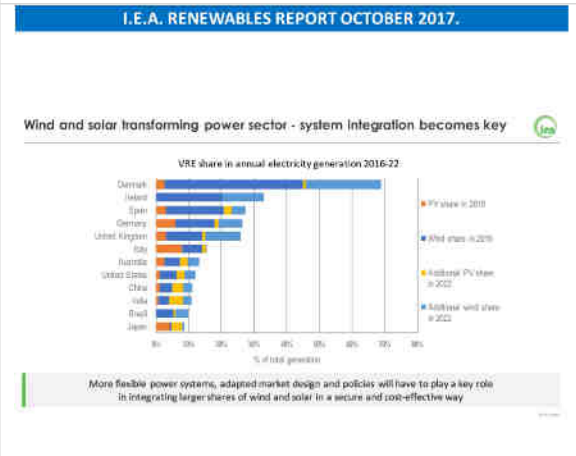


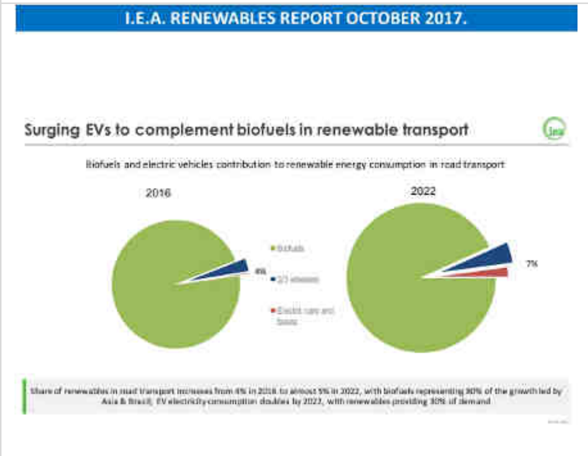
I.E.A. RENEWABLES REPORT OCTOBER 2017.

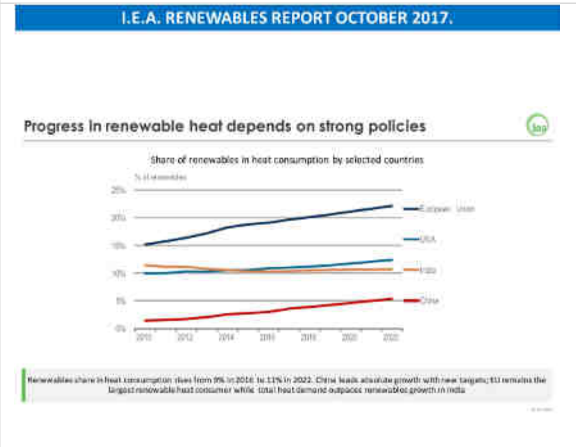



I.E.A. RENEWABLES REPORT OCTOBER 2017.
Solar PV enabling electrification in India, Bangladesh and sub-Saharan Africa
Cumulative growth of off-grid solar PV applications in developing Asia and sub-Saharan Africa
With government policies and innovative business models, off-grid PV capacity triples in Africa and developing Asia. Small home systems bring initial electricity access to almost 70 million by 2022

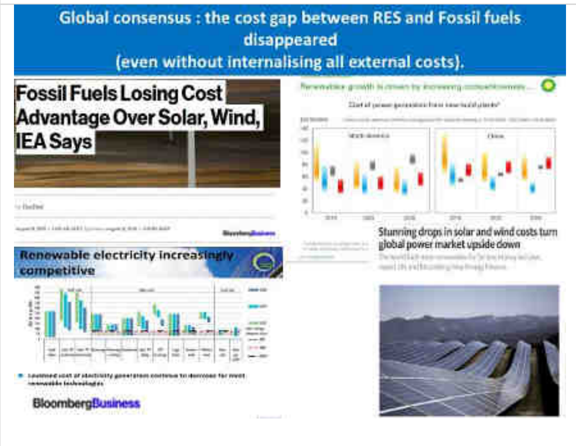

I.E.A. RENEWABLES REPORT OCTOBER 2017.
Renewables closing the gap with coal
Electricity generation by fuel
Renewable generation to expand by over a third with its share increasing from 24% in 2016 to 30% in 2022, rapidly closing the gap with coal

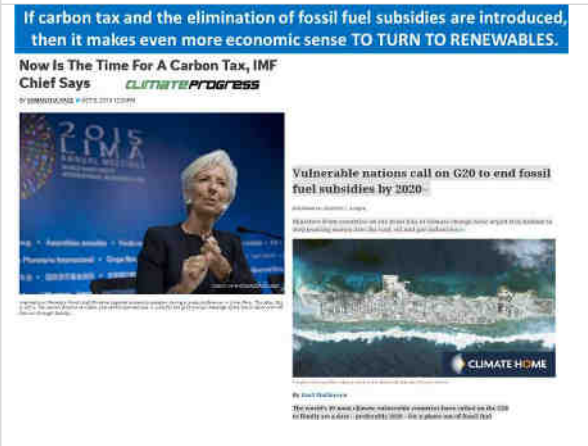

I.E.A. RENEWABLES REPORT OCTOBER 2017.
Wind and solar transforming power sector - system integration becomes key
VRE share in annual electricity generation 2016-22
More flexible power systems, adapted market design and policies will have to play a key role in integrating larger shares of wind and solar in a secure and cost-effective way

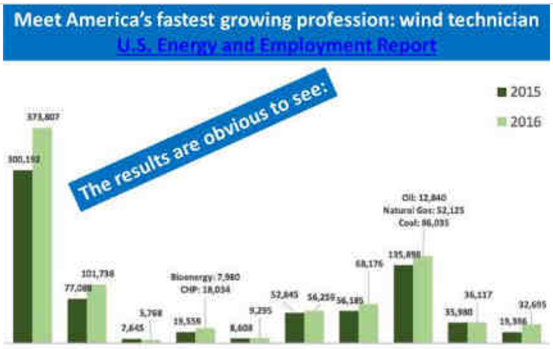

I.E.A. RENEWABLES REPORT OCTOBER 2017.
Surging EVs to complement biofuels in renewable transport
Biofuels and electric vehicles contribution to renewable energy consumption in road transport
2016
2022

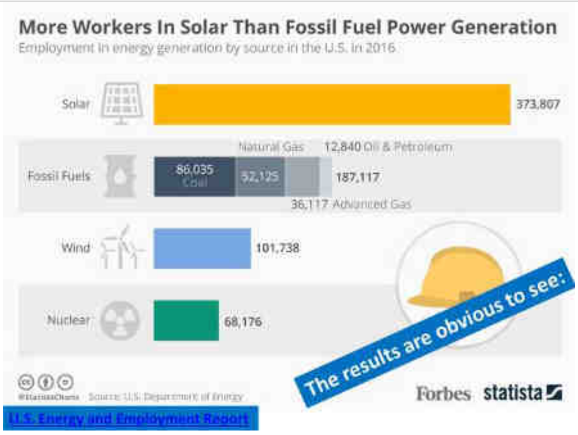

I.E.A. RENEWABLES REPORT OCTOBER 2017.
Progress in renewable heat depends on strong policies
Share of renewables in heat consumption by selected countries

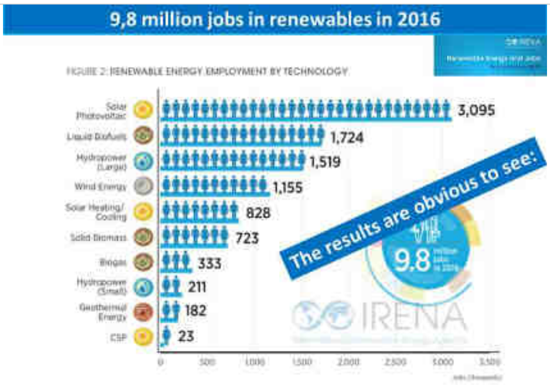

I.E.A. RENEWABLES REPORT OCTOBER 2017.
Concluding remarks
Renewables rise by 1,000 GW to 2022, equal to half of current total coal capacity
Renewables generation exceeds 8,000 TWh by 2022, equal to total electricity consumption of China, India & Germany combined
Solar PV enters a new era leading the growth in renewables, driven by a rapid expansion in deployment & manufacturing capacity in China
Despite rapid growth in EVs, decarbonisation of transport is a long way off
Only 30% of electricity used by EVs is sourced from renewables
Advanced biofuels require specific incentives to bolster deployment
Policymakers have to turn their focus to system integration & expanding the use of renewables for heating & cooling

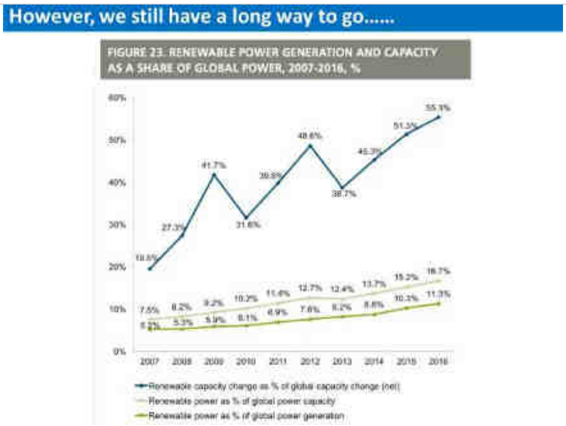

Global consensus : the cost gap between RES and Fossil fuels disappeared
(even without internalising all external costs).
Fossil Fuels Losing Cost Advantage Over Solar, Wind, IEA Says
Renewable electricity increasingly competitive
BloombergBusiness
Stunning drops in solar and wind costs turn global power market upside down


If carbon tax and the elimination of fossil fuel subsidies are introduced, then it makes even more economic sense TO TURN TO RENEWABLES.
Now Is The Time For A Carbon Tax, IMF Chief Says
CLIMATEPROGRESS
Vulnerable nations call on G20 to end fossil fuel subsidies by 2020
CLIMATE HOME

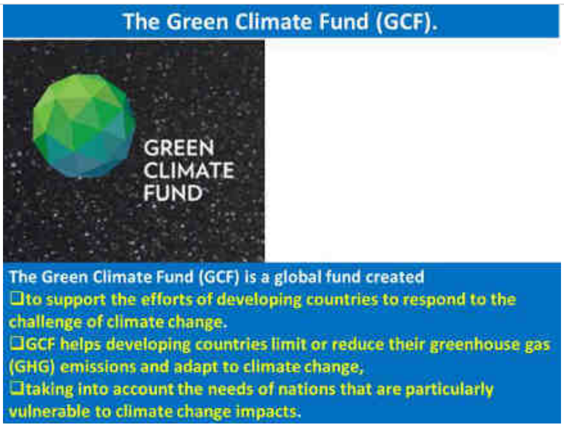

Meet America's fastest growing profession: wind technician
U.S. Energy and Employment Report
The results are obvious to see:
2015
2016


More Workers In Solar Than Fossil Fuel Power Generation
Employment in energy generation by source in the U.S. in 2016
Solar
373,807
Natural Gas
12,840 Oil & Petroleum
Fossil Fuels
86,035 Coal
52,125
187,117
36,117 Advanced Gas
Wind
101,738
Nuclear
68,176
The results are obvious to see:
Forbes statista
U.S. Energy and Employment Report


9,8 million jobs in renewables in 2016
3,095
1,724
1,519
1,155
828
723
333
211
182
23
The results are obvious to see:
9.8
IRENA


However, we still have a long way to go......
FIGURE 23. RENEWABLE POWER GENERATION AND CAPACITY AS A SHARE OF GLOBAL POWER, 2007-2016, %


Contents.
✓Green Climate Fund
✓Perspectives of green investing in Greece
✓100% RES


The Green Climate Fund (GCF).
GREEN CLIMATE FUND
The Green Climate Fund (GCF) is a global fund created
❑to support the efforts of developing countries to respond to the challenge of climate change.
❑GCF helps developing countries limit or reduce their greenhouse gas (GHG) emissions and adapt to climate change,
❑taking into account the needs of nations that are particularly vulnerable to climate change impacts.


The Green Climate Fund (GCF).
GREEN CLIMATE FUND
❑It was set up by the 194 countries who are parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, as part of the Convention's financial mechanism.
❑It aims to deliver equal amounts of funding to mitigation and adaptation, while being guided by the Convention's principles and provisions.
❑ When the Paris Agreement was reached in 2015, the Green Climate Fund was given an important role in serving the agreement and supporting the goal of keeping climate change well below 2 degrees Celsius.


The Green Climate Fund (GCF).
GREEN CLIMATE FUND
❑Advanced economies have agreed to jointly mobilize significant financial resources.
❑Coming from a variety of sources, these resources address the pressing mitigation and adaptation needs of developing countries.
❑GCF launched its initial resource mobilization in 2014, and rapidly gathered pledges worth USD 10.3 billion.
❑These funds come mainly from developed countries, but also from some developing countries, regions, and one city (Paris).

The Green Climate Fund (GCF).

GCF's activities are aligned with the priorities of developing countries through the principle of country ownership,
and the Fund has established a direct access modality so that national and sub-national organisations can receive funding directly, rather than only via international intermediaries.
The Fund pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, in particular
- Least Developed Countries (LDCs),
- Small Island Developing States (SIDS),
- and African States.

The Green Climate Fund (GCF).

- GCF aims to catalyze a flow of climate finance to invest in low-emission and climate-resilient development, driving a paradigm shift in the global response to climate change.
- Use of public investment to stimulate private finance, unlocking the power of climate-friendly investment for low emission, climate resilient development.
- The Fund's investments can be in the form of grants, loans, equity or guarantees.

The Green Climate Fund (GCF).

GCF invests in adaptation and mitigation activities in developing countries, managing a project portfolio that is implemented by its partner organisations, known as Accredited Entities.
GCF's approach is marked by several distinct features:

BALANCED PORTFOLIO.
- The Fund aims for a 50:50 balance between mitigation and adaptation investments over time.
- It also aims for a floor of 50 percent of the adaptation allocation for particularly vulnerable countries, including Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States.

The Green Climate Fund (GCF).

UNLOCKING PRIVATE FINANCE.
- The Fund is unique in its ability to engage directly with both the public and private sectors in transformational climate-sensitive investments.
- GCF engages directly with the private sector through its Private Sector Facility (PSF).
- As part of its innovative framework, it has the capacity to bear significant climate-related risk, allowing it to leverage and crowd in additional financing.

The Green Climate Fund (GCF).

COUNTRY OWNERSHIP.
GCF recognizes the need to ensure that developing country partners exercise ownership of climate change funding and integrate it within their own national action plans. Developing countries appoint a National Designated Authority (NDA) that acts as the interface between their government and GCF, and must approve all GCF project activities within the country. This country-driven approach ensures GCF's activities operate in harmony with national priorities.

The aim of all GCF activities is to support developing countries limit or reduce their greenhouse gas emissions and adapt to climate change impacts.

The Green Climate Fund (GCF).

- 2009: The general concept for GCF is first proposed at the Conference of the Parties (COP) to the UNFCCC in Copenhagen, Denmark (COP 15).
- 2010: The COP in Cancun, Mexico (COP 16), decides to establish GCF.
- 2014: Following the establishment of its operational principles and guidelines, GCF commences its initial resource mobilization, raising over USD 10 billion equivalent by the end of the year. Initial mobilization lasts until 2018, while the Fund remains open for further contributions during this time from both public and private sources.
- 2015: The first investment decisions are taken, including both mitigation and adaptation projects, meeting the target set by the UNFCCC in advance of the Paris COP. 195 countries agree to the historic Paris Agreement, which GCF now serves as a financial mechanism of the Convention.
- 2016: Marks GCF's first full year of operations, with the Fund developing a project portfolio of 35 projects, worth over USD 1.5 billion by the end of the year, to be implemented by its 48 Accredited Entities.

The Green Climate Fund (GCF).

Cairo, 02 Oct 2017

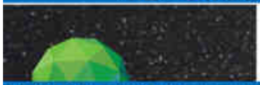
The Green Climate Fund (GCF) concluded its last Board meeting of 2017 by approving 11 new projects and programmes valued at USD 392.86 million to assist developing countries respond to climate change.

Taking these projects into account, the Fund's portfolio now consists of 54 projects and programmes amounting to USD 2.59 billion in GCF funding.

The Green Climate Fund (GCF).

The following projects and programmes were approved :
- ✓B.18: FP046 – USD 8.65 million for the Renewable Energy Programme #1 – Solar in Mongolia with XacBank.
- ✓FP047 – USD 110 million for the GCF-EBRD Kazakhstan Renewables Framework programme in Kazakhstan with the European Bank for Reconstruction and Development (EBRD).
- ✓FP048 – USD 20 million for Low Emissions and Climate Resilient Agriculture Risk Sharing Facility programme in Guatemala and Mexico with the Inter-American Development Bank.
- ✓FP049 – USD 9.98 million for Building the Climate Resilience of Food Insecure Smallholder Farmers Through Integrated Management of Climate Risk project in Senegal with the United Nations World Food Programme (WFP).
- ✓FP050 – USD 26.56 million for the Bhutan for Life project in Bhutan with the World Wildlife Fund (WWF).
- ✓FP051 – USD 17.35 million for the Scaling-up Investment in Low-Carbon Public Buildings project in Bosnia and Herzegovina with the United Nations Development Programme (UNDP).

The Green Climate Fund (GCF).



The following projects and programmes were approved :

✓FP052 – USD 26.91 million for the Sustainable and Climate Resilient Connectivity for Nauru project in Nauru with the Asian Development Bank (ADB).

✓FP053 – USD 31.39 million for the Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions in Egypt project with the United Nations Development Programme (UNDP).

✓FP054 – USD 58.53 million for the Implementation Project for the Management Plan of the Lujan River Basin in Argentina with the Development Bank of Latin America (CAF).

✓FP056 – USD 38.5 million for the Scaling up Climate Resilient Water Management Practices for Vulnerable Communities in La Mojana project in Colombia with the United Nations Development Programme (UNDP).

✓FP058 – USD 45 million for the Responding to the Increasing Risk of Drought: Building Gender-responsive Resilience of the Most Vulnerable Communities project in Ethiopia with the Ethiopian Ministry of Finance and Economic Cooperation (MoFEC).

Contents.

The Green Climate Fund (GCF).

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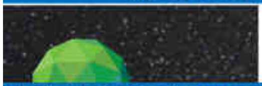


Greece's targets according to EU Directive 28/2009

Overall target : **18% of share of energy generated** from renewable sources in gross final energy consumption (**20%** unilaterally):

✓**Heating and cooling: 20% of heat consumption** met by renewable sources;

✓**Electricity: 40% of electricity demand** met by electricity generated from renewable energy sources;

✓**Transport: 10% of energy demand** met by renewable energy sources.

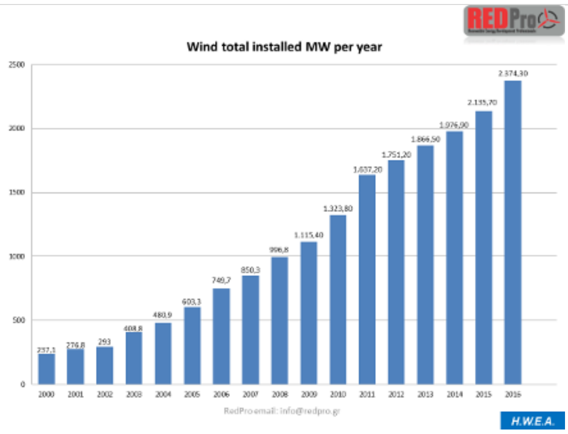
Share of renewable consumption to gross final energy consumption.
Comprises of direct use of renewables (e.g. biofuels) plus energy produced from renewables (e.g. wind, hydro).
Final energy consumption is the energy that households, industry, services, agriculture and the transport sector use.

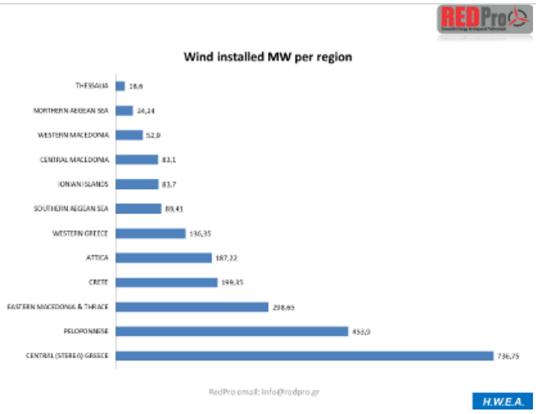
EU Member State	2006	2007	2008	2020 Target	% To cover:
Greece	7.2 %	8.1 %	7.9 %	18 %	10.1 %
Germany	6.9 %	9 %	8.9 %	18 %	9.1 %
Denmark	16.8 %	18.1 %	18.7 %	30 %	11.3 %
Portugal	20.5 %	22.2 %	23 %	31 %	8 %

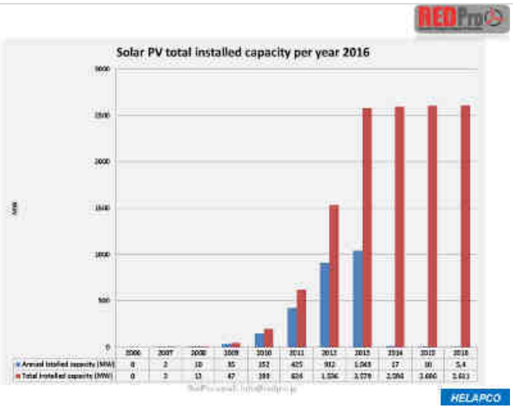
The road map to the 2020 target (2014 - 2020)

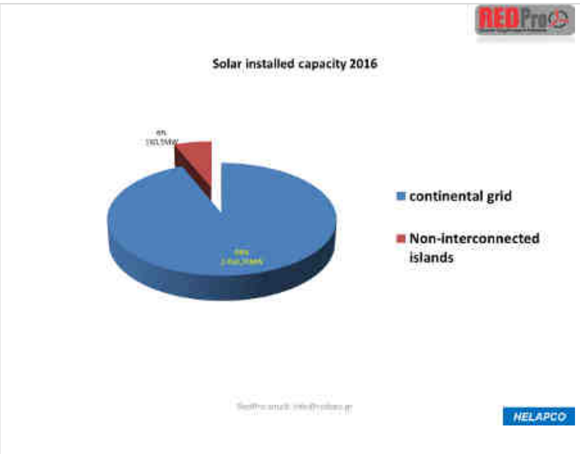
Technology	Capacity (MW)	
	2014	2020
Small Hydro (<=15MW)	300	350
PV	1500	2200
CSP	120	250
Wind (inland and offshore)	4000	7500
Geothermal	0	120
Biomass	200	350

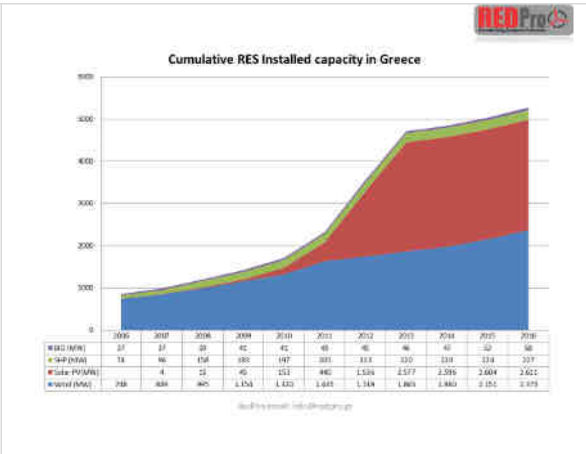
Estimated investment in RES (2010-2020) = 16,5 b€

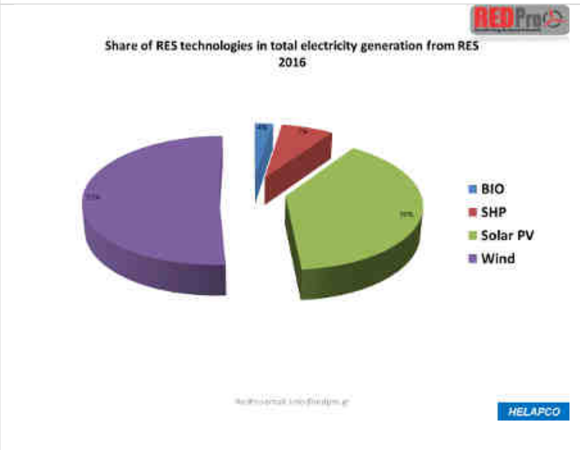


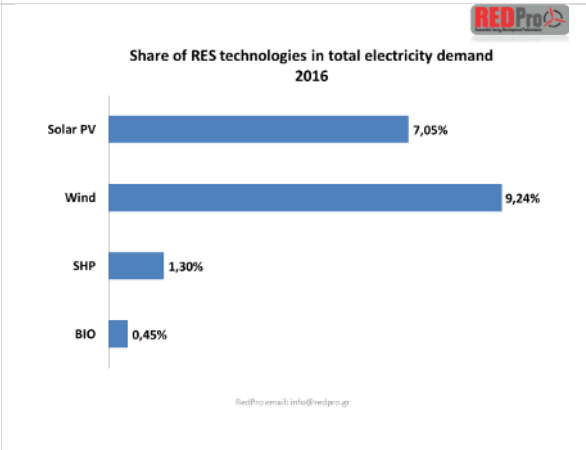


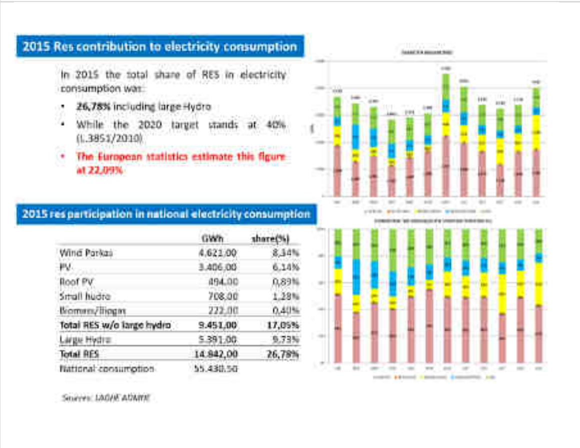




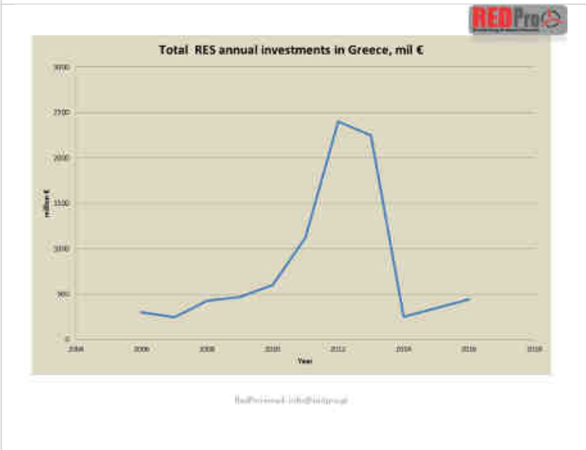


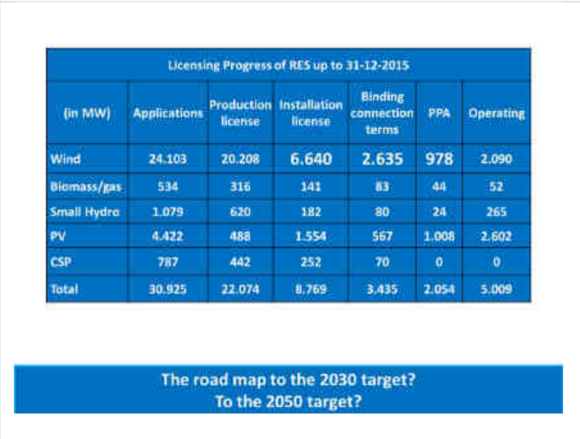






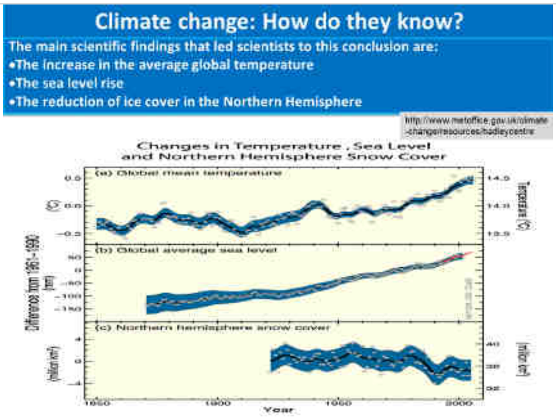
	GWh	share(%)
Wind Parkas	4.621,00	8,34%
PV	3.406,00	6,14%
Roof PV	494,00	0,89%
Small hudro	708,00	1,28%
Biomass/Biogas	222,00	0,40%
Total RES w/o large hydro	**9.451,00**	**17,05%**
Large Hydro	5.391,00	9,73%
Total RES	**14.842,00**	**26,78%**
National consumption	55.430,50	



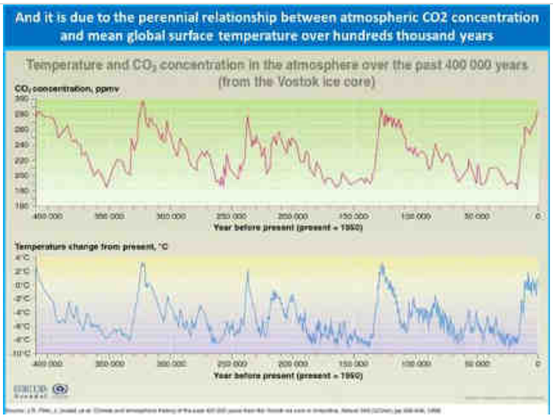

Licensing Progress of RES up to 31-12-2015

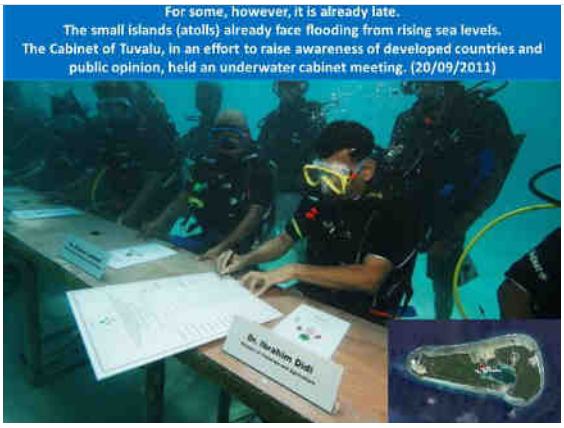
(in MW)	Applications	Production license	Installation license	Binding connection terms	PPA	Operating
Wind	24.103	20.208	6.640	2.635	978	2.090
Biomass/gas	534	316	141	83	44	52
Small Hydro	1.079	620	182	80	24	265
PV	4.422	488	1.554	567	1.008	2.602
CSP	787	442	252	70	0	0
Total	30.925	22.074	8.769	3.435	2.054	5.009


Climate change: Who says so?
The overwhelming majority of the scientists (> 97%) agree that:
• climate change is happening now and
• the primary cause are human activities
13,950 peer-reviewed climate articles
1991-2012
24 reject global warming


Climate change: How do they know?
The main scientific findings that led scientists to this conclusion are:
•The increase in the average global temperature
•The sea level rise
•The reduction of ice cover in the Northern Hemisphere
Changes in Temperature, Sea Level
and Northern Hemisphere Snow Cover
(a) Global mean temperature
(b) Global average sea level
(c) Northern hemisphere snow cover
Difference from 1961-1990
Year

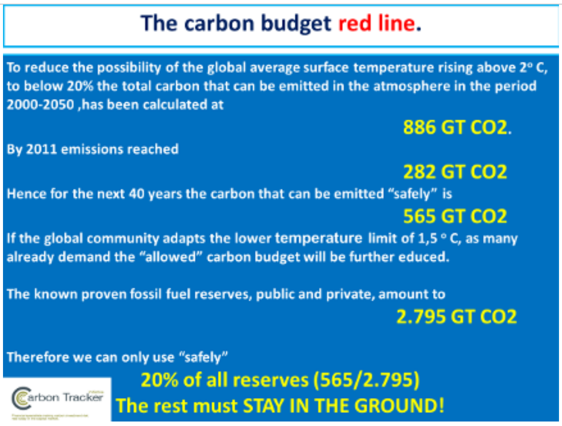

Climate change: Why is it happening?
The greenhouse effect.
We are already past
the 400ppm mark,
that was set as a red line
a few years ago.....
Planet Reaches 410 ppm for First Time in Human History
EcoWatch

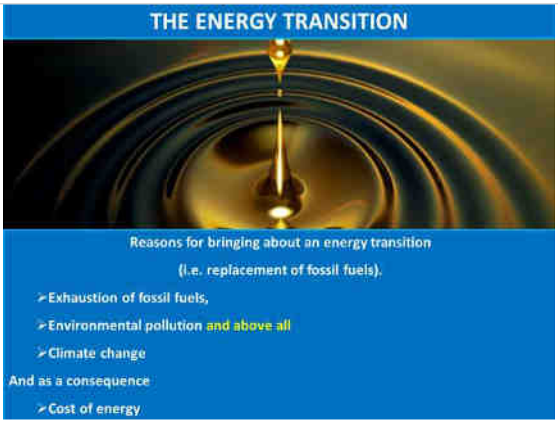

And it is due to the perennial relationship between atmospheric CO2 concentration
and mean global surface temperature over hundreds thousand years
Temperature and CO_2 concentration in the atmosphere over the past 400 000 years
(from the Vostok ice core)
CO_2 concentration, ppmv
Year before present (present = 1950)
Temperature change from present, °C
Year before present (present = 1950)

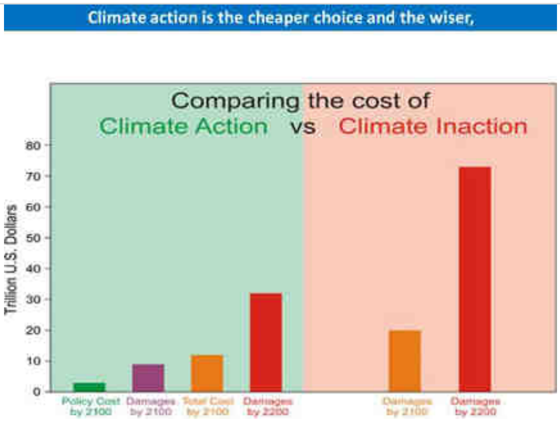

For some, however, it is already late.
The small islands (atolls) already face flooding from rising sea levels.
The Cabinet of Tuvalu, in an effort to raise awareness of developed countries and
public opinion, held an underwater cabinet meeting. (20/09/2011)
Dr. Ibrahim Didi

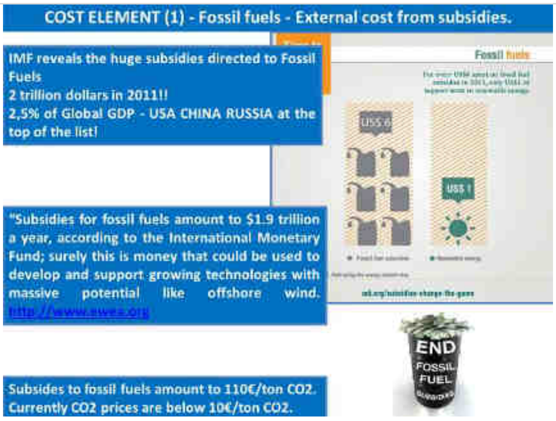

Climate change threat
Climate change will create more climate refugeees
theguardian
Failure to act on climate change means
an even bigger refugee crisis
Global warming does not cause the conflicts that have caused mass movement of
people, but it would be wrong to say it does not contribute


WORLD
RESOURCES
INSTITUTE
CARBON BUDGET
THE CARBON BUDGET
The international consensus of climate experts is clear: The world is warming, and it's largely due to human activities. We're now living on a planet where global temperatures are warmer than most of the past 11,000 years.
The Intergovernmental Panel on Climate Change (IPCC) recently identified the world's "carbon budget," the amount of carbon dioxide that can be emitted if we are to have a likely chance of averting the most dangerous of climate change impacts. The world is currently on track to spend the remainder of this budget in just three decades.

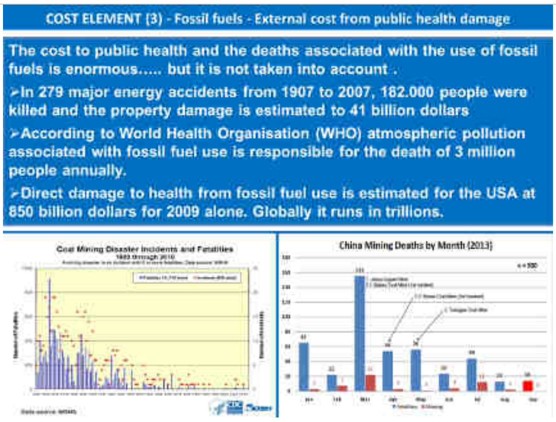

The carbon budget red line.
To reduce the possibility of the global average surface temperature rising above 2° C, to below 20% the total carbon that can be emitted in the atmosphere in the period 2000-2050 ,has been calculated at
886 GT CO2.
By 2011 emissions reached
282 GT CO2
Hence for the next 40 years the carbon that can be emitted "safely" is
565 GT CO2
If the global community adapts the lower temperature limit of 1,5 ° C, as many already demand the "allowed" carbon budget will be further educed.
The known proven fossil fuel reserves, public and private, amount to
2.795 GT CO2
Therefore we can only use "safely"
20% of all reserves (565/2.795)
The rest must STAY IN THE GROUND!
Carbon Tracker


THE ENERGY TRANSITION
Reasons for bringing about an energy transition
(i.e. replacement of fossil fuels).
➢Exhaustion of fossil fuels,
➢Environmental pollution and above all
➢Climate change
And as a consequence
➢Cost of energy


Climate action is the cheaper choice and the wiser,
Comparing the cost of
Climate Action vs Climate Inaction
Trillion U.S. Dollars
Policy Cost by 2100
Damages by 2100
Total Cost by 2100
Damages by 2200
Damages by 2100
Damages by 2200

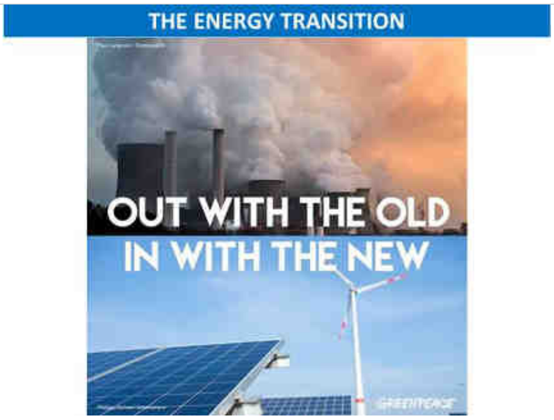

COST ELEMENT (1) - Fossil fuels - External cost from subsidies.
IMF reveals the huge subsidies directed to Fossil Fuels
2 trillion dollars in 2011!!
2,5% of Global GDP - USA CHINA RUSSIA at the top of the list!
"Subsidies for fossil fuels amount to $1.9 trillion a year, according to the International Monetary Fund; surely this is money that could be used to develop and support growing technologies with massive potential like offshore wind.
http://www.ewea.org
Subsides to fossil fuels amount to 110€/ton CO2.
Currently CO2 prices are below 10€/ton CO2.
Fossil fuels
US$ 6
US$ 1
END FOSSIL FUEL

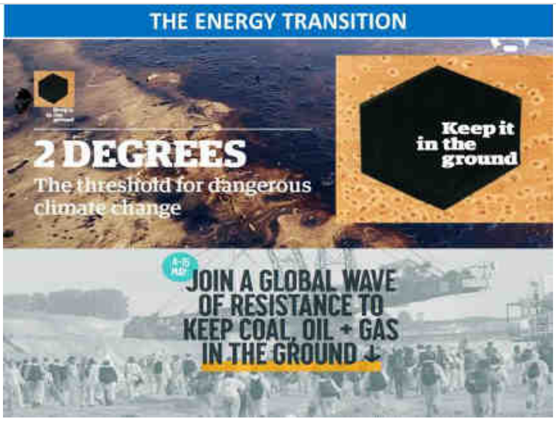

COST ELEMENT (2) - Fossil fuels - External cost from environmental pollution
THE WALL STREET JOURNAL.
IMF Estimates Trillions in Hidden Fossil-Fuel Costs
Fossil fuel use has catastrophic environmental consequences along the whole chain of utilization, namely drilling/mining, transport, storage, burning. The environmental cost is enormous.
It is estimated that in the USA alone, environmental pollution costs between 14-35 dollar cents per KWh.
This corresponds to 886 billion dollars or 6% of its GDP.
If this figure is extrapolated on a global level, the total cost will be a staggering figure of trillions.


COST ELEMENT (3) - Fossil fuels - External cost from public health damage
The cost to public health and the deaths associated with the use of fossil fuels is enormous..... but it is not taken into account .
➢In 279 major energy accidents from 1907 to 2007, 182.000 people were killed and the property damage is estimated to 41 billion dollars
➢According to World Health Organisation (WHO) atmospheric pollution associated with fossil fuel use is responsible for the death of 3 million people annually.
➢Direct damage to health from fossil fuel use is estimated for the USA at 850 billion dollars for 2009 alone. Globally it runs in trillions.
Coal Mining Disaster Incidents and Fatalities
China Mining Deaths by Month (2013)

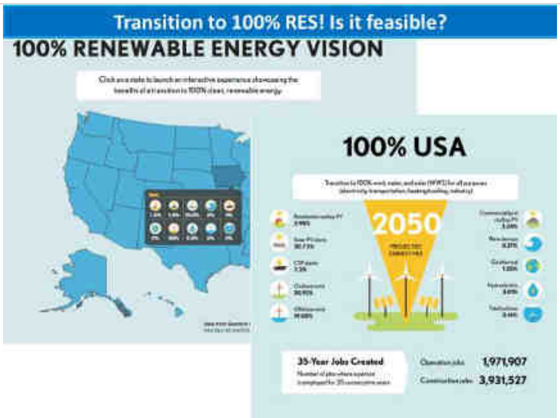

Fossil fuels - External cost from climate changes
The cost from climate catastrophes is rising ....
....but still ignored:
The destruction to peoples and property from climate change phenomena, recorded by the United Nations for the period 2007-2012 is estimated at
2,5 trillion dollars,
with increasing tendencies, of course.
Presently the climate cost is estimated at
1,6% of global GDP
and expected to rise to
3,2% by 2030.
SEVERE WEATHER COST THE NATION $110 BILLION IN DAMAGES IN 2012, THE SECOND-COSTLIEST YEAR IN HISTORY.
#PutAPriceOnCarbon
Reality

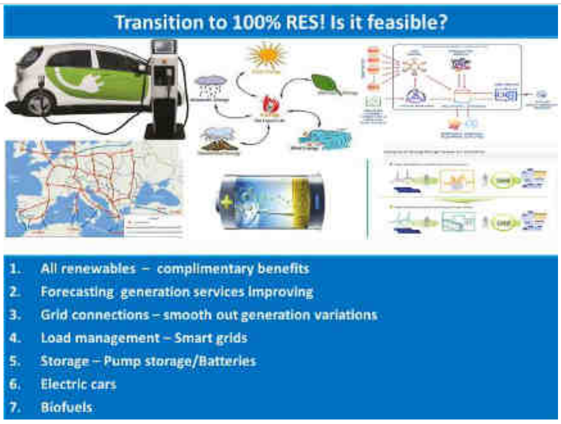

Paris December 2015
The greatest global mobilization ever led 196 countries to agree on the new climate deal, a historic agreement.
Renewable Energy Sources and Energy Efficiency
unlock the solution to the climate crisis.
The world recognizing that the reform of the global energy system is the back bone of climate action, joined forces in the Paris Climate Summit COP21.
The energy sector responsible for 2/3 of carbon emissions must be in the heart of the effort to keep the rise in the average global temperature below 2o Celsius.
The energy reform
✓Meets the climate crisis,
✓Increase energy access,
✓And achieves global sustainability targets
PARIS2015
COP21-CMP11

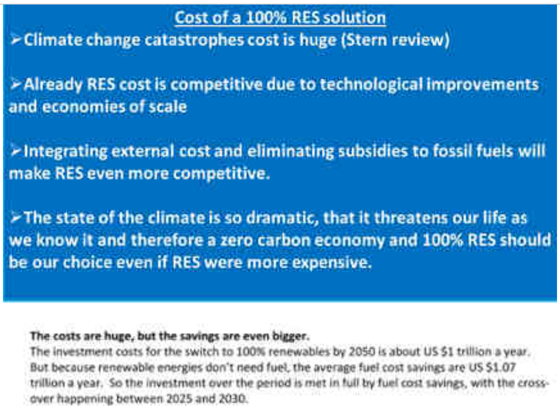

THE ENERGY TRANSITION
OUT WITH THE OLD
IN WITH THE NEW


THE ENERGY TRANSITION
2 DEGREES
The threshold for dangerous climate change
Keep it in the ground
JOIN A GLOBAL WAVE OF RESISTANCE TO KEEP COAL, OIL + GAS IN THE GROUND


Transition to 100% RES! Is it feasible?
SCIENTIFIC AMERICAN
THE SCIENCES MIND HEALTH TECH SUSTAINABILITY EDUCATION VIDEO PODCASTS BLOGS STORE
SUSTAINABILITY
139 Countries Could Get All of their Power from Renewable Sources
Energy from wind, water and sun would eliminate nuclear and fossil fuels


Transition to 100% RES! Is it feasible?
100% RENEWABLE ENERGY VISION
100% USA
2050
35-Year Jobs Created
1,971,907
3,931,527


Transition to 100% RES! Is it feasible?
1. All renewables – complimentary benefits
2. Forecasting generation services improving
3. Grid connections – smooth out generation variations
4. Load management – Smart grids
5. Storage – Pump storage/Batteries
6. Electric cars
7. Biofuels


Cost of a 100% RES solution
➢Climate change catastrophes cost is huge (Stern review)
➢Already RES cost is competitive due to technological improvements and economies of scale
➢Integrating external cost and eliminating subsidies to fossil fuels will make RES even more competitive.
➢The state of the climate is so dramatic, that it threatens our life as we know it and therefore a zero carbon economy and 100% RES should be our choice even if RES were more expensive.
The costs are huge, but the savings are even bigger.
The investment costs for the switch to 100% renewables by 2050 is about US $1 trillion a year. But because renewable energies don't need fuel, the average fuel cost savings are US $1.07 trillion a year. So the investment over the period is met in full by fuel cost savings, with the cross-over happening between 2025 and 2030.


EXXON new about climate change and kept funding climate deniers……
Exxon knew of climate change in 1981, email says - but it funded deniers for 27 more years
theguardian


What if….. A win - win scenario
CLIMATE SUMMIT
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?


Turning to Renewables it's not the best solution.
It is the ONLY solution!!
THE ENERGY REPORT

THANK YOU !

DAY 2: Scientific Conference

Session 1: Energy – Climate Policies

Current trends in CO_2 capture

by

Prof. Krzysztof WARMUZINSKI

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Abstract

There are several commercially available methods which can be used for the removal of CO_2 from flue gases. However, a number of novel approaches are extensively studied, leading to breakthrough technologies. These include hybrid adsorption-membrane systems, poly(ionic liquid) membranes and enzyme-enhanced absorption. The hybrid approach, which combines pressure swing adsorption with membrane separation is an interesting alternative to adsorptive or membrane systems operating as stand-alone units. Extensive experiments performed over a wide range of the operating parameters have consistently shown the possibility to increase the CO_2 content from the initial 12% to over 95%, with a recovery of 100%. The experiments reveal the practical potential of such a technique. In a European project completed this year the possibility of using poly(ionic liquids) (PILs) as membranes was studied. The polymers were synthesized and then transformed into active layers on suitable supports. However, laboratory studies yielded mixed results. Whereas some of the PILs reveal quite interesting properties in terms of the relevant permeabilities and selectivities, most do not yet seem competitive enough compared with the existing polymeric materials. Another new route explored in the project was the enhancement of classical amine absorption by enzymes. The enzyme, carbonic anhydrase, was used in two ways: as an activator dissolved in the absorbing liquid or, alternatively, immobilized on the column packing. The results consistently show that the enzyme-activated absorption is an attractive option, leading to a much faster separation of carbon dioxide from flue gas streams.

Keywords: CO_2 capture, hybrid systems, poly(ionic liquids), carbonic anhydrase.

1. Introduction

The purpose of CO_2 capture is to produce a concentrated stream of CO_2, in a dense super-critical state, that can be readily transported to a storage site. Generally, there are three main approaches to CO_2 capture:

- *Post-combustion* systems, which separate CO_2 from flue gases produced by the combustion in air of a primary fossil fuel (coal, natural gas or oil) or biomass fuel
- *Pre-combustion* systems, which process the primary fuel in a reactor in the presence of steam or oxygen to produce separate streams of CO_2 and hydrogen that is then used as an energy carrier
- *Oxyfuel combustion* systems, which use oxygen instead of air for combustion to produce a flue gas that is mainly water and CO_2, which is subsequently removed for storage.

There are several commercially available technologies which in principle can be used for the removal of CO_2 from flue gases. However, comparative assessment studies have shown that absorption processes based on chemical solvents are currently the preferred option for post-combustion systems. A pre-combustion capture process typically comprises a first stage of reaction producing a mixture of hydrogen and carbon monoxide, followed by the shift reaction to convert CO to CO_2 by the addition of steam. The oxyfuel combustion process eliminates nitrogen from the flue gas by combusting a fuel in either pure oxygen or a mixture of pure oxygen and a CO_2-rich recycled gas to lower the combustion temperature.

There is clearly room for major improvements in the existing capture methods. A conceptual picture of the relative maturity of the various possibilities suggests key areas for further research. These include better oxygen separation and CO_2 absorption, improved solvents and membranes and, possibly, solid sorbents and biotechnology.

In what follows certain key results will be presented concerning novel approaches to post-combustion capture. These results are based on two separate projects focused on (but not limited to) the removal of CO_2 from flue gas streams. The projects included several emerging technologies and demonstrated their relative advantages and drawbacks compared with the established techniques.

2. Adsorptive-membrane hybrid systems

The hybrid approach, which combines adsorption with membrane separation, is an interesting alternative to adsorptive or membrane systems operating as stand-alone units (Figure 2, Warmuzinski et al., 2015). The hybrid process is a natural extension of two-stage adsorptive or membrane separations which, while combining the advantages of the two, mitigates the negative characteristics of these processes, namely, high energy consumption in the case of pressure swing adsorption (PSA) and considerable capital cost of membrane systems.

Extensive experiments performed over a wide range of the operating parameters have consistently shown the possibility to increase CO_2 content from the initial 12 vol.% to over 95 vol.% (or even 99 vol.%, depending on the type of membrane module employed), with a recovery of 100%. The experiments fully corroborate the preliminary theoretical conclusions and reveal the potential of such a technique for efficiently removing carbon dioxide from flue gas streams. Although the scale of the process (5-10m^3 (STP)/h of the feed gas) was small compared with real-life situations, the study has provided a wealth of data that show the principal directions in which further studies should proceed. In particular a rigorous optimization of the process might improve even further its attractiveness as an alternative to the existing, mature capture technologies.

3. Poly(ionic liquid) membranes

A membrane is a thin barrier that allows selective passage of different species. In our case, these species include carbon dioxide, nitrogen, oxygen, water vapour and, possibly, some trace impurities. The performance of the active layer of a membrane depends on a combination of two essential parameters, namely, permeation (which shows the rate at which the individual species are transported across the membrane), and selectivity (which describes the relative ease with which two or more components pass through the membrane).

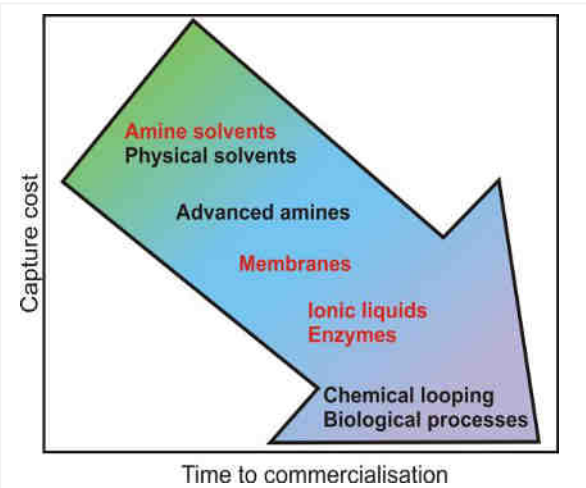

Figure 1: Maturity and cost for various capture options (Mills, 2011). Techniques dealt with in the present paper are highlighted in red.

The combination of the two parameters is commonly given as the so-called Robeson plot. In the Robeson plot the whole permeability-selectivity domain may be divided into two areas. The area above the straight line is the one interesting from the practical standpoint, whereas the region below shows the current status of membrane separative characteristics. In a European project completed this year the possibility of using poly(ionic liquids) (PILs) as membrane layers was studied. The membranes were first synthesized and then transformed into active layers on suitable supports. Their properties are again shown on the Robeson plot (Figure 3, Nikolaeva et al., 2017).

In general, although some of the PILs studied reveal quite interesting properties, these properties do not seem competitive enough compared with those of the existing polymeric materials. It has to be noted, though, that the number of cation-anion combinations is almost infinite, and further research may identify PILs with characteristics by far better than those of the existing materials.

4. Enzyme-enhanced absorption

Another new route explored was the enhancement of classical amine absorption by enzymes. Enzymes are natural bio-catalysts, and some of them have the capability to catalyse the hydration of CO_2. The enzyme selected was carbonic anhydrase, which occurs naturally in human body and is known for its selectivity (Gladis et al., 2017). The enzyme can be used in two ways: as an activator dissolved in the absorbing liquid or, alternatively, immobilized on a packing (Figure 4).

The results consistently show that the enzyme-activated absorption is an attractive option, leading to a much faster separation of carbon dioxide from flue gas streams (Figure 5, Gladis et al., 2017). Although there are several problems associated with the use of enzymes, like scaling-up a relevant process, generating sufficient quantities of enzyme and its thermal stability, an option to overcome the temperature limitation of the enzyme is to recover it before the regeneration of the solvent is carried out.

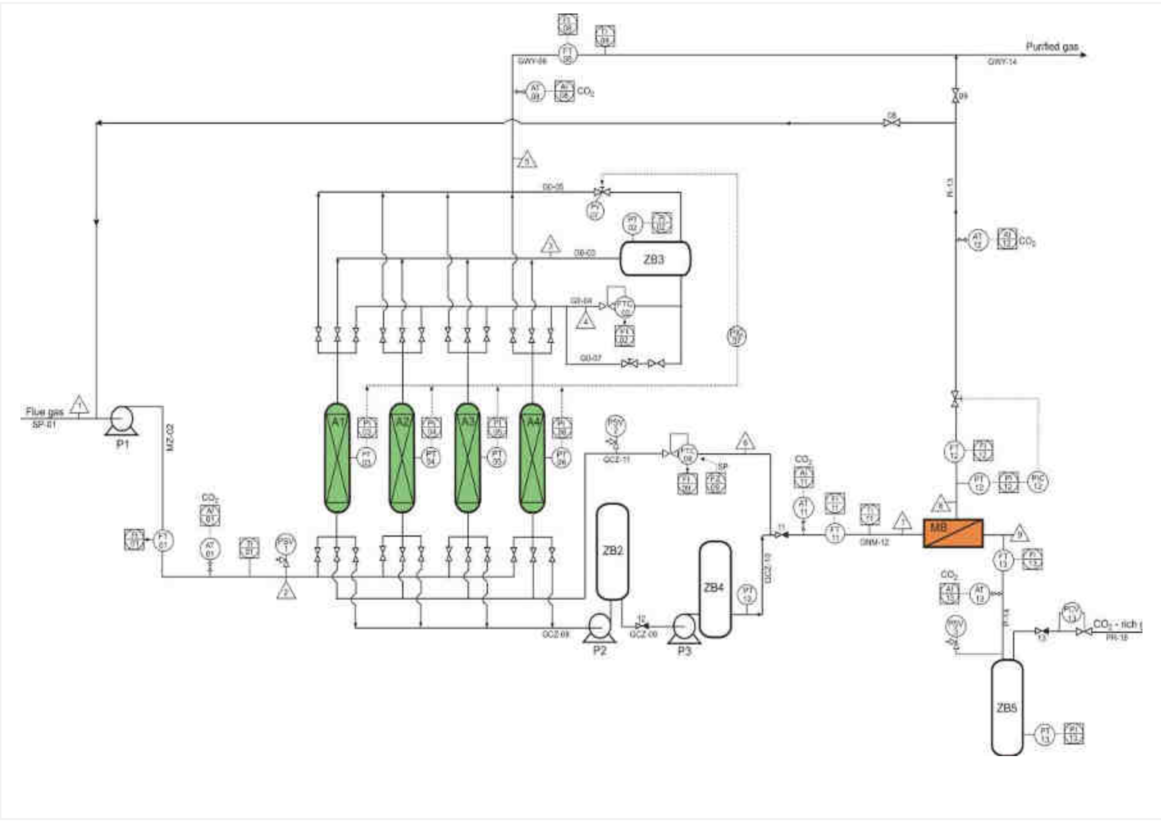

Figure 2: Hybrid installation for the CO_2 capture from flue gases (A1-A4 – adsorbers, AT – gas composition, MB – membrane module, PT – pressure, P1 – blower, P2 – vacuum pump, P3 – compressor, TI – temperature, FT – gas flow rate, ZB2 – enriched gas, ZB3 – purified gas, ZB4 – buffer tank, ZB5 – CO_2) (Warmuzinski et al., 2015).

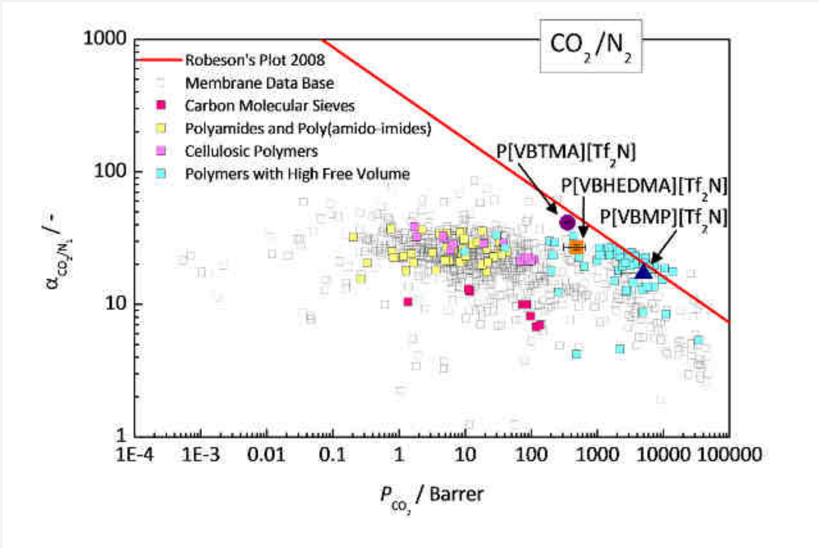

Figure 3: Robeson plot showing the separative properties of some of the poly(ionic liquid) membranes (Nikolaeva et al., 2017).

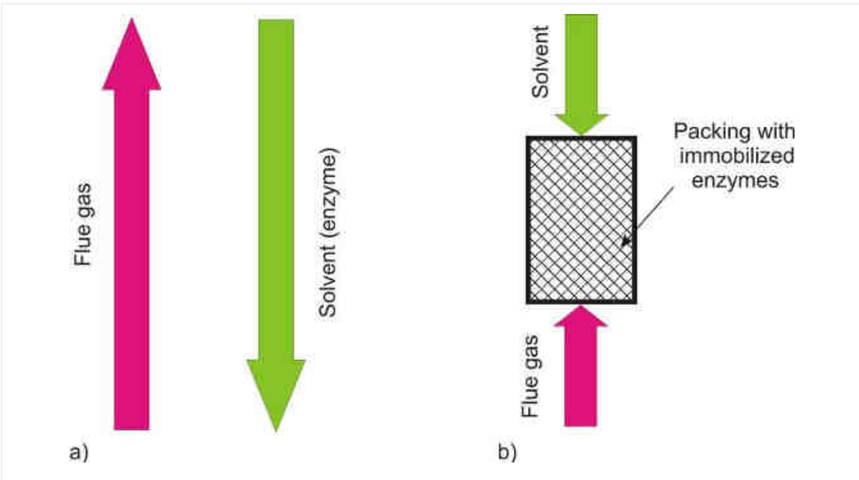

Figure 4: Absorption using enzymes as a solvent activator (a) or immobilized on a packing (b).

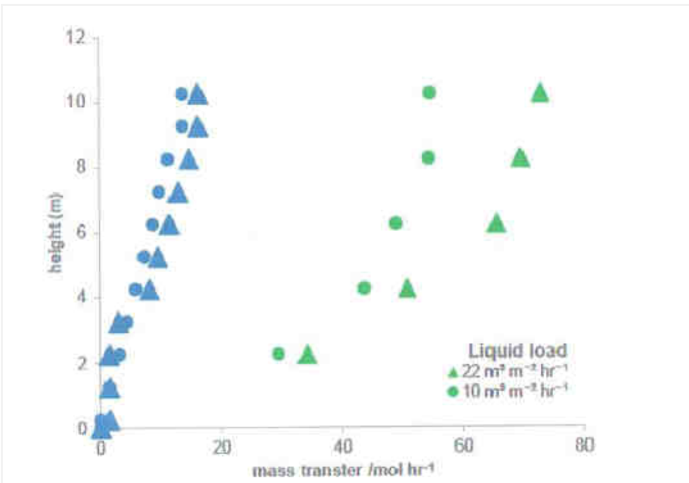

Figure 5: The rate of mass transfer along the column height. Blue symbols – 30% MDEA, green symbols – 30% MDEA + carbonic anhydrase (Gladis et al., 2017).

In general, however, the enzyme can significantly increase both the absorption and desorption rates, and thus greatly improve the overall efficiency of the process.

5. Conclusions

When William Shakespeare took a breath over four centuries ago, 280 molecules out of every million entering his lungs were carbon dioxide. Each time we draw breath today, 380 molecules per million are carbon dioxide. That proportion climbs about two molecules every year. Nothing, however, says that CO_2 must be emitted into the air. The atmosphere has been our prime waste repository, because discharging exhaust up through smokestacks, tailpipes and chimneys is the simplest and least costly thing to do. The good news is that the technology for capture and storage already exists, in either mature or promising form, and that the obstacles hindering implementation seem to be surmountable.

Acknowledgement

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Impact of CO_2 on mechanical properties of sandstone during sequestration for climate change mitigation

by

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Abstract

CO_2 capture and storage technology (CCS) is estimated to contribute in mitigation of climate change by reducing CO_2 emissions in the atmosphere. It gained a lot of scientific attention after the IPCC Special Report on Carbon Dioxide Capture and Storage was published on 2005. Among other proposed geological formations, deep saline aquifers are considered as the most favorable storage-reservoirs, mainly due to their abundance on earth's surface.

Rock formations are always fractured and jointed, though researchers prefer to simulate this hydro-chemo-mechanical process by using equivalent continuum models (transport through porous media, with introduction of a permeability tensor). Just recently, tools and codes for discontinuous analysis of CO_2 storage are being developed (transport through fractured media), and initial simple simulations are being published.

We are undertaking a series of laboratory tests, aiming to observe the impact of CO_2-water solution on mechanical properties of fractured rock (sandstone) and the changes in hydraulic behavior under in situ conditions. During fracture shear movement, there are areas on fractures surface under tensile stress. In this paper CO_2 impact on tensile strength of sandstone is presented.

Key words: CO_2 storage, carbon sequestration, green-house effect mitigation, rock-tensile strength, Brazilian test, climate change, CO_2- rock interaction.

1. Introduction

CCS (carbon capture and storage) technology has been proposed since 2005 (Metz et al., 2005) as a very prospective method for climate change mitigation, by storing anthropogenic CO_2 emissions underground, for extended time periods. Among other suggestions for storage sites (deep ocean storage, mineralization of CO_2, artificial or natural cavern storage (Huijgen and Comans, 2005), (Holloway, 2005)), geologic sequestration in deep saline aquifers is the most prominent, mainly due to the great abundance of such aquifers on earth's surface as well as the significant experience gained from application in hydrocarbon industry (Metz et al., 2005), (Meyer, 2005), (Gozalpour et al, 2005), (Holloway, 2005), (Hendriks and Blok, 1993), (Voormeij and Simandl, 2004).

While injecting CO_2 in deep aquifers, a series of perturbations of local chemo-thermo-mechanical conditions occur in the reservoir and the sealing caprock (Rutqvist, 2012), (Xiao et al, 2009), (Grgic, 2011), (Vilarrasa et al., 2014). CO_2 flow, which is in supercritical stage due to temperature and pressure, through the reservoir (multiphase reactive flow) happens through the rock matrix and rock fractures (Iding and Ringrose, 2010), governed mainly by buoyancy, capillary forces, fluid overpressure, temperature and salinity of reservoir's brine (Oldenburg and Rinaldi, 2011).

In general, rock mass in reservoir scale is always a discontinuous mass (fractures, faults, joints) (Wittke, 1990), though since the initiation (2005 till now) of intense scientific simulation of CO_2 storage, the majority of studies were performed with codes and software that approach the rock mass as an equivalent continuous medium (Rutqvist and Tsang, 2003), (Zhang et al., 2011), (Kitamura et al., 2013), (Lee et al., 2013), (Finsterle et al., 2014). This is due to the significant lower demands of computation power and memory that continuous medium simulations have.

Lately a number of studies try to follow the realistic approach of rock mass and fluid flow through rock, and simulate CO_2 storage by using Discrete Fracture Networks (DFN) (Pashin et al., 2008), (Bigi et al., 2013), (Hyman et al., 2015), (Lei et al, 2017), this will allow for more thorough understanding of the involvement of fractures and faults in long term CO_2 storage (Bond et al, 2013).

Our team executes a number laboratory experiments performed on low porous calcite-rich sandstone, in an effort to study effects of CO_2 storage on rock's discontinuities both mechanically and hydrologically. While fractures are under shear displacement, some areas are under tensile stress (Asadi et al., 2013), (Bahaaddini et al., 2013). In this paper we present tensile strength results of sandstone samples, under static in situ (temperature and pressure conditions) exposure with CO_2-H_2O solution. Mechanical strength tests were performed at exposed samples and results were compared with intact samples.

2. Materials and methods

2.1. Sandstone samples and in situ exposure

Surface sandstone samples from a potential geologic storage formation were collected on site, cored and saw cut in the laboratory (Figure 1). The sandstone formation belongs to Mesohellenic Trough (a piggy back basin which was developed between middle of Eocene to middle of Miocene) at North-West Greece (Kontopoulos et al, 1999), (Doutsos et al 1994). Mineralogical analysis showed that sandstone has a great percentage of calcite (47%) (Table 1).

Table 1: Sandstone mineralogical composition (XRD analysis).

Sandstone	
Mineral	Percentage
Calcite	47%
Quartz	16%
Feldspar	14% (12% plagioclace, 2% K-feldspar)
Clay minerals	8%
Mica	7%
Clorite	5%
Dolomite	3%

Figure 1: Sandstone samples for indirect tensile strength test.

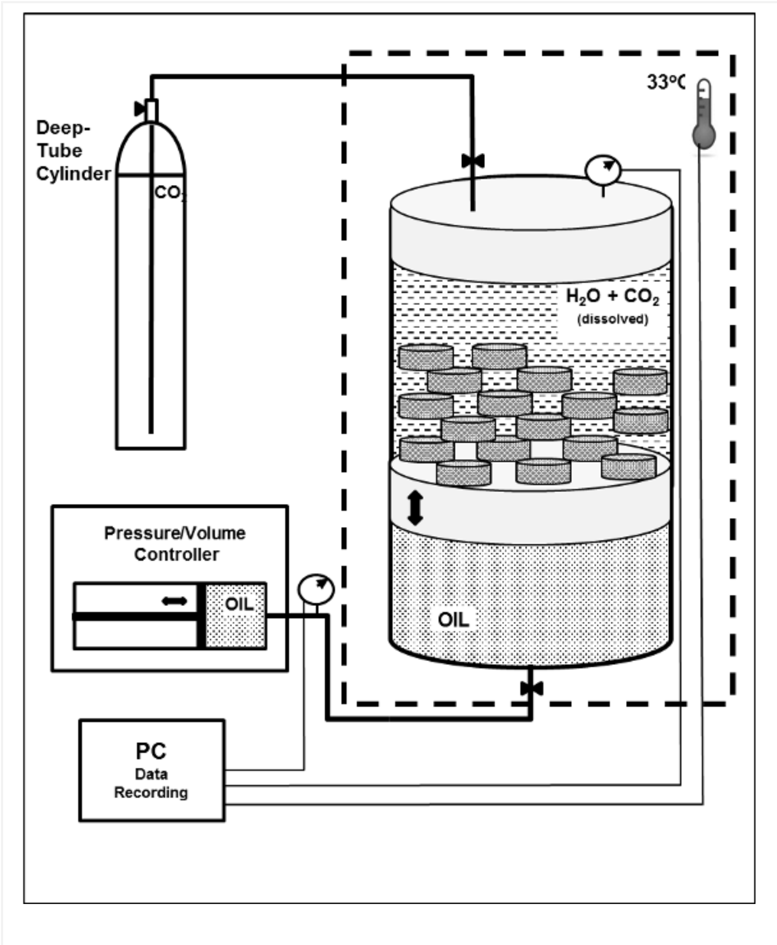

Figure 2: Experimental setup for in-situ exposure of sandstone samples in CO_2 saturated water solution.

Cylindrical core samples were extracted from sandstone. Wet core drilling was performed with a rock driller (Milwaukee 4096-4, 2.8 kW) with 1.5-inch (3.8 cm) core drill bit, operated at 450 rpm and then saw cut performed to result in 25 specimens with 38mm diameter and 15 mm thickness (Figure 1). Three unexposed specimens were tested dry (dried for 24 hours in 100^o C), three of them were saturated with water under vacuum (1h under vacuum followed by water immersion) and 16 specimens were exposed up to 260 days in CO_2-H_2O solution under in situ temperature and pressure.

We simulate conditions of a reservoir at around 1000m depth were temperature is expected to be around 33^o C and local brine's pore-pressure at 7,5MPa. We used tap water for the experiment, instead of brine, so as to reduce effects linked to brine salinity (Rathnaweera et al., 2013).

This batch reactor experiment performed in an experimental setup consisted of: a) pressure application unit, b) cylindrical piston accumulator made of special corrosion-resistant alloy (Hastelloy piston accumulator of VINCI technologies), c) deep tube CO_2 container, d) thermal insulated chamber and heating device. The schematic diagram of the setup can be seen in Figure 2.

Six specimens were inserted each time in the hastelloy cylinder filled with 800ml water. The cylinder was later sealed and pressure controller was set in advance mode, water pressure raised till meet CO_2 cylinder's pressure. CO_2 valve was set open and pressure controller set in reverse mode till the desired volume of pressurized CO_2 entered the reactor. To reach a CO_2 saturated water solution, a minimum of 5.5% w/w rate of CO_2 / H_2O required (Rochelle and Moorre, 2002), (Duan and Sun, 2003). After closing the valve of CO_2 cylinder the pressure in the piston accumulator was raised by setting the pressure controller in advance rate to reach 7.5MPa.

The Solution was left to come in equilibrium for 24 h (Carroll and Knauss, 2005), and then test time counting initiated. Every time that the cylinder was opened for sampling and testing of specimens, a new solution was prepared with the above method. Solution was left no more than 15 days in the cylinder, to ensure solution's chemical activity. Exposure time for specimens was from 15 days to 260 days (360÷6240 hours). Due to limited volume of the cylinder the above procedure was performed three times (six or five samples placed in the cylinder each time) and 16 sandstone specimens were exposed in total. Throughout the experiment steady pressure was controlled by the pressure/volume controller and steady temperature by keeping all experimental setup in thermo-insulated room (furnace).

Specimens were tested in indirect tensile strength (Brazilian test) (Figure 3), strength tests were performed with GDS Virtual Infinite Stiffness Loading System 10kN. Data acquisition for strength test (axial deformation, radial deformation, load) and experimental conditions (solution pressure and temperature) were captured via a data acquisition console (Kyowa UCAM 10B) and a standalone PC.

2.2. Indirect tensile strength test

Specimens were tested in indirect tensile strength (Brazilian test), while being saturated. Tensile strength was calculated according to Equation 1.

$$f_t = \frac{2P}{\pi DL} \qquad (1)$$

Where f_t is the tensile strength, P is the vertical load. D the diameter of specimen and L the thickness of specimen. The schematic analog of Brazilian test can be seen on Figure 3. Testing method was in accordance to ASTM standards (ASTM, 2008).

2.3. XRD and SEM imaging

Sandstone mineralogical analysis performed by X-ray Powder Diffraction (XRD) method on an unexposed specimen. As to obtain the desired powder, one fourth of the cylindrical specimens were crushed manually and the resulted powder was sieved, only powder with diameter smaller than 75μm was used as to avoid noise in results.

Chips from two specimens (one exposed and one unexposed) were used for SEM imaging with a JEOL JSM 84A electron microscope, selection of resulted images were edited with ImageJ software to produce binary images representing the crack extents on unexposed and exposed (60 days of exposure) specimens.

Images were initially converted in 8bit gray scale, crack areas were selected by setting threshold value of histogram at 20, and then converted again to binary images (b/w) where black to white ratio was calculated.

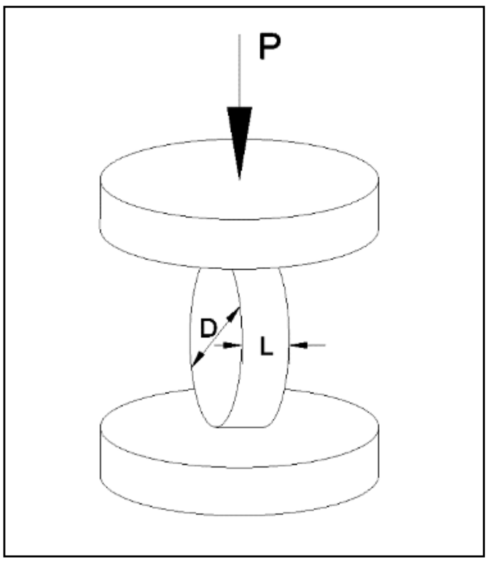

Figure 3: Schematic illustration of indirect tensile strength test (Brazilian test).

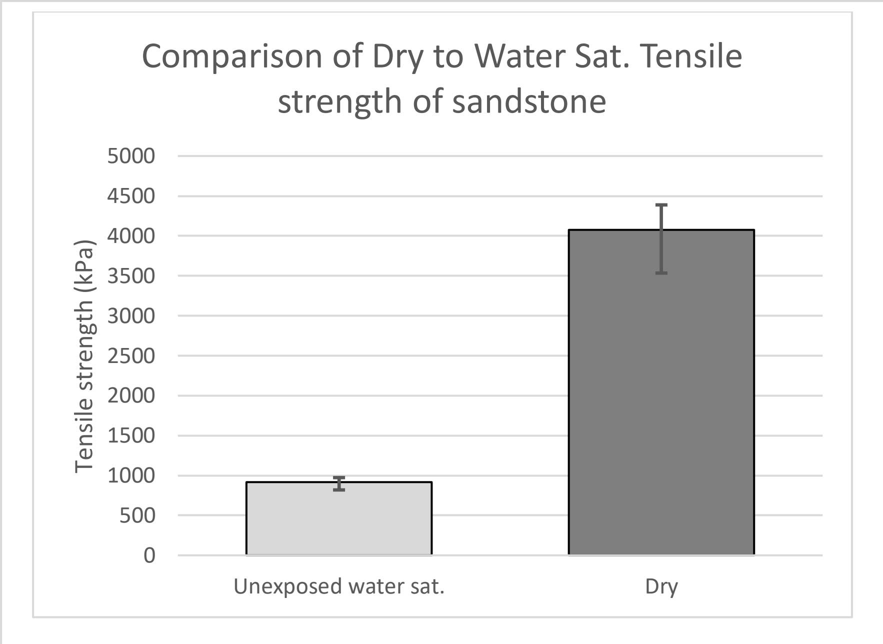

Figure 4: Tensile strength difference between Dry and Water Saturated samples, due to water weakening effect.

3. Results

Tensile strength of dry sandstone had a mean value of 4075 kPa (max 4440 kPa min 3453 kPa) the water saturated sandstone achieved 917kPa (max 1016 kPa min 821 kPa) (Figure 4), great difference of tensile strength for dry and water saturated samples is explained by weakening effect of water (Broch, 1979), (Hoek and Brown, 1997), (Nermoen et al., 2014), (Zhou et al., 2016). The observed variation in strength values in samples of same group (dry, water saturated and exposed in CO_2) is due to inhomogeneity of sandstone and the micro-bedding structure of sedimentary materials (Karpyn et al., 2009).

Exposed in situ specimens had a negative regression towards time, with a fair linear fit. Specimens that were exposed in CO_2 up to a month had almost no change in tensile strength compared to unexposed samples. From day 40 till the end of experiment, solution's corrosive environment resulted to a drop of tensile strength up to 514kPa (-43%) (Figure 5).

If we try to eliminate differences in specimens dimension and we consider the tensile strength as per volume of rock in specimen volume, we observe that for unexposed water saturated specimens is around 0.054 MP/mm^3 and after 260 days it is reduced at 0.03 MPa/mm^3 (Table 2 and Figure 6). XRD analysis on intact pulverized sandstone, showed that the sample contains high percentage of calcite 47% and just 16% of Quartz (Table 1). Calcite is the cement of grains consisting the sandstone. Comparison of SEM analysis images with respect to surface crack propagation due to calcite dissolution, resulted in a raise of cracks area from 1.3% of unexposed sample to 9.3% at the exposed sample (60d), meaning that their cracks were broaden about 6 times (Figure 7 and Figure 8). This has happened as a result of chemical reaction between calcite and carbon acid. According to Equations 2 and 3.

$$CO_{2(aq)} + H_2O \longleftrightarrow H_2CO_{3(aq)} \qquad (2)$$

$$CaCO_3 + 2H_2CO_3 \longleftrightarrow Ca^{2+} + 2HCO_3^- \qquad (3)$$

4. Conclusion / Discussion

Sandstone samples (high in Calcite content 47%) were exposed under insitu pressure and temperature in CO_2-H_2O solution, simulating conditions met in a geological reservoir (deep saline aquifer) for CO_2 storage. After exposure indirect tensile strength test (Brazilian test) was performed. Duration of exposure differ for specimens in order to investigate tensile strength loss with time, maximum exposure was 260 days.

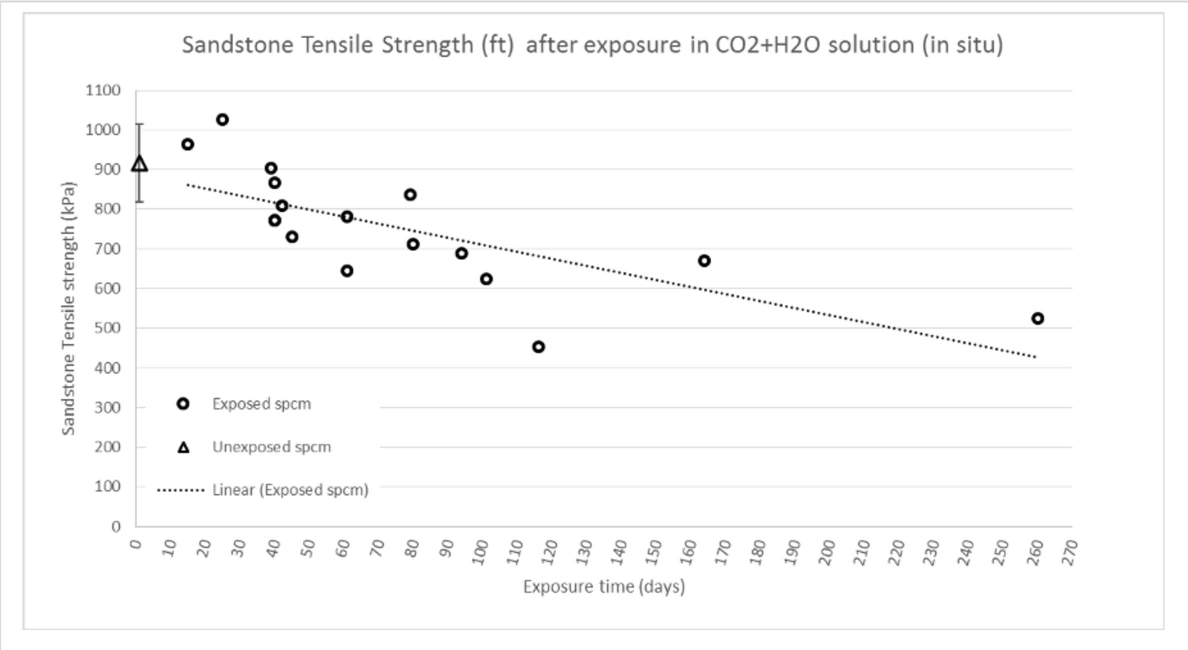

Figure 5: Tensile strength of sandstone after in situ exposure in saturated CO_2-H_2O solution, scatter of results due to anisotropy induced by micro-bedding.

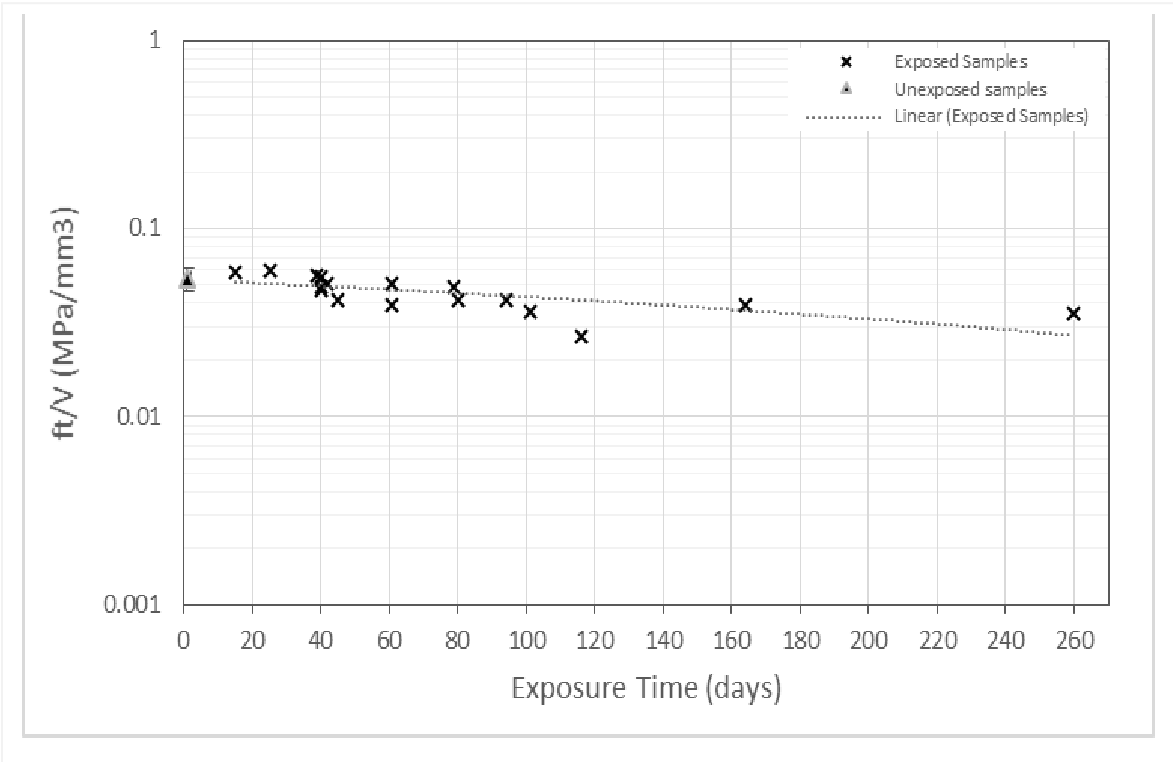

Figure 6: Change of tensile strength per rock volume and per exposure time.

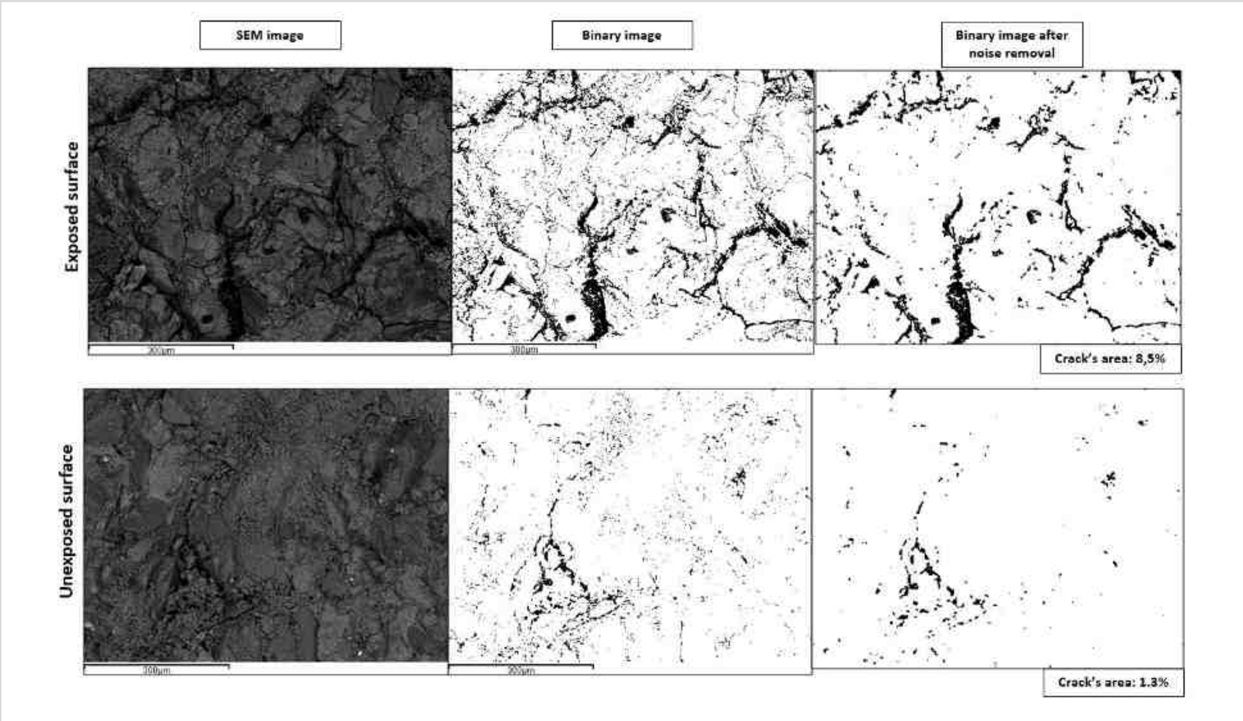

Figure 7: Comparison of surface cracks area of exposed and unexposed sample from edited SEM images.

Table 2: Tensile strength per rock volume.

Exposure Time (days)	0	15	25	39	40	40	40	42	45
f_t/V (MPa/mm^3)	0.054	0.058	0.060	0.056	0.049	0.047	0.055	0.051	0.041
Exposure Time (days)	61	61	79	80	94	101	116	164	260
f_t/V (MPa/mm^3)	0.050	0.039	0.049	0.041	0.042	0.036	0.027	0.040	0.035

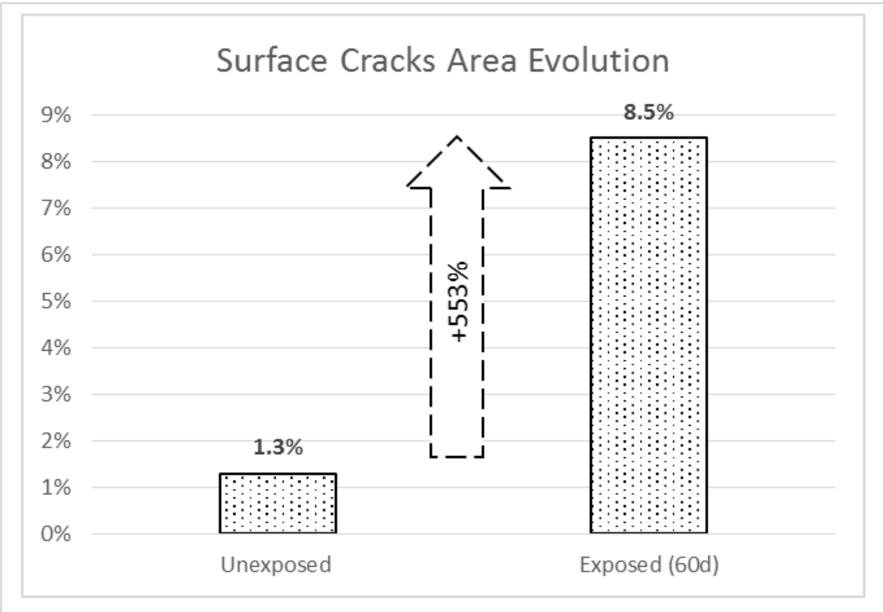

Figure 8: Percentage of sandstone surface covered by cracks before and after exposure to CO_2.

Even though tensile strength variation observed, linked with high anisotropic behavior due to micro-bedding of the sedimentary rock, we can safely present tensile strength loss, with fair linearity with time. For the specimen with the highest exposure time, the loss was almost 40 percent. The initial 40 days tensile strength remained nearly equal to unexposed water saturated levels, however after that period constant lower values were observed.

SEM imaging reveals a significant broadening of sandstone's surface cracks (raise of +500% within 12 days of exposure) and absence of cementing material (Calcite). These facts strongly suggest that a deterioration zone appears on rock surface moving towards inner mass of specimens, leaving rock grains slightly cemented to each other. As a result, the rock volume capable to carry loads is decreased. Especially for fractures, the outer deteriorated surface will have less tensile capacity, leading in lower shear capacity. Our observation meets finding of previous studies (Grgic, 2011), (Ojala, 2011), (Guen et al., 2007).

In scheduled future work we will simulate a jointed geologic reservoir for CO_2 storage, and will try to observe the response of rockmass and especially joints' shear and hydrologic behavior, under induced deformation (swelling due injection pressure build up (Birkholzer et al., 2015) and compaction due to brittle compaction at granular scale (Le Guen, et al., 2007)).

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Tax incentives for conservation of land and forests – reviewing Australian and Canadian experience

by

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Abstract

Australian climate policy significantly relies on forests and land use to reach its mitigation target. However, across Australia, about 50% of the remaining forest has been estimated to be severely degraded. At a local and regional scale, unsustainable land and forest use pressures are equally or even more important than larger-scale climate change driven by greenhouse gas (GHG) emissions. By protecting and restoring Australia's forests we allow them to make a massive contribution to reducing Australia's GHG emissions and the severity of climate change. The permanent protection of native forests would result in an immediate reduction in emissions from the clearing and logging of forests and the degradation of natural carbon stores due to human activities. Moreover, protection of native forests is in line with adaptation strategies aimed to enhance ecosystems resilience to cope with altered climatic conditions.

This paper provides an overview of tax measures related to land and forests conservation in Australia. In particular, the paper examines tax incentives for conservation currently offered in Australia, compares them with similar mechanisms and regulations in Canada, examines their effectiveness or otherwise, and draws conclusions about potential reforms that should be considered to support Australia's land and forests conservation. The paper demonstrates that current tax mechanisms can be improved subject to several substantial developments, including modification of tax deduction and, more generally, advancement of the taxation regimes that affect land and forests conservation.

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Tax incentives for conservation of land and forests – reviewing Australian and Canadian experience

Scientific Conference on Energy and Climate Change
12 October 2017, Athens, Greece

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1

Background

- Australia's forests and woodlands are home to more than half of terrestrial biodiversity and they are a large store of terrestrial carbon.
- Australian climate policy significantly relies on forests and land use to reach its mitigation target.
- Across Australia, about 50% of the remaining native forest has been estimated to be severely degraded.
- The main causes for the decline in biodiversity and forest health are drought, fire, disease, pests and weeds, while stressors such as clearing, fragmentation and climate change are considered to underlie and further exacerbate these problems.

2

Background

- The significant part of the Australian legislation governing forests is state- or territory-based, with the exception of a few federal acts.
- Some commentators argue that the Australian forest policy lacks credibility, as it fails to protect native forests and does not provide an incentive to landholders for the sustainable management and conservation of forests.
- There is an enormous challenge for forest governance in Australia that has not yet been solved.

3

Background

- In Australia, as in some other industrialised countries, a significant part of native forest is privately managed, thereby creating an additional layer of complexity in terms of forest management and conservation.
- Private landholders need to be provided with effective incentives for conservation of native forests.
- The largest part of Canadian native forest is managed by provinces rather than privately. Nonetheless, Canada has one of the largest forest areas in the world and quite advanced forest regulations.

4

Background

- Literature generally confirms that using taxation incentives to stimulate private sector conservation has the potential to promote social objectives and increase private conservation of land and forest
- This study examines the tax incentives for forests and land conservation currently offered in Australia, compares them with similar mechanisms and regulations in Canada, examines their effectiveness or otherwise, and draws conclusions about potential reforms that should be considered to support Australia's land and forests conservation.

5

Tax incentives

There are different types of taxation provisions that can be used to encourage private conservation of land and forest. This paper discuss most commonly used tax measures that are grouped as follows:

- General deduction provisions
- Specific or targeted deduction provisions
- Exemptions and special concessions

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General deductions

- Tax deductions is one of the key considerations that may encourage conservation.
- Under Australian and Canadian tax law, a general deduction is only available if the expense is incurred in producing assessable income or in carrying on a business. For example, landholders carrying on a business on their land can deduct the cost of rates and land tax from their assessable income.
- Some conservation activities may involve producing income through financial incentives provided by various conservation schemes, but generally conservation of land is unlikely to represent income-producing or business-related activities therefore, the general deduction would not cover the conservation of land or forests.

7

Specific or targeted deductions

- One of the most relevant provisions providing deductions related to conservation covenants or some other permanent protection instruments registered on title is Division 31 of ITAA97.
- A conservation covenant can be defined as a voluntary agreement between a landholder and an authorised body (normally a Covenant Scheme Provider) that aims to protect the natural, cultural and/or scientific values of the land.
- The landholder owns, uses and lives on the land but the natural values of an area are conserved by the landholder with assistance of an eligible Covenant Scheme Provider.

8

Specific or targeted deductions

- Eligible taxpayers holding a conservation covenant could be entitled to a deduction under Division 31. The deductable amount is the difference between the market value of the land before entering into the covenant agreement and the market value of the land directly after that.
- A deduction is only available where there is no payment received in return for entering into the covenant.
- Therefore, the deduction is not available in cases where a landholder enters into a covenant and also participates in the National Landcare Program that provides certain grants.

9

Specific or targeted deductions

- The Canadian *Income Tax Act* also provides some specific tax incentives to encourage conservation that protect natural values of land.
- The tax incentives are delivered via the ecological gifts program (EGP) for gifts of interests in environmentally sensitive land made to qualified conservation charities, federal, provincial, territorial and municipal governments.
- To qualify under the EGP, land donated as an 'ecological gift' must be 'ecologically sensitive land'.

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Specific or targeted deductions

- Canadian individual taxpayers who make gifts to entities qualified under the EGP obtain a non-refundable tax credit.
- Canadian corporate donors are treated differently from individuals. In particular, corporations are not entitled to the tax credit and instead are able to deduct the value of an ecological gift from their income.
- The Australian tax regime provides the 5-year limit for deduction that could be extended to at least 10 years, as in Canada, allowing land-rich, low-income landholders to utilise the deduction under Division 31 more effectively.

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Specific or targeted deductions

- There is an additional incentive for ecological gifts of property under the Canadian tax regime. In particular, split-receipting rules recognise a gift for income tax purposes where a landholder receives a partial payment for transfer of property that is environmentally sensitive land.
- Under the split-receipting approach, a landowner in effect receives two benefits; that is, a payment for permanently protecting environmentally sensitive land and a tax deduction.
- Hence, the split-receipting rules distinguish the private benefit – that is, the consideration received for conservation of the land – and the 'charitable' (public) benefit of transferring the land for conservation purposes and reducing its fair market value.

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Exemptions and special concessions

- The Capital Gains Tax (CGT) regime may also cover conservation-related transactions and conservation covenants in particular.
- In Australia, entering into a conservation covenant over land triggers CGT; that is, CGT provisions will apply as if the covenant is a sale or gift of the land.
- In cases where no payment is received, a capital loss equal to the costs incurred in granting the covenant will arise.
- If a payment is received for entering into a conservation covenant landowners may be entitled to access some general CGT concessions or exemptions

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Exemptions and special concessions

- Under the Canadian tax regime, gifts of land are deemed disposition of capital property that can result in taxable capital gains.
- Under paragraph 69(1)(b) of the Income Tax Act a taxpayer who is gifting a property shall be deemed to have received payment equal to fair market value of the property.
- However, the Canadian tax regime exempts ecological gifts from capital gains tax. Hence, qualifying ecological gifts are completely excluded from capital gains tax.

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Taxpayers comments

- Trust for Nature conducted a survey of private landholders enquiring about environmental market schemes and private land conservation.
- Generally, participants in environmental market schemes and land conservation are impacted by the complexity and fragmentation of the tax treatment of landholders.
- Specifically, one of the landholders remarked: 'The tax implications are so complex. Nearly all of it is disadvantageous ... That is a deadly serious point: those who are going to be committed to [these types of projects] are going to be useless at the complexities! ... It's pathetic how complex government makes it for us.'

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Taxpayers comments

- Such critique relates to uncertainties in terms of tax liability, complexities of the tax provisions and generally taxation of conservation activities which are public interest in nature.
- The Canadian study conducted by Hossain and Lamb (2011) explored the effectiveness of tax incentives on charitable donations in Canada. Their research suggests that tax incentives significantly affect donations in Canada.
- A more recent study by Parachin (2012) observed that the proportion of Canadian taxpayers who acknowledge tax incentives as an influential encouraging factor has progressively increased.

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Recommendations

- Generally, the Australian tax system facilitates some incentives encouraging private conservation of land but there are also a number of impediments distracting conservation.
- One of the possible lessons from the Canadian experience could be the introduction of more beneficial CGT provisions, which would provide a straightforward exemption for the land that is donated for conservation.
- Specifically, the CGT exemption for land conservation would be very helpful for Australian taxpayers involved in conservation activities.

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Recommendations

- The Australian and Canadian tax regimes may be improved if the expenditure of landholders involved in conservation would be deductable from their assessable income earned, irrespective of source of income.
- One of the major weaknesses of the Australian tax system is that, in some cases, it fails to recognise the public interest character of private conservation.
- Where a landholder receives some consideration in return for entering into a conservation covenant the Australian tax regime classifies such transactions as private in nature and the tax benefits do not apply.

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Recommendations

- The Canadian split-receipting approach is a valuable method of recognising and accommodating both the public and private interest character of environmentally beneficial transactions.
- A necessary step for Australian tax policy which would help to recognise public and private interest in conservation transactions would be the prompt introduction of a split-receipting mechanism that works well in the Canadian system.

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Conclusions

- A tax incentives system must ensure a certain degree of simplicity and certainty, it must be able to provide consistent support and incentive to biodiversity conservation, it must provide flexibility in its approach and it must be effective in the sense of being beneficial and transparent for taxpayers.
- The Australian system does not always achieve all of these goals; the Canadian system scores considerably better on them.

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Conclusions

- These measures, for Australia and Canada, may not fix all the problems related to biodiversity conservation that exist in each of the countries; however, at least they may go some way to ensuring that the tax incentives addressing land conservation are improved in both countries.

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Questions?

22

A Model for Natural Gas Consumption Forecast

by

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Abstract

Liberalization of natural gas market makes that accurate forecasting of natural gas consumption for specific distributive area is of great importance for financial sustainability and reliable operation of distributive system operator (Ivezic D., 2006). Different approaches in natural gas consumption forecast have been used in recent years (Ivezic D., 2006; Sabo K. et al., 2011; Brown R.H. et al., 1994; Szoplik J., 2015; Soldo B., 2012). Still there is no method that can be reliable for all possible cases. In this paper four different methods have been used for forecasting of natural gas consumption for a measuring and regulation station in distribution network. The aim was to evaluate the accuracy of forecasting, based on the results from the applied algorithms. Results of using Neural Network algorithm, Multiple Linear Regression, Curve Fitting Model and Average Model are presented. Available data about consumption and corresponding daily temperature were divided in two groups that were used for training and testing. In the case of NN with three layers data on consumption and average daily temperature of the previous day, forecasted temperature and corresponding day of the week were selected as inputs. These data are used for adjustment of weights in hidden and output layers. Similarly, in the case of MLR and CFM, adjustment of variables and coefficients was done for the same inputs. Evaluation of predicted consumption is analyzed by using the mean absolute percentage error (MAPE). Depending of implemented algorithm and method, MAPEs are in a range from 5% to 15%. It was shown that the Average Model, based on results of three other methods provided the best result for MAPE.

1. Introduction

Natural gas is one of the most attractive energy sources. Appliances fueled by natural gas are cost effective, reliable and efficient. The greatest share of natural gas is used for energy purposes and is consumed in industry, households, commercial sector and transport. It can be used for non-energy purposes in chemical and petrochemical industry. Compared to others fossil fuels, natural gas represents the most environmentally friendly option.

With the share of 21.6% in the worlds primary energy mix, natural gas is the third most used fuel in the world. More detailed consideration shows that its consumption is characterized with significant variation (daily, weekly, seasonal) of consumers' demand. In order to establish efficient natural gas market some forecasting of consumption should be provided. It is very important to estimate expected consumption of natural gas in order to supply and deliver adequate quantity of gas to consumers in accordance with mutual contracts between transporters, distributors, suppliers and consumers. In the last decade, a significant number of scientific papers (Ivezic D., 2006; Sabo K. et al., 2011; Brown R.H. et al., 1994; Szoplik J., 2015; Soldo B., 2012; Baldacci L. et al., 2016; Aydinalp-Koksal M., Ugursal VI., 2008; Kavaklioglu K. et al., 2009; Brown Ronald H. et al., 1994; Gorucu F.B., Gumrah F., 2004; Bradec M. et al., 2008; Tonkovic Z. et al., 2009) explained the use of neural networks and other regression models for estimating and prediction of future natural gas consumption. This is especially important in the winter period, characterized with significant increase of consumption. Different time horizons have been used for forecasting natural gas demand (short term, midterm and long-term period). Specific forecasting technique presented in (Baldacci L. et al., 2016) was developed to support control operators in identifying irregular consumption. Forecasting the energy demand with time series (TM), regression model (RM) and artificial neural network (ANN) was proposed in (Aydinalp-Koksal M., Ugursal VI., 2008) and (Kavaklioglu K. et al., 2009) and comparisons between them were made. Models based on feed-forward artificial neural network (Brown Ronald H. et al., 1994) were developed to predict gas consumption on a daily basis. Statistical multivariable regression analysis presented in (Gorucu F.B., Gumrah F., 2004) was developed to understand the factors affecting gas demand and to forecast gas consumption for the city of Ankara. Daily natural gas consumption was predicted on the level of individual customers, using nonlinear regression model with individual customer-specific parameters (Bradec M. et al., 2008). Prediction model of natural gas consumption on a regional level by using neural networks is explained in (Tonkovic Z. et al., 2009). In (Brown R.H. et al., 1994), a methodology based on ANN and linear regression model has been used. These models were compared and it was shown that ANN model gives better results than linear regression.

In this paper, natural gas consumption is analyzed and forecasted for the level of single measuring and regulation station. Via selected MRS consumers in households and commercial sector are supplied. Parameters that affect the consumption of natural gas in these sectors are selected and analyzed. Four different methods for natural gas forecast were applied. Algorithm for Artificial Neural Network – ANN and Multiple Linear Regression - MLR, Curve Fitting Model – CFM and Average Model – AM are implemented and mutually compared. The aim was to evaluate the accuracy of forecasting, based on the results from the applied algorithms.

2. Parameters for Forecast of Natural gas consumption

The most important factors that have influence on natural gas consumption are temperature and past trends in consumption behavior. For forecasting daily natural gas consumption these factors are introduced by parameters:

- Average daily temperature (historical data and forecast for selected day),
- Daily natural gas consumption (historical data),
- Day in the week for which forecast is required,
- Other factors (wind, thermal memory, solar radiation…)

Temperature is the most significant factor for modeling, because in the most cases natural has been used for heating. The influence of average daily temperature to gas consumption at selected MRS is shown on figure 1. High gas consumption corresponds to low temperatures and vice versa. Desired indoor temperature also has an influence. This influence is used in some models by using heating degree day (HDD) (Brown R.H. et al., 1994), which can be used as another input value in addition to average daily temperature.

The correlation between average daily temperature and corresponding daily gas consumption from a selected measuring and regulation station in distribution network are shown in figure 2. On this figure, inverse dependence between these two variables can be clearly seen – with increasing of average daily temperature, natural gas consumption is decreasing. This correlation between gas consumption and temperature points out the importance of daily temperature as a parameter for forecasting. During summer period of the year, in the household sector natural gas is used mostly for cooking and for the preparation of sanitary hot water. Consumption of natural gas in that period is significantly less compared to the winter period, and dependence from temperatures doesn't exist. Therefore, temperature is the weather parameter that is mostly used for forecasting natural gas demand during winter period.

In this paper **forecasted temperature** represents estimated temperature for the next day. Forecasted temperature is very important since error between daily average temperature and forecasted temperature, Δt, may impact on forecasting gas consumption too. That means if Δt is larger, difference between real and predicted consumption will also be larger (Baldacci L. et al., 2016). Forecasted temperature is employed as an input value.

Previous day consumption is another important factor which is selected as input in the model. It represents "yesterday gas consumption" (Vitullo S.R. et al., 2009). Employing previous day consumption as input value provides to take into account previous behavior of consumption in order to have precise prediction of future consumption. Forecasting gas consumption for "next day" is made using information about consumption of previous day. Consideration of consumption for several previous days gas consumption, as input to the forecast model, can improve the level of forecast accuracy and forecast reduce error (Vitullo S.R. et al., 2009).

Specification of the day in the week is additional information that can be used. Introduction day of the week is important because gas consumption shows dependence of different days of the week. Consumption from Monday to Friday is different comparing with gas consumption during weekend (Ivezic D., 2006). Working days have higher consumption than weekend days. Some of public and commercial buildings are not heated during weekend. As a consequence, consumption on Monday is higher than in the rest of the week because of additional energy, necessary to overcome thermal inertia of the building. Heating in the household sector has an opposite consumption interpretation. Consumption of gas is bigger during weekend than during working days. Days in week are represented by single value in row of seven inputs. Saturday and Sunday have values 1, Friday is 0.5, and rest days have value -1.

Other factors: Heat losses depend on wind speed and indoor-outdoor temperature difference. Therefore, gas consumption for heating depends on wind strength and direction. Wind speed could be included as another input to the vector of inputs (Vitullo S.R. et al., 2009). Thermal memory as another influence parameter on gas consumption, describes the prolonged effect that recent days outdoor temperatures have on daily building heat consumption.

The effective temperature on a given day is dependent on outdoor temperature for several previous days (Oliver R. et al., 2017) and these temperatures could be used as input values. Some other potential influential factors are solar radiation, cloudiness, holydays and days before and after etc. (Vitullo S.R. et al., 2009).

3. Algorithms for Forecast of Natural gas consumption

Based to previous considerations, common 10x1 input vector is defined for all proposed algorithms for forecast of natural gas consumption. It consists of scalars: average daily temperature (t_k), forecasted temperature, for day ahead (t_{k+1}) and daily consumption of natural gas (c_k), as well as of 7x1 row vector (d_k) that represent corresponding day of the week.

3.1 Artificial Neural Network

Knowing the biological neurons functioning, today it can be described artificial neurons from a mathematical standpoint of view. This means that created artificial neuron or mathematical neuron works on the principle of synaptic and somatic operations. Synaptic operations gives weight to each input signal while somatic neurons operations involves collecting all input signals and if their cumulative value is greater than bias value then neuron impulses are generated and sent to other neurons. This means that this operation is mathematical operations. Neuron can be seen as a multi-transmission system, a system with multiple inputs and multiple outputs. For this reason, it was defined n-dimensional vector input x. $x = (x_1 \quad x_2 \quad \dots \quad x_n)^T$ - Represent an n-dimensional vector of inputs; $w = (w_1 \quad w_2 \quad \dots \quad w_n)^T$ - Represent vector of the weight; θ - Represents a bias. The output of neurons is calculated according to the familiar formula:

$$y = w^T \cdot x - \theta = \sum_{i=1}^{n} w_i \cdot x_i - \theta \tag{1}$$

Where: y is output of a neuron, x_i are input signals, w_i are weights, θ is bias value. In figure 3 mathematical model of neuron is shown.

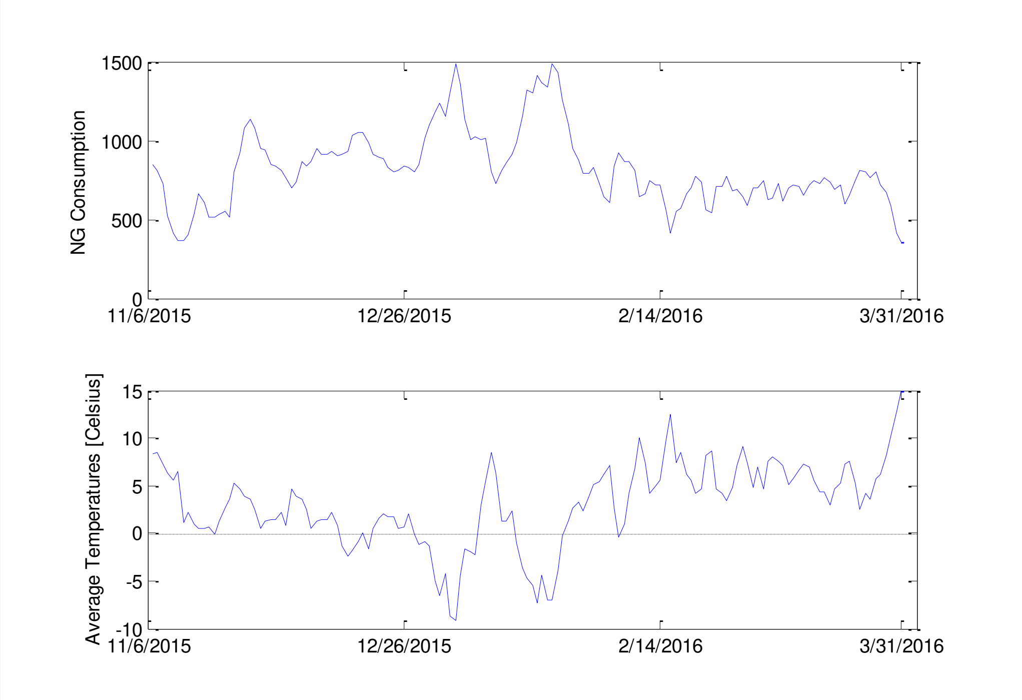

Figure 1: Daily gas consumption and average temperatures at selected MRS.

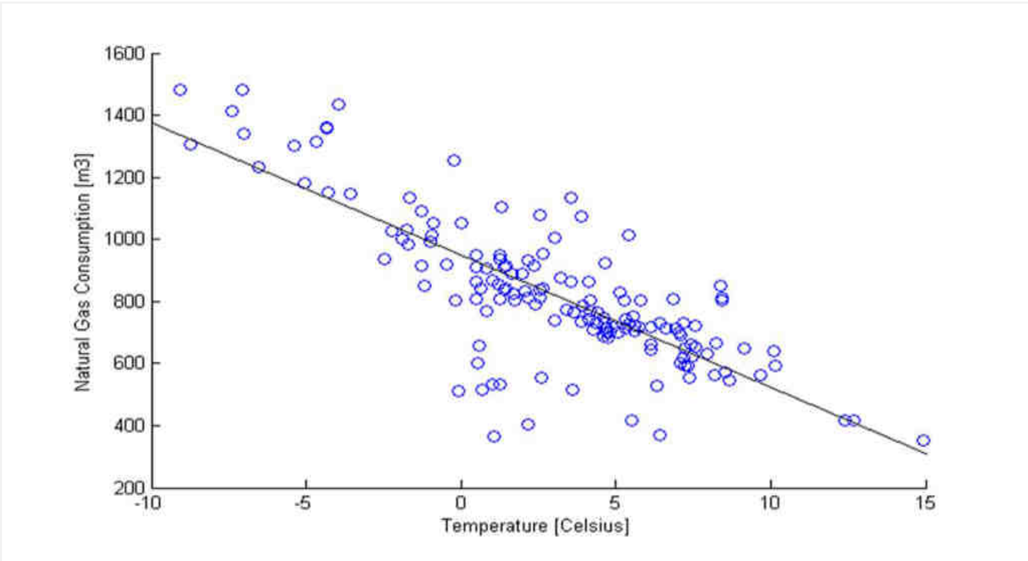

Figure 2: Correlation between NG consumption and outdoor daily temperature at selected MRS.

One of the most important achievements in the development of neural networks is the algorithm of training network with feedback propagates of error (back propagation). This algorithm is mainly applied for multilayer networks and provides procedures for changing the weighting factor for different set of training input and output parameters. For setting the weight it was used gradient method of simple perceptron with activation function. This technique is most often used to train a neural network towards a desired outcome by running a training set of data with known patterns through the network. Feedback from the training data is used to adjust weights until the correct patterns appear. Available data about consumption and corresponding daily temperature were divided in two groups, which were used for training and testing. ANN can have different organizations structure, it all depends on number of layers and number of neurons or nodes, beside that type of connections between those neurons are different too.

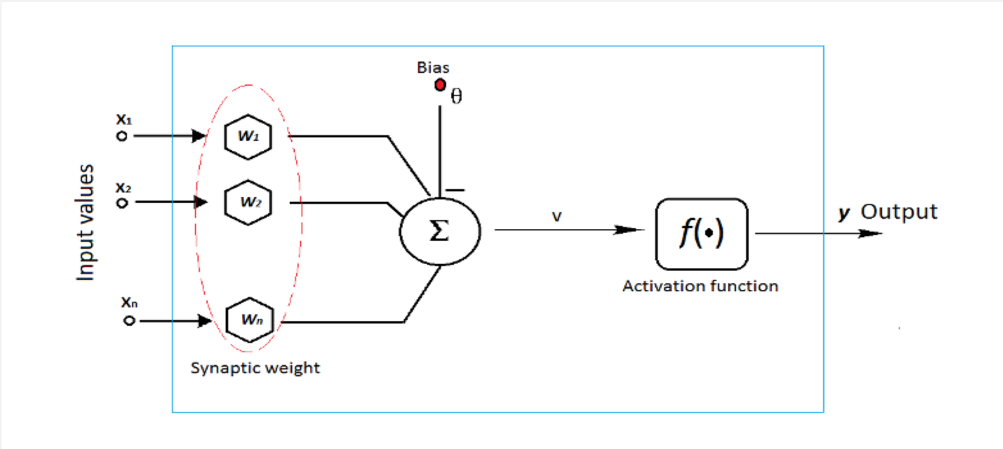

Figure 3: Schematic illustration of neuron.

Neural network has first layer, which represents input layer and the last layer called output layer. Between input and output layers it can be one or more hidden layers. All input data, from the first layer, are going to hidden layer where hidden nodes are multiple with weights. Weights are set of predetermined numbers stored in the script. Output data from this multilayer neural network, theoretically can have binary values 0 or 1, but also can provide continuous data in the case when a sigmoid function is used like in this paper. For this reason, a back-propagation training algorithm can be used. This sigmoid function has a form:

$$f(x) = \frac{1}{1+e^{-x}} \qquad (2)$$

This sigmoid function is used as a function of activation. Where parameter λ determines the slope of the function. A neuron model that uses a sigmoid function as an activation function is called Linear Garded Unit. Structure of created ANN has one hidden layer. Learning of neural network is the base of this method, and in the literature, it can be found big number of learning methods. As previously mentioned, used data was natural gas consumption from a measuring and regulation station in distribution network. Idea was to train neural network on real historical consumption data from the station, where for every input network produces output value and calculating error value until that error goes to acceptable minimum value. In the case of ANN with three layers data on consumption and average daily temperature of the previous day, forecasted temperature and corresponding day of the week were selected as inputs. These data are used for adjustment of weights in hidden and output layers. Created model is a matrix of weights, trained by the historical data of natural gas consumption and using weights, model can predict future consumption of natural gas. In figure 4 it is presented algorithm of this model. The success of ANN models depends on properly selected parameters such as the number of nodes(neurons) and layers, the nonlinear function used in the nodes, the learning algorithm, the initial weights of the inputs and layers, and the number of epochs for which the model is iterated (Demirel O. F. et al., 2012).

3.2 Multiple Linear Regression

Regression models can be single variable regression (SVR) and multiple variable regressions (MVR). The main difference between them is that MVR models provide higher accuracy than SVR models because gas consumption represents complex function of many factors (Yildiz B. et al., 2017). Multiple linear regressions are one of the most commonly used methods for prediction models (Haida T. and Muto S., 1994). This method is one of the most forms of linear regression analysis and its purpose is to show relationship between one dependent variable and two or more independent variables. Regression models are statistical methods for estimating relationship between the output and the variables that have influence on the output (Yildiz B. et al., 2017). Method has multiple uses, for example it can be used for identification of correlation between more independent variable and one dependent variable in order to define how strong is an impact of those independent variables. Above that, this method found its place like a very used method for prediction of future values. The mathematical form of this model is:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad (3)$$

where: Y-Dependent variable (or response); β_o-intercept; $\beta_1, \ldots \beta_n$-Regression coefficients; $X_1, \ldots X_n$-Independent variables; ε - Error (stochastic variable)

The main goals of this regression method are: 1) prediction of correlation between response Y and independent variables, 2) prediction of Y value. Estimated multiple regression equation have a form:

$$\hat{Y} = b_0 + b_1 \cdot X_1 + \cdots + b_n \cdot X_n \quad (4)$$

Where: $b_o, b_1, \ldots, b_n$ fitted coefficients are estimates of $\beta_o, \beta_1, \ldots, \beta_n$ and $\hat{Y}$ is predicted value of dependent variable (estimated response).

To find numerical values of vector b and to solve regression equation function *regress* in software Matlab was used. Historical values are obtained in data for Y and X. Vector X represent independent variables, those variables are all factors that influence output variable Y. Algorithms of MLR vary the coefficients b_0 to b_n because it is necessary to minimize the sum of squared errors. The mean squared difference between the predicted value $\hat{Y}$ and response Y is used to estimate the coefficients by minimization. Important steps in using this approach include estimation and inference, variable selection in model building, and assessing model fit. Multiple linear regressions are statistical approach. It basically produces coefficient vector that can be multiplied with any input to provide an estimated output. Multiple linear regression model do not require any additional configuration for the parameters by means of validation process, thus they were adjusted on the bias of the conjunction of both validation and training sets, being later applied to the test data (Pino-Mejias Rafael et al., 2017). For natural gas forecasting regression models show relationship between the historical values of the gas consumption with the parameters of influence in order to predict the future value of consumption. Many different models have been created to forecast future data. In this paper regression model is built based on real historical consumption data and other parameters such as weather variables. Each b_n is a parameter that specifies how the output is related to the n input. Figure 5 shows algorithm of Multiple Linear Regression in general.

3.3 Curve Fitting Method

Curve-fitting is a mathematical tool for modeling the any type of experimental data (Lorenz-Fonfria A. Victor, Padros Esteve, 2004). In this case that was data about natural gas consumption. In general, in this model, adjustable parameters, contained in the vector a of length N, are varied, until the best agreement between real data and estimated data is obtained. There are many solutions how to find best fit-parameters, or otherwise saying how to do the minimization of error (for example, least square method, Gauss-Newton method, Nelder-Mead Simplex method (Press W.H. et al., 1996; Johnson M.L., Faunt L.M., 1992) etc.). In this work, curve-fitting method was done using Fourier equation. The reason for using this equation is because most of the functions can be represented by an infinite sum of sine and cosine terms.

Every times series which have series of sine curve, as part of own trend thought the time, it can be model as Fourier times series. As well as in the previous methods, historical data about natural gas consumption are used to find coefficients of a Fourier equation. If we have consumption data those data can be represented in the sine and cosine. A Fourier series is a sum of sine and cosine functions that describes a periodic signal. It is represented in the trigonometric form. Following the theory, general form of continuous functions:

$$y = f(x) = a_o + \sum_{i=1}^{n} \alpha_i \cos(i\omega x) + b_i(i\omega x) \quad (5)$$

$$\alpha_o = \frac{1}{T}\int_0^T f(t)dt \quad (6)$$

$$a_i = \frac{2}{T}\int_0^T f(t)\cos(i\omega x)\,dt \quad (7)$$

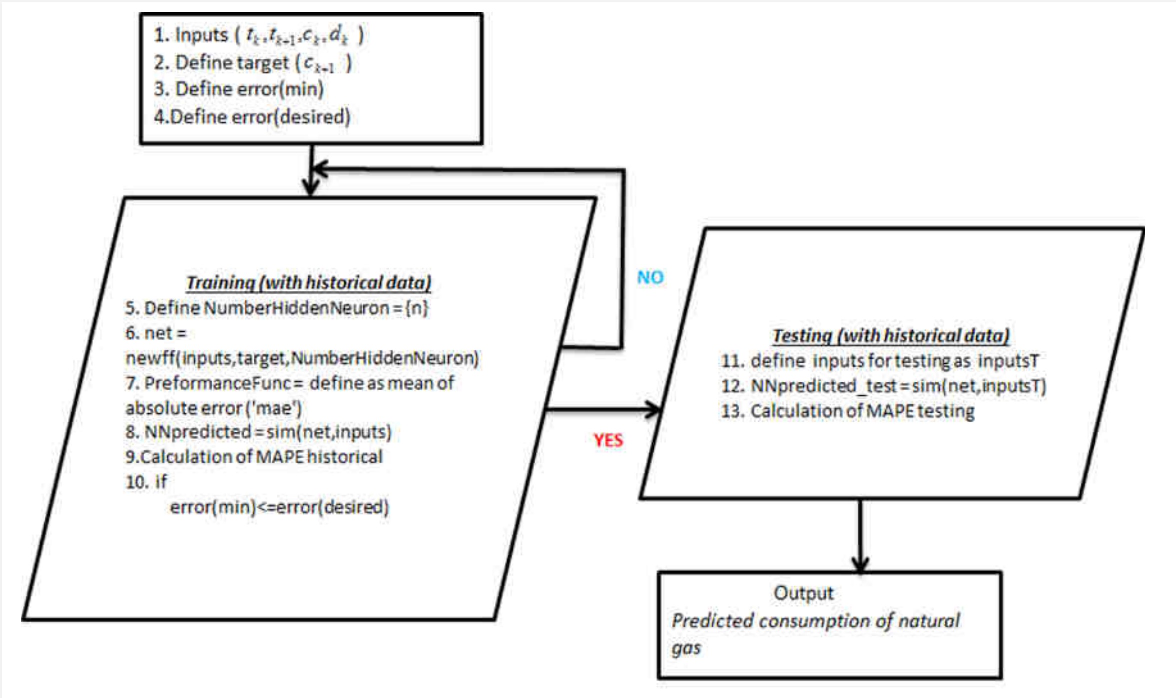

Figure 4: Neural Network Algorithm.

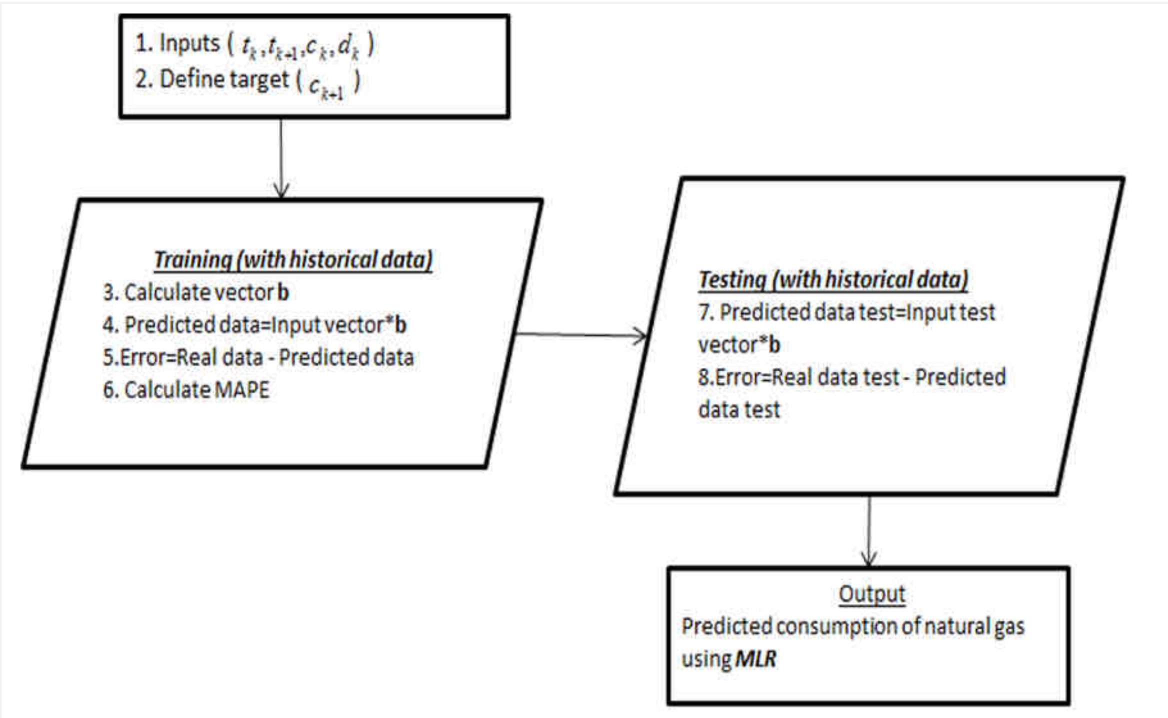

Figure 5: Multiple Linear Regressions Algorithm.

$$b_i = \frac{2}{T}\int_0^T f(t)\sin(i\omega x)\,dt \qquad (8)$$

Where a_0 is a intercept term in the data and is associated with the $i=0$ cosine term, ω is the fundamental frequency of the signal, n is the number of terms (harmonics) in the series.

Concrete form of Fourier form, for problem of natural gas consumption, which was used, is:

$$f(t)_{fit} = \alpha_o + \sum_{n=1}^{8} a_n \cos(n\cdot x\cdot\omega) + \sum_{n=1}^{8} b_n \sin(n\cdot x\cdot\omega) \qquad (9)$$

General algorithm of this method is shown in figure 6.

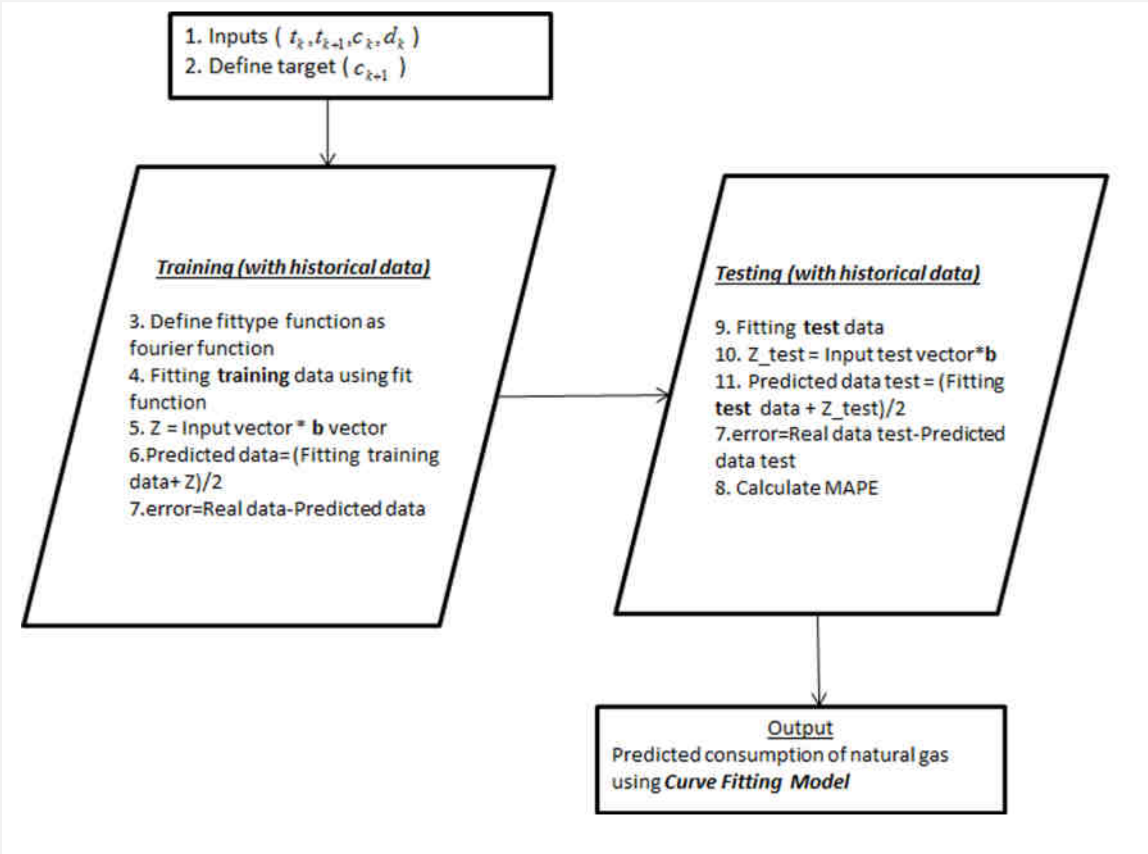

Figure 6: Curve Fitting Model Algorithm.

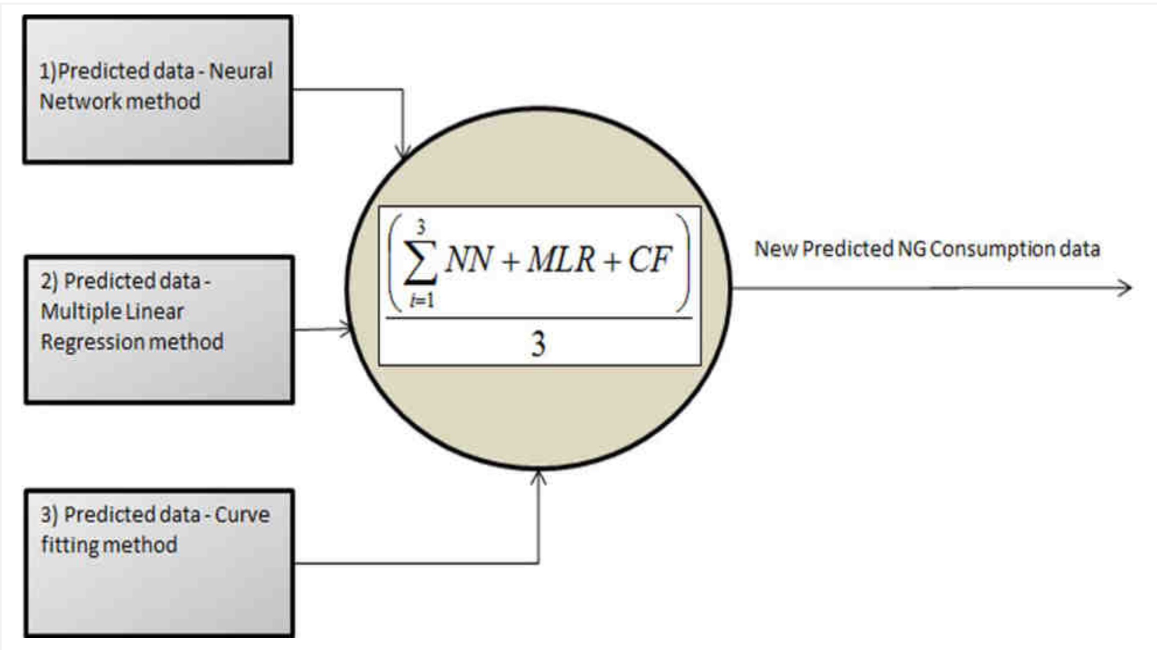

Figure 7: Schematic illustration of Average Model.

3.4 Average Model

In this model we take the advantage of ANN in nonlinearities and curve fitting in general trends of data and regression in good responses and average those models to get a model that has results better than the three models alone. After creating three different models for forecasting natural gas consumption, the fourth model in actually average model of previous three. In Average Model algorithm are incorporated algorithms of ANN, MLR and CF. In the first iteration prediction is happening by ANN algorithm, in the second iteration MLR algorithm is calculating future data and third iteration is prediction by CF algorithm. This Average Model represent hybrid algorithm because it includes different methods inside one algorithm. Predicted gas consumption data represent average values based on predicted data from ANN, MLR and CF. The idea was to create new prediction model by following algorithm shown at figure 7.

4. Results and discussion

Selected models are tested with data of natural gas consumption from selected measuring and regulation station in distribution network in Serbia. For historical trend and training of different models, available data were for winter season 2015/2016 (trend of consumption is shown in Figure 2).

In the most cases (Ivezic D., 2006; Sabo K. et al., 2011; Brown R.H. et al., 1994; Szoplik J., 2015; Soldo B., 2012; Baldacci M. et al., 2016) appropriate number of training data is in range from 1000 to1500 gas consumption days. Historical period of gas consumption includes period of three or four years for training data, which is good start for future forecasting. Longer historical period of consumption can have positive effect on developed models, resulted as a smallest deviation between real consumption and forecasted consumption. When forecasters have data for long period, behavior is clearer and it is easier for understanding. Sometimes historical data about consumption are not available, which was the case of the presented model. Only consumptions for last two winter periods are available. Because of that, relatively little training data were implemented in models.

Proposed models for forecast of gas consumption are tested on real data for winter season 2016/2017.Results of consumption forecasting obtained from different models and their comparison with measured consumption are presented on Figures 8 – 11.

It can be concluded that all used models are suitable for forecasting purposes. Some of algorithms had shown better test result, some of them less accurate result, but that does not mean that such models should not be used as forecast models. Results with good accuracy results were obtained by ANN, CF and AM models, and differences between test consumption data are small both for mutual comparison and for comparison with real test consumption data for winter season 2016/2017. MLR method turned out to be very good at fitting the trend of consumption, which is inacceptable since it is a linear model.

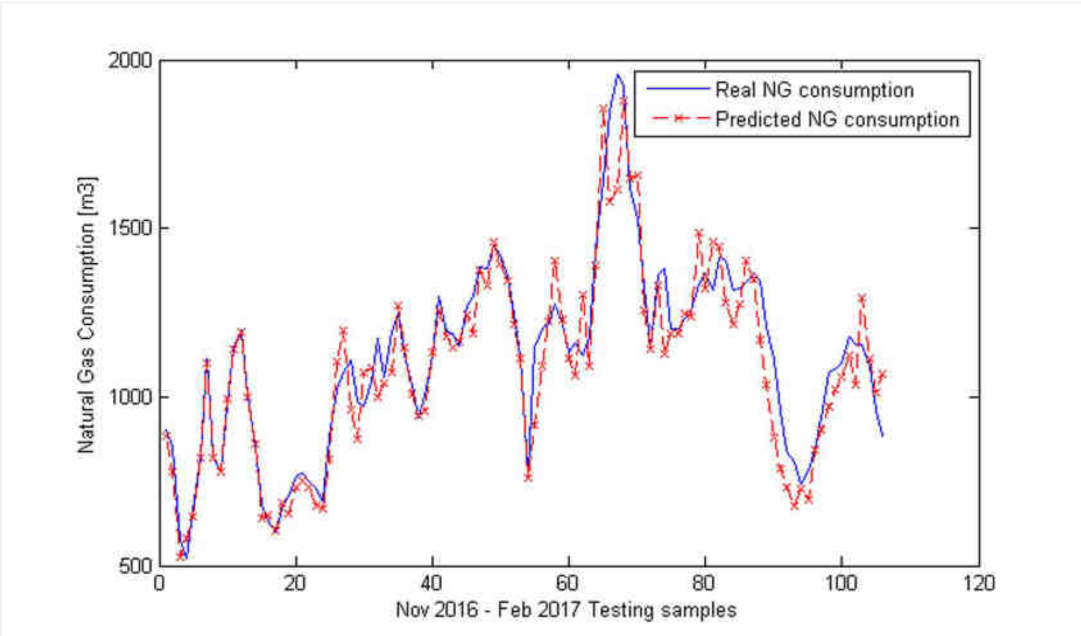

Figure 8: Forecasts by Neural Network Model for testing data.

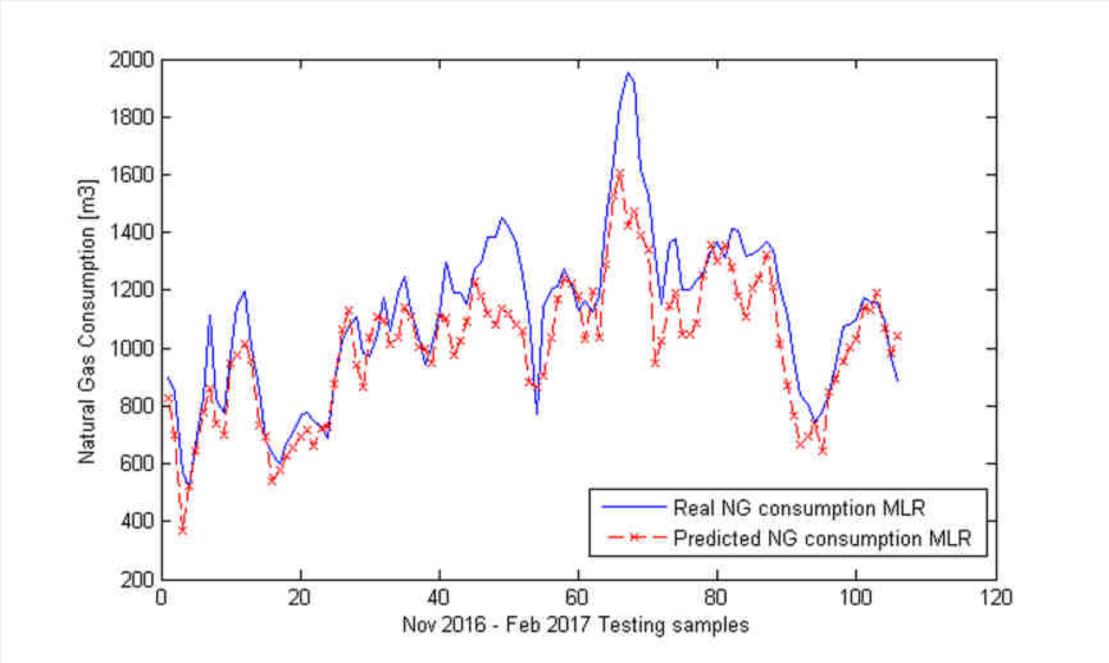

Figure 9: Forecasts by Multiple Linear Regression model for testing data.

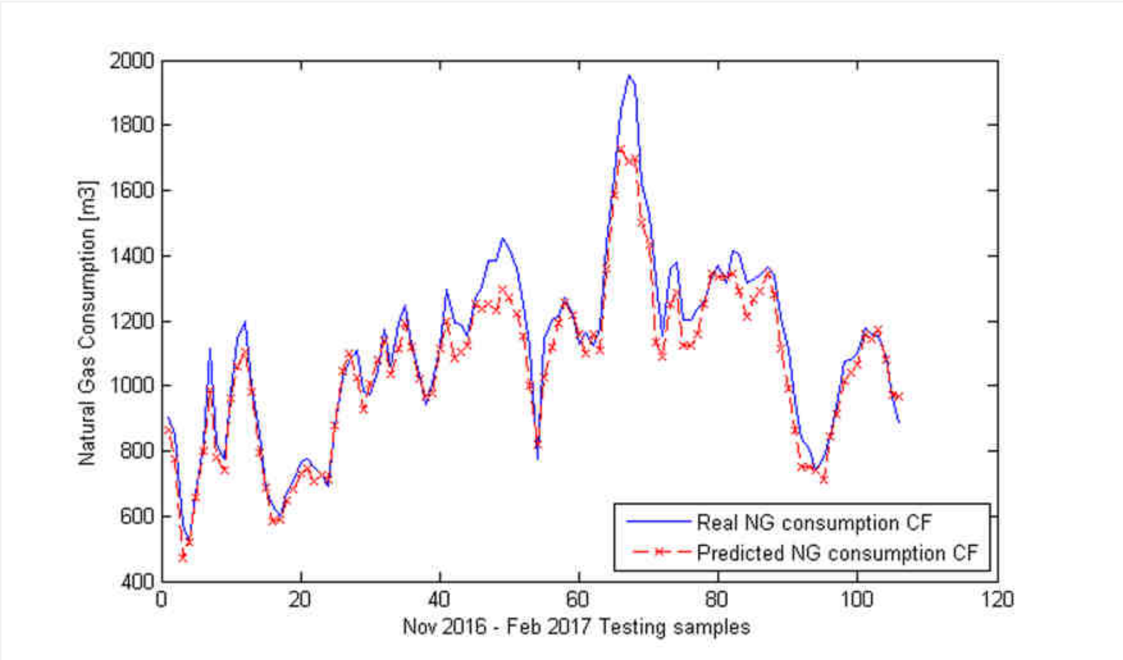

Figure 10: Forecasts by Curve Fitting model for testing data.

Evaluation of forecasted consumption is analyzed by using the mean absolute percentage error (MAPE). MAPE was calculated according to the following equation (N is the number of samples):

$$MAPE = \frac{1}{N}\sum_{i=1}^{N}\left|\frac{data_{actual} - data_{predicted}}{data_{actual}}\right| \cdot 100\% \tag{10}$$

Figure 12 shows comparison of MAPEs during different days of the week. It was showed that lower values of MAPEs are during Monday, Tuesday, Saturday and Sunday and the bigger MAPE values are during Wednesday, Thursday and Friday. Lower MAPEs values shows that forecasted data has a smaller deviation from the measured consumption.

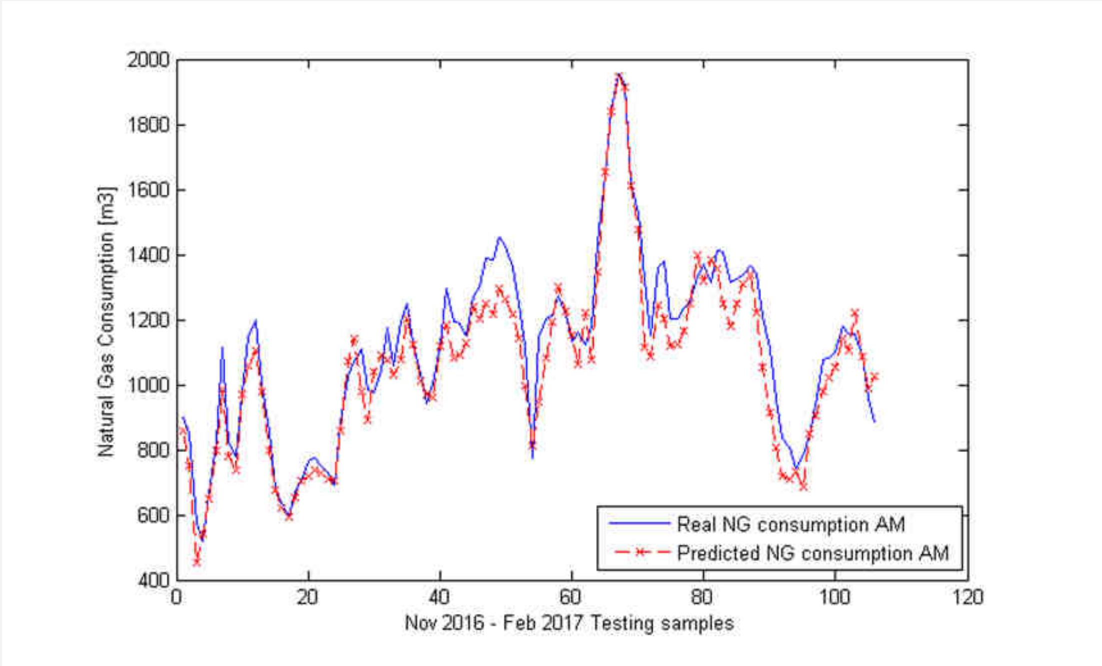

Figure 11: Forecasts by Average Model for testing data.

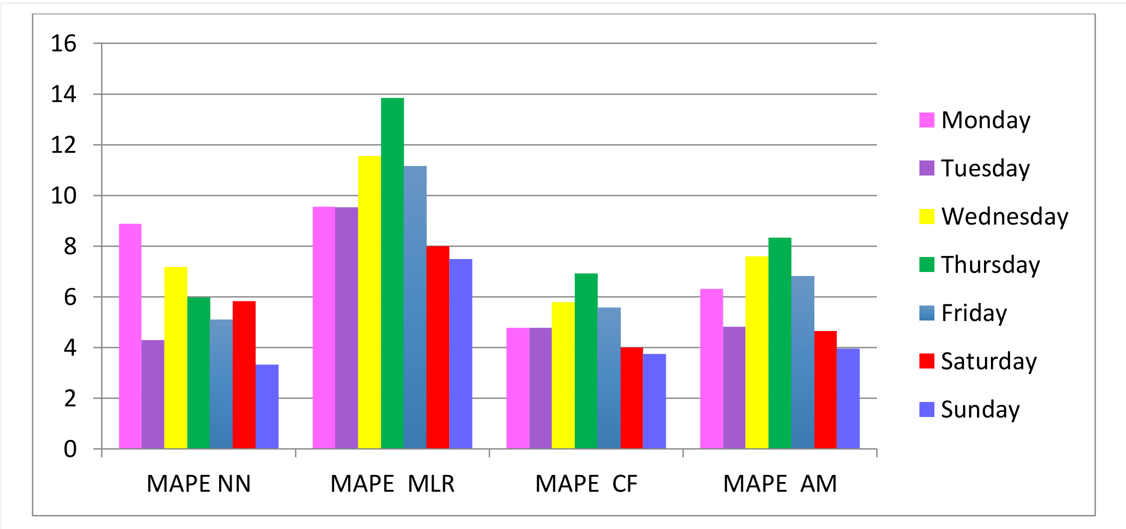

Figure 12: Comparison of average MAPE values for different models for forecasting NG demand.

In this case study lack of historical consumption data has influence to somewhat higher MAPEs values. It can be seen on figure 13 that range for average MAPE for these four models is $5\% \leq MAPE \leq 15\%$. AM model has the best match for the observed winter period consumption. The MAPE for AM is 5.16%.

5. Conclusion

Artificial Neural Network, Multiple Linear Regression, Curve Fitting and Average models are used for forecasting of daily natural gas consumption. Various variables with a significant influence to gas consumption are taken as inputs to models (temperature, previous day consumption, day of the week). Input data are considered on daily basis, and forecasting of natural gas consumption is for day ahead.

Obtained results of forecasting has shown little difference compared to measured actual consumption, thus they are acceptable. Three models have similar, relatively good results, and only MLR model shows significantly bigger mismatch with measured data. Reason for that is its linearity, while ANN or CF can be used for nonlinearities.

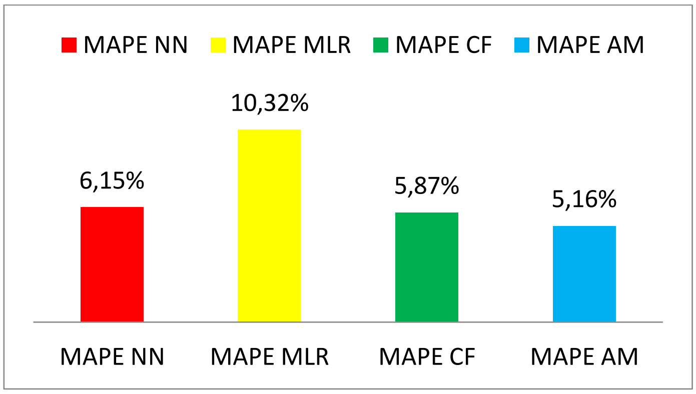

Figure 13: Average MAPE values.

It was shown that the Average Model provided the best results. Forecasting in Average Model is based on forecasted data from ANN, MLR and CF and it takes average consumption values. These average values are closest to actual consumption data for testing samples. Therefore, the deviations from the real data are the smallest, and this can be confirmed with values of MAPE. Implementation of proposed hybrid model could be helpful for a daily base planning of operation of distributive gas network. It can be used as assistant tool for operators in estimating future consumption at selected urban area. With a further training with real data, proposed model could be a part of fully automated system for forecast of natural gas consumption.

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Nature, Energy, Citizenship

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Abstract

Energy systems have gained relevance through the concept of the Anthropocene. Humans are becoming informed actors for destroying, maintaining or repairing their habitat. Dominated by its electricity form, energy systems were a main ingredient in forming advanced industrial-based civilizations. IPCC (2014) declared electrical energy production (especially coal) as a main driver of climate change. The paper discusses the possibility of responsible "energy citizens" that develops skills relating to new energy regimes more characterized by sustainability, decentralization and mass production market organization. Energy was traditionally local, even family, matters of skill and caring, but gradually developing into large scale, industrialized, centralized and commodified socio-technical systems. We discuss perspectives, practices and alienation towards nature that came with modernity and industrialism, new forces of governance and the resulting institutions of huge grids and big power plants. The climate change challenge goes together with changing perspectives on nature and cultural anti-commodification factors. Together with more consumer-oriented, mass-produced and decentralized energy regimes (examples are wind and solar) these factors may create a renaissance for roles of responsible energy-consumer-prosumers. Consumers may develop into actors in several ways; in ordinary markets through grades of political consumerism, in private life with new energy awareness and handling, but also as co-producers in a dialectical and growing interface with new technology. These trends combine a longing for lost authenticity (de-commodification) with the possibility for being a responsible Anthropocene actor.

Keywords: Citizenship, Energy, Transformation.

1. The Challenge of the Anthropocene

Energy systems have gained new relevance. Dominated by its electricity form, it was a main ingredient in forming advanced industrial-based civilizations. These energy systems are now a main actor that threats to destroy them. IPCC (2014) declared electrical energy production (especially from coal) as a main driver of destructive climate change. Through energy production patterns, humans are now able to destroy the nature's fundaments for their civilization.

The paper discusses several perspectives and practices towards nature that came with industrialism, the new forces of governance and the resulting institutions of huge centralized grids and big power plants that resulted. Consumers start to be actors in new ways, even energy citizens and co-producers, "prosumers". Technology development and structural changes points to smaller scale, flexibility and decentralization. These factors work together and creates rapid development of new markets, new manufacturing and new niches of energy production and many of them are around their tipping points to become major energy production regimes.

The Anthropocene Era has raised, and is raising a new and enhanced actor-role, as humans recognize that are collectively now geological agents[1] capable of eroding the eco-system services upon which they depend both for their biophysical survival and for the survival of their social world (civilizations). Today we humans are, in double sense, children of the Anthropocene - we are both living through the consequences of impacts of our actions on earth systems and are becoming increasingly aware of our new and emerging status as geological agents. We know who we are, who we have become and who we are capable of becoming.

The combination of impacts (damage) to geological systems that we humans have already realized, the knowledge we now have of what we have and are capable of doing to both destroy and rehabilitate ecological systems is a frightening prospect. The concept of Anthropocene Era (Schwägerl C., 2014) is a parallel to the concept of Risk Society (Beck U., 1992) on a meta-level. Beck's central idea was that the new technology of nuclear weapons and power and new consciousness of pollution created risk that both became a new cultural-political force and one that could not be limited to national-state boundaries or political parliamentary periods. New anxieties and risk called for new models for action and actor-roles. The Antropocene concept takes this logic to a new level where the natural/material basis for civilizations is changing and humans are invited into even more fundamental anxiety, risk-awareness and actor-creating processes.

The first uses of the Anthropocene concept were mainly negative, like the example of nuclear weapons, but in principle it is more about a new human position, as conscious actors, shaping, maintaining, destroying or enhancing our own conditions, and fate.

A foundational assumption that grounds, and shapes, our research is that human civilizations (and the economies that sustain them) will continue to require (demand) a constant and expanding supply of electricity. Today electricity is a sin qua non of human civilization. While it might be possible for humans to survive as biophysical beings without abundant electricity their "worlds" will collapse (Diamond J., 2005) without this.

Crucial within energy production and distribution has been the search for alternative methods of generating sustainable (that is eco-system friendly) electrical energy. There are major initiatives underway globally to produce energy in more sustainable ways. Indeed, these developments are at the very forefront of efforts to respond to the challenges of the Anthropocene such as climate change.

2. What is energy?

First, energy is <u>not a limited resource</u>. For example, the direct sunshine alone is capable of delivering all the energy that humans are ever likely to require (McKevitt S., Ryan T., 2013). In addition, there is the indirect old energy from the sun (coal, oil and gas), the gravitational force of the moon (tidal power), the weather system makes hydroelectric possibilities, wind, waves, The earth itself gives geothermal energy. Finally, the conversion of matter into energy (nuclear - both fission and fusion) have a potential that again in theory can deliver as much energy that may ever be needed without reducing mass in any significant way.

Second, <u>energy is never lost</u>; it transforms and moves along complicated chains. In the very long run the energies of the earth and sun will probably gradually dissipate into cold space according to the second law of thermodynamics At present and at the global and human scale of time and space it seems that humans have gotten the earth system into the problem of dissipating too little energy back to the universe (=global warming or more precise too much energy left in climate system).

The technology of using concentrated energy resources, such as fossil fuels, and the conversion of heat provide electricity has been of great importance for development of

[1] The distinction between ecological and geological refers to the fact that human influence now reaches further then the living ecosystem, it includes the climate, oceans and land structures as well

modern human civilizations. Given this, a crisis in this area quickly becomes social crisis that can lead to the destruction of civilizations. These technologies were of course not seen as problematic when they were institutionalized and may, as we shall see later, be seen as unfortunate historical choices among other possibilities that existed. Today they may seem so dominating in the socio-technical energy regime that the historically new insight of its damaging capabilities may look overwhelming. On the other hand, the long history of the less problematic technologies of hydroelectrical and classical wind power energy is one indication that reminds us of earlier and more fortunate choices and of new openings.

The impression that energy constitute a "limited resource", and a resource that damages earth systems while used, is a construct of special historical and techno-social factors. The close links that developed historically, given the preferred energy technologies, between fossil fuels (stored solar energy) and electrical energy generation technology creates the impression of a limited and dangerous energy system. Behind this appearance are strong paths of social and technological investments and institutions. They could have been changed earlier, but it did not seem necessary. Now it is necessary.

It is the institutionalized reliance on technologies that have used non-renewable resources to produce energy - a reliance that has a very long history - that is at the root of many of the features of the Anthropocene such as the destruction of ecological systems that are crucial for human survival as biophysical entities. Provision of energy for maintaining welfare and society is a social and political problem, not resource- or technology based.

3. Humans, energy, society and the crisis

What is special about humans is the level of energy that they have been able to produce (=concentrate) through processes of enrolment of other parts of earth systems - these include the early enslavement of biophysical forms (humans and animals) plus the use of physical features of different earth systems. This has enabled humans to sustain massive levels of social organization (civilizations). Today energy in its electrical form is the crucial energy required for social organization (this is especially true for low-power cyberspace even if this is an extreme energy efficient mode of communication).

A crucial driver of human engagements with earth system has been sustaining the high levels of energy required to sustain their civilizations. This is unlikely to change without major shift in power balance between central actors. We expect such shifts to occur through social acceptance and definition of crisis-situations, like pollution (China), supply system breakdown (South Africa) and of course the gradually developing citizen concern for the climate end the evolving crisis of extreme weather that is our main topic on the following pages.

The crucial question is: How can we humans continue to use the high levels of energy our civilizations require while sustaining the eco-systems that these civilizations to sustain humans as biophysical beings. The answer depends on technology, production, institutions and many groups of actors. Our concern in this paper is a mall part: the cultural/political construction of energy-relevant citizens, its history and development at general level.

4. Consumption and production are not the primary problems

The level of human activity (called production or consumption) in a society is not the fundamental problem, since the level of energy flowing through is not the fundamental problem. The problems are the damaging side effects, that varies with the organization and technology used. Societies have fallen apart even on low levels of consumption, if the way the uses energy are damaging (Diamond J., 2005) and vice versa. Given a special way of damaging production, the level of usage (consumption) is of course important, like in a coal-based industrial system, but this is not the key to understanding the challenge.

Stopping or reversing the general level of activity (called welfare, consumption or production) is therefore not necessary in a strict logical way, it depends on the way energy is “produced”. The key is the way it is done, not the volume. Reversing growth in economy, number of people or the general level of consumption is not the general solution, the solutions are more questions like: how, in what mix, driven by which values, what knowledge and what kind of responsibility.

This fact is often hidden behind ways of doing statistics (like GNP) that mix all kinds of activity together both activity that damage and activity that heals or a neutral to nature, both living with nature and against it. Simple example are the extra work needed to build cars that can be recirculated and do not pollute, or the extra cost of isolating houses better. It is “good” extra consumption.

5. Knowledge

When it comes to knowledge and motivation regarding the climate challenge and its links to some forms of energy concentration, it becomes slightly more complicated.

The well-documented and simple fact is, however, that the climate challenge is accepted and the basic mechanisms well known. Humankind is worried. There might be disputes or distrust on details (how much warming, is the storms this year really due to climate change) but the robust answer is that people all over the world are worried and share a basic understanding. There is awareness. As nature is never fully deterministic and always more complex than models, science will seldom be spot on. It may seem like it has been very difficult to see how the effects of “warming” (=more energy stored) are divided between different practical effects like higher temperature, more extreme weather and ocean current changes. But the general and accepted attitude is more and more that we have a responsibility and should act and that the effects are already piling up around the world. Surveys tend to show that people are willing to act and make priorities even if they are not fully convinced by the researchers, and this can be interpreted as a quite reasonable principle of being careful and respectful.

6. Actors and Values

6.1. Fire

The practical skill of making a fire was a dramatic change and progress for humankind, using concentrated energy in a way that propelled formation of society and genetic development of humans (Harari Y.N., 2014) Even now, fire is for many linked to important personal skill learned in the family setting. Fire was and is life-saving. It was about sustain life, family care, heating and cooking. It became linked to religions. This is not only a tale from thousands of years ago, it is both still a necessity for many, and we all have some part of it. The personal skills and handling of fire are closely linked to the relation nature and the longing for a stronger actor status. That a book about chopping of wood became an instant bestseller (Mytting L., 2015) and translated to 6 languages might illustrate the cultural content of the classic fire.

There are also important positive symbols (and taste) of "real wood fire"-made bread/pizza/meat all over the world, like the Argentinian, US and South African grill tradition (braai). There are lots symbolic coziness and religious symbolism in lighting a candle. The skills and proudness of making a camping fire or (for me personally) the importance of being able and trusted by the family to handle and have your own "primus" for camping kerosene cooking. This is reminding us that energy is also a tale of skill, personality, family, care, food, survival, religion, honor, socializing, tradition and good taste. This is quite fundamental and long before the construction of an energy market and the electrical form.

6.2. From Nature to Commodities

The classic ideals of governance come with several different views on “nature”. The influential classic Greek elitism of Plato had a quite special construction were the ruling elite itself should be free from important aspects of their human character. Love, sexuality, emotions or children should be banned from the elite so they could have the virtue of “pure reason”. The Plato governance construct is a form of pure calculating reason that should be placed to rule from a point above “nature”. The world of Plato and also some modern philosophers (one example is Hannah Arendt, see Arendt 1958) seem to try to lift governance out of the spheres of nature, production and consumption.

After the classic period, the centuries of Christian/Catholic influence had their own twist where the “rational men” was to be trusted as rulers and not women because they had more nature in them (and less “God”). Nature was created by God and should be respected, but also ruled by humans (men) by applying rules and reason.

In the Renaissance, governance took a turn away from religion and became more of a way of acting and thinking in its own right. Hobbes construction of a mighty Leviathan that the, by nature, weak and chaotic humans have in their interest to be ruled by (1651) is a bit parallel to Plato (Leo Strauss 193X). Machiavelli advices on politics as a culture/art/craft that can be mastered and both are part of a movement away from both religion and the personalized king in the direction towards nation states ruled from a central point, applying reason and social power.

The new "modern" rationality attempts to use the emerging sciences as a model for politics. Hobbes used physics and mathematics as model for his political visions, mathematicians/philosophers like Laplace (1749-1817) and "The father of statistics" Quetelet (1796-1874) argued for a ruling system based om mathematical/statistical methods applied from the top (Hayek F.A., 1955; Jensen T., 2015). The Hobbesian vision of a one-point ruling system above humans and nature merged with new sciences that had the promise of making this possible in a precise way that included ever more aspects of nature and society taken in under the governing system (Foucault M., 1978, published 1991). And then we arrive at governance in the age of modernity.

In the debate on governance, moral and citizenship towards nature was also in the debate. Some of the central actors, like John Stuart Mill and John Dewey, (Selznik P., 1992) pointed out that humans are <u>in, not above</u>, nature, and that "untouched" nature was (therefore) not an ideal. Nature should be seen in the perspective as value and relevance to humans. In the discussion Selznik (1992, p58) points out the damage that is done when rationality is used without the braking force of practical reason and plural values.

In the age of industrialism, attitudes towards nature became more aggressive and one-sided, it was all about exploitation of resources through big market units and/or central planning. The (short-time) progress made was easy to see (US and UK growth, Soviet Union, Nazi Germany). This is an age that still forms parts of our thinking and values, and was the forming period of the dominant energy regimes of today: the technology, the structure, the popular raw materials to use, the calculative skills, the mentalities as well as the distribution system and all its social fabric. (Hughes T., 1988) With electricity as an energy carrier, electrical grid-based energy systems became crucial to industrial growth, they became centralized and one of the main public utilities.

An old power station is a symbol of pride. Often it will have polished brass, copper and marble integrated in the technical layout and the building itself is designed as a temple of progress and prosperity. A famous quotation from the communist leader Lenin is: "Communism is Soviet power plus the electrification of the whole country." In paintings and pictures (good examples are China, Soviet-Union, US, Norway) the buildings, the dams, the smoke and the high-voltage gridlines through woods and over mountains were presented in a glorious symbolic manner. It was man's victory over nature. This romantic and progress-oriented perspective is also today important (and reasonable) as symbol and value in poor countries. To be connected to electricity is the sign of progress in welfare, hygiene, education and family safety. But the magic of electricity also hides the sources of the energy and its roots in nature from the eyes of the user, illustrating our next topic

The critique

This modernity-type symbolism is much broader than only electrical energy, even if it is an important end good example. The basic topic is the relation to nature in the industrial era. An important (1930's) critique came from the German philosopher Martin Heidegger (The Question concerning technology, Harper 1977). He argued that modern industrialism created a way of thinking, a perspective that formed our value system with few possibilities of escape. The way of thinking makes nature appear in very special way: as a "standing reserve" for production. Trees are for paper, waterfall for energy, soil for large-scale food production or metals, air is a source for fertilizer and so on. How to get the other values and the holistic soul of nature back the human think in nature? Heidegger thought it was almost impossible from within industrialism and searched for a solution inspired by the Nazi movement.

One specific aspect of "value" is the tendency to see it as money. With the modernity perspective of which Heidegger accuses industrialism, nature have no value per se, the only value is the one linked to the usage for production purposes. Even if early works of Karl Marx had a (for the time) good understanding of the metabolism of nature (Foster J. B., Clark B. and York R., 2010), his theory of value is linked only to the work that goes into the extraction and production. His analytical system (and his legacy) still remains a production-side value-system, where human work is the only significant value. This is also emphasized by Schumacher in his classical “Small is Beautiful” from 1973. There is a complicated addition by Marx that allows for a contribution to the owner of the land/resource, but our main argument remains.

This tendency for industrialized countries to see nature as a kind of free (and sometimes endless) stockpile of resources and recipient for waste is of great importance. We are not using the term capitalistic; the East European socialist countries had the same attitude to nature. The examples are many, one is that until the 1970's serious researchers on fishing resources believed that there was no connection between fishing and the actual amount of fish in the sea (Norway, see Gran 2013, BP quarterly 197X).

This is not the place for a large discussion on the character of governance activities towards nature and the trends in change, but two different and classic studies will be referred to before we continue to the more specific topics.

All trees present and accounted for…..,

Scott’s book (James C Scott: Seeing like a state. *How Certain Schemes to Improve the Human Condition Have Failed,* 1998) has a strong theoretical argument in the Hayek tradition of explaining how a central authority (state) must simplify and standardize in their governance, they have to “see” the world in a special way characterized by standardization, simplification, accounting procedures and statistical techniques of averaging. And because of this tendency mistakes are done, especially when dynamic processes and pluralism are involved (like nature). Scott has his background in political science, anthropology and agrarian studies and his examples and case studies in the book are mostly from large-scale attempts to govern nature. One example is from Germany in the 19th century and is also a good illustration of Heidegger’s point. It is the attempt to centrally and rationally govern the forest as a production system for wood. The best way from the state perspective is to line up the trees in rows (to allow easy counting and control procedures), to ensure they are as like each other as possible and to minimize all other life forms that can disturb. Then it is possible to calculate production, to plan the cutting and to have a rational plan for the usage of the wood, with very precisely information on volume and quality. This was (and is) not so special, it is like most industrial farm-/plantage- like enterprises. It is the long-time frame for Scott’s study and the forest as a complex natural system that tells us very easily that probably this was not a success. It was a kind of success in the short run, for the first few (2) generations of trees. But for all other usages of the forest and in the longer run it was a disaster that exemplifies very well how the industrial/centralized way of seeing like a state is ruining nature.

The forest becomes complicated (books by Kaufmann 1960 and Tipple T., Wellman D., 1990)

Herbert Kaufmann’s The Forest Ranger (1960) is a classic study in political science, about the role as the governing agent of the forest. For us, one of the main point pints is that the stability, unity and success of the forest rangers are being made possible through two factors. One is relative limited scope for the “governing” forests, maybe “protecting” or “inspecting” is better words for the relative limited set of relevant goals with efficiency and economy as keywords for the internal life of the system. The other is a structure of freedom and fragmentation at the bottom level, leaving the individual forest ranger with broad possibilities for adaption to local conditions. Thirty years later, his study is reanalyzed by Tipple and Wellman (Tipple, Terrence J. and J. Douglas Wellman (1991) *Herbert Kaufman's Forest Ranger Thirty years later: From simplicity and Homogenity to Complexity and Diversity*). One of their main observations is that Kaufmann could see the policy goals for natural resource management as stable and simple, in accordance with the limited scope of governance and the lack of conflicts in this area of politics. Thirty years later the environmental movement is an independent political force, the indigenous groups are organized and have relevant interests, the tourist industry is reaching into the forests and generally: the list of values and interest to be taken into account is not only significantly longer, it has become unpredictable and unstable. Not only has the forest grown more complex, containing ever more and shifting values and interests in addition the evolving scientific premises lead down by new sciences of ecology and climate. The structure of policy implementation has changed from a simple hierarchy system to a complex system of representation, negotiation and responsiveness. From a hierarchy government implementation system of limited scope to a system of governance to be interpreted, created and handled at the local level.

Together these two contributions to understanding “governance of nature” highlights both the problems of the centralized simple implementation of a production-side perspective on nature and the challenges of the more complicated modern shifting multi-stakeholder governing systems, highlighting the many different human roles and interests that relates to nature. Just a few decades ago, energy production was almost only engineering and economic matters. Now major energy projects face a long series of possible considerations relating to an ever more complicated knowledge of nature, indigenous groups, agriculture, fishing and forests, tourist interests, esthetical considerations, evaluation of electromagnetic fields and their possible harm, district interest and (if nuclear) a time-frame of thousands of years. Most people will today accept that this is about values and politics linked to a long series of different expertise, while the normal attitude in 1960’s and 1970’s was that it was simple engineering/economic matters. It is also tempting to conclude a little more optimistic and say that the governance relevant to nature today reflects a lot more of the genuine multitude, lack of determinism and dynamics of nature itself.

But Heidegger is not only concerned about value as "price of extraction". It goes deeper, to genuine values, to the mystery, soul or spirit of nature and our lost ability to see it. Rachel Carson, by many called the mother of the modern environmental movement, was a biologist and her main book (Silent Spring, 1962) was mainly about facts. But in another work (The Sense of Wonder, 1965) she writes:

To counter the "sterile preoccupation with things that are artificial, the alienation from the sources of our strength" it is necessary to cultivate a renewed "sense of wonder" toward the world and living beings. It is not enough to contemplate life. It is necessary to sustain it, which means actively opposing the "gods of profit and production".

This is connected to the notion that the era of mass production also is the era of a special form of detachment, called commodification or alienation. It means that the information and emotional links between products their sources in nature and human work are gradually disappearing, replaced by calculation. We lose the attachment and the information and the emotional links to the production disappears: the place, the materials, the worker, the country and tradition. Finally, the goods become only commodities of price and technical properties. They appear without relevant qualities besides price and technical properties. And this way of seeing the world also gradually becomes the way we see each other, the society, and finally, ourselves. This aspect of industrialism is discussed as negative by philosophers (from James Mill in late 1700, with Karl Marx and Sigmund Freud as the best known).

Humans do not like to be commodities and tend to prefer having their products more authentic and personalized that the rationalized commodities of mass production will give. The commodification has been counteracted by a lot of forces, from branding and history-telling and personalization and other forms of longing for authenticity (Taylor C., 1998) as a strong force in markets. The pressure from consumers for products with authenticity is easy to see in many areas. Organizations like Slow-Food tries to decommodify food from its industrial settings, using words like sensuality, authenticity, tradition and social quality as illustrations for (again) linking food stronger to nature and culture.

Again, electrical energy seems to be a very good example. It is in the connector and we have few clues to its production, its toll on nature or the people who do the work. And it seems to be fully interchangeable, all energies look and feel the same when leaving the connector as long as voltage and other technicalities are OK. Electrical energy is one of the most important and most commodified elements in modern life. Energy as part of nature, transformation and concentration of energy as possible harmful in some of its form, and haw energy is entangled in and extracted from the processes of nature are not easy to see.

6.3. Getting the nature and its electricity back

So far, we have tried to make some assumption about attitudes and values around the relation between humans and nature. How humans were thinking nature under the spell of industrialism. This way of seeing nature that belonged to the era of industrial modernity is now under critique and it feels wrong together with the governance principles it builds on. Both this perspective on nature and the commodification problem of modernity mass production have created a cultural resistance. The environmental problems, evolving into the climate challenge and Anthropocene have created anxiety and a new sense of cultural unease. Together these developments point to developments of citizenship, energy citizenship and a political consumerism. In the last part of the paper we will look into the shape of these shifts and the possibilities for a new actor role.

One of the most famous science fiction novels ever written is DUNE by Frank Herbert. Several volumes adding up to around 4000 pages from 1965 and dedicated to dry land ecologists, at that time a very small part of the science community.[2] It is also a story about how to relate to nature.

On the planet Dune water is the really scarce resource that has to be concentrated, organized, saved, stored and circulated. The villain of the story is a high-technology culture protected in large spheres, using imported energy. They have all the traditional aspects of an industrial-modernist perspective on nature: They use technology to be protected from nature, living inside their high-technology bubble. The heroes, on their side, well aware that they are part of nature- Their values and traditions, as well as some selected advanced technologies, are at the core of the coping strategies. All dedicated to respecting and handling water. The metaphor of dying is "to give your water back to the tribe". Water handling and respect for the planets' limited water resources is the fundament of the civilization and is within all sub-parts of the social systems: Religion, hierarchy, family values, trade, technology regimes. Their ability to respectfully be a part of nature is, in the end, the secret of their victory. This kind of story is of course repeated in later popular culture and the recent movie Avatar (2012) is an example, where the heroes literally melts into nature and the villains are high tech-protected exploiters. For our purpose it reminds us that governance and its roles and actions are rooted in ways of thinking and in organized daily-life value systems and that the unease and problems of industrial modernity now are quite present in popular culture.

But how can we, as consumers and citizens, rediscover electricity as rooted in nature, as diversified, as taking Anthropocene responsibility? James Pierce and Eric Paulos from Human-Computer Interaction Institute published a series of papers 2010-2014 (Pierce/Paulos 2010 a,b,c 2011, 2012, 2013, Pierce/Paulos/Schiono 2010) that takes a fresh approach and uses both philosophy and practical examples to see how energy can be practical, personalized and treated with respect linked to a multitude of producing and storing possibilities. They also include the aspect of emotional connections, personal attachment and authenticity. Our interests is the simplest arguments is that it will create possibilities for responsible energy citizens that treat electricity with the respect nature deserve. These possibilities are tightly linked to new energy producing and storing technologies that are more integrated with information technology and also technologies

[2] The movie (1984, by David Lynch) is not recommended in our setting, as it concentrates on the war and actions aspects of the story

that are easily downscaled to home-size. Keywords are smart grids, smart metering, solar energy, battery storage and internet of things. This package of technologies has the advantage of mass-production and falling prices, is growing fast and is called "The Participatory Energy Model" (Seba T., 2014).

More at the market level and within the existing distribution systems there are already two practical tendencies in the energy markets that can be seen as a small reversing of commodification. The first is the attempt by some producers to "label" and "brand" their energy in different ways. The simplest way is to guarantee that they only deliver sustainably produced energy and that their chain of production is nature-friendly as it goes into the net. They can also, like other producers, make claims regarding their organizational behavior (CSR) and take values and nature into their electricity in indirect ways (one example is that the producer will guarantee contribution to rainforests support, according to energy purchase). Energy is then not only energy, it is infused by values and branded as such. Often this is combined so that companies take social responsibility by installing sustainable energy, to show customers that they take responsibility even if they operate on other markets than energy. This is actually one important driving mechanism for solar energy installation. The other process is connected more directly to the generation of electricity. More sustainable and decentralized technologies are being developed into deliverable products and also distributional markets are more decentralized and diversified around many technologies. Off-grid technologies (solar, mini- hydro, mini-wind, heat-pumps) makes it possible for individuals, families, neighborhoods, islands, boats, lighthouses, villages, individual farms and cottages as well as companies can be self-powered with their own energy. This can also be blended into their grid connection in several ways, the simplest being that grid usage is only happening when there is need above the locally produced energy or (more complicated) excess of local energy production can be loaded onto the grid. (To use external energy only when needed is quite simple and included in modern solar water heaters, to deliver excess to a grid is a bit more complicated, but is implemented in large scale networks in several countries, like Germany, US and other places).

Generally, the idea of the rational market actor has hampered our ability to see such value-driven options Consumers cannot be understood from a generic private rationality-perspective alone. ("Price matters, values decide")(Etzioni, 1988). Use of energy to make a "warm" welcoming home for guests in cold countries is as important as the habits of turning off as you leave the house. The values linked to sustainability gradually becomes built-in manners of decent behavior, both for individuals and companies. Recirculation and waste sorting are going through such a process. Often such changes are too slow to be noticed or the analysts themselves share the values in a way that blocks this insight into them as something other/more than "the only way". Foucault (1991) and Rose (1989) have highlighted the processes that builds values into individual behavior. Daily-life values, habits, technologies and practices often show huge changes in more sustainable direction, contrasting more macro-oriented measures. Daily handling of waste, shopping selection of declared environmental-friendly goods and services and a respectful attitude to nature are easy detectable and often contrasting large-scale factors like oil export and GDP growth.

In Burckhardt's (1860) analysis of the civilization process of the Renaissance in Italy he is clear that the (self-) construction of a social responsible individual was an important part of a process that made the whole society more decent and concerned, creating power structures that had to take a web of factors into consideration, and where even the doge of Venize and other noble rulers had to rule according to the norms of decent behavior. This was replacing an earlier system where "The King is the Law" (L'etat c'est moi) and the level of brutality was significantly higher. Norbert Elias (1994) is from another angle making points about how rules of behaviors gradually change into more "civilized" pattern, where "civilized" means rituals and habits that may be seen as treating the world and each other more gently. A relative new contribution is Rifkin (2009) that uses the concept of "empathy" and includes the biosphere. An interesting contribution comes from Bruno Latour (2004, 2005) and invites us to see the bonds (network elements) between nature, things and humans as the basic element of governing (ANT).

For us the point is that habits and internalized values change and reflect underlying beliefs and considerations, and considerations of energy usage and its link to nature may be one of them. There are many organizations and public initiatives today that actually work in this area, making both levels and type of energy usage into areas of "decent behavior". In the corporate world the popular concept of CSR (Corporate Social Responsibility) is gradually replaced by CSV (Creating Shared Values) that remind us to see also the corporate world as actors with values, and values that can be shared and also, as often is the case, represent popular and non-contested values of nature.

6.4. Energy citizenship

The classic notion of a "citizenship" is changing. It used to be linked to nation-state duties and rights, especially in the formal political system. But individual freedom and resources, as well as the changing character of nation-states, have created different citizens' identities and initiatives in many sub-areas (Isin E.F. and Wood P.K., 1990). Citizenships, responsibilities and actions are formulated and socially created around platforms of race, sex, gender, consumer, environmentalism, food, and (of course) energy. They are platforms for formulations of values, rights and interests, making organizations and actions emerge and forming individuals' mind. The struggle of indigenous people is one example, the gay movement another. Food as a platform for citizens' responsibilities and actions were clear already in the early years of the role of housewife (also linked to the science and education in "home economics") Linkages to traditional politics were made through campaigns for saving resources, reducing imports and more generally educating new responsible citizens in food related areas. After the era of the housewife, this citizenship was no longer connected to a personalized role, it was more generalized and gradually linked to broader social values and now "Food Citizenship" (Jensen T., 2007) The big range of food-related organizations are increasingly taking up topics like fighting industrialization (=commodification), health considerations, environmental and climate responsibility, diversity and culture as well as minority interests and fairness for developing countries.

Energy citizenship is only in its beginning. The concept has also (in the US) been used by big oil companies pushing the interpretation as "the right to energy". But mostly the idea has been linked to the responsible energy behavior that takes nature into considerations and there is an interesting literature on the conditions for developing such a citizenship role. It can be seen as an arm or a further development of the "Consumer Citizenship" and its conceptual cousin "Political Consumerism" (Jensen T., 2008). Consumer Citizenship is a common concept that covers school education, international NGO's, governmental initiatives and a substantial stack of literature. Our general argument of taking responsibility and linking to values of sustainability and nature is very clear. Citizenship development depend on the ability to have a choice, make a difference, to take responsibility and that again requires market possibilities an information on usage and consequences of the use. Technologically this also points to more or less "smart" meters and the organization and information capacity of organizations (often NGO's, but paradoxically often also the sellers/producers of electricity)

The biggest users of energy is companies (in many countries 50-70 % of total). They are also actors (organization-level citizens) and including energy in their CSR/CSV work (even sometimes the using energy citizenship concept) are becoming more common. The fact that companies are the main consumers of electricity must be taken into account when actions and changes are discussed.

Also, parallel to the food citizenship is the (anti-commodifying) process of shortening the social distance between production and consumption. The popular example is the growing "farmers' markets" and the Slow Food movements. This push producers more directly in contact with consumers. The result is information and knowledge on food as nature, discussions on how to prepare food, the values included and how to grow etc. Consumers will both be more competent and also taking up their own activities, leading to the phenomenon of the prosumer (Toffler A., 1980). One part of this can be seen in the rapidly growing popularity of urban food production, hobby parcels and farm holidays. For the energy sector this will be the gradual mobilization of consumers from active consumers to co-producers of their energy, both for own purposes and for delivering to the grid. (limited by their private usage, their company needs or even delivering onto a smart grid). Parallel to the food sector, there is a gradual development from developing responsibility and economy in the home, to more neighborhood and political-type action and even involvement in (alternative) production. Energy is becoming linked to nature and establish a platform for consumer actions and even a role as an energy citizen. This role is one of the most important drivers of change, given institutional and regulative openings.

6.5. The power of weak consensus values

What kind of political value is in the link between nature and energy? We stated earlier that the value was more or less consensus: It is not seriously contested. We will probably have no political party that states clearly that they oppose taking nature into consideration regarding electricity generation. Quite the opposite, at symbolic levels most companies and actors pays tributes to these values. Even BP tried to explain their name as meaning "Beyond Petroleum" and both Shell and Norwegian Statoil are advertising in newspapers about their commitment to clean sustainable energy. In our daily shopping life, there are tens of thousands of declarations, markings and claims on all kinds of products and services regarding sustainability. Also, popular culture have changed, Categories like Eco- thrillers and Climate-thrillers are now quite common. Even the famous Matrix (1999) movie-trilogy started with energy for computers being unavailable due to human-made climate change and the need for new sustainable energy sources. Surveys also underline this culture of worrying and taking nature seriously.

So why is the word "weak value" indicated in the headline? The basic and traditional party structure of most industrialized countries was made around the material interests of production (workers, owners, farming, fishing). There are exceptions and they are growing in number (green parties), but main political structure is still evolving around production-side interests. Around this party structure there usually is a system of strong organizations that are represented in committees and formal negotiations. They are even more marked by the production- side skewness. And more and more there is a system of paid lobbyists even stronger representing the owner side of production systems. Many of these people are nice people that have some green values like others, but in these functions, they are bound to their institutional roles of the core of the interests they are there to defend.

It is a relevant observation that this logic not only applies to values of nature and climate, it also applies to development, nutrition, health and peace. They are all rooted in social consensus, but may be at odds with the structure and values of the formal political power system and its implementation bodies. Again, this could be seen as more or less reasonable when knowledge of damage to nature was missing and benefits of economic growth was easy to see in health and living standards. There is, however, one positive side of the consensus-logic: it seems to be a “ratchet”, that is moving forward in small and more or less irreversible steps. Values like nature and climate, that is opposed and that have a good media potential, will gradually change practices, again the example is the myriad of small daily life habitual changes, in regulatory new rules, applying of criminal law to environmental bad behavior and international negotiations.

7. Summing up, focusing on factors that press for change

The first group of factors is general in its character, a reason for change that have our attention. The first and most fundamental is **the Anthropocene**, the fact that we as humans are influencing/making/destroying our habitat and are aware that this is the situation and that this fundamentally changes our ideas and our abilities about change. We are reconstructing ourselves as Anthropocene actors. For energy this is narrowed down to the harm that is done by carbon burning to extract energy and letting pout huge amounts of CO_2 into the atmosphere. Energy production is the most significant single factor that harms the climate with CO_2. The second factor is closer to our own health and short-term damages, it is about more **local pollution factors**. This is most visible in China and in some local areas around production plants, but is certainly visible and creating attention and direction. The third factor is linked to a general consequence of modernity, **commodification,** that means that goods and services loses contact with the producing forces of nature and humans and becomes anonymous generalized, like electricity in the grid. Since the start of modern industrialism commodification have created several kinds of discomfort at the human and cultural level, the attention creates a longing for the personal and authentic and the responsible role of the actor-citizen. The fourth factor is **technology development** that continuously widens the menu of possible solutions, creating openings, pathways, for the actions of **energy citizenship** in a more decentralized system.

To end up with an optimistic and possible pattern of possible change, the following events may happen so that a new sustainable energy cultural and socio-technical landscape will emerge:

Anthropocene responsibility will be a factor on many actor levels (politics, companies, citizens) that fit with new and more decentralized and sustainable ways of energy production, storage and distribution. Energy citizenship will be a meaningful role linked to possibilities for action. This also fits well with the tendency for modern consumers to want a clearer actor status to fight commodification. These forces are helped and formed by regulative skills and structures so that the new systems pass the tipping points and becomes the new mainstream. The material and immaterial structures of the old industrial modernity will be left to creative destruction, propelled by its destructive effects of pollution, climate damage and lack of adaptability to energy demands in developing countries. The old will give way to new forces and on the way creates opportunities for energy citizenship and production that is sustainable non-destructive.

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Application of HERON Decision Support Tool for the Greek case (transport)

by

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Abstract

HERON DST is a user-friendly software that facilitates the selection of the optimum combination of technologies and practices minimizing the negative impact of end-users behavior in the implementation of Energy Efficiency scenarios.

This paper concerns the Greek transport sector. Six scenarios are developed: the Business As Usual (BAU), the Energy Efficiency Scenario without barriers (EE T0); the Energy Efficiency Scenario with all barriers (EE T1); three scenarios considering best combinations of technologies/actions and minimized impact of selected barriers (EE T2, EE T3 and EE T4). Description of scenarios, assumptions and HERON DST outcomes are presented and discussed.

Keywords: barriers, scenarios, energy efficiency.

1. Introduction

The transport sector accounts for the 7% of the EU GDP and for 7.06% of the total employment in the EU, corresponding to more than 15 million people in absolute terms (2014 figures) (European Commission, 2016). The sector is vital to the EU economy in terms of exports with the maritime transport accounting for 90% of the EU's external trade (ODYSSEE – MURE, 2015).

In 2015, transport was one of the three dominant final end uses of energy in the EU-28. Its respective share was 33.1% followed by households with 25.4% and industry with 25.3% (Eurostat, 2017; European Commission, 2016). For the same year in the EU-28, the total energy consumption of all transport modes amounted to 359 Mtoe (Eurostat, 2017). Until year 2007, consumption had consistently increased, rising each year from the start of the time series in 1990 (Eurostat, 2017; ODYSSEE – MURE, 2015). One year later, the energy consumption for transport fell by 1.5% and this reduction continued (Eurostat, 2017). In 2012 it was 11% lower than in 2007 at EU level (ODYSSEE – MURE, 2015). Overall, between the relative peak of 2007 and the low of 2013, final energy consumption for transport in the EU-28 fell by 9.3%. This reduction is attributed to the economic recession by approximately 40%, with a decrease in freight traffic and the stability of passenger traffic (ODYSSEE – MURE, 2015). The remaining almost 60% is due to improvements in Energy Efficiency (EE), mostly for passenger cars (ODYSSEE – MURE, 2015).

In 2014 the European Council endorsed a binding EU target of an at least 40% domestic reduction in GHG emissions by 2030 compared to year 1990 which is expected to be delivered collectively by the EU in the most cost-effective manner possible (European Commission, 2016). Reductions in the ETS and non-ETS sectors (transport, buildings, agriculture and waste management) amount to 43% and 30% by 2030 respectively compared to 2005, but no sectoral target has been established for the transport sector (European Commission, 2016). Due to developments under current trends and adopted policies, there is need for additional policies, especially post-2020, so as to close the gap of 6-7 percentage points and provide a cost-effective transport contribution to the 2030 Climate and Energy policy framework (European Commission, 2016). A Communication on actions needed to decarbonise the transport sector has been announced by the Commission in the Energy Union Roadmap and will further complement Member States efforts (European Commission, 2017).

This paper concerns the development of EE scenarios for the Greek transport sector. The methodological approach is different compared to the until now followed ones due to the need of incorporating barriers towards EE targets due to end-users behavior and developing an effective policy mixture adjusted to the national framework. With the use of HERON-DST that allows incorporation of behavioral barriers in EE modelling, 6 scenarios were developed: Business As Usual (BAU), Energy Efficiency Scenario without barriers (EE T0); Energy Efficiency Scenario with all barriers (EE T1); three scenarios considering best combinations of technologies/actions and minimized impact of selected barriers (EE T2, EE T3 and EE T4). Description of scenarios, assumptions and HERON DST outcomes are presented and discussed.

2. Hellenic transport sector

2.1. National EE targets for the transport sector

The sector will contribute to the national EE target (18,4Mtoe final energy consumption of year 2020) by restricting its respective amount to 6,7TWh (MEECC, 2014).

2.2. General description

During the previous decade the ownership of passenger cars increased due to economic development and improved living standards. This resulted to a tripled number of the passenger cars compared to the 1990 levels, but also to an increase in 2008 of the share of medium passenger vehicles by 27% and of the larger size ones by 36% compared again to year 1990 (MEECC, 2014). Similar trends were recorded also for the number of trucks, buses and motorcycles (MEECC, 2014).

Due to the economic crisis this trend is decelerating, even though the percentage of car ownership in Greece is lower than the EU average. Additionally, the reduced trend will be retained due to the high taxation imposed on vehicles with engines over 2.000cm^3 (in 2011, the share of passenger cars with an engine capacity greater than 1.400cm^3 was 34%) (MEECC, 2014).

According to estimations there are approximately 45.000 businesses - covering all sizes - activated in Greece and concern all transportation activities (in mainland – road and railway, air, sea, logistics included) (SEB, 2012). These types range from private – personal to multi-national ones. The activity is more intensive at the big urban centers.

2.3. Energy consumption

Transport energy consumption peaked in 2009 at 8.4 Mtoe, but fell by one-third in the three years to 2012, and has been stable since then (IEA, 2017). In 2011, the energy consumption for transportation accounted for 35,9% of the total final energy demand (MEECC, 2014). The oil products dominate the final energy use with a share of more than 99,5% (MEECC, 2014). The remaining share concerns biofuels and small shares of natural gas and electricity (IEA, 2017). Motor gasoline and diesel are the most common oil fuels, representing 45% and 39% of the total oil consumption, respectively in 2015 (IEA, 2017).

Gasoline is consumed mainly by passenger cars, diesel oil by trucks and means of maritime transport and railroads; jet fuel by aircraft; and smaller amounts of Liquid Petroleum Gas (LPG) and diesel oil by taxis (MEECC, 2014). Railroads (until 1996) used exclusively small amounts of steam coal, while electric buses (trolleys) and the metro that operate in the central Athens area use electricity (MEECC, 2014).

The share by type of vehicles remained basically constant during the period 2000-2013 (CRES, 2015). Road transport accounted for 88% of the total transport energy consumption in 2014, sea transport for 8% and smaller shares for domestic aviation and rail transport (IEA, 2017). Passenger vehicles accounted for over half of the energy consumption within road transport, with freight transport was responsible for most of the remaining energy use (IEA, 2017). The biggest energy consumption of the road transport is attributed to cars with an average share of 57% in the final consumption of the mode. Trucks and light vehicles follow with 38% of the total consumption of road mode (CRES, 2015).

2.4. National policy framework for EE in the national transport sector

So far, only National Energy Efficiency Action Plans (NEEAP) refer to the transport sector. Their policy instruments include (HERON, 2015a):

- *Planning policy instruments:* Cycling and pedestrianism in the city; improvement of infrastructure for electric vehicles;
- *Regulatory policy instruments:* Emission standards (Euro 5 and Euro 6); Establishment of Permanent Committee on Green Transport; Energy labeling for transport);
- *Financial policy instruments:* taxation on energy products and electricity; Registration and circulation tax exemption for electric and hybrid vehicles); incentives to replace old technology cars and motorcycles (subsidies, tax exemptions));
- *Dissemination and awareness instruments:* Consumer information fuel economy and CO_2 emissions of new passenger cars; eco-driving; Green Public Procurements for transport sector.

2.5. Energy savings potential

For this sector the highest energy savings potential is expected from the use of private cars (73% of the total energy savings of this sector) and from the freight transport using trucks (21% of the total energy savings of this sector) (2nd NEEAP, 2011; 1st NEEAP, 2008).

2.6. End-use technologies

The EE technologies of the Hellenic market include per type of transport mean (HERON, 2015b):

- Cars (private and public): vehicles meeting EURO 5 standards, Compressed Natural Gas (CNG) and LPG-powered private passenger vehicles, electric vehicles (including motorcycles, bicycles, heavy vehicles), LPG vehicles and bi-fuel natural gas vehicles (municipal fleet).
- Buses: natural gas public transport buses.
- Light trucks (private and public): vehicles meeting EURO 5 standards.
- Infrastructure: vehicle recharging points (Renewable Energy Sources (RES)-powered and/or conventional).

3. Methodological approach

The scenarios are developed by incorporating the barriers linked with end-users behaviour; then their time development is specified through the used energy model. Two research tools are used for this approach: i) The HERON-DST for calculating the impact of barriers, incorporating them in EE scenarios and exploring the best combinations of EE technologies/practices; ii) The modeling tool, LEAP, for understanding the time development of the developed scenarios. The next paragraphs refer to these tools.

3.1. HERON Decision Support Tool (HERON - DST)

The innovative HERON - DST enables the quantitative transformation of the qualitative characteristics of the end-users behavior that hinder the implementation of EE policies in buildings and transport (HERON, 2016a). HERON - DST, developed by KEPA in cooperation with App-Art, provides policy makers with a user-friendly software facilitating them in selecting the optimum combination of technologies/practices and minimizing the negative impact of end-users behavior in the implementation of EE scenarios. It has two sets of 27 barriers each including non-economic and non-market elements; these barriers are common for six and one candidate EU Member States (Bulgaria, Germany, Greece, Estonia, Italy, Serbia and United Kingdom).

3.2. LEAP

The Long range Energy Alternatives Planning system (LEAP) - developed by the Stockholm Environment Institute - is a widely-used tool for energy policy and climate change mitigation assessment[3]. It can be used to: i) track energy consumption, production, resource extraction, and GHG emissions in all economic sectors (Heaps C., 2016); ii) create models of different energy systems and iii) support a wide range of modeling methodologies on the: a) energy demand side (bottom-up, end-use accounting techniques to top-down macroeconomic modeling); b) supply side (powerful accounting and simulation methodologies for modeling electric sector generation and capacity expansion planning) (Heaps C., 2016).

4. Development of scenarios

4.1. Using HERON – DST for calculation of impact factor of barriers

Barriers are mapped, merged and grouped into three main categories: i) Social-Cultural-Educational, ii) Economic and iii) Institutional. Afterwards, barriers are compared pair-wised and the importance of one barrier over the other is assessed using a 1-9 scale (Mavrakis, Konidari, 2017).

After the completion of all comparisons, the Impact factor for each one of the identified barriers is calculated. The Impact factor is a numerical outcome, expressing the contribution of the concerned barrier in preventing the achievement of EE targets. The Impact factors for the Hellenic case were calculated using the HERON – DST and the outcomes are presented in Table 1.

The total impact of the assumed barriers on a certain input is expressed by the Total Impact Factor which is also calculated. Consequently, EE technologies and practices are linked with the relevant barriers through their Total Impact factors that are provided by HERON – DST. Occurring deviations are calculated.

Options for reducing deviations through the optimum combination of EE technologies and practices and the minimization of the impact factors leads to optimized outcomes. Outcomes are available to be used as inputs to EE modelling. The methodology has six steps:

Step 1: Mapping, categorization and merging of behavioral barriers;

Step 2: Development of the AHP tree and matrices;

Step 3: Calculation of weight coefficients;

Step 4: Definition and calculation of Impact Factors of barriers;

Step 5: Linkage of Impact factors with input drivers;

Step 6: Incorporation of the Total Impact factors in the forward-looking EE modelling.

4.2. Developed EE scenarios considering end-users behaviour

Common key assumptions for the scenario development concerned population and Gross Domestic Product (GDP). Eurostat population projections for Greece were used, while forecasts from the EU- Ecofin[4] and the 3rd NEEAP were used for the GDP.

CRES provided the available historical data for the time period 1990 - 2013 (HERON, 2016b). The forward-looking scenarios for EE in the Hellenic transport sector were developed with time horizon the year 2030 (HERON, 2016b). These are the following (HERON, 2016b):

- **Business as Usual (BAU) scenario**: It looks into current possible trends until 2030 with policy measures/instruments already implemented.
- **Energy Efficiency (EE T0) scenario**: It reflects a forward-looking path towards the achievement of the maximum possible amount of energy savings based on the national potential through a combination of technologies/actions. It is the synthesis of five (5) developed sub-scenarios for this sector, each of which was assumed to have a specific level of penetration in LEAP for one technology/measure.

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3 http://www.energycommunity.org/default.asp?action=47

4 http://ec.europa.eu/economy_finance/eu/countries/greece_en.htm

Table 1: Total impact of barriers for the Hellenic transport sector.

Type	Name of barrier	Impact
Social	Low satisfaction with public transport/lack of trust	**0.111**
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	**0.156**
Social	Heterogeneity of consumers	**0.025**
Social	Suburbanisation trends/Low density	**0.017**
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/	**0.019**
Social	Inertia	**0.017**
Cultural	Car as a symbol status and group influence	**0.029**
Cultural	Habit and social norm of driving, car ownership and use	**0.125**
Cultural	Cycling is marginalized	**0.013**
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	**0.053**
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	**0.052**
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	**0.052**
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – *Negative perception*	**0.007**
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	**0.028**
Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ -	**0.026**
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	**0.076**
Economic	Low purchasing power of citizens/Financial crisis	**0.031**
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for	**0.033**
Economic	Payback period of fuel efficient vehicles	**0.008**
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	**0.008**
Institutional	Administrative fragmentation and lack of integrated governance	**0.020**
Institutional	Transport EE on the Government Agenda/priorities	**0.027**
Institutional	Barriers to behavior change due to problems with infrastructure/public transport	**0.044**
Institutional	Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for bike and pedestrian mobility/ Limited policy on freight efficiency/city logistics	**0.004**
Institutional	Limited/complex funding in urban public transport	**0.004**
Institutional	Barriers to behavior change due to no policy support to technological issues/research needs (Immature status of developing technologies for EVs/ULEVs - Range of distance travelled between charges for EVs)	**0.004**
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	**0.010**

- These sub-scenarios are:
    - *Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable):* The additional (to BAU policy mixture) policy instruments for supporting these technologies are: i) Grants of 3000-8000 Euros for the purchase of Hybrid Electric Vehicles (HEVs) (YPEKA, 2012); ii) Grant of up to 10% of the price for the purchase of Plug in Hybrid Vehicles (PHEVs) and Battery Electric Vehicles (BEVs) (YPEKA, 2012); iii) Campaigns for raising awareness towards electric vehicles; iv) Extension of the grid of e-mobility (charger points, etc.).
    - *Eco-driving in freight and passenger transport:* The additional policy instruments include: i) Awareness campaigns about eco-driving; ii) Inclusion of eco-driving as part of education of new drivers.
    - *Modal shift in freight and passenger transport:* The only additional policy instrument concerns the “Extension of rail grid”.

- *Use of biofuels in freight and passenger transport:* No additional (to those of BAU) policy instruments for supporting this technology.
- *More efficient vehicles in passenger and freight transport:* No additional (to those of BAU) policy instruments for supporting this technology.

The combination of all developed sub-scenarios into one scenario again aimed to lead to at least 27% energy savings compared to BAU scenario, without considering the impact of barriers linked with end-users' behavior.

- **Energy Efficiency (EE T1) scenario**: It reflects the forward-looking path of EE T0 scenario but after incorporating the impact of barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the HERON - DST, the deviation of this situation is now quantified and reflected in the results of this scenario. EE T1 scenario is again the combination of the five (5) sub-scenarios into one (1) EE scenario using the expected levels of penetration, derived from HERON - DST. Now, the targets are lower than the expected due to the impact of barriers (see Table 2). **Its policy package is the same with that of EE T0**.
- **Energy Efficiency (EE T2) scenario**: It reflects the improved EE T1 scenario, through the most promising combination of three technologies/actions (Electric and hybrid vehicles – Modal shift – More efficient vehicles) (based on HERON - DST). The situation was improved compared to EE T1 from the point of energy consumption and GHG emissions. Improvement is expected through the minimization of specifically selected – by the user - barriers linked with "Electric and hybrid vehicles" that was considered as the priority technology/action out of the aforementioned three due to the larger number of its barriers.

The minimization of the barriers – by using the HERON - DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE T1. Its policy package includes that of EE T0 and a number of more additional policy instruments aiming to confront selected barriers for "electric and hybrid vehicles" (see Table 3). By minimizing the impact of barriers for the "Electric and hybrid vehicles", the other two technologies/actions "Modal shift" and "More efficient vehicles" will be also benefited. From the minimized barriers a notable shortcoming of the EE-T0 scenario emerges (see Table 2). The previous scenario was developed focusing only on assumptions for supporting technologies.

Now, due to barriers it is noticeable that measures/actions for improving public transport are need also. For instance, the creation of a Green Transport Committee (Regulatory policy instrument) will allow: i) the better coordination of actions that will improve infrastructure and public transport services.

Table 2: Assumptions of EE-T0 and EE T1 scenarios.

Sub-scenarios	Assumptions for EE T0	Assumptions for EE T1 (after the use of HERON – DST)
Electric and hybrid vehicles	25% penetration of HEVs by 2030 7% penetration of EVs by 2030 10% penetration of PHEVs by 2030	16,102% penetration of HEVs by 2030 4,508% penetration of EVs by 2030 6,441% penetration of PHEVs by 2030
Eco-driving	10% energy savings in road transport (private vehicles, buses and trucks)	7,642% energy savings in road transport (private vehicles, buses and trucks)
Modal shift	30% shift from road to rail by 2030	17,494% shift from road to rail by 2030
Use of biofuels	penetration of biofuels: in road transport 10% by 2020 and 20% by 2030, and 5% by 2030 in aviation	penetration of biofuels 8,190% by 2020 and 16,380% by 2030 in road transport, and 4,095 % by 2030 in aviation
More efficient vehicles	50% more efficient private cars and trucks (petrol and diesel) by 2030	41,125% more efficient private cars and trucks (petrol and diesel) by 2030

Table 3: Policy package of EE T2 scenario for the Hellenic sector.

EE Technologies/Actions	Assumptions	HERON – DST outcomes	Additional policy instruments for confronting barriers	Selected barriers for minimized impact
Electric and hybrid vehicles (Priority)	By year 2030 penetration shares for HEVs - 25% EVs - 7% PHEVs - 10%	HEVs – 19,482% Evs – 5,501% PHVs - 7,859%	- Grants of **4000-9000 Euros** for the purchase of HEVs (YPEKA, 2012) **(modified)** - **Grant of up to 20%** of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) (modified) - Campaigns for raising awareness towards electric **vehicles/more efficient vehicles** - Extension of the grid of e-mobility (charger points, etc.) **and development of web-site for mobile applications so that drivers know where charger points are.** - **(New) Creation of a Green Transport Committee**	– Lack or limited finance / incentives (Economic); – High costs (Economic); – Concerns on reliability / Hesitation to trust new technologies (Social); – Problems with infrastructure / public transport services (Institutional); – Limited infrastructure investment for public transport (Economic).
Eco-driving (road transport (private vehicles, buses and trucks))	10% energy savings	7,642% energy savings	No additional PIs.	Common barriers with “electric and hybrid vehicles”.
Modal shift	30% shift from road to rail by 2030	20.140%		
Use of biofuels	penetration in road transport: 10% by 2020 and 20% by 2030, and penetration in aviation by 2030: 5%	penetration in road transport: 8,190% by 2020 and 16,380% by 2030 penetration in aviation by 2030: 4,095 %		
More efficient vehicles	50% more efficient private cars and trucks (petrol and diesel) by 2030	46.323%	Tax exemptions for three years for those that purchase more efficient vehicles.	Common barriers with “electric and hybrid vehicles”.

Table 4: Policy package of EE T3 scenario.

EE technologies/Actions	Assumptions	HERON – DST outcomes	**Additional policy instruments for confronting barriers**	**Selected barriers for minimized impact**
Electric and hybrid vehicles (Priority)	By year 2030 penetration shares for HEVs - 25% EVs - 7% PHEVs - 10%	HEVs – 20,808% Evs – 5,826% PHVs – 8,323%	- Grants of **4000-9000 Euros** for the purchase of HEVs (YPEKA, 2012) **(modified)** - **Grant of up to 20%** of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) (modified) - Campaigns for raising awareness towards electric **vehicles/more efficient vehicles** - Extension of the grid of e-mobility (charger points, etc.) **and development of web-site for mobile applications so that drivers know where charger points are.** - **(New) Creation of a Green Transport Committee**	– Concerns on reliability / Hesitation to trust new technologies (Social); – Problems with infrastructure / public transport services (Institutional); – High costs (Economic); – Lack or limited finance / incentives (Economic); – Limited infrastructure investment for public transport (Economic).
Eco-driving (road transport (private vehicles, buses and trucks))	10% energy savings	7,642% energy	Same as in EE T0 and EE T1.	No common minimized barriers.
Modal shift	30% shift from road to rail by 2030	17,494% shift from road to rail by 2030	Same as in EE T0 and EE T1.	No common minimized barriers.
Use of biofuels	10% by 2020 and 20% by 2030 penetration of biofuels in road transport, and 5% penetration of biofuels by 2030 in aviation	18,255% - road 4,564% - aviation		The policy instruments for “Electric and hybrid vehicles” (as described in EE T2) will benefit this technology also.
More efficient vehicles	50% more efficient private cars and trucks (petrol and diesel) by 2030	45,521%	- Tax exemptions for three years for those that purchase more efficient vehicles. - Soft loans for purchasing “more efficient vehicles” - Development of a more coordinated plan for public transport.	Common barriers with “Electric and hybrid vehicles”.

Table 5: Policy package of EE T4 scenario for the Hellenic transport sector.

EE technologies/actions	Assumptions	HERON – DST outcomes	Additional policy instruments for confronting barriers	Selected barriers for minimized impact
Electric and hybrid vehicles (Priority)	By year 2030 penetration shares: HEVs - 25% EVs - 7% PHEVs - 10%	HEVs - 16,102% EVs - 4,508% PHEVs - 6,441%	Same as in EE T0 and EE T1.	No common barriers with “more efficient vehicles”.
Eco-driving (road transport (private vehicles, buses and trucks))	10% energy savings	7,828% energy savings	Same as in EE T0 and EE T1.	No common barriers with “more efficient vehicles”.
Modal shift	30% shift from road to rail by 2030	17,494% shift from road to rail by 2030		
Use of biofuels	*penetration of biofuels in road transport:* 10% by 2020 and 20% by 2030, and *penetration in aviation:* 5% by 2030	8,190% by 2020 and 16,380% by 2030 penetration of biofuels in road transport, and penetration in aviation: 4,095 % by 2030 (No change)	Same as in EE T0 and EE T1.	No common barriers with “more efficient vehicles”.
More efficient vehicles	50% more efficient private cars and trucks (petrol and diesel) by 2030	43,519%	- Tax exemptions for three years for those that purchase more efficient vehicles; - Soft loans for purchasing “more efficient vehicles”; - Development of a more coordinated plan for public transport.	– Problems with infrastructure / public transport services (Institutional); – Lack or limited finance / incentives (Economic); – Limited infrastructure investment for public transport (Economic); – Low purchasing power of citizens / Financial crisis (Economic).

- **Energy Efficiency (EE T3) scenario**: It is an improved EE T1 scenario, based on the second most promising combination of three technologies/actions (Electric and hybrid vehicles – Use of biofuels – More efficient vehicles) (using HERON - DST). The situation was improved compared to EE T1 and EE T2 due to minimization of specifically selected barriers linked with "Electric and hybrid vehicles". Its policy mixture is presented in Table 4.
- **Energy Efficiency (EE T4) scenario**: It is also an improved EE B1 scenario, based on the third most promising combination of three technologies (More efficient vehicles – Eco-driving – Use of biofuels) (using HERON - DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 through the minimization of specifically selected barriers linked with the "More efficient vehicles" option. Its policy mixture is presented in table 5.

4.3. Results of EE scenarios compared to BAU scenario and policy targets

The target for year 2020 is to achieve total final energy consumption (for all sectors) 18,4 Mtoe (3rd Hellenic NEEAP, 2014; HERON, 2016b). The transport sector accounts for 42% of the total energy according to 2013 data (CRES, 2015). Since Greece does not have sectoral targets, the assumption is that the share of the transport sector remains 42% and the sectoral target is 0,42x18,4=7,728 Mtoe for year 2020. The overall GHG target for 2020 is 4% reduction of GHG emissions compared to 2005 levels. There are no sectoral GHG targets, consequently this target is assumed to apply for all sectors. The overall target of 2030 is assumed to be 16% reduction of GHG emissions compared to 2005 levels, according to the proposal for effort sharing[5]. Deviation results are presented in Tables 6 and 7.

5. Conclusions

The developed scenarios for the Hellenic transport sector differ compared to others that concerned also forward – looking energy efficiency paths, due to the incorporation in energy modelling, with the use of the HERON – DST, the end-users behaviour. Through the HERON - DST software and based on the conducted work for mapping the barriers for the Greek case (HERON, 2015c) and the responses of the experts (HERON, 2016a), the impact of barriers linked with the behaviour of the national energy end-users was quantified and used in the developed scenarios (EE T1 – EE T4).

The use of the HERON - DST allowed the understanding of: i) how barriers linked with end-users' behaviour prevent the achievement of the set targets (EE T0) and the size of this deviation (comparing EE T0 with EE T1). ii) the policy mixture (the set of policy instruments) that will overcome the barriers preventing significantly the achievement of the targets. iii) which combinations of technologies are more promising in achieving the set targets.

The development of scenarios with the use of the HERON - DST has led to the following key findings for the building sector:

The minimization of barriers linked with technologies/actions that concern the "electric and hybrid vehicles" affects other technologies as well and allows better results.

Table 6: Comparisons among scenarios for final energy consumption in transport sector in Mtoe.

Scenarios	*2020 national target*	*LEAP outcomes for year 2020*	*%Change in 2020 compared to reference year of national target*	*LEAP outcomes for year 2030*	*%Change in 2030 compared to BAU scenario*
BAU	7,728	7,240	-6,30	8,592	0,00
EE T0		6,031	-22,00	5,767	-32,90
EE T1		6,373	-17,50	6,463	-24,77
EE T2		6,288	-18,63	6,286	-26,84
EE T3		6,315	-18,28	6,356	-26,02
EE T4		6,368	-17,59	6,456	-24,86

[5] http://ec.europa.eu/clima/policies/effort/proposal/index_en.htm

Table 7: Direct GHG emissions in $MtCO_2$.

	1990	2005	2020	2030
EU Policy target and national target if applicable	17,18	23,81	22,86	20,00
HERON BAU scenario			20,97	24,73
% change compared to target			+8,27%	-23,65%
HERON EE T0 scenario			15,91	12,64
% change compared to target			-30,40%	-36,80%
HERON EET1 scenario			17,492	15,909
% change compared to target			-23,48%	-20,46%
HERON EET2scenario			17,123	15,103
% change compared to target			17,950%	37,70%
HERON EET3 scenario			17,145	15,817
% change compared to target			17,950%	38,26%
HERON EET4 scenario			17,479	15,890
% change compared to target			16,41%	35,65%

Table 8: Energy savings/cap and GHG emissions/cap for transport for 2020 and 2030 per scenario.

Scenarios	***Energy savings/capita in toe***		***GHG emissions per capita in*** tCO_{2eq}	
	2020	**2030**	**2020**	**2030**
BAU	-	-	1,96	2,45
EE T0	0,113	0,280	1,487	1,252
EE T1	0,041	0,211	1,634	1,577
EE T2	0,089	0,229	1,600	1,500
EE T3	0,086	0,221	1,601	1,568
EE T4	0,081	0,212	1,633	1,575

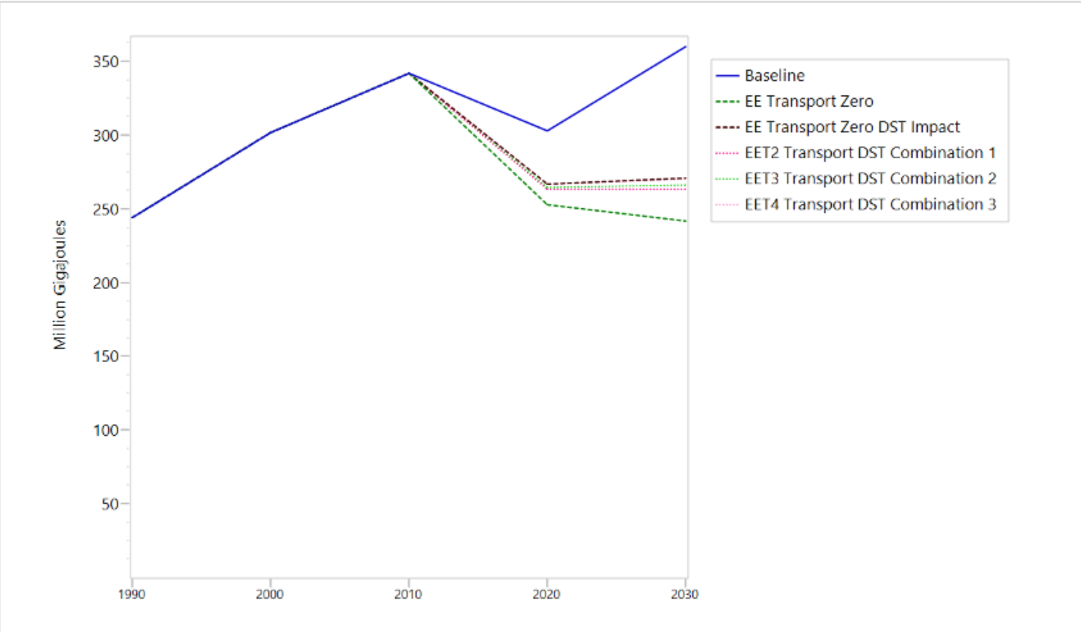

Figure 1: Final energy consumption of the transport sector in the six (6) scenarios.

– It is the technology with the largest number of barriers and efforts to overcome them affect other technologies that have common barriers with the “electric and hybrid vehicles”.

– The assumed policy instruments are targeting specific barriers and from that point policy instruments can de designed to be more successful.

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Implementing Carbon Free Ferry Technology on West Coast Norway - The Electrical Route

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Abstract

Norwegian carbon footprint is considerable due to oil exploiting industry. The carbon emissions per capita from Norwegians are 2 x above global average and 40% above the EU average. On the other hand, Norway is one of the most privileged countries in the world with close to 100% supply of electricity from the source of hydropower. It is relatively easy access to more sustainable energy. Technological shifts from fossil energy to green electricity is therefore crucial and logical in Norway.

Due to political pressure from green popular movements, several political institutions have been searching for paths for implementing green initiatives. Approx. 3 years ago, the Parliament of the West Coast County Hordaland decided to organize a process of tender requiring low emission from new ferries with 700 daily departures crossing the fjords. Due to new disruptive technology, local innovative industry combined with political visons and regulations, contracts for 17 ferry connections have been signed. The public invitation to tender for new contracts was technology neutral and claimed new ferries with at least 55% reduction of CO_2 emission. The winning bids however, represent reduction on close to 90% reduction of emission and 60-74% reduction of energy needed. The winning engine technology shifted from diesel to electrical energy.

This paper discuss technological-, organizational-, political- and actor aspects of this radical shift of maritime transport technology in the fjords of Western Norway.

1. Introduction

As most other regions in the world, Northern Europe face serious climate challenges. Dramatic temperature increase has been measured[6] and record decline of the arctic multiyear ice cover in 2017[7]. We experience ricing incidents of extreme weather with storm and heavy rain. According to IPCC AR5 Synthesis Report, 65% of carbon budget for 2°C target globally is already used (IPCC, 2014).

[6] https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally
[7] http://www.yr.no/artikkel/_-stadig-mindre-is-i-arktis-1.11888837

The environmental problems affecting both the air and ocean, and thus lately, a changing decision-making landscape reading from, among others, the COP21 agreement, have led to many new and innovative initiatives and investments. This is for instance evident in the global installation boom of solar and wind power, especially in China. This is also true for the transport sector. In Norway, an active subsidy policy has led to a massive increase in the implementation of electric and hybrid cars in the last few years, approaching 50 % of all new cars sold in September 2017in Norway (ABC Nyheter, 2017; Valle, 2016a).

One sector that traditionally have been one of the greatest polluters is the maritime sector. The use of contaminating hull coatings, sound pollution and Sulphur containing bunker oil as fuel, have resulted in this label. International seaborne shipping is responsible for the carriage of about 90% of world trade. The maritime industry is also a significant contributor to pollutant emissions (Corbett and Koehler, 2003; Dalsøren, Eide et al., 2008; McLauchlan and Stephens, 2016).

This paper discusses one case of possible disruptive green technology (Sæle and Eggen, 2017) in the maritime sector in Norway. This country has one respectable and one not so respectable record on climate change and climate emission.

Norway is one of the most privileged countries in the world with close to 100% supply of electricity from the source of hydropower. This electrical path provides excellent opportunities for renewable technology in engines. Generous tax reductions have been imposed on imported electrical vehicles (Bjerkan, Nørbech et al. 2016, Zhang, Qian et al. 2016). Norway are with Canada and Brazil among the countries in the world with the highest share of energy production from sustainable hydropower sources.

Thus, expanding the usage of electricity as an energy source to new sectors has been actualized as a means to cut emissions. The latest report from the Norwegian Water Resources and Energy Directorate (NVE) states that electricity usage will increase by 5.6 % from 2015-2020, mostly due to the expansion of electric cars. (NVE, 2017). This electric trend is also moving towards the maritime part of transportation.

More than 1000 vessels traffic 202 ferry connections and passenger liners in fjords and coastlines of Norway (Aaadland, 2017). In 2015, the first electrical ferry for passengers and cars were introduced in Sognefjorden in Norway (Svendsen and Hauso, 2014). However, other low emission technologies are also expanding. This includes gas, biofuel and hydrogen. "The Government is requested by the Parliament, to ensure that zero-emission technology (and low-emission technology) are included in all future tenders for public ferries, when the technology allows for it." (Inst. 2 S Addition 1 (2014–2015)). So, does the technology allow for a green shift? And what are the traits of the decision-making landscape for these technologies on the West Coast of Norway today?

The non-optimistic news on climate change and emission in Norway is the climate effect of Norway as a leading oil-producing nation. The oil-producing sector and transport sector in a country with long distances. Compared to other European countries, Norway has not been successful in reaching its goals for reducing climate emission. According to UNFCCC, Norway has not yet abided the joint agreement of reducing greenhouse gas emissions to the level of 1990. The CO_2 emissions were 25% higher in 2015, compared to the level of 1990.

This paper will explore the new electrical route strategy in the maritime ferry sector with several dimensions. First the innovation aspect on introduction of disruptive technology (March 1991, Christensen 2006). The ferry fleet today is based on engine technology fuelled with diesel. Second - technological standardisation vs. new niches (Geels 2005, Geels and Schot 2007, Schot and Geels 2008). Third – the importance of public regulation for new renewable technology (Braithwaite and Drahos 2000, Persson 2015) and finally decision making processes for radical environmental shift in public funded public transport (March and Olsen 1989, Olsen 1989, Wüstenhagen, Wolsink et al. 2007). Our primary research question is: *What central conditions can be identified for successful radical innovation for renewable technology in public transport at sea?*

2. Theory

2.1. Two dimensions

2.1.1. Technological standardization vs. new niches (Geels 2005; Geels and Schot 2007).

Achieving a sustainable innovation, can be enabled by creating technological niches, postulated by the term *strategic niche management* (SNM) (Schot and Geels, 2008). Early SNM research highlighted the internal factors (learning, networking, expectations), but external factors have gained increasing attention in later years. Niches allows for experimentation of new potentially disruptive technologies, for user testing and learning, and for public regulations to form. It is important to mark that this approach is not merely a "technology push", but rather a mix of technological and social interaction, where the influence of endogenous processes are important. Nevertheless, the governmental structures may facilitate for innovation to be more sustainable (ibid.). From this, three analytical levels have emerged (first formulated by Rip and Kemp, 1998), namely the micro-level of internal steering, the meso-level of the socio-technical regime that consists of the cognitive, the regulative and normative roles, and the macro-level of the socio-technical landscape (Schot and Geels, 2008) (see Figure 1).

In their study, Schot and Geels conclude that niches serve as critical factors for regime shifts, but that several other factors, such as the socio-technical regime and landscape, are necessary for those niches to diffuse extensively (as can be seen in Figure 1). The concept of *landscape* covers the entire sector and relevant environment - cognitive and normative expectations from markets, civic society and governmental actors.

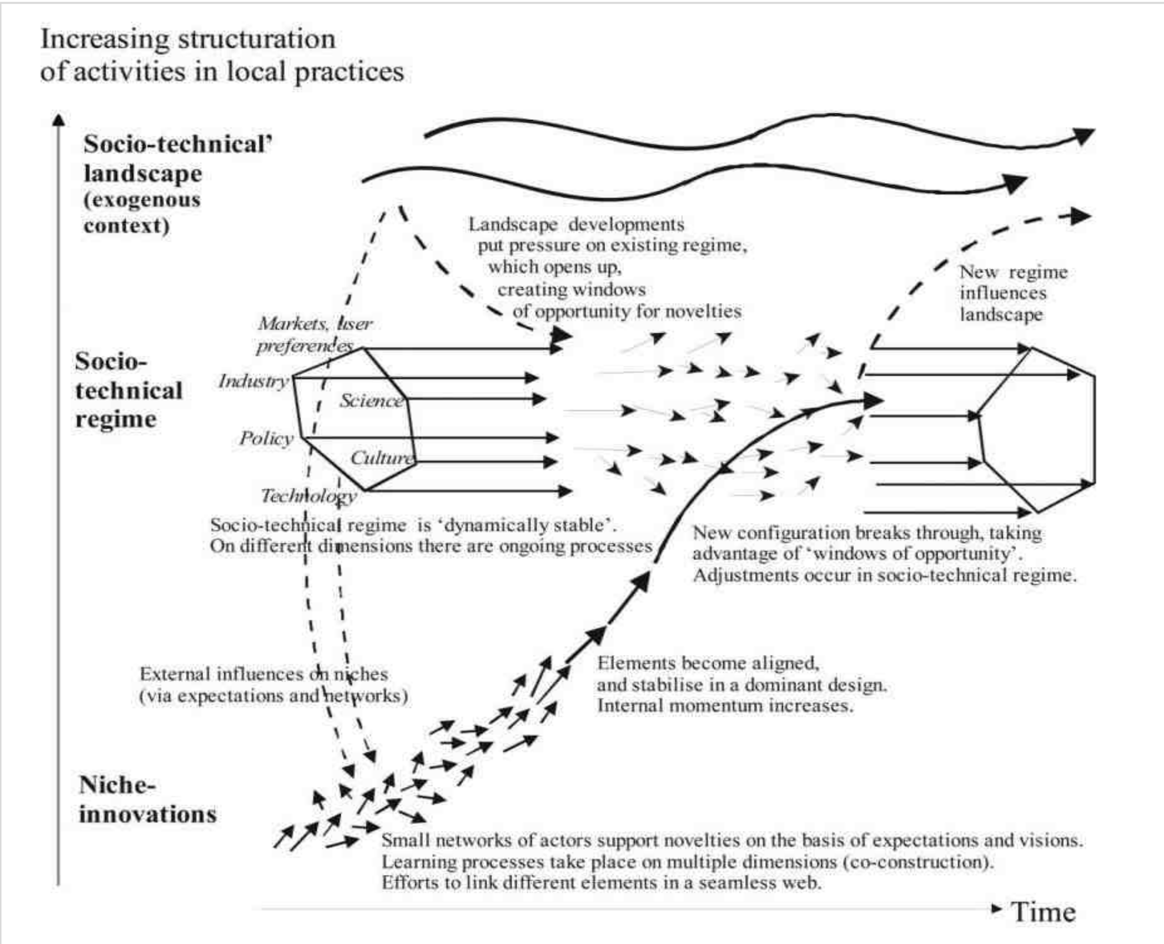

Figure 2: The three levels of structuration, related to time. Source: Schot and Geels, 2008 (adapted from Geels, 2002).

Figure 3: The three dimensions of social acceptance of renewable energy innovations. Source: Wüstenhagen et al., 2007.

Our assumption is that the new contracts for ferry services from the West Coast of Norway study represent a case enabling and moving from niche to new scaled up and standardized dominate socio-technological solutions – the electrical route in coastal maritime sector.

2.2. *The decision-making processes for radical environmental shift in public funded public transport (March and Olsen 1989, Olsen 1989).*

The governmental target to implement new technologies in the renewable energy sector may show to be constrained by the social acceptance factor (Wüstenhagen et al., 2007). By introducing three dimensions of social acceptance, Wüstenhagen et al. seek to clarify the term targeted at renewable energy (see Figure 2).

The first dimension is the socio-political acceptance, seeking to cover the most general form. Policy makers, key stakeholders and the public "require the institutionalization of frameworks that effectively foster and enhance market and community acceptance" (Wüstenhagen et al., 2007). Examples of this will include collaborative decision making, or options for investors.

The second dimension consist of the local stakeholders, authorities and residents, making up the community acceptance dimension. Research on this topic show several contradicting conclusions, where some suggest a low acceptance (and even a resistance) from people directly affected by a renewable energy project ("not in my own backyard"), while other studies show that resistance decrease with the degree of being affected by the project (Simon and Wüstenhagen, 2006). Either way, the time is of most importance for the acceptance of these projects, where it tends to be a high acceptance before the initiation of projects, a lower acceptance during the building, and a higher acceptance when the technology is up and running (Wolsink, 2007). Alternatively, we might argue that the basic driver is the "degree of being engaged and involved in the project or projects".

The third dimension involves the market acceptance, which includes the adoption of the innovation to the market, also known as diffusion (Wüstenhagen et al., 2007). The consumer is an important part of this dimension, and it depends on the infrastructure of the technology as well, thus it might be more challenging to use this theoretical approach of consumers on complex innovations, such as new ferry technologies that require upgrading of the energy infrastructure for instance. However, the market acceptance might also be influenced by investors, and last, it might also be subject to impacts from intra-firm relations. Firms influence each other, and at the same time, firms can influence political strategies and decisions (ibid.).

Our case exceeds a narrow market-oriented category, as political actors do have a role in all three dimensions. Political institutions carry political premises for socio-political acceptance. In a democracy, they also represent social and political movements for community acceptance. In our case the county organizes the tender process. They represent the market for ferry services. The services are subsidized, and public authorities secure infrastructure for power-supply. As the negative impact of technological shift to users of the ferries seems to be limited, we assume that socio-political acceptance might be the most important dimension.

2.3. Summary of the dimensions

Based on the above-mentioned dimensions, we will proceed with a composition of these. Our main theory will be the three levels presented by Schot and Geels, 2008, due to its ability to cover a vast number of influential players in a changing technological environment. Nevertheless, we will include the social acceptance concept (Wüstenhagen et al., 2007), especially for the level of socio-technical regime. As the ferry sector is public regulated and subsidized we expect the socio-political acceptance to the most important one.

2.4. Methodology

A policy's popularity, legitimacy and at last, its effectiveness, can be judged on the perception by the public space (Brænder et al., 2014:249). By this, the importance of contextualizing the topic with a sufficient surrounding, to improve the understanding of decisions being made, becomes apparent. A text may serve as a controlled messenger, where the ability to control the framework of a message exists.

Data from the regional authority Hordaland fylkeskommune, the parliament - Storting and Government, reports and newspapers make up the core of the data collection, as well as reported data to UNFCCC, reports presented by DNV GL, commissioned by the Ministry of Climate and Environment in Norway. Teknisk Ukeblad, Sysla and other newspapers serve as supporting data sources. The main source is official data or presentations from the decision making body in Hordaland county.

We will use the three levels of niches, socio-technical regime and landscape as a guiding tool for data collection on decision making and technological innovation n the case of new ferries at the West Coast of Norway.

3. Results

3.1. The emission context of the landscape

The EU target by 2020 use the formula 20-20-20. The member countries aims to reduce its greenhouse gas emissions "by at least 20%, increase the share of renewable energy to at least 20% of consumption, and achieve energy savings of 20% or more. All EU countries must also achieve a 10% share of renewable energy in their transport sector."[8]

Ahead of the global Paris summit, European leaders agree to cut greenhouse gas emissions by 40% by 2030[9]. The EU targets are supported by Norway. Based on the climate consensus in the Parliament – Storting – from 2012[10] the Government proposed to support the EU targets. The 40% reduction target for Norway as well as a target for Norway as a low carbon society in 2050 was accepted by the Storting early 2017[11].

In a comparative perspective, Norway has not been able to fulfill the obligations until this day. According to the UNFCCC time series data, Norway together with Iceland, Ireland, Portugal and Spain had in 2015 more

[8] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2020-energy-strategy
[9] https://www.theguardian.com/world/2014/oct/24/eu-leaders-agree-to-cut-greenhouse-gas-emissions-by-40-by-2030
[10] Innst. 390 S (2011–2012)
[11] Sak nr. 17 [14:40:33] Stortingets vedtak til lov om klimamål (klimaloven) (Lovvedtak 95 (2016–2017), jf. Innst. 329 L (2016–2017) og Prop. 77 L (2016–2017))

greenhouse gas emission (GHG) than the base year 1990[12]. In the sake of framing, it might be reasonable to note that the 1990 base data in the Norwegian case was relatively low because of hydropower production. Germany with its policy for energiwende has been able to effectively reduce the use of coal in energy production. No electricity at mainland Norway is produced from coal. It is also noteworthy that total GHG emission had its peak in 2007. In 2014, the emission was 53.2 million ton which is a reduction of 3.7 ton from 2007[13].

The Norwegian case looks even grimmer if we use data for CO_2 emissions only. Table 1 shows trends from 1990 to 2015 for EU and selected countries. Denmark, UK, Germany have a reduction on respectively 34%, 30% and 25%. EU (convention) on 22%. The US CO_2 carbon emission is + 6%, Norway is +25% in 2015 compared to 1990.

3.2. The political shift

Several decision-making bodies in Norwegian politics have opened new paths for green house emission reduction in the maritime sector. They affect all three dimensions in Figure 2.

On the national level several initiatives in the Storting was taken in 2015, 2016 and 2017 aiming a national policy for green technological shift in maritime sector. New policies for low carbon engines in Norwegian ferries were specifically addressed.[14]. The government included funding for technological shift in their strategy and budgets for 2016[15]. A large fund was allocated to a fund for climate- and energy, the directorate for conversion to the low-emission society - ENOVA[16], and to a national environmental technology project[17].

Our case represents 20 ferries at 17 ferry connections with 700 daily ferry departures. Average age for the ferries in service is 28 year. CO_2 emissions from the vessels are equal to the total emission from all 800 busses in Hordaland (Hammer 2017). Most of the old contracts for ferry services expires in 2020.

Several initiatives were also taken in the county parliament of Hordaland in 2014 and 2016 in order to prepare for a green shift in the regional ferry maritime sector[18]. Preparing the new tender process for ferry contracts, an important decision taken in 2015. The administration presented three alternatives for the political decision making board (see Table 1).

The regional executive board – Fylkesutvalet – adopted the most radical alternative 2 in January 2015. This alternative was to be implemented in the new announced tender at the public database for public procurement - Doffin[19].

The new principles established:

- An environmental model for tender process should be introduced. *Low emission* from engine is a basic requirement with at least 55% reduction of CO_2 emission.

Table 1: Alternatives presented to political decision-making boards in the county of Hordaland 2014/2015 (Hammer 2017).

Alternatives	Minimum reduction CO_2	Minimum increased energy efficiency	Weighting of Environment as an award criteria
Alternative 1	20 %	15 %	20 %
Alternative 2	55 %	25 %	30 %
Alternative 3	35 %	25 %	30 %

[12] http://di.unfccc.int/time_series - table GHG total without LULUCF
[13] https://www.regjeringen.no/no/aktuelt/full-fart-i-klimapolitikken/id2470709/
[14] Sources at The Storting: http://sok.stortinget.no/relatequery?udid=MA-S2-1458226800-8ABSPZZ&clusterby=true&
[15] https://www.regjeringen.no/no/aktuelt/full-fart-i-klimapolitikken/id2470709/
[16] www.enova.no
[17] https://www.regjeringen.no/no/aktuelt/full-fart-i-klimapolitikken/id2470709/
[18] One of the authors of this paper, Tom Skauge, were a member of the parliament in the formative years from 2011-2015.
[19] https://www.doffin.no/

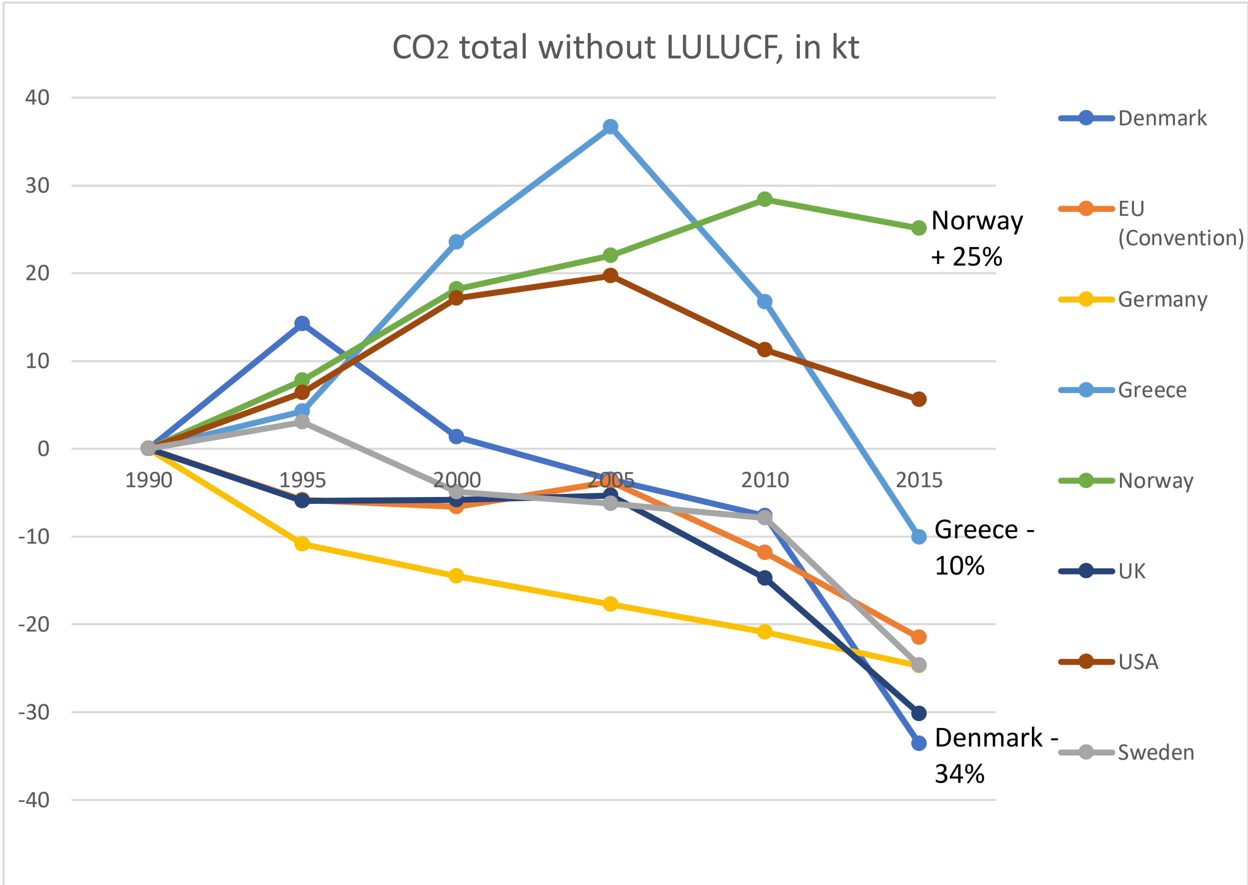

Figure 1: CO_2 total emission for EU and selected counties without LULUCF in kt. Trends comparing 1990 with 2015[20]

[20] Source: http://di.unfccc.int/time_series, loaded 051017

- *Zero emission technology* should be prepared for ferry connections when it is technologically and economically feasible, given extra funding from state level.
- Extended length for contract 8-14 years in order to give economic capacity for innovation. [21]
- 30% weighting of environmental premises as award criteria.

The new emission requirements were radical and asked for niche technology to be scaled up as standardized technology for the engines in the ferries.

It is an open question if the public institutions responsible for transportation including ferries crossing the fjords demanded new disruptive technology or not. We will discuss how the premises of demand – primarily low emission - from political actors met with premises of industrial actors representing the supply side.

The low emission requirement was operationalized as minimum 55% reduction of CO_2. This might open for LNG-based engines. One of the mots heavy trafficked connections Halhjem – Sandvikvåg with approx. 2.2 million cars and about five million passengers in 2011, used natural gas. The innovation reduced NO_X emissions of approximately 90 per cent. CO_2 emissions should be reduced with 25 per cent[22].

3.3. The technological shift

Hordaland County organized the announced tender in four packages, mainly to cover different regions. The providers to the announced tender did not respond to the claim for 55% reduction of CO_2 in a limited way. However, the best bid accepted by Hordaland County authorities proved to be more radical than expected. The accepted ferry technology offered between 86% and 92% reduction of expected CO_2 emission and between 58 and 74% expected reduction in energy usage.

All of the engines for the vessels in the winning contracts are powered by electricity. Most of the ferries use a hybrid technology with a biodiesel backing system. This of course indicate that a conclusion on actual emission reduction cannot be drawn before the new ferries are put into operation – most of them in 2020.

4. Discussion

4.1. Niche innovations

The technology is a vital part of all the theoretical dimensions presented in this paper, thus we will first investigate the different technological possibilities in this chapter. The advantages and disadvantages will be studied, and this will serve as background knowledge for the discussions, to better understand the decision-making processes.

4.2. Traditional diesel ferries

The traditional engine technology for ferries today, run on diesel fuel. About 90% of Norway's ferries are based on this technology (Berger, 2016). Emissions originating from using diesel for fuel, have a potential of emission reduction in the range of 20% (Kollektivtrafikk, 2016). Conclusively, this is not considered a low emission ferry technology in this paper, thus it is excluded for further discussion. In our case this is Alternative 1 in our Table 1.

4.3. Zero and low emission ferries

Zero and low emission ferries, what is it? This question does not have an intuitive answer. The answer depends on which parts of the lifetime emissions are calculated.

Is it sufficient merely to include the emissions associated with the operation of the ferry, or should the entire lifetime from production to scrap be included? In addition, one ferry technology can be emitting low levels of greenhouse gases, and at the same time be a local air polluter. Because this paper seeks to investigate the decision-making processes on the West Coast of Norway, we have chosen the broad definition from the Ministry of Climate and Environment in Norway. It is important to mark that this is not a strict definition, but the basis is fulfilling the 2-degree limit set in Paris (DNV GL, 2016). In addition, we have compared this definition with the definition from Norwegian Public Road Administration, seeking to find whether there are technologies that has not been covered.

[21] Minutes from the meeting in the steering bord of Hordaland County 29.01.2015

[22] http://www.lngworldnews.com/norway-fjord1-launches-lng-ferry/

Table 2: Result from the tender process of new ferry-services in the county of Hordaland 2018.
Main sources: Doffin (Doffin, 2017), Presentation given by the county Public Transport office - Skyss, Karl Inge Nygård (Nygård, 2017), presentation given by political representative Marthe Hammer, committee of environment and transport, Hordaland county (Hammer, 2017). Details in appendix 1.

"Rutepakke" Packeges of connections	Current / former technology	New technology	Expected CO_2 reduction	Expected energy reduction	In traffic from
Package 1: • **Krokeide - Hufthamar** • **Krokeide - Hufthamar** • **Husavik - Sandvikvåg** • **Halhjem - Våge** • **Sløvåg - Leirvåg** • **Fedje - Sævrøy** • **Hatvik - Venjaneset** • **Langevåg - Buavåg**	7 diesel ferries, 1 LNG ferry refitted with plug-in hybrid propulsion	8 ferries where an electrical battery is the main energy source, with a biodiesel-generator as back-up for electrical propulsion	87 %	60 %	3 ferries from 01.01.2018, the rest from 01.01.2020
Package 2: • **Skjersholmane - Ranavik** • **Skjersholmane - Ranavik** • **Jektevik – Nordhuglo -Hodnanes** • **Gjermundshamn - Varaldsøy - Årsnes** • **Jondal - Tørvikbygd**	4 diesel ferries, 1 rebuilt diesel-electric hybrid	4 ferries where an electrical battery is the main energy source, with a biodiesel-generator as back up for electrical propulsion, will be built. 1 ferry has been rebuilt for induction charging	90 %	65 %	01.01.2020
Package 3: • **Klokkarvik - Lerøy - Bjelkarøy - Hjellestad** • **«Fjellbergsambandet»**	2 diesel ferries	High degree for electrification	86 %	58 %	01.01.2020
Package 4: • **Masfjordnes - Duesund**	Cable ferry with diesel generator	Fully-electrical ferry	88 %	65 %	01.01.2020
Package 5: • **Kvanndal - Utne** • **Kinsarvik - Utne** • **Skånevik - Matre - Utåker**	3 diesel ferries	High degree for electrification	92 %	74 %	01.01.2020

Where the Ministry of Climate and Environment defines the selection of zero and low emission ferries to include electric batteries, hybrids (electric + gas/diesel), biodiesel, liquid bio gas (LBG), and hydrogen (DNV GL, 2016), the Norwegian Public Road Administration in addition includes hybrids (electric + hydrogen) and LNG (Sandvik, 2016). The use of LNG is mentioned to be relevant if less polluting technologies are not technological or economical feasible (DNV GL, 2016). We will therefore, briefly present this technology.

4.4. LNG/gas engines single/dual fuel

In 2006, Fjord1 introduced their new ferry MF Bergensfjord, running on LNG gas. Comparing this ferry with diesel fueled ferries, a reduction of CO_2 emission would be 25-30 %, NO_x around 90 % and Sulphur and smaller particles, 100 % (BT, 2006). However, due to a tighter time schedule for the ferries, they had to go faster, resulting in more energy consumed. In addition, more than 3% of the fuel would not combust, emitting methane directly into the air (Killingberg, 2011). This is not a good development when the methane level in the atmosphere was measured to be alarmingly high in 2016 (Haabeth, 2016). However, the technology have been greatly improved since this disclosure.

4.5. LBG

LBG is often a result of waste or bi-products (DNV GL, 2016). In 2012, Sweden was one of the first countries building a LBG production facility (Renvall, 2012). The production transformed vegetable and grain waste products into liquid gas. The decrease in CO_2 emissions from using LBG for fuel, compared to conventional diesel, can be discussed. This will depend on the calculation method used, and the CO_2 emission reduction ranges from 100% to 80%. The explanation for the argument of no pollution is that the CO_2 emitted from biological waste would have been emitted to the atmosphere anyway. However, local pollution from other pollutants might still be a problem. A ferry running on LBG can also use LNG as fuel, thus the technology is compatible with 2 different fuels.

4.6. Biodiesel

Biodiesel (and LBG) have the same problems concerning local pollution from combustion, as diesel and LNG have. However, when it comes to CO_2 emissions, biodiesel and LBG, rely on the same argument, namely that it will be released nevertheless. But due to the production of biodiesel, and a faster consumption of the energy, compared to the natural process of biological decay, the CO_2 is emitted faster, thus Statens Vegvesen only calculate a 50 % reduction in emission (DNV GL, 2016). The price of biodiesel is 20 - 40 % more expensive than traditional fossil diesel. Biodiesel is the planned fuel for the diesel part of the ferry engines in hybrid systems.

4.7. Electric batteries

One of the technologies that have gained much attention lately is the electric ferry. The ferry Ampere, covering two locations in Sognefjorden, Norway, have gained a lot of attention worldwide (Madslien, 2017). Based on the Nordic energy mix, the reduction in CO_2 emissions compared to traditional fossil diesel, have been calculated to be 90% in tenders (DNV GL, 2016). This makes the battery one of the best technologies, solely evaluating the environmental aspect.

This technology have been, and are, subject to several improvements, where the charging of the batteries are the most prominent ones. There exist several companies trying to find the best technology for fast, safe and sufficient charging (IN, n.a.; Stensvold, 2017).

In our case not all detail on battery packages has been decided upon. Given premises is that charging systems for electricity, external batteries are needed for most connections, as well as upgraded powerlines. In order to be eligible for public funding these installations has to be owned by the county of Hordaland and not the contractors.

4.8. Hydrogen

This is one of the technologies that has been developed the least, nevertheless it is promising due to the reduction of emissions and the ability to be run on high-energy demanding fjord crossing, due to difficulties resulting from weather or length. Hydrogen is a chemical element that can be used in fuel cells to convert stored energy in a chemical process into fuel for for instance ferries.

Because it does not often appear in its pure form, one has to extract Hydrogen from other sources that contain it, for example from water in a process called electrolysis. Another method, that is the most advanced due to its low price, is production of Hydrogen using natural gas and water. The “waste” result of this chemical reaction is CO and CO_2. Evaluating Hydrogen based on this production method decreases its potential environmental improvement. However, there exists a global development in improving this drawback from production. Low price on electricity as the situation is in Norway, also support hydrogen in the future.

4.9. Hybrids

This term means that two technologies are combined, and within ferries this might include many different compositions of technology. Technologies that are in use today includes diesel-electric, LNG-electric, etc. A new non-emitting technology would include battery-hydrogen ferries. For an easier implementation and feasibility testing of hydrogen ferries, the project HYBRIDShips in Trondheim, aim at introducing a hydrogen and fuel cell ferry, with support from electric batteries, within 2020 (NMA, 2017). CMR Prototech plan on testing a hydrogen-battery hybrid on the ferry MF Ole Bull, on the West Coast of Norway this year (Valle, 2016b).

4.10. Summing up the technologies

The electric ferry, the gas ferry and the biodiesel/LBG have already been verified as feasible ferry technologies, even though there has been a learning process along the way. Due to the possibility of completely fulfilling the environmental aspect of the Triple Bottom Line, the electric ferries and hydrogen ferries are the most interesting technologies. Nevertheless, the hydrogen technology has not been verified in terms of commercialization.

In 2000, Glutra was the first ferry to use LNG fuel, making Norway the first country to verify the commercial use of LNG motors on ferries (Stensvold, 2016). 15 years later, Norway was the first country to use a fully-electrical ferry. The new goal is to be the first to run a hydrogen ferry by 2021. These occurrences show Norway's position as a first-mover in the technological feasibility testing of disruptive low- and zero emitting ferries.

From early SNM research, this development can be attributed to niche developments within fringe networks supporting innovations based on visions and expectations (Schot and Geels, 2008). Selectively revealing for the market a new and sustainable technology that is able to replace the old, leading and polluting technology, might be achieved by niche development. Thus, the Ampere ferry has been a good example of the technological feasibility of the electric ferry technology, both nationally and globally. However, moving from one example ferry to an all-out shift towards electrification of ferry transportation demands more radical changes.

4.11. Socio-technical regime

However, for this new technology to be sustainable, the socio-technical regime must be altered (Schot and Geels, 2008). In early SNM research, the belief was that innovations grew from the technological niches first, and then they attained the market niches, before gradually replacing the existing regime. Nevertheless, after decades of using the traditional diesel ferry technology, which is still the standard, the skilled workers knowledge, the design, and the governmental regulations based on this leading technology continue to make up the industry complex dominating the ferry transport sector.

This accentuates the path dependence of a landscape surrounding a technology. Changing such a rigid system requires not only a lot of collaborating work and strategic planning, but also takes a long time, as the industry needs to adapt and reorient itself to the change in technologies.

However, the technology push approach from a bottom-up perspective might not be the only possibility for this development in Norway. Schot and Geels (2008) conclude that the traditional way of implementing a new technology is deeply embedded in today’s society and that the technology actors focus too much on the technological improvements, rather than the market desires and needs. At least in the beginning of the development.

Thus, considering the users of the new ferry technologies should be a priority. There exists a generally high public acceptance for renewable energy technologies and policies in most countries (Eurobarometer, 2003). A stakeholder analysis on the Urban Water Shuttle project (UWS) on the West Coast of Norway, showed that politicians, public transport users and providers, emphasized the importance of this technology's improvement of environmental factors and its possibility of time saving (Sylthe and Gran, 2014).

Nevertheless, a number of other factors, for instance the aesthetical aspect of windmills (Wüstenhagen et al., 2007), might also prohibit social acceptance. This might be true for the ferry as well. UWS is designed to look like a future-oriented ferry, directly targeting one aspect of the aesthetical factor considered by the public. This is a deliberate strategy, moving away from the old design and changing the traditional view of a ferry.

Another social factor that might be important to focus on for the implementation of a new ferry technology, is the possibility of job creation. This is a factor that would help improve the relatively high unemployment rate we see in Norway today, benefitting the inhabitants, as well as the Norwegian economy. Four of the biggest battery manufacturers (for among other, ferries) will soon be operating in Norway (Stensvold, 2017). When combining this information with the assumption that the market for battery technology within the maritime sector will double by 2024 (ibid.), it might strengthen the expectations of further job creation as a result of a new ferry technology in Norway. This accentuates the need for Norway to stay at the forefront of this development.

5. Socio-technical landscape

In the decision-making process, the economical aspect is important, both for companies within the industry and for the governmental agencies that facilitate financial support. Electric batteries, hydrogen and hybrids could potentially be more cost effective in an entire lifespan calculation, than the traditional marine gas oil (DNV GL, 2016). The investment will be higher, but the cost of operation will decrease. When it comes to the bio fuel technologies, the investment is inexpensive, but the cost of operation will increase. In 2016, LBG was calculated to become 200% more expensive than LNG and MGO (DNV GL, 2016). When including the funding schemes of Enova and the NOx-fund, the most environmental-friendly technologies appear to have a few advantages. Based on this, the electric, the hydrogen and the hybrid technologies might show to be better.

In addition to the ferry technologies, the technology on land has to be improved as well. In 2015, EnergiNorge mapped the need for 900 million NOK investment in the grid, as a result of an electrification of the ferry fleet (DNV GL, 2015). The LNG supply has been a limiting factor in the beginning, but this has improved greatly. There is no production of LBG in Norway today (DNV GL, 2016), complicating the emergence of LBG use. The access to hydrogen, also, has to be improved, and several new companies are targeting this window of opportunity (for example Greenstat located in Bergen). Therefore, investments in the infrastructure are (and have been) necessary for the new ferry technologies. The LNG technology is the most proven technology in regards to infrastructure today.

6. Summing up the decision-making landscape

It is difficult to divide the traits of the different possible ferry technologies into the three levels of Schot and Geels (2008), due to the interconnectedness and relation between the three levels. There will always be an overlap between the three parts, thus it may be beneficial to look at the synergies, and its effects. Schot and Geels (2008) accentuates the importance of the new approach in the SNM literature as well. The top-down approach must be considered, in addition to the bottom-up perspective, due to the possibility of for instance governmental landscapes putting pressure on existing regimes. I our case we expect government-pull to be of importance.

Using competitive tender and development competitions (utviklingskonkurranse) for direct influence on the technological development might be possible. The new regulations for emissions in the maritime sector, where "the Government is requested by the Parliament, to ensure that zero-emission technology (and low-emission technology) are included in all future tenders for public ferries, when the technology allows for it" (Sandvik, 2016), shows a will to change this sector from the top-down approach. At the same time, it is emphasized that the technology must allow for it, thus it involves the bottom-up perspective also. Especially for the development competitions. This might be used as a governmental approach to facilitate the emergence of new technology, where niche innovations is the result in the beginning.

7. Conclusions and Policy Implications

The contracts awarded for 17 ferry connections in the West Coast county of Hordaland represents a radical green shift in maritime ferry technology – a possible game changer. The industrial suppliers strengthened the reduction of CO_2 emission from the political demand of at least 55% to 80-90% reduction. Engines powered with electricity og hybrid electricity/biodiesel challenge the up til now dominant diesel engine regime in Norwegian ferries.

A niche technology of electrical supplied engines for ferries seemed to have been transformed into a new dominant socio-technical regime in the county of Hordaland – The electrical route.

The new technology has been partly available some for years and has been tested in pilot projects. The most relevant is the ferry “Ampere”, transporting passengers and cars crossing Sognefjorden at the main Western Coast north-south connection “Europavei” no. 39.

The political landscape has been marked by expectations of a double character. The lack of Norwegian performance in CO_2 reduction have mobilized political grass root actors claiming political shifts for green development. On the West Coast the oil industry had a serious setback from 2014/2015 due to falling prices of oil and declining operations searching for new oil fields. Political actors, actors representing industry and labor organizations were desperately looking for innovations and new industrial opportunities – especially at the oil coast in Western Norway.

Developing new ferries in a nation of sailors and strong maritime traditions was a broadly accepted opportunity – a win-win situation. The Norwegian hydropower based electricity represent a relatively easy access to zero carbon energy for new ferry technology.

The wave of green technology powered by electricity for new ferry contracts can be explained by a triple win-win situation. Green movement claimed political actions in Norway in order to reduce CO_2 emission. The *Socio-political acceptance* are strong. West Coast Industry are looking for alternative production as oil-activity is reduced. The *market acceptance is good*. *Community acceptance* were also strong as the new strategy of green shift was combined with the framing of better quality and robustness of the ferry connections.

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Appendix 1

Ferry connections	**Current/past name**	**Current/ past technology**	**New name**	**New technology**	**"Rute-pakke"**	**Expected CO_2 reduction / energy reduction**	**Ordered by**	**In traffic from**
Halhjem - Våge	MF Selbjørnsfjord	LNG refitted with a plug-in hybrid propulsion system	n.a.	Electrical motor, with a biodiesel-generator as back-up	Package 1	87% / 60%	Fjord1	01.01.2020
Krokeide - Hufthamar	MF Trondheim	Diesel	MF Møkstrafjord	Electrical motor, with plugin hybrid-technology	Package 1	87% / 60%	Fjord1	01.01.2018
Krokeide - Hufthamar	MF Marstein	Diesel	MF Horgefjord	Electrical motor, with plugin hybrid-technology	Package 1	87% / 60%	Fjord1	01.01.2018
Husavik - Sandvikvåg	MF Herlaug	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 1	87% / 60%	Fjord1	01.01.2018
Sløvåg - Leirvåg	MF «Melderskin»	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 1	87% / 60%	Fjord1	01.01.2020

Fedje - Sævrøy	MF "Fedjefjord"	Diesel	n.a.	"All ferries ordered by Fjord1 will be powered by electricity, but will have another energy source as back-up" (mail from Deon in Fjord1 3.10.17)	Package 1	87% / 60%	Fjord1	01.01.2020
Hatvik - Venjaneset	MF Fosen	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 1	87% / 60%	Fjord1	01.01.2020
Langevåg - Buavåg	MF Utstein	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 1	87% / 60%	Fjord1	01.01.2020
Masfjordnes - Duesund	Fjon M	Cable ferry (with a diesel generator)	n.a.	Wergeland are planning on rebuilding exisitng ferry to a fully-electric ferry	Package 4	88% / 65%	Wergela nd AS	01.01.2019
Skjersholmane - Ranavik	MF Strand (damaged by fire. Not in use)	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 2	90% / 65%	Fjord1	01.01.2020
Skjersholmane - Ranavik	MF Gloppen	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 2	90% / 65%	Fjord1	01.01.2020

Jektevik - Nordhuglo-Hodnanes	MF Folgefonn	Originally diesel, rebuilt for diesel-electric (hybrid) propulsion in 2014.	MF Folgefonn	As of 2017 MF Folgefonn have been installed with induction charging (The first of its kind) and has the potential to sail fully-electric	Package 2	90% / 65%	Fjord1	01.01.2020
Gjermundshamn - Varaldsøy - Årsnes	MF Hordaland	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 2	90% / 65%	Fjord1	01.01.2020
Jondal - Tørvikbygd	MF Etne	Diesel	n.a.	All ferries ordered by Fjord1 will be powered by electricity, but will use electricity generated by biofuel as back-up	Package 2	90% / 65%	Fjord1	01.01.2020
Klokkarvik - Lerøy - Bjelkarøy - Hjellestad	MF "Rosesund"	Diesel	n.a.	High degree of electrification	Package 3	86% / 58%	Norled	01.01.2020
«Fjellbergsambandet»	MF Sveio	Diesel	n.a.	High degree of electrification	Package 3		Norled	01.01.2020
Kvanndal - Utne	MF Utne	Diesel	n.a.	High degree of electrification	Package 5	92% / 74%	Boreal Sjø	01.01.2020
Kinsarvik - Utne	MF Jondal	Diesel	n.a.	High degree of electrification	Package 5		Boreal Sjø	01.01.2020
Skånevik - Matre - Utåker	MF Ølen	Diesel	n.a.	High degree of electrification	Package 5		Boreal Sjø	01.01.2020

Session 2: Energy – Climate Change – Renewable Energy Sources

From power vs nature to environmental energy. The political discourse on hydropower and nature conservation in Norway 1900-2000

by

Svein Ivar ANGELL and **Ole Andreas BREKKE**

Abstract

The political discourse on hydro power and water course protection in Norway has undergone several shifts throughout the 20th century. The first half of the century was characterised by a strong expansion in hydro power both for industrial as well as household purposes. However, already since the beginning of the century, protection of water courses was a political issue. While aesthetics and nature were in the foreground in these formative years, interests related to recreation and agriculture also became parts of the foundation for water course protection from the 1950s and -60s. The early 1970s, however, represented a major turning point. At this stage, protection campaigns gained a broader ideological and scientific foundation, including biological and ecosystem arguments for protection. In the 1980s, nationwide plans for for both protection and further exploitation of water courses were developed, and since the early 1990s large hydro power projects have no longer been politically feasible. Since then, we have witnessed an expansion of small scale hydro power plants, which basically have been legitimated from environmental reasons. In the paper we discuss the development of the political discourse over protection or exploitation of water resources in general, and how the expansion of issues have given rise to new conflicts and alliances, as well as given new meaning to old ones. In particular, we will explore how notions of nature and the environment have changed throughout, and how local, national and global concerns have been voiced and processed in the debates.

1. Introduction

Watercourse management has been one of the most debated issues in Norwegian politics over the last century. Norway has a huge amount of water resources, well distributed in different watercourses throughout the country. Due to the abundance of water resources, Norway is today the largest producer of hydro power in Europe, with 99 % of electricity production in the country stemming from hydro power (www.nve.no).

However, hydro power production and the utilization of river basins for electricity production have always confronted environmental concerns. During the 20th Century, State policies on hydro power have shifted. While the State was the main driving force in developing hydro power in the post-war years, from the late 1960s onwards, State policies gradually started to lean more towards conservationist concerns. The main expression of this change in policies, was the development of "the National plan for protection of river basins", which is essentially a list of watercourses to be protected from hydro power development in the future. The plan is not enacted by law, but is a plenary resolution adopted by the Norwegian parliament, the Storting. The process leading up to the plan started in the 1960s. Due both to the large number of river basins and the different interests involved, the working out of the plan was a complex process. The plan was developed in four successive stages, gradually increasing the number of watercourses to be protected, and it was not completed until 1993. Even then, the completion turned out to be temporary, as several amendments have been made since, adding new watercourses to the plan (Angell and Brekke 2011: 86).

Thus, the process related to the Norwegian protection plans for river basins stretched over several decades. During this time, the parameters of the process also shifted as new understandings of environmental concerns related to energy production – of both global and local nature – were introduced. In addition the process was characterized by a gradually more complex system for resource management. In the 1970s two new ministries with specific obligations in the field were established: The Ministry of the Environment in 1972 and The Ministry of Petroleum and Energy in 1978. From 1980 onwards the government also initiated a Master Plan for Watercourses, containing a listing of watercourses that could potentially be developed in the future, ranked according to the anticipated level of conflict and environmental impact. Parallel to this a plan for the management of Norwegian National Parks was worked out which also had implications for energy policy (Angell and Brekke 2011). Thus, in the course of this 30-year period, the state policies shifted from aan expansionist policy for hydro power development to a protectionist policy of resource administration.

In this paper we discuss the driving forces behind the shift form hydro power to resource administration manifested in the process leading up to the National Plan for protection of river basins. The very length of the process as well as the different interests, concerns and ways of framing the issues, makes this a privileged case for understanding the broader issues involved in watercourse management and the problems, dilemmas and opportunities facing such management today. Since the plan was first completed in the early 1990s, international developments, both the internationalizing of the electricity market as well as the introduction of a new global discourse of the environment, present new challenges to national water management policies. How these new framings and understanding may affect the legitimacy and relevance of the existing plan system will be briefly discussed towards the end of the paper.

2. Background

Although much of the water resources in Norway are under private landownership, exploitation of watercourses is fully regulated by the state. This is due to the "concession laws", which states that any exploitation must be licensed by the government. The concession laws were established from 1906 until 1917 basically to prevent foreign capitalists from gaining control of Norway's natural resources. In addition, the laws provided the authorities with tools to decide provisions for watercourse development (Falkanger 2002: 40 ff.).

In the period when the concession laws were established, environmental concerns related to hydro power production were not particularly articulated. Even so, different concerns were raised. At the turn of last century, Norwegian landscape and waterfalls had become more important for tourism, and both the Norwegian Trekking Association (est. 1868) and the Norwegian Society for the Conservation of Nature (est. 1914) worked against utilization of the most popular waterfalls for hydropower production due to aesthetic concerns. The first law for preservation of nature was passed in Parliament in 1910. In 1924, due to the efforts of the two above organizations, the waterfall Vettifossen in the western parts of the mountain area Jotunheimen was conserved and protected from utilization (Berntsen 1994).

Another concern related to hydro power utilization in this period was the damages to agricultural production caused by industry deriving electricity from hydro power. Although such problems basically concerned the utilization of hydro power in an indirect way, they articulated local concerns in a more direct way than the above aesthetic concerns, mainly raised by urban elites (Angell 2006).

In this early period also the physical structure of the hydropower system was established. The system gained a dual character as it was developed according to two basic objectives: The large scale power plants produced electricity for industrial purposes. These plants for the most part were owned by the industrial stakeholders themselves. In addition a wide range of small hydro power plants serving the needs of households and smaller industrial enterprises developed. These power plants were for the most part owned by local communities and governed by local municipalities or counties (Thue 1995).

In the first decades of the 20th century, several of the main conflict dimensions that came to characterize the politics of hydro power production in Norway, was developed.

These issues were of continued importance to the process leading up to the National protection plan. The major issue was of course the question of utilization or protection of watercourses. But furthermore there was a conflict dimension concerning ownership and control of hydro power resources, basically related to whether hydro power production should serve industrial or mutual societal needs. The importance of local communities as developers of hydro power later on materialized as a conflict between local interests and nationally formulated aims for hydro power development. This was also related to a conflict between hydro power utilization and conditions of other commercial interests, such as agriculture and tourism. In the immediate post-war period, from the late 1940s, such a combination of interests was of particular importance. At this point hydro power production for industrial purposes was seen as the main locomotive for developing the future Norwegian welfare state (Angell and Brekke 2011). While the State had played a more passive role as regulator of the system in the pre-war years, it now took on a new active role as entrepreneur of several major power projects. The hydro power policy of the post-war years was both a politics for industrial development as well as district development. Hydropower-based industries were placed in rural areas in order to promote local development. In Parliament the new State involvement ignited debates over the conditions for exploitation of water courses. A major issue in these debates was the damages to local interests caused by hydro power developments and the demand that losses should be duly compensated, and not just in monetary but in real terms. The range of possible damages was also expanded to include both a wider geographical area as well as more long-term consequences than before. Another result of this new orientation was the inclusion of a broader range of stakeholders in the planning of new hydro power projects.

Around 1960 a stronger consideration of the damages caused by hydro power exploitation had evolved and several arrangements had also been established to deal with this. However, the focus was still on compensatory arrangements. Environmental concerns related to hydro power had still not developed as a political field in its own right. This all changed during the 1960s (ibid.).

3. The 1960s: A watershed in water policy

From the 1960s a stronger awareness on the environmental concerns related to water course utilization emerged. In both public and political debates, new views on the damages caused by hydro power plants were expressed. Increasingly, the irreversible nature of such damages was underlined. Critics also pointed out that in debates over specific hydro power projects the interests in favour of conservation always seemed to abdicate. A broader and more long-term policy for hydro power development was advocated. In the early 1960s Parliament appointed an investigative committee (The Gabrielsen-committee) to find ways to integrate the different interests in the field more properly. The committee did not come up with concrete measures and a report worked out by the committee was not handled by Parliament until 1969 (Nilsen 2006: 90).

During the course of the committee's mandate period, however, the opinions on water course management changed fundamentally. In Norwegian society, there was a growing concern on the recreational qualities of nature, which in fact became part of welfare ideology. Partly due to this, and partly due to international trends, there was a growing environmental concern in the population. In the mid-1960s, the Norwegian Society for the Conservation of Nature was reorganized and experienced a massive inrush of new members (Berntsen 1994). Another development in this period was the conservationists' reorientation towards a more ecologically oriented ideology, focusing on the watercourses as biotopes (Jansen and Osland 1996: 182). The bioscientific reasoning for preserving watercourses shifted from the protection of specific species to the preservation of the ecological system as such. In a political sense this implied that the aesthetic motivations for conservation were supplemented by scientific arguments, which also found its way into the Government's reports to the Parliament in the period (e.g. St. meld. 64 (1965-66: 4)).

Despite these new trends, no watercourses were conserved during the 1960s. At the end of the decade however, the government stated that conservationist interests were seen as equal to interests in favor of exploitation in matters concerning licensing of hydro power projects (St. meld. 26 (1968-69): 49). Such a comprehension must also be seen in relation to the fact that hydro power policy at this stage was becoming part of a broader political field. The notion of *energy policy* had been introduced in the 1960s, and in 1969 the government issued its first White Paper on Energy policy. Hydro power was gradually understood as one of several sources for energy, besides nuclear power and fossils like oil and gas (St. meld. 97 (1969-70). A result of the debate over the white paper was the appointment of a new committee; “the contact committee for hydropower development and nature conservation” (or for short “The Sperstad-committee”, after the committee leader), with representatives from The Water Resource Directorate as well as the Environmental Administration.

4. The 1970s: Institutionalization of watercourse protection

Due to the development in the 1960s, around 1970 it was evident that some kind of institutions that was able to take the conservationists interests into account had to be established. Such a comprehension was also fuelled by a more activist opposition to watercourse utilization. In 1970 a decision to allow exploitation of the Mardøla-river in the northern parts of Western Norway led to acts of civil disobedience by environmentalists. The activists represented a new kind of alliance which also illustrated the different interests in the field at this stage: “Traditional” environmentalists, scientists and intellectuals, left-wing activists as well as activists from the local communities took part in the protests (Berntsen 1994: 136-137). The ‘battle of Mardøla’ gained much media attention and increased public awareness of the environmentalist concerns (Jansen and Osland 1996).

In 1973 the first national plan for protection of river basins were presented to Parliament. The plan was based on recommendations from the Sperstad-Committee, which stated that the main motivation behind the process was the need for a comprehensive assessment of the conservationists’ interests – including concerns for open-air recreation – in relation to water course exploitation. So far, such interests had not carried much weight, which in the Committee’s view was du to the fact that:

> *“The licensing-applications have been processed one by one, and not in accordance with a plan for which watercourses that should be protected from exploitation (St. prp., nr. 4 (1972-73): 9.”*

The committee’s report as well as the parliamentary process reflected the new trends characterizing the field. The parliamentary decision implied that 50 watercourses were to be protected from utilization for ten years. These decisions were only meant to be temporary, however, as further scientific investigations should be made in order to document the preservationist interests in the watercourses, which should then form the basis for a new protection plan. The process also reflected the controversies related to the issue. The Ministry of Industry and The Norwegian Water Resources and Energy Directorate (NVE) were strongly critical of the Plan, while the newly established Ministry of Environment was supportive.

The Sperstad-committee was restructured and presented a new plan, Protection Plan II, in 1976 (NOU 15: 1976). Protection plan II was worked out in an atmosphere in which the attention related to water course protection reached new heights in Norway. Among other factors, the three most important NGOs in the field, The Norwegian Trekking Association, The Norwegian Society for the Conservation of Nature and The Norwegian Organization for Hunters and Anglers, coordinated their activity and formed a new body: The Council for Nature Protection. This council in fact represented several hundred thousands of members, and intended to generate political pressure in particular issues related to preservation of natural resources. The opinion in these matters also materialized in a nationwide pressure group for the protection of watercourses, which in turn was linked up to a separate mobilization for improving living conditions and welfare in small local communities throughout the country (Berntsen 1994: 219-220, Aksjon Bygde-Norge, 1977). This alliance between urban and rural interests was of particular importance in framing the discourse of the protection plan in this period: between national formulated obligations and aims and interests in the Norwegian districts. In several political conflicts in Norway such alliances have turned out to be decisive, and in the 1970s in particular. However, centre-periphery is also a central conflict dimension in Norwegian politics in general, also when it comes to hydro power issues. Traditionally, hydro power had been seen as a blessing for recipient communities, and parallel to the consolidation of the protectionists' opinion, the so-called "hydro power municipalities" formed their own organization, Norwegian organization for hydroelectricity producing municipalities (LVK). LVK opposed the protectionist opinion and formed alliances with hydro power protagonists among politicians and in industry (Thue 2004).

Thus, in the course of the 1970s the number of actors claiming a say in the field expanded. Furthermore, the governance system had become more complicate, as anew agencies engaged in environmental issues had been established form the late 1950s onwards, Environmental administration at the central level remained however highly fragmented until 1972, when a new Ministry of the Environment was formed. The Ministry was to coordinate the different policy areas involved, such as pollution control, nature conservation, outdoor recreation and physical-economic planning according to a general policy of '"growth with conservation" (Jansen 1989; Jansen and Osland 1996: 182). In the policies of water management, the new ministry did not however have that much influence. This policy area was still the responsibility of the Ministry of Industry, and in 1978 they became the responsibility of the new Ministry for Oil and Energy (Grønlie 2009: 361 ff.).[23]

It was this new ministry that was accorded responsibility to prepare the report from the Sperstad-commission to Parliament. A main premise behind Protection Plan II was that the growth in energy consumption had to be reduced. This was stated in a new White paper on energy that was launched in the period between the first and the second Protection Plan (St. meld., nr. 100, 1973/74). Another consequence was that in Protection Plan II hydro power utilization to a larger extent than previously was seen in relation to energy production in general. Although it was suggested that Norway in the more distant future could utilize nuclear and gas for its energy supply, growth in energy consumption in the more immediate future would have to rely on hydro power. The committee therefore spoke up for the use of price mechanisms in order to reduce energy consumption (St. prp. 77, 1979-80: 10). It furthermore spoke up for a more rational construction of the hydro power plants in order to reduce the damages on nature. In this respect the two motives related to water course protection were combined: the aesthetic and the ecological motivations. The report launched the principle of "living nature" as a guiding line for hydro power utilization. This implied that damages to the landscape as well as the water milieu should be reduced to a minimum by restructuring the original conditions in the catchment area as far as possible after the construction work was accomplished (ibid.: 12, Nilsen 2010: 75).

Protection Plan II distinguished between four criteria for protection: Natural scientific concerns, recreational and out-door interests, interests related to the river basins recipient functions for waste water and interests related to the cultural historical and commercial values in the local communities (St. prp. 77, 1979-80: 12). Such criteria illustrated that the new trends characterizing the discourse over river basin protection had a strong impact upon the committee's work. What was also underlined by the committee was that Norway had international commitments in the field because of the unique qualities represented by the river basins: "Norway has international obligations to document and preserve intact areas for the study of geo-systems, which can be preserved for the future" (ibid.: 13). Such an emphasis on international obligations was something new. The same must be said about a new aspect that was stressed in the report: The obligation related to the indigenous people in the north, the Sami people. A new focus on the rights of the ethnic minorities was

[23] Mark the phrasing; oil *and* energy. Designating 'oil' as something distinct from energy says something about the importance accorded to the oil industry in Norwegian politics.

a typical aspect by the political discourse in the 1970s, and the government had in fact stated that the significance of the natural resources for the Sami people had to be taken into account in the new protection plan (ibid.: 14).

Protection plan II had a scientific obligation, and the committee worked due to scientific methodology (Faugli 1976). Still, one of the most ostensible aspects of the process related to the plan was the intentions to integrate the different political interests in the field. For one thing this was evident by the fact that the plan should reflect a geographically representative sample of river basins. Furthermore, it was reflected by the fact that a wide range of interests – administrative bodies, NGOs etc. - were invited to take part in the process (St. prp. 77, 1979-80: 8). In the debate in Parliament there was also consensus over the main principles in the plan as well as the extension of protected river basins.

Protection plan II was also influenced by political obligations to reduce the growth in energy consumption and also consider water course policy as part of a broader energy politics.. For one thing this was evident in a new White paper on energy policy that was launched simultaneously to the political handling of Protection Plan II. In the White paper, a “careful growth in hydro power exploitation” was seen as a guiding line for the energy policy in the immediate future. However, the white paper stated that gas power turbines would be important in a longer term. In addition, the prospect of other renewables than hydro power was for the first time stated as an important ingredient of future energy production. The white paper in fact estimated that other renewables should represent 20-25 % of the energy consumption in 2020 (St. meld., 54 (1979-80): 72).

In the White paper a new system for dealing with the proposed “careful growth in hydro power exploitation” was also introduced: the Master Plan for Watercourses. In fact two principles for the Master Plan were put forward. The Ministry of Environment prescribed a principle in which exploitation projects were organized according to the level of conflict with environmental concerns. The Ministry of Oil and Energy for their part prescribed that the main obligation was to accommodate the need for energy (ibid.: 52 ff.). Such a clash of principles for hydro power policy in fact illustrated that hydro power had become an integrated part of a wider energy policy field. It also illustrated that the field at this stage was characterized by a more general conflict between energy and environment, rather than the more enveloped conflict between water course exploitation and conservation (Angell and Brekke 2011: 48).

The extension of the conflicts in the field also materialized in two issues over river basin exploitation that took place in the late 1970s: The exploitation of the watercourse Alta in Northern Norway was met with major public protests and acts of civil disobedience. In this conflict several of the old and also new conflict dimensions in the field materialized: On one hand the conflict between hydro power protagonists and environmentalists, on the other hand the conflict between nationally formulated obligations for energy policy and local interests. In this conflict, the local opposition consisted of the Sami traditionally living in the area proposed for exploitation, and they argued that exploitation of the Alta river would damage the very foundations of their subsistence, adding an ethnic dimension to the conflict (Berntsen 1994: 215-218, Angell and Brekke 2011).

But the protesters were defeated in the short run, the Alta river dam project was built in the first half of the 1980s. The Alta conflict was won by hydro power protagonists, many of whom were old school industry socialists within the governing Labour party. The industry socialist had always held a stronghold of the Labour party, but this was to be their last victory. A new generation of Labour party leaders were coming up, both more market-oriented and environment friendly than the previous leadership of the party. Heading this new generation was Gro Harlem Brundtland. Coming from the post as Minister of the Environment she became prime minister in early 1981, after a bitter struggle within the party organisation.

At the same time as the Alta-conflict, another conflict was going on concerning plans for exploiting some of the watercourses at the Hardangervidda plateau in Southern Norway. Here the local communities were in favour of exploitation and formed an alliance with hydro power protagonist at the national level, and in parts of the Labour Party in particular. The environmentalist won an important victory in this issue, as only part of the project was carried out (Nilsen 2006: 144, Grove 2010: 283, Angell and Brekke 2011: 50). This result was also due to the fact that a national park was established on Hardangervidda simultaneously. This arrangement placed heavy restrictions on any activity in the area, also the exploitation of river basins. Over the next decade a national policy for national parks was established, which became a new aspect of the framework for river basin protection (Angell og Brekke 2011).

5. A broader spectrum of water course management arrangements

The Master plan for river basins was worked out in the early 1980s. The Ministry of Environment took the initiative in this process, and its influence meant that more than being a plan for how to continue developing hydro power it became a plan for resource management (Nilsen 2006: 220, Utne and Vandenær 1989, S. tidende (1980-81): 1167-1253). The process related to the master plan stood in a direct relationship to the protection plan for river basins. The master plan was intended to be a plan for how to prioritize between river basins that were not protected from utilization in the protection plan or had not been the object of a licensing process. The intention behind the plan then was to "outline any interest in the watercourses in order to prioritize between protection, utilization or other objectives" (St. meld. nr. 68, 1980-81). This implied that a comprehensive documentation was carried out. All in all the interests related to 310 hydro power projects were elucidated.

As was the case with the protection plan, a basic intention behind the master plan was also to integrate the different interests in the field. A wide range of stakeholders at different politico-administrative levels, from government agencies to counties and municipalities, as well as NGOs, commercial interests etc., were involved. In fact the master plan was an effort to institutionalize the conflicts in the field in order to reduce the high degree of political tension that had developed in the aftermath of the Alta conflict. Like the protection plan, the master plan also aimed to provide political decision makers with more comprehensive knowledge of the interests related to the river basins around the country. In the parliamentary debate one of the MPs claimed that the master plan was "a breakthrough for the idea of a centralized management….it will provide us with the opportunity to perform an overall management of a basic part of our natural resources" (S. tidende 1985-86: 3598).

The master plan was a central premise for the new version of the protection plan – Protection Plan III – launched in 1986. In the process prior to the new version of the protection plan, conservationist interests in river basins that had been temporarily protected in Protection Plan I or II were reviewed, together with a few major watercourses that had not yet been considered. After the examinations were carried out, it was for the Parliament to decide whether the watercourses should be preserved or not. If not, they were placed in the master plan (St. prp. 89 (1984-85): 46).

To a higher extent than the former versions, Protection Plan III was based on empirical data. The process in relation to the plan was also characterized by extensive research (cf. Faugli 1994: 78). Scientific arguments now had gained a more prominent position in the debate, due to the fact that the political struggles over river basin protection had reached a peak in the late 1970s (Jansen and Osland 1996: 184-185). Now the premises for protection were also specified extensively. Of particular importance was that the interests of the Sami people were even more emphasized, not only as reindeer herding was concerned, but according to the importance of the Sami cultural heritage as well.[24] It was claimed that cultural heritage was not properly emphasized in the former versions of the protection plan (St. prp. 89 (1984-85): 23). Such an emphasis on the Sami interests reflects the significance of the political struggles over river basin protection in the late

[24] However, the Sami were not yet recognized as an indigenous ethnic minority with the more legal rights and privileges that went along with such a status, this was not granted until the 1990s.

1970s, and the Alta-issue in particular (cf. above). The intentions to institutionalize political conflicts in the field were also reflected by the fact that Protection plan III even more stressed the importance of a geographically representative sample of river basins in the plan. In fact, water course protection now was seen as a resource that had to be the object of redistribution in line with societal resources. A major concern in the parliamentary proposition was that river basins with potential for preservation was unevenly distributed around the country, which was a big challenge from a conservationist point of view (ibid.: 46). Such an argument illustrates that the protection of river basins had gained wide political acceptance, something which was also illustrated in the broad acceptance by different political parties of the plan (S. tidende (1985-86): 3543, cf. Osland and Jansen 1995: 184-185).

Compared to the discourse in the 1960s, a huge transformation had by now taken place. While in the 1960s it was hydro power production that was the object for redistribution, in the 1980s it had become river basin protection.

Protection Plan III was prepared in an atmosphere in which conservationists' argument had gained wide acceptance. This was also related to the general situation concerning energy consumption. Due to much rainfall in the first half of the 1980s there was a surplus of electricity in Norway. Major gas finds in the North Sea also meant that gas power tubines became a realistic alternative to further expansion of hydro power. In a new white paper on energy in 1987 the government stated that gas power should be introduced, and that it was to provide about 15 % of the total amount of Norwegian electricity production in 2000 (St. meld. 38 (1986-87): 8, 104).

However, in the late 1980s more attention was put on environmental issues in the public debate. This was not least due to events on the international scene, such as the Chernobyl disaster in 1986 and the report by the World Commission on sustainable development (Brundtland-Commision) in 1987. In Norway new and more activist environment groups were established, with a stronger focus on pollution from industry and carbon emissions. This development also influenced Norwegian politicians, turning the general election in 1989 into an "environment election" with political parties overbidding each other on the level of cuts in Co^2 emissions (Nilsen 2001: 105-06). However, a stronger emphasis on the downsides of gas production did not result in a demand for more hydro power. The cold and dry winters in the mid 1980s was relieved by mild winters with high levels of precipitation towards the end of the decade. Earlier estimates of future energy consumption were downscaled, with no need for increased production (Energidata AS 1988, Angell and Brekke 2011: 60).

This gyration of prognoses illustrated that the public opinion on energy production in general, and river basin protection in particular, also relied on weather conditions. The weather conditions would become an even more central part of the framework for energy policy in the years to come. A reason for this was the Energy Bill, passed by the Norwegian parliament in 1990. This law – rated as the most liberal and market-oriented regulation of any national energy sector in the world at the time – implied that commercial principles rather than estimates of societal demands for energy supplies should determine the level of energy production. Norwegian energy production and consumption should obey to market rules, and profitability became the guiding principle for hydro power production (Ot.prp. 43 (1989-90), Thue 1996: 92). The reason for radically altering the existing price mechanisms was the conclusion by a new generation of economists that the prevailing system had led to both over-production, because the power companies did not have to take the full costs of new installations, as well as overconsumption, due to artificially low prices.[25] Such

[25] At the same time however, the change meant that power companies formerly governed by local councils now adapted to the new competition buy becoming limited liability companies and merging into larger and more competitive regional concerns. Thus, the company structure in many ways became more economically efficient, but it also meant that political control was now – at best – at a distance. Although most companies remained in public ownership, the local anchorage

considerations now also became part of the discourse on river basin protection (cf. S. tidende (1994-95): 2328).

6. Water course protection in the context of globalization

In the late 1980s two elements were added to the discourse of river basin protection, that of globalization of the environmental issue and commercialization of the energy market. In the early 1990s these elements coincided in the process that at the time was seen as the completion of the Protection plan for river basins.

In 1993 Norway ratified the Convention on Biological Diversity which was a result of the UN Rio-summit in 1992. This implied that Norway had committed to ensure biological diversity and ecological systems in river catchment areas. Because Norway is the country in Europe with the most diverse sample of river basins, this made the obligations even stronger. Another matter in this respect was that Norway had special obligations to ensure the spawning areas of the Atlantic wild salmon, located in several river basins along the coast (St. meld. nr. 60, 1991-92: 27, Angell and Brekke 2011: 66). At the same time, Norway, like the rest of Europe, was hit by economic recession in the early 1990s and consequently a decline in demand on energy. Investments in new hydro power projects was no longer profitable. In the parliamentary debates on Protection plan IV and a new version of Master plan for Watercourses in 1993, one MP described the situation after the passing of the Energy Act as such:

> *"There is too little activity in economy and industry, there has been too much of rain and mild weather during the winter…. It is no longer prognostics or political decisions that decide whether a power plant is to be developed or not. The decisive aspects are rather market demand for energy and the profitability of the specific project" (S. tidende (1992-93): 3209-3210).*

In the proposal on the new and final version of the Protection plan all in all 127 objects representing a hydro power potential of 11.6 TWh was preserved from utilization. Like the former versions of the plan, the new proposal was also prepared for by an expert committee. In addition to the previously included grounds for protection, the committee added a few more, reflecting the development in the field from the late 1980s. First of all, Norway's obligations concerning biological diversity were stressed. At the same time, problems related to CO_2-emmisions had become part of the committee's considerations, as an argument in favor of restricting the extent of river basin protection. Replacing hydro power with fossil sources, was not an environmentally acceptable solution any more. The committee also stressed the new framework for electricity-production represented by the Bill on Energy and the restructuring of the energy sector. It was no longer locally defined demands on energy that decided where hydro power production was situated. Electricity had become the object for centralized trade and profit was now the basic motive for utilization projects. In such a situation the prize-mechanism also became a tool to reduce demand on energy and consequently the pressure for more hydro power production (St. meld. 60 (1991-92): 8). In this respect the market mechanisms would also enforce a more rational use of energy among customers (ibid.: 28).

The proposition on Protection Plan IV and a new version of Master Plan for Watercourses was presented to Parliament simultaneously. In fact, as the process related to the protection plan now was considered to be accomplished, the complementary relationship between the two planning systems was even more obvious than it had been previously. The decisions concerning the watercourses to be protected in the protection plan determined which projects were to be considered in the master plan (St. meld. nr. 60 1991-92): 28). Another complementary planning system that was also negotiated simultaneously in Parliament was the Plan for National Parks. The catchment area of 32

of the hydro power industry, which had been a distinct trait of the Norwegian energy system since its conception, was dramatically altered.

objects that were proposed to be protected from utilization in Protection Plan IV was part of areas that were also proposed to be preserved in the Plan for National Parks. This implied that the extension of river basin protection could be expanded even further in these areas (St. meld. 62 (1991-92: 42). Of particular interest in our context is also that the Plan for National Parks relied on the same international obligations that were stressed in Protection Plan IV (ibid.: 30).

In the course of the 1990s, the premises for the discourse on protection of river basins were contested. Dry and cold winters towards the middle of the decade created a new demand for energy and electricity prices sky-rocketed, as the market mechanism set to work. Power production based on gas plants was again raised as an alternative to new hydro power projects. However, in the mid-1990s the context had changed in comparison with the 1980s. In that period the question was to what extent gas power plants could supplement hydro power production. In the 1990s gas power was discussed in the context of climate policy as a new political field. Like other states, Norway was now committed to the obligations following the UN Framework Convention on Climate Change and consequently to reduce emissions of CO_2. In Norway these commitments became an argument for adherents as well as opponents to gas power production. Adherents claimed that Norwegian natural gas could replace electricity production based on oil and coal on the continent, which would be advantageous from a climate perspective. The opponents on their side claimed that Norway would never be able to fulfil its obligations concerning CO_2 emissions if gas power turbines without facilities for capturing CO_2 emissions were build. During the summer of 1997 the opposing side won this battle and the construction of gas plants were put on hold (Nilsen 2001: 225).

However, this also meant that the river basin protection regime was contested. The second half of the 1990s was furthermore a period of economic growth which also increased the demand on energy. In 1997 a government committee was appointed to analyze developments in electricity demand over the following decades. Their conclusion was that there would be a strong increase. However, they also pointed out that electricity production in Norway was too heavily dependent on hydro power and consequently vulnerable (NOU 1998: 11: 5). In a white paper on energy in 1999 the government argued not for more hydro power, but for an increased variety in energy production, especially from other renewables, such as wind (St. meld. 29 (1998-99): 6). Thus despite the perceived energy deficit, the Protection plan for river basins was not actually challenged when Norway turned the new century.

7. 2000s: Further consolidation of the protectionist regime:

At the entrance to the 2000s the energy issue had come onto a track that in reality supported demands for further protection of watercourses. One was a new interest in other renewables, another was the issue of gas power plants: While the Bondevik-led centre coalition government had put the issue of developing gas plants on hold, the Laobur party pushed for allowing it, and allied with right wing parties to overthrow the government on the issue. The perceived availability of gas as well as renewable sources, sat the background for the new prime minister Stoltenberg's new years' day speech in 2001, when he stated that the era of large hydro power development have come to an end (Stoltenberg 2001).[26] However, no new gas power plants were developed under Stoltenberg's first government. But when he came back to power in 2005, he proclaimed an ambitious project for developing CO_2 catching technologies, realizing the dream of emission-free gas power. However, as of today, the project is still just that, a dream.

In the early 200s it became more and more clear that the Master plan for watercourses was not working as intended. The idea had been to prioritize potential projects before concessions were applied for, securing that the

[26] In reality, this was nothing new. No large hydro power developments had been initiated in the 1990s., and politicians from other parties had stated more or less the same in the debates on Protection plan IV in 1993. However, such a statement coming from the leader of the party who had been the most eager supporter of hydropower since the war, made an impression.

least conflictual projects were developed first. However, in practice, even projects that were rated within the least conflictual category, were opposed by conservationist interests. It was argued that the Master plan had lost its function as a project catalogue and could not bind future decisions on specific projects. Rather, the Protection Plan should be further expanded to include “those watercourses [from within the Master plan] where hydro power development would have the most negative effects and disadvantages to the environment” (St.meld 37 (2000-2001): 27). Rather than a catalogue of development projects, the Master plan should become an overview of water course resources.

A government proposition to supplant Protection plan IV was presented to Parliament in 2004 (St.prp. 75, 2003-2004).[27] While the Government did not realize the proposed reorganizing of the master plan, projects where the environmental effects were substantial was transferred to the Protection plan. But at the same time they proposed lifting the existing size limit on projects to be included in the Master Plan, from 1 MW installed effect up to 10 MW. The maximum level for installations in protected water courses was sat to 1 MW. Thus the Government achieved a double manoeuvre. The number of protected water courses was increased as the same time as it became easier to develop smaller hydro power plants. This led to a surge of local interest in developing small hydro power: More than 300 concessions for small hydro power installations with a total capacity of approximately 4 TWh/yr were granted from 2003 until 2010 (www.nve.no).

The major debate in 2004 concerned the Vefsna watercourse in Nordland, where both Sami interests as well as a major wild salmon presence and the aesthetic and recreational value of the watercourse were arguments for protection. An advocacy group “Protect Vefsna”, initiated by the major conservationist NGOs and supported buy the Socialist Left party, was formed, claiming that:

> *“An unregulated water course combined with cultural landscape, salmon- and sea trout fishing and local foods can provide a much-coveted tourism product creating much local employment, in particular for women” (VG (daily tabloid) 26.june 2004).*

But Vefsna was not included this time round. The result in Parliament was the inclusion of 50 more watercourses to the Protection Plan, bringing the total number of protected watercourses to 391, representing a potential hydro power production of 45 TWh/year.

In 2009, however, Vefsna was included when a final supplant to the Protection plan was introduced to Parliament. When the new labour-led coalition government was formed in 2005, the Socialist Left party had managed to include a provision to protect Vefsna in the Government settlement. This was by no means within ordinary procedures. The issue was also controversial as several local municipalities strongly disagreed with the provision. As compensation, the municipalities affected by the provision were granted a fund to support local industry of NOK 150 Million. In addition, Government allowed for small hydro power installations in Vefsna “…without any further limitations on installed effect as long as these do not in any way conflict with the protection values” (St.prp. 53 (2008-09) 12).

In Parliament the proposal was approved against the votes of the Conservative party Høyre and the right wing Progress party (Fremskrittspartiet). The debate in parliament in 2009 illustrates well how the legitimacy accorded to different arguments have changed over time. While the concern for growth was the crown argument in the 1950s, more or less trumping any other concerns, this had all

[27] Another new issue that had arisen by now, was the protection of the wild salmon. In 2003, Parliament hd established 21 national salmon waterways and 21 samlmon fjords, as a first step in securing the wild salmon habitat in Norway. Another trait of the 2004 proceedings, was the strong emphasis being put on Sami interests. The Sami Parliament stated that several water courses had not been included in the proposed conservation plan (that this time was worked out by the Water resources and energy directorate), even though there were obvious Sami interests there. Their viewpoints gained support from the environmental administration, form the Directorate of Nature administration.

changed in 2009. Neither the conservative party nor the Progress party used economic growth as an argument in the debate. The conservative Party referred to concerns for climate change, while the Prorogress Party argued that protection of Vefsna was a scorn to the value of local democracy. The only party who referred to economic growth was the Socialist Left Party, but then as an argument *for* protection. In the battle between growth and conservation it seemed as though conservation had definitely conquered the pole position.

8. Concluding remarks – and an outlook at things to come…

Management of water course resources have been high on the political agenda throughout the period discussed in the paper, dating all the way back to the Concession laws in the early years of the 20th Century. The foci of such management have however shifted significantly.

Both before but most significantly after the war the development of hydro power defined the politics of watercourse management, In the post-war period hydro power became maybe the most potent symbol of national rebuilding and progress. Even so, much of the history of hydro power development in Norway concerns confrontations between different interests, and efforts to integrate them through planning and political decisions. The present system of watercourse management is a product of a layered development of cleavages as well as regulatory efforts. While nature conservation at best played second fiddle in the post-war years, from the 1960s onwards the balancing of opposing interests was the declared ambition of government policies. But the main oppositions have shifted across time. From the 1960s until the 1990s the dominant cleavage shifted from hydro power versus nature conservation towards a more generalized opposition between energy and environment. The regulatory system has to a large degree developed along the same demarcation lines. New concerns have over time been met with institutional innovations. The early regulatory hegemony of the Norwegian Water Resources and Energy Directorate (NVE) has since the 1970s been countered by the institutionalizing of environmentalist concerns. From the early 1980s the central regulatory system of watercourses have been split in two, with the Ministry of the Environmen (1972) t and the Directorate of Nature Management (since 1985) on the one hand, and the Ministry of Petroleum and Energy (1979) and NVE on the other.

The main developmental trend in the relations between hydro power production and environmental concerns has been the successive expansion of governance efforts and institutions as new interests and lines of conflicts has emerged on the political agenda. However, although the institutional structure have remained more or less the same since the 1980s, the framework for watercourse politics have undergone major changes since then. Resource management has more or less replaced hydro power development as the major driver for watercourse policies. The 1990 Energy Act resulted in a major change in the organization of the hydro power sector. Although most hydro power companies are still under public ownership, they have been transformed into shareholding companies operating under market conditions. Electricity resources are no longer directed towards local or national consumption, but are pooled together and brokered at international markets. Thus, the local and democratic anchoring of hydroelectric power is ruptured.

In one way, these changes have been to the benefit of conservationist interests. The development of the Protection plan shows how conservation interests have managed to gain the upper hand, managing to create a discursive monopoly no longer challenged by concerns for economic growth.

However, in parallel to the internationalization of the electricity market, concerns for the environment have also been globalized. National concerns for the protection of watercourses thus are increasingly challenged by global concerns for renewable energy. The opening for small scale hydro power in protected watercourses in the latest protection plan indicates one such challenge to the prevailing protectionist regime. The huge increase in the number of small hydro power installations have also provided ammunition for protagonists of large-scale hydro power, claiming that one large project could well be less environmentally degrading than many small projects.

The integration of the European electricity markets and the shift from fossil or nuclear towards renewable energy throughout Europe have also created a new comparative advantage to Norwegian hydro power. Unlike other renewable energy sources, hydro power can be stored in water reservoirs for later use. This quality has led to proposals for Norway becoming a “green battery” for Europe, capable of providing a ‘back-up’ of clean energy as the continent shifts from fossils to renewable but less reliable electricity sources, such as wind power (NTB, 20/1–2011). Since 2010, several flooding events due to climate change have also raised a debate on the need for regulating waterways through hydropower dams. Thus there are several signs in later years that the prevailing protectionist regime may be about to be challenged.

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Simulation of a solar absorption air conditioning system for Batna, Algeria

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Abstract

The global primary energy demand has increased rapidly due to increasing population and industrialization. More than a third of the energy demand in the world is used in the residential sector. In the building sector, the energy consumption by the HVAC (Heating, Ventilation and Air Conditioning) equipment is ranging from 16% to 50% of total energy consumption worldwide. Currently the most popular cooling systems using solar thermal energy to produce cold, are closed systems using absorption machine which base their operation in the production of cold on hot water provided by solar collectors. The main objective of this work is to develop a computational model that allows the simulation of an hourly basis for an absorption cooling system assisted by solar energy and natural gas as auxiliary fuel. This model will be developed using the dynamic simulation program TRNSYS, considering three specifics steps of work: an implementation of the calculation model for the absorption cooling system to ensure a thermal load of 25 kW, then a parametric optimization of the systems components, all this will be followed by an optimum dimensioning of the solar absorption system in the region of Batna.

Keywords: Solar cooling systems; absorption chiller; simulation; TRNSYS.

1. Introduction

Since the beginning of the last century, the average surface temperature of the Earth has increased by about 0.6 °C according to the Intergovernmental Group of Experts on Climate Change. This temperature could increase by 1.4 to 4.5°C by 2100 (GIEC, 2001). The signs of this warming are becoming more numerous and are manifested by melting glaciers, raising the level of the sea waves and extreme summer heat, found in many countries. Although there are natural elements that have contributed to global warming, climate change observed over the past 50 years are likely due to human activities (GIEC, 2001). After realizing the seriousness of the situation, the international community decided to take action to slow the process. One such effort is the Kyoto Protocol, an international treaty on global warming which took effect from 16 February 2005. This protocol is a legal agreement under which industrialized countries must reduce their emissions of greenhouse gas emissions, calculated on an average basis over five years from 2008 to 2012, from 5% compared with 1990. The main objectives are the reduction of 8% for the European Union, to 7% for the United States and 6% for Japan (M. Olivier, 2010).

The heating and air conditioning are among the most affected areas to achieve these goals. Indeed, over the past fifteen years, the requirements of the occupants of commercial buildings or dwellings have changed significantly. Demand for more convenience we observe stricter especially in summer. This increased need for air conditioning induced a significant increase in the consumption of electricity as conventional technologies (mechanical vapor compression) implemented are very energy intensive (Balaras C. A. et al., 2007).

In this difficult context energy, solar cooling systems are among the attractive alternatives to conventional air conditioning systems, to the extent that the primary energy is consumed mainly in the form of heat from the sun, so free. The other great advantage of these methods is that the need for cooling coincides mostly with the availability of solar radiation.

Research currently focuses on the study of solar cooling methods and more particularly on systems with low cooling capacity. The objective of this kind of installation is to expand the market for solar cooling systems for residential, which is a major environmental issue. However, these methods are not economically profitable because of their capital cost, but also maintenance operation. This economic aspect remains a major obstacle to their development. Indeed, conventional air conditioning systems are cheap and their coefficients of performance are equivalent electrical or better than methods solar cooling (R.Z. Wang et al. 2009; Jakob U., Pink W., 2007). The objective of this work is to present a simulation of a solar absorption cooling in the optimization of its performance goal.

2. Potentialities

With an area of 2,381,741 km², Algeria is the largest side of the Mediterranean countries. Due to its geographical location, Algeria has one of the highest in the world solar deposits. Sunshine duration on almost all the national territory exceeds 2000 hours annually and can reach 3900 hours (Highlands and Sahara). The daily energy received on a horizontal surface of 1 m² is around 5 kWh over most of the country, or nearly 1700 kWh/m²/year in the north and 2,263 kWh/m²/year in the South of the country (ALGERIA MEM, 2014).

The region of Batna (35.33° N, 6.11° E) in Algeria has a climate of semi-arid very favorable to the use of solar energy.

3. Description of simulation system

3.1. Climate Data

To make the dynamics simulations of a solar absorption cooling systems, some basic questions must be considered, the first related to the type of weather and solar radiation information available for the study area (A. Buonomano et al. 2013).

To evaluate the thermal performance at the system level in the long term, it is proposed to have a database of typical meteorological year (TMY) of the study site. In this work, the climate database was built using information provided by the METEONORM software for meteorological coordinates of Batna (METEONORM handbook, 2016). Fig. 1 shows the time variation of the global solar radiation and ambient temperature for one year.

3.2. Construction of model solar absorption cooling system using TRNSYS

To make and to know the operational performance of the absorption cooling system, TRNSYS 16 is used. This simulation program has a modular structure that divides the system into a series of components (types) that are interconnected with each other and compiled through the interface TRNSYS Studio. The simulated cooling system consists of:

- An area of 70 m² of solar collector plane.
- A volume of 2 m³ storage tank hot water, with cylindrical shape and height of 1.5 m.
- A circulation pump for the series of solar capture at a rate of 38 kg/m² hr.
- A controller ON-OFF acting on the pump to control the circuit on and off. It has a high temperature cutting, which is activated if the temperature of the intake manifold is greater than 98°C were considered to be 2°C and 0.15°C as deadband values and upper deadband lower, respectively.
- A pressure relief valve, which acts at temperatures above 100 °C.
- A single-effect absorption chiller, brand YAZAKY WFC-SC10 model (YAZAKI Products, 2016) represented by the "Type 107". This machine uses the LiBr-H2O solution as the working fluid and is fed by a stream of hot water between 75 and 105 °C. It has a capacity of 35 kW and a nominal COP equal to 0.7.
- An auxiliary heater with natural gas as fuel, which has a maximum capacity of 30 kW, with an average efficiency of 85% and a temperature setting of 90°C to provide the energy deficit.

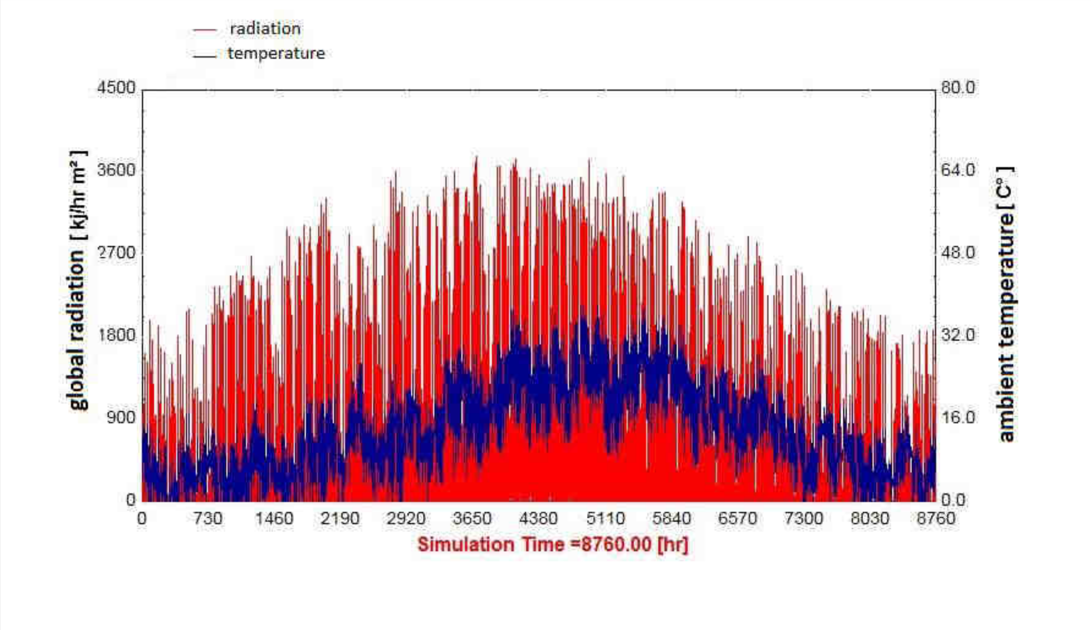

Figure 1: Hourly variation of global solar radiation and ambient temperature.

Each component is represented by a constant number of settings, input and output related to simulation time. Output data of a component can be used as input to another (or others) component (s). The final system is assembled by connecting all the inputs and outputs in an appropriate manner to simulate the actual solar absorption system. Finally, it is made of the construction of the model that will be used to simulate the solar absorption system. The pattern obtained with the major components of all interconnections TRNSYS and system are presented in Figure 2.

The meteorological data used were TMY2 format (typical meteorological year) for the city of Batna and these data are read by the "Type 109" of TRNSYS. To perform the simulation for one day from 08h00 am until 04h00 pm we add a function component forced "Type 14h".

4. Results and discussion

This study considers a solar absorption cooling system that provides demand for air conditioning in the climate of the city of Batna. The simulation was done during the summer months (June, July, August), where the demand for air conditioning was represented by a load of 25 kW in this simulation.

The process of parametric optimization has the goal of reaching a correct sizing of components and operating conditions of the system, we start with a low-power machine that was chosen based on actual installations and existing research literature (Ursula Eicker, Dirk Pietruschka, 2009; G.A. Florides, et al., 2002; A. Allouhi et al., 2015). To see the evolution of the different temperatures at the cooling installation was running the software for the first fifteen days of July when the installation operated from 08h00 am until 04h00 pm. The results obtained are illustrated in Figure 3.

Several simulations are carried out with TRNSYS model to assess the most relevant factors that make possible an idea of the optimal size of the solar absorption cooling system and analyze the effects of key variables that affect performance.

Among the factors studied: the solar collector area. An auxiliary heater with natural gas as fuel as a backup, which has a maximum capacity of 30 kW. The Fig. 4, shows the influence of the surface of solar collectors, on the energy supplied by the auxiliary heating system. The range of analysis varied from 20 m² to 100 m² of the surface of solar collectors, with a variation of 10 m². It is observed that the increase in the collector surface resulted in a reduction in energy requirements of the auxiliary heating device. The effect is amplified when the use of a high efficiency solar collector. But this amplification requires a thermo-economic analysis. The effect of the collector area on the solar gain useful energy is shown in Figure 5, for area varies between 20 and 160 m².

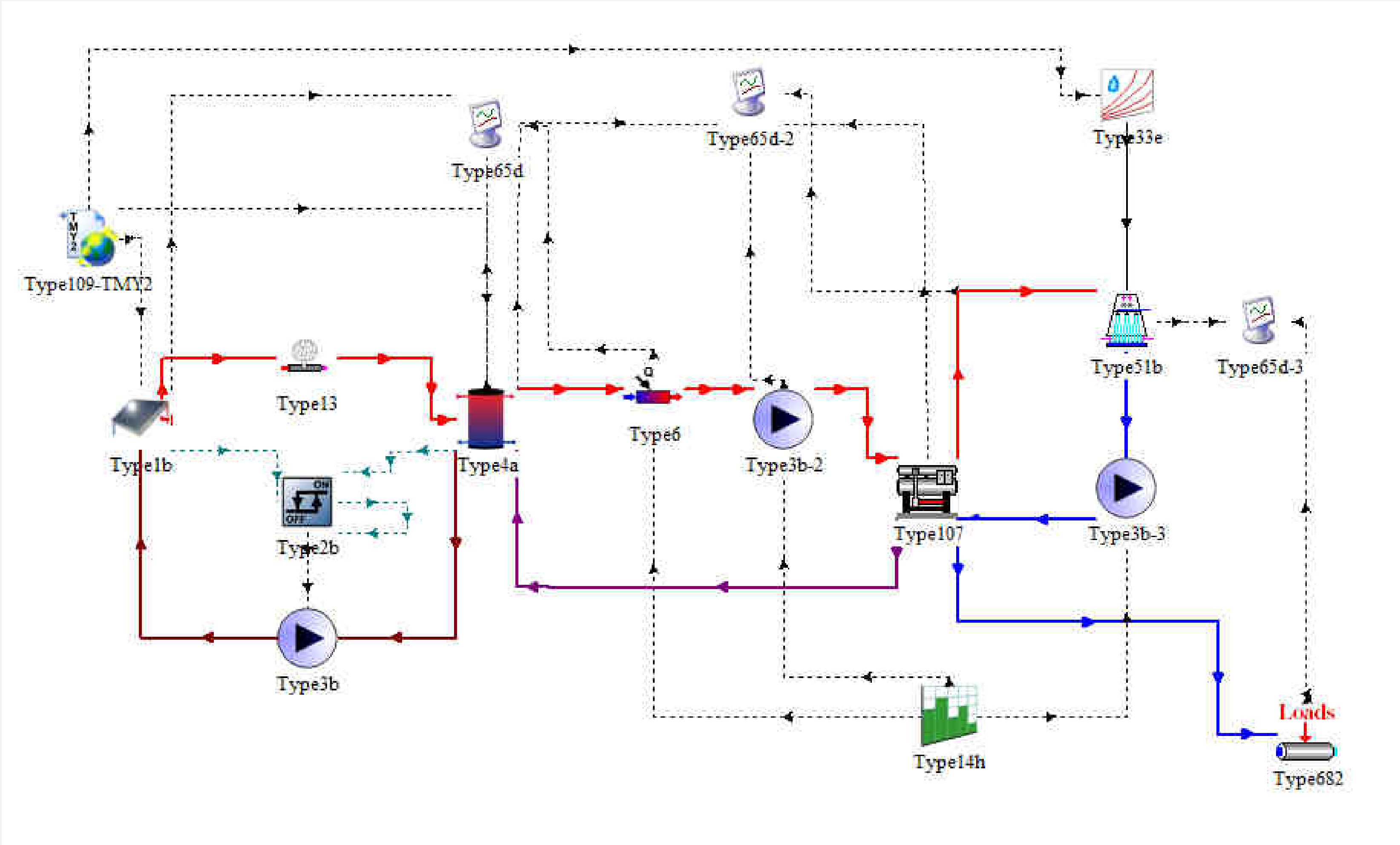

Figure 3: TRNSYS model of the solar absorption cooling system.

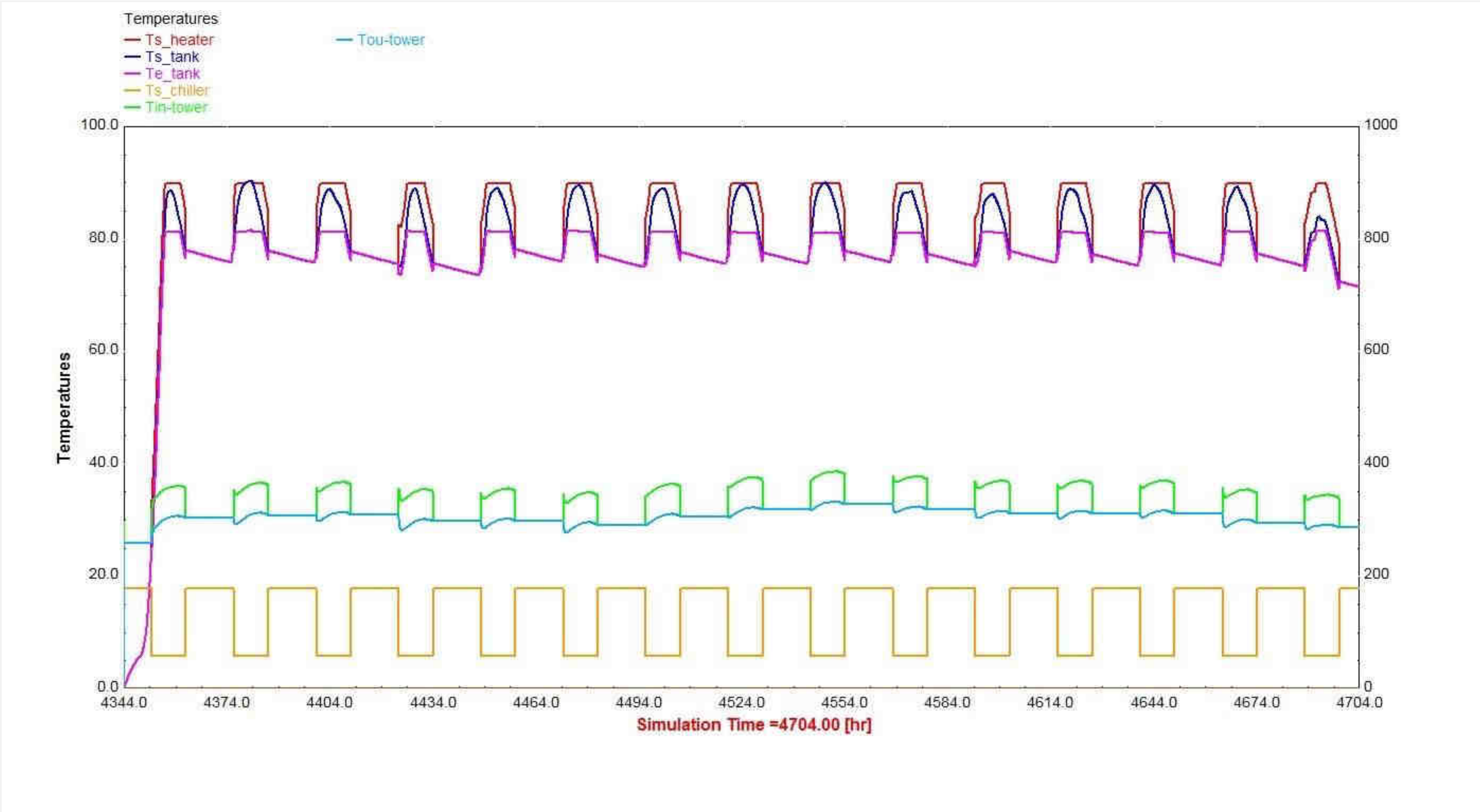

Figure 4: Evolution of different temperatures occur in the cooling installation.

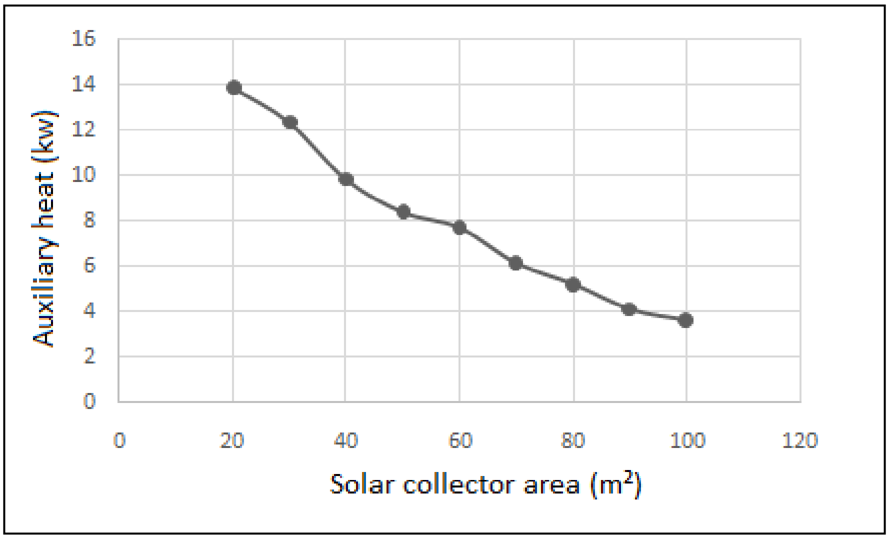

Figure 5: Effect of the collector area on the auxiliary heat of the system.

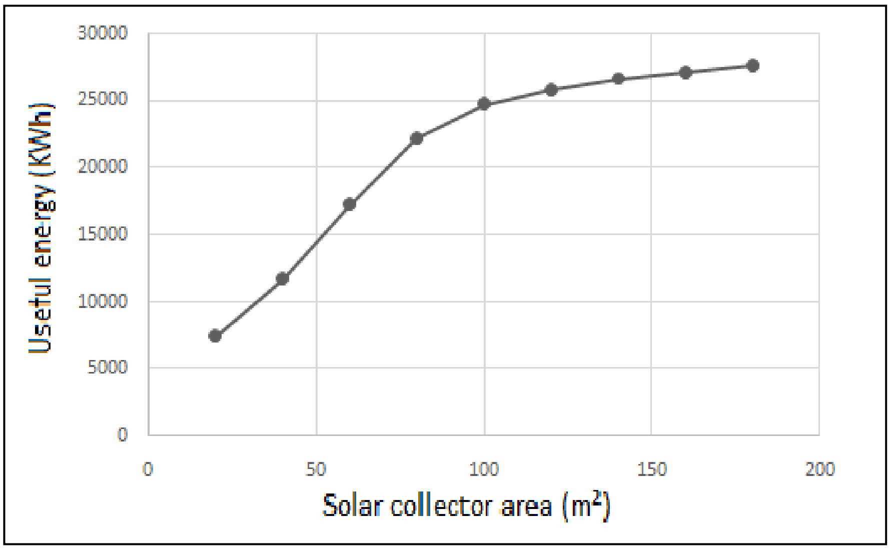

Figure 6: Effect of the collector area on the gain of useful energy.

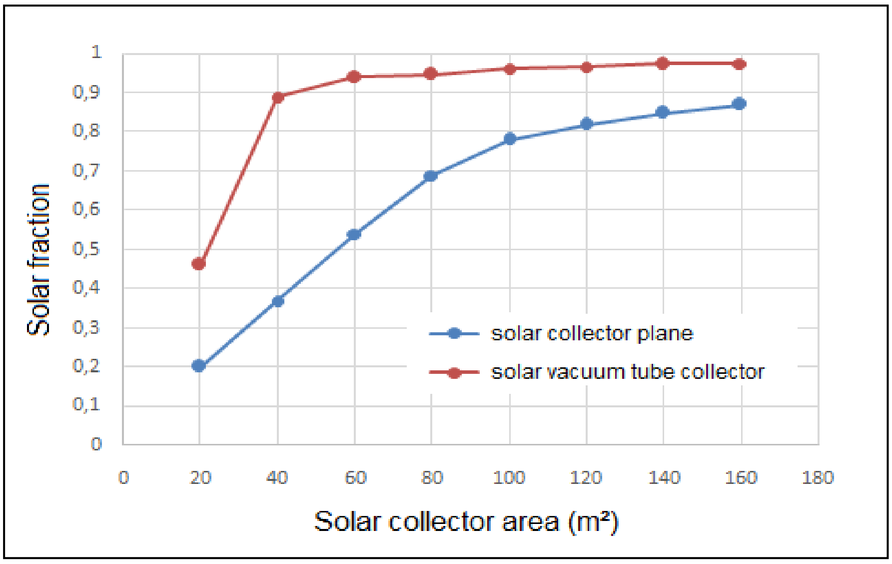

Figure 7: Solar fraction which is defined as the ratio of the cooling and heating.

This shows that the useful energy gain increases with increase of the solar collector area consumptions provided by the solar system to the total cooling and heating consumptions of the building (Yin Hang, 2014). The figure shows the influence of the collecting area on the solar fraction of the system, wherein it is observed that the increase in surface zone increases the value of the solar fraction, an effect that also increases in the case of the use of a vacuum solar collector with a greater efficiency as compared to a plane collector.

5. Conclusion

The main objective of this study was to simulate a system of absorption cooling assisted by solar energy and natural gas, a computer model that allows for a parametric optimization process to find the right size of the system. This objective was successfully achieved, given that the model is not only possible to the size of the design parameters, but also provides the ability to simulate new dimensions and future configurations.

In modeling of the demand for air conditioning was used the type 682 of Library TESS that works based TRNSYS which allows simply imposes a load specified by the user and some models of load profiles with the simplifying hypotheses of the literature.

The results of the parametric optimization of an absorption cooling system assisted by solar energy, indicate that with an area of 70 m² of flat plate collectors with an inclination of 35.33° and 2 m^3 storage tank is achieved to cover the demand of air conditioning a load of 25 kW located in Batna, maximizing the gain of useful energy of the system and minimizing the consumption of auxiliary energy.

Finally, the model developed can be used in future work to perform a thermo-economic optimization of the system, which will allow evaluating the performance and economic viability of the system on a long term. Additionally, different alternatives to those considered in this investigation can be evaluated, for example: different sizes of absorption chiller, variable flow pumps, different climates, especially in the southern cities of Algeria.

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Supporting global and European climate and energy policy-making through the nexus approach

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Abstract

This paper shows how an advanced macroeconomic simulation tool can be represented in reduced form, so that it can be used to assess energy policy and the linkages between energy and water demand in countries with data constraints. Using Azerbaijan as a case study, a simplified single-region Input-Output modelling tool is presented that could assist policy-makers in emerging economies to overcome the lack of reliable data and allows the analysis of more complex policy scenarios.

Several policy areas (e.g. bio-based economy, circular economy) increasingly consider the Nexus concept because ignoring synergies and trade-offs between energy and natural flows, can lead to misleading modelling outcomes. Several modelling tools are available to address energy and the Nexus: Cambridge Econometrics' energy-environment-economy approach is one of the most sophisticated. The E3ME model provides a credible tool to help assess the impact of certain policies on the labour market, on sector competitiveness and the resulting socio-economic consequences. For example, with our modelling tool, we can describe what the targets of the Nationally Determined Contributions (NDCs) might mean for jobs in their economies.

This paper uses Azerbaijan as a case study of Black Sea Economic Cooperation (BSEC) to present insights from the ongoing Sim4Nexus project – funded under Horizon 2020 – that aims to support climate and energy policy-making through economic modelling – using the 'Nexus approach'. We will estimate the impact of moving towards a diversified economy with a higher share of renewables and lower oil exports, considering the nexus challenges in the country.

Keywords: Nexus approach, energy policy, economic modelling.

1. Introduction

The purpose if this paper is to provide a summary of an innovative way of looking at nexus challenges and opportunities, and their use in policy assessment, as part of the H2020 project 'SIM4NEXUS'. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement NO 689150 SIM4NEXUS.

The importance of the Nexus concept is presented below, focusing on the increasing cross-sectoral dimensions in European policy-making. This is followed by a brief introduction to the SIM4NEXUS project. Then it provides a detailed overview of four key models used to support climate and energy policy-making. The next section discusses Azerbaijan as a case study where a single country model had to be constructed due to the limited availability of data. The model framework is presented, followed by potential policy scenarios to be analysed.

2. The Nexus approach

Europe's economic development and well-being is linked to its natural environment. Natural resources enable the functioning of the economy (globally, continentally, nationally and regionally) and support our quality of life. These resources include (renewable and non-renewable) energy, wood from forests, food and fibre from crop production, quality of soil, water and air. Competition between land, water and energy resources is increasing, and is exacerbated by climate change. For example, global demand for fresh water is expected to increase by 40% in 2030, demand for energy to increase by 50% and demand for food by 35% (Alexandratos and Bruinsma, 2012). Such trends largely depend on growth in global population, increased urbanization and changes in consumption patterns. Continuing current trends in the use of these natural resources means that nations are living beyond their biocapacity, thus creating an ecological deficit (WWF, 2014). Improving resilience and securing resource availability would require improving resource efficiency. The European Commission has shaped an initiative towards a resource-efficient Europe aimed at reversing those trends. Land, food, energy and water are interconnected, comprising a coherent system (the 'Nexus'), dominated by complexity and feedback. Interconnections between the Nexus sectors, e.g. energy and climate, often are bi-directional. Energy consumption, for example, has a direct effect on greenhouse gas emissions and subsequently impacts global climate. Moreover, climate change could have a direct effect on energy use as well: Total energy demand is foreseen to remain pretty stable, but energy demand for heating is decreasing and energy demand for cooling is increasing (EEA, 2017). Renewable energy production in Northern Europe may benefit from climate change, but rising temperatures could increase severity of storms and impact conventional electricity generators (EEA, 2017). Furthermore, the Sustainable Development Goals (SDGs) address the sustainable use of natural resources and stress how a Nexus assessment would play a catalytic role in achieving them all simultaneously.

A deep understanding of the Nexus can provide the informed and transparent framework that is required to meet increasing global demands without compromising sustainability. The nexus approach will also allow decision-makers to develop appropriate policies, strategies and investments, to explore and exploit synergies, and to identify and mitigate trade-offs among the development goals related to water, energy and food security. A proper understanding of how energy systems operate requires a good understanding of energy (including mining), engineering, hydrology, economics, food science, geography, social science and climatology. The transition of the energy system towards lower carbon emissions is a challenge to society, and matching energy demand with supply is increasingly dependent upon natural resources, which could be allocated for different purposes, leading to a potential scarcity (i.e. of water and land). An additional layer of complexity is added by the potential future impacts of climate change on all of these areas. Hence, energy models need to take the Nexus aspects into consideration in order to minimize the natural, social and economic risks (Brouwer et al., forthcoming).

3. Introduction to the SIM4NEXUS project

SIM4NEXUS, acronym for 'Sustainable Integrated Management FOR the NEXUS of water-land-food-energy-climate for a resource-efficient Europe', is a H2020 project under the topic for integrated approaches to food security, low-carbon energy, sustainable water management and climate change mitigation.

The project aims at developing innovative methodologies to facilitate the design of policies and bridge knowledge and technology gaps in the field of the water-land-food-energy-climate Nexus under climate change conditions. SIM4NEXUS aims to develop a methodology of integration using a complexity science approach and a Serious Game, as an integrating tool for testing and evaluating policy decisions. The Serious Game will be operable at different scales ranging from regional to national, to continental, to global, as well as at different time horizons.

The objectives of SIM4NEXUS are:

1. To adopt existing knowledge and develop new expertise on the Nexus to support the goals of the EU 2020 vision for smart, sustainable and inclusive growth, including resource efficiency objectives, by testing improvements in resource efficiency and low-carbon energy use. Also under this objective, pathways to 2050 are explored.
2. To use advanced integration methodologies based on complexity

science approaches in order to bridge the knowledge gap related to the complex interactions among all components in the water-land-food-energy-climate Nexus and to reduce uncertainties of how policies, governance and institutions affect complex changing environmental systems and what their impacts are on resources.

3. To showcase the implementation of the SIM4NEXUS methodology, by using a network of regional and national case studies in Europe as a test bed for achieving resource efficiency through successful policy initiatives.

The desired outcomes will be:

1. Increased understanding of how water management, food, biodiversity and land use policies are linked together and to climate and sustainability goals.
2. Reduction of the uncertainties about the opportunities and limitations of low-carbon options, such as bioenergy technologies and resource efficiency measures, in view of relevant near-term policy initiatives.

As part of the SIM4NEXUS project, 12 case studies are being developed at regional, national, continental and global scale. The case studies will serve as test-beds for the models and the integration of methodologies. In all the case studies, the aim is to study the Nexus trade-offs and the impact of different policies for the future. In the case of the regional and national case studies, the SIM4NEXUS project team engages with local stakeholders and decision makers for the development of polices policy scenarios that will be analysed.

This project also aims to create a scientific inventory on the Nexus, by studying and quantifying interlinkages between water, energy, food and land under climate change. The different components of the Nexus have their own specialised tools that are used for assessment. For the Azerbaijan case study, these four models were selected to investigate their potential to improve support to national energy policy. They are designed independently and with distinct purposes, using independent data sets, assumptions, and methodologies.

- CAPRI: a global agro-economic model with regionalized EU detail;
- OSeMOSYS: a global/ national energy modelling system;
- MAGNET: a CGE model with a focus on bio-economy and food security;
- E3ME: a global macro-econometric energy, environment and economy model.

Thematic models

This section provides a detailed description of the models considered for the Azerbaijan case study, the links of these models to the Nexus components covered and the model interactions.

The level of detail describing the energy system in each model varies considerably:

- OSeMOSYS (Open Source Energy Modelling System) provides the highest level of detail.
- the FTT (Future Technology Transformations) component of E3ME (Energy-Environment-Economy Macro-Econometric model) provides technological detail in the power and road transport sectors explicitly and directly, both for supply and demand.
- MAGNET (Modular Applied General Equilibrium Model) focuses more on land use and the economy but has linkages to energy consumption through e.g. the use of biofuels.
- in CAPRI (Common Agricultural Policy Regional Impact Analysis) energy is only partly covered.

The **CAPRI** model is a tool for ex-ante impact assessment of agricultural and international trade policies with a focus on the European Union. As an economic partial comparative static equilibrium model for agriculture, its core consists of two interlinked modules: about 250 regional aggregate models covering the EU27, Norway and Western Balkans at the NUTS 2 level and a global spatial multi-commodity model for agricultural commodities, which together allow calculation of a wide range of economic and environmental indicators (Henrichsmeyer et al., 1997).

Table 1: Azerbaijan case study thematic models and nexus components.

AZERBAIJAN	Thematic model applied			
Nexus system	E3ME	MAGNET	CAPRI	OSeMOSYS
Climate	X	X		X
Land Use	X	X	X (env, bioenergy)	
Energy	X	X		X
Water			X	X
Food		X	X	X
Economy	X	X		

A spatial downscaling component allows impact assessment at the 1x1 km grid level for EU27 (Leip et al., 2008). CAPRI has been extensively used to assess agricultural policy measures, GHG emissions from the agricultural sector, food-water-energy linkages and climate change impacts.

Recent applications of CAPRI include: evaluation of the impacts of climate change on EU agriculture; evaluation of the livestock sector's contribution to the EU greenhouse gas emissions; assessment of the effects of EU biofuel policies; analysis of the effects of recent agricultural policy reforms (direct payments harmonisation, greening); assessment of agriculture-water relationships; Evaluation of the impact of recent Agricultural and Trade Policy Reform on Land Use.

OSeMOSYS is an open source modelling system for long-run integrated assessment and energy planning[28]. It has been employed to develop energy systems models from the scale of continents (African Power Pools, South America, EU28 down to the scale of countries and regions.

It is a systems cost-optimization model idealised for long-run energy planning. Yet, this modelling tool can flexibly accommodate constraints imposed by other systems, e.g. land use, water availability and climate change. For example, from a land use perspective, the integration can be achieved using different approaches, either by acting over biomass availability or by diversifying its sources.

At global level, the GLUCOSE (UN, 2014; Taliotis et al., 2013) toolkit aimed at exploring climate change and mitigation strategies by exploring the interactions between three modules: the energy sector, land and food production, and material production.

More recently it was used to model the electricity systems of African countries, for the World Bank's study "Enhancing the Climate Resilience of Africa's Infrastructure", in which the water-energy nexus was explored through the analysis of climate change impacts in selected river basins, which were then reflected on the performance of African countries energy generation mix and in cross border electricity trade. Competing uses of shared water resources were studied using Sava River, Syr Darya, and Drina River basins. The competition was represented with an integrated analysis that considered agriculture, energy and ecosystem needs. In these studies, which contributed the UNECE nexus assessment process under the water convention, a generic methodology was developed. That methodology helped reconcile a variety of approaches and tools for the assessment of resources. For example, for the Sava River Basin, included the nexus between climate change, hydropower expansion and water demand for agriculture. Two other nexus projects are currently under development for Nicaragua and Uganda, based on the Climate, Land Use, Energy and

[28] http://www.osemosys.org/

Water strategies (CLEWs) framework, under the supervision of UNDESA.

For the purpose of the Azerbaijan case study, OSeMOSYS has been adapted to make best use of the available information on the country's energy system (see section below on data limitations). OSeMOSYS can cover the climate, energy food and water parts of the nexus.

MAGNET is a global computable general equilibrium model with an additional focus on agriculture, it is a tool for analysis of trade, agricultural, climate and bioenergy policies. The model was developed at Landbouw-Economisch Institut (LEI) at Wageningen University as a successor to LEITAP[29]. The MAGNET model has been used in the Agricultural Model Inter comparison Project (AgMIP) (van Lampe et al., 2014), looking at long-term effects of projected climate change on agriculture (Wiebe et al. 2015) as well as the effect on food prices and land use of a significant increase in bio-energy as a climate mitigation option (Banse et al., 2008). The macro-economic contributions of the emerging bio-economy are studied for the EU and The Netherlands by including detailed biofuels, bioenergy, biochemicals sectors and related policies within the model. MAGNET has been used to examine the interplay between the U.N. program to Reduce Emissions from Deforestation and Forest Degradation (REDD) and increased biofuel production from the Renewable Energy Directive (RED) (Dixon et al., 2015).

E3ME is a global, macro-econometric simulation model designed to address major economic and economy-environment policy challenges[30]. It offers and integrated treatment of the world's economies, energy systems, emissions and material demands. It is based on post-Keynesian economic principles[31] and is built on a set of macro-econometric behavioural equations (estimated over time series covering 1970-2015) It is coupled to the FTT, an evolutionary model of technology diffusion, with sufficiently realistic features of consumers that enable the user to simulate the impact of detailed climate policies. FTT models focus on the power and transport sectors, with additional models covering land, industry and households under development. Policies in the combined framework are assessed on the basis of their ability to effectively achieve certain objectives through the simultaneous use of several policy instruments that interact with one another. This approach is consistent with the one recommended by the European Commission in its Better Regulation guidelines (European Commission, 2015). E3ME would provide information on the energy and climate parts of the nexus, as well as macroeconomic results.

Recent applications of E3ME include: inputs to the assessment of the EU's Clean Energy Package, the joint IEA/IRENA G20 report on expanding renewable energy[32] and an assessment of the economic and labour market effects of the EU's Energy Roadmap 2050[33].

The models outlined in this section were going to be used to simulate various policy scenarios (as defined by stakeholders and the project team) and produce results for the Nexus components to evaluate and quantify the effects on resource allocation of new policies, such as climate change and mitigation practices, adopting low-carbon options, new investments and interventions or the implementation of technological and social innovations.

However, as described in more detail in the next section, E3ME has a very high disaggregated data requirement so was not suitable to be used for the Azerbaijan case study.

4. Use of model soft-linking

The integration of the thematic models' knowledge would lead to reduced uncertainty

[29] http://edepot.wur.nl/310764

[30] The full model manual (Cambridge Econometrics, 2014) is available at the model website www.e3me.com

[31] Post-Keynesian models are demand driven models which are characterised by non-optimisation (full employment of resources is not a necessary result in Post-Keynesian models). Microeconomic theory in the Post-Keynesian tradition is based strongly in behavioural economics.

[32] http://www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf

[33] https://ec.europa.eu/energy/sites/ener/files/documents/2013_report_employment_effects_roadmap_2050.pdf

when modelling policy outcomes. Integrating model outcomes would highlight interlinkages, unintended consequences of policies which may have been overlooked in a single model analysis, or underline unexpected trade-offs between nexus components. The figure below illustrates the concept how integrating all resource aspects provides a 'Nexus-compliant' process.

The team evaluating the Azerbaijan case study agreed that soft-linking of the thematic models will be used to facilitate scenario analysis. Soft-linking will enable the team to run more complex and informed scenarios by using outputs from one model as inputs into the other models. The box below provides more information on model linking and what soft-linking refers to.

Azerbaijan case study

Azerbaijan is one of the national case studies and was selected as part of this project in part because the country is a member of the Council of Europe, and of the EU Eastern Partnership. Azerbaijan has signed agreements with the EU for implementing EU Directives (such as the Water Framework Directive), however it has not yet implemented them. The country was also selected because it offers a unique perspective for the Nexus context, as its economy is dependent mainly on fossil fuel extraction and exports (oil and gas), which raises issues with regards to the climate and energy nexus aspects. It is also an interesting additional to the nexus studies in terms of food, land-use and water, as a considerable part of the country -the Karabakh region- suffers of droughts and floods, including the relocation of population due to long term post-conflict consequences.

The work on the Azerbaijan case study is currently in progress. The organisations maintaining the models involved in the case study have worked on extending their models to cover the country in their modelling frameworks, or, if the country was already included in their models, then updating the information they had. While some of these models were able to cover Azerbaijan in their modelling framework to some extent, the limited availability of detailed economic and energy data meant that not all modelling groups were able to integrate the country in their model and an alternative solution was sought. One such example is the E3ME model, which has quite high-level data requirements both in terms of variables as well as level of disaggregation. As the level of detail of the data available wasn't enough to include Azerbaijan in E3ME as a separate region, an alternative solution was found in the form of a *single-region Input-Output model.* The model will be constructed in order to help bridge the gaps between models and their outputs and enable a more meaningful scenario analysis, and to allow for soft-linking with the E3ME model.

5. Data availability and constraints in Azerbaijan

This section discusses the E3ME data requirements compared to what was available from official sources. Most of E3ME's data is time series, with each individual region described by the following dimensions:

- indicator (various economic and energy/environment indicators);
- sector (69 sectors for EU countries and 43 for non-EU regions, different classification for consumer expenditure and for energy data);
- time period (annually from 1970, although data starting from 1995 may be enough in some cases).

In addition, indicators that are expressed in monetary units have constant and current price versions. The main economic indicators with full sectoral disaggregation are:

- output (constant and current price bases);
- GVA at market prices and factor cost (constant and current price bases) investment;
- R&D spending;
- household expenditure (by product, constant and current price bases);
- government final consumption (by category, constant and current price bases);
- exports (by sector, constant and current price bases);
- imports (by sector, constant and current price bases);

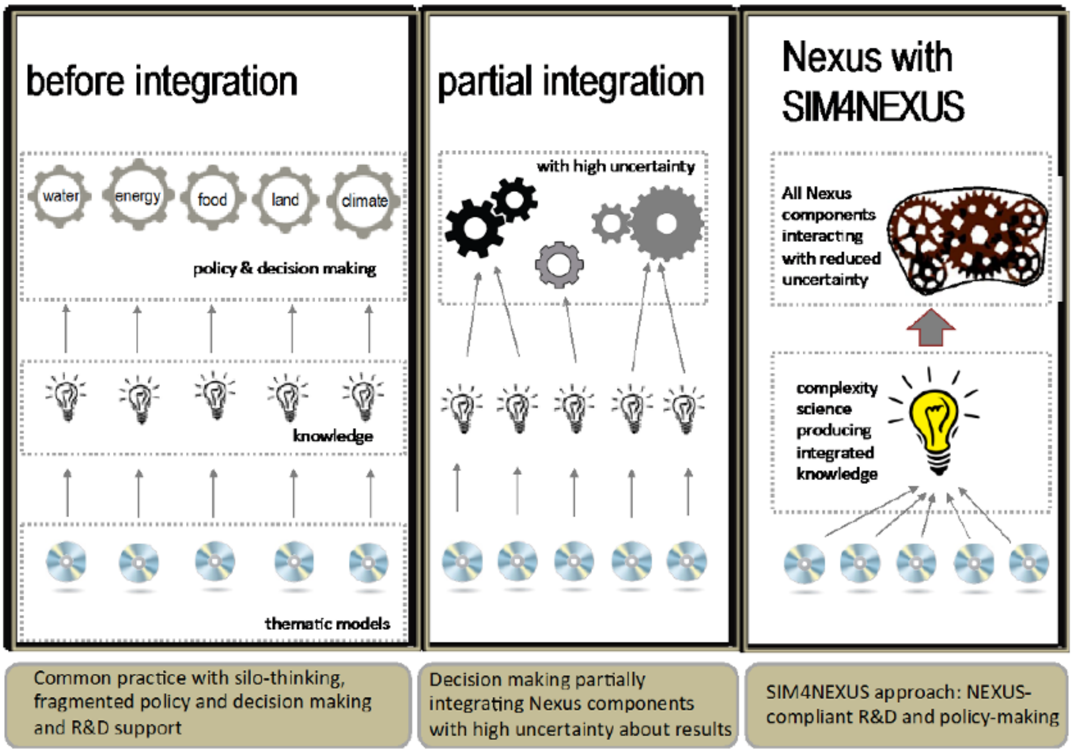

Figure 1: Model integration, the Serious Game and the SIM4NEXUS concept.

Box 1. Model linking

Linking models can facilitate better scenario analysis by allowing modellers to make use of more in-depth detail or see interactions over a broader range of variables. The key to linking models is to identify the overlaps in the model system (macroeconomic and engineering systems have different approaches, but some areas overlap such as economic growth assumptions/ results) and whether these overlaps are inputs and/or outputs for the different models. These factors may determine the direction of the linkages (e.g. if one model takes as an input a variable that is an output from another model, then this would determine which way the feedback between the models is set up.

Models can be hard-linked or soft-linked depending on the way information is transferred between the models.

Soft-linking implies information transfer is controlled by the user. The user evaluates model results and decides if and how the inputs to each model should be used/modified. In other words, the user decides if and when feedback between models takes place. The information transfer is 'manual'.

Hard-linking, on the other hand, implies formal links where information is transferred without any user judgment. In the case of hard-linking, information transfer is usually handled by computer programs. In areas where the models overlap an algorithm may be used to negotiate results. Usually one model is given control over certain results, and the other model is set up to reproduce those.

- employment;
- labour costs (current prices);
- average working hours.

There are also time series for population and labour force, disaggregated by five-year age band and gender.

In addition, there are a number of macro-level time series that are used in the modelling.

These include GDP, household incomes, exchange rates, tax and interest rates and the unemployment rate. They are also collected on an annual basis, starting from 1970, but 1995 start might also be acceptable.

E3ME cross-sectional data includes Input-Output tables, and bilateral trade data that show trade flows by origin and destination country for 44 sectors. Energy and emissions data requirements include:

- energy demand data by 23 fuel uses and 12 energy carriers (please refer to Annex for actual classifications);
- CO_2 emissions data for each of the 23 fuel user categories, as well as more detailed GHG data;
- energy price data (with and without taxes) for 18 types of fuel categories;
- electricity generating capacity by 24 technologies.

In Azerbaijan's case, the energy demand data can be easily taken from IEA energy balance statistics, the same data source as for the other E3ME regions. However, limited information could be found on energy prices and taxes and on electricity generating capacity. Indeed, information on electricity generation is limited, but some data are available showing that the electricity capacity in the country is split between hydro power and thermal power plants. Information on the country's CO_2 emissions can be found in the Emissions Database for Global Atmospheric Research (EDGAR) maintained by the European Commission Joint Research Centre[34].

Annex 2 provides detailed information about the economic data and time series data available, it can be seen that the level of sectoral disaggregation varies. The most detailed disaggregation was found for output, with 29 sectors compared to E3ME's 70 sectors – less detailed data was found for employment and investment.

Less detailed level of disaggregation is available for consumer expenditure as, more importantly for trade of goods and services. It has also proved difficult to find data in constant price base.

In summary, the data requirements are quite extensive for E3ME modelling. Luckily, a very detailed Input-Output (IO) table for 2011 was available from the Azerbaijan National Statistics Office, covering 81 sectors and products. This find was very helpful for the team working with the E3ME model, as it provided a solution for the lack of detailed data availability. The team decided that a better approach would be to design a single-region model for the country, specifically tailored for the scenarios that would be explored as part of the SIM4NEXUS case study and that could be soft-linked to the other models used if necessary. This solution is discussed in more detail in the following sections of this paper.

6. Azerbaijan – the single country model

This section summarises the basic construction of the single-region IO model for Azerbaijan. A basic input-output model depicts inter-industry relationships within an economy, showing how output from one industrial sector may become an input to another industrial sector. In the inter-industry matrix, column entries typically represent inputs to an industrial sector, while row entries represent outputs from a given sector. This format therefore shows how dependent each sector is on every other sector, both as a customer of outputs from other sectors and as a supplier of inputs. Each column of the input–output matrix shows the monetary value of inputs to each sector and each row represents the value of each sector's outputs. For example, we have an economy with n sectors. Each sector produces x_i units of a single homogeneous good. Assume that j^{th} sector, in order to produce 1 unit, must use a_{ij} units from sector i. Also, assume that each sector sells some of its output to other sectors (intermediate output) and some of its output to consumers and the government (final demand). Let's call final demand in the i^{th} sector d_i, and we have the following identity:

$$x_i = a_{i1}x_i + a_{i2}x_i + \cdots \ldots \ldots \ldots \ldots . . + a_{in}x_n + d_i$$

In other words, total output equals intermediate output plus final demand.

[34] http://edgar.jrc.ec.europa.eu/

If we name A as the matrix of coefficients a_{ij}, x the vector of total output and d the vector of final demand, then our expression for the economy becomes

$$x=Ax+d$$

which can be rewritten as $(I - A)\,x = d$

The matrix I – A is invertible, this means the above linear system of equations has a unique solution, and so given some final demand vector the required output can be found. Furthermore, if the principal minors of the matrix I – A are all positive (known as the Hawkins–Simon condition), the required output vector x is non-negative.

The main advantages of input-output techniques are:

- very good at showing the supply chain linkages;
- captures full system effects including the induced effect if the household sector is made endogenous;
- transparent;
- can produce results sector by sector;
- allows scenarios to be modelled.

The main disadvantages are:

- availability of reliable primary data for the transaction table;
- does not capture differences in production techniques and thus productivity;
- differing propensities to import (can be partially overcome);
- changes in the inter-industry linkages;
- assumption of constant returns to scale;
- assumption that there are no supply constraints.

By using the above methodology, the E3ME team circumvents the data availability issues and can make use of a tool that allows to explore supply-chain linkages and changes to final demand components.

In the current work on the Azerbaijan case study, the basis of the single country model is a 2011 input-output table covering 81 sector/ products. The Input-Output table, is currently in development, but in its initial stage it is a static Input-Output model that can then be expanded and modified to be better suited for the scenario analysis, as well as to allow some level of soft linking with the other models within the SIM4NEXUS project.

As the scenario design has not fully been agreed upon yet, the model is currently set up such that it derives results for industry gross output (and hence value added and employment) for a change in final demand (e.g. exports). It is expected that this will be expanded once the scenario design is finalised.

In the case of Azerbaijan, the IO table available is a ‘combined table’, representing spending on all products (rather than just on domestically-produced products). As such, we needed to deduct imports from the table. To do this we took the column of import supply from the table and allocated it pro rata to spending in the combined table. Hence, the accounting should look like as in Figure 1.

We also wanted to have induced household consumption to be included in the single region model, so we constructed an extended matrix of coefficients, referred to as A* from here onwards (see Figure and equation below). The accounting of the figure can then be written as:

$$\binom{y}{GDI} - A^{*}\binom{y}{GDI} = f^{*}$$

where

GDI is the macro variable gross household disposable income[35]

f* is a column of final demand spent on domestic products, excluding household consumption, with a final entry that represents the difference between GDI and aggregate household consumption (‘saving’).

Hence, we arrive at the model:

$$\binom{y}{GDI} - A^{*}\binom{y}{GDI} = f^{*}$$

This should match the base year data from which each item is calculated in the equation.

[35] An alternative to using GDI is simply to use total compensation of employees. If that is the case, the logic is that the whole of any increase in compensation of employees is spent on consumption, and so this yields a higher Keynesian multiplier than the case where you use GDI. GDI isn’t perfect either: it includes all the other influences on incomes (including, for examples, net taxes to and transfers from government, which are not modelled at all).

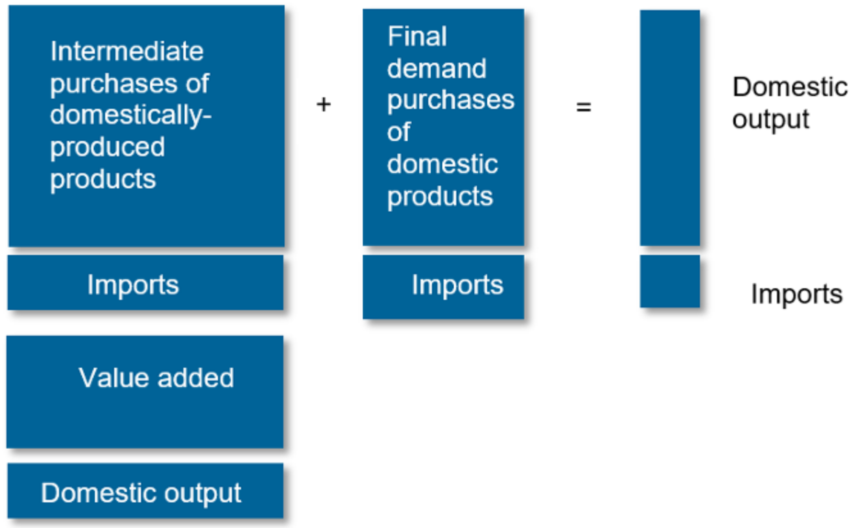

Figure 2

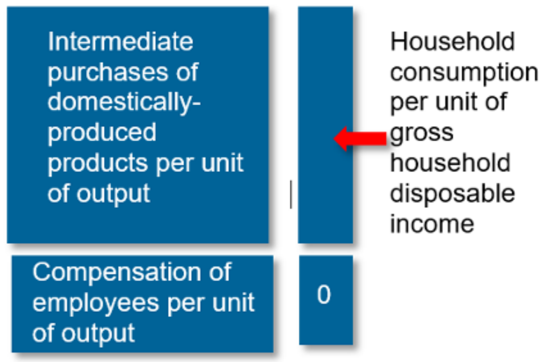

Figure 3

If the elements of f* then change -for example, lower exports of a particular product is assumed-, the equation will give the new values of y that result: both indirect and induced effects.

The model is also fairly easy to expand at this point, for example to cover the final demand components in detail, in order to better facilitate the scenario analysis.

Further model developments currently being considered are:

- basic modelling for the other final demand components (e.g. consumer expenditure and investment);
- basic modelling for employment;
- introducing the possibility of changing government balances with possible links to potential scenario analysis;
- basic modelling for final energy demand and power generation.

In the case of modelling the other components of final demand currently some basic relationships are being explored. For example, in the case of consumer expenditure, this has been related to changes in income. For investment, we are currently considering the changes to this final demand component in relation to output. In this case the most basic approach would be to assume constant shares between investment and output, such that the change in output would lead to a proportional change in investment. Another, more sophisticated, option being explored is to make use of the estimated parameters from the E3ME investment equation from another exiting region, which can be used as a proxy. In this approach the relationship between investment and output would be based on the estimated equation coefficient from the selected proxy region. Indeed, a similar approach is also considered for employment.

Introducing changes to government balances would be done based on the policy scenarios explored. For example, when looking at a scenario with decrease in oil and gas exports, then the adjustment on government balances would be introduced to reflect the loss of government revenues due to such a decrease. In this case, results from E3ME (changes in oil and gas prices and decrease in export volumes) and additional information (tax levels for example) would be used to estimate the loss in revenues. This information would then be fed into the single region model.

We are also currently exploring the possibility of introducing final energy demand changes and feedbacks into the single region model, perhaps using estimated parameters from an E3ME proxy region.

7. Policy scenarios to be modelled for Azerbaijan

The remainder of this chapter focuses on the potential scenarios that could be modelled in the Azerbaijan case study. For example, results from a scenario run in E3ME can be used to inform demand changes (e.g. changes in trade) in the single region model for Azerbaijan.

Given Azerbaijan's economic dependence on oil and gas exports, an interesting set of scenarios to explore would be looking at the economic impact of a decrease in demand in these exports, particularly as a result of EU policy actions. A set of scenarios could estimate the decrease in EU oil and gas imports, for example, (1) in the case of increased support for alternative fuel vehicles, (2) the achievement of NDC targets, or (3) the more ambitious policies trying to achieve the 2°C target.

A further set of scenarios could be designed to look at mitigating the impacts of such a decrease in demand for oil and gas exports from Azerbaijan, looking, perhaps, at ways to encourage economic diversification, by boosting investment support into strategic sectors.

When exploring scenarios relating to water supply, potential topics to be explored could include looking at alternatives to conventional water supply, options for improved irrigation and/or crop adaptation. From a nexus perspective, it would be interesting to explore the impact of increased economic diversification, including perhaps a shift to renewables, and the impact this may have on land use and water resource use.

In more practical terms, the SIM4NEXUS team working on the Azerbaijan case study is planning to soft-link model inputs and outputs in order to generate more detail, and insightful scenario results. For example, in the case of a scenario exploring a decrease in oil and gas exports in Azerbaijan because of the EU's shift in policy, it would be possible to make use of E3ME model results. E3ME could be used to simulate EU policies leading to a decrease in EU imports of oil and gas and which then can be used to estimate, based on available data, the decrease in Azerbaijan energy exports. In turn these estimates can be run through the single-region model to estimate the economic impacts of such a policy, then the results from this model could be fed into MAGNET, in order to see the changes to water supply and possibly land use and potential food security issue (e.g. the impact of less water used in oil extraction and potential redirection to agriculture). It is then also possible to use the Osemosys model, to get an indication of changes to the energy system in the country.

At the end of October 2017, the Azerbaijan case study team is planning to meet in order to discuss in more detail the potential policy scenarios that can be explored, how the model soft-linking may take place and identify any other potential issues.

8. Conclusions

This paper has discussed how advanced macroeconomic simulation modelling tools can be represented in reduced form, so that they can be used to assess energy policy and the linkages between energy and water demand in countries where data availability is low.

Summary of results

The level of data availability, both in terms of the level of disaggregation and the number of indicators covered, may influence the modelling techniques that can be used as well as the scenarios that can be modelled. Given a set of available data the choice of policy scenario that we wish to explore also influences the modelling technique. Limited data availability in the Azerbaijan case study means that the number of policy scenarios that can be explored becomes smaller. It also means that some links and feedbacks that exist in the established model framework may be overlooked. For example, if enough data were available to integrate Azerbaijan in the E3ME framework this would have allowed for two-way feedbacks between the region and the rest of the world, however this is not possible in the proposed framework with a single-region model.

Further work

From a policy perspective, it would be interesting to explore how sensitive the country's economy is to changes in demand for oil and gas from the rest of the world. It would also prove interesting to explore ways in which this can be mitigated.

Policy relevance

Findings from the Azerbaijan case study and the conclusion to build a single country input-output model to substitute the use of more detailed and complex economic models may be particularly interesting for the policy makers in emerging economies as this makes it possible to overcome data constraints and allows the analysis of more complex policy scenarios.

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Annexes

E3ME energy classifications

E3ME energy carriers	E3ME fuel users	E3ME power generation technologies
1 Hard coal	1 Power own use & transformation	1 Nuclear
2 Other coal etc	2 O energy own use & transformation	2 Oil
3 Crude oil etc	3 Hydrogen production	3 Coal
4 Heavy fuel oil	4 Iron and steel	4 Coal + CCS
5 Middle distillates	5 Non-ferrous metals	5 IGCC
6 Other gas	6 Chemicals	6 IGCC + CCS
7 Natural gas	7 Non-metallic minerals	7 CCGT
8 Electricity	8 Ore-extraction (non-energy)	8 CCGT + CCS
9 Heat	9 Food, drink and tobacco	9 Solid Biomass
10 Combustible waste	10 Textiles, clothing & footwear	10 S Biomass CCS
11 Biofuels	11 Paper and pulp	11 BIGCC
12 Hydrogen	12 Engineering etc	12 BIGCC + CCS
	13 Other industry	13 Biogas
	14 Construction	14 Biogas + CCS
	15 Rail transport	15 Tidal
	16 Road transport	16 Large Hydro
	17 Air transport	17 Onshore
	18 Other transport services	18 Offshore
	19 Households	19 Solar PV
	20 Agriculture, forestry, etc	20 CSP
	21 Fishing	21 Geothermal
	22 Other final use	22 Wave
	23 Non-energy use	23 Fuel Cells
		24 CHP

Level of disaggregation of output data compared to E3ME EU regions

No.	Sectoral data available for Azerbaijan (output data)	E3ME sectoral disaggregation requirement
1	Mining industry: Extraction of crude petroleum and natural gas	A01 - Crop and animal production, hunting and related service activities
2	Mining industry: Non-Extraction	A02 - Forestry and logging
3	Manufacturing industry: manufacture of food products	A03 - Fishing and aquaculture
4	Manufacturing industry: manufacture beverage products	B - Coal
5	Manufacturing industry: manufacture of tobacco products	B - Oil and Gas
6	Manufacturing industry: textile industry	B - Other mining
7	Manufacturing industry: manufacture of wearing apparel	C10-C12 - Manufacture of food products; beverages and tobacco products
8	Manufacturing industry: manufacture of leather, leather products and footwear	C13-C15 - Manufacture of textiles, wearing apparel, leather and related products
9	Manufacturing industry: manufacture of wood and woodwork	C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
10	Manufacturing industry: manufacture of paper and paper products	C17 - Manufacture of paper and paper products
11	Manufacturing industry: printing production	C18 - Printing and reproduction of recorded media
12	Manufacturing industry: manufacture of refined petroleum products	C19 - Manufacture of coke and refined petroleum products
13	Manufacturing industry: chemical industry	C20 - Manufacture of chemicals and chemical products
14	Manufacturing industry: manufacture of basic pharmaceutical products	C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
15	Manufacturing industry: manufacture of rubber and plastics products	C22 - Manufacture of rubber and plastic products
16	Manufacturing industry: manufacture of construction materials	C23 - Manufacture of other non-metallic mineral products
17	Manufacturing industry: metallurgy industry	C24 - Manufacture of basic metals
18	Manufacturing industry: manufacture of fabricated metal products	C25 - Manufacture of fabricated metal products, except machinery and equipment
19	Manufacturing industry: manufacture of computer and other electronic equipment	C26 - Manufacture of computer, electronic and optical products
20	Manufacturing industry: manufacture of electrical equipment	C27 - Manufacture of electrical equipment
21	Manufacturing industry: manufacture of machinery and equipment	C28 - Manufacture of machinery and equipment n.e.c.
22	Manufacturing industry: manufacture of motor vehicles and trailers	C29 - Manufacture of motor vehicles, trailers and semi-trailers
23	Manufacturing industry: manufacture of other transport equipment	C30 - Manufacture of other transport equipment
24	Manufacturing industry: manufacture of furniture	C31_C32 - Manufacture of furniture; other manufacturing

25	Manufacturing industry: manufacture of jewelleries, musical instruments, sport goods and medical equipment	C33 - Repair and installation of machinery and equipment
26	Manufacturing industry: repair and installation of machinery and equipment	D - Electricity
27	Electricity, gas and stem production, distribution of supply	D - Gas, steam and air conditioning supply
28	Water supply; wastes treatment and disposal	E36 - Water collection, treatment and supply
29		E37-E39 - Sewerage, waste management, remediation activities
30		F - Construction
31		G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles
32		G46 - Wholesale trade, except of motor vehicles and motorcycles
33		G47 - Retail trade, except of motor vehicles and motorcycles
34		H49 - Land transport and transport via pipelines
35		H50 - Water transport
36		H51 - Air transport
37		H52 - Warehousing and support activities for transportation
38		H53 - Postal and courier activities
39		I - Accommodation and food service activities
40		J58 - Publishing activities
41		J59_J60 - Motion picture, video, television programme production; programming and broadcasting activities
42		J61 - Telecommunications
43		J62_J63 - Computer programming, consultancy, and information service activities
44		K64 - Financial service activities, except insurance and pension funding
45		K65 - Insurance, reinsurance and pension funding, except compulsory social security
46		K66 - Activities auxiliary to financial services and insurance activities
47		L - Real estate activities
48		L68A - Imputed rents of owner-occupied dwellings
49		M69_M70 - Legal and accounting activities; activities of head offices; management consultancy activities
50		M71 - Architectural and engineering activities; technical testing and analysis
51		M72 - Scientific research and development
52		M73 - Advertising and market research
53		M74_M75 - Other professional, scientific and technical activities; veterinary activities
54		N77 - Rental and leasing activities
55		N78 - Employment activities

56	N79 - Travel agency, tour operator reservation service and related activities
57	N80-N82 - Security and investigation, service and landscape, office administrative and support activities
58	O - Public administration and defence; compulsory social security
59	P - Education
60	Q86 - Human health activities
61	Q87_Q88 - Residential care activities and social work activities without accommodation
62	R90-R92 - Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
63	R93 - Sports activities and amusement and recreation activities
64	S94 - Activities of membership organisations
65	S95 - Repair of computers and personal and household goods
66	S96 - Other personal service activities
67	T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
68	U - Activities of extraterritorial organisations and bodies
69	Unallocated/Dwellings
70	Hydrogen

Comparative analysis among preferable energy efficiency scenarios

by

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Abstract

Comparative analysis on barriers, technologies and policy mixtures aims to provide the commonalities and differences among the case studies, to show common advantages in confronting barriers linked to end-users behaviour and, to identify the common framework that can be implemented at any level in order to reach the EE EU target.

The HERON – DST provided numerical values that reflected the impact of the barriers on the adoption of EE technologies, and allowed the development of the scenarios for seven countries with the LEAP software. The obtained policy mixtures of the scenarios were then evaluated with the AMS method and led to the preferable policy mixtures in confronting barriers. The preferable policy mixtures of the national scenarios were all compared to each other for identifying the commonly used policy instruments, the weaknesses and the strengths that characterize them.

Outcomes showed which barriers have higher/lowest impact and under which groups/sub-groups they fall, which EE technologies need to be promoted as a matter of priority over others, while based on these outcomes policy recommendations were also drawn.

Keywords: Barriers, technologies, comparative analysis, energy efficiency scenarios, policy recommendations.

COMPARATIVE ANALYSIS ON HERON RESEARCH OUTCOMES

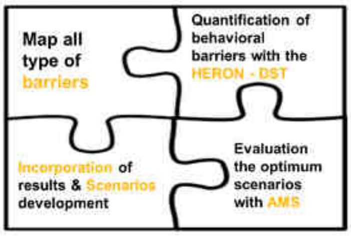
Aliki-Nefeli MAVRAKI, MSc.
NKUA - KEPA

Contents

- The HERON puzzle
- Comparative analysis with HERON – DST on
  - barriers
  - technologies
  - policy mixtures
- Conclusions

HERON

The HERON puzzle



Comparative analysis

The analysis

–Provides commonalities and differences among the cases in study.

–Shows which are the common advantages in confronting barriers linked to end-users behavior.

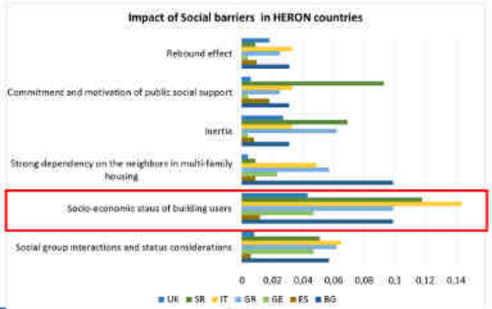
–Identifies the framework that can be implemented at any level in order to reach the EE targets.

HERON

ANALYSIS ON THE BARRIERS
WITH THE USE OF HERON-DST
BUILDINGS

HERON

Social barriers in buildings



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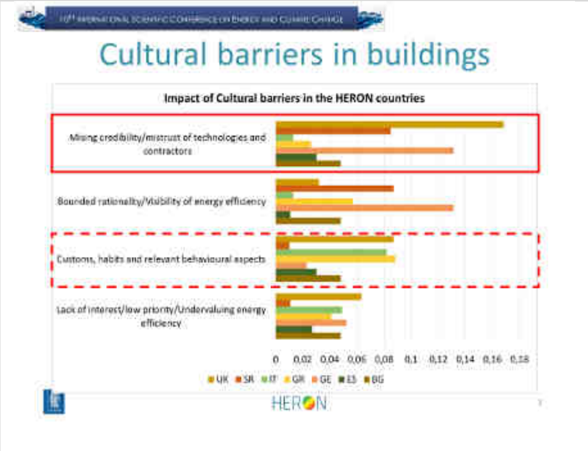
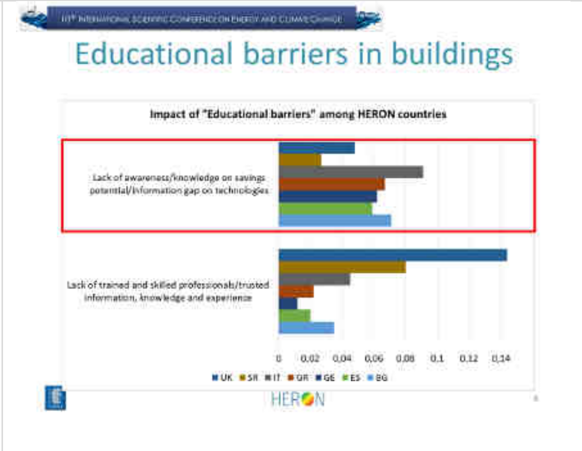
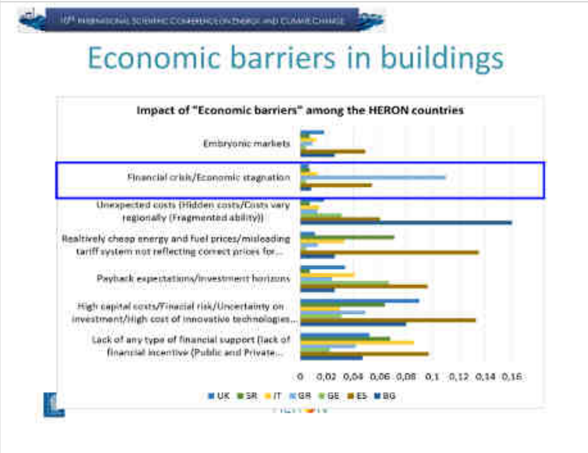
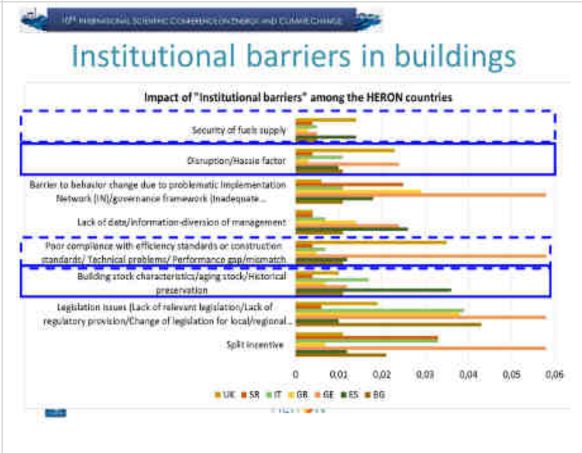
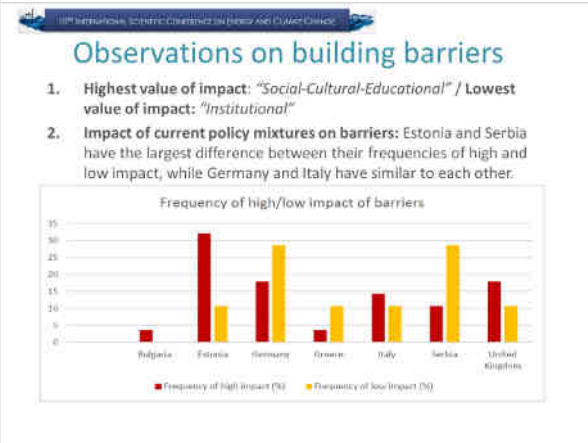

Cultural barriers in buildings
Impact of Cultural barriers in the HERON countries
Missing credibility/mistrust of technologies and contractors
Bounded rationality/Visibility of energy efficiency
Customs, habits and relevant behavioural aspects
Lack of interest/low priority/Undervaluing energy efficiency
0 0,02 0,04 0,06 0,08 0,1 0,12 0,14 0,16 0,18
UK SR IT GR GE ES BG
HERON

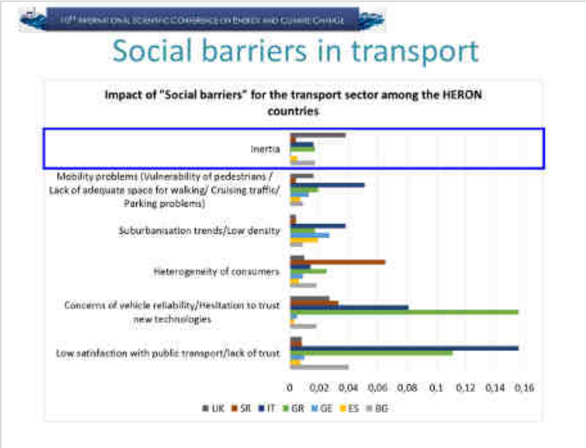

Educational barriers in buildings
Impact of "Educational barriers" among HERON countries
Lack of awareness/knowledge on savings potential/information gap on technologies
Lack of trained and skilled professionals/trusted information, knowledge and experience
0 0,02 0,04 0,06 0,08 0,1 0,12 0,14
UK SR IT GR GE ES BG
HERON

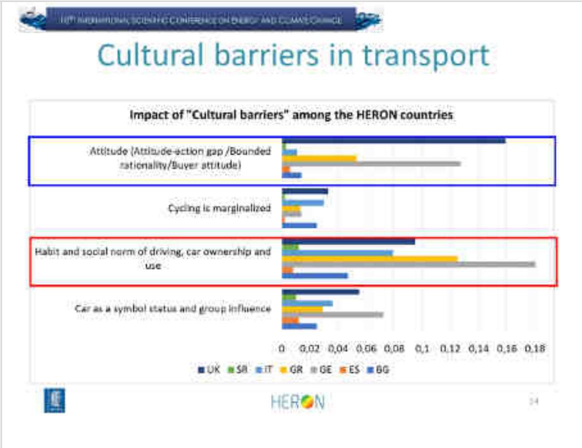

Economic barriers in buildings
Impact of "Economic barriers" among the HERON countries
Embryonic markets
Financial crisis/Economic stagnation
Unexpected costs (Hidden costs/Costs vary regionally (Fragmented ability))
Realtively cheap energy and fuel prices/misleading tariff system not reflecting correct prices for...
Payback expectations/investment horizons
High capital costs/Finacial risk/Uncertainty on investment/High cost of innovative technologies...
Lack of any type of financial support (lack of financial incentive (Public and Private...
0 0,02 0,04 0,06 0,08 0,1 0,12 0,14 0,16
UK SR IT GR GE ES BG

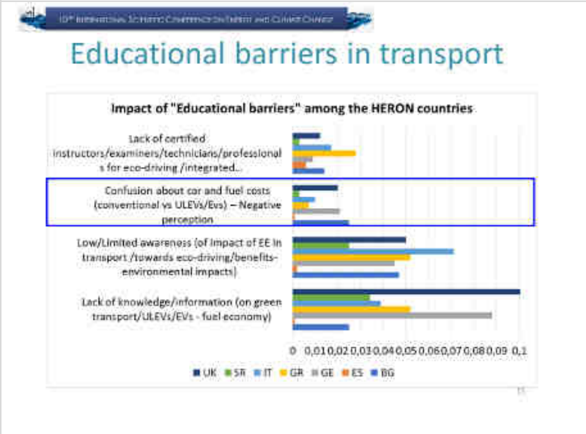

Institutional barriers in buildings
Impact of "Institutional barriers" among the HERON countries
Security of fuels supply
Disruption/Hassle factor
Barrier to behavior change due to problematic implementation Network (IN)/governance framework (inadequate...
Lack of data/information-diversion of management
Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch
Building stock characteristics/aging stock/Historical preservation
Legislation issues (Lack of relevant legislation/Lack of regulatory provision/Change of legislation for local/regional...
Split incentive
0 0,01 0,02 0,03 0,04 0,05 0,06
UK SR IT GR GE ES BG

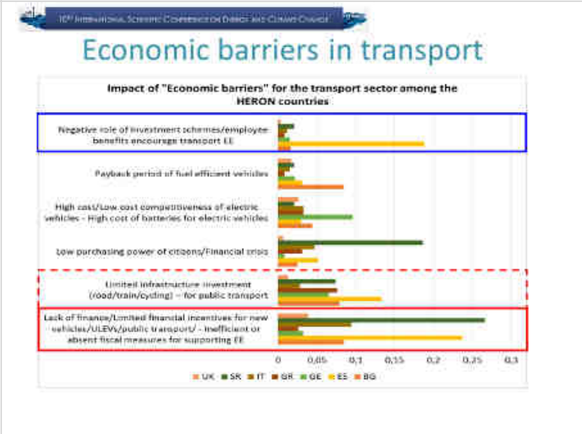

Observations on building barriers
1. Highest value of impact: "Social-Cultural-Educational" / Lowest value of impact: "Institutional"
2. Impact of current policy mixtures on barriers: Estonia and Serbia have the largest difference between their frequencies of high and low impact, while Germany and Italy have similar to each other.
Frequency of high/low impact of barriers
Bulgaria Estonia Germany Greece Italy Serbia United Kingdom
Frequency of high impact (%) Frequency of low impact (%)

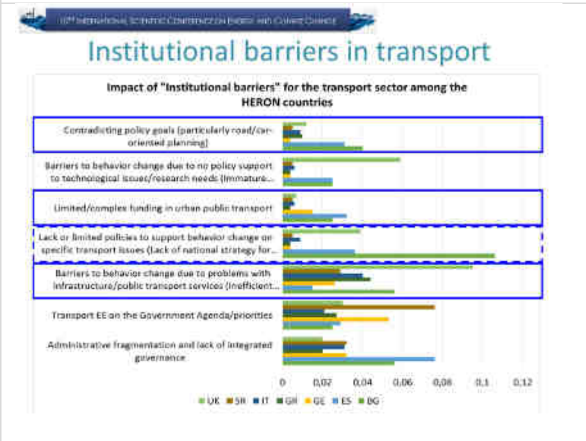

ANALYSIS ON THE BARRIERS
TRANSPORT
HERON

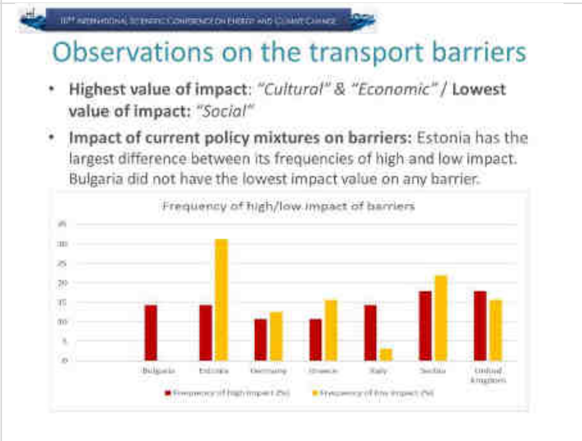

Social barriers in transport
Impact of "Social barriers" for the transport sector among the HERON countries
Inertia
Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)
Suburbanisation trends/Low density
Heterogeneity of consumers
Concerns of vehicle reliability/Hesitation to trust new technologies
Low satisfaction with public transport/lack of trust
0 0,02 0,04 0,06 0,08 0,1 0,12 0,14 0,16
UK SR IT GR GE ES BG


Cultural barriers in transport
Impact of "Cultural barriers" among the HERON countries
Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)
Cycling is marginalized
Habit and social norm of driving, car ownership and use
Car as a symbol status and group influence
0 0,02 0,04 0,06 0,08 0,1 0,12 0,14 0,16 0,18
UK SR IT GR GE ES BG
HERON


Educational barriers in transport
Impact of "Educational barriers" among the HERON countries
Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated...
Confusion about car and fuel costs (conventional vs ULEVs/Evs) – Negative perception
Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)
Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)
0 0,01 0,02 0,03 0,04 0,05 0,06 0,07 0,08 0,09 0,1
UK SR IT GR GE ES BG


Economic barriers in transport
Impact of "Economic barriers" for the transport sector among the HERON countries
Negative role of investment schemes/employee benefits encourage transport EE
Payback period of fuel efficient vehicles
High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles
Low purchasing power of citizens/Financial crisis
Limited infrastructure investment (road/train/cycling) – for public transport
Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE
0 0,05 0,1 0,15 0,2 0,25 0,3
UK SR IT GR GE ES BG


Institutional barriers in transport
Impact of "Institutional barriers" for the transport sector among the HERON countries
Contradicting policy goals (particularly road/car-oriented planning)
Barriers to behavior change due to no policy support to technological issues/research needs (immature...
Limited/complex funding in urban public transport
Lack or limited policies to support behavior change on specific transport issues (Lack of national strategy for...
Barriers to behavior change due to problems with infrastructure/public transport services (inefficient...
Transport EE on the Government Agenda/priorities
Administrative fragmentation and lack of integrated governance
0 0,02 0,04 0,06 0,08 0,1 0,12
UK SR IT GR GE ES BG


Observations on the transport barriers
Highest value of impact: "Cultural" & "Economic" / Lowest value of impact: "Social"
Impact of current policy mixtures on barriers: Estonia has the largest difference between its frequencies of high and low impact. Bulgaria did not have the lowest impact value on any barrier.
Frequency of high/low impact of barriers
Bulgaria Estonia Germany Greece Italy Serbia United Kingdom
Frequency of high impact (%) Frequency of low impact (%)

ANALYSIS ON THE TECHNOLOGIES

BUILDINGS & TRANSPORT

HERON

Combination of technologies – Most promising policy mixtures – *buildings*

	Countries						
	BG	ES	GE	GR	IT	SR	UK
Technologies	Building Shell Improvement	Building Shell Improvement	Building Shell Improvement	Building Shell Improvement	Efficient heating	Building Shell Improvement	Efficient heating
	Efficient lighting	Efficient lighting	Efficient lighting	Efficient cooling	Efficient cooling	Efficient heating (heat pumps & heating appliances)	Efficient cooling
	Efficient appliances	Efficient appliances	Efficient appliances	Efficient appliances	Heat pumps	Efficient appliances	Efficient lighting
Priority technology	**Building Shell Improvement**	**Building Shell Improvement**	**Efficient lighting**	**Building Shell Improvement**	**Heat pumps**	**Building Shell Improvement**	**Efficient heating**

HERON

Observations on buildings policy mixtures

- "Building Shell Improvement" is linked with a considerable set of barriers that includes common barriers with other EE technologies.

  The minimization of barriers for "Building Shell Improvement" affects strongly the penetration of other EE technologies.

- "Efficient appliances" are after the "Building Shell Improvement" the next most frequently encountered technology in these combinations.

HERON

Combination of technologies – Most promising policy mixtures – *transport*

	Countries						
	BG	ES	GE	GR	IT	SR	UK
Technologies	Electric & hybrid vehicles	Electric & hybrid vehicles	Electric & hybrid vehicles	Electric & hybrid vehicles	Electric & hybrid vehicles	Use of biofuels	Electric & hybrid vehicles
	Eco – driving	Eco – driving	Modal shift	Modal shift	Modal shift	Eco – driving	Use of biofuels
	More efficient vehicles	More efficient vehicles	More efficient vehicles	More efficient vehicles	Heat pumps	More efficient vehicles	More efficient vehicles
Priority technology	**Electric & hybrid vehicles**	**Electric & hybrid vehicles**	**Modal shift**	**Electric & hybrid vehicles**	**Use of biofuels**	**Use of biofuels**	**Electric & hybrid vehicles**

HERON

Observations on transport policy mixtures

- "Electric & hybrid vehicles", "More efficient vehicles" and "Use of biofuels" are most frequently encountered technologies/ actions in these combinations.
- "Electric & hybrid vehicles" are linked with a considerable set of barriers that includes common barriers with other EE technologies.

HERON

ANALYSIS ON POLICY MIXTURES

BUILDINGS & TRANSPORT

HERON

in buildings

Criteria	Performance of policy mixture						
	BG	ES	GE	GR	IT	SR	UK
Direct contribution to GHG emission reductions (0,833)		↑				↑	
Indirect environmental effects (0,167)		↑				↑	
Environmental performance (0,168) - A		↑				↑	
Cost efficiency (0,474)			↑	↑	↑		↑
Dynamic cost efficiency (0,183)	↑	o		o			o
Competitiveness (0,085)		o	↑	o	o	o	o
Equity (0,175)		↑					
Flexibility (0,051)	↑			o	o	o	o
Stringency for non-compliance (0,032)	o	o	o	o	o	o	o
Political acceptability (0,738) - B			↑		↑		
Implementation network capacity (0,309)	o		o		o	o	o
Administrative feasibility (0,581)	↑	o	o	↑	o	o	o
Financial feasibility (0,110)	↑		↑	o	↑	o	↑
Feasibility of implementation (0,094) - C	↑		↑	o	↑	o	↑

Observations on buildings policy mixtures

- The assumed policy mixtures for the preferable scenarios have the following advantages:
  - They support the competitiveness of the country
  - They offer flexibility to the end-users
  - Their technological options for promoting EE are cost-efficient

in transport

Criteria	Scenarios						
	BG	ES	GE	GR	IT	SR	UK
Direct contribution to GHG emission reductions (0,833)		↑	↑	↑		↑	↑
Indirect environmental effects (0,167)			↑	↑		↑	↑
Environmental performance (0,168) - A		↑	↑	↑		↑	↑
Cost efficiency (0,474)	↑	o		o	↑		o
Dynamic cost efficiency (0,183)	↑	o	↑	o	↑	↑	o
Competitiveness (0,085)		o		o	o	↑	o
Equity (0,175)	o	↑	↑	↑		↑	o
Flexibility (0,051)	↑	o	o		o	o	o
Stringency for non-compliance (0,032)		o		o	o	o	o
Political acceptability (0,738) - B	↑	↑		↑		↑	↑
Implementation network capacity (0,309)		o			o	↑	o
Administrative feasibility (0,581)	o	o		↑	o	↑	o
Financial feasibility (0,110)		o		o	o	↑	o
Feasibility of implementation (0,094) - C		o		o	o	↑	o

HERON

Observations on transport policy mixtures

- The assumed policy mixtures for the preferable scenarios have the following advantages:
  - They are expected to deliver very good environmental outcomes due to their performance in the first criterion (less GHG emissions/ less amount of consumed energy)
  - They have high political acceptability
  - They are likely to be feasible for implementation

HERON

Conclusions

- Commonalities & differences in HERON countries:
  - Majority of barriers with **high impact** fall under the Social – Cultural – Educational category.
  - Majority of barriers with **low impact** fall under the Institutional category.
  - "Building Shell Improvement" and "Electric/ Hybrid vehicles are the EE technologies need to be promoted.
- Common advantages in EU:
  - A set of common barriers for all EU MS would allow the monitoring of progress in the implementation of EE policies.
  - A "barrier registry" would demonstrate over time how and if the implemented policies have confronted the identified barriers.
- Framework
  - EU policies should incorporate the deviations caused by the end-users behavior in their EE policy making.

HERON

THANK YOU FOR YOUR ATTENTION!

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HERON

Forward looking EE modelling incorporating behavioral barriers for buildings in Greece

by

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Abstract

Deviations from the set Energy efficiency (EE) targets are attributed to barriers linked with the end-users behaviour. This paper examines the development of EE scenarios for Greece after incorporating such barriers with the use of the HERON Decision Support Tool (HERON-DST). Two more research tools are used, LEAP and AMS. The developed EE scenarios are evaluated so as to conclude to the most appropriate scenario for the country. Conclusions discuss methodology, most promising scenario and policy recommendations.

Keywords: Barriers, evaluation, energy efficiency scenarios, policy recommendations.

1. Introduction

In November 2016, the European Commission proposed a new binding 30% Energy Efficiency (EE) target for 2030 (higher than the target of at least 27%)[36]. This new target is: i) part of a package of EE measures (such as upgrading the 2012 Energy Efficiency Directive, measures for EE of buildings, improvement of energy performance of products, informing consumers, and a smart finance for buildings proposal); ii) aiming to achieve a 23% cut in energy consumption compared to 2005 levels, helping the EU to achieve the objectives of the Paris climate agreement; iii) expected to lead to an increase in Gross Domestic Product (GDP) of around 0.4% - or €70 billion; iv) set to unlock energy savings that can boost EU economy, create jobs and lower energy bills for consumers.

Under this context, EU Member States are committed to implement ambitious EE policies and increase their efforts considerably in all sectors while new national measures must ensure major energy savings for consumers and industry (European Commission, 2017). Greece as an EU Member State has made noticeable progress, during the last years, with its energy-sector reforms (IEA, 2017). The country is expected to achieve its 2020 Greenhouse Gas (GHG) emission reduction and EE targets due to a combination of policy measures for renewable energy and EE and the substantially lower energy demand due to the economic crisis (IEA, 2017). On the other hand, current

[36] https://ec.europa.eu/energy/en/news/commission-proposes-30-energy-efficiency-target

policies are not adequate for the long-term energy transition of the Greek energy sector (IEA, 2017). Simultaneously, different types of barriers, particularly those linked with end-users behaviour, affect negatively the achievement of these targets (McCollum L. David et al., 2016; European Commission, 2015a; 2015b; 2015d; European Environmental Agency, 2013). As a consequence, EE policies and measures do not deliver the expected benefits (ie energy savings, GHG emission reductions), employment, poverty alleviation etc) (UNEP, 2014; IEA, 2014).

This paper examines the development of EE scenarios for Greece after incorporating behavioral barriers with the use of the HERON Decision Support Tool (HERON-DST), Long-range Energy Alternatives Planning System (LEAP) and AMS. The policy mixtures of these developed EE scenarios are evaluated for concluding to the most promising scenario for the Hellenic case. Conclusions discuss the methodology, most promising scenario and policy recommendations.

2. Hellenic building sector

2.1. General information

The national building sector has two main subsectors: residential and tertiary (Table 1). Households represent a share of 84% of the total building stock (72% of total surface) (MEECC, 2014). From the remaining 16%, the 3,62% corresponds to offices, stores, educational buildings, hospitals and hotels. All these are part of the tertiary sub-sector (MEECC, 2014).

2.1.1. Domestic sub-sector (Households)

This sub-sector accounted for the 24% of the total final energy consumption of the country for year 2013 (YPEKA, 2015). It uses electricity (40% of the total final energy consumption of the sector), oil products (26%), natural gas (6%) and RES (26.5%, with biomass at 21% of the total final energy consumption of the sector) (YPEKA, 2015). The Renewable Energy Sources (RES) share concerns mainly biomass (wood used in fire places or ovens), solar energy for production of domestic hot water (YPEKA, 2015).

2.1.2. Tertiary sub-sector

In 2007 the number of *public buildings* was estimated at around 200.000, representing a share of 5% of this sub-sector (Greenpeace, 2007). These buildings demonstrate a wide diversity of their characteristics since they were built at different time periods and for fulfilling different needs from those finally being used. A large portion of them (60% in 2007) are rented and differ among them in used equipment, heat convenience etc (Greenpeace, 2007).

Only a share of 0.26% of the total number of buildings represents *hotels*, which are responsible for 29% of the energy consumption in the private sector (Maleviti E. et al., 2012; 2011). This relatively high percentage is due to space heating/cooling equipment, hot water needs, facilities and services offered and to the number of tourist arrivals during operation (Maleviti E. et al., 2012; 2011).

2.1.3. Energy consumption

The energy use of this national sector - for the year 2011 - was approximately 40% of the total energy demand (MEECC, 2014). Energy was used primarily for space heating and cooling, and domestic hot water production, while other energy uses were electricity for appliances/equipment and for operation of building services systems (MEECC, 2014).

Table 2: Number of buildings and their usage in years 2001 and 2011 (Source: MEECC, 2014).

Usage of building	Number of buildings	
	Year 2001 (ELSTAT)	2011 (TABULA)
Domestic sub-sector (Households)	2.755.570	2.468.124 (4.122.088)
Hotels	5.595	8.309
Schools – Buildings for education	16.804	15.576
Hospitals-Clinics	1.961	1.742
Others	625.630	625.630
TOTAL	**3.516.657**	**3.271.931 (4.925.895)**

Changes of the energy consumption are attributed to: *the improved living standards of the Greek society* and *the increased number of dwellings*. There were improved levels of heating/cooling and increased ownership of home electric appliances (MEECC, 2014). There was also increased electricity demand for ventilation, lighting and other office equipment due to substantial increase in the floor area of commercial premises (MEECC, 2014). Figures 1 and 2 show the average primary energy consumption per sub-sector and end-use.

The contribution of electricity to total energy consumption in this sector increased from 29% in 1990 (1,4 Mtoe) to 40% in 2011 (3,2 Mtoe), while consumption of oil products accounted for 39% of energy consumption from 54% in 1990 (2,7 Mtoe) (MEECC, 2014). Compared to previous years there was significant increase in using natural gas in the sector during year 2011 (21,5 PJ) (MEECC, 2014). The RES share of the sector in the total energy consumption was reduced from 15% in 1990 (0,7 Mtoe) to 10% in 2011 (0,8 Mtoe) (MEECC, 2014).

A new trend for biomass was recorded. Biomass was the primary energy source until 1985 in the countryside for heat requirements of households and holiday homes (MEECC, 2014). Since then, gradually large urban areas, apart from the countryside, started using biomass as a secondary energy source. This shift was attributed to: i) increasing population of the large cities in Greece and ii) renewed demand for installation of fireplaces in private residences and apartment buildings (MEECC, 2014).

2.1.4. Energy savings potential

The activities of the *residential* sector with the highest energy saving potential are (1st NEEAP, 2008):

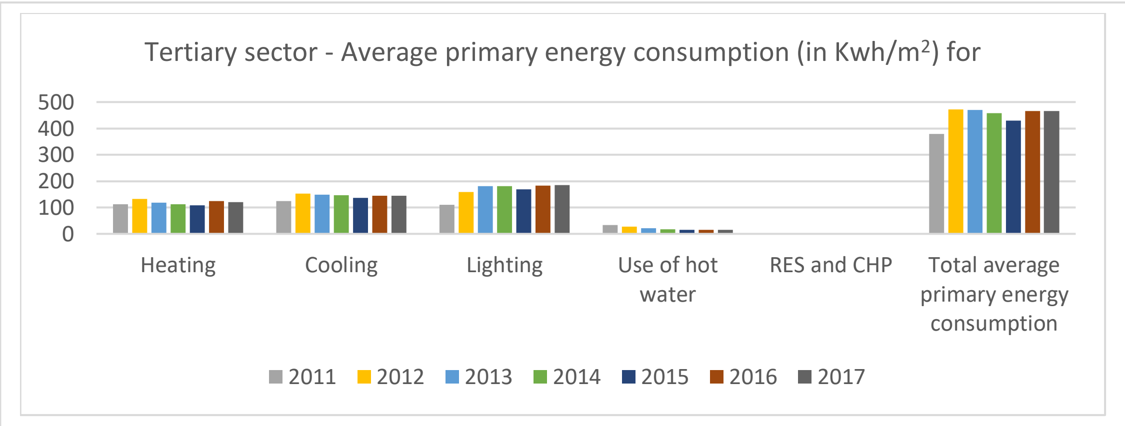

Figure 2: Average primary energy consumption for the tertiary sector (Source: http://bpes.ypeka.gr/wp-content/uploads/000_000_02_005b_PEA_Consumptions.pdf)

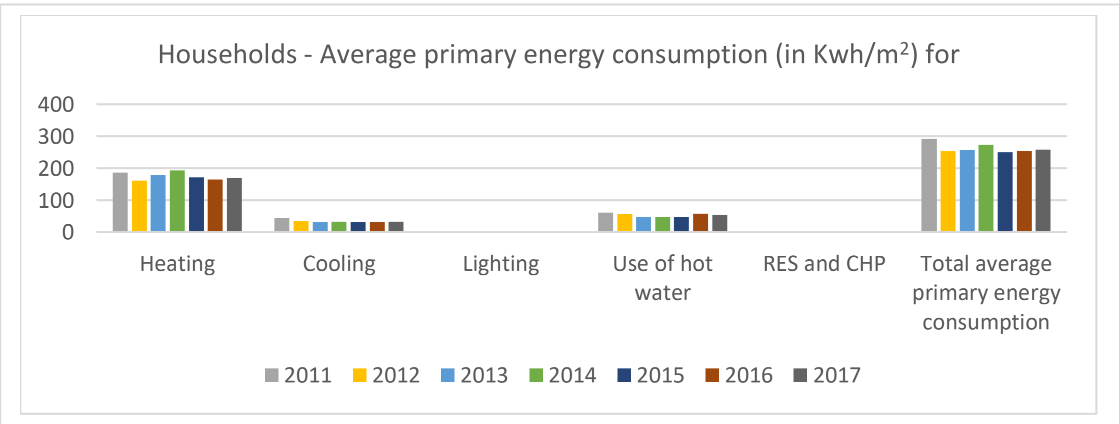

Figure 3: Average primary energy consumption for the sector of households (Source: http://bpes.ypeka.gr/wp-content/uploads/000_000_01_005b_PEA_Consumptions.pdf)

i) space heating that covers 57% (reaching even 3,3TWh) of the total possible energy savings in 2016, out of which 60% is attributed mainly to building envelope improvements; ii) use of hot water by 22% (1,2TWh is mainly due to the penetration of solar collectors) and iii) lighting by 9% (0,5TWh is mostly due to replacement of conventional lamps with more energy efficient ones) (1st NEEAP, 2008). For the *tertiary* sector the space heating is expected to contribute by 70% in the total energy savings of this sector, lighting by 15% and space cooling by 13% (1st NEEAP, 2008).

2.1.5.End-use technologies

The available in the Hellenic market EE technologies for buildings include (HERON, 2015b):

- **Building design and envelope:** thermal insulation, shading systems, green roofs, energy management systems and Building Energy Management Systems (BEMS), cool materials on roofs and facades, bioclimatic interventions such as passive solar systems;
- **Heating-Cooling and Hot Water systems:** solar thermal systems, RES, heat pumps, highly efficient boilers, high-efficiency CHP;
- **Lighting:** lighting control systems with motion sensors, LEDs, light bulbs of maximum energy efficiency (A, A+, A++);
- **Appliances:** high efficient devices (such as high energy class and inverter-type air-conditions).

3. Hellenic policy framework

3.1. National objectives

The national target is to achieve 18,4Mtoe of final energy consumption in 2020 (CRES, 2015; MEECC, 2014; 3rd NEEAP, 2014; Law 3855/2010[37]). Buildings are to contribute to this amount by (MEECC, 2014): i) 5,5TWh final energy consumption for the residential sector and ii) 5,7TWh final energy consumption for the tertiary sector. These targets remained under the last Law 4342/2015[38] regarding EE measures for the country so as to comply with recommendations of Directive 2012/27/EU. All national targets are presented in Table 1. The annual renovation of 3% of the total floor area of heated and/or cooled buildings is an additional EE target for buildings.

It concerns those with total used floor area more than 250m^2 and which do not fulfil the EE requirements on the 1st January of every year as these were set under Law 4122/2013 - owned and occupied by the central government (Article 5, Law 4342/2015, Government Gazette 143, 9 November 2015) (CRES, 2015).

Table 3: National EE targets for years 2020 and 2030. Sources: European Commission, 2015c; CRES, 2015; ENSPOL, 2015; 3rd NEEAP, 2014).

2020 EE target (including all sectors)	2030 EE target (including all sectors)
24,7 Mtoe of primary energy consumption or 18,4Mtoe of final energy consumption	(*Discussed to be*) 19 Mtoe of final energy consumption
Energy savings target for the period 2014-2020*	
3.332,7 ktoe (38,8 TWh) in total, out of which the total for all new annual savings is 902,1 ktoe (10,5 TWh)	
intermediate total energy savings target for monitoring progress about total energy savings target and new savings	
for period 2014-2015 - 300,7 ktoe (3,5 TWh)	
for period 2016-2018 - 1.678,9 ktoe (19,5 TWh)	
2020 GHG target	
4% reduction of GHG emissions compared to 2005 levels[39].	

* *calculated under Article 9 of the Law 4342/2015 concerning the adoption of EE obligation schemes)*

[37] Government Gazette (in Greek) http://www.ypeka.gr/LinkClick.aspx?fileticket=AxgQsUVAUjA%3D&...

[38] https://www.buildingcert.gr/files/FEK_143A_2015.pdf

[39] http://www.ypeka.gr/LinkClick.aspx?fileticket=vBWJVY3FdTk%3D&

Greece has not set a qualitative or quantitative target regarding Nearly Zero Energy Buildings (NZEB)(European Commission, 2016). However, following the provisions of Directive 2010/31/EU on the energy performance of buildings[3] (known as Energy Performance Building Directive (EPBD)): i) All new buildings by 31 December 2020 are expected to be NZEB; ii) new buildings occupied and owned by public authorities are expected to be NZEBs [40]after 31 December 2018.

3.2. Policy instruments for achievement of national EE targets

The national EE targets for buildings are expected to be achieved through (HERON, 2015a):

- ***Regulatory policy instruments:*** Energy labelling (Article 9 of Law 4342/2015); Energy audits and energy auditors (Article 10 of Law 4342/2015); Building Energy Management Systems (Article 10 of Law 4342/2015); Metering or information on energy tariffs (Articles 11 and 12 of Law 4342/2015); Regulation for Energy Performance of Buildings Minimum requirements of energy performance for buildings; eco-design requirements; Establishment of the Special Fund for EE (Article 21 of Law 4342/2015). Its priority is to implement measures for EE concerning households that suffer from energy poverty.
- ***Economic policy instruments:*** taxation on energy products and electricity; Green Fund-subsidies; financial incentives (subsidies, financial exemptions); financial incentives for replacement of devices/systems; Financial incentives, access to funding (loans or subsidies) (Article 13 of Law 4342/2015);
- Policy instruments for the promotion of energy services (ESCO market promotion): Energy Services Companies (Article 19 of Law 4342/2015);
- ***Dissemination and awareness instruments/informative policy instruments:*** Green Public Procurements (Article 24 of Law 4342/2015); Awareness campaigns/programs for households (Article 10 of Law 4342/2015); energy performance certificate; Voluntary agreements.

4. Methodological approach

The scenarios are developed by incorporating the barriers linked with end-users behaviour; then their time development is specified through the used energy model and the performance of their policy mixtures is evaluated. Three research tools are used for this approach: i) The HERON-DST for calculating the impact of barriers, incorporating them in EE scenarios and exploring the best combinations of EE technologies/practices; ii) The modeling tool, LEAP, for understanding the time development of the developed scenarios, and iii) the evaluation multi-criteria method AMS, that allows understanding which of the developed scenarios (and the respective policy portfolio) is the most preferable one for the Hellenic case. The next paragraphs refer to these tools.

4.1. HERON Decision Support Tool (HERON - DST)

The innovative HERON - DST enables the quantitative transformation of the qualitative characteristics of the end-users behavior that hinder the implementation of EE policies in buildings and transport (HERON, 2016a). HERON - DST, developed by KEPA in cooperation with App-Art, provides policy makers with a user-friendly software facilitating them in selecting the optimum combination of technologies/practices and minimizing the negative impact of end-users behavior in the implementation of EE scenarios. It has two sets of barriers, with 27 barriers each including non-economic and non-market elements; these barriers are common for six and one candidate EU Member States (Bulgaria, Germany, Greece, Estonia, Italy, Serbia and United Kingdom).

4.2. LEAP

The Long range Energy Alternatives Planning system (LEAP) - developed by the

[40] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0483R(01)&from=EN

Stockholm Environment Institute - is a widely-used tool for energy policy and climate change mitigation assessment[41]. It can be used to: i) track energy consumption, production, resource extraction, and GHG emissions in all economic sectors (Heaps C., 2016); ii) create models of different energy systems and iii) support a wide range of modeling methodologies on the: a) energy demand side (bottom-up, end-use accounting techniques to top-down macroeconomic modeling); b) supply side (powerful accounting and simulation methodologies for modeling electric sector generation and capacity expansion planning) (Heaps C., 2016).

4.3. AMS

AMS is the combination of three standard multi-criteria methods: Analytical Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT) and Simple Multi-Attribute Ranking Technique (SMART) (Konidari and Mavrakis, 2007). The method has been used in similar study cases. It consists of four steps: i) creating the criteria-tree; ii) determining weight coefficients for criteria/sub-criteria; iii) grading the performance of policy instruments/policy mixtures under a criterion/sub-criterion; iv) collecting the previously produced grades and forming the aggregate grade for each evaluated policy instrument/mixture. The necessary consistency and robustness tests are performed within the relevant steps (Konidari and Mavrakis, 2006; 2007).

5. Developing EE scenarios

5.1. Using HERON – DST for calculation of impact factor of barriers

Barriers are mapped, merged and grouped into three main categories: i) Social-Cultural-Educational, ii) Economic and iii) Institutional. Afterwards, barriers are compared pair-wised and the importance of one barrier over the other is assessed using a 1-9 scale (Mavrakis, Konidari, 2017).

After the completion of all comparisons, the Impact factor for each one of the identified barriers is calculated. The Impact factor is a numerical outcome, expressing the contribution of the concerned barrier in preventing the achievement of EE targets. The Impact factors for the Hellenic case were calculated using the HERON – DST and the outcomes are presented in Table 3.

The total impact of the assumed barriers on a certain input is expressed by the Total Impact Factor which is also calculated. Consequently, EE technologies and practices are linked with the relevant barriers through their Total Impact factors that are provided by HERON – DST. Occurring deviations are calculated.

Options for reducing deviations through the optimum combination of EE technologies and practices and the minimization of the impact factors leads to optimized outcomes. Outcomes are available to be used as inputs to EE modelling. The methodology has six steps:

Step 1: Mapping, categorization and merging of behavioral barriers;

Step 2: Development of the AHP tree and matrices;

Step 3: Calculation of weight coefficients;

Step 4: Definition and calculation of Impact Factors of barriers;

Step 5: Linkage of Impact factors with input drivers;

Step 6: Incorporation of the Total Impact factors in the forward-looking EE modelling.

5.2. Developed EE scenarios considering end-users behaviour

Common key assumptions for the scenario development concerned population and GDP. Eurostat population projections for Greece were used, while forecasts from the EU-Ecofin[42] and the 3rd NEEAP were used for the GDP. CRES provided the available historical data for the time period 1990 - 2013 (HERON, 2016b). The forward-looking scenarios for EE in the Hellenic building sector were developed with time horizon the year 2030 (HERON, 2016b).

These scenarios (same for residential and tertiary subsectors) were:

- **Business as Usual (BAU) scenario**: It looks into current possible trends until 2030 with policy measures/instruments already implemented.

41 http://www.energycommunity.org/default.asp?action=47

42 http://ec.europa.eu/economy_finance/eu/countries/greece_en.htm

Table 4: Set of behavioural barriers for the building sector (HERON, 2015c; 2015d; 2016a; 2016b).

Type	Name of barrier	Impact factor
Social	Social group interactions and status considerations	**0.062**
Social	Socio-economic status of building users	**0.099**
Social	Strong dependency on the neighbors in multi-family housing	**0.057**
Social	Inertia	**0.062**
Social	Commitment and motivation of public social support	**0.025**
Social	Rebound effect	**0.025**
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	**0.041**
Cultural	Customs, habits and relevant behavioural aspects	**0.088**
Cultural	Bounded rationality/Visibility of energy efficiency	**0.057**
Cultural	Missing credibility/mistrust of technologies and contractors	**0.026**
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	**0.022**
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	**0.067**
Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	**0.042**
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative	**0.049**
Economic	Payback expectations/investment horizons	**0.024**
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting	**0.013**
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	**0.013**
Economic	Financial crisis/Economic stagnation	**0.110**
Economic	Embryonic markets	**0.009**
Institutional	Split Incentive	**0.007**
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change	**0.038**
Institutional	Building stock characteristics/aging stock/ Historical preservation	**0.007**
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	**0.005**
Institutional	Lack of data/information-diversion of management	**0.014**
Institutional	Barrier to behavior change due to problematic Implementation Network (IN)/governance framework (Inadequate IN/governance framework /Inadequate implementation of policy measures / poor Policy coordination across different levels/cooperation of municipalities)	**0.029**
Institutional	Disruption/Hassie factor	**0.003**
Institutional	Security of fuel supply	**0.003**

– **Energy Efficiency (EE B0) scenario**: It reflects a forward-looking path towards the achievement of the maximum possible amount of energy savings based on the national potential through a combination of EE technologies. The impact of barriers is not taken into account. It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which has an assumed specific level of penetration in LEAP for one technology/measure. The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings, according to the EU target, compared to BAU scenario, without considering the impact of barriers. Its assumed policy package *includes the BAU policy package plus additional policy instruments per supported technology (explanations are provided)* below. These additional policy instruments aim to support the EE technologies and facilitate the achievement of the EE B0 target of energy savings. The sub-scenarios and their policy mixtures are:

1. Efficient heating: It focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems

(such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary). The additional policy instruments compared to BAU include *(for Residential and tertiary sub-sectors) (HERON, 2016b): i) Financial incentives to citizens (capital subsidy - low interest loans) like the "Save Energy at Home" programme but with more favourable terms; ii) Awareness campaigns (there are in BAU, but now specifically for this technology); iii) Educational programmes (not in BAU).*

2. Building shell improvement (building fabric upgrade): It focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). It decreases the energy intensity of the space heating for all housing types of the existing building stock. The additional policy instruments include (HERON, 2016b): i) *(Households - hotels) Awareness campaigns about the potential of energy savings due to improvement of insulation in existing buildings (windows, doors); ii) (Residential) Financial incentives: Similar to the "Save Energy at home" programme a new one providing home owners with capital subsidy and low interest loans combined with an interest rate subsidy and covers the cost of energy inspections; iii) (Tertiary) Educational programmes for technical staff of municipalities (not in BAU); iv) (Tertiary) A new "SAVE" Programme for Local Authorities (not in BAU).*
3. Efficient cooling: It focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary). Additional policy instruments are assumed to be (HERON, 2016b): i) *(Residential and tertiary) Continuation of programme "Replace Air-Conditioning system" and training of retail staff with modifications; ii) Higher financial incentives (grants, subsidies, tax reductions); iii) Awareness campaigns; iv) Training courses for technicians.*
4. Efficient appliances: It focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters. *Its policy mixture includes (for both sub-sectors)* (HERON, 2016b): *economic incentives, education, and training for retail staff*[43]*;*
5. Efficient lighting: It focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary). *Additional policy instruments: Awareness campaigns, stricter green public procurement (for both sub-sectors).*
6. Application of BEMS: It focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary). Additional policy instruments are: Educational programmes for professionals in both sub-sectors.

The scenarios developed after considering the impact of barriers based on HERON -DST were (HERON, 2016a, 2016b):

- **Energy Efficiency (EE B1) scenario**: It reflects the EE B0 scenario but after incorporating the impact of all barriers through the technologies of the sub-scenarios. The existence of barriers prevents the achievement of the intended situation in EE B0. With the use of HERON - DST, the deviation from EE B0 is now quantified in this scenario and reflected in its outcomes (see next session). EE B1 has the same policy mixture with EE B0.
- **Energy Efficiency (EE B2) scenario**: It reflects the forward-looking path of improving EE B1 scenario, through the most promising combination of 3 technologies (Building Shell Improvement – Efficient cooling – Efficient Appliances). The HERON - DST provided this combination (higher number of common barriers among 3 technologies and lower impact of barriers compared to other combinations).

[43] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

Table 5: Policy mixture of scenarios EE B2, EE B3, EE B4 (HERON, 2016b).

EE B2		
EE Technologies/Actions	**Additional to EE B0/EE B1 policy instruments for confronting barriers**	**Minimized impact of barriers**
Efficient heating	No – same as in EE B0 and EE B1.	No
Building shell improvement (priority)	– policy instruments that support professionals in acquiring additional skills and knowledge on energy efficient technologies and practices. – The implementation network has institutes that can be assigned with the responsibility to educate professionals regularly (every 6 months) and certify them (every 2 years) so as to be aware and capable of handling new EE technologies/practices. – Inclusion of sanctions for those that install old and energy intensive technologies related to building shell improvement will reduce the impact of relevant barriers. – more effective awareness campaigns (TV messages or brochures, friendly-user web sites with simple information). Detailed and targeted information is attractive to end-users. – Subsidies and tax reliefs for building/apartment owners that intend to proceed with renovation investments but cannot afford it. They will receive financial amount once they prove completion of the renovation. – Free of charge study of the building or apartment from certified professionals hired from the relevant ministry of municipality.	– Lack of experienced professionals, trusted information (Educational); – Lack of awareness on savings potential, technologies, EE (Educational); – Missing credibility – mistrust in technologies / contractors (Cultural); – Split Incentive(s) (Institutional); – Problematic implementation network / governance framework (Institutional); – Legislation issues (Institutional); – Strong dependency on neighbours (multi – family housing) (Social); – Lack of any type of financial support (Economic); – High costs and risks (Economic).
Efficient cooling	No	Common barriers with “Building shell improvement”.
Efficient appliances	Awareness campaigns targeting also the use of efficient appliances in households.	Common barriers with “Building shell improvement”.
Efficient lighting	No	No
Application of BEMS	No	No
EE B3		
Efficient heating	Awareness campaigns are commonly used in national climate change policy.	Common barriers with “Building Shell Improvement”
Building shell improvement (Priority)	– policy instruments that support professionals in acquiring additional skills and knowledge on energy efficient technologies and practices. – The implementation network has institutes that can be assigned with the responsibility to educate professionals regularly (every 6 months) and certify them (every 2 years) so as to be aware and capable of handling new EE technologies and practices. – Inclusion of sanctions for those that install old and energy intensive technologies related to building shell improvement will reduce the impact of the relevant barriers. – more effective awareness campaigns (TV messages or brochures, friendly-user web sites with simple information). detailed and targeted information is attractive to end-users. – Subsidies and tax reliefs for building/apartment owners that intend to proceed with renovation investments but cannot afford it. They will receive the financial amount once they prove that the renovation is completed.	– Lack of experienced professionals, trusted information (Educational); – Lack of awareness on savings potential, technologies, EE (Educational); – Missing credibility – mistrust in technologies / contractors (Cultural) – Split Incentive(s) (Institutional) – Problematic implementation network / governance framework (Institutional) – Legislation issues (Institutional)

	– Free of charge study of the building or apartment from certified professionals that are hired from the relevant ministry of municipality.	– Strong dependency on neighbours (multi – family housing) (Social) – Lack of any type of financial support (Economic) – High costs and risks (Economic)
Efficient cooling	None. Same as in EE B0 and EE B1.	No minimized barriers for this technology/action.
Efficient appliances	Awareness campaigns are commonly used	Common barriers with "Building Shell Improvement"
Efficient lighting	None	No minimized barriers for this technology/action.
Application of BEMS	None	No minimized barriers for this technology/action.
EE B4		
Efficient heating	Financial incentives and awareness campaigns (as explained in "Efficient appliances").	Common barriers with "Efficient appliances".
Building Shell improvement	*None*	No minimized barriers for this technology/action.
Efficient cooling	As for "Efficient heating".	Common barriers with "Efficient appliances"
Efficient appliances (Priority)	— economic incentives that target low and middle income households; these may include tax reliefs or deductions from electricity bills for a certain time period; — education, and training for retail staff[44] — Eco-labelling with more information (for energy savings that can be achieved, environmental benefits, contribution in mitigating climate change); — I) Economic motives to manufacturers for promoting more energy efficient products; II) tax reliefs if products achieve energy savings above a specified limit; — Awareness campaigns – i) Information to consumers how to realize the differences among devices regarding energy consumption. ii) information how to use a device (energy efficient mode, preference to devices that "sleep").	— Customs – habits – relevant behavioural aspects (Cultural) — Lack of any type of financial support (Economic); — High costs and risks (Economic); — Lack of awareness on savings potential, technologies, EE (Educational).
Efficient lighting	None	No minimized barriers for this technology/action.
Application of BEMS	None	No minimized barriers for this technology/action.

[44] http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Greece.pdf

- The EE B1 situation was improved through the minimization of specifically selected (by the user) barriers of the "Building Shell Improvement" that was considered as the priority technology out of three due to the larger number of barriers linked with it. The minimization of the barriers –using HERON - DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to those of EE B1. Its policy mixture includes the already presented policy instruments of EE B0/EE B1 plus those needed for confronting barriers with minimized impact (Table 4).
- **Energy Efficiency (EE B3) scenario**: It follows the rationality of EE B2 and is based on the second most promising combination of three technologies (Building Shell Improvement – Efficient heating – Efficient Appliances) (provided again by HERON - DST) and minimization of specifically selected barriers linked with "Building Shell Improvement". Its policy mixture is presented in Table 4.
- **Energy Efficiency (EE B4) scenario**: It refers to the third most promising combination of technologies (Efficient cooling – Efficient heating – Efficient Appliances) (provided by HERON - DST). Its policy mixture is presented in Table 4. The situation was improved compared to EE B1, but not compared to EE B2 and EE B3 through the minimization of specifically selected barriers linked with "Efficient appliances" (see next session).

5.3. LEAP Outcomes

LEAP was used for understanding the time development of the described scenarios. The outcomes are understood after taking into account the following: As aforementioned the target for year 2020 is to achieve 18,4 Mtoe of total final energy consumption (for all sectors). The residential sector accounts for 25% and the tertiary sector for 12% of the total energy according to 2013 data (CRES, 2015). Since Greece does not have sectoral targets, the percentage of the residential sector is assumed to remain 25% and the sectoral target is 0,25x18,4=4,6 Mtoe for 2020. Similarly, the percentage of the tertiary sector is assumed to remain at 12% and the sectoral target is 0,12x18,4=2,208Mtoe for 2020. Consequently, the target for the whole building sector is 4,6+2,208=6,81 Mtoe approximately (Table 5).

In year 2020, the LEAP outcome for the final energy consumption of the whole building sector is 4,36+2,079 = 6,44Mtoe (Table 5). This shows reduction under the BAU scenario by 5,4% compared to target of year 2020. Since for year 2030 there is no official target, no column was added regarding comparison with the national target as in the case of year 2020, but only compared to BAU.

The overall GHG target for 2020 is 4% reduction of GHG emissions compared to 2005 levels. There are no sectoral GHG targets, consequently this target is assumed to apply for all sectors. The overall target of 2030 is assumed to be 16% reduction of GHG emissions compared to 2005 levels, according to the proposal for effort sharing[45]. There are no national targets for NO_x emissions. The results of NO_x emissions for each scenario will be compared to BAU respective results. The results of all scenarios for the building sector are presented below in the tables and figures.

6. Evaluation

Evaluation is performed with the multi-criteria method AMS for concluding to the most promising policy mixture/scenario for the country (HERON, 2016b). Explanations for assigned grades are quoted under each sub-criterion and presented in the relevant tables.

6.1. Criterion 1: Environmental performance

6.1.1. Sub-criterion "Direct contribution to GHG emission reductions"

The evaluation of the policy packages of the scenarios is based on LEAP outcomes (total expected GHG emissions of the country in year 2030). The scenario with the lowest amount of emissions has the best performance for this sub-criterion (Grade 100), while the scenario with the highest amount of GHG emissions is evaluated as the worse one (Grade 0) (Konidari and Mavrakis, 2006; 2007).

[45] http://ec.europa.eu/clima/policies/effort/proposal/index_en.htm

Table 6: Comparisons among scenarios for final energy consumption in building sector in Mtoe.

Scenarios	*National target for final energy consumption by 2020*	*Final energy consumption in year 2020 (LEAP outcome)*	*% Change compared to 2020 national target*	*Final energy consumption in year 2030 (LEAP outcome)*	*% Change in 2030 compared to BAU scenario*
BAU	6,81	6,44	-5,4	7,24	0
EE B0		5,48	-19,5	4,83	-33,3
EE B1		5,676	-16,65	5,462	-24,57
EE B2		5,648	-17,06	5,356	-26,0
EE B3		5,623	-17,43	5,281	-27,03
EE B4		5,651	-17,02	5,404	-25,33

Table 7: Direct GHG emissions in $MtCO_2$.

	1990[46]	2005[47]	2020	2030
EU Policy target and national target if applicable	5,34	11,43	10,97	9,60
HERON BAU scenario			5,13	5,64
% change compared to target			-53,27%	-41,27%
HERON EE B0 scenario			3,53	2,64
% change compared to target			-67,76%	-72,42%
HERON EE B1 scenario			3,68	3,09
% change compared to target			-66.46%	-67,86%
HERON EE B2 scenario			3,67	3,02
% change compared to target			-66,59%	-68,58%
HERON EE B3 scenario			3,65	2,96
% change compared to target			-66,75%	-69,13%
HERON EE B4 scenario			3,66	3,05
% change compared to target			-66,62%	-68,25%

Table 8: Comparisons among scenarios for NO_x emissions in $MtCO_{2eq}$ (HERON, 2016b).

Scenarios	*2020*	*% Change in 2020 compared to BAU*	*2030*	*% Change in 2030 compared to BAU*
BAU	0,0082	0	0,0090	0
EE B0	0,0060	-26,90	0,0047	-47,90
EE B1	0,0064	-22,072	0,0059	-34,41
EE B2	0,0062	-24,72	0,0053	-41,420
EE B3	0,0062	-24,98	0,0052	-42,23
EE B4	0,0082	0,00	0,0090	0,00

Table 9: Energy savings/cap and GHG emissions/cap for 2020 and 2030 per scenario (HERON, 2016b).

Scenarios	*Energy savings/capita in toe*		*GHG emissions per capita in tCO_{2eq}*	
	2020	**2030**	**2020**	**2030**
BAU	0,000	0,000	0,479	0,559
EE B0	0,090	0,238	0,330	0,262
EE B1	0,072	0,176	0,344	0,306
EE B2	0,074	0,186	0,342	0,299
EE B3	0,077	0,194	0,341	0,294
EE B4	0,074	0,182	0,342	0,302

6.1.2. Sub-criterion - Indirect environmental effects

Evaluation now is based on the total environmental effects provided by LEAP. For facilitating comparison with other national cases only NO_x emissions are used. The rationality is the same as in the case of the previous sub-criterion (Table 9).

[46] This value is based on LEAP calculation for 1990.
[47] This value is based on LEAP calculation for 2005.

Table 10: Evaluation under sub-criteria "Direct contribution to GHG emission reductions" and "Indirect environmental effects".

Scenarios	Direct contribution to GHG emission reductions		Indirect environmental effects	
	Direct GHG emissions in $MtCO_2$ for year 2030	Grades under MAUT scale of AMS	NO_x emissions in $MtCO_{2eq}$ *for year 2030*	Grades under MAUT scale of AMS
BAU	5,64	0	0,009	0,00
EE B0	2,64	100	0,005	100,00
EE B1	3,09	85	0,006	71,87
EE B2	3,02	87,33	0,005	86,53
EE B3	2,96	89,33	0,005	88,21
EE B4	3,05	86,33	0,009	0,00

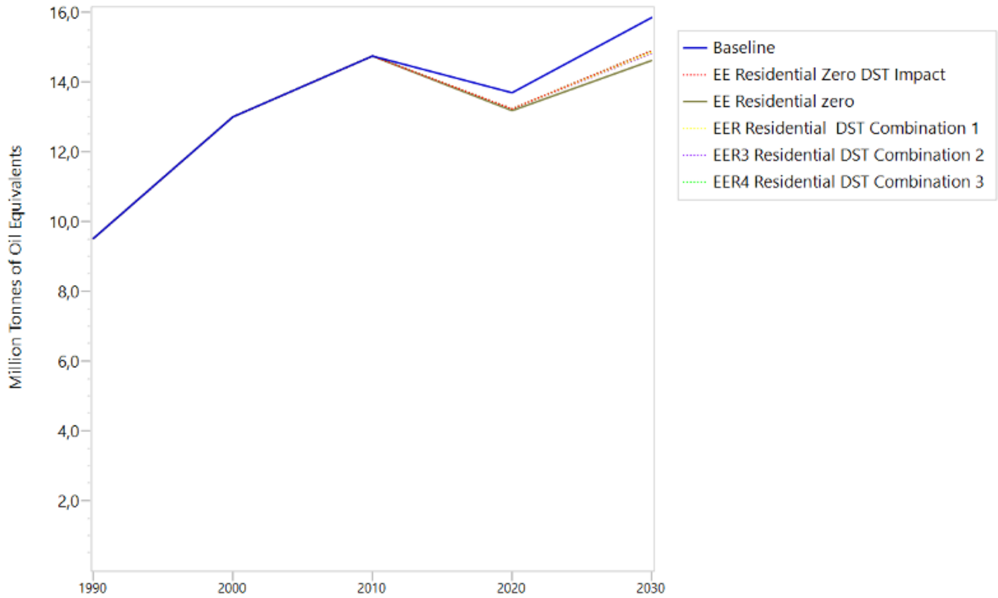

Figure 4: Final energy consumption of the residential sector in the developed scenarios (HERON, 2016b).

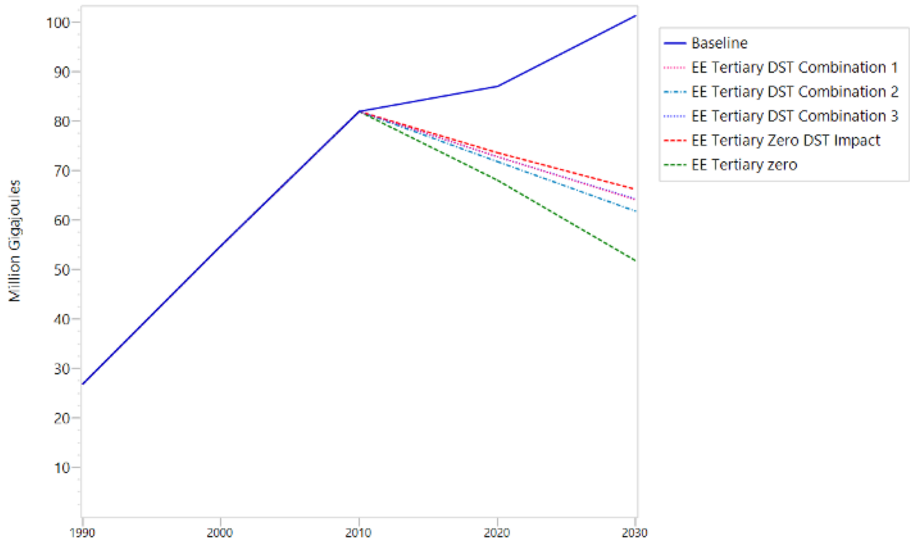

Figure 5: Final energy consumption of the tertiary sector in the five (5) scenarios (HERON, 2016b).

6.2. Criterion 2: Political Acceptability

6.2.1. Sub-criterion – Cost Effectiveness

Official information about the cost effectiveness of existing and innovative EE technologies in the Hellenic market is not available. Under the BAU scenario, all EE technologies are included with the same importance. The scenario is characterized with low cost effectiveness. Under EE B0 and EE B1 scenarios all EE technologies are again included with the same importance. Again, these two scenarios are characterized with low cost effectiveness.

Under the EE B2, its technologies are "Building shell improvement", "Efficient heating" and "Efficient cooling". Under the "*Building shell improvement*" sub-scenario, the information about the cost of the included measures is (YPEKA, 2014):

- External insulation of opaque structural elements according to specifications of the Regulation on the efficiency of buildings (KENAK) has intervention costs of approximately 50€/m^2 for preventing loss that results to savings potential of 33-60% (YPEKA, 2014).
- Replacement of single glazing with other glazing complying with high thermal insulation specifications and with low thermal emissivity (low-e) has intervention costs of approximately 200-250€/m^2 with savings potential of 14-20% (YPEKA, 2014).
- Replacement of window and door frames with energy-efficient ones, fitted with a thermal break system, according to specifications of KENAK has intervention costs of approximately 200-250€/m^2 with savings potential of 14-20% (YPEKA, 2014).

Under the "Efficient heating" sub-scenario, heat pumps (HERON, 2015b) have cost range for power of 11 - 16 KW (80m^2-120 m^2) at 4500EUR - 7500EUR approximately (without labour costs).

Under the "*Efficient appliances*" sub-scenario, the costs are (HERON, 2015b):

- For water heaters: i) Electric heaters: 100-300 EUR (100-150 lt); ii) Solar thermal systems: 1000 EUR approximately (for 150lt installed in residence).
- For cooking devices: i) Electric cooking devices: 320EUR-1500EUR (energy class A); ii) Gas cooking devices: 230EUR-1700EUR (LPG devices with energy class A) /250EUR-900EUR (natural gas); iii) The cost for professional cooking devices (restaurants, bakeries, hotels, etc.) can overcome the amount of 3000EUR.

The range of costs is 50 - 7500 EUR with 6 low cost options (less than 500EUR). Due to financial incentives under EE B2 its policy package appears more cost effective compared to BAU, EE B0 and EE B1 considering also the existing relevant barriers and their impact.

Under the EE B3 scenario ("Building shell improvement", "Efficient heating" and "Efficient cooling"). Costs for "efficient cooling technologies" are:

- Energy efficient electric systems: 750-2500 EUR approximately (14000-18000 BTU).
- CHP systems: the indicative cost for micro-CHP unit in an apartment house is 25000€.
- Trigeneration systems (power-heating-cooling): the indicative cost for a hospital is 600.000EUR (515 kWe).

So, costs range from 50 to 600.000EUR with 4 low cost options (less than 500EUR).

Under the EE B4 scenario for "Efficient cooling – Efficient heating and Efficient appliances" the costs range from 100 to 600.000EUR with 3 low cost options (less than 500EUR).

The EE B2 is more cost efficient compared to the others considering the minimized barriers, the policy package, the range of costs and the number of low cost options.

6.2.2. Sub-criterion – Dynamic efficiency

Based on HERON – DST outcomes about the penetration rates after considering the impact of barriers (see Table 11), the assigned grades for this sub-criterion are in Table 12.

6.2.3. Sub-criterion - Competitiveness

There are no official data to be used for comparing the performance of the policy mixtures of the scenarios under this sub-criterion. Information from official sources are used. The competitiveness of the national industry of EE technologies is rather moderate.

Table 11: Evaluation under "cost effectiveness" and "Dynamic cost efficiency".

Scenarios	**Cost effectiveness**		**Dynamic cost efficiency**	
	Grades under SMART scale of AMS	**SMART Grades converted to grades of MAUT scale of AMS**	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	5	12,36	5	12,36
EE B0	5	12,36	5	12,36
EE B1	5	12,36	5	12,36
EE B2	7	31,01	7	31,01
EE B3	6	19,57	6	19,57
EE B4	5	12,36	5	12,36

Table 12: Penetration shares for technologies/measures per scenario (HERON - DST outcomes).

	BAU	**EE B0**	EE B1	EE B2	EE B3	EE B4
Efficient heating						
penetration of heat pumps by 2030 in all existing households		**20%**	17,651%	17,651%	**8,118%**	**7,688%**
Building shell improvement		–				
– External insulation of opaque structural elements – Replacement of single glazing with other glazing – Replacement of window and door frames with energy-efficient ones, fitted with a thermal break system		**0,987% and 1,798%**	0,163% and 0,297%	**0,328% and 0,607%**	**0,163% and 0,297%**	**0,163% and 0,297%**
Efficient cooling (penetration of highly efficient (A+, A++, A+++) air-conditioning systems by 2030 in all existing households).		**40,8%**	32,773%	**37,179%**	37,179%	**37,265%**
Efficient appliances						
penetration of highly efficient (A+, A++, A+++) appliances and electric cooking devices by 2030 in all existing households		**25%**	14,757%	**18,779%**	**19,521%**	**17,905%**
highly efficient water heaters by 2030 in all existing households		**5%**	3,442%	3,673%		3,590%
Efficient lighting (penetration of LEDs by 2030 in all existing households)		**70%**	55,841%	55,841%	55,841%	55,841%
Application of BEMS (energy savings in lighting by 2030 in all existing households)		**10% (23,4kWh energy savings per dwelling**	8,857%	8,857%	8,857%	8,857%

The following described situation concerns the BAU scenario. The Greek ground source heat pump market is developing slowly. In 2006, 129 units were installed; in 2007 the number increased to 194 units while there were approximately 10 installers. Greece is not included in the list of countries that consist the European Heat Pump markets (European Heat Pump Association, 2016).

The energy services market shows great potential of development. Companies that develop new competitive products in the EE sector are those producing building materials, insulation materials, solar thermal systems, smart home applications and have obtained a significant market share in the country and abroad. EE products and services are part of a wider chain linked with the construction sector and is based on the qualified domestic scientific and technical staff (GSRT, 2012).

The retrofitting market is driven mostly by living styles, security and comfort matters (Gelegenis J. et al., 2014). Companies that produce building materials, aluminium, solar thermal systems and obtain a significant market share in the country and abroad, develop also new competitive products in the EE sector (GSRT, 2013). Business perspectives in this sector are related to new energy saving technologies in the building envelope, heating-cooling procedures and equipment (insulation, window/door frames) (GSRT, 2013). Also, through the implementation of Energy Performance Certificates, the most commonly recommended measures were the replacement of windows/door frames, particularly aluminium frames, and the installation of solar water heating collectors. These market trends are significantly influenced by the existence of strong domestic industries producing aluminium profiles and solar collectors (Gelegenis J. et al., 2014).

Hellas is one of the largest European markets of solar thermal systems. For many years, over 70% of the relevant sales have come from Germany, Austria and Greece (ESTIF, 2013). The industry of solar collectors at the beginning of '90s started to occupy a significant share in the European and world markets (GSRT, 2013). In 2013, the overall installed capacity reached the 4 million m^2, following Germany (14 million m^2) and Austria (4,6 million m^2) (GSRT, 2013). In 2013, 99% of production concerned the hot water heating and only 1% the space heating and industrial use (GSRT, 2013). In 2014 the Hellenic market grew by 18,9% (newly installed capacity 189MWth which represents 270.000 m^2 of newly installed collector area) compared to 2013. This evolution derived from investments in the tourism sector of the country due to the increased number of tourists that visited Greece. These new installations were mainly for hot water supply in the tourism sector/ islands (hotels, holiday lets, etc.). Greece reached a total installed capacity of 3 GWth (4,3 million m^2) that provides an estimated energy supply of 2,989 GWh (ESTIF, 2013; ESTIF, 2015).

The national industry of insulation materials began to grow more rapidly after 1979, when the implementation of the first Insulation Building Regulation. The Panhellenic Association of Insulation Companies[48] now includes more than 120 members, out of which at least 30 are involved, inter alia, in the domestic production of insulation materials. The leading position in thermal insulation materials in the country is held by the extruded polystyrene, followed by polystyrene and mineral wool and other fibrous minerals (GSRT, 2013).

The industry of window/door frames has also been affected significantly by the increasing requirements of the EE building regulations and is one of the most dynamic productive sectors of the Hellenic manufacturing industry with strong and increasing exports. The production of aluminum frames holds a dominant position in national industry due to the comparative advantage of domestic primary production of aluminum. Other types of frames, like wooden ones, hold much smaller percentages. Additional activity in the construction of frames is the production of energy efficient glazing (double, coated, with vacuum, etc.), some of which is being processed in domestic production units. The significant decline in construction activity had adverse effects on the national industry of frames which shows significant decrease of sales in the domestic market. The production of semi-finished extruded aluminum (the majority of which relates profile) reached 120.000 tons in 2010, out of which 50% was exported (GSRT, 2013). According to estimations by the Hellenic Aluminum Company, the same year, 2 million aluminum frames were produced. A number of small businesses and SMEs currently operate in the final construction and installation of frames. Indicatively, the "Hellenic Association of Aluminum Manufacturers" includes more than 200 members, spread in all prefectures of the country. The aluminum sector shows also significant exports since the domestic demand has been drastically decreased over the last period. The rise of the market in these systems favors the industry, but the dynamics of the domestic market are questionable. Instead, abroad and especially in Western Europe, a significant increase in demand is recorded and exports have surpassed the domestic demand after decades (GSRT, 2013).

Production companies of building materials have significant presence abroad (Balkan/Mediterranean countries, Middle East etc.), while study offices and construction companies are operating abroad. This export activity emerged due to their strategy to expand activity and now exports have increased up to a

[48] http://www.psem.gr/

significant extent (70% exports compared to domestic sales) (GSRT, 2013). There are also new and dynamic companies with activity in designing and developing "smart home" applications and services. Indicatively these are (GSRT, 2013): Amitec Ltd, NOVOCAPTIS, Qplan. The activities of the companies are supplemented by research and innovation laboratories of universities and research institutes, such as Foundation for Research and Technology, CRES, etc. (GSRT, 2013).

The situation does not change in the developed scenarios. Those that support the “Building shell improvement” technologies are more likely to contribute in competitiveness since related products are already in the market and market signals are encouraging.

6.2.4. Sub-criterion – Equity

The evaluation of the policy packages is based on LEAP outcomes (Table 12).

6.2.5. Sub-criterion – Flexibility

The BAU policy package has limited flexibility for target groups (Table 3)). The policy package that has more incentives compared to the others is assigned with a higher grade compared to the others (Table 13).

6.2.6. Sub-criterion – Stringency for non-compliance

The policy package of the BAU scenario is not characterized as stringent for non-compliance cases. Most of the implemented policy instruments do not have provisions for penalties or sanctions. Table 13 is indicative for reflecting the situation in all scenarios.

6.3. Criterion 3: Feasibility of Implementation

6.3.1. Sub-criterion – Implementation network capacity

Although the implementation network has a considerable number of entities, the outcomes of its performance are rather low (HERON, 2015a). This situation will not change unless there are structural changes. Regarding transparency and work exerted by it, the following are indicative: There are no available results on the relevant web-site of the Ministry[49] regarding the implementation of the energy audits.

Table 13: Evaluation under “Competitiveness” “Equity” for the policy packages of the scenarios.

Scenarios	Competitiveness		Equity	
	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS	LEAP outcomes	Grades of MAUT scale of AMS
BAU	5	10,41	0	0,00
EE B0	5	10,41	0,238	100,00
EE B1	5	10,41	0,176	73,95
EE B2	7	26,14	0,186	78,15
EE B3	7	26,14	0,194	81,51
EE B4	6	16,50	0,182	76,47

Table 14: Evaluation under “Flexibility” and “Stringency of non-compliance” for the policy packages of the Hellenic building sector scenarios.

Scenarios	Flexibility		Stringency of non-compliance	
	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS	Grades under SMART scale of AMS	SMART Grades converted to grades of MAUT scale of AMS
BAU	6	12,90	5	13,95
EE B0	6	12,90	5	13,95
EE B1	6	12,90	5	13,95
EE B2	7	20,44	6	22,10
EE B3	7	20,44	6	22,10
EE B4	7	20,44	5	13,95

49 http://www.ypeka.gr/Default.aspx?tabid=400&language=el-GR

On the specific web-site for energy audits[50], the public cannot enter and get more information on outcomes without being a registered user. Despite the existence of all these entities, available reports about EE issues are limited. Reports from MECCC and CRES are mainly about policy and technical issues, not about implementation outcomes.

Under EE B2, EE B3 scenarios, the requirements for the implementation of their policy packages increase compared to those for EE B0 and EE B1. In EE B4 the requirements are reduced compared to EE B2 and EE B3.

6.3.2. Sub-criterion – Administrative Feasibility

The situation under the BAU scenario in combination with the mapped barriers (HERON, 2016a) show difficulties in implementing its policy package. There are overlaps of responsibilities, coordination issues and shortcomings in legislation (HERON, 2015c). There is no dedicated Committee or body with the assignment of coordinating efforts for promoting EE policies, technologies/practices. There is a diversity of involved entities with most important ones for the building sector, MEECC and CRES. The multi-level governance includes almost all involved stakeholders, but there is absence of end-users (household associations, hotel or school managers etc). On the other hand, local and regional authorities/governments cannot promote EE just by themselves, but depend on national governments regarding policy direction, legal frameworks and funding (IEA, 2009).

EE has not been promoted as desired due to institutional, financial and legislative barriers. The NZEB definition has been introduced to the national legislation but only in general terms. Detailed requirements and application in practice are not yet specified (RePublic_ZEB, 2015). In addition, it is suggested to ensure the continued adoption and implementation of measures related to informing and educating consumers so that they choose highly energy-efficient buildings / products and change their behaviour regarding energy use and consumption (RePublic_ZEB, 2015). The system of EPC (Energy performance certificate) is still in early stages of implementation (BPIE, 2014). Access to outcomes is offered by using the EPC identification number (known only to the building's owner) (BPIE, 2014). Only aggregated results are publicly available (BPIE, 2014).

The assessment of the national EE Action Plan and Policies concludes with (Energy Efficiency Watch, 2013): a) Medium ambition of the national policy framework, while large potentials remain untapped; b) The most important gap in EE policies was identified at the public sector due to i) lack of an overall strategy of this sector and ii) no targets for energy consumption of its buildings.

Assuming that among minimized barriers are those that concern this sub-criterion, the situation is improved for EE B2 and EE B3.

6.3.3. Sub-criterion – Financial Feasibility

There are no available official data about the cost of implementing the current policy mixture from the perspective of the implementation network (HERON, 2015a). The evaluation will be based on the financial requirements and the impact of the related barriers. In EE B0 and EE B1 the situation has worse performance compare to BAU since the barriers remain and no actions are considered for achieving the assumed targets.

In EE B2 for the need of overcoming of barriers such as "High costs and risks" the policy package included more financial incentives. This assumption requires financial resources which are not available due to the "Economic recession/financial crisis". Same situation for the other scenarios also.

6.3.4. AMS Outcomes

Based on the assigned grades per sub-criterion, calculations resulted in outcomes of Table 16.

7. Conclusions

All scenarios do not reach the set EE target. Apart from the EE B0 scenario which does not face the barriers, the EE B2 scenario is closer in achieving the target. The main characteristics of EE B2, EE B3 and EE B4 scenarios are the minimized impact of barriers and the best technological combinations. The

[50] https://www.buildingcert.gr/info.html

EE B2 has the lowest impact of barriers and from that point it is more likely to be successful in delivering the expected targets. The minimization of barriers linked with technologies/actions for the "Building Shell improvement" affects other technologies as well and allows better results. It is the technology with the largest number of barriers and the assumed efforts to overcome them affect other technologies that have common barriers with the "Building shell improvement".

The impact of barriers can create 6-9% deviations between the compared (EE B1, EE B2, EE B3, EE B4) and the theoretically most possible to happen scenario (EE B0). The assumed policy instruments under each scenario target specific barriers and can de designed to be more successful.

After the overall evaluation of the six scenarios the "*Energy Efficiency Buildings 2 (EE B2)*" proved to be the optimum (most promising) since: 1) it integrates in the greatest extent the end-users' behavior; 2) shows the smallest deviation in achieving EE targets; 3) it contains the policy mixture that best supports the penetration of technologies in the Greek market.

This scenario has the following elements:

1. It includes all the technologies but mainly focuses on supporting the combination of three of them (Building Shell Improvement – Efficient Cooling – Efficient Appliances);
2. With the use of the innovative HERON - DST tool, barriers linked to the 'Building Shell Improvement" were minimized, but simultaneously affected the penetration of the other two technologies of the combination.
3. The minimized barriers were:

a. Strong dependency on the neighbors in multifamily housing (Social);
b. Missing credibility/ mistrust of technologies and contractors (Cultural); Lack of trained and skilled professionals / trusted information, knowledge and experience (Educational);
c. Lack of awareness/knowledge on savings potential, information gap on technologies (Educational);
d. Lack of any financial support (Economic);
e. High costs and risks (Economic);
f. Split Incentive (Institutional);
g. Legislation issues (Institutional);
h. Problematic implementation network/ governance framework (Institutional);

The policy mixture for this scenario includes: a. Financial incentives; b. Awareness campaigns; c. Educational programs; d. Establishment of educational institutions for professionals aiming at systematic vocational training; e. Subsidies and tax exemptions.

In conclusion, this scenario has emerged as the optimal (most promising) because it is more effective than the others; exhibits the smallest deviation from the target after minimizing the barriers with the use of HERON - DST. The minimization is supported by the policy mixture of the scenario, which offers more information to end-users about energy savings and more financial incentives (tax exemptions, subsidies, exemptions from energy audit fees). Also, the combination of the technologies for this scenario has more financial options that can be selected by the end-users.

Table 15: Evaluation under "Implementation network capacity" "Administrative feasibility" – "Financial feasibility" for the policy packages of the scenarios.

Scenarios	**Implementation network capacity**		**Administrative feasibility**		**Financial feasibility**	
	Grades under SMART scale of AMS	**SMART Grades converted to grades of MAUT scale of AMS**	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**	**Grades under SMART scale of AMS**	**SMART Grades converted to grades of MAUT scale of AMS**
BAU	6	27,14	5	13,95	5	27,16
EE B0	5	17,13	5	13,95	3	10,91
EE B1	5	17,13	5	13,95	3	10,91
EE B2	4	10,73	6	22,10	4	17,00
EE B3	4	10,73	6	22,10	4	17,00
EE B4	5	17,13	5	13,95	4	17,00

Table 16: AMS results for each scenario.

Criteria	Scenarios					
	BAU	**EE B0**	**EE B1**	**EE B2**	**EE B3**	**EE B4**
Direct contribution to GHG emission reductions (0,833)	0.00	83.30	70.81	72.75	74.41	71.92
Indirect environmental effects (0,167)	0.00	16.80	12.00	14.45	14.73	0.00
Environmental performance (0,168) - A	**0.00**	**16.80**	**13.91**	**14.65**	**14.98**	**12.08**
Cost efficiency (0,474)	5.84	5.84	5.84	14.67	9.26	5.84
Dynamic cost efficiency (0,183)	1.09	2.74	2.74	3.90	3.90	3.90
Competitiveness (0,085)	0.89	0.89	0.89	2.22	2.22	1.40
Equity (0,175)	0.00	17.50	12.94	13.68	14.27	13.38
Flexibility (0,051)	0.65	0.65	0.65	1.03	1.03	1.03
Stringency for non-compliance (0,032)	0.47	0.47	0.47	0.75	0.75	0.47
Political acceptability (0,738) - B	**6.60**	**20.73**	**17.37**	**26.75**	**23.19**	**19.21**
Implementation network capacity (0,309)	8.39	5.29	5.29	3.31	3.31	5.29
Administrative feasibility (0,581)	8.10	8.10	8.10	12.84	12.84	8.10
Financial feasibility (0,110)	2.99	1.20	1.20	1.87	1.87	1.87
Feasibility of implementation (0,094) - C	**1.83**	**1.37**	**1.37**	**1.69**	**1.69**	**1.44**
Total (A+B+C)	**8.43**	**38.90**	**32.65**	**43.09**	**39.86**	**32.73**

Acknowledgment

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DAY 3: Brokerage event

Session 1: Projects

Urban resilience and adaptation to climate change

by

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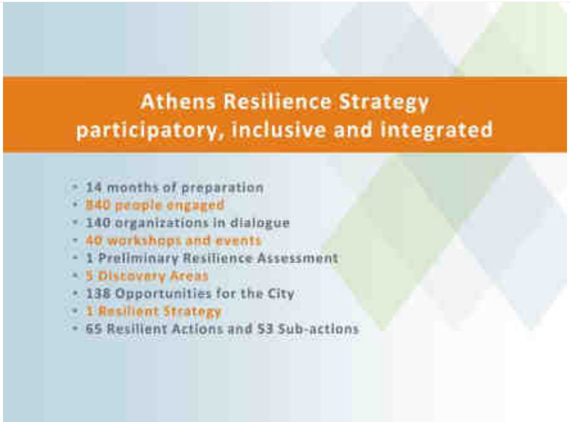
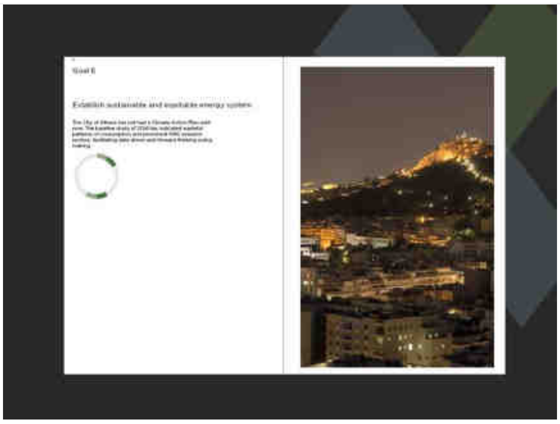
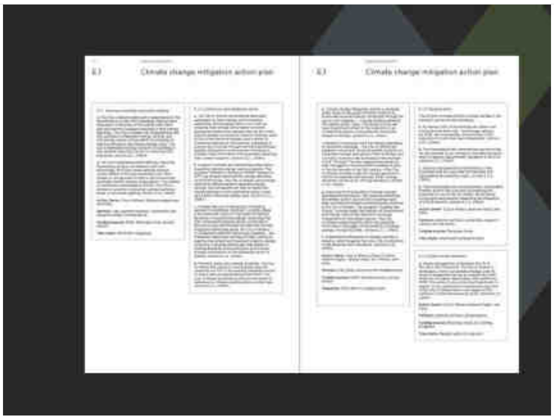






Sector	GHG emissions tons CO2eq (baseline year 2014)	GHG emission reductions until 2030 tons CO2eq/y	% reduction
Residential Sector	1.595.033	447.469	-28,05%
Commercial and municipal sector	1.909.463	795.242	-41,65%
Manufacturing industries and industrial processes	142.184	30.023	-21,12%
On road transportation	1.015.754	423.567	-41,70%
Public transportation (metro, tram)	48.775	0	0,00%
Solid Waste (landfill)	334.082	334.082	-100,00%
Biological waste (alternative ways of management)	41	0	0,00%
Wastewater	23.342	0	0,00%
Total	**5.069.040**	**2.030.383**	**-40,05%**

Mitigation Actions (technological & non technological actions)	Energy savings (MWh/year)	GHG emissions reduction (CO_2eq/year)
Energy renovation of municipal buildings	27.219	15.386
Energy Upgrade of municipal lighting	26.402	10.039
Citizens Campaigns on low cost actions regarding residential building renovation	62.894	41.451
Promote national funding programs for energy saving (i.e. "Saving at Home")	298.099	205.892
Connecting residential buildings to Natural Gas Network	45.151	12.084
Net Zero Energy Buildings (NZEB)	181.781	131.910
Climate Change Adaptation actions	8.319	9.961
Creation of fund for energy renovations of residential buildings	51.117	48.162
Campaign to entrepreneurs for energy saving	866.016	775.430
Municipal fleet upgrade	2.840	707
Eco driving	2.422	585
Effective management of municipal fleet and fuels	4.845	1.169
Sustainable mobility plan	1.606.944	421.106
Bio-waste segregation from landfill	-	334.082
Total	**2.984.030**	**2.030.383**


Relevant Municipal Projects
• Energy Upgrades
[municipal & school buildings, public lighting, IZNEB]
• Urban Renewal
[playgrounds, squares, trigono]
• Waste Management
[connection with tourism industry]
The proposed programs will be funded by municipal funds as well as the structural funds through Region of Attica


International Networks working together in Athens
• MoU between C40 Cities and 100 Resilient Cities
C40 CITIES


Athens vision compatible with COP21 (Paris Agreement)
- 20% Renewable Energy Sources by 2030
- 40% reduction of GHG emissions by 2030
Athens has a high GDP and high GHG emissions. It would need a much more ambitious plan and everyone on board to reach the 1,5 Celsius goal or in order to reach the goal of100% renewable energy generation by 2050

HORIZON 2020	HERON
Title: Forward-looking socio-economic research on Energy Efficiency in EU countries **Project Web Site:** https://heron2017.wordpress.com http://heron-project.eu/ **Duration:** 31 months **Start Date:** 01/05/2015 **Key Words:** energy efficiency, buildings, transport, end users' behavior, decision support tool	**Funding mechanism:** Horizon 2020, Secure Clean and Efficient Energy, Research and Innovation Action. **Total Cost: 958.750,00 €** **EC Contribution: 958.750,00 € (100%)** **Consortium:** 7 members from 6 EU and 1 EU candidate countries **Project Coordinator:** National and Kapodistrian University of Athens, Energy Policy and Development Centre (Greece)

The Challenge

HERON aims at facilitating policy makers of multi-level governance in EU, to develop and monitor energy efficiency policies in building and transport sectors, through forward-looking socio-economic research in seven EU and one candidate countries.

HERON developed an innovative decision support tool (HERON DST) to incorporate non-economic and non-market elements, such as social, educational and cultural, into scenario analysis into energy scenarios development software, such as LEAP.

Project Objectives

- impact of socio-economic and institutional factors on implementing energy efficiency policies and measures,
- development of energy-efficient pathways to the horizon 2030 and beyond taking into account the socio-economic drivers and the updated energy efficiency measures,
- contribution to improving energy modeling by incorporating social, educational and cultural factors so as to reflect the end-user behavior,
- establishment of communication channels between researchers, decision makers of different governance levels and social and market stakeholders.

Methodology

The above objectives were achieved through the following activities:

1. Mapping of energy efficiency policy instruments, available technologies and social, economic, cultural and educational barriers in transport and buildings,
2. Assessment of the evidenced barriers and the main driving factors, in order to define their weight/importance for the implementation of energy efficiency policies,
3. Determination of linkages between the factors and the energy efficiency,
4. Forward-looking scenario analysis, focusing on macro- and micro-economic impacts of energy efficiency policy options,
5. Policy recommendations through multi-criteria evaluation and feedback mechanisms with policy makers and market stakeholders from EU (member states, Covenant of Mayors) and neighboring countries (Business Council of BSEC).

The methodology that is implemented is consisted of successive steps that aim to develop, transfer and implement the necessary high quality knowledge for the development and assessment of Mitigation / Adaptation policy portfolios for each beneficiary country and identify existing gaps and needs. In parallel it is encouraged the interaction and cooperation between academic, governmental and market communities at national and international – regional level.

Expected Results

- Deliver a pathway towards preferable EE scenarios in Buildings and Transport sectors that incorporates the end-users' behavior factor.
- Develop a decision support tool that allows the quantification of qualitative information into numerical data, translating end-users behavior into target deviations.
- Provide results of the above pathway implementation into 7 countries (6 EU, 1 EU candidate).
- Provide comparative analysis of the results, investigating the possibility of common regional or European level policy scenarios' mixtures suggestion.
- Provide new area of research, in terms of energy efficiency scenarios development, on Buildings and Transport sectors.

Additional secondary results are:

- Strengthening of the EU role in climate change policy research;
- Integrating global climate policy needs into the EU's external relations and building a new alliance with partners around the world;
- Means through which climate change can be confronted;
- Cooperation among scientists from different countries.

Project partners

National and Kapodistrian University of Athens, Energy Policy and Development Centre (Greece)

Bocconi University, IEFE (Italy)

Black Sea Energy Research Center (Bulgaria)

Oxford Brooks University (United Kingdom)

Wuppertal Institute for Climate and Energy (Germany)

University of Belgrade, Faculty of Mining and Geology (Serbia)

Estonian Institute for sustainable development, Stockholm Environment Institute Tallinn Centre (Estonia)

Contact

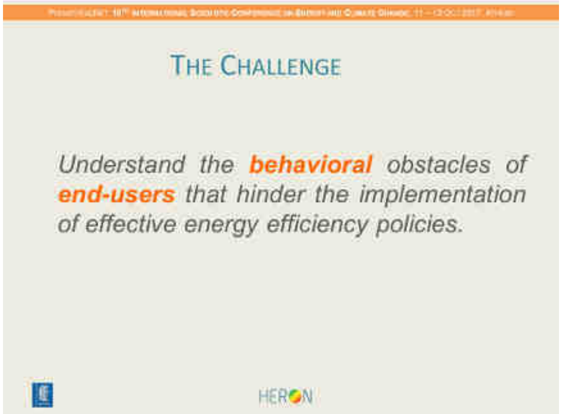
NKUA – KEPA: epgsec@kepa.uoa.gr

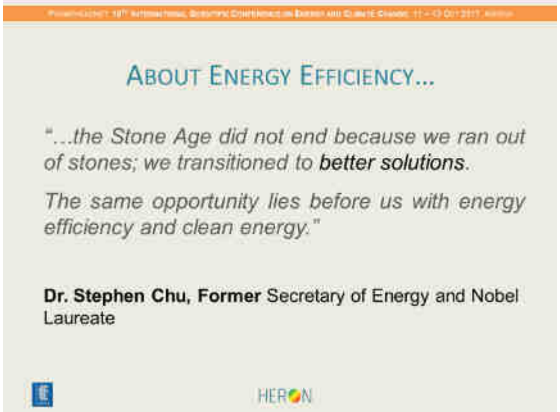
HERON – Forward-looking socio-economic research on energy efficiency in EU countries, H2020 project

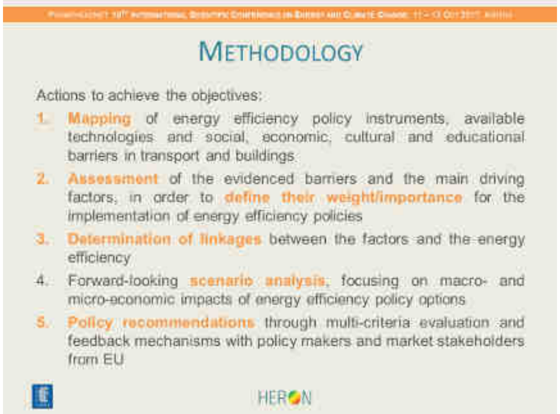
by

Ms. Eleni-Danai MAVRAKI,

Energy Policy and Development Centre (KEPA), NKUA - Greece







Consortium

1. National and Kapodistrian University of Athens – Energy Policy and Development Centre (**KEPA**) – **Hellas**
2. University of Bocconi, Centre for Research on Energy and Environmental Economics and Policy (**UB-IEFE**) – **Italy**
3. Black Sea Energy Research Centre (**BSREC**) – **Bulgaria**
4. Oxford Brookes University (**OBU**)– **United Kingdom**
5. Wuppertal Institute for Climate, Environment and Energy (**WI**) – **Germany**
6. University of Belgrade – Faculty of Mining and Geology (**UB-FMG**) – **Serbia**
7. Estonian Institute for Sustainable Development, Stockholm Environment Institute Tallinn Centre (**SEI-T**) – **Estonia**

Expected Result

*To empower policy makers and market players by **providing them an innovative policy tool** allowing them to select and implement the most effective policy instruments for energy efficiency in building and transport sector incorporating the end-users behavior.*

1 month before project closure

TODAY

Outcomes

1. Barriers and technologies in Buildings and Transport **mapping**
2. Developed Decision Support Tool (**HERON DST**) converting quantitative information to qualitative data.
3. Developed **scenarios** with HERON DST incorporated data
4. Concluded **preferable scenarios** per sector for each case study country
5. Developed **policy dialogue** on national and EU level

Outcomes: Mapping

- Mapping of **technologies** in Buildings and Transport sectors (WI)
- Mapping of **barriers** based on data and literature (OBU)
- **Survey** for non numerical barriers mapping (UB-IEFE)

Outcomes: Innovative Tool

Decision support **Tool** (HERON DST)converting qualitative information into quantitative, allowing the **incorporation** in energy modeling and scenarios development (UoA-KEPA)

Outcomes: EE developed scenarios

- **6 developed scenarios per sector** in LEAP energy tool for each country (84 scenarios in total) (SEI-T)
- **1 optimum scenario per sector** for each country (14 optimum scenarios) (Consortium)

HERON

The EE developed scenarios

1. BAU: Business as Usual
2. EE0: Scenario ***without barriers***
3. EE1: Scenario considering ***all*** barriers
4. EE2: Scenario with a HERON DST suggested minimized barriers **mixture (1)**
5. EE3: Scenario with a different HERON DST suggested minimized barriers **mixture (2)**
6. EE4: Scenario with a different HERON DST suggested minimized barriers **mixture (3)**

6 scenarios per sector developed into LEAP tool, with incorporated the HERON DST outcomes.

HERON 14

Outcomes: Evaluation

- Evaluation of scenarios per sector for each country (UoA-KEPA)
- **1 concluded preferable scenario** per sector for each country (14 optimum scenarios) (UoA-KEPA)

HERON

Evaluation reasons

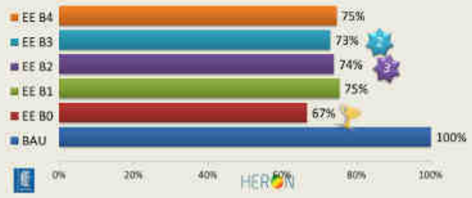
After the incorporation of HERON DST outcomes into LEAP developed scenarios, we have results pointing an optimum scenario

is that enough?

LEAP

Case: Greece, Transport sector

Final energy consumption in year 2030, compared to BAU



HERON

Evaluation reasons

Initial criteria: Incorporate the end-users behavior
Present the most Energy Efficient scenario

How to conclude to a **preferable** scenario?

by adding criteria

Additional criteria, supported by the selected evaluation method (AMS)

A – Environmental performance
B – Political acceptability
C – Feasibility of implementation

HERON

The selected evaluation method

Integrated multi-criteria analysis method for quantitative evaluation of climate change mitigation policy instruments.

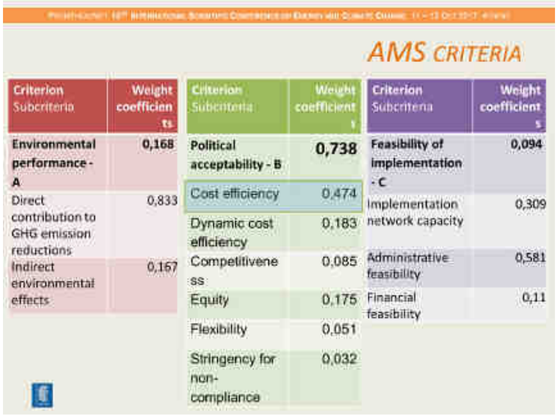
Consists of:

1. a set of criteria supported by sub-criteria, all of which **describe the complex framework** under which these instruments are selected by policy makers and implemented
2. an Analytical Hierarchy Process (**AHP**) process for **defining weight coefficients** for criteria and sub-criteria according to the preferences of three stakeholders groups and
3. a Multi-Attribute Theory (**MAUT**)/Simple Multi-Attribute Ranking Technique (**SMART**) process for **assigning grades to each instrument** that is evaluated for its performance under a specific sub-criterion

The method was named AMS from the initials of the combined processes and techniques

http://www.sciencedirect.com/science/article/pii/S0301421507003229

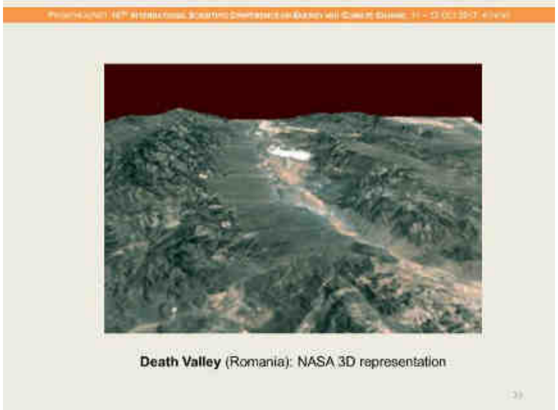
HERON



Criterion Subcriteria	Weight coefficients
Environmental performance - A	**0,168**
Direct contribution to GHG emission reductions	0,833
Indirect environmental effects	0,167

Criterion Subcriteria	Weight coefficienty
Political acceptability - B	**0,738**
Cost efficiency	0,474
Dynamic cost efficiency	0,183
Competitiveness	0,085
Equity	0,175
Flexibility	0,051
Stringency for non-compliance	0,032

Criterion Subcriteria	Weight coefficients
Feasibility of implementation - C	**0,094**
Implementation network capacity	0,309
Administrative feasibility	0,581
Financial feasibility	0,11



INTERREG MEDITERRANEAN	MOTIVATE
Title: Promoting citizens' active involvement in the development of Sustainable Travel Plans in Med Cities with Seasonal Demand **Project Web Site:** https://interreg-med.eu/en/thematics/urban-transports/ **Duration:** 30 months **Start Date:** 01/11/2016 **Key Words:** sustainable urban mobility, SUMP, mobility data, participatory approach, crowd sourcing, social media, Mediterranean Region	**Funding mechanism:** European Regional Development Fund (ERDF) **Total Cost:** 1,927,608.75€€ **EC Contribution:** 1,638,467.45€ **Consortium:** 9 partners and 2 associate partners from 4 countries **Project Coordinator:** Câmara Municipal de Almada

The Challenge

Large fluctuations in population weighs heavily on environment and transport infrastructure In the Mediterranean. Therefore, increasing the use and access to low carbon systems becomes a priority, allowing travelers, i.e. residents and visitors, to move around in ways that help preserve the natural and cultural heritage of Mediterranean cities, all while strengthening social cohesion and improving local quality of life. To this direction, MOTIVATE contributes to the uptake of low-carbon transport in five MED cities - Ioannina, Rhodes, Larnaca, Almada and Siena - by actively engaging travelers in the development and implementation of Sustainable Urban Mobility Plans (SUMPs) through the use of social media and crowdsourcing techniques.

Project Objectives

- To accelerate SUMP development through participatory approach focusing on the needs of urban MED areas and aligning both residents and visitors needs with sustainable mobility policy goals.
- To prove the dynamic and effectiveness of using social media and crowdsourcing techniques for facilitating SUMP development.
- To develop an innovative and cost-efficient data collection framework by demonstrating a mobility observatory, which integrates the use of mobile applications in the collection of transportation related data in form of trip diaries.

Methodology

MOTIVATE aims to help decision makers to gain a strong understanding of the main mobility problems that residents and tourists face, and the most accepted and sustainable interventions, using cost effective ways of data collection and analysis, which will make the development, update and monitoring of SUMP much more targeted and efficient.

To achieve more participatory planning and implementation of SUMP, MOTIVATE offers tools allowing:

1. authorities and policy makers to capture real time mobility data and adjust their services and strategies accordingly
2. travelers (residents & tourists) to be better informed about transport services, have a say in their evaluation and contribute to their improvement
3. open dialogue among stakeholders on planned and envisioned transport interventions in MED cities
4. the uptake of alternative, sustainable mobility

MOTIVATE e-platform and mobile app are the main tools / outputs of the project. Both will be tested in a period of 18 months, covering both touristic and non-touristic seasons. These activities will take place in 5 pilot cities: Ioannina, Rhodes, Larnaca, Almada, and Siena.

Project partners

MemEx (Italy)

AEGEA (Greece)

HIT/CERTH (Greece)

Tiemme spa (Italy)

Municipality of Rhodes (Greece)

Municipality Of Ioannina (Greece)

Municipality of Larnaka (Cyprus)

Municipality of Almada (Portugal)

Municipality of Sienna (Italy)

Associate partners

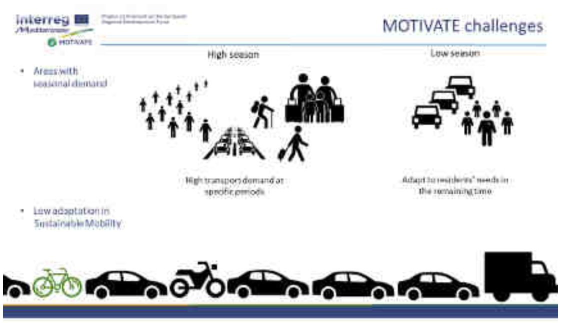
Network of Sustainable Greek Islands DAFNI (Greece)

RODA (Greece)

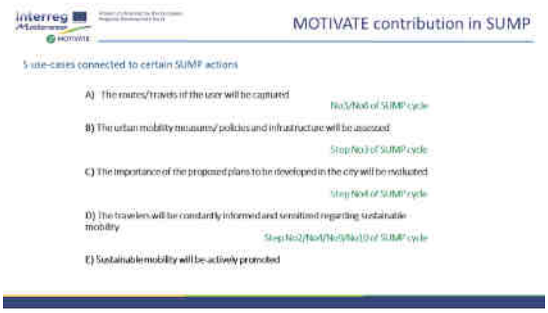
MOTIVATE – Promoting citizens' active involvement in the development of Sustainable Travel Plans in Med Cities with Seasonal Demand, INTERREG Med projects

by Ms. Alexia SPYRIDONIDOU,

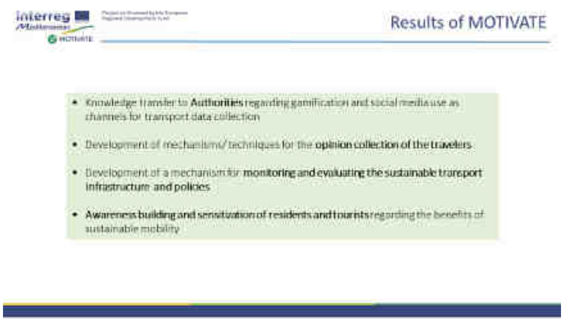
Sustainable Mobility Expert, Aegean Energy & Environment Agency, Greece

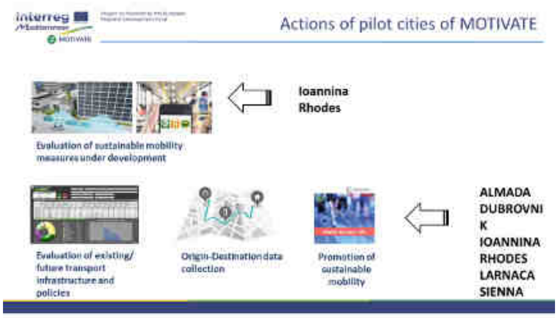


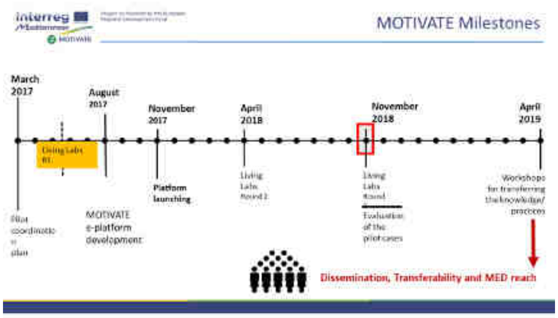

MOTIVATE
Platform
Download Motivate Apps at:
Google Play
App Store
http://www.motivate.imet.gr


MOTIVATE contribution in SUMP
5 use-cases connected to certain SUMP actions
A) The routes/travels of the user will be captured
B) The urban mobility measures/ policies and infrastructure will be assessed
Step No3 of SUMP cycle
C) The importance of the proposed plans to be developed in the city will be evaluated
D) The travelers will be constantly informed and sensitized regarding sustainable mobility
E) Sustainable mobility will be actively promoted


MOTIVATE contribution in SUMP
D
D
D
A,B
A
C,D


Results of MOTIVATE
Knowledge transfer to Authorities regarding gamification and social media use as channels for transport data collection
Development of mechanisms/ techniques for the opinion collection of the travelers
Development of a mechanism for monitoring and evaluating the sustainable transport infrastructure and policies
Awareness building and sensitization of residents and tourists regarding the benefits of sustainable mobility


Actions of pilot cities of MOTIVATE
Ioannina
Rhodes
Evaluation of sustainable mobility measures under development
Evaluation of existing/ future transport infrastructure and policies
Origin-Destination data collection
Promotion of sustainable mobility
ALMADA
DUBROVNIK
IOANNINA
RHODES
LARNACA
SIENNA


MOTIVATE Milestones
March 2017
August 2017
November 2017
April 2018
November 2018
April 2019
Platform launching
MOTIVATE e-platform development
Dissemination, Transferability and MED reach

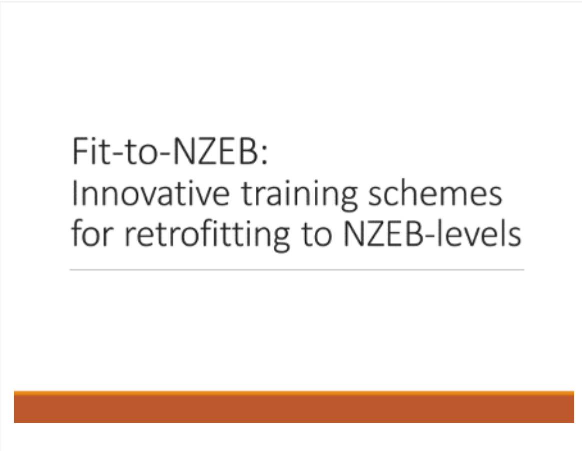

Interreg
Mediterranean
MOTIVATE
Any questions?
Contact information:
alexia.sp@aegean-energy.gr
10th International Scientific Conference on Energy and Climate Change
Athens, 13/10/2017

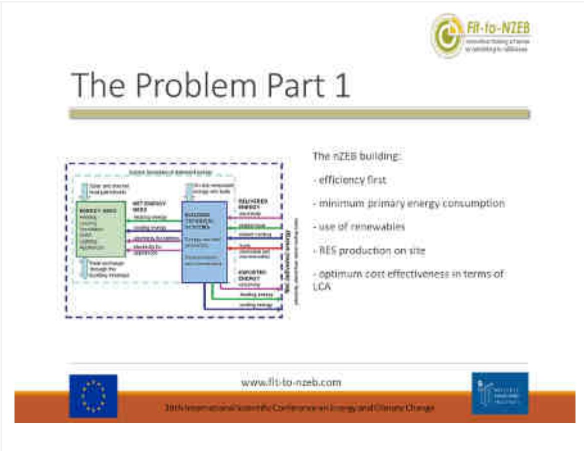
FIT-to-NZEB – Innovative training schemes for retrofitting to nZEB-levels, H2020 project

by

Mr. Stefanos PALLANTZAS,

Hellenic Institute of Passive Building, Greece






Fit-to-NZEB
The new EPBD
www.busenerpro.co
m
"Energy efficiency first" is a key element of the Energy Union
About 75% of buildings are energy inefficient
Only 0.4-1.2% of the stock is renovated each year
The main objective is to accelerate the cost-effective renovation of existing building, which is a 'win-win' option for the EU
Renovation work and energy retrofits add almost twice as much value as the construction of new buildings
www.fit-to-nzeb.com


Fit-to-NZEB
The new EPBD
www.busenerpro.co
m
Long-term strategies for renovation of the building stock (Art. 4/EED becomes Art. 2a/EPBD)
Mobilizing funding for carbon-free buildings: targets for 2030/2050: market signals to investors
ICT and smart technologies, automation and BIM, e-mobility
Link between public funding and EPCs; focus on microclimate and health (heating and ventilation)
www.fit-to-nzeb.com


Fit-to-NZEB
Institutional framework
Horizon 2020: Energy Efficiency Call for proposals
Topic EE-04-2014 Construction Skills
Legacy of BUILD UP Skills Initiative (2011-2017)
Other projects under this topic:
Running: BUStoB; ingREeS; MEnS; PROF-TRAC
Starting in 2017: BIMplement; BIMEET; Net-UBIEP; NEWCOM
More info:
BETTER
www.fit-to-nzeb.com


Fit-to-NZEB
The BUILD UP Skills Initiative
Pillar I started in 2011 under Intelligent Energy Europe Program
Similar projects in 30 EU + associated countries
Resulting in National roadmaps for improving the skills in the construction sector
Pillar II started in 2013-2014 focusing on training programs on EE & RES in buildings
Last projects being finalized now
Continued in H2020 Construction Skills
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Fit-to-NZEB
BUS EnerPro II: The Programs
Training frameworks and materials developed on 10 programs:
Building envelope, Building systems, and Building market and products
PV installations, Solar thermal, Mini-wind generators, Biomass installation, Heating, ventilation and AC, Thermal pumps, Integrated systems
Focus on practical trainings
Broad consortium of training institutions
www.fit-to-nzeb.com


Fit-to-NZEB
Train-to-NZEB: The Building Knowledge Hubs
Improving the training facilities; new BKHs in Bulgaria, Romania, Czech Republic, Turkey and Ukraine
ToRs for equipment and services,
Business plans
Innovative training programs
Qualified and attractive trainers
Trainings for 2400 construction workers, 480 designers and 720 non-specialists
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Fit-to-NZEB
The BKHs
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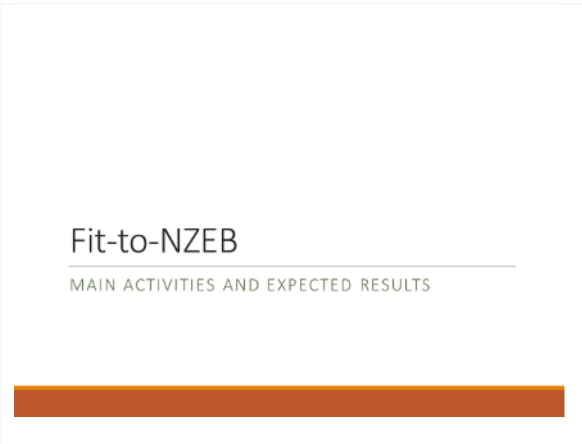
Fit-to-NZEB
MAIN ACTIVITIES AND EXPECTED RESULTS


Fit-to-NZEB
F2NZEB: The Basics
Acronym: FIT-TO-NZEB (F2NZEB)
Full name: Innovative training schemes for retrofitting to NZEB-levels
Web address: www.fit-to-nzeb.com
Language: British English
Supporting program: Horizon 2020
Grant Agreement Number: 754059
Duration: 15 June 2017 – 15 June 2019
EnEffect
SEVEn
CTU
CLUSTER pRO nZEB
PASSIV ITALIA
TU
www.fit-to-nzeb.com


List of project partners
1. Center for Energy Efficiency EnEffect – Bulgaria (coordinator),
2. University of Architecture, Civil Engineering and Geodesy – Sofia, Bulgaria,
3. SEVEn, the Energy Efficiency Center – Prague, Czech Republic,
4. Czech Technical University in Prague, Czech Republic,
5. Association Cluster for Promoting Nearly Zero Energy Buildings (Pro-nZEB), Romania,
6. Technical College for Architecture and Public Works, Bucharest, Romania,
7. Passive House Academy / MosArt Landscape Architecture Research, Ireland,
8. University of Zagreb, Faculty of Civil Engineering, Croatia,
9. Zero Energy and Passivhaus Institute for Research (ZEPHIR), Italy,
10. Hellenic Passive House Institute, Greece,
11. Technical University – Vienna, Austria,
www.fit-to-nzeb.com


Geographic scope
Involved countries:
Bulgaria, Romania, Czech Republic, Italy, Greece, Croatia, Ireland, Austria
Partners from Train-to-NZEB: Turkey, Ukraine
www.fit-to-nzeb.com


Composition of the consortium
Type of involved partners:
Technical and architecture universities
Professional high schools / colleges
Active vocational training centers
Energy and building experts
Highlights: transfer of experience from PHA, transfer of experience and further expansion of the BKHs' network under T2NZEB, enhancing the regional scope, involving the Passive House community
www.fit-to-nzeb.com


Logic of the project
The logic behind:
Tackling the most pressing issue around
Covering the full scale of the academic & VET system (EQF levels 2-7)
Complementing and providing sustainability of T2NZEB, resp. BUILD UP Skills
Local capacity for trainings on deep energy retrofit
Broadening of the geographical scope and large-scale networking
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Fit-to-NZEB Goals
Elaborate a set of required technological competences related to DER;
Develop new training programs employing the newly elaborated technical competences;
Review the national educational plans for the relevant professions and introduce changes;
Train and certify a sufficient number of trainers;
Support and monitor the first courses on the new programs at all levels.
www.fit-to-nzeb.com


Fit-to-NZEB Objectives
1) Compendium of the knowledge, skills and competencies required for DER
2) Design-focused training programs for higher education establishments (EQF 6-7)
3) DER training program for the professional high schools (EQF level 3-5)
4) Training content to be included in the RES training plans and programs in the professional high schools (EQF level 3-5)
www.fit-to-nzeb.com


Fit-to-NZEB
Fit-to-NZEB Milestones
Internal communications set-up
Communications strategies
Visual identity
Web based networking platform and website launched
Catalogue of existing and available resources on DER
Catalogue of learning outcomes: M6
Design of 2 training and demo models
National training of trainers
Training program for EQF level 6-7
Training program for EQF level 3-5
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Fit-to-NZEB
Fit-to-NZEB Milestones (cont.)
Training programs for vocational training centers (EQF 3-4)
Training materials for EQF level 6-7
Training materials for EQF level 3-5
Training materials for VTCs (EQF 3-4)
Interim evaluation of the communication strategy
Interim report on management and risk mitigation
Conduction of pilot courses for EQF levels 6-7, 3-5 and short courses for VTCs
Monitoring and evaluation reports on the training courses
www.fit-to-nzeb.com


Fit-to-NZEB
Fit-to-NZEB main results
Unique educational and training programs on deep energy retrofit
Design drawings of innovative training and demonstration models
Building local capacity: training of sufficient number of trainers
Monitoring and evaluation of pilot courses
Increased awareness on the benefits of deep energy retrofit
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Fit-to-NZEB
Next step
BKH IN ATHENS
One-stop-shop for energy efficiency
Education and Certification center
Permanent materials and services exhibition
Co-working space for young architects and engineers
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Fit-to-NZEB
Communication
Web:
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Facebook:
Twitter:
www.fit-to-nzeb.com


Contact Information
Web:
Facebook:
Twitter:
COORDINATOR OF THE PROJECT
Center for Energy Efficiency EnEffect
EnEffect

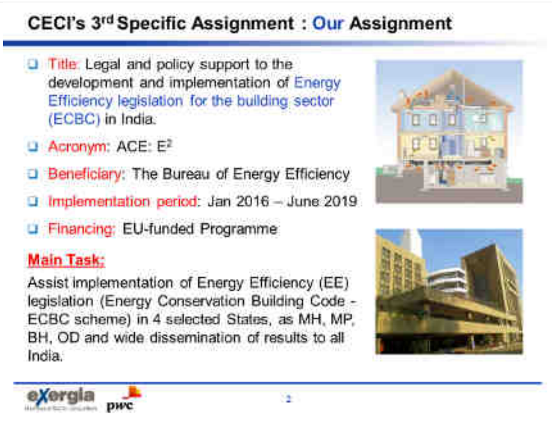

Fit-to-NZEB
Sustainable future : the red pill
Thank You
This is your last chance. After this, there is no turning back. You take the blue pill—the story ends, you wake up in your bed and believe whatever you want to believe. You take the red pill—you stay in Wonderland, and I show you how deep the rabbit hole goes. Remember: all I'm offering is the truth, nothing more.
www.fit-to-nzeb.com

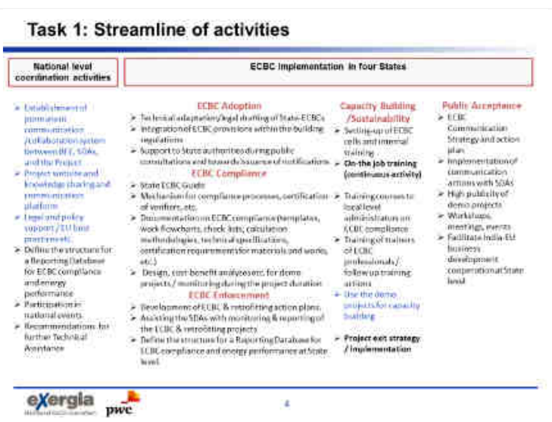
ACE: E2 project: Adoption, Compliance Enforcement for Energy Efficiency in Commercial Buildings in India

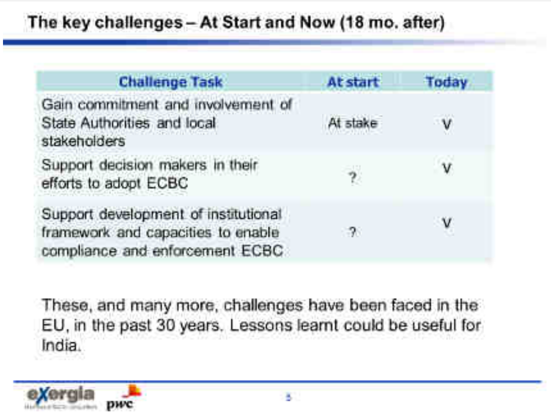
by

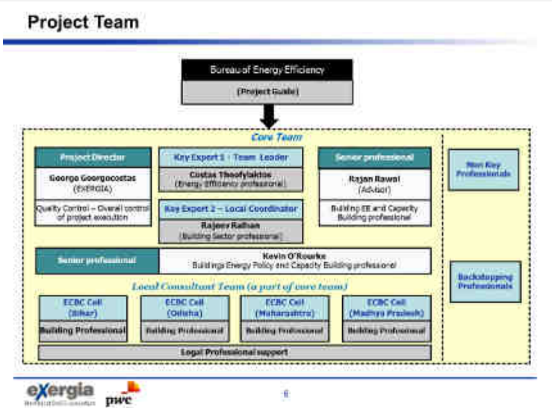
Mr. Costas THEOFYLAKTOS and Mr. Panagiotis VOURLIOTIS

Hellenic Association for Cogeneration of Heat & Power (HACHP), Hellas









The four States involved – The Stakeholders involved

STATES
- Maharashtra
- Madhya Pradesh
- Odisha
- Bihar

BENEFICIARIES
- MEDA
- MPUVNL
- BDA
- BREDA

Our understanding on relevant stakeholders in the state

Stakeholder
- SDA
- UDD - Mandates through notification & DCR/GDCR
- ULB - Enforces ECBC implementation
- Developer/Owner
Constructs new building/retrofits existing building
- Engineer/Architect/Design team/Universities
- Electricity Regulatory Commissions & Utility
Monitor consumption
- Equipment supplier - provides necessary certification for products
- ECBC Assessor/Auditors/Trainers
Assists and ascertain compliance of ECBC

MAHARASHTRA SCENARIO

- **307,713 sq. km;** Maharashtra is third largest state by area of India
- **Four climatic zones;** namely classified as Cool, Warm and Humid, Composite and Hot-dry
- **6 Administrative Divisions: Kokan, Pune, Aurangabad, Nagpur, Amaravati and Nasik**
- **Four DISCOM;** MSEDCL, TATA Power, Reliance Energy and B.E.S.T.
- **Maximum share of commercial connections above 100kW;** Mumbai and Pune city and suburban region
- **Around 1000 new connections every year of** commercial buildings with connected load more than 100kW will be added

No. of Electrical Connections (2016) – 10,652

Anticipated Energy Saving Potential

Assuming that ECBC is implemented in 2018, total anticipated cumulative energy saving potential by 2030 could be around 15,000 GWh

Implementation of ECBC
- **Stakeholder's participation:** All key stakeholders engaged in the development of ECBC rules
- **ECBC Amendment:** Maharashtra ECBC rules have been amended and approved as per the requirement of the state
- **ECBC is expected to be notified by November 2017**
- **Capacity Building** program has been designed
- **Demonstration Projects** work for two ECBC compliant demonstration buildings has been initiated

Impact of EU's program
- *Helped to track the existing energy consumption scenario of the state.*
- *Strategies to integrate ECBC in building permit approval process is being developed for the state.*
- *Prepared Rules to comply and enforce the adoption of ECBC, considering the existing administrative working system; for building approval system*

MADHYA PRADESH SCENARIO

- **308,252 sq. km of area;** makes Madhya Pradesh an second largest state of India
- **Two climatic zones;** namely classified as Composite and Hot-dry
- **10 Administrative Divisions;** Bhopal, Chambal, Gwalior, Ujjain, Rewa, Sagar, Indore Narmadapuram, Jabalpur, Shahdol
- **Three DISCOM;** Madhya Kahtera Vidyut Vitran Co. Ltd., Paschim Kshetra Vidyut Vitran Co. Ltd., Poorv Vidyut Vitran Co. Ltd.
- **Maximum share of commercial connections above 100kW;** Bhopal & Indore
- **Around 100 new connections every year of** commercial buildings with connected load more than 100kW will be added

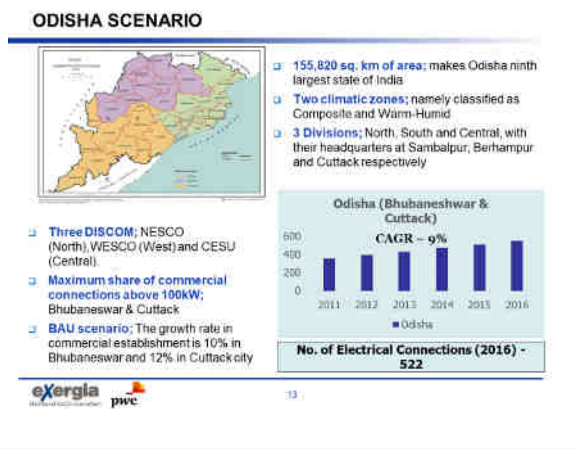
No. of Electrical Connections (2016) – 1,115

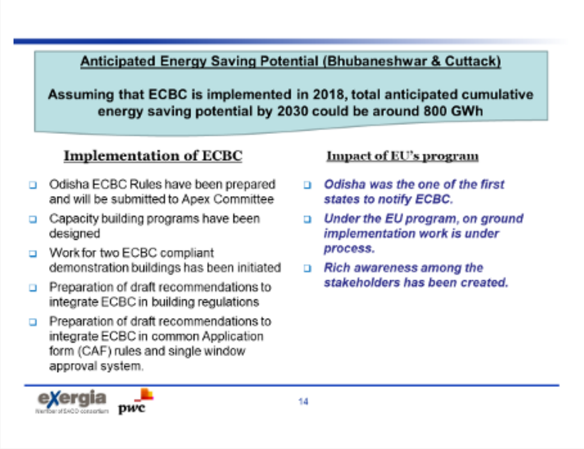
Anticipated Energy Saving Potential

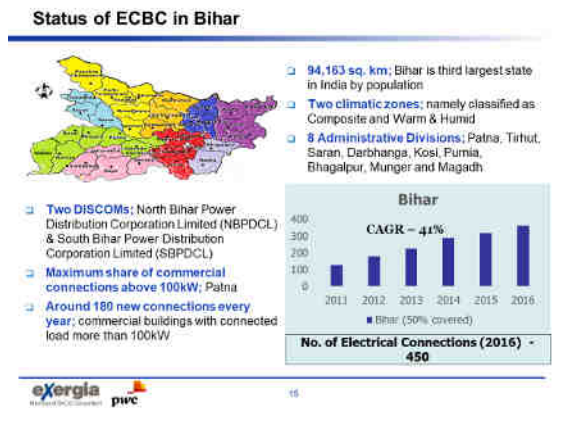
Assuming that ECBC is implemented in 2018, total anticipated cumulative energy saving potential by 2030 could be around 1000 GWh

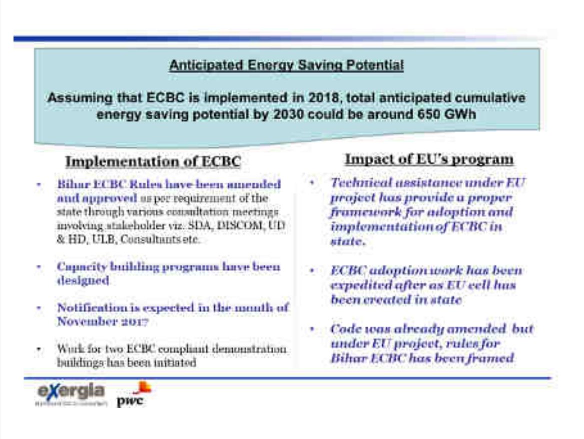
Implementation of ECBC
- **All Stakeholders were engaged in development of ECBC Rules;** UADD DISCOM, CREDAI members, and others
- **MP-ECBC Rules have been amended;**
- Notification is expected by November 2017
- **Capacity Building Program, & Demonstration project;** is in progress

Impact of EU's program
- *Helped to track the existing energy consumption scenario of the state.*
- *Strategies to integrate ECBC in building permit approval process is being developed for the state.*
- *Prepared Rules to comply and enforce the adoption of ECBC, considering the existing administrative working system; for building approval system*


ODISHA SCENARIO
155,820 sq. km of area; makes Odisha ninth largest state of India
Two climatic zones; namely classified as Composite and Warm-Humid
3 Divisions; North, South and Central, with their headquarters at Sambalpur, Berhampur and Cuttack respectively
Three DISCOM; NESCO (North), WESCO (West) and CESU (Central)
Maximum share of commercial connections above 100kW; Bhubaneswar & Cuttack
BAU scenario; The growth rate in commercial establishment is 10% in Bhubaneswar and 12% in Cuttack city
Odisha (Bhubaneshwar & Cuttack)
CAGR ~ 9%
600
400
200
0
2011
2012
2013
2014
2015
2016
Odisha
No. of Electrical Connections (2016) - 522
eXergia
pwc
13


Anticipated Energy Saving Potential (Bhubaneshwar & Cuttack)
Assuming that ECBC is implemented in 2018, total anticipated cumulative energy saving potential by 2030 could be around 800 GWh
Implementation of ECBC
Odisha ECBC Rules have been prepared and will be submitted to Apex Committee
Capacity building programs have been designed
Work for two ECBC compliant demonstration buildings has been initiated
Preparation of draft recommendations to integrate ECBC in building regulations
Preparation of draft recommendations to integrate ECBC in common Application form (CAF) rules and single window approval system.
Impact of EU's program
Odisha was the one of the first states to notify ECBC.
Under the EU program, on ground implementation work is under process.
Rich awareness among the stakeholders has been created.
eXergia
pwc
14


Status of ECBC in Bihar
94,163 sq. km; Bihar is third largest state in India by population
Two climatic zones; namely classified as Composite and Warm & Humid
8 Administrative Divisions; Patna, Tirhut, Saran, Darbhanga, Kosi, Purnia, Bhagalpur, Munger and Magadh
Two DISCOMs; North Bihar Power Distribution Corporation Limited (NBPDCL) & South Bihar Power Distribution Corporation Limited (SBPDCL)
Maximum share of commercial connections above 100kW; Patna
Around 180 new connections every year; commercial buildings with connected load more than 100kW
Bihar
CAGR ~ 41%
400
300
200
100
0
2011
2012
2013
2014
2015
2016
Bihar (50% covered)
No. of Electrical Connections (2016) - 450
eXergia
pwc
15


Anticipated Energy Saving Potential
Assuming that ECBC is implemented in 2018, total anticipated cumulative energy saving potential by 2030 could be around 650 GWh
Implementation of ECBC
Bihar ECBC Rules have been amended and approved as per requirement of the state through various consultation meetings involving stakeholder viz. SDA, DISCOM, UD & HD, ULB, Consultants etc.
Capacity building programs have been designed
Notification is expected in the month of November 2017
Work for two ECBC compliant demonstration buildings has been initiated
Impact of EU's program
Technical assistance under EU project has provide a proper framework for adoption and implementation of ECBC in state.
ECBC adoption work has been expedited after as EU cell has been created in state
Code was already amended but under EU project, rules for Bihar ECBC has been framed
eXergia
pwc


Thank you for your attention!
EXERGIA Energy and Environment Consultants
In collaboration with
PricewaterhouseCoopers India
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http://www.ace-e2.eu
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17

NATIONAL FUND FOR SCIENTIFIC RESEARCH	DUNK-01/3, DFNI E 02/17
Title: Creating an University Research and Development Centre for innovation and transfer of knowledge in the field of micro/ nano technologies and materials, energy efficiency and virtual engineering	**Funding mechanism:** National Fund for Scientific Research at the Ministry of Education and Science of Bulgaria DUNK-01/3 **Partner**: Technical University of Sofia
Title: Parametric analysis for evaluation of the efficiency of transparent structures in systems for utilization of solar energy	**Funding mechanism:** National Fund for Scientific Research at the Ministry of Education and Science of Bulgaria DFNI E 02/17 **Partners**: University of Chemical Industry and Metallurgy - Sofia, the Technical University of Sofia and the Technical University Angel Kanchev- Rousse

Abstract

Results from two research projects funded by the National Fund for Scientific Research at the Ministry of Education and Science of Bulgaria under contract DUNK-01/3 "Creating an University Research and Development Centre for innovation and transfer of knowledge in the field of micro/ nano technologies and materials, energy efficiency and virtual engineering " in TU-Sofia and contract DFNI E 02/17" Parametric analysis for evaluation of the efficiency of transparent structures in systems for utilization of solar energy - with partners: the University of Chemical Industry and Metallurgy - Sofia, the Technical University of Sofia and the Technical University Angel Kanchev- Rousse, are presented.

By means of advanced technical equipment parametric analysis of the thermal properties of materials is carried out in the temperature range from -70° C to 1500 °C for identification of their functional dependence on temperature. Results of energy performance test of new types of heat regenerators for application in building ventilation systems are presented.

The characteristics of different types of solar collectors have been investigated under different solar radiation images and the deviation of the actual efficiency from the declared under standard conditions has been evaluated. An adsorption system for cold production based on solar energy utilization is built and allows exploration of different heat and cold storage strategies. Special emphasis is placed on the study of thermal processes through non-flat transparent elements and passive elements - the Trombe wall.

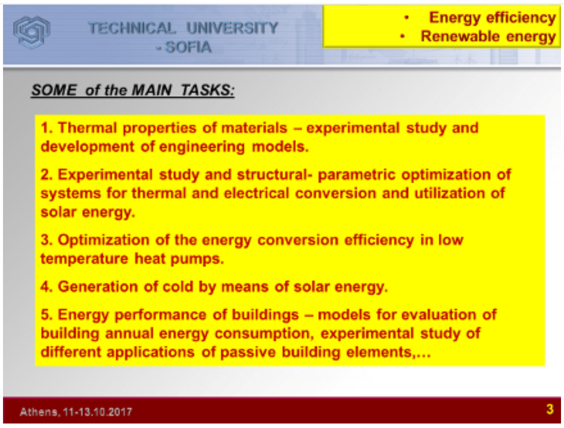
Opportunities for experimental study of open and closed Trombe wall and evaluation of the efficiency in ventilation, heating and cooling for the climatic conditions of Bulgaria were created. The results provide a basis for changing the traditional architectural and technical solutions and are a challenge to increase energy and environmental efficiency in the building sector.

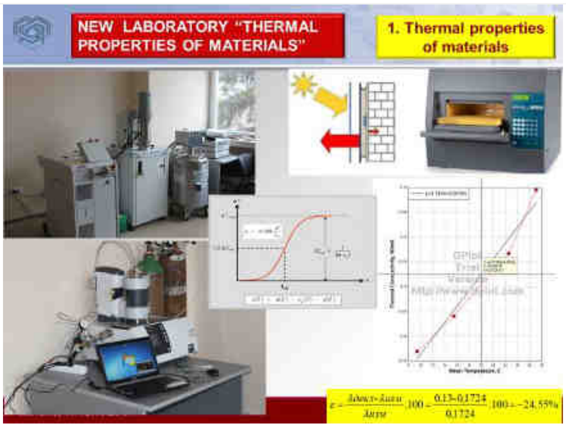
New challenges for the building energy efficiency in Bulgaria – results of two R&D projects at the Technical University – Sofia

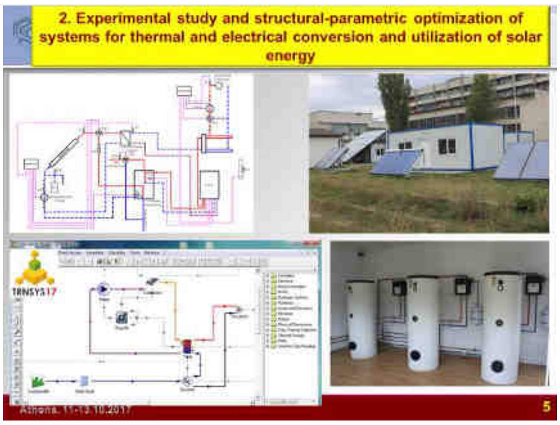
by

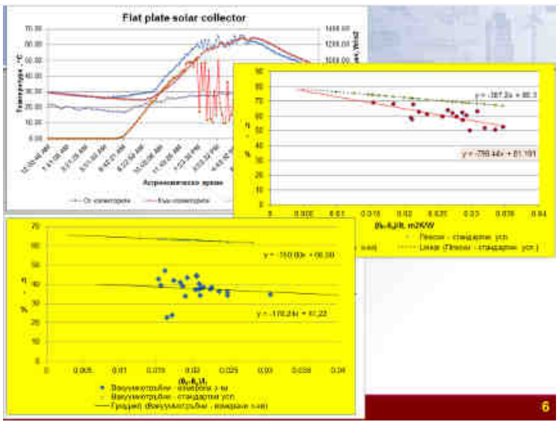
Prof. Nikolas KALOYANOV,

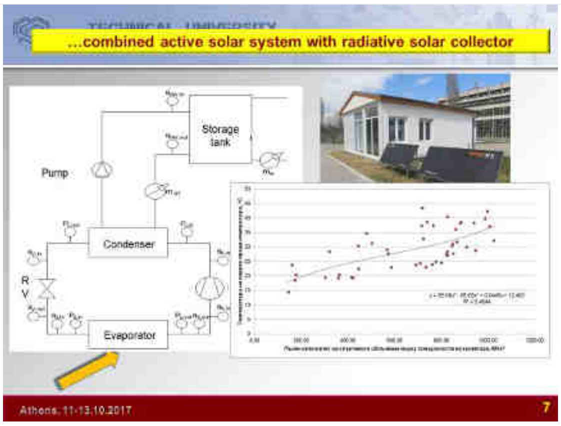
Technical University of Sofia, Bulgaria

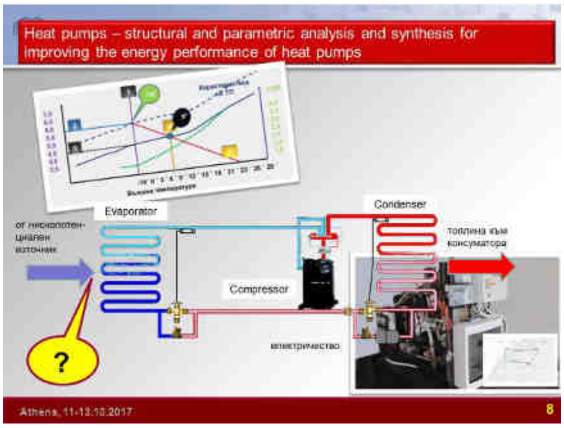


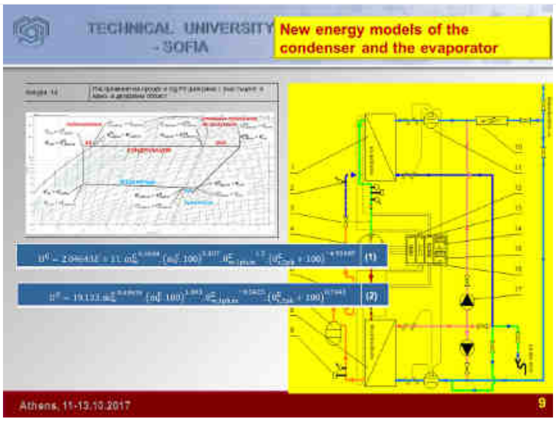


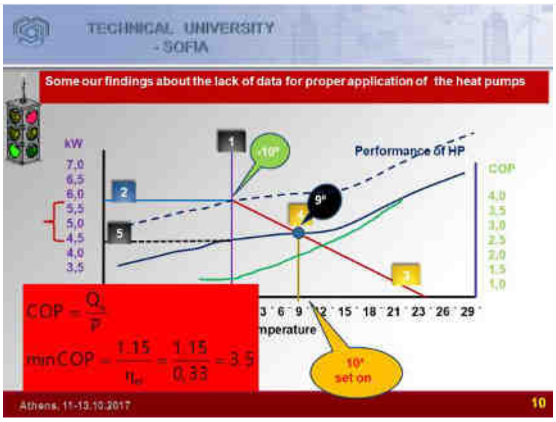


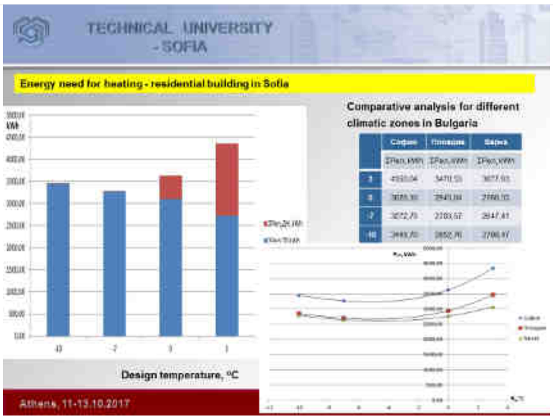



...combined active solar system with radiative solar collector
Storage tank
Pump
Condenser
Evaporator
Athens, 11-13.10.2017
7

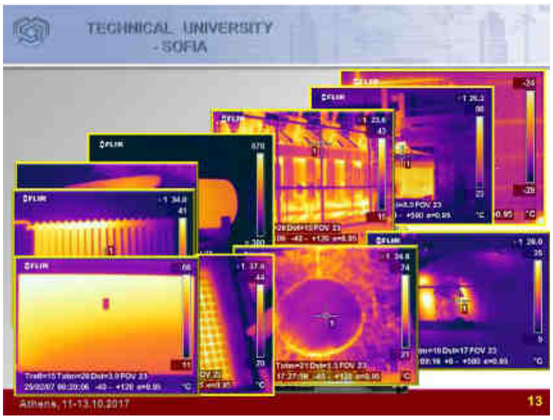

Heat pumps – structural and parametric analysis and synthesis for improving the energy performance of heat pumps
Evaporator
Condenser
Compressor
?
Athens, 11-13.10.2017
8

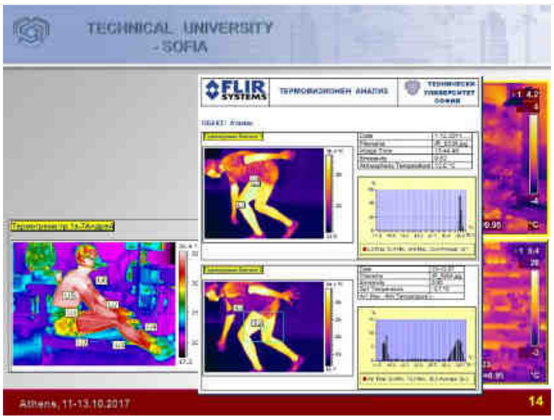

TECHNICAL UNIVERSITY - SOFIA
New energy models of the condenser and the evaporator
(1)
(2)
Athens, 11-13.10.2017
9


TECHNICAL UNIVERSITY - SOFIA
Some our findings about the lack of data for proper application of the heat pumps
kW
Performance of HP
COP
10°
set on
Athens, 11-13.10.2017
10


TECHNICAL UNIVERSITY - SOFIA
Energy need for heating - residential building in Sofia
Comparative analysis for different climatic zones in Bulgaria
Design temperature, °C
Athens, 11-13.10.2017

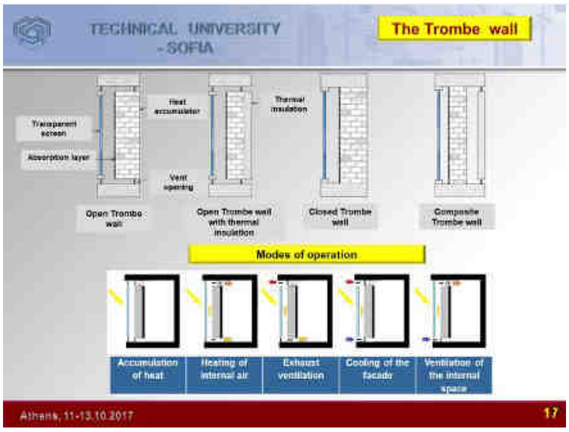

TECHNICAL UNIVERSITY - SOFIA
RESEARCH LABORATORY FOR INFRARED ANALYSES
Development of methods and procedures for application of the infrared analysis for assessment of properties
1. Energy efficiency
• buildings,
• HVAC systems
• industrial and electrical systems
2. Diagnostics and preventive control
• mechanical and electrical systems
• quality control
3. New materials
• identification of properties of new materials
• thermal properties of new components
4. Medicine
• assessment of medical apparatus for therapy
• microclimate
5. Sport
Athens, 11-13.10.2017
12


TECHNICAL UNIVERSITY - SOFIA
Athens, 11-13.10.2017
13


TECHNICAL UNIVERSITY - SOFIA
FLIR SYSTEMS
Athens, 11-13.10.2017
14


TECHNICAL UNIVER
- SOFIA
4. Generation of cold by means of solar energy


TECHNICAL UNIVER
- SOFIA
5. Energy performance of buildings
...passive building elements
TRNSYS
TRNSYS 17


TECHNICAL UNIVERSITY
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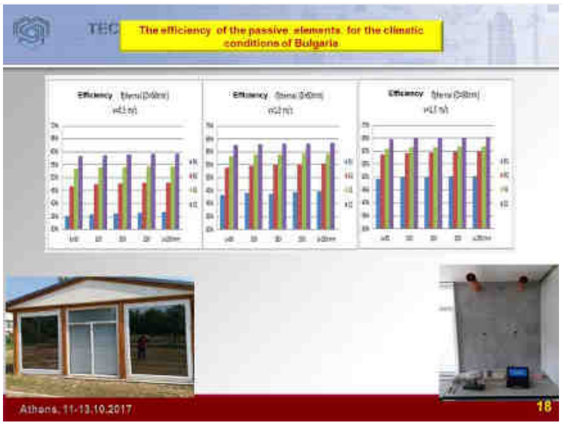
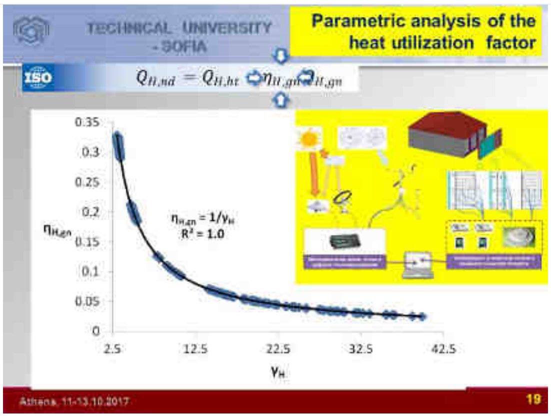
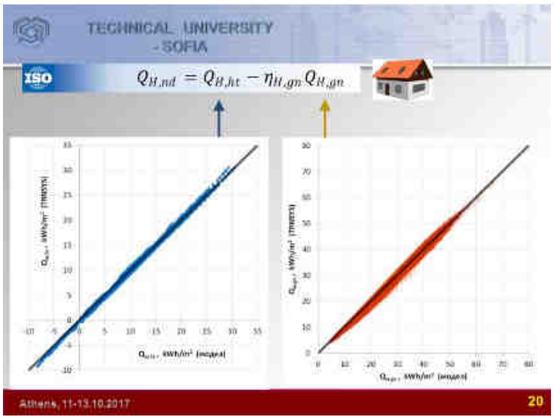
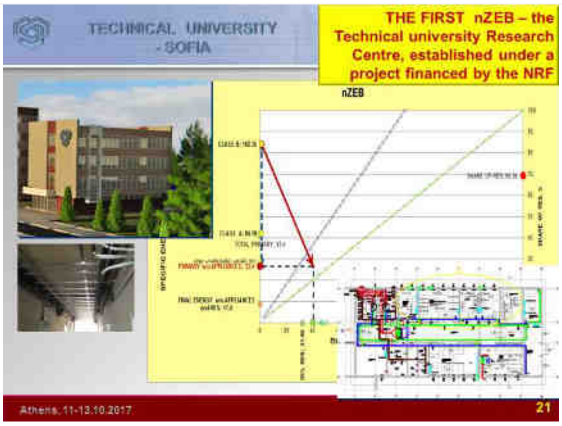
The Trombe wall
Transparent screen
Absorption layer
Heat accumulator
Thermal insulation
Vent opening
Open Trombe wall
Open Trombe wall with thermal insulation
Closed Trombe wall
Composite Trombe wall
Modes of operation
Accumulation of heat
Heating of internal air
Exhaust ventilation
Cooling of the facade
Ventilation of the internal space
Athens, 11-13.10.2017
17


TEC
The efficiency of the passive elements for the climatic conditions of Bulgaria
Athens, 11-13.10.2017
18


TECHNICAL UNIVERSITY
- SOFIA
Parametric analysis of the heat utilization factor
ISO
$Q_{H,nd} = Q_{H,ht} - \eta_{H,gn} Q_{H,gn}$
$\eta_{H,gn} = 1/\gamma_H$
$R^2 = 1.0$
$\eta_{H,gn}$
γ_H
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2.5
12.5
22.5
32.5
42.5
Athens, 11-13.10.2017
19


TECHNICAL UNIVERSITY
- SOFIA
ISO
$Q_{H,nd} = Q_{H,ht} - \eta_{H,gn} Q_{H,gn}$
Athens, 11-13.10.2017
20


TECHNICAL UNIVERSITY
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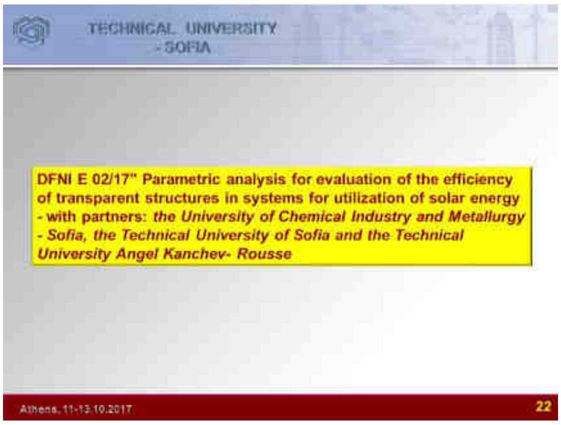
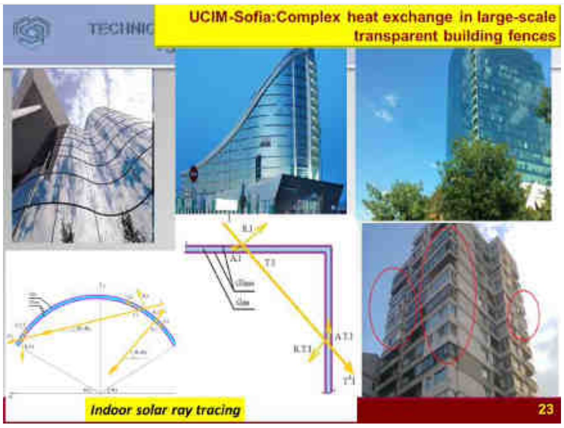
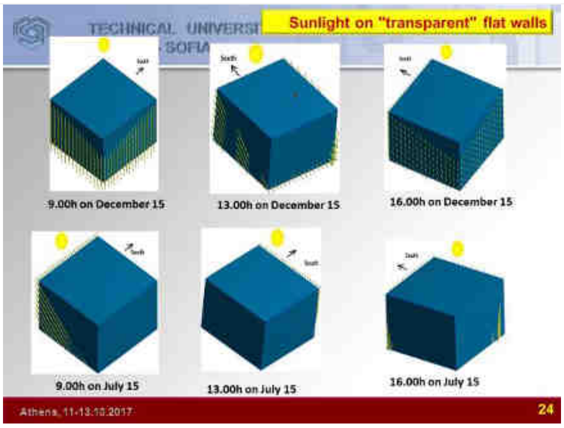
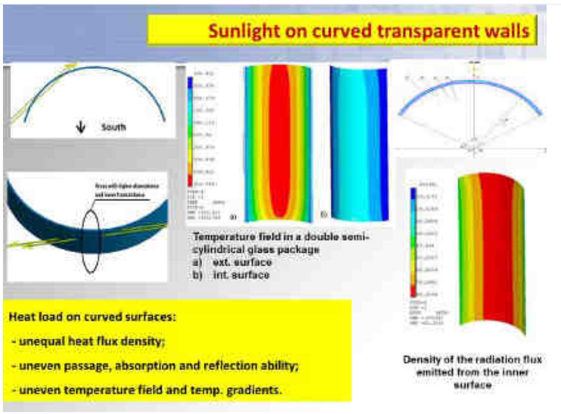
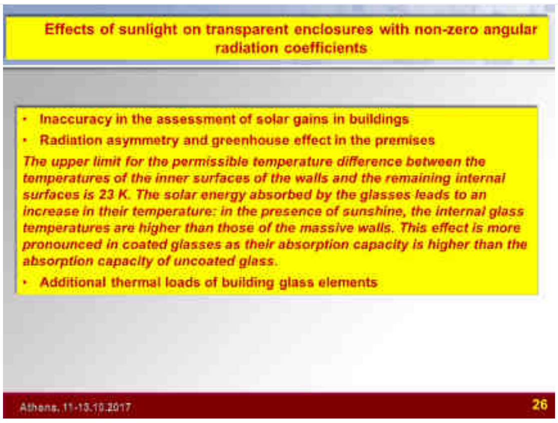
THE FIRST nZEB – the Technical university Research Centre, established under a project financed by the NRF
nZEB
Athens, 11-13.10.2017
21

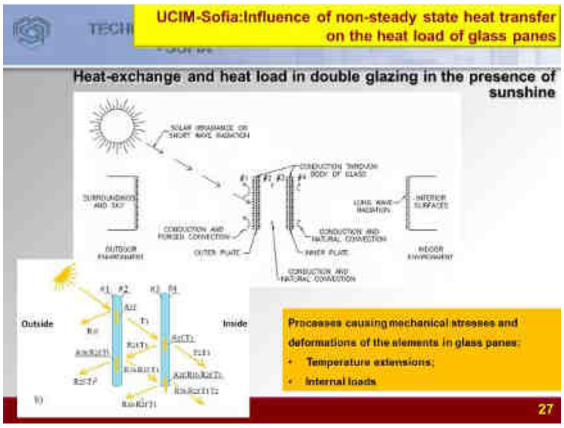

TECHNICAL UNIVERSITY
- SOFIA
DFNI E 02/17" Parametric analysis for evaluation of the efficiency of transparent structures in systems for utilization of solar energy - with partners: the University of Chemical Industry and Metallurgy - Sofia, the Technical University of Sofia and the Technical University Angel Kanchev- Rousse
Athens, 11-13.10.2017
22


UCIM-Sofia:Complex heat exchange in large-scale transparent building fences
Indoor solar ray tracing
23


Sunlight on "transparent" flat walls
9.00h on December 15
13.00h on December 15
16.00h on December 15
9.00h on July 15
13.00h on July 15
16.00h on July 15
Athens, 11-13.10.2017
24


Sunlight on curved transparent walls
South
Temperature field in a double semi-cylindrical glass package
a) ext. surface
b) int. surface
Heat load on curved surfaces:
- unequal heat flux density;
- uneven passage, absorption and reflection ability;
- uneven temperature field and temp. gradients.
Density of the radiation flux emitted from the inner surface


Effects of sunlight on transparent enclosures with non-zero angular radiation coefficients
• Inaccuracy in the assessment of solar gains in buildings
• Radiation asymmetry and greenhouse effect in the premises
The upper limit for the permissible temperature difference between the temperatures of the inner surfaces of the walls and the remaining internal surfaces is 23 K. The solar energy absorbed by the glasses leads to an increase in their temperature: in the presence of sunshine, the internal glass temperatures are higher than those of the massive walls. This effect is more pronounced in coated glasses as their absorption capacity is higher than the absorption capacity of uncoated glass.
• Additional thermal loads of building glass elements
Athens, 11-13.10.2017
26


UCIM-Sofia:Influence of non-steady state heat transfer on the heat load of glass panes
Heat-exchange and heat load in double glazing in the presence of sunshine
Outside
Inside
Processes causing mechanical stresses and deformations of the elements in glass panes:
• Temperature extensions;
• Internal loads
27


Objective: to create an algorithm for predicting thermo-mechanical behavior and the possibility of fatigue of transparent elements of glass-packets in the seasonal variation of climatic conditions and solar radiation.
Modeling of conjugated heat exchange through glazing units
Practice shows that non-stationary temperature fields in transparent facade elements with practical accuracy can be considered as a sequence of stationary ones, resulting from boundary conditions reflecting current weather conditions.
System of equations based on differential method.
Fluid environment (pressurized gas space of glass):
• continuity equation;
• motion equations;
• energy equation;
• model of turbulence;
• models of dynamic and thermal boundary layer.
Non-fluid medium (glass sheets, spacer, gaskets):
• Energy equation for rigid fixed environment (Fourier-Kirchhoff).
The surfaces limiting the pressurized gas space form a closed system. Modern computational simulation environments offer possibilities for calculating angular coefficients and heat exchange by emitting between the "mutually visible" surfaces of the finite elements / volumes in closed and open systems [Radiosity solver method].
Athens, 11-13.10.2017
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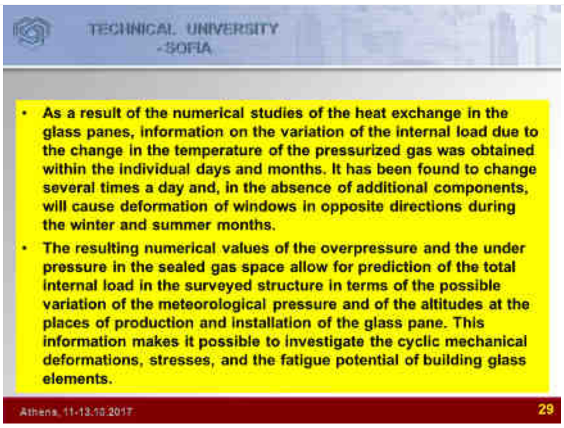
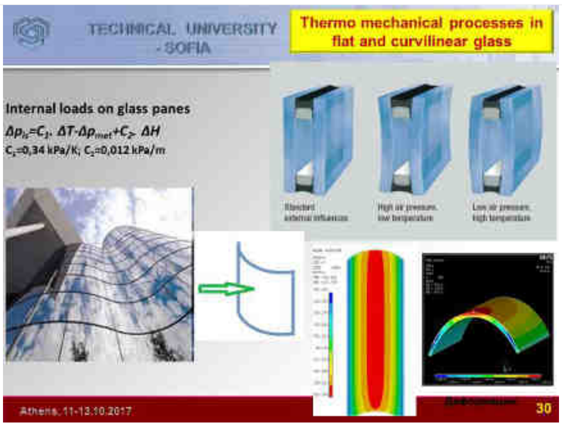
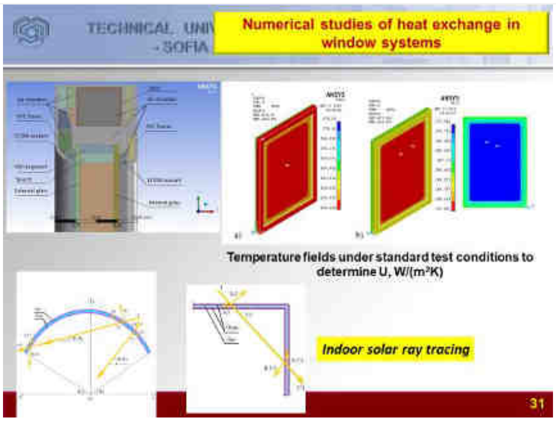
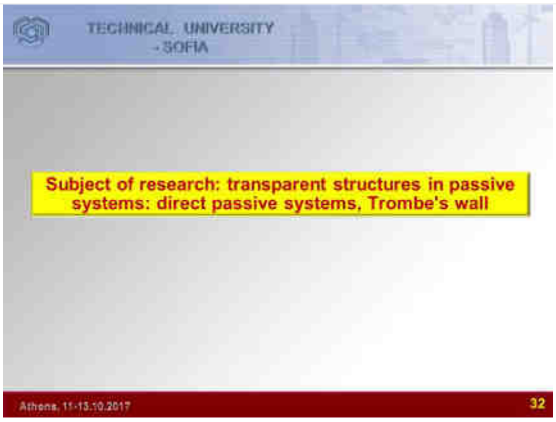
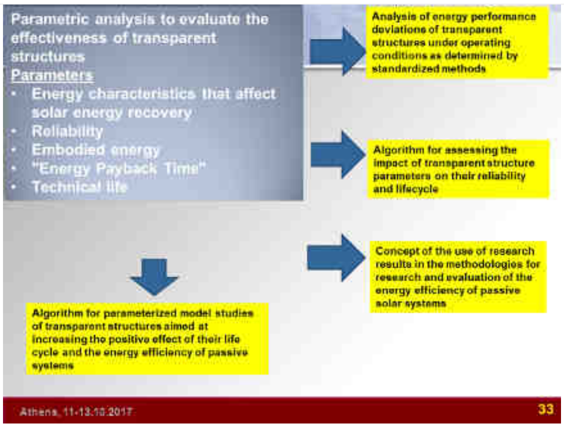
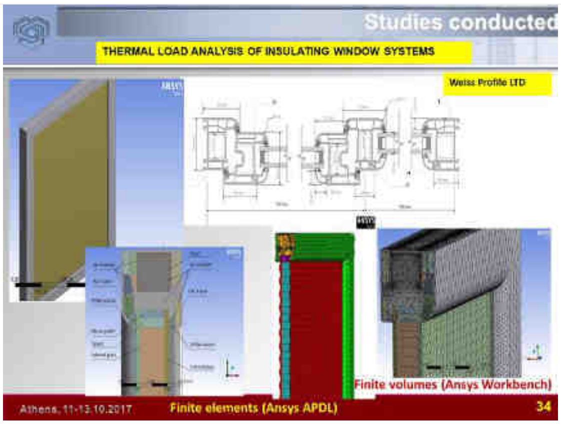

TECHNICAL UNIVERSITY - SOFIA
• As a result of the numerical studies of the heat exchange in the glass panes, information on the variation of the internal load due to the change in the temperature of the pressurized gas was obtained within the individual days and months. It has been found to change several times a day and, in the absence of additional components, will cause deformation of windows in opposite directions during the winter and summer months.
• The resulting numerical values of the overpressure and the under pressure in the sealed gas space allow for prediction of the total internal load in the surveyed structure in terms of the possible variation of the meteorological pressure and of the altitudes at the places of production and installation of the glass pane. This information makes it possible to investigate the cyclic mechanical deformations, stresses, and the fatigue potential of building glass elements.
Athens, 11-13.10.2017
29

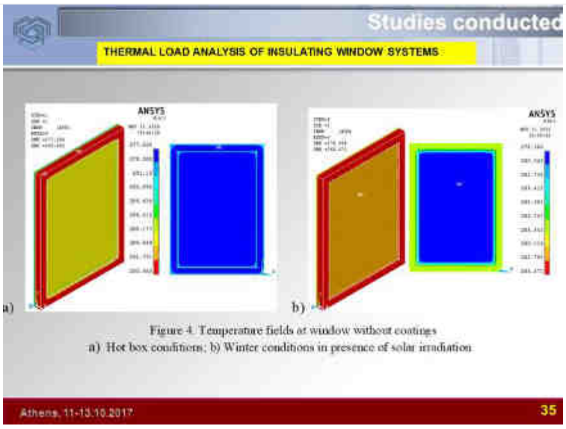

TECHNICAL UNIVERSITY - SOFIA
Thermo mechanical processes in flat and curvilinear glass
Internal loads on glass panes
$\Delta p_{is}=C_1 \cdot \Delta T \cdot \Delta p_{met}+C_2 \cdot \Delta H$
C_1=0,34 kPa/K; C_2=0,012 kPa/m
Athens, 11-13.10.2017
30





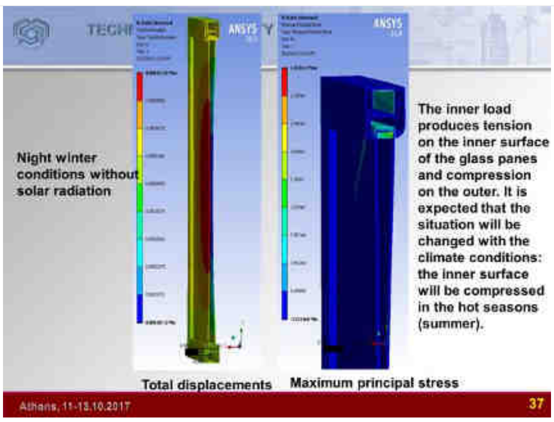


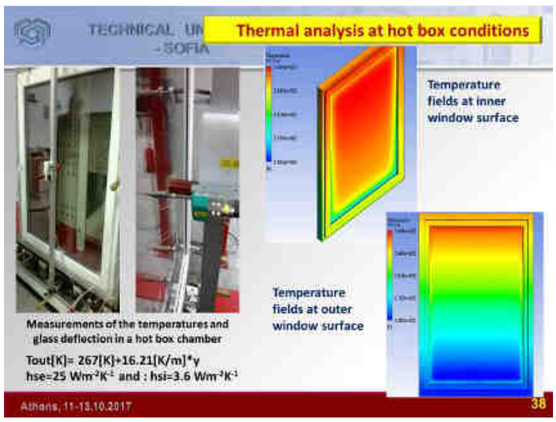


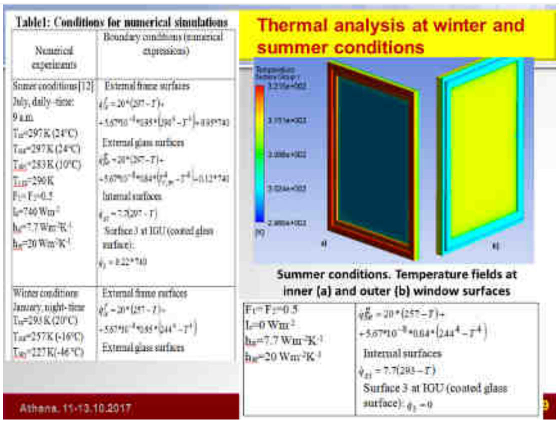


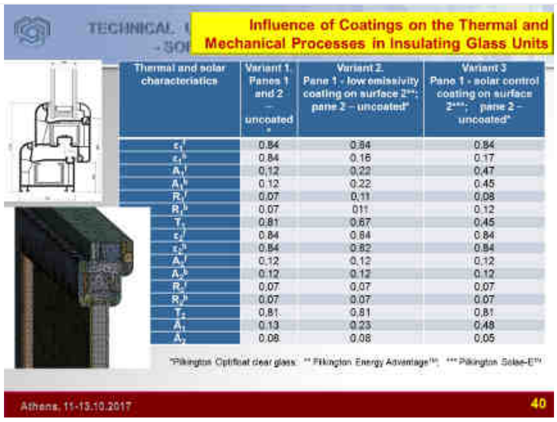
Average temperature and isochoric pressure of the hermetically sealed gas (argon)

Numerical experiments	Test conditions at Hotbox chamber t_{in}=21°C, t_{out}=3°C h_{si}=3,6 W/m²K⁻¹ h_{se}=23 W/m²K⁻¹ (Analysis by ANSYS APDL/Flotran)	Daily winter conditions with solar irradiation t_{in}=21°C, t_{out}=3°C, t_{sky}=-10 °C, F_t=0.5; I_s=350 W/m² h_{si}=3,6 W/m²K⁻¹ h_{se}=23 W/m²K⁻¹ (Analysis by ANSYS APDL/Flotran)	Night winter conditions t_{in}=21°C, t_{out}=3°C t_{sky}= -10 °C; F_t=0 h_{si}=3,6 W/m²K⁻¹ h_{se}=23 W/m²K⁻¹ (Analysis by ANSYS/Fluent)
Window system with low-e coating on surface 3	t_{gas}=11°C ΔT=-9 K Δp_s=-3060 Pa	t_{gas}=16°C ΔT=-4 K Δp_s=-1360 Pa	t_{gas}=11°C ΔT= -9.2 K Δp_s=3106 Pa
Window system without coatings on the glass surfaces	t_{gas}=10°C ΔT=-10 K Δp_s=3400 Pa	t_{gas}=12°C ΔT=-8 K Δp_s=-2720 Pa	-
UGU with low-e coating on surface 3	t_{gas}=11°C ΔT=-9 K Δp_s=3060 Pa	-	-

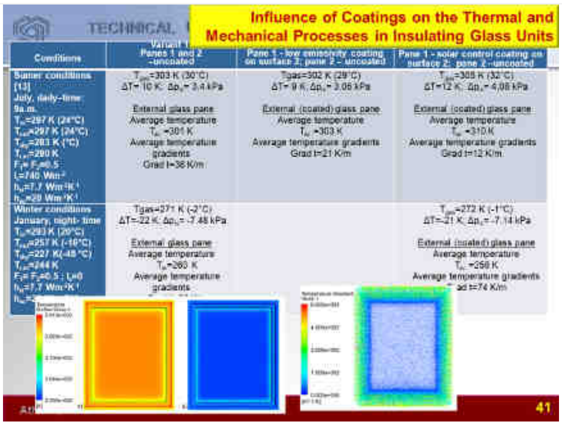


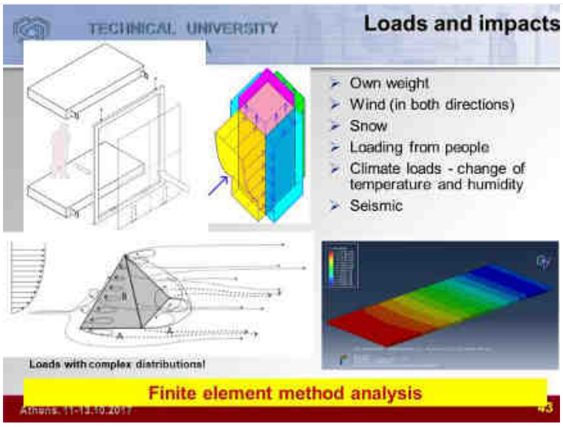


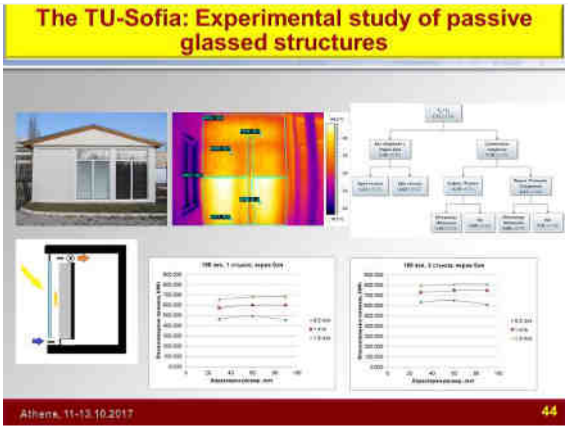


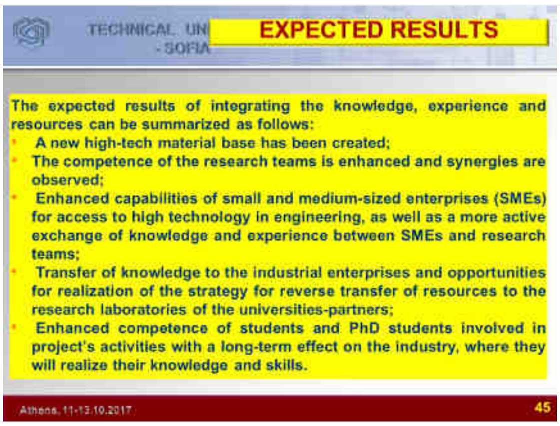


Thermal and solar characteristics	Variant 1. Panes 1 and 2 – uncoated*	Variant 2. Pane 1 - low emissivity coating on surface 2**; pane 2 – uncoated*	Variant 3 Pane 1 - solar control coating on surface 2***; pane 2 – uncoated*
ε_1^f	0.84	0.84	0.84
ε_1^b	0.84	0.16	0.17
A_1^f	0,12	0,22	0,47
A_1^b	0.12	0.22	0.45
R_1^f	0.07	0,11	0,08
R_1^b	0.07	011	0.12
T_1	0,81	0,67	0,45
ε_2^f	0.84	0.84	0.84
ε_2^b	0,84	0.82	0,84
A_2^f	0,12	0,12	0,12
A_2^b	0.12	0.12	0.12
R_2^f	0,07	0,07	0,07
R_2^b	0.07	0.07	0.07
T_2	0,81	0,81	0,81
A_1	0.13	0.23	0,48
A_2	0.08	0,08	0,05









HORIZON 2020	WiseGRID
Title: Wide scale demonstration of Integrated Solutions and business models for European smartGRID **Project Web Site:** https://www.wisegrid.eu/ **Duration:** 42 months **Start Date:** 01/11/2016 **Key Words:** smart grid, consumer-centric energy grid, sustainable energy communities, decentralized energy system, storage technologies, renewable energy sources, electric vehicles, open energy market	**Funding mechanism:** European Union's Horizon 2020 Research and Innovation programme under grant agreement No 731205 **Total Cost:** 17.595.500€ **EC Contribution:** 13.854.247€ **Consortium:** 21 partners from 8 countries **Project Coordinator:** ETRA INVESTIGACION Y DESARROLLO SA

The Challenge

European Commission aims to put the consumer at the center of the energy system, to promote and support sustainable energy communities.

To this direction, WiseGRID will provide a set of solutions and technologies to increase the smartness, stability and security of an open, consumer-centric European energy grid. The project will combine an enhanced use of storage technologies, a highly increased share of Renewable Energy Sources (RES) and the integration of charging infrastructure to favor the large-scale deployment of electric vehicles. It will place citizens at the center of the transformation of the grid. In addition to the consumer-centric approach, the project will make a difference in the market by delivering tools that facilitate the creation of a healthy, open market, where not only 'traditional' utilities but also players such as electric cooperatives and SMEs can play an active role.

WiseGRID integrated solution will be demonstrated and evaluated under real life conditions in 4 large scale demonstrators - in Belgium, Italy, Spain and Greece - under different technical, climatological, regulatory, legislative and social conditions.

Methodology

More than 1.700 users will demonstrate WiseGRID solutions in 4 large scale pilot sites during at least 15 months. The demonstration activities will take place in real conditions in different electric Cooperatives, consumer-centric public Distribution System Operators (DSOs), and other larger and private entities, involving different types of actors of the distribution grid and the energy retail market, such as customers/prosumers (households and business), DSOs, retailers, aggregators and car-sharing companies.

In order to facilitate the cross-site assessment of the performance, transferability and scalability of WiseGRID solutions, the demonstrations will be conducted following 7 common high-level use cases:

- Integrate and demonstrate the largest possible share of intermittent decentralized RESs, showing the services that will provide stable and secure grids in these circumstances, including avoiding curtailment.
- Decentralized control automation of the distribution grid: To provide an intelligent distributed control for DSO in order to detect faults, self-protect and self-reconfigure the network in a robust way to restore the power system without the intervention of a central intelligence (self-healing).

- Integration of e-mobility and electric transport systems into the network with the implementation of the Vehicle-to-Grid (V2G) technology in order to provide services to the grid, such as storage capacity.
- Integration of energy storage systems substation level: Use of storage systems integrated into the utilities and substations level in order to give flexibility to the grid and auxiliary power supply.
- Integration of cogeneration in a public building or collective housing, using hot water thermal storage units where heat can be used optimally and with the possibility to work with power to heat.
- Technical and economic feasibility of the Virtual Power Plant (VPP) concept, achieving higher efficiency by means of aggregated resources, i.e. to deliver peak load electricity or load-aware power generation at short notice.
- Empowerment and protection of citizens (Including energy self-consumption) and reduction of energy poverty.

Project Objectives

1. ***Demand-response***

   With different technologies such as smart metering, smart home appliances, batteries, EVs, etc., WiseGRID wants to create a win-win situation for both grid and consumers, allowing active participation, protection and empowerment of the European consumers and prosumers.
2. ***Smartening the distribution grid***

   WiseGrid aims to use technologies and methods to gain advanced monitoring and awareness of variable generation, integration of Virtual Power Plants and micro-grids as active balancing assets.
3. ***Integration of renewable energy storage systems in the network, such as batteries or heat accumulators***

   WiseGrid wants to optimize the market deployment of these storage systems, manage and balance the network optimally, respond better to changes in demand and reduce at the same time losses in distribution.
4. ***Smart integration of electric mobility services***

   for charging, providing storage capacity or to supply electricity to the grid, including the possible use of their batteries as storage systems.

Project partners

ETRA INVESTIGACION Y DESARROLLO SA, (Spain)
BOUYGUES ENERGIES & SERVICES (France)
ENGINEERING - INGEGNERIA INFORMATICA SPA (Italy)
CENTRUL ROMAN AL ENERGIEI (Romania)
ASM TERNI SPA IT (Italy)
ECOPOWER (Belgium)
COOPERATIVA ELECTRICA BENEFICA SANFRANCISCO DE ASIS SOCIEDAD COOPERATIVA VALENCIANA (Spain)
HYPERTECH (CHAIPERTEK) ANONYMOS VIOMICHANIKI EMPORIKI ETAIREIA PLIROFORIKIS KAI NEON TECHNOLOGION (Greece)
AMPERE POWER ENERGY SL (Spain)
ASOCIACION INSTITUTO TECNOLOGICO DE LA ENERGIA (Spain)
INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (Greece)

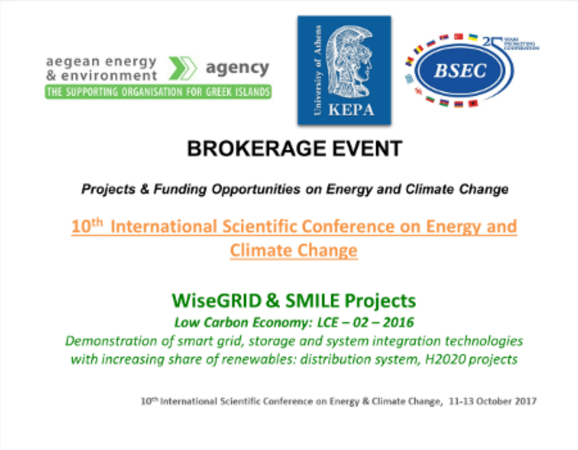
DIACHEIRISTIS ELLINIKOU DIKTYOU DIANOMIS ELEKTRIKIS ENERGEIAS AE (Greece)
ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS - RESEARCH CENTER (Greece)
RESCOOP EU ASBL (Belgium)
VARTA STORAGE GMBH (Germany)
QUEEN MARY UNIVERSITY OF LONDON (United Kingdom)
EMOTION SRL (Italy)
PARTAGO (Belgium)
Aegean Energy and Environment Agency (Greece)
Εταιρεία Παροχής Αερίου Αττικής ΑΕ (Greece)
ASOCIACION ESPANOLA DE NORMALIZACION Y CERTIFICACION (Spain)

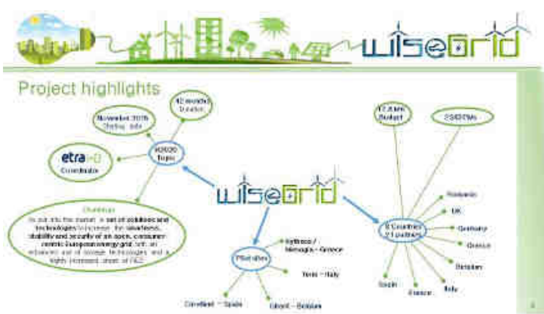
WiseGRID & SMILE – Demonstration of smart grid, storage and system integration technologies with increasing share of renewables: distribution system, H2020 projects

by

Ms. Alkisti FLOROU

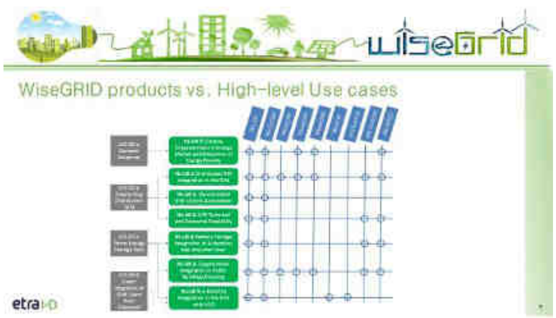
Aegean Energy & Environment Agency, Greece






wisegrid
WiseGRID technological solutions → 9 products (cont.)


wisegrid
WiseGRID technological solutions


wisegrid
WiseGRID products vs. High-level Use cases
etra


wisegrid
Demonstrators
WiseGRID integrated solution will be demonstrated and evaluated under real life conditions in 4 large scale demonstrators -in Belgium, Italy, Spain and Greece- under different technical, climatological, regulatory, legislative and social conditions.
Demonstration sites will involve more than 1700 users, 60 batteries -totalling more than 300KWh of installed capacity-, 50 heat pumps -totalling more than 160KWh of installed capacity-, 100 EV, 40 charging stations and more than 70MWh of RES -PV, Wind Turbines and Hydro-.


wisegrid
Demonstrators
Electric cooperative Crevillent, Spain
RES cooperative Flanders, Belgium
Public DSO Terni, Italy
National DSO Greece

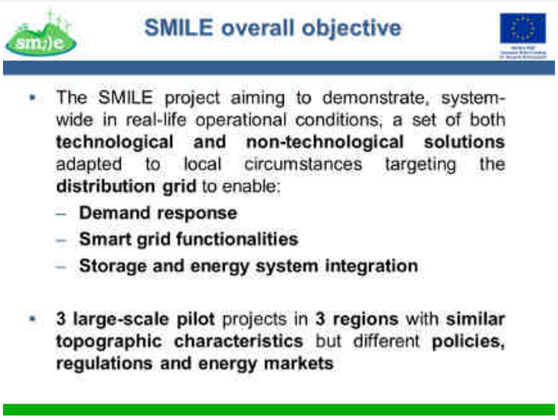

wisegrid
WiseGRID partners
etra
VARTA
HEDNO
emotion
Ecopower
ASM
ITE
ENERCOOP
CRE
HYPERTECH
Queen Mary
AENOR

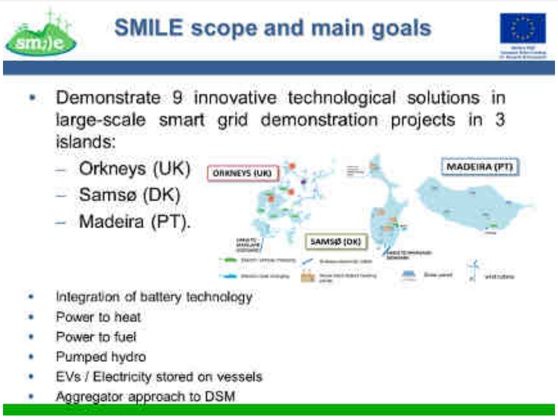
SMILE – Smart Island Energy Systems

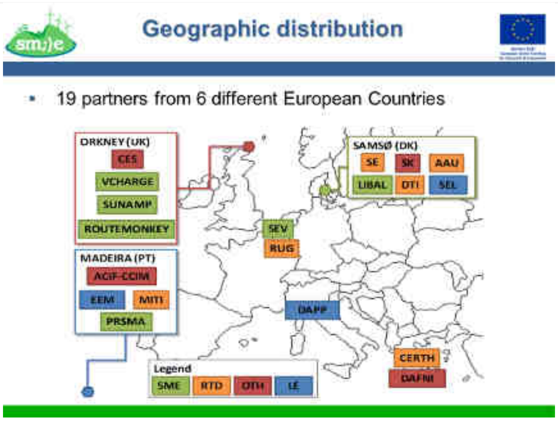
by

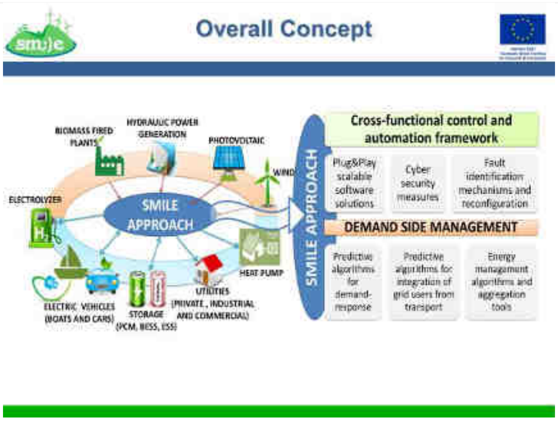
Ms. Alkisti FLOROU,

Aegean Energy & Environment Agency, Greece









Why island locations?

- Island communities can be **more easily engaged** in the real-life testing of solutions with measurable impact
- The 3 selected case studies:
  - Characterised by high shares of RES
  - Intend to demonstrate **stable grid operation** in the context of the **adoption of energy storage solutions** and/or the connection between the electricity network and other energy networks
  - Intend to demonstrate smart **integration of grid users** from transport and mobility.

Why island locations?

- Each pilot brings:
  - Specific set of challenges
  - Technology options
  - Energy market conditions
- The sites are therefore **effectively representative of the majority of the EU energy** markets and offer excellent demonstration settings which will deliver **maximum impact in terms of replicability**.

Replication

- Each case study is **representative of an important energy challenge common to several** locations in Europe, on islands as well on mainland.
- **Orkney Islands and Samsø are electrically connected to the mainland network** and can therefore be representative of **smart grids located on the mainland as well**
- **Madeira is the only case of a total energy island**, not connected to the mainland network.
- Mutual learning approaches
- Replication (DAFNI/Greek islands)

Communication

For more info

Webpage: http://www.h2020smile.eu

Social Media:

INTERREG MEDITERRANEAN	STEPPING
Title: Supporting the EPC (Energy Performance Contracts) public procurement in going-beyond **Project Web Site:** https://stepping.interreg-med.eu/ **Duration:** 2,5 years **Start Date:** 01/11/2016 **Key Words:** Energy Performance Contract (EPC), public buildings, energy upgrading, energy efficiency, investment scheme, Mediterranean Region	**Funding mechanism:** European Regional Development Fund (ERDF) **Total Cost:** 1.943.112,50€ **EC Contribution:** 1.651.645,63€ **Consortium:** 9 partners and 5 associate partners from 7 countries **Project Coordinator:** Piedmont Region

The Challenge

Energy Performance Contract (EPC) constitutes an investment scheme for buildings' energy upgrading. However, STEPPING's partners past experience and results of MED projects developed under previous programs, show that it is necessary to adapt this investment scheme to the conditions of the MED area in order to increase EPC diffusion and effectiveness. To this scope, it is necessary to introduce innovative approaches in the design of investment plans.

Through cooperation and knowledge sharing, STEPPING seeks to adapt EPC to the specific conditions prevailing in the Mediterranean, especially with regards to investment planning for the implementation of energy efficiency projects in public buildings. The project foresees the development and pilot implementation of 8 investment plans covering 60 municipalities, and the launch of tenders for EPC implementation in selected buildings.

Project Objectives

- To adapt the application of EPC investment for public buildings scheme to MED specific context
- To test the implementation of EPC MED schemes inside investment plans and public procurement
- To raise the competences on EPC for public building of MED public procurers and market players

Methodology

STEPPING work-plan includes the following actions:

1. Past and ongoing EPC projects will be analysed in order for barriers to be identified and specific solutions to be designed.
2. 8 new EPC investment plans for public buildings inside 7 MED countries, including island's communities, will be developed and tested. The Investment plans will be tested through the launch of tenders calls aimed at verifying plans' reliability.
3. Based on the results of the plans and tenders, the efficacy of identified measures will be checked and validated, and guidelines for EPC in MED area will be developed.

4. The results will be transferred to ordinary tender procedures of partners and engagement of largest audience will be achieved through dissemination and training activities.

Project partners

Città metropolitana di Torino - Piemonte Region (Italy)

Energy and Sustainable Development Agency of Modena (Italy)

BSC, Business Support Center Ltd, Kranj, Regional Development Agency (Slovenia)

ENVIRONMENT PARK SPA (Italy)

Huelva County Council (Spain)

Malta Intelligent Energy Management Agency (Malta)

Aegean Energy and Environment Agency (Greece)

Regional Energy and Environment Agency in Rhone-Alpes (France)

Regional Energy and Environment Agency from North Alentejo (Portugal)

Associate partners

Network of Sustainable Greek Islands (Greece)

Centre For Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning (France)

City of Torino (Italy)

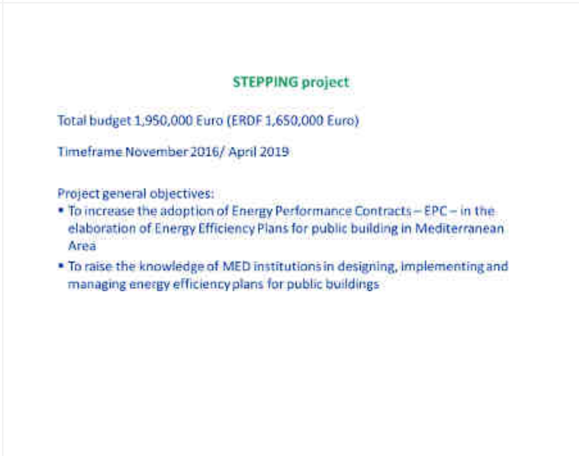
Institute of Systems and Robotics - University of Coimbra (Portugal)

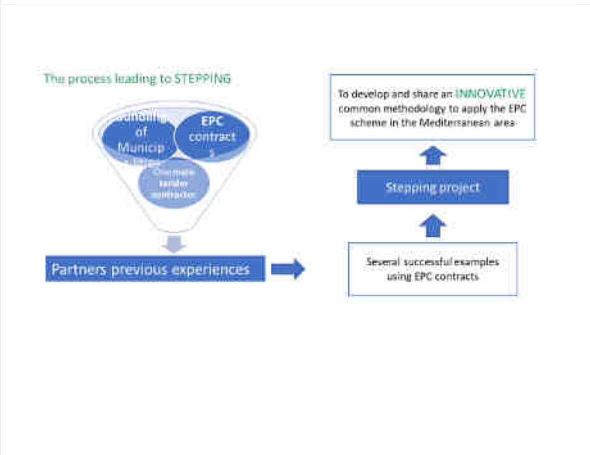
COMUNIDADE INTERMUNICI PAL DO ALTO ALENTEJO (Portugal)

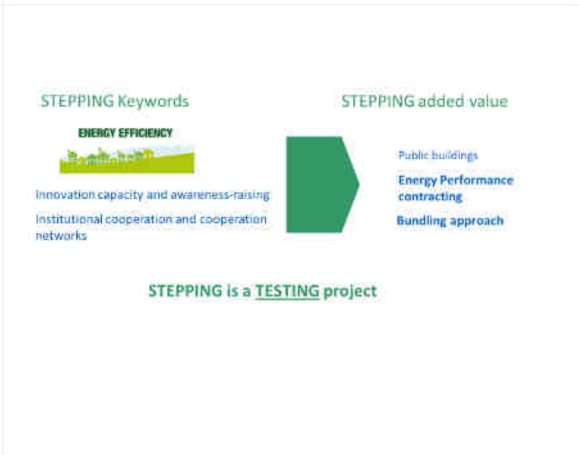
STEPPING – Supporting the EPC Public Procurement IN Going – Beyond, INTERREG Med project

by

Ms. Alkisti FLOROU
Aegean Energy & Environment Agency, Greece







STEPPING MAIN OBJECTIVES

- Adaptat the application of EPC investment for public buildings scheme to MED specific context: METHODOLOGIES ➡ TESTING
- Test the implementation of EPC MED schemes inside investment plans and public procurement: TENDER DOCUMENTS ➡ TESTING
- Raise the competences on EPC for public building of MED public procurers and market players: TRAINING ➡ TRANSFERRING
- Involve into project activities the largest audience of stakeholders: DISSEMINATE methodologies and results: ➡ COMMUNICATION

STEPPING MAIN RESULTS

- Prepare 8 investment plan in MED AREA for municipalities
- Launch 4 investment plan in 4 countries
- Train 600 public officers, experts, public procurers on EPC
- Deliver MED guidelines for EPC in public buildings for wider dissemination

Interreg Mediterranean STEPPING

Project co-financed by the European Regional Development Fund

For more info

Webpage: https://stepping.interreg-med.eu/en/

Social Media:

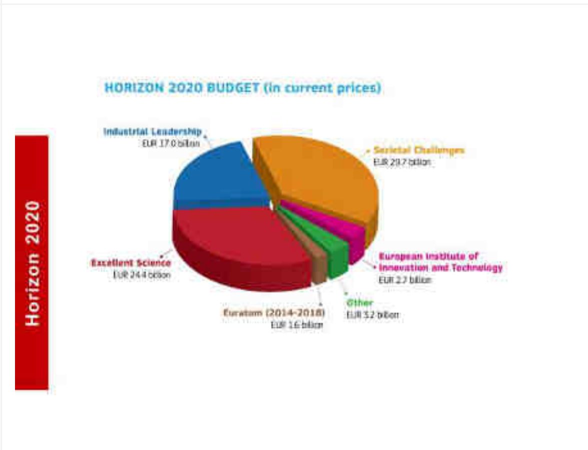
Session 2: Funding opportunities

H2020 – Energy: new calls

by

Ms. Christiana SIAMPEKOU

National Contact Point, National Documentation Centre, Greece



Draft Energy WP 2018-20

Introduction to the draft WP 2018-2020 "Secure, Clean and Efficient Energy"

Activities should deliver:

- cheaper and more performant generation technologies (e.g. renewable energy technologies);
- a smarter, more flexible and resilient energy system (including affordable and integrated energy storage solutions);
- increased overall energy efficiency (e.g. in the EU's building stock) and provision of means to enable consumers to play a more active role in the energy transition;
- a better understanding of the specific socio-economic contexts in which the energy transition takes place;
- increased market-uptake of innovations, including the implementation of energy policy, the preparation for rolling-out investments, and the support for capacity-building

Draft Energy WP 2018-20

Main thematic areas

- Energy efficiency
- Global leadership in renewables
- Smart and clean energy for consumers
- Smart citizen-centred energy system
- Smart Cities and Communities
- Enabling near-zero CO2 emissions from fossil fuel power plants and carbon intensive industries
- Joint Actions
- Cross-cutting issues
- Other actions

Disclaimer: This draft has not been adopted or endorsed by the European Commission. Only the adopted work programme will have legal value. The adoption of the work programme will be announced on the Horizon 2020 website and on the Participant Portal.

Draft Energy WP 2018-20

Energy Efficiency
- Upgrading buildings' energy performance and smartness
- Energy efficient industry and services
- Energy efficiency is an investment
- Energy efficiency is an energy source
- Support for policy-driven innovations

Global leadership in renewables
- Next Renewable energy solutions
- Renewable energy solutions for implementation at consumer scale
- Renewable energy solutions for energy system level implementation
- Renewable Fuels for

Smart and clean energy for consumers
- The role of consumers in changing the market through informed decision and collective actions
- Mitigating household energy poverty
- Consumer engagement and demand response

Draft Energy WP 2018-20

Smart citizen-centred energy system
- Electricity markets and consumers, interacting with other energy vectors
- Decarbonisation of local energy systems whether on islands or on the continent

Smart Cities and Communities
- Integrated innovative solutions for Positive Energy Blocks/Districts will be developed and tested and performance-monitored in the Lighthouse Cities
- Interaction and integration between the buildings, the users and the larger energy system, increased electro-mobility, its impact on the energy system and its integration in planning

Enabling near-zero CO2 emissions from fossil fuel power plants and carbon intensive industries
- Advanced CO2 capture technologies
- Conversion of captured CO2
- Strategic planning for CCUS (conversion of captured CO2) development
- Integrated solutions for flexible operation of fossil fuel power plants through power-to-X-to-power and/or energy storage
- Low carbon industrial production using CCUS
- Geological Storage Pilots

Draft Energy WP 2018-20

Joint Actions
- Support for joint actions and public partnerships between European, national and regional funding agencies and processes through the use of several Horizon 2020 instruments (ERANET Cofund, Pre-Commercial Procurement etc)
- The objective of topics included in this area is to facilitate the creation or continuation of energy R&I public partnerships between the European Commission and/or countries and

Cross-cutting issues
- Social Sciences and Humanities (SSH) aspects of the Clean-Energy Transition
- Modelling in support to the transition to a Low-Carbon Energy System in Europe
- Support for the opening of low-carbon energy research databases in Europe
- Support to sectoral fora, Research, innovation and educational capacities for energy transition
- Transition in coal intensive regions

Other actions
- Horizon prizes
- Grants to identified beneficiaries
- Public procurements etc.

Draft Energy WP 2018-20

Important details

Estimated total budget (EUR million)	2018	2019	2020
	~650	~749	~805

- Energy infodays 2017: 23-25 October 2017, Brussels https://ec.europa.eu/inea/en/news-events/events/horizon-2020-energy-info-days-2017
- Draft Energy Work Programme 2018-2020: https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/draft_sc3_wp_2018-2020_preliminary_publication.pdf

Partner Search tools

Enterprise Europe Network

enterprise europe network

Business Support on Your Doorstep

C-Energy 2020

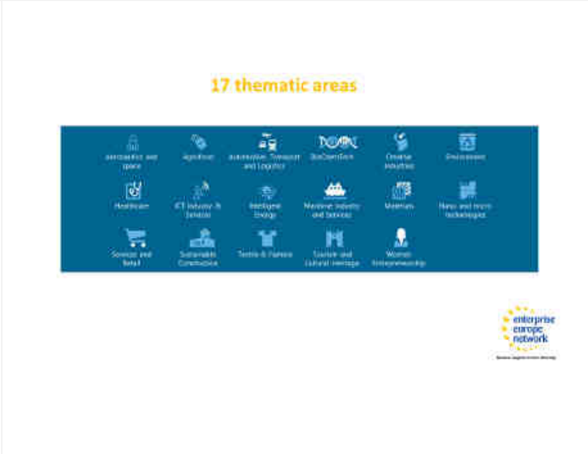
C-Energy2020

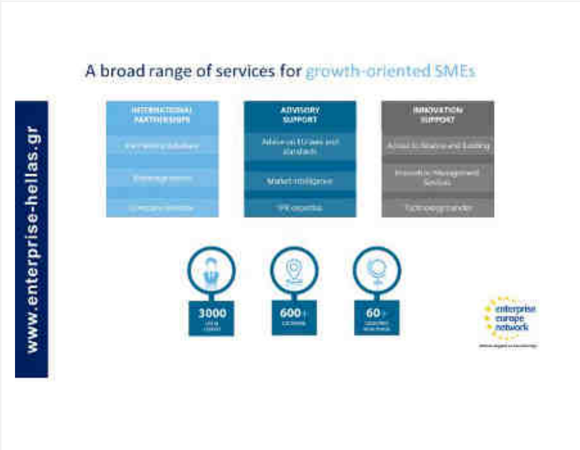
One-stop shop for European SMEs

20 years of experience

The largest network of integrated business support


3000
LOCAL EXPERTS
600+
LOCATIONS
60+
COUNTRIES WORLDWIDE
enterprise europe network


17 thematic areas
enterprise europe network


www.enterprise-hellas.gr
A broad range of services for growth-oriented SMEs
3000
600+
60+
enterprise europe network


www.enterprise-hellas.gr
How do I find a new market abroad?
How do I get European funding?
I need a business partner in another country...
How can I sell my innovative ideas and technology?
What does this EU law mean for my business?
enterprise europe network


www.enterprise-hellas.gr
Enterprise Europe Network – Useful links
• Enterprise Europe Network – Hellas
http://www.enterprise-hellas.gr/
• Enterprise Europe Network (EU)
http://een.ec.europa.eu/
enterprise europe network


The international network of
H2020 Energy National Contact Points (NCPs)
http://www.c-energy2020.eu/
https://www.youtube.com/watch?v=r-0EusGTv8w
C-Energy2020


www.c-energy2020.eu/
Dedicated Partner Search tool for Horizon2020
'Secure, Clean and Efficient Energy' topics:
http://www.partnersearch.c-energy2020.eu/
PS Tool User manual – available on website
Advantages
- Possibility to post a profile for R&I topics
- May focus on more than one H2020 calls
- Known to NCPs and the research and academic community
Partner Search
C-Energy2020


Contact:
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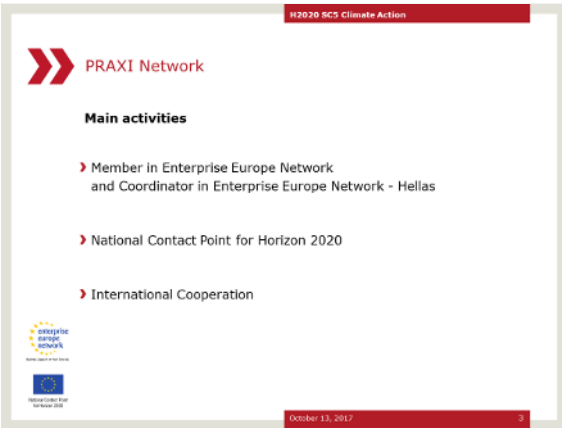
E-mail: schris@ekt.gr / horizon2020@ekt.gr
Website: www.ekt.gr
EKT
enterprise europe network

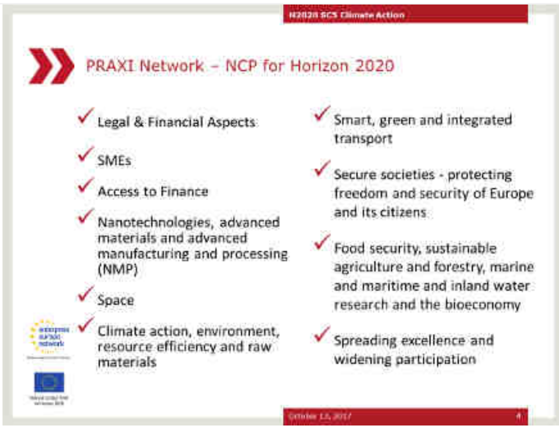
H2020 – Climate action and Environment: new calls

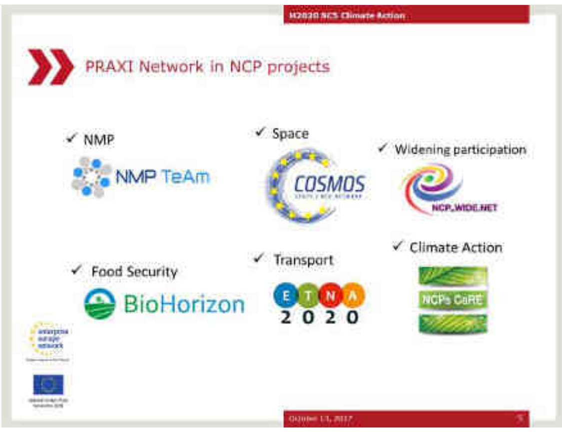
by

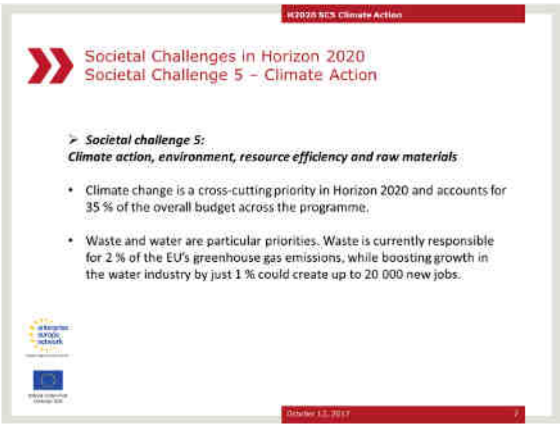
Ms. Katerina PAPADOULI

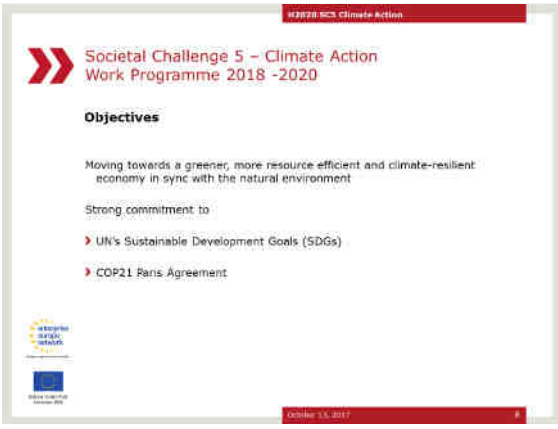
National Contact Point, National Documentation Centre, Greece

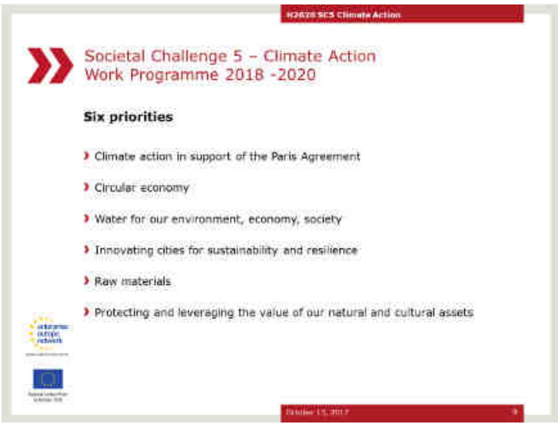


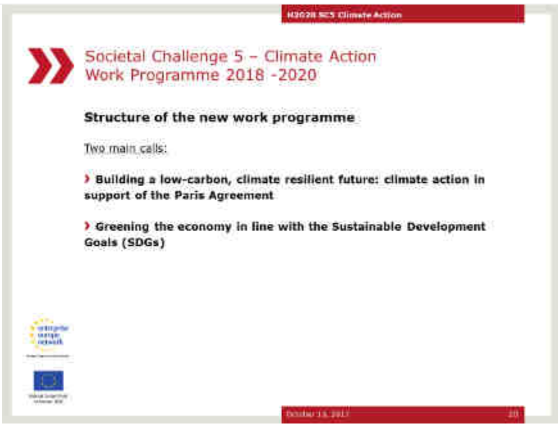




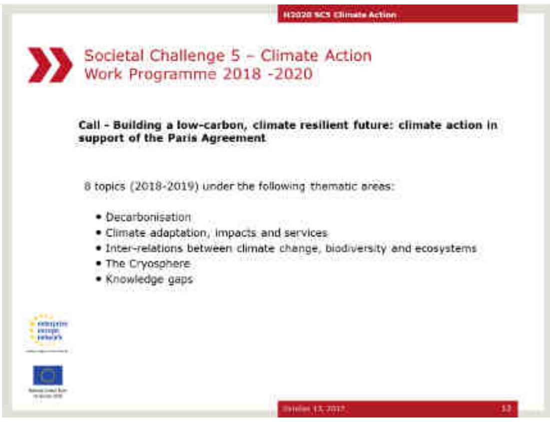

H2020 SC5 Climate Action
Societal Challenges in Horizon 2020
Societal Challenge 5 – Climate Action
Societal challenge 5:
Climate action, environment, resource efficiency and raw materials
• Climate change is a cross-cutting priority in Horizon 2020 and accounts for 35 % of the overall budget across the programme.
• Waste and water are particular priorities. Waste is currently responsible for 2 % of the EU's greenhouse gas emissions, while boosting growth in the water industry by just 1 % could create up to 20 000 new jobs.

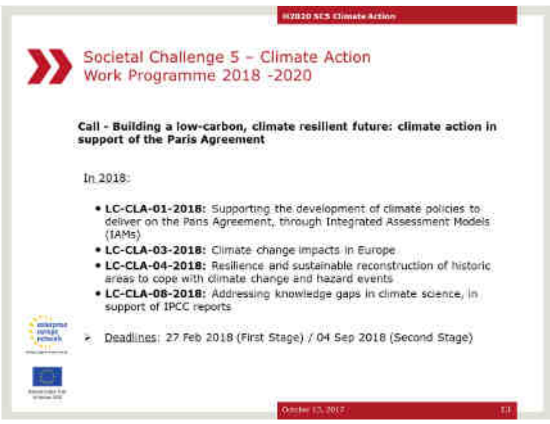

H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Objectives
Moving towards a greener, more resource efficient and climate-resilient economy in sync with the natural environment
Strong commitment to
UN's Sustainable Development Goals (SDGs)
COP21 Paris Agreement


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Six priorities
Climate action in support of the Paris Agreement
Circular economy
Water for our environment, economy, society
Innovating cities for sustainability and resilience
Raw materials
Protecting and leveraging the value of our natural and cultural assets


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Structure of the new work programme
Two main calls:
Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement
Greening the economy in line with the Sustainable Development Goals (SDGs)


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement
The COP21 Paris Agreement (PA) marked the beginning of a new era in the fight against climate change. Governments agreed to limit global temperature rise to well below 2°C and to make efforts to limit this to 1.5°C, as well as to enhance adaptive capacity, strengthening resilience and reducing vulnerabilities. This call contributes in its entirety to the Focus Area "Building a low-carbon climate-resilient future", which brings together funding to support the goals of the PA.


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement
8 topics (2018-2019) under the following thematic areas:
• Decarbonisation
• Climate adaptation, impacts and services
• Inter-relations between climate change, biodiversity and ecosystems
• The Cryosphere
• Knowledge gaps


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Building a low-carbon, climate resilient future: climate action in support of the Paris Agreement
In 2018:
• LC-CLA-01-2018: Supporting the development of climate policies to deliver on the Paris Agreement, through Integrated Assessment Models (IAMs)
• LC-CLA-03-2018: Climate change impacts in Europe
• LC-CLA-04-2018: Resilience and sustainable reconstruction of historic areas to cope with climate change and hazard events
• LC-CLA-08-2018: Addressing knowledge gaps in climate science, in support of IPCC reports
Deadlines: 27 Feb 2018 (First Stage) / 04 Sep 2018 (Second Stage)


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
This call focuses on moving to a greener, more resource efficient and climate-resilient economy in sync with the natural environment, demonstrating a strong commitment to supporting the UN's Sustainable Development Goals (SDGs).


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
21 topics (2018-2019) under the following thematic areas:
• Connecting economic and environmental gains - the circular economy
• Raw materials
• Water for our environment, economy and society
• Innovating cities for sustainability and resilience
• Protecting and leveraging the value of our natural and cultural assets: Earth observation
• Protecting and leveraging the value of our natural and cultural assets: Nature-based solutions, disaster risk reduction and natural capital accounting
• Protecting and leveraging the value of our natural and cultural assets: Heritage alive
October 13, 2017
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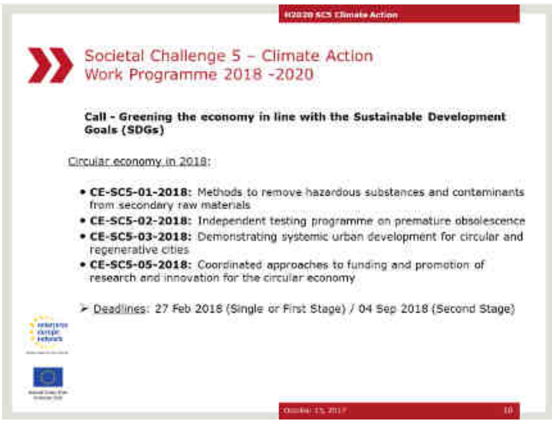
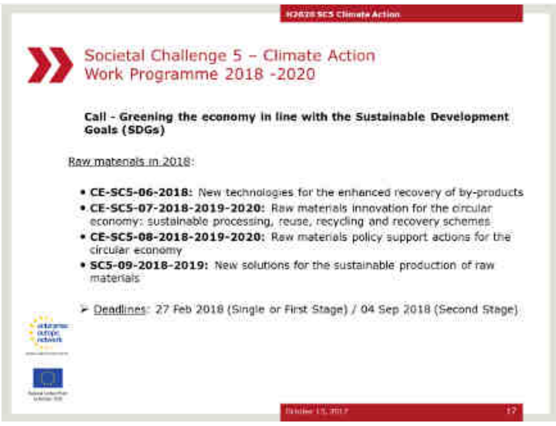

H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Circular economy in 2018:
• CE-SC5-01-2018: Methods to remove hazardous substances and contaminants from secondary raw materials
• CE-SC5-02-2018: Independent testing programme on premature obsolescence
• CE-SC5-03-2018: Demonstrating systemic urban development for circular and regenerative cities
• CE-SC5-05-2018: Coordinated approaches to funding and promotion of research and innovation for the circular economy
➢ Deadlines: 27 Feb 2018 (Single or First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
16


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Raw materials in 2018:
• CE-SC5-06-2018: New technologies for the enhanced recovery of by-products
• CE-SC5-07-2018-2019-2020: Raw materials innovation for the circular economy: sustainable processing, reuse, recycling and recovery schemes
• CE-SC5-08-2018-2019-2020: Raw materials policy support actions for the circular economy
• SC5-09-2018-2019: New solutions for the sustainable production of raw materials
➢ Deadlines: 27 Feb 2018 (Single or First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
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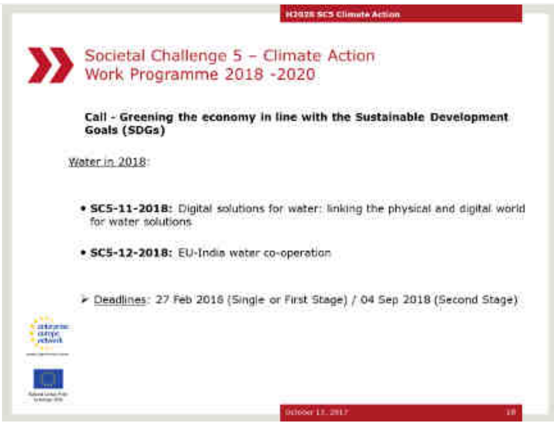
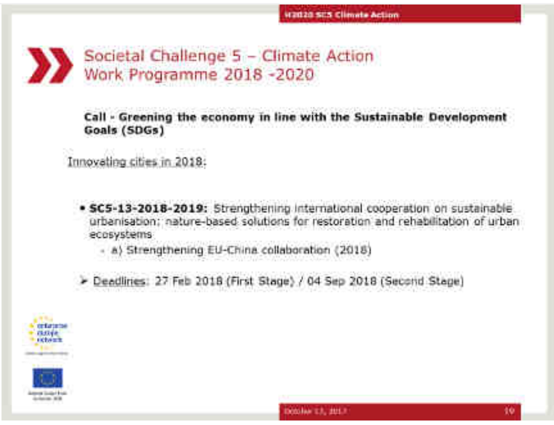
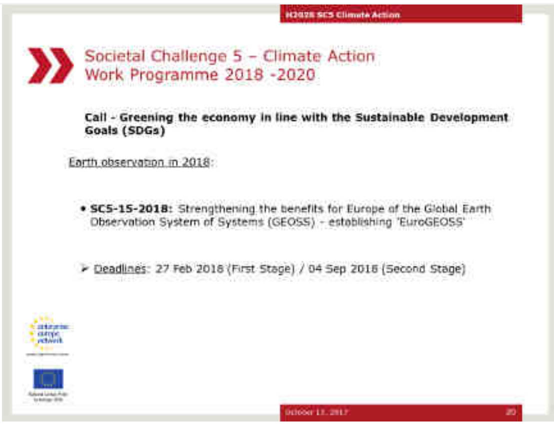

H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Water in 2018:
• SC5-11-2018: Digital solutions for water: linking the physical and digital world for water solutions
• SC5-12-2018: EU-India water co-operation
➢ Deadlines: 27 Feb 2018 (Single or First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
18


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Innovating cities in 2018:
• SC5-13-2018-2019: Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems
- a) Strengthening EU-China collaboration (2018)
➢ Deadlines: 27 Feb 2018 (First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
19


H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Earth observation in 2018:
• SC5-15-2018: Strengthening the benefits for Europe of the Global Earth Observation System of Systems (GEOSS) - establishing 'EuroGEOSS'
➢ Deadlines: 27 Feb 2018 (First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
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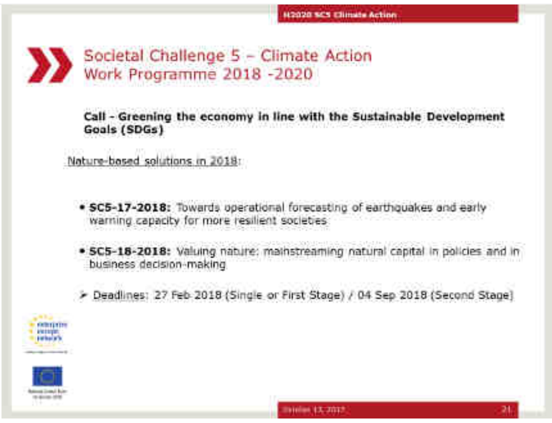
H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Nature-based solutions in 2018:
• SC5-17-2018: Towards operational forecasting of earthquakes and early warning capacity for more resilient societies
• SC5-18-2018: Valuing nature: mainstreaming natural capital in policies and in business decision-making
➢ Deadlines: 27 Feb 2018 (Single or First Stage) / 04 Sep 2018 (Second Stage)
October 13, 2017
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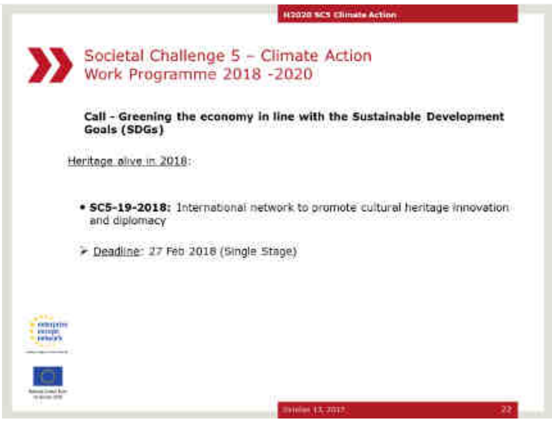
H2020 SC5 Climate Action
Societal Challenge 5 – Climate Action
Work Programme 2018 -2020
Call - Greening the economy in line with the Sustainable Development Goals (SDGs)
Heritage alive in 2018:
• SC5-19-2018: International network to promote cultural heritage innovation and diplomacy
➢ Deadline: 27 Feb 2018 (Single Stage)
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H2020 SC5 Climate Action

Type of actions in Horizon 2020

Rules for Participation
Standard eligibility conditions

Type of Action	Eligibility Conditions
Research & Innovation Actions (RIA) Innovation Actions (IA)	✓ At least three legal entities. ✓ Each of the three must be established in a different EU Member State or Horizon 2020 associated country. ✓ All three legal entities must be independent of each other.
Coordination & Support Actions (CSA)	✓ At least one legal entity established in an EU Member State or Horizon 2020 associated country.

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H2020 SC5 Climate Action

Technology Readiness Level in Secure Societies

Definitions of Technology Readiness Level

- ✓TRL 1 – basic principles observed
- ✓TRL 2 – technology concept formulated
- ✓TRL 3 – experimental proof of concept
- ✓TRL 4 – technology validated in lab
- ✓TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- ✓TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- ✓TRL 7 – system prototype demonstration in operational environment
- ✓TRL 8 – system complete and qualified
- ✓TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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H2020 SC5 Climate Action

H2020 SC5 Information day and brokerage event

Information Day and brokerage event on the H2020 WP 2018-2020 SC5 Climate Action, Environment, Resource Efficiency & Raw Materials - 2018 calls 8 and 9 November 2017, Brussels

➢ The event will be web-streamed
https://ec.europa.eu/easme/en/2017-information-day
(Registration is closed)

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H2020 SC5 Climate Action

Save the date!

Horizon 2020 Information Day

November 7, Athens

Presentation of the new Work Programmes 2018-2020:
- NMPB
- Transport
- Space
- Climate Action
- Food Security

➢ Stay updated: http://praxinetwork.gr

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H2020 SC5 Climate Action

NCPs CaRE project
www.ncps-care.eu

SC5 National Contact Points network

- Information and networking events and services
- Support in partner search

NCPs CaRE

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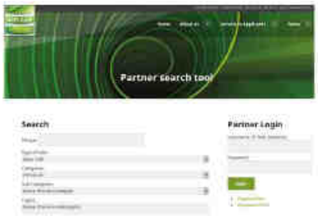
H2020 SC5 Climate Action

NCPs CaRE – Partner search tool

http://partnersearch.ncps-care.eu/

- Create your cooperation profile
- Search for partnership opportunities



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H2020 SC5 Climate Action

Useful links

- Horizon 2020 Participant Portal
  http://ec.europa.eu/research/participants/portal/desktop/en/home.html
- Εθνικό Σημείο Επαφής (National Contact Points)
  http://ec.europa.eu/research/participants/portal/desktop/en/support/national_contact_points.html
- Enterprise Europe Network
  http://een.ec.europa.eu/

➢ **Horizon 2020 Draft Work Programmes**
https://ec.europa.eu/programmes/horizon2020/en/what-work-programme

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H2020 SC5 Climate Action

National Contact Point

Vaya Piteli

NCP for H2020 SC5 Climate Action
PRAXI Network
piteli@praxinetwork.gr
+30 2310 552790

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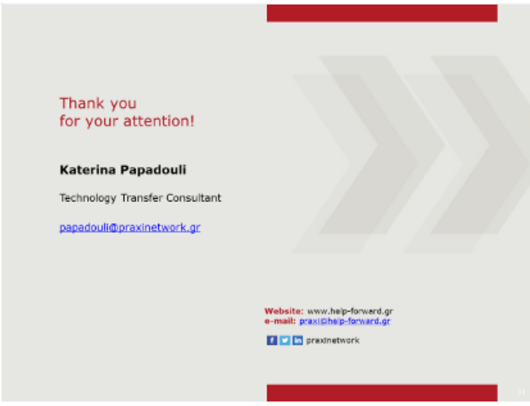
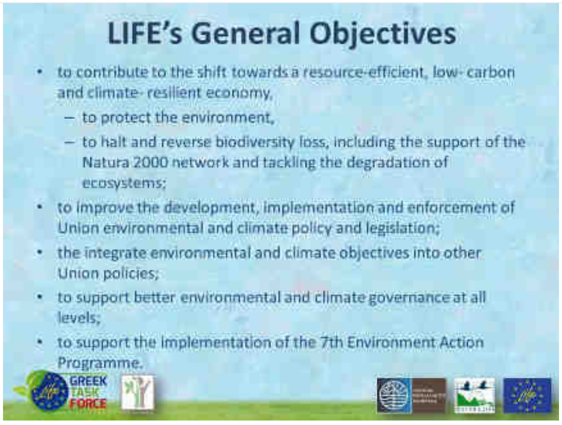

Thank you
for your attention!
Katerina Papadouli
Technology Transfer Consultant
papadouli@praxinetwork.gr
Website: www.help-forward.gr
e-mail: praxi@help-forward.gr
praxinetwork

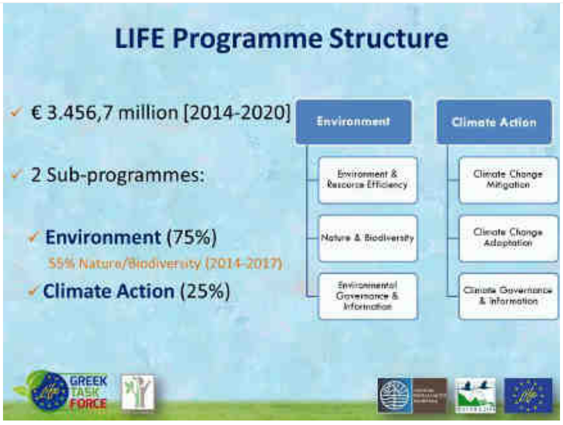
LIFE 2014 – 2020 for ENVIRONMENT

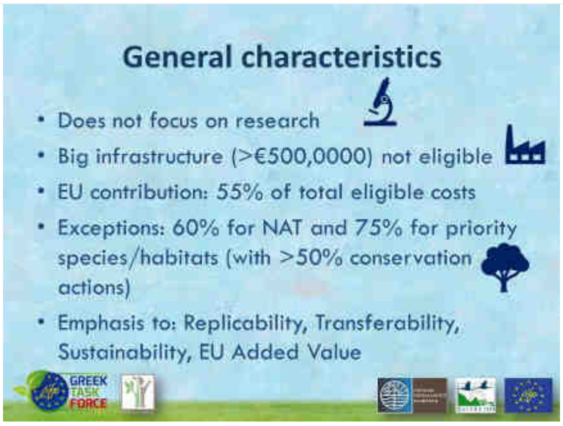
by

Mr. Dimitrios HOMATIDIS

Environment & Resource Efficiency Officer, Greek LIFE



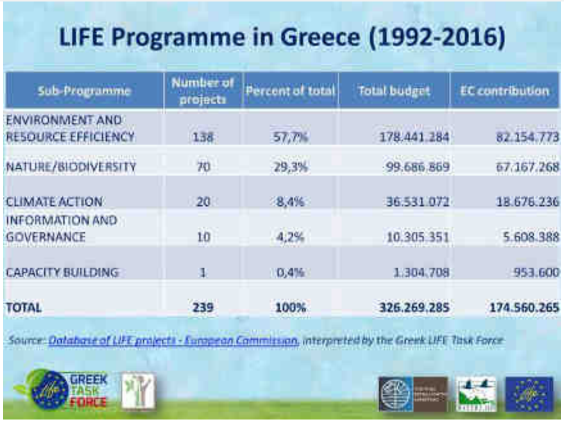





Project categories
Best Practices
Demonstration
Pilot
Information, awareness and dissemination projects
ENVIRONMENT
Environment & Resource Efficiency
Nature / Biodiversity
Environmental Governance & Information
CLIMATE ACTION
Climate Change Mitigation
Climate Change Adaptation
Climate Governance & Information
GREEK TASK FORCE


Close To Market (C2M) projects
Projects that implement environmental/climate solutions in close-to-market conditions (i.e. industrial, commercial scale) in short-medium term
Projects that have clear technical and business perspective
Projects that foresee pre-commercial activities and plan them during the application stage (e.g. market analysis, business plan, etc.)
LIFE is a non-stop-shop for businesses from innovation/demonstration/upscaling to commercialization
GREEK TASK FORCE

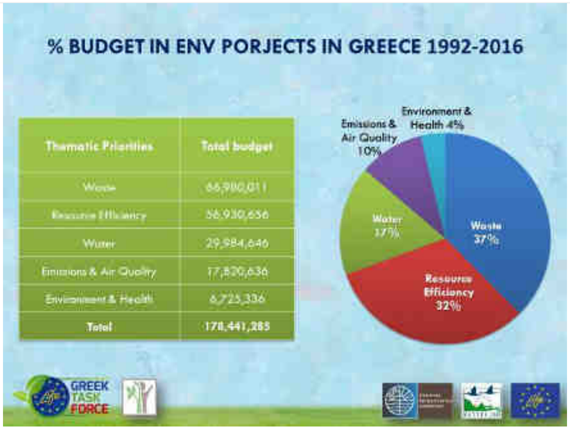

LIFE Programme in Greece
239 projects
174,5 ml. €
326 ml. €
1992
2016
GREEK TASK FORCE


LIFE Programme in Greece (1992-2016)

Sub-Programme	Number of projects	Percent of total	Total budget	EC contribution
ENVIRONMENT AND RESOURCE EFFICIENCY	138	57,7%	178.441.284	82.154.773
NATURE/BIODIVERSITY	70	29,3%	99.686.869	67.167.268
CLIMATE ACTION	20	8,4%	36.531.072	18.676.236
INFORMATION AND GOVERNANCE	10	4,2%	10.305.351	5.608.388
CAPACITY BUILDING	1	0,4%	1.304.708	953.600
TOTAL	239	100%	326.269.285	174.560.265

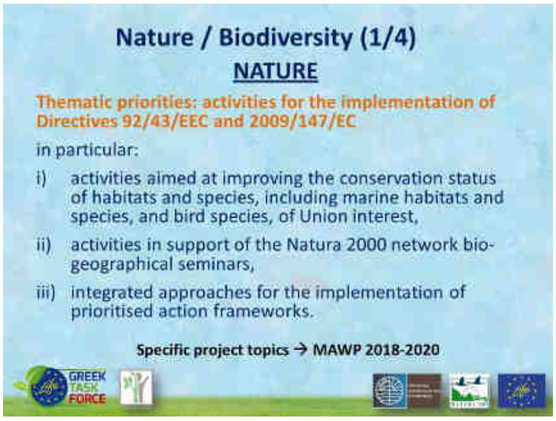
Source: Database of LIFE projects - European Commission, interpreted by the Greek LIFE Task Force
GREEK TASK FORCE


Environment & Resource Efficiency
WATER
Water, floods and drought
Marine and coastal management
Water Industry
WASTE
Implementation of waste legislation
Waste and Resource efficiency
RESOURCE EFFICIENCY
Resource Efficiency, green and circular economy
Soil
Forests
ENVIRONMENT AND HEALTH
Chemicals
Noise
Industrial accidents
AIR QUALITY AND EMISSIONS
Air quality legislation and the NEC Directive*
Industrial Emissions Directive
Urban Environment
*National Emissions Ceilings
Specific project topics → MAWP 2018-2020
GREEK TASK FORCE

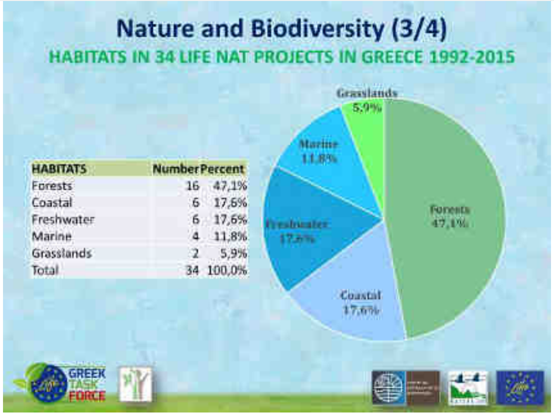

% BUDGET IN ENV PORJECTS IN GREECE 1992-2016

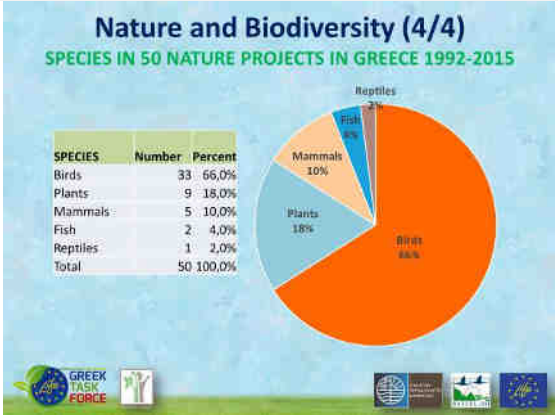
Thematic Priorities	Total budget
Waste	66,980,011
Resource Efficiency	56,930,656
Water	29,984,646
Emissions & Air Quality	17,820,636
Environment & Health	6,725,336
Total	178,441,285

Environment & Health 4%
Emissions & Air Quality 10%
Water 17%
Waste 37%
Resource Efficiency 32%
GREEK TASK FORCE

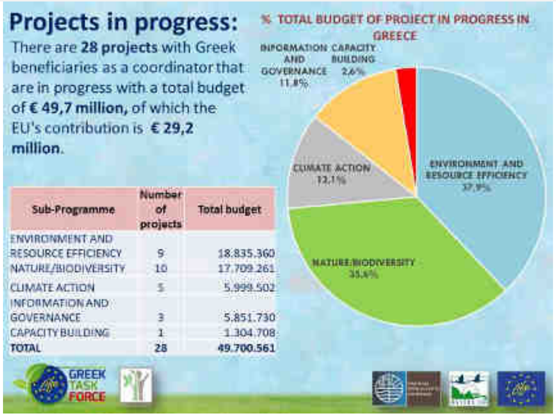

Nature / Biodiversity (1/4)
NATURE
Thematic priorities: activities for the implementation of Directives 92/43/EEC and 2009/147/EC
in particular:
i) activities aimed at improving the conservation status of habitats and species, including marine habitats and species, and bird species, of Union interest,
ii) activities in support of the Natura 2000 network bio-geographical seminars,
iii) integrated approaches for the implementation of prioritised action frameworks.
Specific project topics → MAWP 2018-2020
GREEK TASK FORCE


Nature / Biodiversity (2/4)
BIODIVERSITY
Thematic priorities - activities for the implementation of the Union Biodiversity Strategy to 2020, in particular activities aimed at contributing to the achievement of:
Target 2
Maintain and restore ecosystems
Targets 3, 4, 5
Achieve more sustainable agriculture and forestry
Make fishing more sustainable and seas healthier
Combat invasive alien species
Specific project topics → MAWP 2018-2020
GREEK TASK FORCE


Nature and Biodiversity (3/4)
HABITATS IN 34 LIFE NAT PROJECTS IN GREECE 1992-2015
HABITATS | Number | Percent
Forests 16 47,1%
Coastal 6 17,6%
Freshwater 6 17,6%
Marine 4 11,8%
Grasslands 2 5,9%
Total 34 100,0%
Grasslands 5,9%
Marine 11,8%
Freshwater 17,6%
Forests 47,1%
Coastal 17,6%
GREEK TASK FORCE


Nature and Biodiversity (4/4)
SPECIES IN 50 NATURE PROJECTS IN GREECE 1992-2015
SPECIES | Number | Percent
Birds 33 66,0%
Plants 9 18,0%
Mammals 5 10,0%
Fish 2 4,0%
Reptiles 1 2,0%
Total 50 100,0%
Reptiles 2%
Fish 4%
Mammals 10%
Plants 18%
Birds 66%
GREEK TASK FORCE


Environmental Governance and Information
a) information, communication and awareness raising campaigns in line with the priorities of the 7th Environment Action Programme,
(b) activities in support of effective control process as well as measures to promote compliance in relation to Union environmental legislation, and in support of information systems and information tools on implementation of Union environmental legislation.
GREEK TASK FORCE


Projects in progress:
There are 28 projects with Greek beneficiaries as a coordinator that are in progress with a total budget of € 49,7 million, of which the EU's contribution is € 29,2 million.
% TOTAL BUDGET OF PROJECT IN PROGRESS IN GREECE
INFORMATION AND GOVERNANCE 11,8%
CAPACITY BUILDING 2,6%
CLIMATE ACTION 12,1%
ENVIRONMENT AND RESOURCE EFFICIENCY 37,9%
NATURE/BIODIVERSITY 35,6%
Sub-Programme | Number of projects | Total budget
ENVIRONMENT AND RESOURCE EFFICIENCY 9 18.835.360
NATURE/BIODIVERSITY 10 17.709.261
CLIMATE ACTION 5 5.999.502
INFORMATION AND GOVERNANCE 3 5.851.730
CAPACITY BUILDING 1 1.304.708
TOTAL 28 49.700.561
GREEK TASK FORCE


Establishment and operation of the Greek LIFE Task Force for the period 2014-2017
«LIFE14 CAP/GR/000003 – GR LTF»
Capacity Building projects:
provide financial support to activities required to build the capacity of Member States, with a view to enabling Member States to participate more effectively in the LIFE Programme
Duration:
01/01/2016 – 30/04/2019
Budget:
Total amount: € 1,304,708
Requested EC funding: € 953,600
Beneficiaries:
Green Fund, Coordinator Beneficiary
Ministry of Environment and Energy, Associated Beneficiary
GREEK TASK FORCE


Ομάδα Έργου
Συντονιστής έργου: Γιώργος Πρωτόπαπας (NCP)
Συντονίστρια Περιβάλλοντος: Αλεξάνδρα Καρποδίνη
Συντονίστρια Φύση/ Βιοποικιλότητα: Αναστασία Δαλάκα
Συντονιστής Κλιματικής Αλλαγής: Δημήτρης Νιαβής (NCP)
Εμπειρογνώμονας Φύση / Βιοποικιλότητα Κατερίνα Κουτσοβούλου
Εμπειρογνώμονας Κλιματική Αλλαγή Σπυριδούλα Νταμίρη
Εμπειρογνώμονας Διαχείριση Δεδομένων / GIS Παναγιώτης Στρατάκης
Εμπειρογνώμονας Επικοινωνία για το Περιβάλλον Κέλλη Καλιγιώργα
GREEK TASK FORCE


GR LTF Role
More efficient participation of Greece in LIFE projects through:
• Informing potential beneficiaries
• Supporting the preparation of proposals process
• Providing technical assistance and consulting to potential beneficiaries
• Promoting the exchange of experiences, best practices and the uptake of LIFE projects results
• Enhancing the LIFE National Contact Points
GREEK TASK FORCE

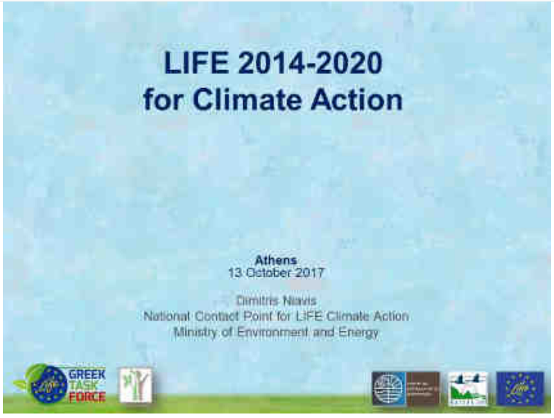

Thank you for your attention
dhomatidis@prasinotameio.gr
life@prasinotameio.gr
http://www.prasinotameio.gr
http://www.ypeka.gr
http://www.lifetaskforce.gr
GREEK TASK FORCE

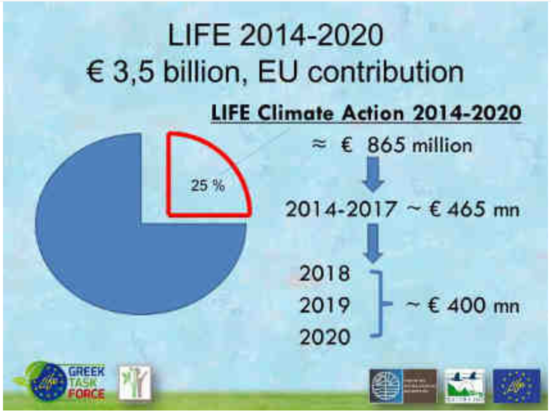
LIFE 2014 – 2020 for Climate Action

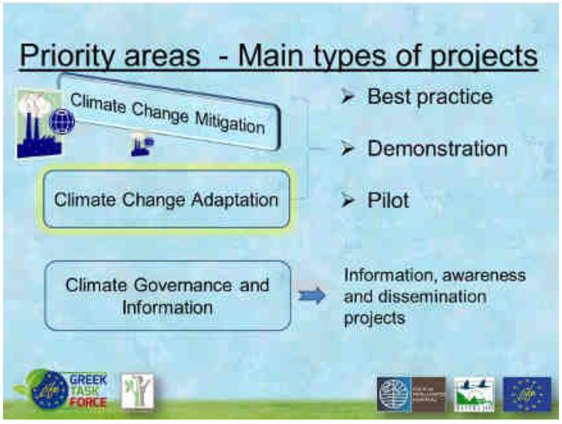
by

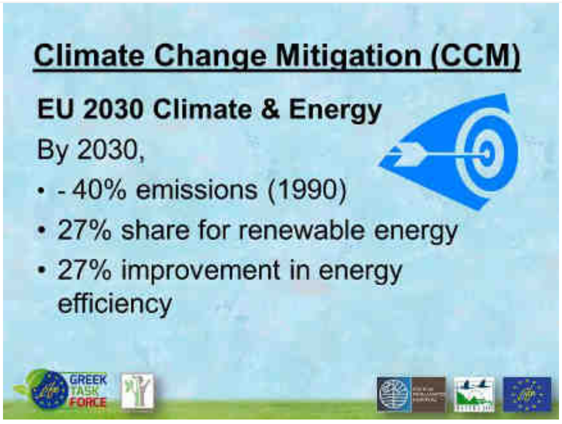
Mr. Dimitrios NIAVIS

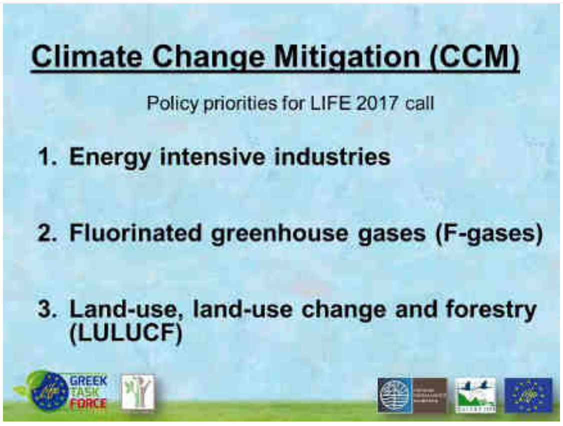
National Contact Point, Hellenic Ministry of Environment and Energy

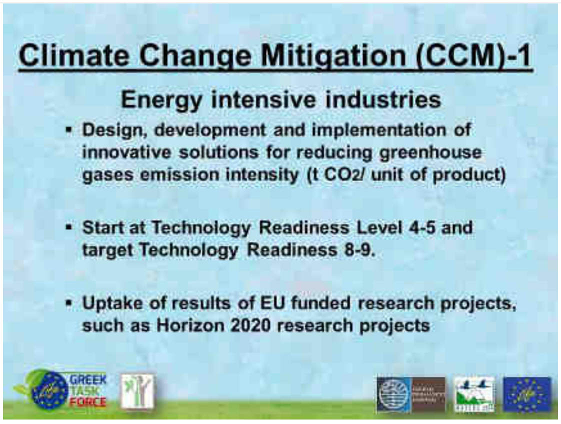


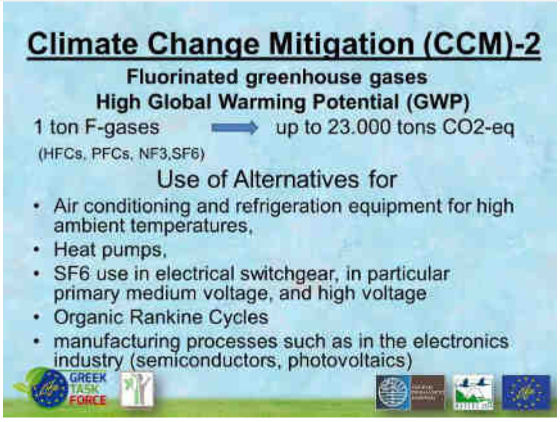




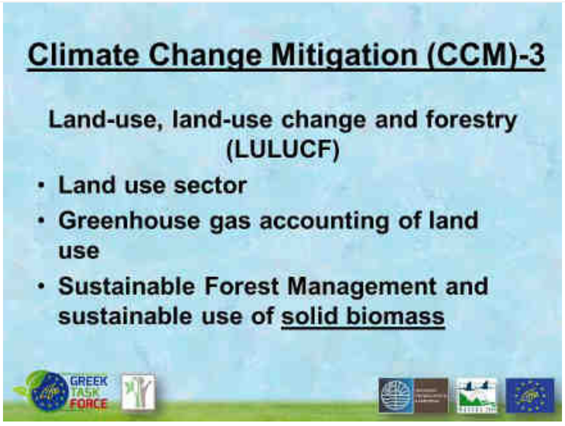


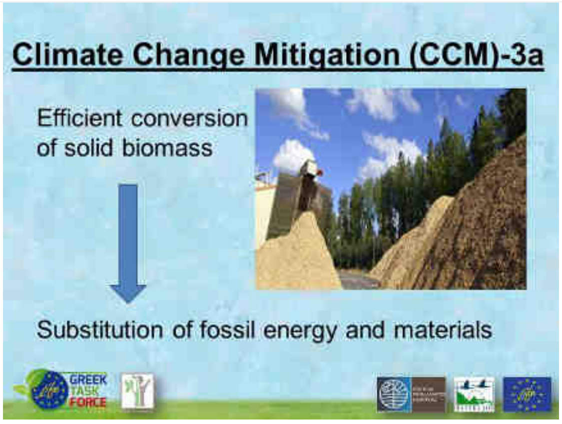


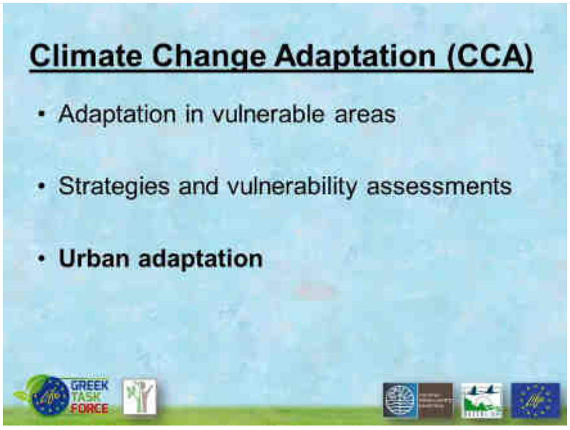


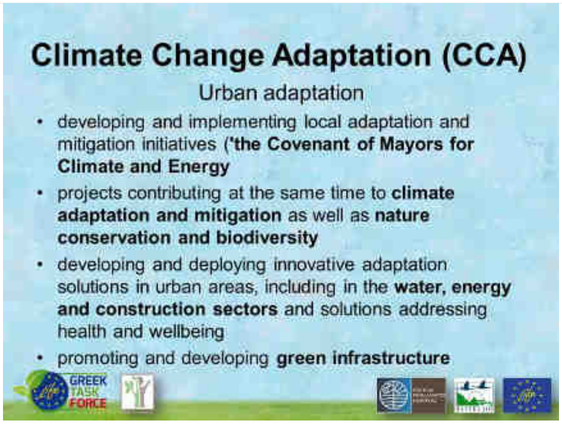


Alternative	Global Warming Potential (GWP)	Properties to be addressed	Commercial availability
Hydrocarbons	3-5	Flammable	Immediate
CO_2 (R744)	1	High pressure	Immediate
Ammonia (NH3, R717)	1	Toxic	Immediate
Water (R718)	1	No risks	Immediate
R32 (an HFC)	675	Mildly flammable	Immediate
HFOs	4-9	Mildly flammable	Immediate/Short-term
R32-HFO blends	200-400	Mildly flammable	Mid-term

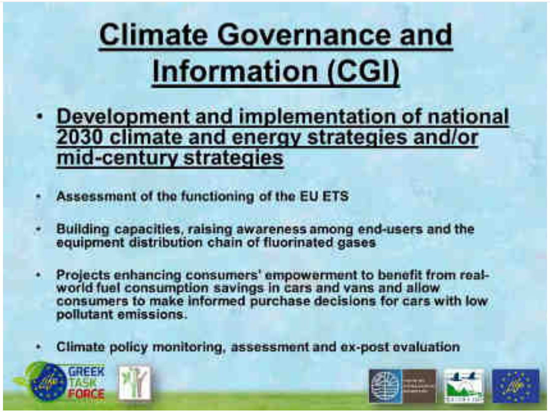






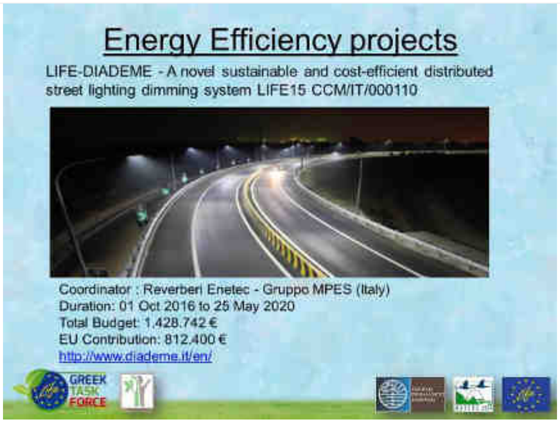



promoting and developing **green infrastructure**
GREEK TASK FORCE


Climate Governance and Information (CGI)
Development and implementation of national 2030 climate and energy strategies and/or mid-century strategies
Assessment of the functioning of the EU ETS
Building capacities, raising awareness among end-users and the equipment distribution chain of fluorinated gases
Projects enhancing consumers' empowerment to benefit from real-world fuel consumption savings in cars and vans and allow consumers to make informed purchase decisions for cars with low pollutant emissions.
Climate policy monitoring, assessment and ex-post evaluation
GREEK TASK FORCE


Renewable Energy projects
LIFE DEMOWAVE, Demonstration of the efficiency & environmental impact of wave energy converters (WEC) in high energy coasts. LIFE14 CCM/ES/001209
GREEK TASK FORCE


Coordinator : Quantum Innovative SL (SME from Spain)
Duration: 01 Oct 2015 to 30 Sep 2018
Total Budget: 1.836.788 €
EU Contribution: 1.034.119 €
http://www.life-demowave.eu/en/
GREEK TASK FORCE


Energy Efficiency projects
LIFE-DIADEME - A novel sustainable and cost-efficient distributed street lighting dimming system LIFE15 CCM/IT/000110
Coordinator : Reverberi Enetec - Gruppo MPES (Italy)
Duration: 01 Oct 2016 to 25 May 2020
Total Budget: 1.428.742 €
EU Contribution: 812.400 €
http://www.diademe.it/en/
GREEK TASK FORCE


Energy Efficiency projects
LIFE Conipher - CONcrete Insulation PHotovoltaic Envelop for deep Renovation LIFE14 CCM/FR/000954
Coordinator : VICAT (France)
Duration: 01 Oct 2015 to 31 Aug 2018
Total Budget: 1.228.431 €
EU Contribution: 720.228 €
http://www.life-conipher.eu/
GREEK TASK FORCE


629 PROPOSALS FOR NEW LIFE PROJECTS
Source: European Commission
GREEK TASK FORCE


SUSTAINABLE DEVELOPMENT GOALS
Thank you for your attention!
Dimitris Niavis
National Contact Point for LIFE Climate Action
Ministry of Environment and Energy
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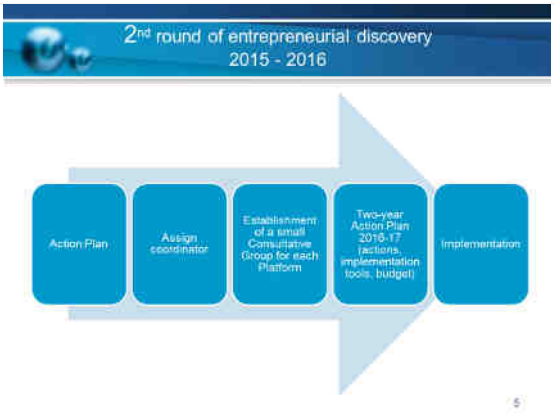
GREEK TASK FORCE

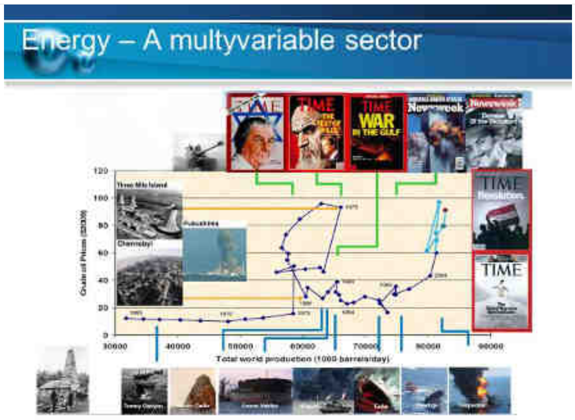
Research and Innovation Strategies and Implementation for Smart Specialization (RIS3) in the Greek Energy Sector

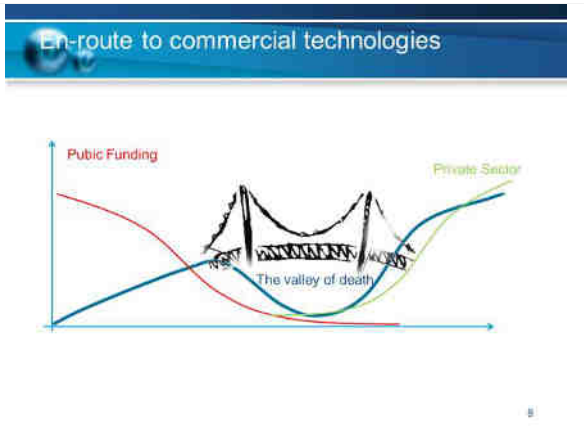
by

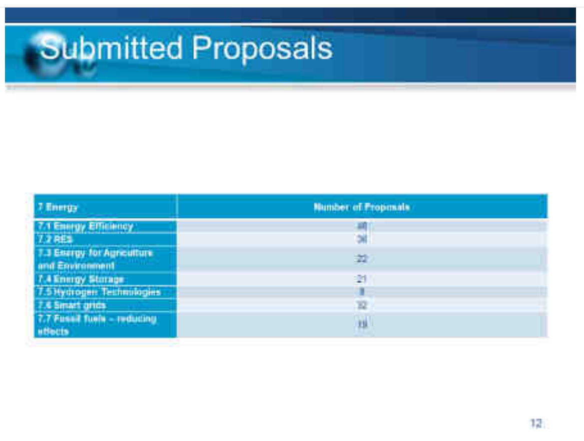
Dr. Kyriakos PANOPOULOS

Coordinator of the Energy Platform for Smart Specialization, General Secretariat for Research and Technology, Greece

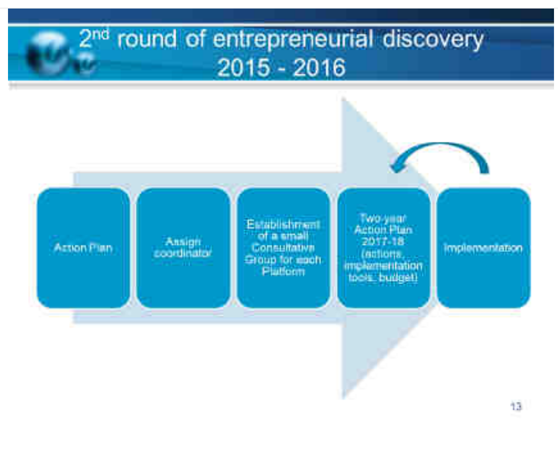








7 Energy	Number of Proposals
7.1 Energy Efficiency	40
7.2 RES	36
7.3 Energy for Agriculture and Environment	22
7.4 Energy Storage	21
7.5 Hydrogen Technologies	8
7.6 Smart grids	32
7.7 Fossil fuels – reducing effects	19



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