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FORWARD LOOKING EE MODELLING INCORPORATING BEHAVIORAL BARRIERS FOR BUILDINGS IN GREECE

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Outline

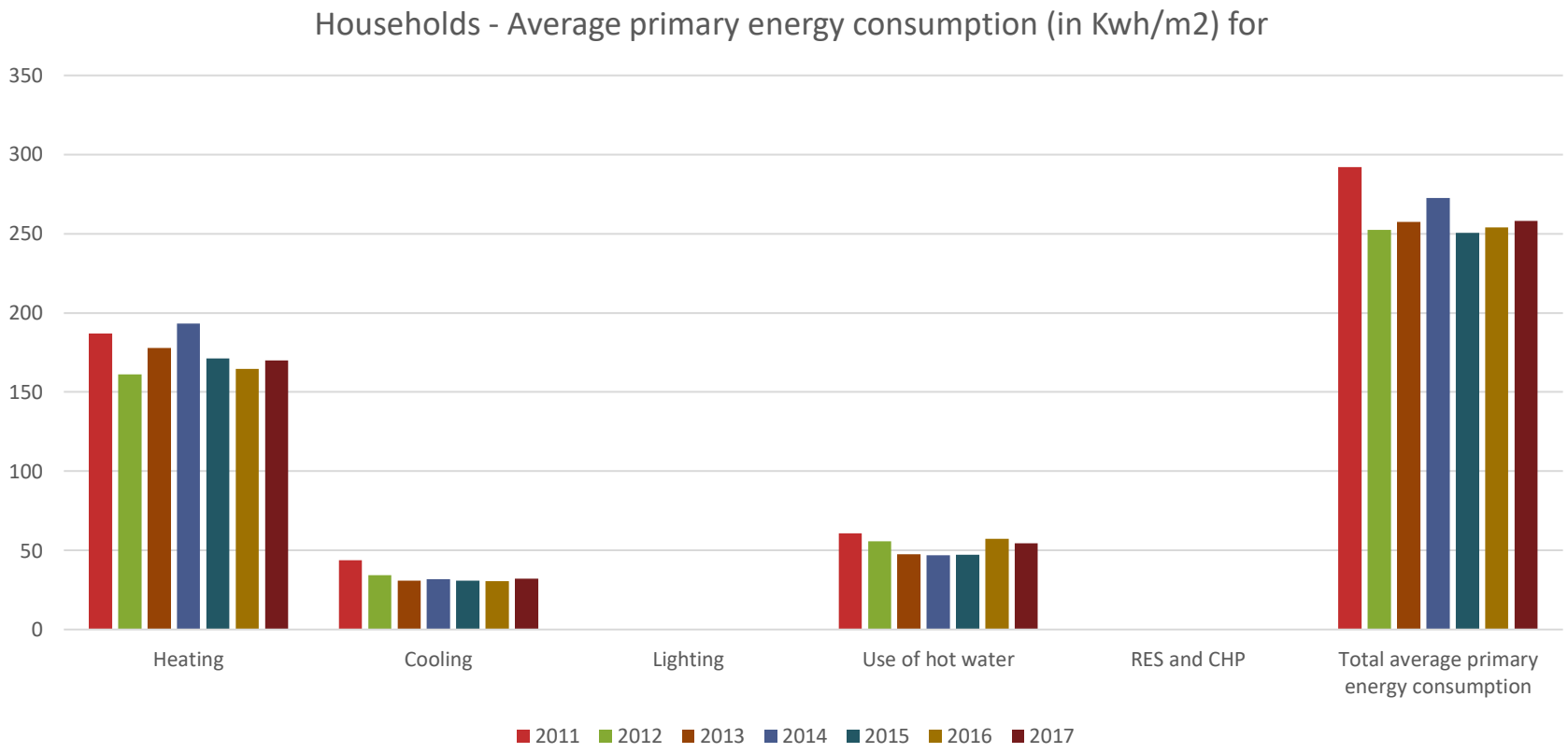
- National framework
  - Targets
  - Sector
  - Policies
  - End-use technologies
  - Barriers
- Research tools
- Scenarios
- Outcomes
- Conclusions

Source: https://www.theguardian.com/environment/2015/apr/27/hand-over-control-of-my-fridge-to-an-energy-company-no-thanks-say-brits

National EE targets

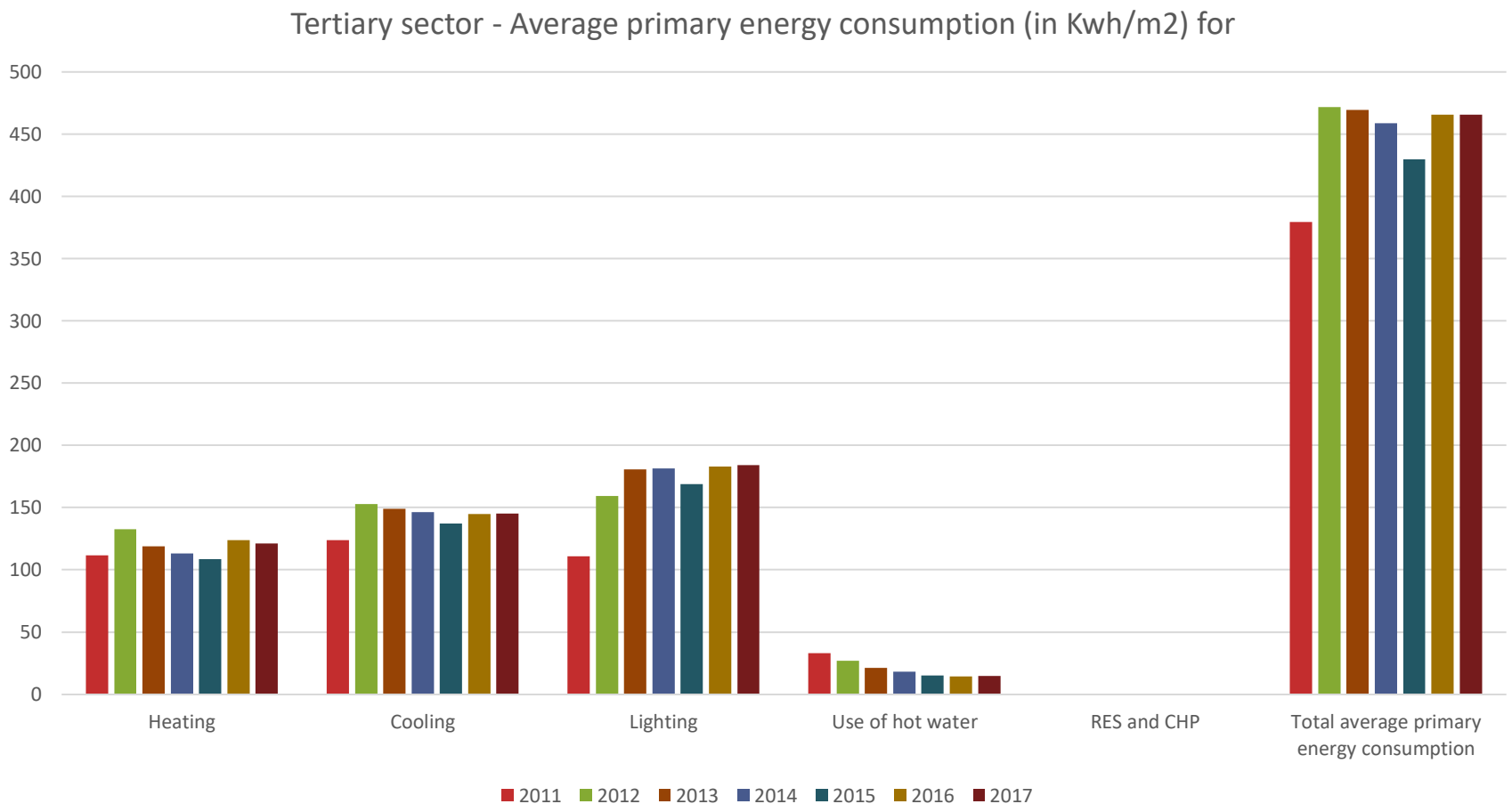
- 2014-2020
  - 3.332,7 ktoe (38,8 TWh) energy savings
- 2020
  - 24,7 Mtoe of primary energy consumption
  - 18,4 Mtoe of final energy consumption
- 2030
  - 19 Mtoe of final energy consumption (discussed)

National building sector



Source: http://bpes.ypeka.gr/wp-content/uploads/000_000_01_005b_PEA_Consumptions.pdf

National building sector



Source: http://bpes.ypeka.gr/wp-content/uploads/000_000_02_005b_PEA_Consumptions.pdf

Policy instruments

- Regulatory
  - Energy labelling, Energy audits and energy auditors, Eco-design requirements, etc
- Economic
  - Taxation on energy products and electricity, Green Fund – subsidies, Financial incentives
- for ESCO market promotion
- for dissemination/awareness

End-use technologies

- 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

End-use technologies

- 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)

Barriers

Type	Name of barrier
Social	Social group interactions and status considerations
Social	Socio-economic status of building users
Social	Strong dependency on the neighbors in multi-family housing
Social	Inertia
Social	Commitment and motivation of public social support
Social	Rebound effect
Cultural	Lack of interest/low priority/Undervaluing energy efficiency
Cultural	Customs, habits and relevant behavioural aspects
Cultural	Bounded rationality/Visibility of energy efficiency
Cultural	Missing credibility/mistrust of technologies and contractors
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies

Barriers

Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users
Economic	Payback expectations/investment horizons
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))
Economic	Financial crisis/Economic stagnation
Economic	Embryonic markets
Institutional	Split Incentive
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)
Institutional	Building stock characteristics/aging stock/ Historical preservation
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch
Institutional	Lack of data/information-diversion of management
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)
Institutional	Disruption/Hassie factor
Institutional	Security of fuel supply

Research tools

- HERON- DST (developed by KEPA)
  - user-friendly software
    - selection of optimum combination of technologies/practices
    - minimizing negative impact of end-users behavior in the implementation of Energy Efficiency scenarios
- LEAP (developed by the Stockholm Environment Institute)
  - widely-used tool
    - energy policy and climate change mitigation assessment

Research tools

- AMS (developed by KEPA)
  - Multi-criteria evaluation method
    - Evaluation of the performance of policy mixtures against three criteria and their supportive sub-criteria
      - Environmental performance, political acceptability, feasibility of implementation

Developing scenarios 1

- BAU
- Energy Efficiency scenario (EE B0)
  - Efficient heating
  - Efficient cooling
  - Building shell improvement
  - Efficient appliances
  - LEDS
  - BEMS

Software HERON Decision Support Tool

Barriers

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

Barriers

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 technologies for end-users	0,049
Economic	Payback expectations/investment horizons	0,024
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE	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 of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	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

EE B1 Scenario

- Energy efficiency scenario with barriers
  - Its policy mixture same with that of EE B0
  - Its assumptions incorporate the impact factor of barriers

EE B2 Scenario

- Promising combination of three technologies
  - Building Shell Improvement
  - Efficient cooling
  - Efficient appliances
- Minimized barriers for BSI
- Assumed the appropriate policy mixture

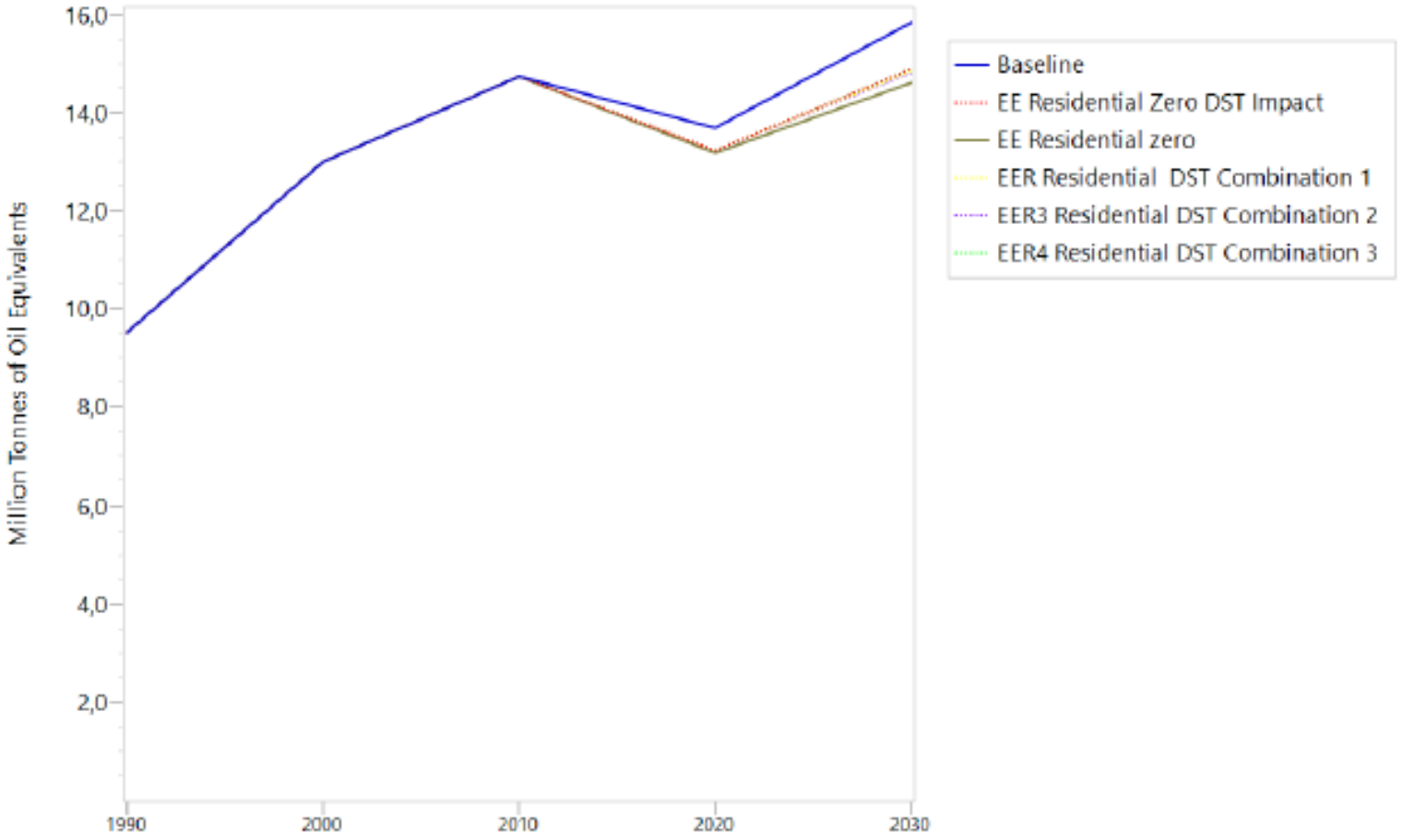
EE B3 Scenario

- Promising combination of three technologies
  - Building Shell Improvement
  - Efficient heating
  - Efficient appliances
- Minimized barriers for BSI
- Assumed the appropriate policy mixture

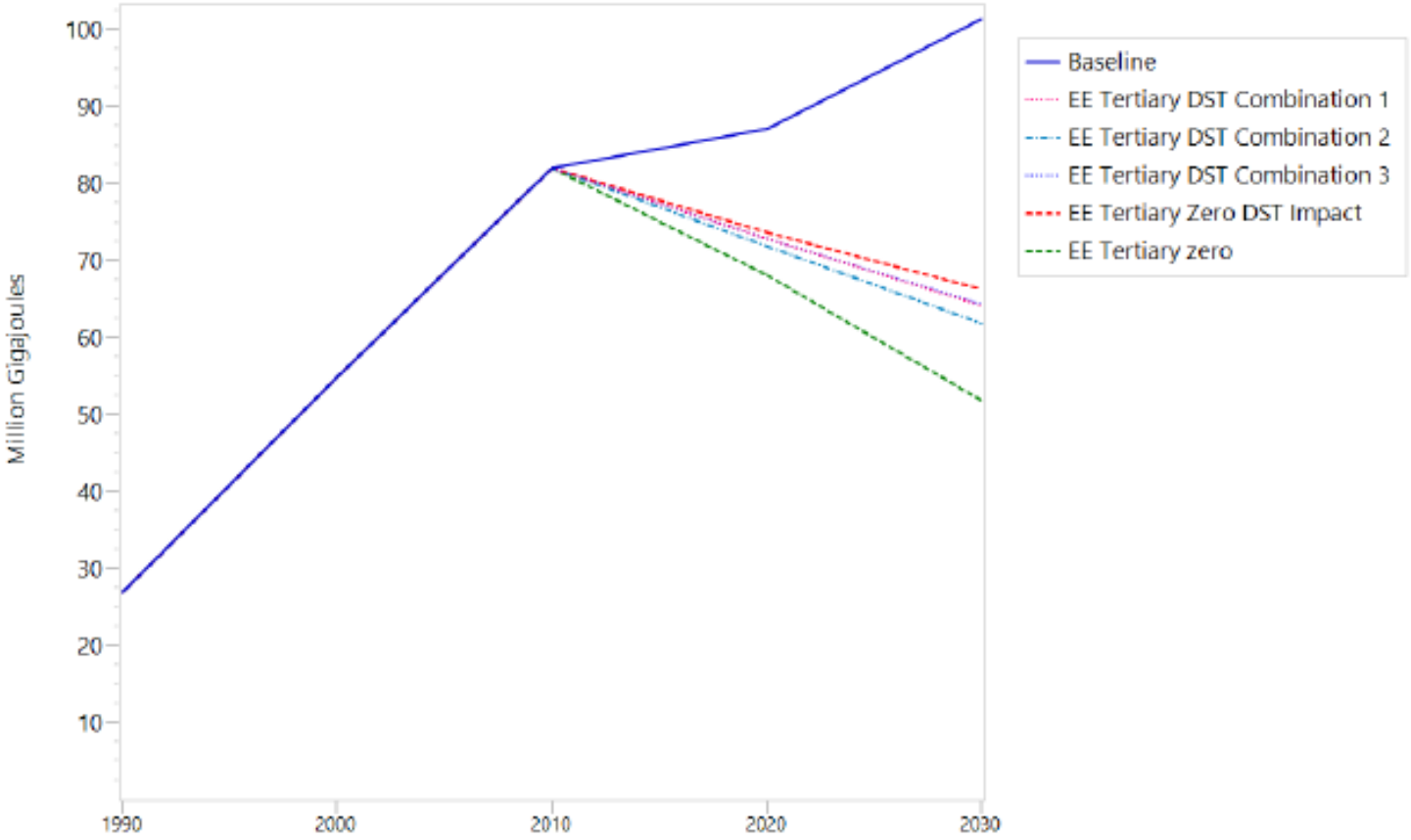
EE B4 Scenario

- Promising combination of three technologies
  - Efficient heating
  - Efficient cooling
  - Efficient appliances
- Minimized barriers for Efficient heating
- Assumed the appropriate policy mixture

LEAP – Residential sector



LEAP – Tertiary sector



HERON DST and LEAP Outcomes

Improving energy efficiency of technology (%)	BAU	EE B0	EE B1	EE B2	EE B3	EE B4
Heating	1,00	10,00	6,88	6,88	8,12	7,69
Building Shell Improvement	1,00	0,99	0,16	0,33	0,39	0,16
Technology penetration (%)						
Cooling	15,00	40,80	32,77	37,18	32,77	37,27
Appliances	10,00	25,00	14,76	18,78	19,52	17,91
Lighting	10,00	70,00	55,84	55,84	55,84	55,84
Building Energy Management Systems	0,00	10,00	8,86	8,86	8,86	8,857

Deviation compared to EE B0	BAU	EE B0	EE B1	EE B2	EE B3	EE B4
Final energy consumption (%)	-	-	13,08	10,89	9,34	11,88
GHG emissions (%)	-	-	17,05	14,39	12,12	15,53

AMS

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**

Outcomes

- *"Energy Efficiency Buildings 2 (EE B2)"* proved to be the optimum
  - integrates in the greatest extent the end-users behavior;
  - shows the smallest deviation in achieving energy efficiency targets;
  - contains the policy mixture that best supports the penetration of technologies in the Greek market.

Conclusions

- The combination of the three research tools is promising
- The outcomes allow the formation of policy recommendations

Thank you

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