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APPLICATION OF HERON DECISION SUPPORT TOOL FOR THE GREEK CASE (TRANSPORT)

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Outline

- Introduction
- Methodology
- Software HERON - DST
- Application
- Conclusions

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

Introduction

- **Problem:** The reduction of the observed deviation in EE targets due to end-users behavioral barriers
- **Concept:** Quantification of the qualitative information concerning end-users' behavioral barriers in energy efficiency modelling
- **Response:** Development of HERON -DST

HERON - DST

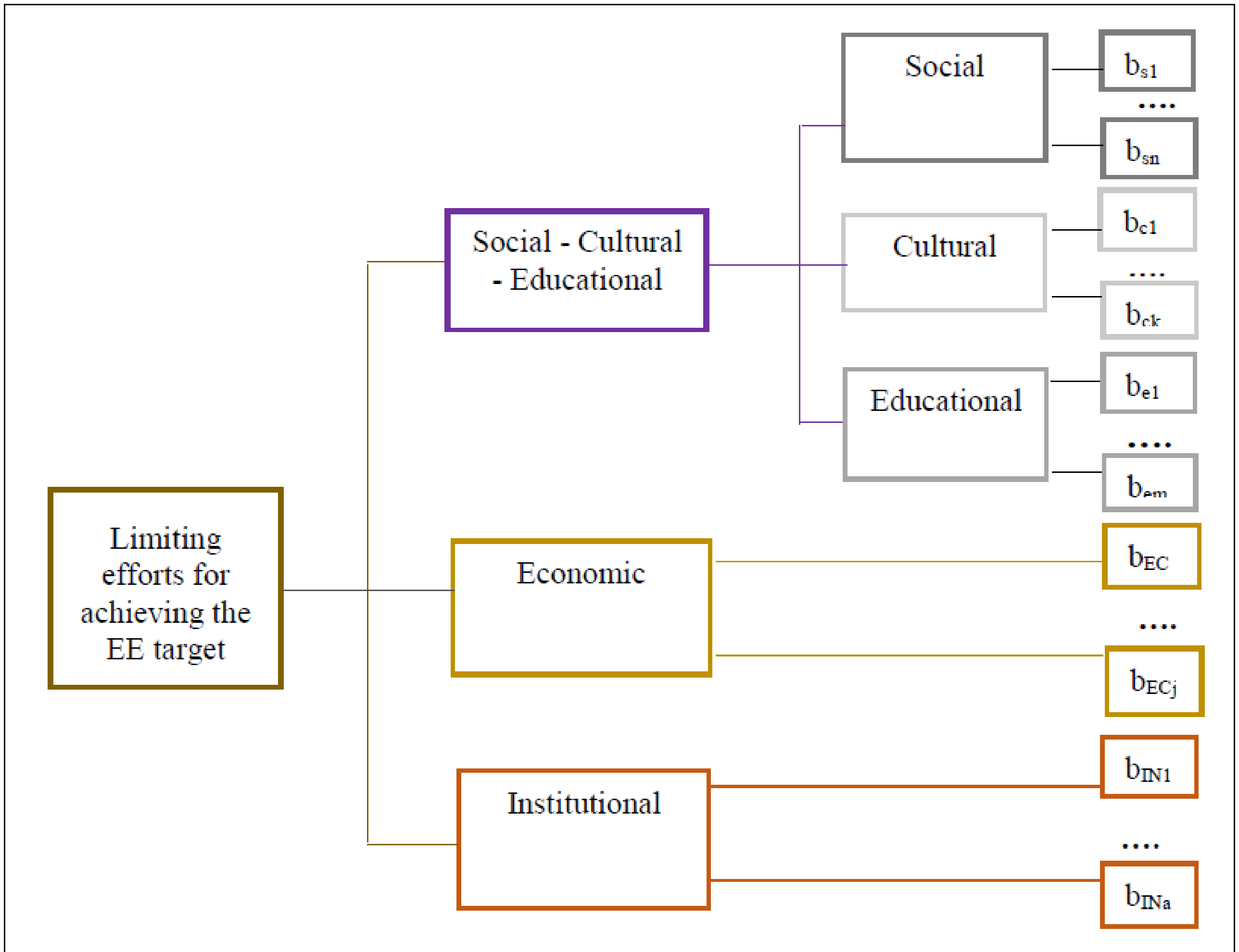
- Facilitates policy and decision makers in
  - Quantification of the impact of barriers
  - Demonstration of the deviation in EE targets
  - Selection of the optimum combination of EE technologies and practices
  - Minimization of the negative impact of end-users behavior in the implementation of Energy Efficiency scenarios

Methodology of HERON - DST

- Six steps – four based on Analytical Hierarchy Process (AHP)
  - *Step 1:* Mapping, categorization and merging 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 (I) 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

Steps 1 & 2

AHP tree and matrices



Barriers

$$I_{s1} = W_{S\text{-}C\text{-}E} * W_s * W_{s1}$$

Type	Name of barrier	Function
Social	Low satisfaction with public transport/lack of trust	$I_{s1} = W_{S\text{-}C\text{-}E} * W_s * W_{s1}$
Social	Concerns of vehicle reliability/Hesitation to trust new technologies	$I_{s2} = W_{S\text{-}C\text{-}E} * W_s * W_{s2}$
Social	Heterogeneity of consumers	$I_{s3} = W_{S\text{-}C\text{-}E} * W_s * W_{s3}$
Social	Suburbanisation trends/Low density	$I_{s4} = W_{S\text{-}C\text{-}E} * W_s * W_{s4}$
Social	Mobility problems (Vulnerability of pedestrians / Lack of adequate space for walking/ Cruising traffic/ Parking problems)	$I_{s5} = W_{S\text{-}C\text{-}E} * W_s * W_{s5}$
Social	Inertia	$I_{s6} = W_{S\text{-}C\text{-}E} * W_s * W_{s6}$
Cultural	Car as a symbol status and group influence	$I_{c1} = W_{S\text{-}C\text{-}E} * W_c * W_{c1}$
Cultural	Habit and social norm of driving, car ownership and use	$I_{c2} = W_{S\text{-}C\text{-}E} * W_c * W_{c2}$
Cultural	Cycling is marginalized	$I_{c3} = W_{S\text{-}C\text{-}E} * W_c * W_{c3}$
Cultural	Attitude (Attitude-action gap /Bounded rationality/Buyer attitude)	$I_{c4} = W_{S\text{-}C\text{-}E} * W_c * W_{c4}$
Educational	Lack of knowledge/information (on green transport/ULEVs/EVs - fuel economy)	$I_{E1} = W_{S\text{-}C\text{-}E} * W_E * W_{E1}$
Educational	Low/Limited awareness (of impact of EE in transport /towards eco-driving/benefits-environmental impacts)	$I_{E2} = W_{S\text{-}C\text{-}E} * W_E * W_{E2}$
Educational	Confusion about car and fuel costs (conventional vs ULEVs/Evs) – Negative perception	$I_{E3} = W_{S\text{-}C\text{-}E} * W_E * W_{E3}$
Educational	Lack of certified instructors/examiners/technicians/professionals for eco-driving /integrated transport/mobility/ ULEVs/Evs	$I_{E4} = W_{S\text{-}C\text{-}E} * W_E * W_{E4}$

Barriers

Economic	Lack of finance/Limited financial incentives for new vehicles/ULEVs/public transport/ - Inefficient or absent fiscal measures for supporting EE	$I_{EC1} = W_{\mathbf{EC}} * W_{EC1}$
Economic	Limited infrastructure investment (road/train/cycling) – for public transport	$I_{EC2} = W_{EC} * W_{EC2}$
Economic	Low purchasing power of citizens/Financial crisis	$I_{EC3} = W_{EC} * W_{EC3}$
Economic	High cost/Low cost competitiveness of electric vehicles - High cost of batteries for electric vehicles	$I_{EC4} = W_{EC} * W_{EC4}$
Economic	Payback period of fuel efficient vehicles	$I_{EC5} = W_{EC} * W_{EC5}$
Economic	Negative role of Investment schemes/employee benefits encourage transport EE	$I_{EC6} = W_{EC} * W_{EC6}$
Institutional	Administrative fragmentation and lack of integrated governance	$I_{I1} = W_{I} * w_{I1}$
Institutional	Transport EE on the Government Agenda/priorities	$I_{I2} = W_{I} * w_{I2}$
Institutional	Barriers to behavior change due to problems with infrastructure/public transport services (Inefficient urban/public transport infrastructure and planning/ Undeveloped cycling/walking infrastructure/ Lack of support for rail transportation/Limited rail infrastructure/ Undeveloped infrastructure for recharging of EV)	$I_{I3} = W_{I} * w_{I3}$
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	$I_{I4} = W_{I} * w_{I4}$
Institutional	Limited/complex funding in urban public transport	$I_{I5} = W_{I} * w_{I5}$
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)	$I_{I6} = W_{I} * w_{I6}$
Institutional	Contradicting policy goals (particularly road/car-oriented planning)	$I_{I7} = W_{I} * w_{I7}$
Institutional	Administrative fragmentation and lack of integrated governance	$I_{I8} = W_{I} * w_{I8}$

Steps 5 & 6 (1/2)

Total Impact factors and EE modelling

- Calculation of Total Impact (TI) factor on input drivers (EE technologies)
  - Link separately each driver with its relevant barriers
  - Sum up the impact factors of these barriers into TI
- Calculation of deviations

$$p_b = \pm\, p * (1 - TI) \quad \text{or} \quad p_b = \pm\, p * (1 - TI_{ol})$$

- p_b – amount after considering barriers (in %)
- p – amount without considering barriers (in %)
- TI – Total Impact of barriers for one input driver (unit-free)
- TI_{ol} – Total Impact of barriers for set of input drivers (unit-free)

Steps 5 & 6 (2/2)

Total Impact factors and EE modelling

- Calculation of reduced Impact factors

$$I_{t,i} = I_{o,i} (1 – (0,2/15)*t)$$

  - $I_{t,i}$ - Impact factor of barrier i in year t after implementing a policy instrument (or instruments) that addresses it
  - $I_{o,i}$ - Impact factor of barrier i in year t=0
  - t – time in years
  - 15 years for the time interval 2015-2030
  - 0,2 or 20% the reduction share after 15 years (UNEP, 2016)

Hellenic transport sector

- Accounts of 37% of the total final energy consumption
- Its highest energy saving potential is in passenger and freight road transport (private cars, trucks)
- Its contribution to the national EE target of 18,4Mtoe is by restricting its final energy consumption by year 2020 to 6,7TWh

End-use technologies (1/2)

- Cars (private and public)
  - vehicles meeting EURO 5 standards, 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

End-use technologies (2/2)

- Light trucks (private and public)
  - vehicles meeting EURO 5 standards
- Infrastructure
  - vehicle recharging points (RES-powered and/or conventional)

Developing scenarios (1/8)

- BAU
  - looks into current possible trends until 2030 with policy measures already decided or in place
    - Planning policy instruments
    - Regulatory policy instruments
    - Financial policy instruments
    - Dissemination/awareness policy instruments

Developing scenarios (2/8)

- Energy efficient scenario (EE T0)
  - forward-looking path towards an ideal situation
    (achieve maximum possible amount of energy savings based on the national potential through a combination of technologies)
  - Sub-scenarios
    - Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
    - Eco-driving in freight and passenger transport;
    - Modal shift in freight and passenger transport;
    - Use of biofuels in freight and passenger transport;
    - More efficient vehicles in passenger and freight transport
  - Improved policy mixture (compared to BAU additional policy instruments)

Developing scenarios (3/8)

Sub-scenarios	Policy assumptions	Policy instruments
Electric and hybrid vehicles	- 25% penetration of HEVs by 2030 - 7% penetration of EVs by 2030 - 10% penetration of PHEVs by 2030	Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012) Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) Campaigns for raising awareness towards electric vehicles Extension of the grid of e-mobility (charger points, etc.)
Eco-driving	10% energy savings from eco-driving in road transport (private vehicles, buses and trucks)	Awareness campaigns about eco-driving Inclusion of eco-driving as part of education of new drivers
Modal shift	30% shift from road to rail by 2030	Extension of rail grid
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	
More efficient vehicles	50% more efficient private cars and trucks (petrol and diesel) by 2030	

Software HERON Decision Support Tool

Developing scenarios (4/8)

- Energy efficient scenario (EE T1)
  - forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour
  - Same sub-scenarios
  - Same policy mixture with EE T0

Developing scenarios (5/8)

Sub-scenarios	Policy assumption(s)	DST outcome (after considering impact of barriers)	Policy instrument(s) that focus on achieving the policy assumption
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	Grants of 3000-8000 Euros for the purchase of HEVs (YPEKA, 2012) Grant of up to 10% of the price for the purchase of PHEVs and BEVs (YPEKA, 2012) Campaigns for raising awareness towards electric vehicles Extension of the grid of e-mobility (charger points, etc.)
Eco-driving	10% energy savings from eco-driving in road transport (private vehicles, buses and trucks)	7,642% energy savings from eco-driving in road transport (private vehicles, buses and trucks)	Awareness campaigns about eco-driving Inclusion of eco-driving as part of education of new drivers
Modal shift	30% shift from road to rail by 2030	17,494% shift from road to rail by 2030	Extension of rail grid
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	- 7,762% by 2020 and 15,345% by 2030 penetration of biofuels in road transport, and 3,836 % penetration of biofuels 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	

Developing scenarios (6/8)

- Energy efficient scenario (EE T2)
  - forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions
  - **Electric and hybrid vehicles – Modal shift – More efficient vehicles** (based on DST).

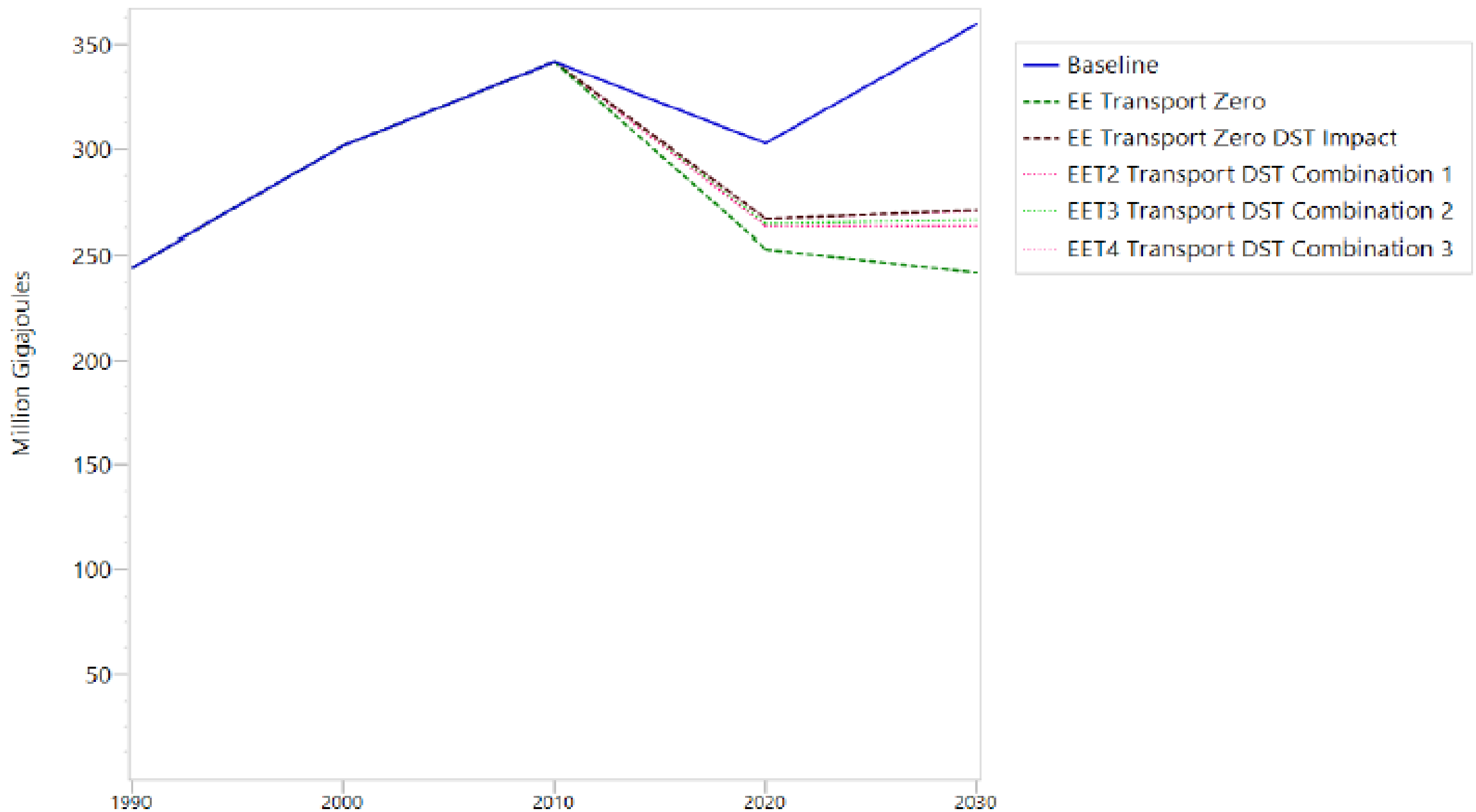
Developing scenarios (7/8)

- Energy efficient scenario (EE T3)
  - forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions
  - **Electric and hybrid vehicles – Use of biofuels – more efficient vehicles** (based on DST).

Developing scenarios (8/8)

- Energy efficient scenario (EE T4)
  - forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions
- **More efficient vehicles – Eco-driving – Use of biofuels** (based on DST).

LEAP outcomes



Conclusions

- HERON – DST provides
  - Common sets of barriers, but each country evaluates differently the impact of barriers
  - Deviations from the EE target(s) and options for reducing them according to preferences per examined case
  - Outcomes in Excel for incorporating in energy modelling
  - Basis for research in a new area

Thank you

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