

QUANTIFICATION OF ENERGY END-USERS' BEHAVIORAL PATERNS

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Outline

- Problem
- Concept
- Approach
- Methodology of DST
- DST - Software
- Conclusions



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

Problem

The reduction of the observed deviation in EE targets due to end-users behavioral barriers



Source: <http://easyenergysavingtips.com/4-trends-in-energy-efficiency/>

Concept

Quantification of the qualitative information concerning end-users' behavioral barriers in energy efficiency modelling

Approach

Calculation of the occurring deviation due to the:

A.- impact factors of barriers related with final EE target

B.- impact factors of barriers on input drivers

Optimization process

1. on selected input drivers (A+B)

2. reduction of impact factors (B)

Development of a set of optimized scenarios

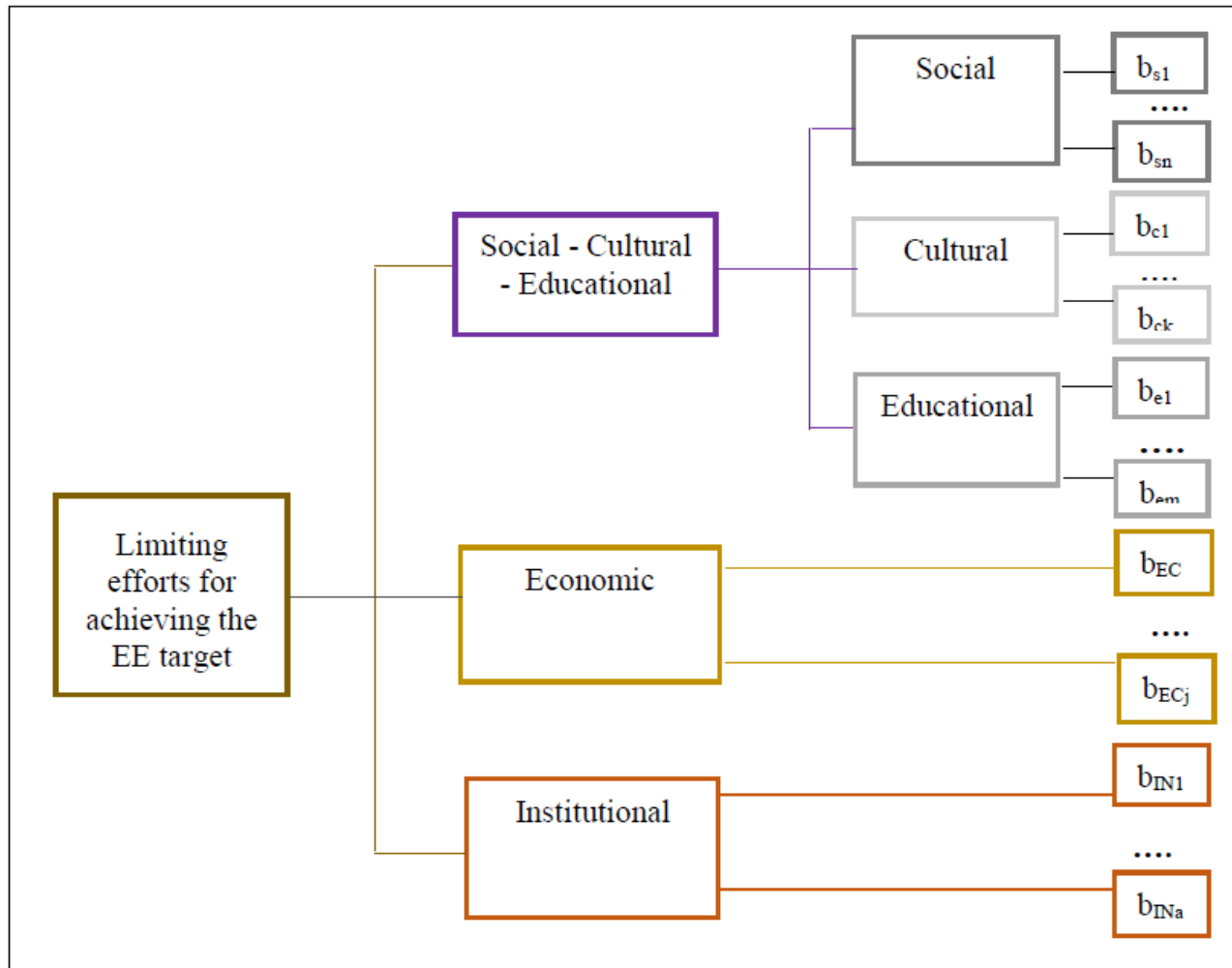
Conclude with preferable (optimum optimum) scenario

Methodology

- 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



Steps 3 & 4

Weight coefficients and Impact factors

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

Building sector – First group

Type	Name of barrier	Function
Social	Social group interactions and status considerations	$I_{s1} = W_{S-C-E} * W_s * W_{s1}$
Social	Socio-economic status of building users	$I_{s2} = W_{S-C-E} * W_s * W_{s2}$
Social	Strong dependency on the neighbors in multi-family housing	$I_{s3} = W_{S-C-E} * W_s * W_{s3}$
Social	Inertia	$I_{s4} = W_{S-C-E} * W_s * W_{s4}$
Social	Commitment and motivation of public social support	$I_{s5} = W_{S-C-E} * W_s * W_{s5}$
Social	Rebound effect	$I_{s6} = W_{S-C-E} * W_s * W_{s6}$
Cultural	Lack of interest/low priority/Undervaluing energy efficiency	$I_{c1} = W_{S-C-E} * W_c * W_{c1}$
Cultural	Customs, habits and relevant behavioural aspects	$I_{c2} = W_{S-C-E} * W_c * W_{c2}$
Cultural	Bounded rationality/Visibility of energy efficiency	$I_{c3} = W_{S-C-E} * W_c * W_{c3}$
Cultural	Missing credibility/mistrust of technologies and contractors	$I_{c4} = W_{S-C-E} * W_c * W_{c4}$
Educational	Lack of trained and skilled professionals/ trusted information, knowledge and experience	$I_{E1} = W_{S-C-E} * W_E * W_{E1}$
Educational	Lack of awareness/knowledge on savings potential/information gap on technologies	$I_{E2} = W_{S-C-E} * W_E * W_{E2}$

Steps 3 & 4

Weight coefficients and Impact factors

Building sector – Second and third group

Economic	Lack of any type of financial support (lack of financial incentive (Public and Private sector)/ Lack of funds or access to finance)	$I_{EC1} = W_{EC} * W_{EC1}$
Economic	High capital costs/Financial risk/ Uncertainty on investment/ High cost of innovative technologies for end-users	$I_{EC2} = W_{EC} * W_{EC2}$
Economic	Payback expectations/investment horizons	$I_{EC3} = W_{EC} * W_{EC3}$
Economic	Relatively cheap energy and fuel prices/ misleading Tariff system not reflecting correct prices for energy use/EE	$I_{EC4} = W_{EC} * W_{EC4}$
Economic	Unexpected costs (Hidden costs/ Costs vary regionally (Fragmented ability))	$I_{EC5} = W_{EC} * W_{EC5}$
Economic	Financial crisis/Economic stagnation	$I_{EC6} = W_{EC} * W_{EC6}$
Economic	Embryonic markets	$I_{EC7} = W_{EC} * W_{EC7}$
Institutional	Split Incentive	$I_{I1} = W_I * w_{I1}$
Institutional	Legislation issues (Lack of relevant legislation/Lack of regulatory provision /Change of legislation for local/regional administrative division/ Complex/inadequate regulatory procedures)	$I_{I2} = W_I * w_{I2}$
Institutional	Building stock characteristics/aging stock/ Historical preservation	$I_{I3} = W_I * w_{I3}$
Institutional	Poor compliance with efficiency standards or construction standards/ Technical problems/ Performance gap/mismatch	$I_{I4} = W_I * w_{I4}$
Institutional	Lack of data/information-diversion of management	$I_{I5} = W_I * w_{I5}$
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)	$I_{I6} = W_I * w_{I6}$
Institutional	Disruption/Hassie factor	$I_{I7} = W_I * w_{I7}$
Institutional	Security of fuel supply	$I_{I8} = W_I * w_{I8}$

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

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

- 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)

Software HERON Decision Support Tool

the link was with the tool so as to perform its live demonstration



Flexibility of software

- Add
 - Other national cases
 - Other sectors
 - New technologies
- Apply in different areas
 - Natural gas
 - Renewable energy sources

Conclusions

- DST provides
 - Common sets of barriers, but each country evaluates differently the impact of barriers
 - Deviations from the 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 other areas

Thank you

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