UNIVERSITÉ DE GENÈVE
INSTITUT DES SCIENCES DE L'ENVIRONNEMENT

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Haute école de gestion Genève

Assessing demand-side behaviour in long-term energy modelling:
The case of Romanian Social MARKAL

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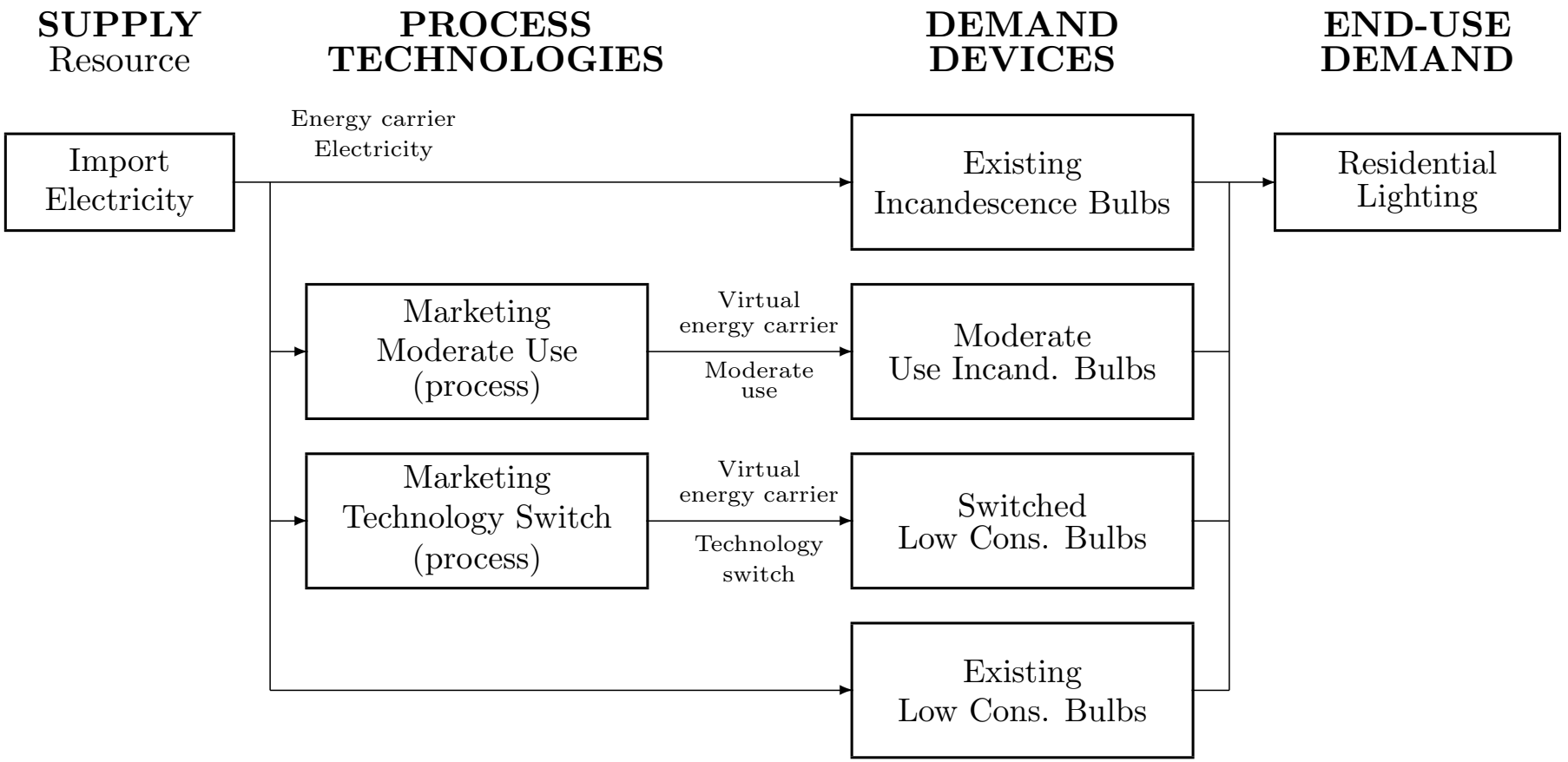
Including Behaviour in Energy/Engineering/Economy/Environment models, London 21 April 2015

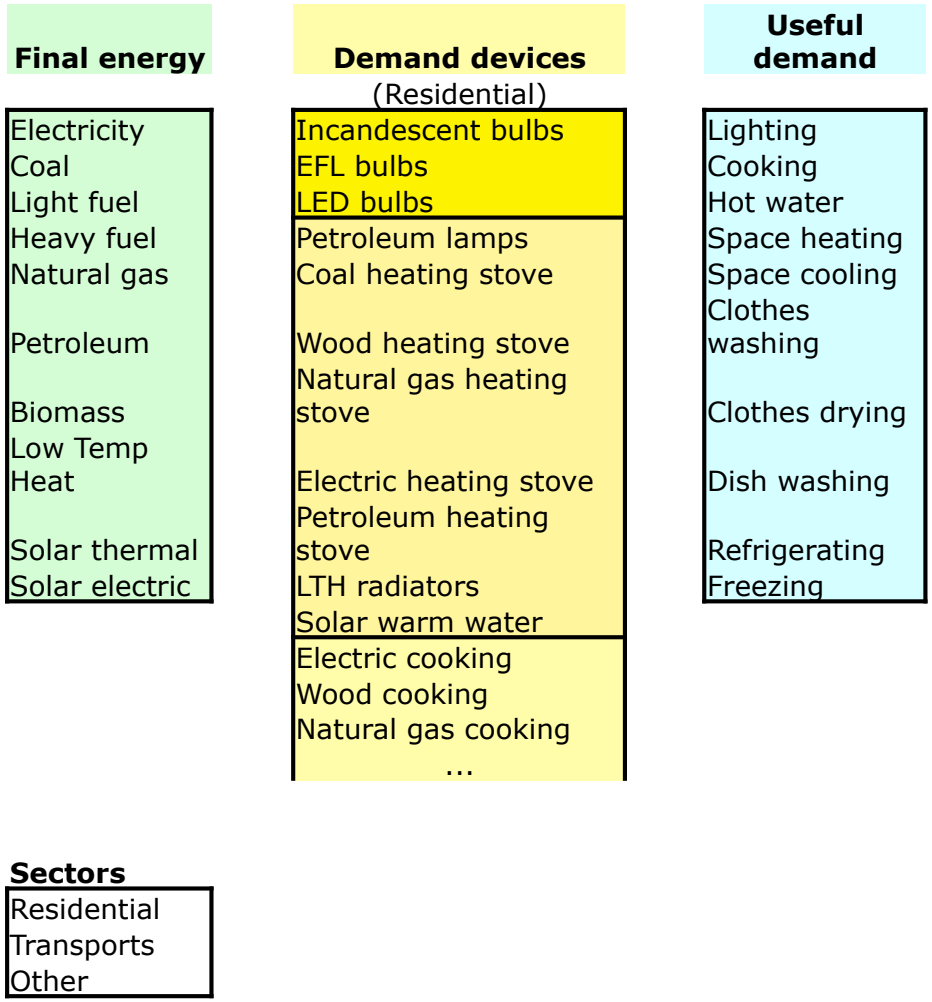
Social MARKAL

Case: residential lighting in city of Nyon

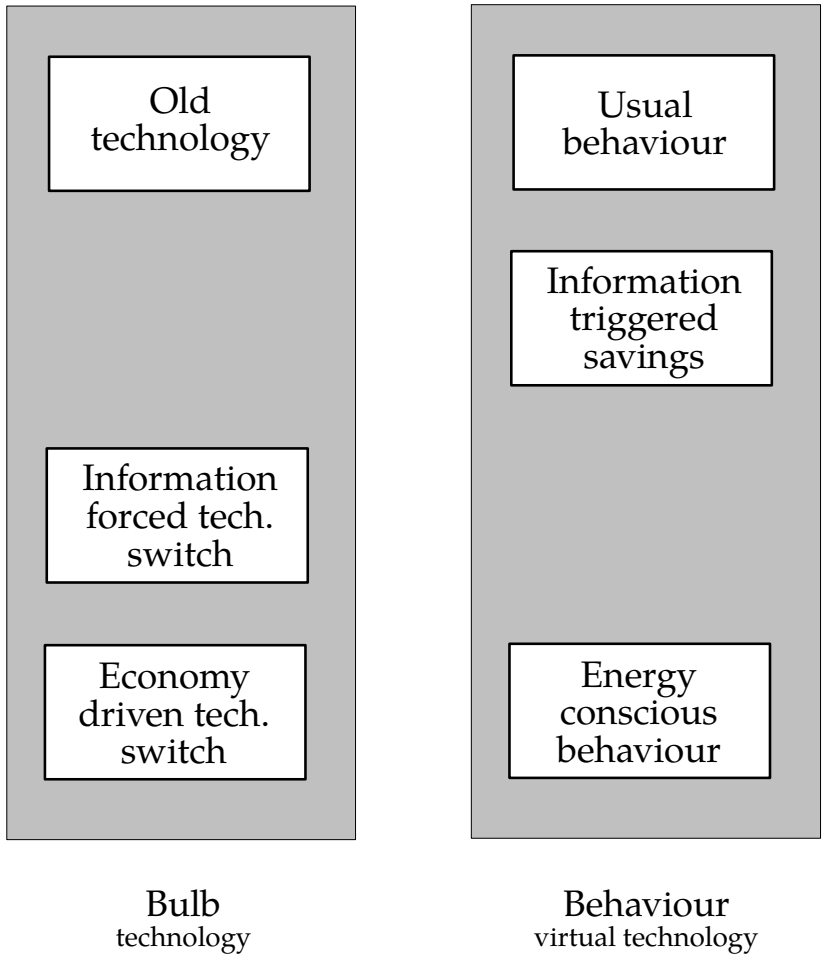


Social TIMES Romania

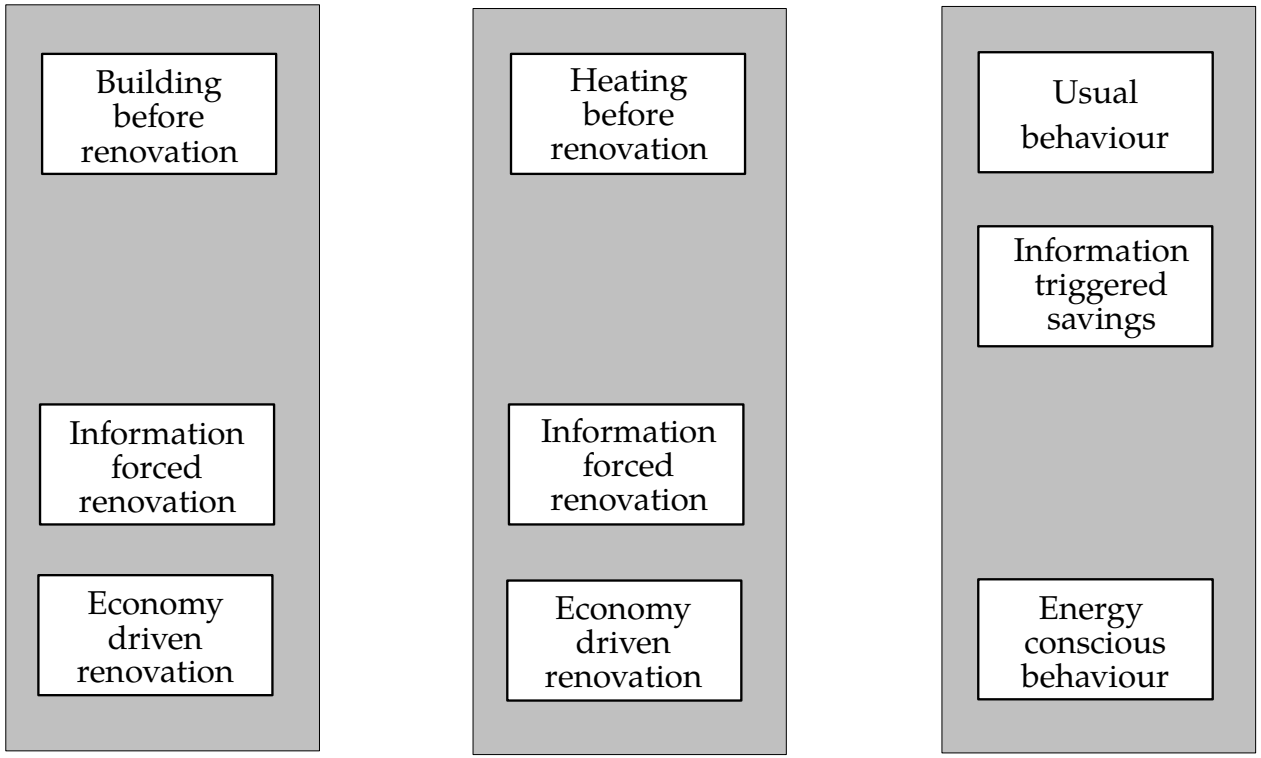
- three sectors: residential, transports, others
- only demand side modeled in detail
- supply side: virtual imports
- start 2010, 6 time slices, 7 periods until 2026



Residential Lighting



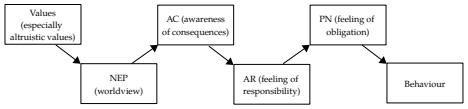
Residential heating

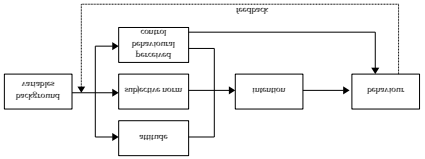


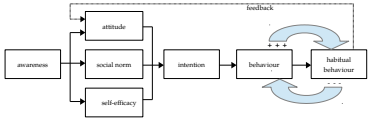
Proceedings of the Energy for Sustainability Multidisciplinary Conference EfS 2013,
8-10 September 2013 - Energy for Sustainability Initiative, University of Coimbra, Portugal

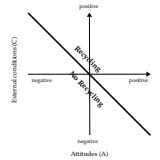
Behaviour models

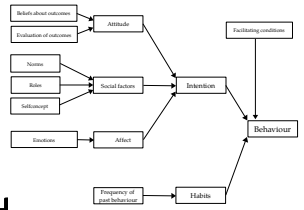
- VBN: Value – Belief – Norm
- TPB: Theory of Planned Behaviour
- HB: Habitual Behaviour
- ABC: Attitude – Behaviour – Context
- IPB: Theory of Interpersonal Behaviour
- MOA: Motivation – Opportunity – Ability

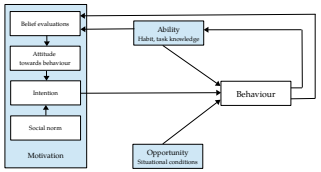




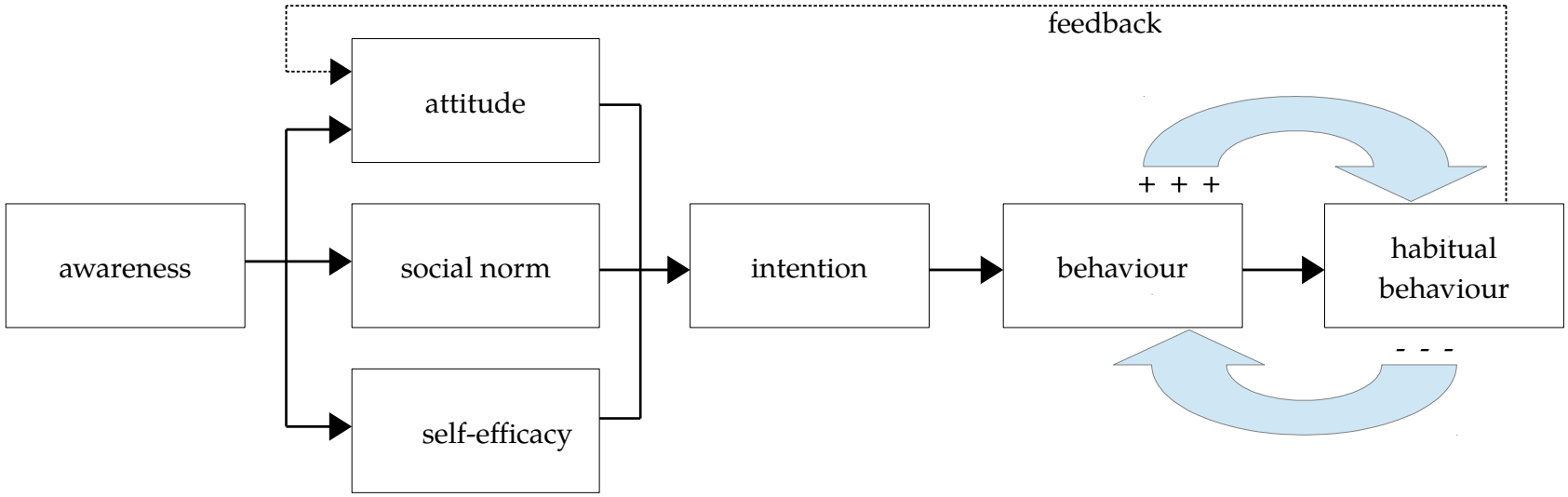








Theory of Habitual Behaviour



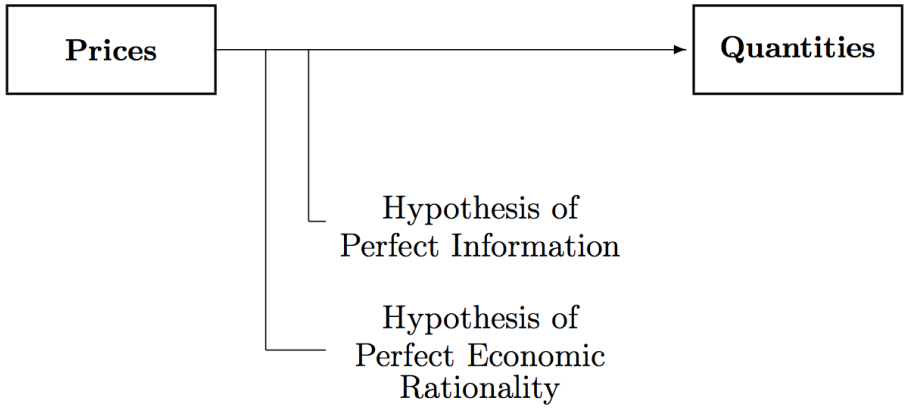
Up to 95% of household energy behaviour is a form of habitual behaviour.

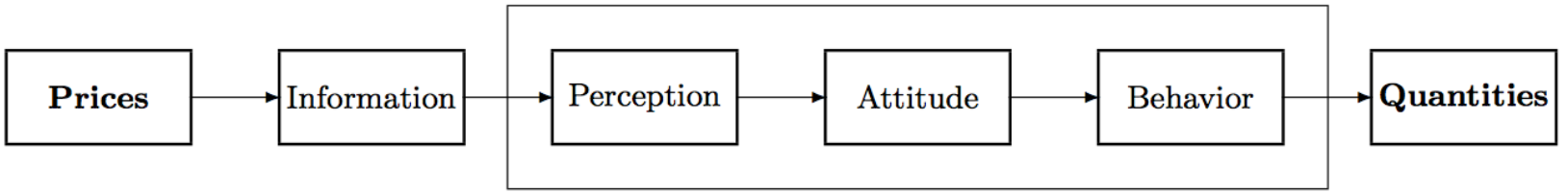
Source: Wagenaar, 1992

To break the habitual loop: removing incentives to habitual behaviour, making consumers aware of their habits, enable to control the outcomes

Source: Egmond and Bruel, 2007

Social MARKAL Behavioural Model





Imperfect Information (can be measured)

Aggregated Rationality

What to measure

Bounds on technologies - share of people who:

- Already do have the information and behave rationally
- Do not have the information but once better informed, they will change their behaviour
- Will never change because of extra-economic reasons

Efficiencies, cost of virtual process technology “infocampaign”:

- Part of people for whom the information campaign is the principal vector of behavioural change - yield
- Part of people who denote a medium as the most efficient one – cost mix

How to measure

Q6: How many light bulbs do you have in your home?

[exact number, -10, -20, -30, -40, 40+, do not know]

Q7: How many of them are low-consumption bulbs?

[none, ¼, ½, ¾, all, don't know]

Q8 : During the last two years, how many incandescent bulbs (conventional bulbs) have you replaced with low consumption bulbs?

[exact number, none, ¼, ½, ¾, all, do not know]

How to measure (2)

Q10: Do you know that low consumption bulbs can consume 5 times less energy than incandescent bulbs? [yes, no]

Q11: Do you know that low consumption bulbs have a lifespan of up to 10 times superior to incandescent bulbs? [yes, no]

Q12: Were you better informed about economic advantages of the low-consumption bulbs, would you be ready to abandon the incandescent bulbs? [yes, no]

Geneva					Romania				
yes	no	missing	total y/n	full total	yes	no	missing	total y/n	full total
267	120	6	387	393	280	123	4	403	407
67.9%	30.5%	1.5%		100%	68.8%	30.2%	1.0%		100%
69.0%	31.0%		100%		69.5%	30.5%		100%	

How to measure (3)

Q13: Did you know that a household where half of all incandescent bulbs are replaced by low-consumption bulbs can realise a saving up to 200 Frs per year? [yes, no]

Geneva					Romania				
yes	no	missing	total y/n	full total	yes	no	missing	total y/n	full total
99	293	1	392	393	96	309	2	405	407
25.2%	74.6%	0.3%	99.7%	100%	23.6%	75.9%	0.5%	99.5%	100%
25.3%	74.7%		100%		23.7%	76.3%		100%	

Q14: Based on this information, would you change at least the half of your bulbs? [yes, no, already did]

Geneva						Romania					
yes	no	already did	missing	total y/n	full total	yes	no	already did	missing	total y/n	full total
207	71	111	4	389	393	235	60	109	3	404	407
52.7%	18.1%	28.2%	1.0%	99.0%	100%	57.7%	14.7%	26.8%	0.7%	99.3%	100%
53.2%	18.3%	28.5%		100%		58.2%	14.9%	27.0%		100%	

How to measure (4)

Q15: Your electricity consumption would be susceptible to change following a:

15.1 opinion or advice of a close person (neighbour, family member, colleague)

15.2 information campaign in medias, advertisements

15.3 request from your children

15.4 modification of your revenue

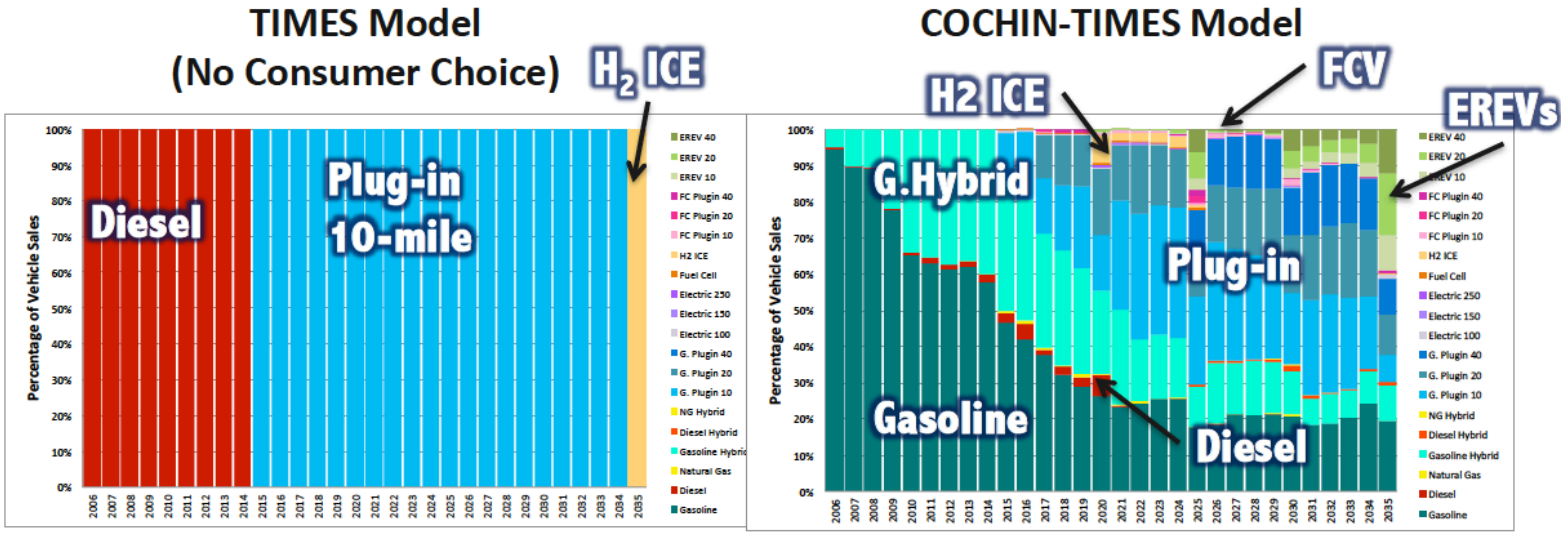
15.5 important electricity price increase

15.6 nothing could change my current behaviour

Geneva				Romania			
Q 15.6	missing	total y/n	full total	Q 15.6	missing	total y/n	full total
39	4	389	393	32	0	408	408
9.9%	1.0%	99.0%	100%	7.8%	0%	100%	100%
10.0%		100%		7.8%	0%	100%	

A hybrid simulation-optimisation model

Results: Reference Case (Percentage of Vehicle Sales)

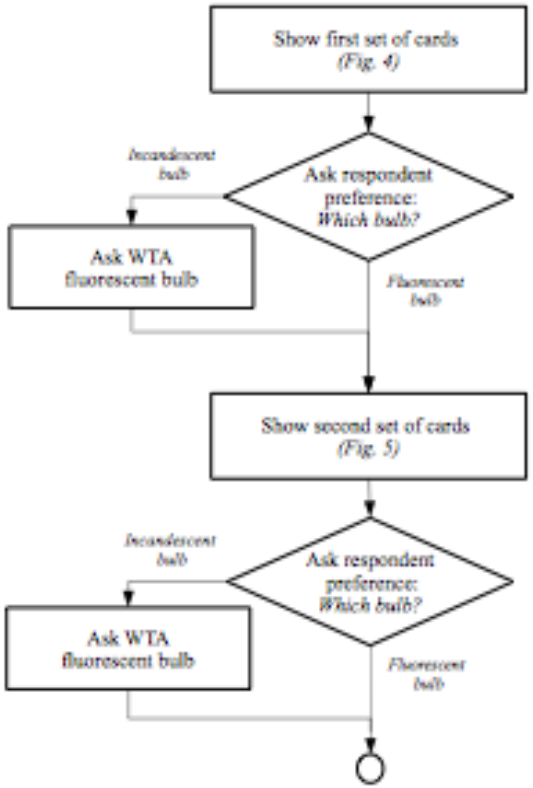


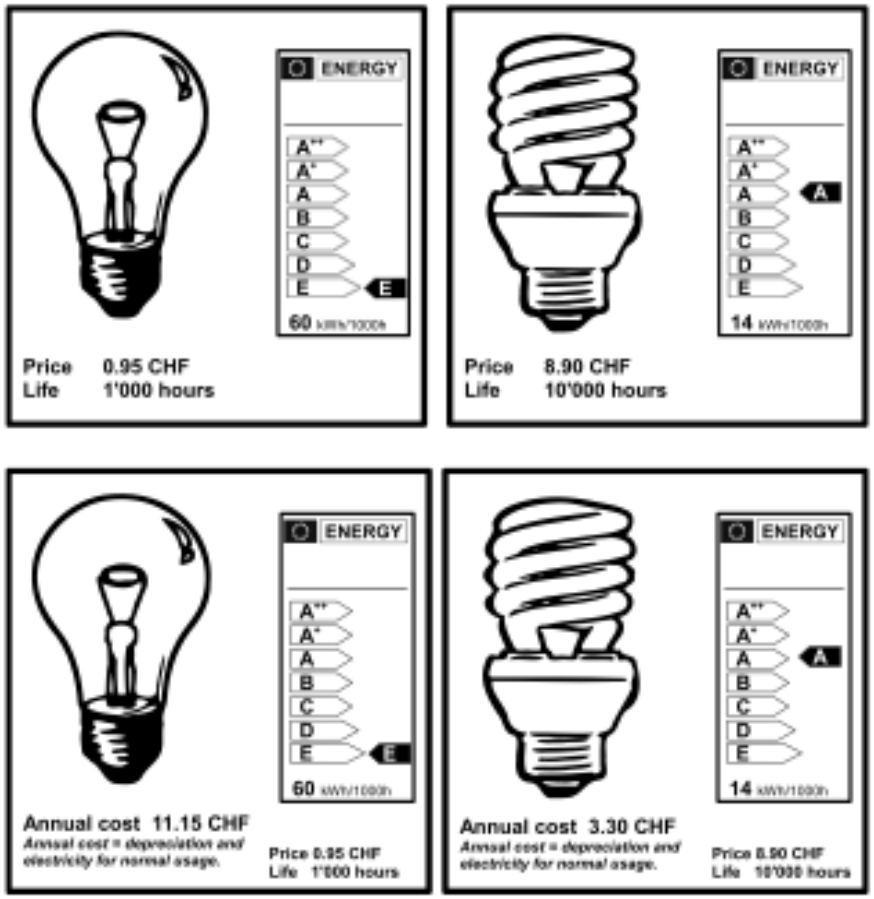
- TIMES model investments follow 'winner takes all' phenomenon (in this conceptual model, there are no market constraints).
- COCHIN-TIMES investment decisions are far diverse, mainly dominated by gasoline cars, followed by gasoline hybrids and gasoline plug-in cars in the later years.
- No Supply restrictions: Faster penetration of plug-in hybrids since currently there are no manufacturer supply limitations in the model.

UCDAVIS
SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS

Source: K. Ramea et al., **Incorporation of Consumer Demand in Energy Systems Models and their Implications for Climate Policy Analysis, IEW Paris, IEA 19-21 June 2013**

Share of Choice - Research setup





Share-of-Choice MARKAL

Respondent	k	=	$1 \ldots K$.
Period	t	=	$1 \ldots T$.
Campaign level	j	=	$0, 1$. 1 if campaign and 0 otherwise.
Subsides level	l	$\geq$	0.

$$u(k,j) = \begin{cases} 1 & \text{if } l_b(k,j) = 0 \\ -l_b(k,j) & \text{otherwise.} \end{cases}$$

part-worths for the low consumption bulb

$d(t)$	forecasted demand for bulbs	$z_1(t)$	installed capacity of incandescent bulbs
c_q	cost of the campaign	$z_2(t)$	installed capacity of low consumption bulbs
λ	cost of the subsides	q	campaign configuration: 1 if campaign and 0 otherwise.
		l	subside level - amount of subside per bulb
		$p(k)$	preference for respondent k: 1 if respondent becomes a new client 0 otherwise.
		$x = (y, z)$	the variable describing the activities in the classical model (i.e. investment in each technology, etc.)

$$\min_{x,p,q,l} c \cdot x + c_q \cdot q + \lambda \cdot l$$

$$A \cdot x \geq b.$$

$$k = 1 \ldots K$$

$$u(k,0) \cdot (1-q) + u(k,1) \cdot q + l \geq (p(k) - 1) \cdot M,$$

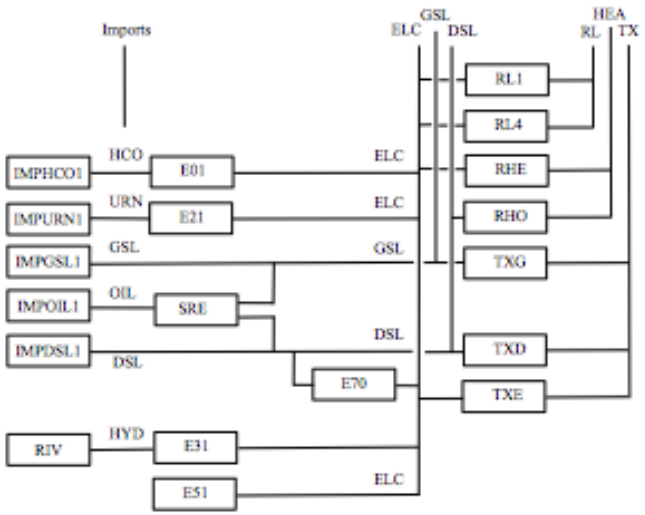
$$u(k,0) \cdot (1-q) + u(k,1) \cdot q + l \leq p(k) \cdot M,$$

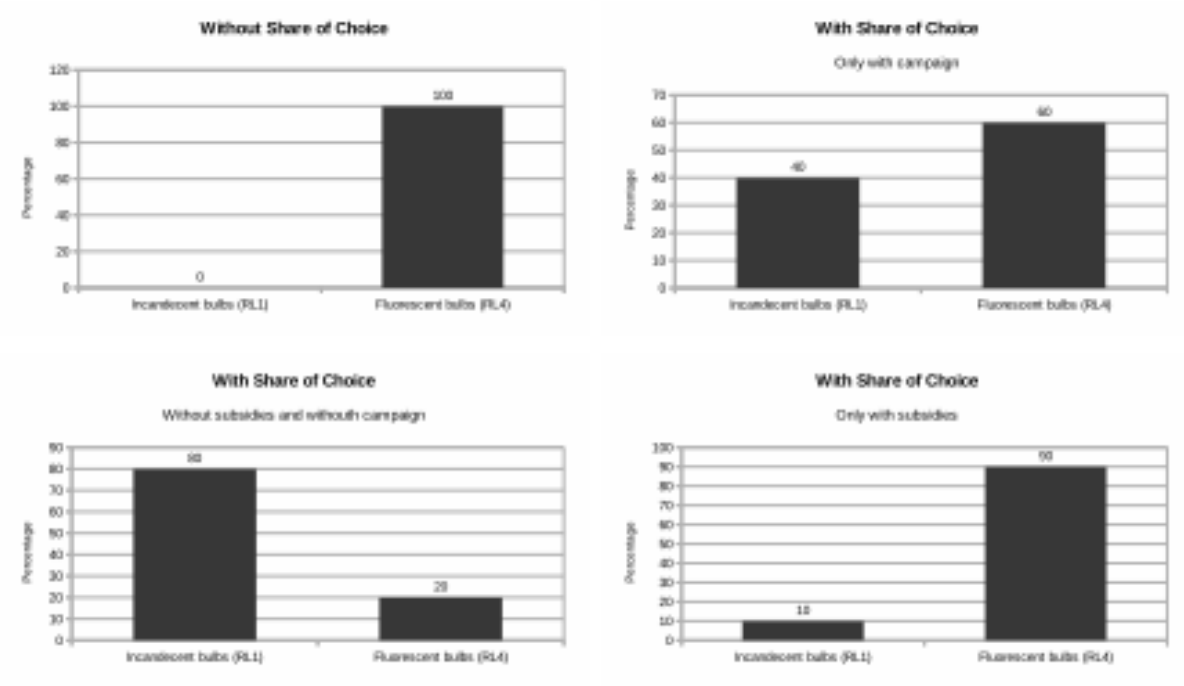
$$P = \frac{1}{K} \sum_{k=1}^{K} p(k)$$ proportion of low consumption bulbs

$$z_1(t) = d(t) \cdot (1 - P),$$

$$z_2(t) = d(t) \cdot P$$

Share of Choice - Results





Proceedings of the 53rd Meeting of the Euro Working Group on Commodities and Financial Modelling (EWGCFM) and 2nd International Conference of the Research Centre for Energy Management (RCEM), 22-24 May 2014, Chania, Crete

Proceedings of the 14th Informatics in Economy International Conference, 30 April - 2 May 2015, Bucharest, Romania

A comparison of the approaches

	bounds	SocialMarkal	Cochin-TIMES	Share-of-Choice
objectivity	subjective	objective	objective	objective
linearity	part of model	yes	no	no
hard-link	part of model	no	no	yes
soft-link	no	yes	yes	yes
external data	yes/no	survey	study	survey
technological detail	yes	yes	yes	yes
synoptic aggregation	yes	no	no	no

Research project

- Swiss Enlargement Contribution in the framework of the Romanian-Swiss Research Program

- Swiss National Fund of Scientific Research Grant IZERZ0_142217

- Research team:
  - Geneva: Emmanuel Fragnière, Francesco Moresino, Roman Kanala
  - Bucharest: Ion Smeureanu, Marian Dardala, Andrea Reveiu, Emilia Titan, Felix Furtuna