

Behavioural Energy Economics: Drivers, concepts and policy implications

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And the global financial crisis.....



A. Greenspan: "*[I am in] shocked disbelief*"; that "*the whole intellectual edifice [had] collapsed*"

Key behavioural deviations

Bounded rationality

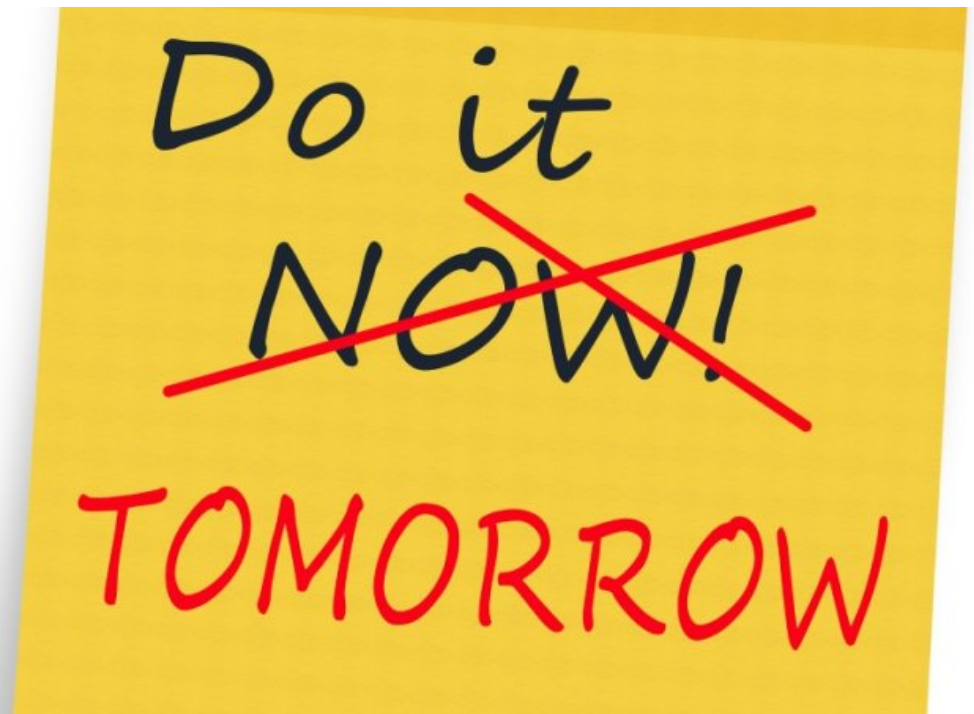
I trust my gut,
Our project is too complex
for logic and evidence.



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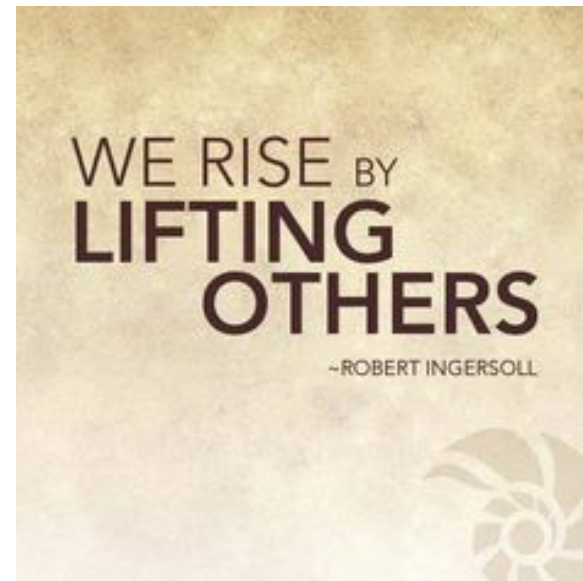
Key behavioural deviations

**Bounded
willpower**



Key behavioural deviations

**Bounded
self-interest**



- *Endowment effect/reference* (Kahneman et al, 1990, 1991; Thaler, 1981; Knetsch, 1989; Dinner et al, 2011)
- *Status-quo bias/reference* (Kahneman et al, 1991; Samuelson & Zeckhauser, 1988; Ritov & Baron, 1992; Camerer & Lovallo, 1999; Terrell, 1994)
 - *Value function* (Tversky & Kahneman, 1992; Kahneman & Tversky, 1984; Tversky & Kahneman, 1981)
- *(Loss aversion/reference)* (Kahneman & Tversky, 1979; Shogren & Taylor, 2008)

- *Discounting* (Hyperbolic/implicit) (Loewenstein & Thaler, 1989; Thaler, 1981; Shane, Loewenstein & O'Donoghue, 2002; Collier & Williams, 1999)
- *Risk (aversion) and time-varying decision* (Camerer & Loewenstein, 2004; Frederick et al, 2004; O'Donoghue and Rabin, 2000; Loewenstein et al. 2003; Bell, 1985; Thaler & Shefrin, 1981)
- *Value commitment* (Ashraf et al, 2006; Green & Myerson, 1994; Della & Malmendeir, 2006)

Prospect Theory

Intertemporal Choice

Behavioural Economics

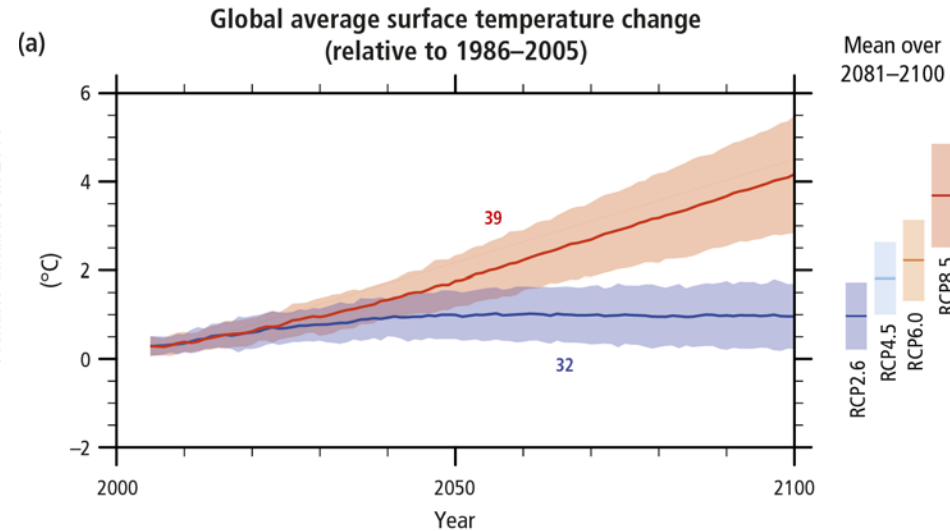
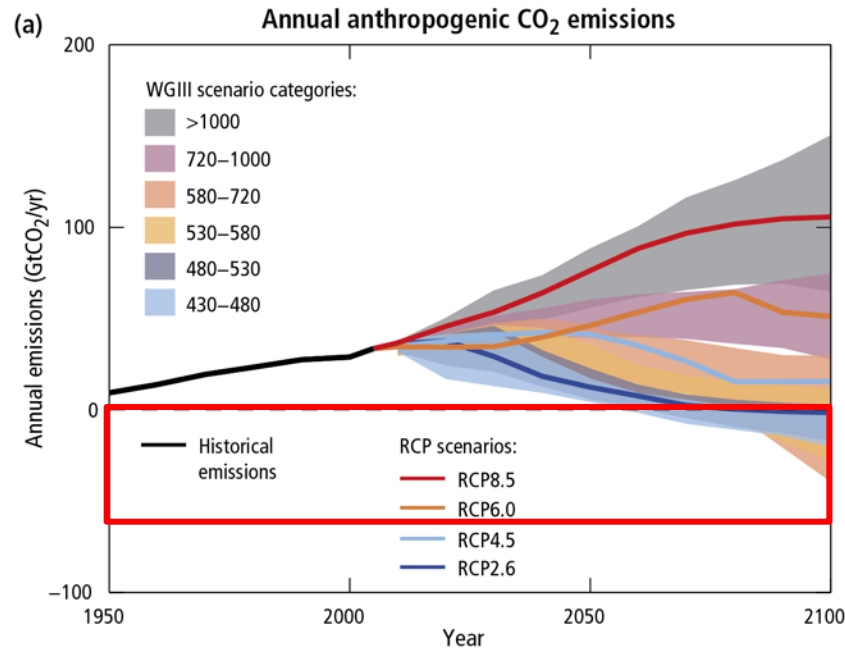
Norms and Moral Behaviour

- *Fairness* (Kahneman et al., 1986; Cardenas & Carpenter, 2008; Fehr & Schmidt, 1999; Falk et al, 2008; Forsythe et al, 1994)
 - *Cooperation* (conditional) (Ostrom, 1998; Frey & Meier, 2004; Fischbacher et al., 2001)
 - *Reciprocity* (Croson et al, 2005; Fehr & Gächter, 2000; Gouldner, 1960; Falk & Fishbacher, 2006; Berg et al, 1995)
 - *Warm-glow effect* (Andreoni, 1990; Crumpler & Grossman, 2008; Isen & Levin, 1972; Menges et al., 2005; Gneezy & Rustichini, 2000)
 - *Norm-based motivation* (Andreoni et al, 2009; Brekke et al, 2003; Nyborg et al, 2006; Biel & Thøgersen, 2007)

Cognitive Science & Bounded Rationality

- *Choice overload/paradox* (Schwartz, 2004; Iyengar & Lepper, 2000; Scheibehenne et al, 2010; Reed et al, 2011; Hogarth & Reder 1987; Smith, 1991; Fehr & Rangel, 2011)
- *Heuristics* (sub-optimal) methods (Simon, 1947; 1957; Camerer & Loewenstein, 2004; Thaler, 1991; Heath & Soll, 1996; Tversky & Kahneman, 1981; Tversky & Shafir, 1992)
- *Salience* (Kahneman, 2003; Avineri, 2012)
- *Satisficing behaviour* (Simon, 1947, 1972, 1979; March & Simon, 1963; Winter, 2000; Augier & March, 2002)
- *Self-deception* (Mijovetic & Prelec, 2010; Mazar & Ariely, 2006)

And major assessments....



Source: IPCC (2014)

And major assessments....

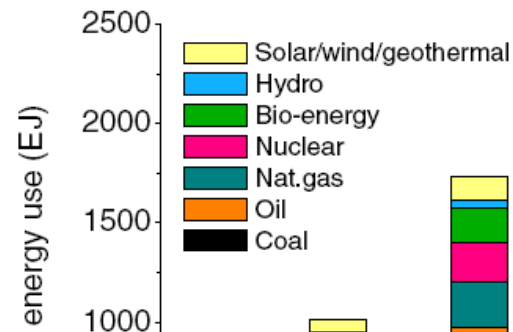
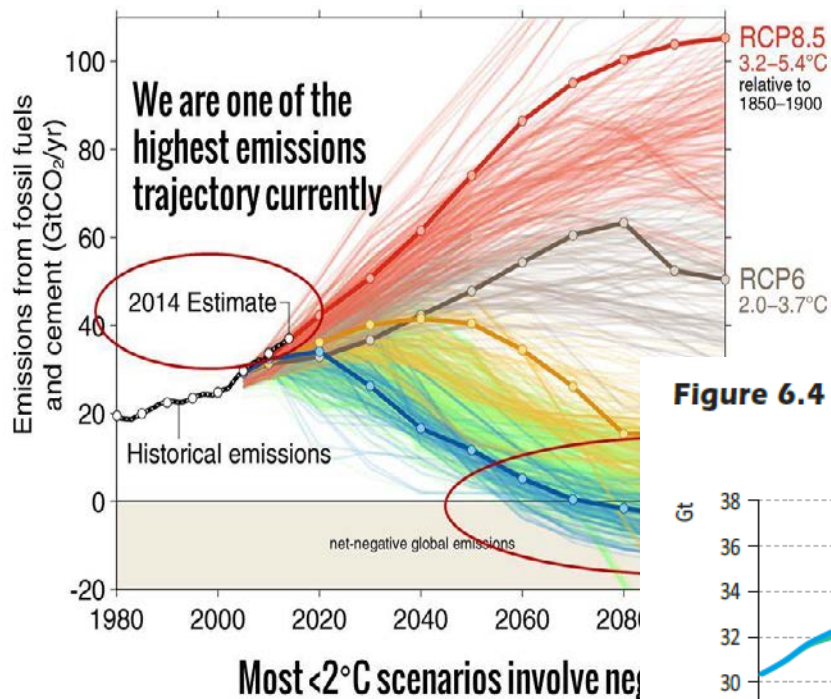
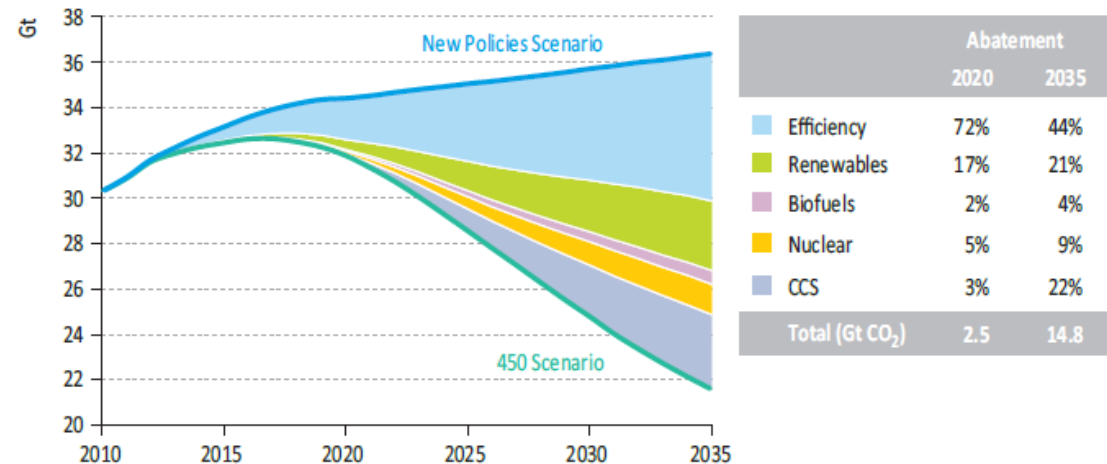


Figure 6.4 • World energy-related CO₂ emissions abatement in the 450 Scenario relative to the New Policies Scenario

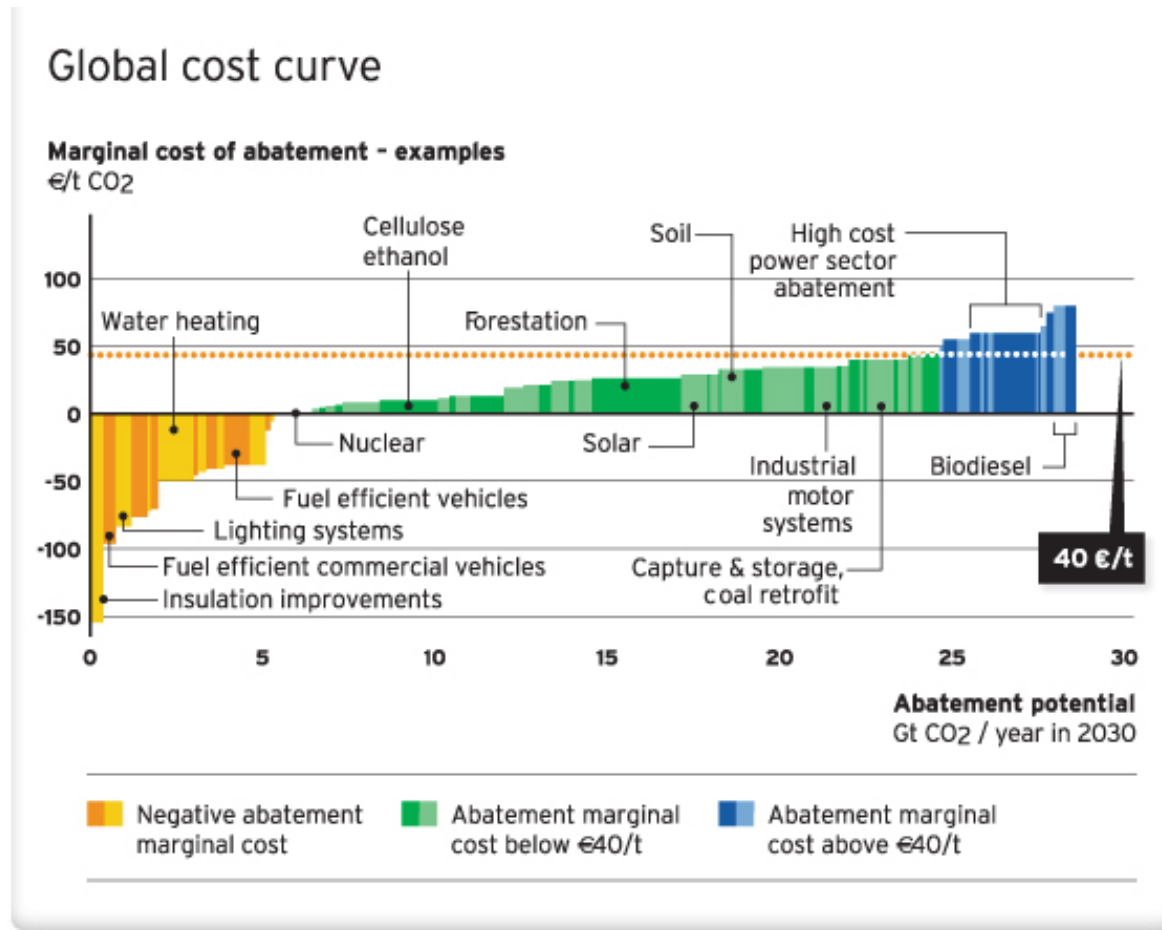


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Source: IEA (2011)

And major 'popular' assessments....



Source: McKinsey (2009)

Practice in energy-economy models?



Evaluating Energy Efficiency Policies with Energy-Economy Models

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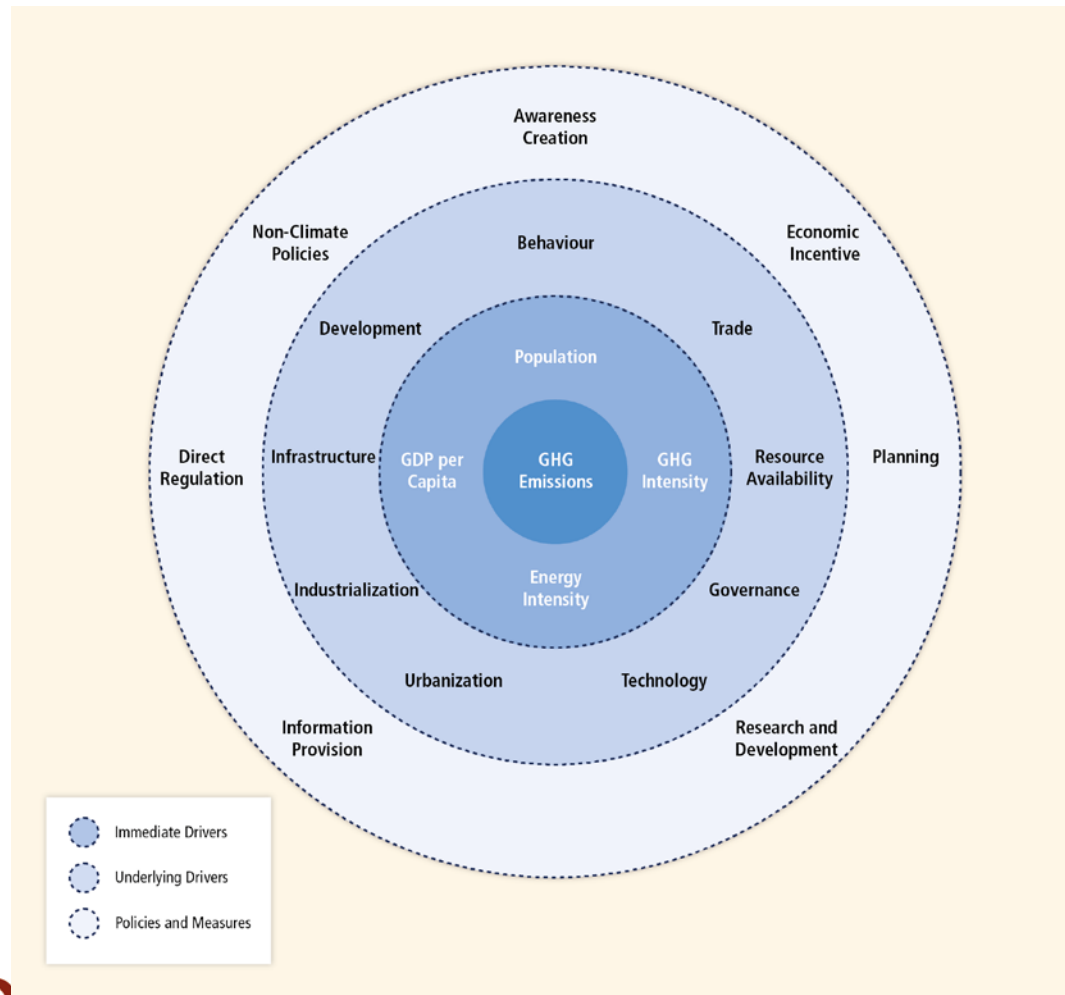
Key Words

household sector, induced technological change, policy evaluation, policy instruments, technology choice determinants

Abstract

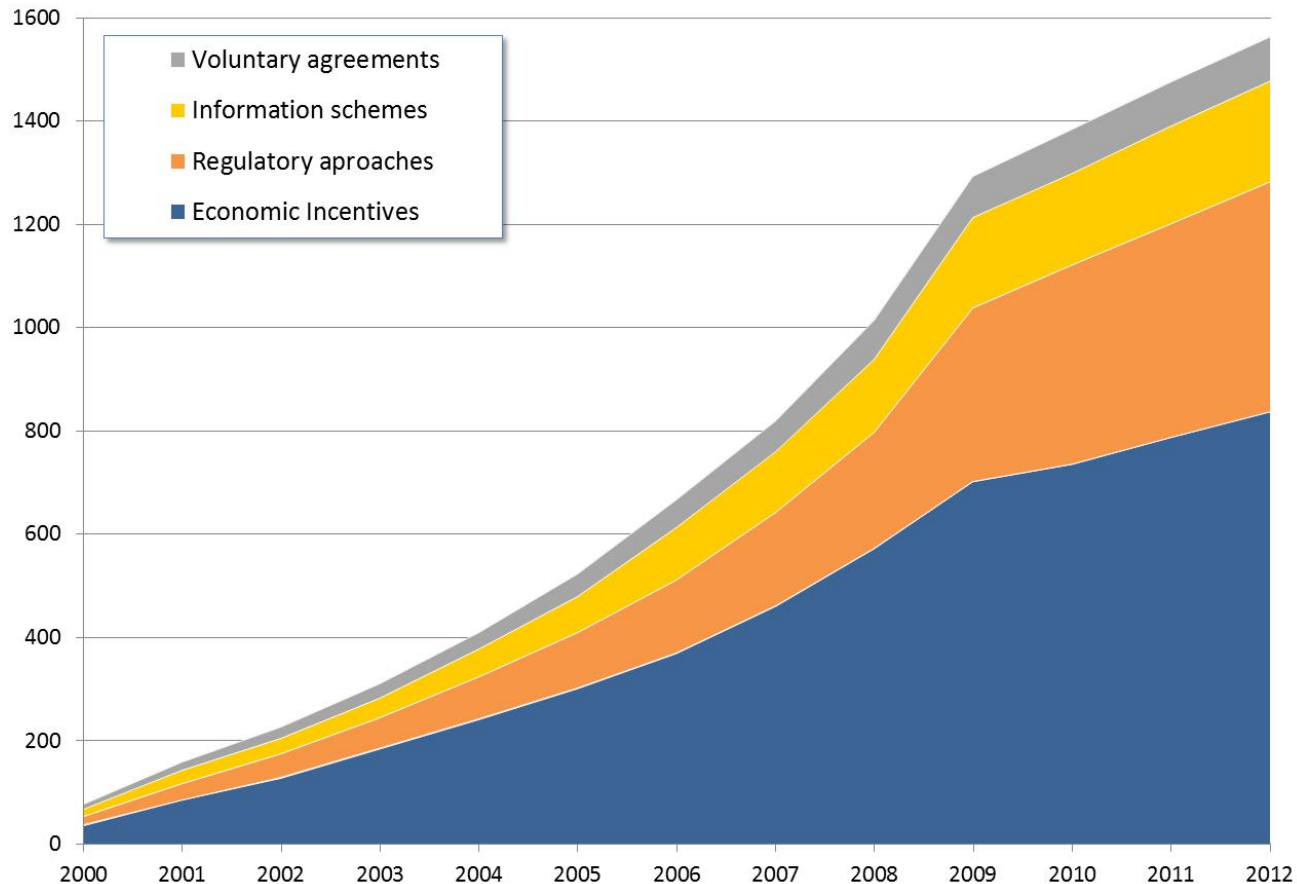
The growing complexities of energy systems, environmental problems, and technology markets are driving and testing most energy-economy models to their limits. To further advance bottom-up models from a multidisciplinary energy efficiency policy evaluation perspective, we review and critically analyze bottom-up energy-economy models and corresponding evaluation studies on energy efficiency policies to induce technological change. We use the household sector as a case study.

And policies?

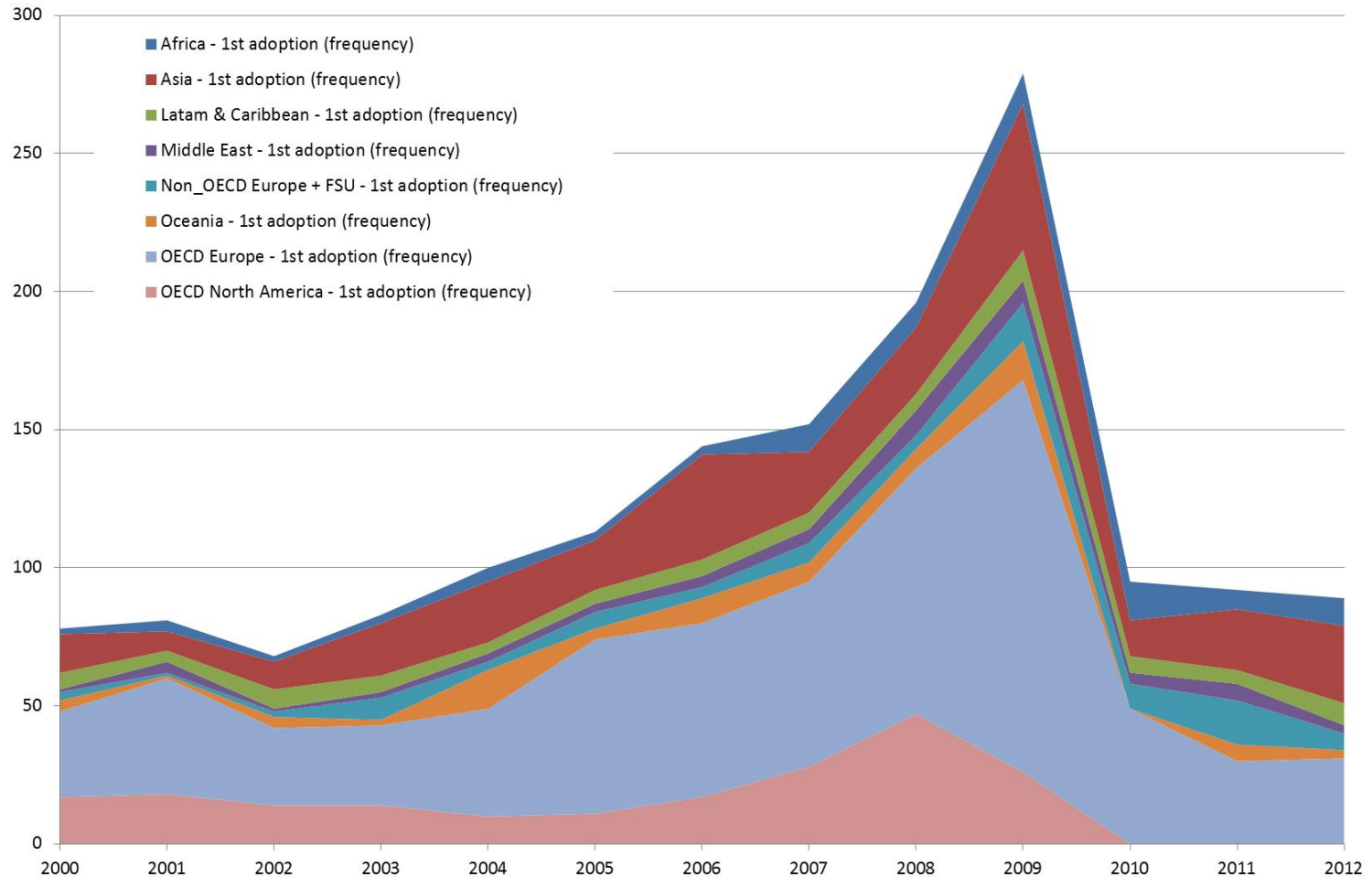


Source: Blanco et al. (2014)

Top-down overview of LCET policies



Top-down overview of LCET policies



Behavioural-oriented policy approaches

“Common” approaches:

- Energy pricing
- Command-and-control
- Awareness raising
- Education
- Financial incentives

“Innovative” approaches:

- Social norms
- Real-time feedback
- Default choices
- Salience
- Dynamic tariffs
- ‘Urgency’
- Etc.

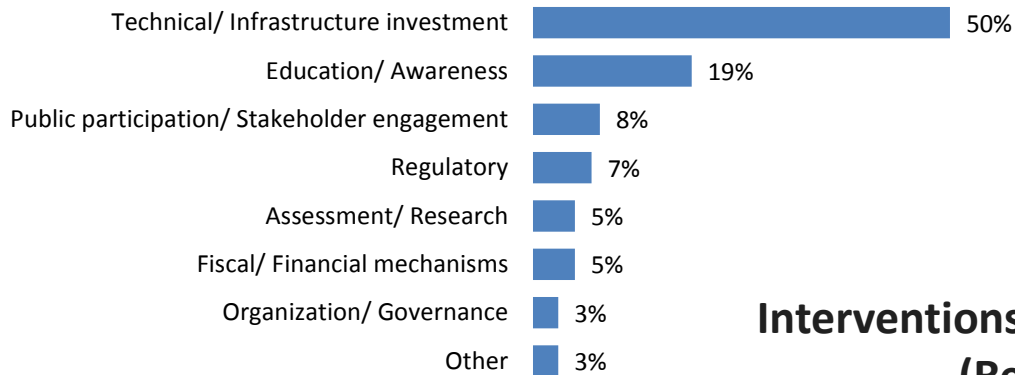
Bottom-up overview of LCET interventions

Critical review of :

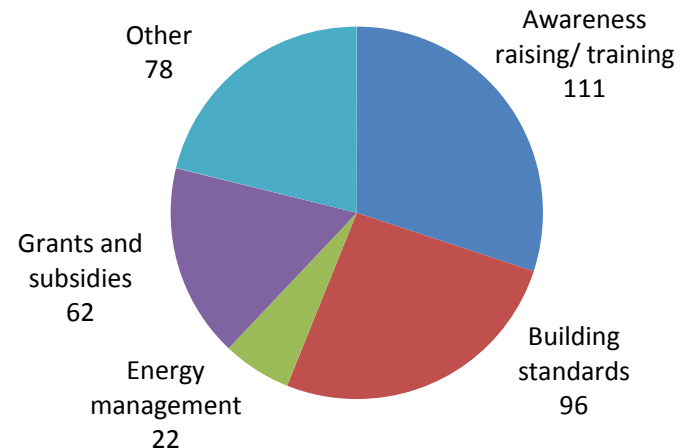
- Compact of Mayors (500+ cities; 6,200 actions)
- Covenant of Mayors (6,700 EU cities; 3,200 actions)
- Energy cities (1,000+ EU cities; 485 good practice cases)
- C40 (80 large cities; 50 good practice cases)
- Carbon Neutral City Alliance (17 large cities; policy framework)

Bottom-up overview of LCET interventions

Interventions under 'Compact of Mayors'



Interventions under 'Covenant of Mayors' (Residential Building)



Source: Sonnenschein (2016)

IPCC AR5 (WGIII)

“More research that incorporates behavioural economics into climate change mitigation is needed”

“More work on understanding how individuals and their social preferences respond to (ambitious) policy instruments and make decisions relevant to climate change is critical”

Behaviour, context and electricity use

Tedenvall & Mundaca (2016)

- **Objective:**
 - Effectiveness of ‘*standard*’ RTF technology in the Swedish residential sector
 - Understanding of behavioural, moral and context determinants that affect electricity use via RTF provision
- **Sweden**
 - Rather limited knowledge: marginal reductions; lack of large scale trials; low participation rates; EU goal 10% reduction?

Experiment - Sweden

- Role of “standard” RTF technology
 - Control group: Random readings, “normal” feedback (via elect bill); size 1,342 households
 - Intervention group: Provision of RTF technology “100Koll” smartphone app; size 1,753 households



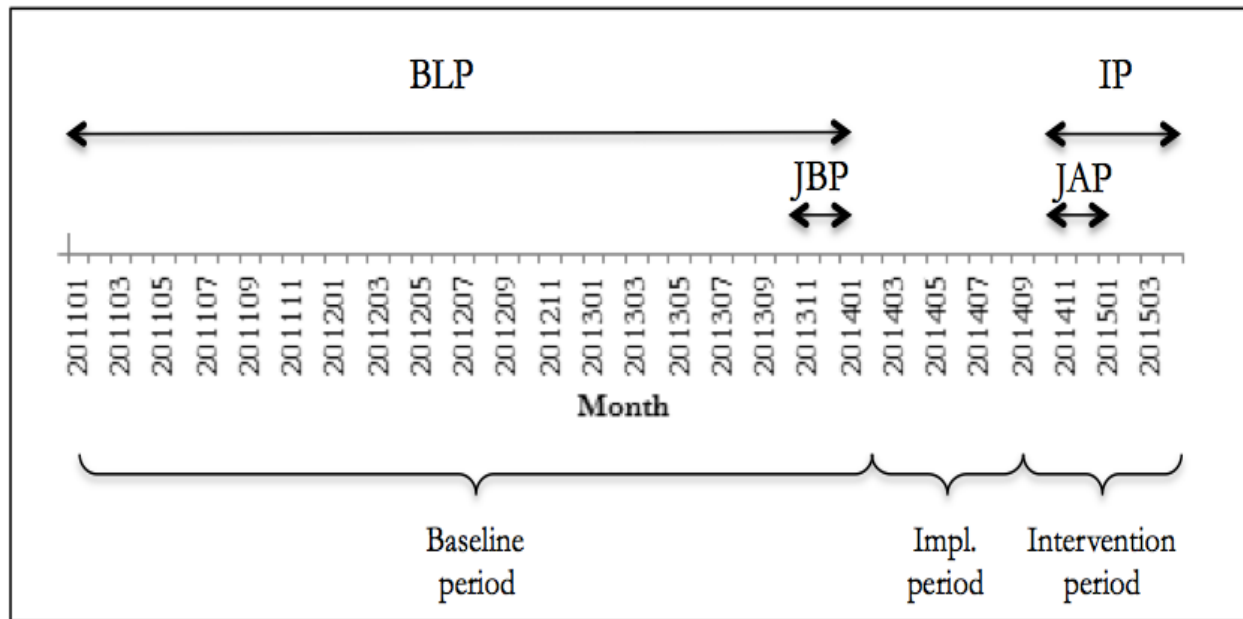
Source: E.ON (used with permission)

Experiment - Sweden

- Survey addressing 'Intervention Group'
 - Socio-economic and context: age, education level, household income, living area, etc.
 - Behavioural and moral aspects:
 - ✓ Awareness of consequences
 - ✓ Ascribed responsibility
 - ✓ Personal norms
 - ✓ Attitudes
 - ✓ Perceived behavioural control
 - ✓ Etc.

Experiment – Sweden

- Timeframes to estimate alternative baselines and effectiveness



Baseline period (BLP), intervention period (IP), period just before (JBP) and just after (JAP) implementation.

Results & Discussion - Sweden

- Effectiveness of RTF technology
 - Baseline 1: Average Swedish households =1,287 kWh for BLP (Mdn = 1091, SD = 805, N=20475)
 - Baseline 2: Control group = 1,542 kWh for JBP + IP
 - Intervention group: 1,269 kWh for BLP + IP (Mdn = 1080, SD = 815, N=1753). Effectiveness –1.4%
 - Intervention group: 1,512 kWh for JAP and 1,530 kWh for IP. Effectiveness –0,8%~1.9%

Results & Discussion - Sweden

- Comparative analysis
 - In line with: $-0.04 \sim 2.24\%$ (Pyrko, 2009; Uggmark, 2013); -1.5% Matsukawa (2004); $-0.7 \sim 1.6\%$ (Bager & Mundaca, 2015); short-term effects larger than long-term effects (Ehrhardt-Martinez, 2010)
 - A bit far off from: $-5 \sim 15\%$ (Darby, 2006), $-3 \sim 5\%$ (McKerracher & Torriti, 2013); -4.5% (Schleich et al. 2013); $-11 \sim 17\%$ (Gans et al. 2013)

Results & Discussion - Sweden

- Regression coefficients (stepwise)

Dependent variable	Independent variables	β	<i>p</i> -value (variable)	Adjusted R^2	F	<i>p</i> -value (model)
<i>Elect_use</i>	<i>Living area</i>	2284	< .001	.176	F[3,230]= 17.0	< .001
	<i>Household size</i>	1051	= .008			
	<i>Income</i>	1940	< .001			
<i>ES_behaviour</i>	<i>PBC</i>	.87	< .001	.074	F[2,225]= 9.9	< .001
	<i>Education</i>	.51	= .019			
<i>100K_reduces</i>	<i>PBC</i>	.24	= .001	.167	F[2,230]= 24.1	< .001
	<i>PN</i>	.37	< .001			
<i>100K_action</i>	<i>PN</i>	.11	< .001	.052	F[1,231]= 13.8	< .001

Making 'Smart Meters' Smarter?

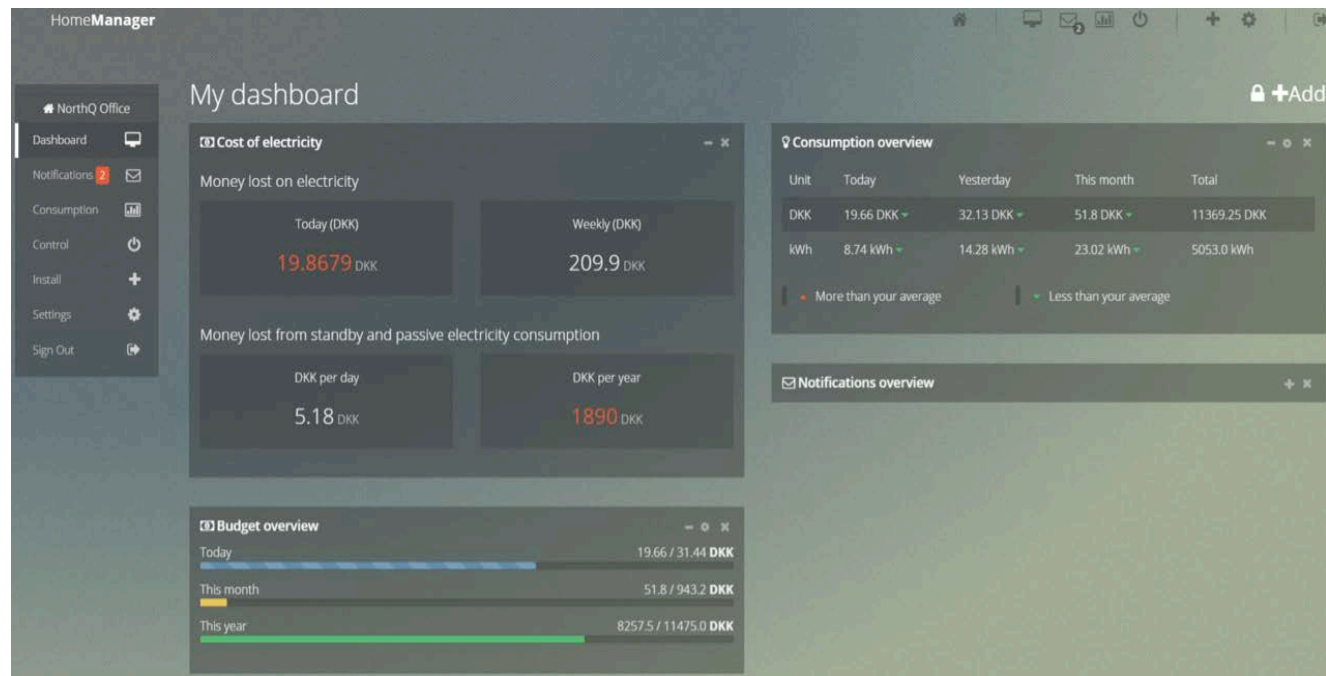
Bager & Mundaca (2016)

- Objective:
 - Effectiveness of '*behavioural-oriented*' RTF technology in the Danish residential sector
 - Understanding of the role of *framing* and *salience* to overcome intuitive judgement and bounded rationality
- Denmark
 - Rather limited knowledge: low participation rates; 'SMS/email': -3%; EU goal 10% reduction?

Experiment - Denmark

- Role of 'behavioural-oriented' RTF technology
 - Baseline from 3,000 Danish households
 - Experiment #1 (control group): Provision of “normal” feedback via “standard” SM; size: 92 households in Copenhagen
 - Experiment #2 (Intervention group): Provision of ‘behavioural-oriented’ RTF technology; ‘real-life setting’; size 11 households

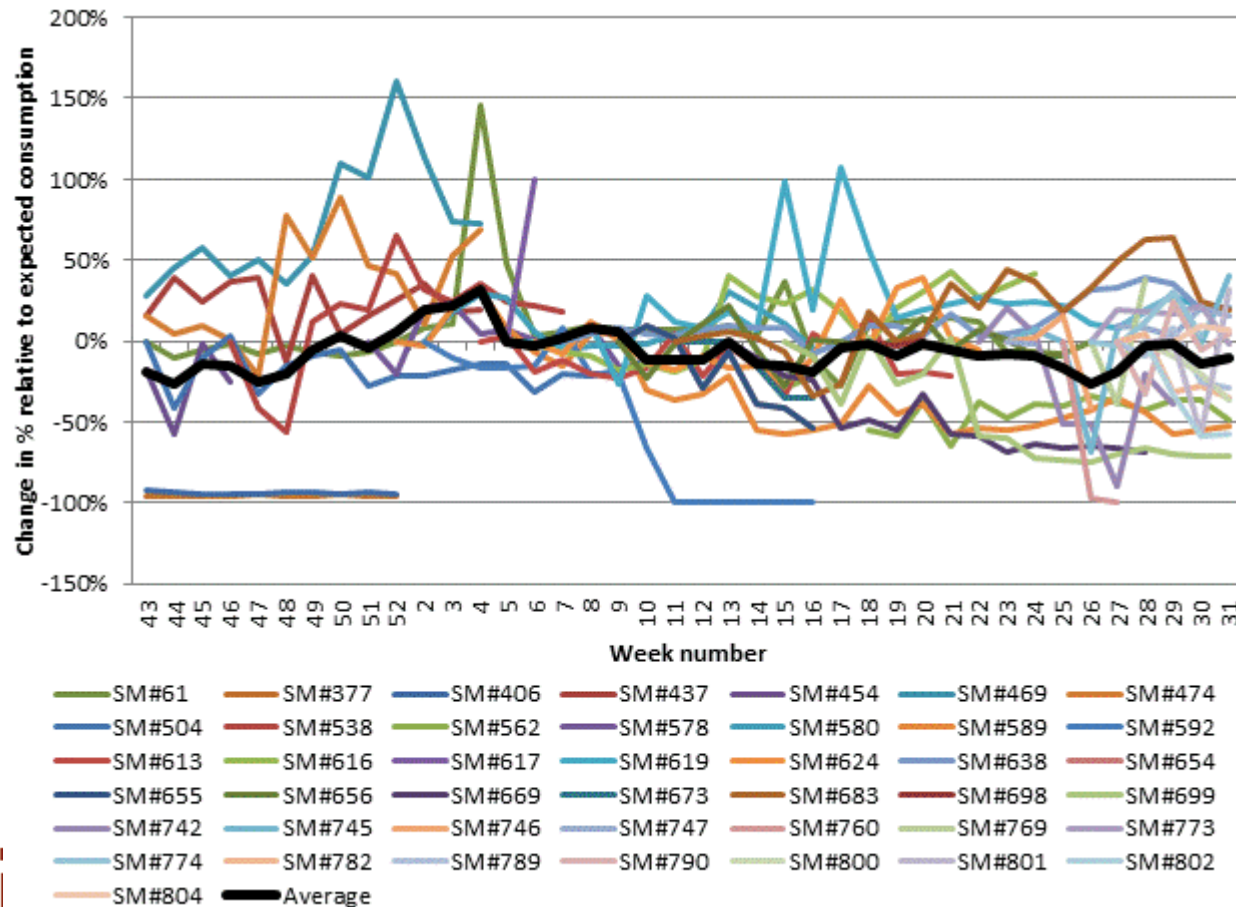
Experiment - Denmark



Source: NorthQ (used with permission)

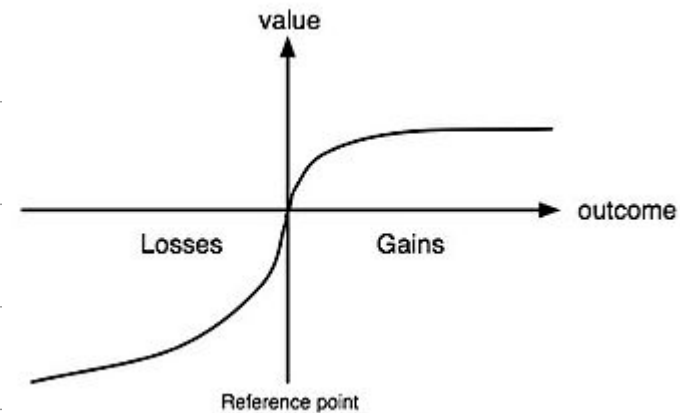
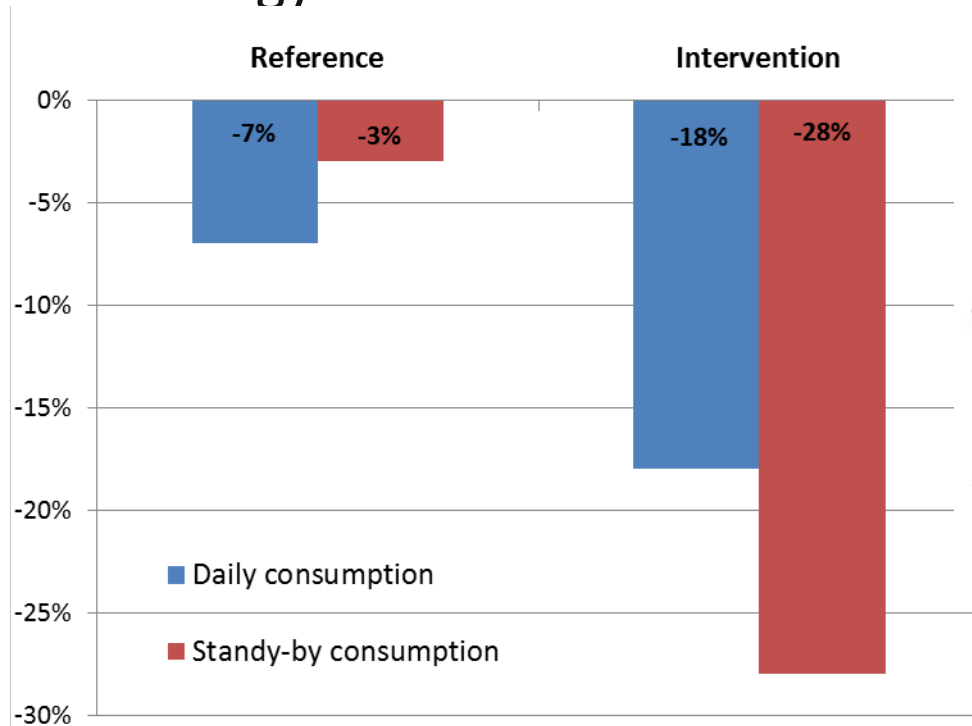
Results & Discussion – Denmark

- Experiment #1: Provision of “standard” RTF technology



Results & Discussion – Denmark

- Experiment #2: Provision of 'behavioural-oriented' RTF technology



Source: Kahneman (2003)

Results & Discussion - Denmark

- Comparative analysis
 - +/- in line with: –5~15% (Darby, 2006), –3~5% (McKerracher & Torriti, 2013); –4.5% (Schleich et al. 2013); –11~17% (Gans et al. 2013); short-term effects larger than long-term effects (Ehrhardt-Martinez, 2010)
 - From related BE experiments, e.g. social norms: –2.24% (OPOWER; Klos, 2009); –1~2% (UK; Raw et al., 2011); –6.6% (Competing buildings; McClelland & Cook, 1980); –10% (comparative ‘door hangers’; Nolan et al., 2008) .

Concluding remarks

- Behavioural vs technological change? No! Plenty of synergies!
- Key to accelerate transition to low-carbon energy-economy systems
- BEE interventions very cost-effective; but not the panacea. Context- and case-specifics results
- Ambitious policy portfolios are needed!