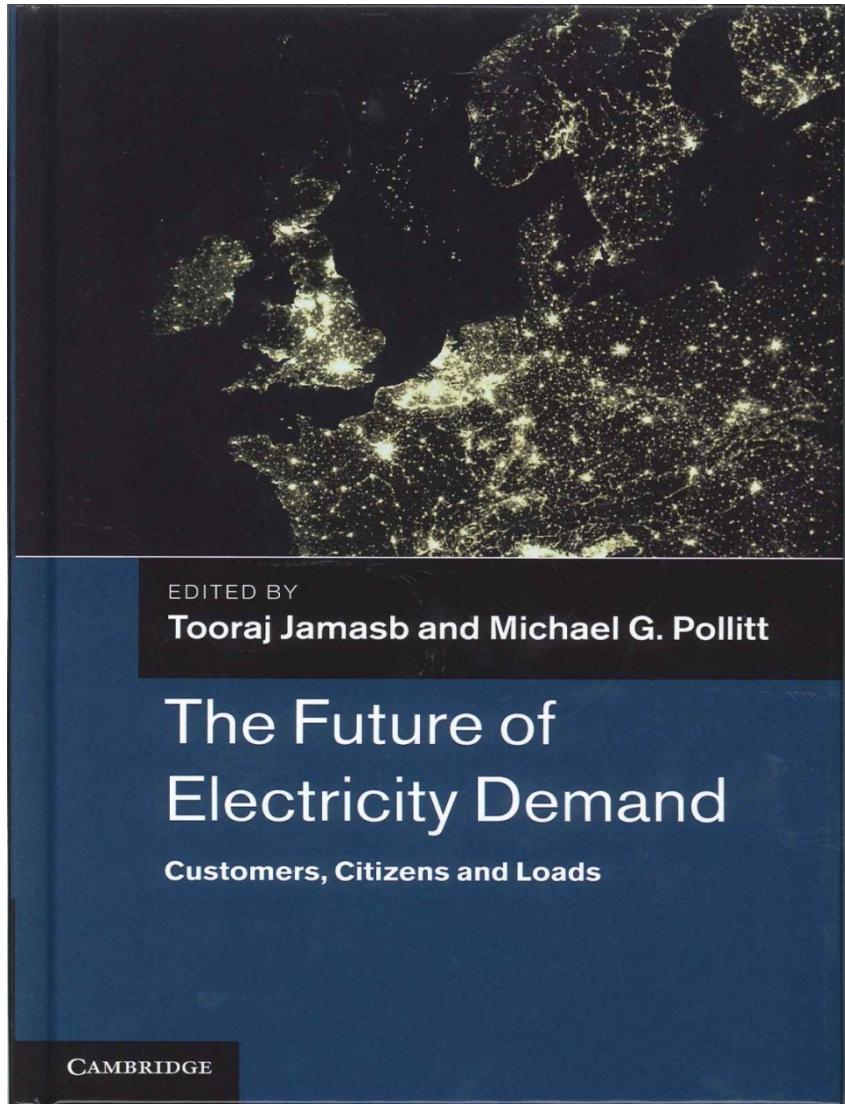




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- Customers
- Citizens
- Loads

*Department of Energy and Climate Change  
18 January 2012, London*

# Background

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- Acknowledgments:  
ESRC, EPSRC, Supergen-Flexnet project, and  
41 contributing authors
- Outline:
  - Economics
  - Technology
  - Social Dimensions
  - Policy and Regulation



# Some terms

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- Demand Reduction
- Demand Side Management (DSM)
  - Links between two.
- Time of Use (TOU) tariffs
- Critical Peak Pricing (CPP)
- Real Time Pricing (RTP)
  - Smart meters as enabler of above.
- Energy Services and Energy service companies (ESCos)



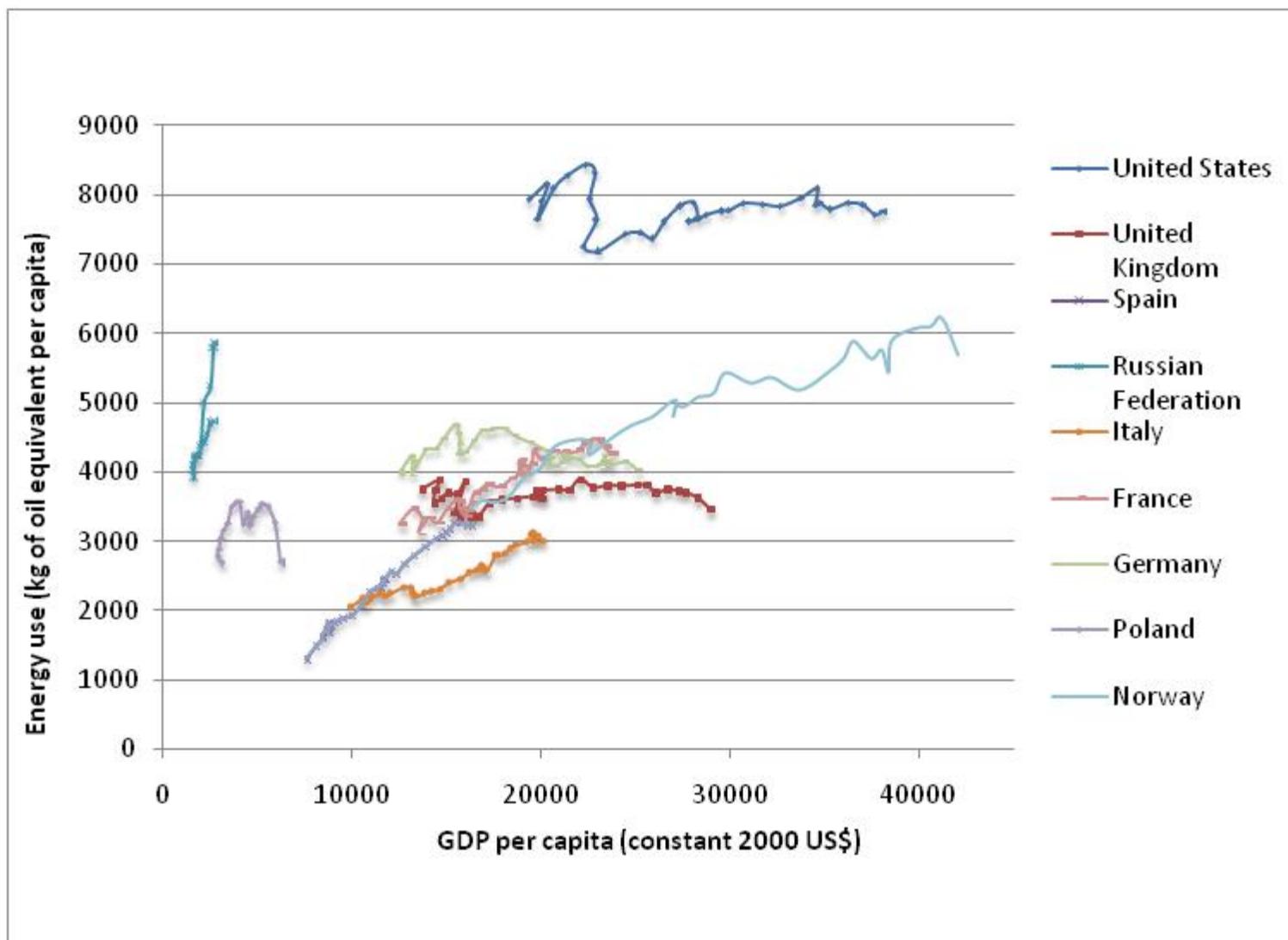
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# THE ECONOMICS



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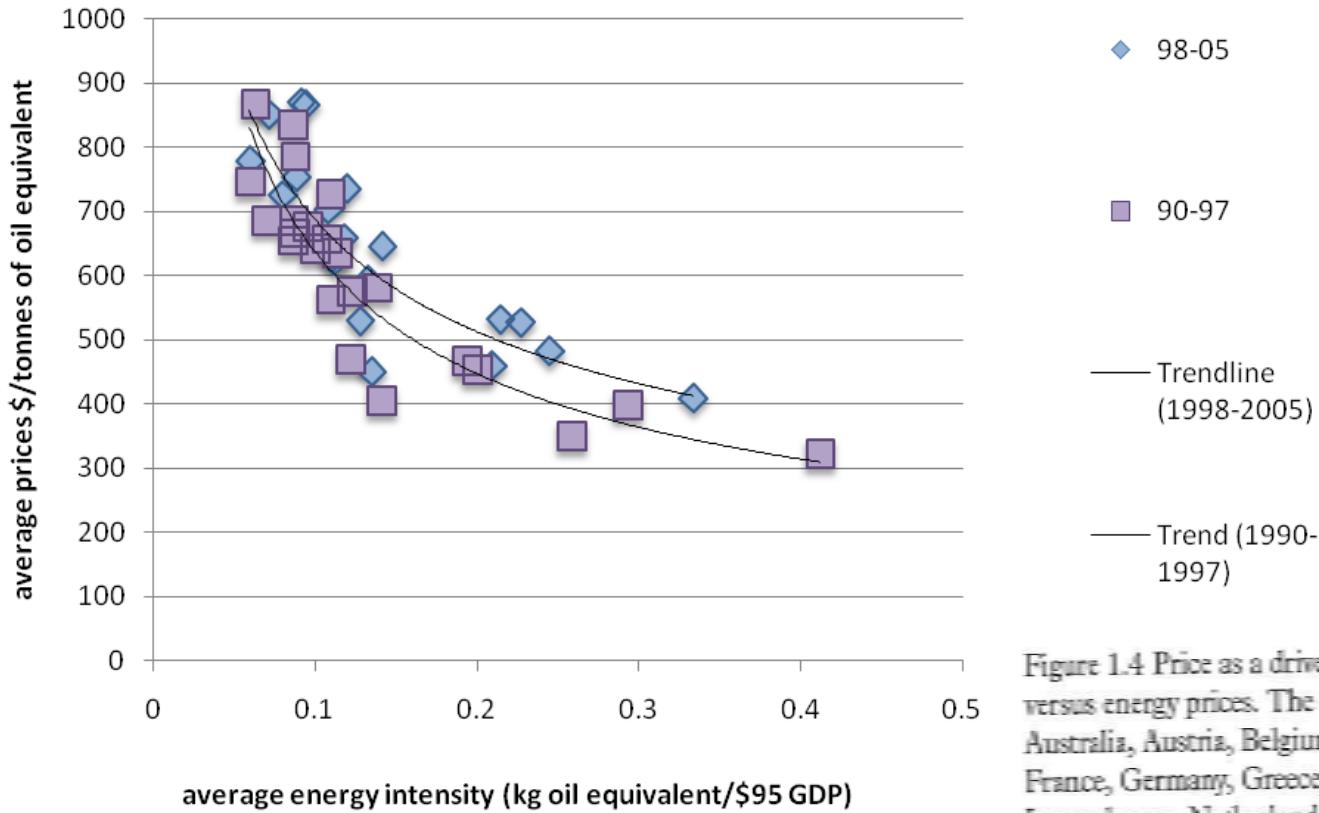
# Energy demand is related to income...



1972-2008. Source: Platchkov and Pollitt, in J&P, 2011, p.20.



# Lower demand needs higher prices...



Source: Platchkov and Pollitt, in J&P, 2011, p.20

Figure 1.4 Price as a driver of energy consumption – energy intensity versus energy prices. The data points include the following countries: Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden, UK, USA.  
Source: Data from Steinbuks (2010).



# Similar relationship for just electricity...

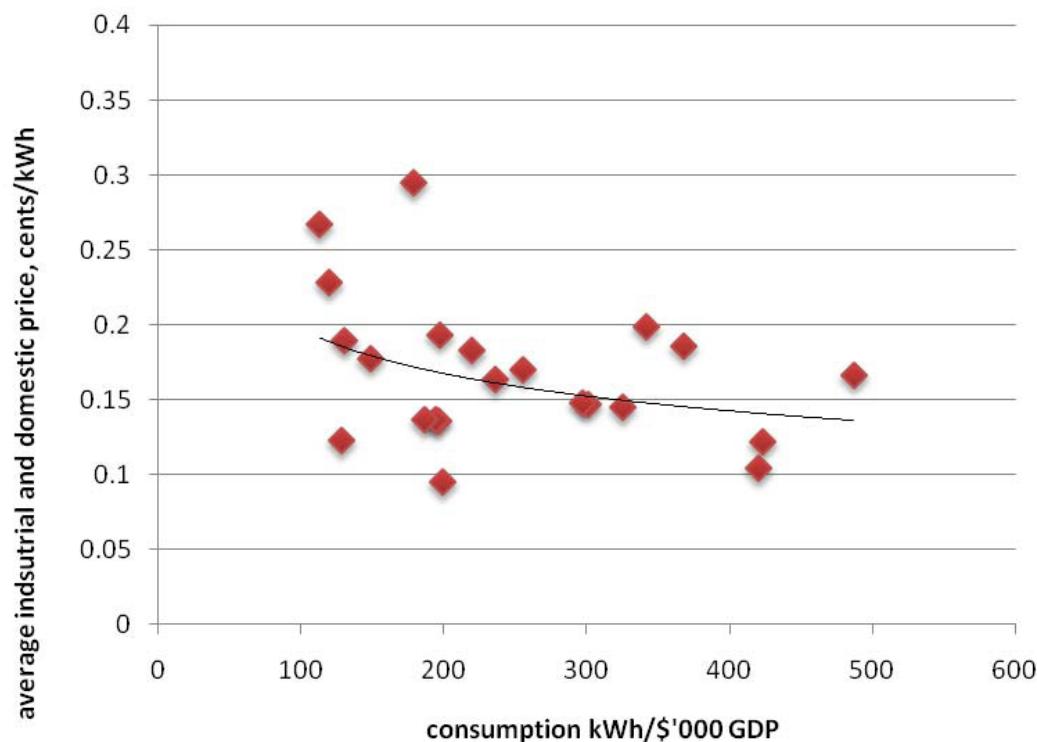


Figure 1.5 Price as a driver of electricity consumption: 2008 data.  
Source: IEA (2010b); Countries: Austria, France, Luxembourg, Slovak Republic, United Kingdom, Belgium, Greece, Netherlands, Spain, United States, Czech Republic, Hungary, Norway, Sweden, Denmark, Ireland, Poland, Switzerland, Finland, Italy, Portugal, Turkey.

Source: Platchkov and Pollitt,  
in J&P 2011, p.21



# Variation by energy services...

Table 1.2 *Lifetime costs of certain energy-related services*

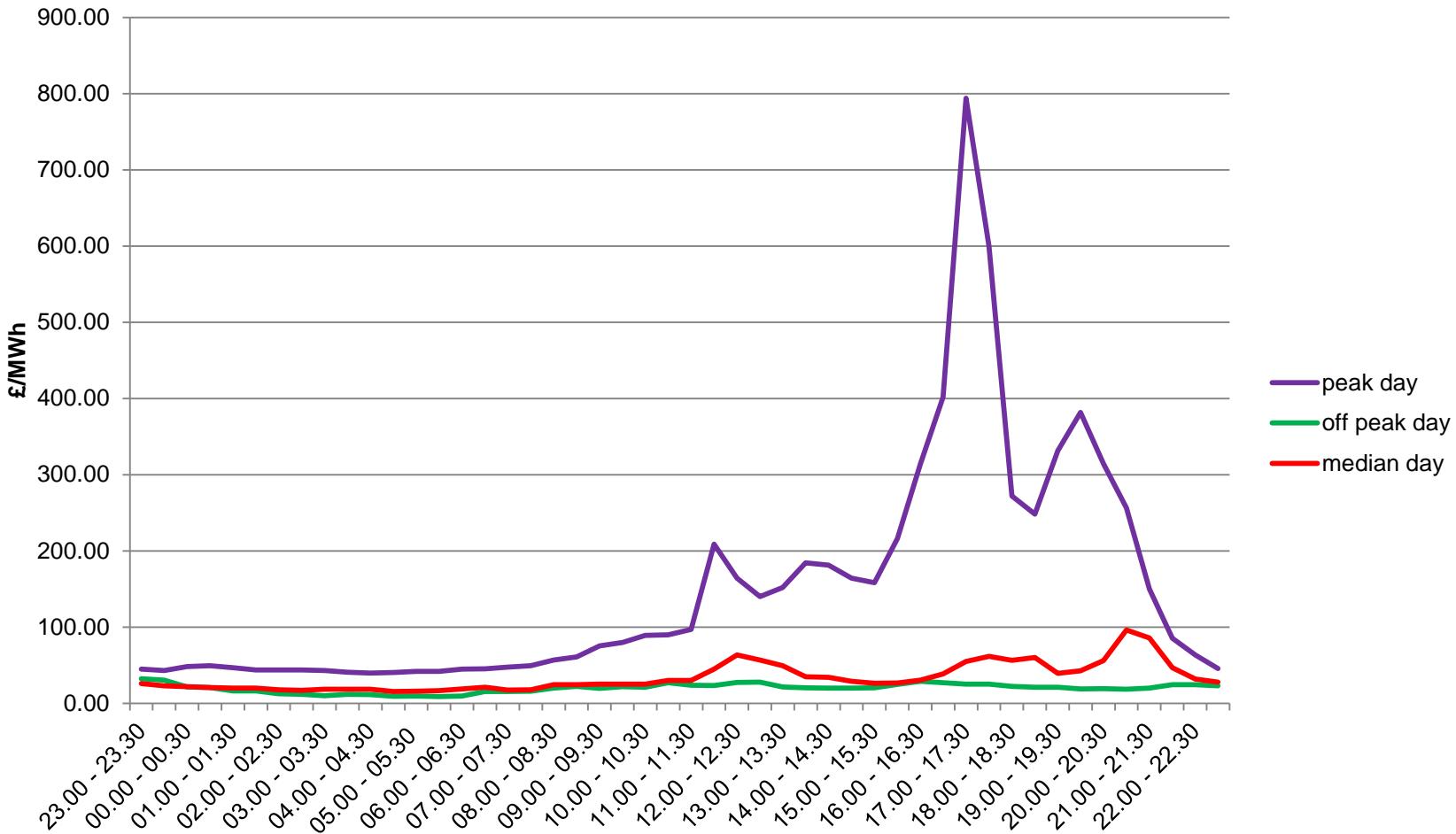
	Capital cost £	Lifetime energy cost £	Total cost £	Energy cost %
Light bulb 100W	0.35	18.98	19.33	98.2%
Light bulb low energy 100W	1	15.53	16.53	94.0%
Gas boiler	1000	7629.05	8629.05	88.4%
TV	700	540.01	1240.01	43.5%
Fridge	300	159.56	459.56	34.7%
Car (annual)	2500	1000.00	3500.00	28.6%
Computer	1000	48.84	1048.84	4.7%
Mobile phone (annual)	360	1.42	361.42	0.4%

Key assumptions: electricity 13p/kWh; gas 3.5p/kWh; 5% discount rate.

Source: Platchkov and Pollitt, in J&P 2011, p.35.



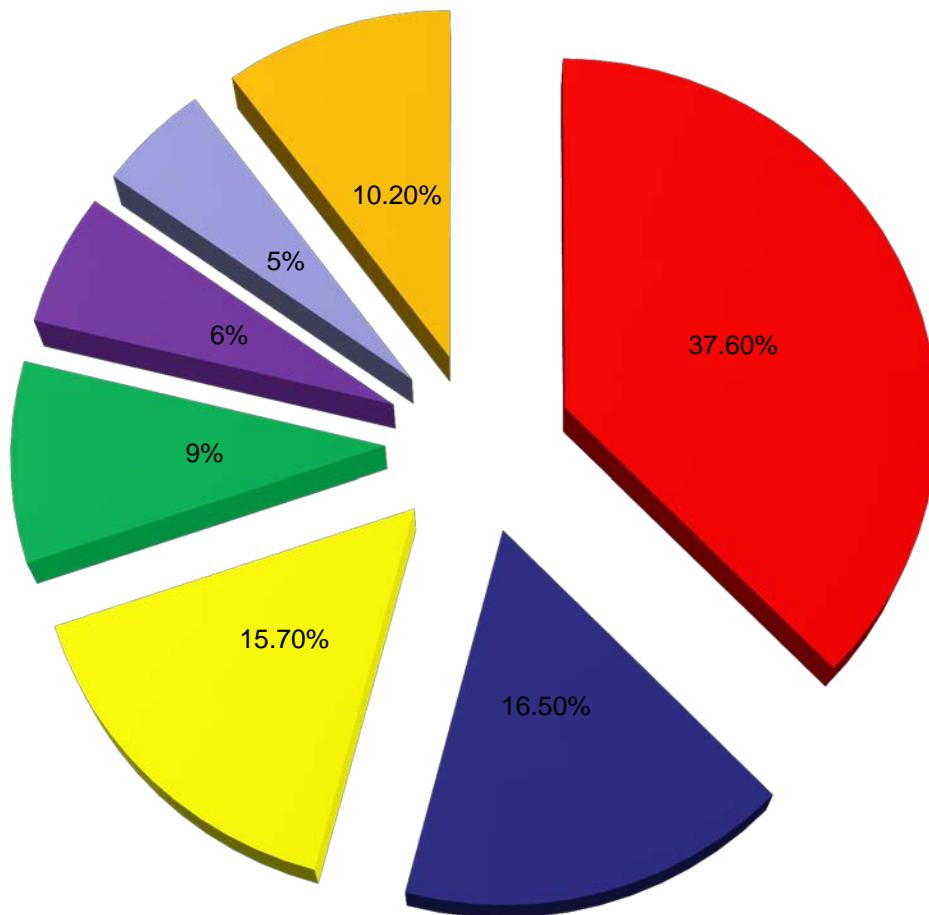
# Scope for household TOU tariffs?



2009 data. Source: APX (2010), Platchkov and Pollitt, in J&P, 2011 p.39.



# Household demand at the evening peak



Example: Total UK Demand 52 GW  
Household demand: 45% of total.

- cooking appliances (8750 MW)
- electric water heaters (3833 MW)
- lighting (3667 MW)
- cold appliances (2083 MW)
- wet appliances (1417 MW)
- stand-by/on mode TVs, videos and stereos (1083 MW)
- others

Source: adapted from Lampaditou, E. and M. Leach (2005),  
Platchkov and Pollitt, in J&P, 2011, p. 40.



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# TECHNOLOGY



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# Lots of technical potential for DSM...

Table 5.1 *Various control priorities, methods and durations for residential appliances*

Load	Control method			
	On/Off	Partial	Time	Priority
Hot water	✓	✓	Hour/Min	High
Washing machine	✓	✓	Hour/Min	High
Tumble dryer	✓	✓	Hour/Min	High
Dishwasher	✓	✓	Hour/Min	High
Fridge/Freezer	✓		Min	High
Towel rails	✓	✓	Min	High
Elec. apps (with chargers)	✓	✓	Min	High
Lighting	✓	✓	Min/Sec	High
Elec. apps (heating)	✓	✓	Sec	High
Electric oven/hob	✓	✓	Min	Medium
Slow cookers	✓	✓	Min	Medium
Elec. heating	✓	✓	Min	Medium
Air conditioning	✓	✓	Min	Medium
Elec. blanket	✓	✓	Min	Medium
Microwaves	✓		Sec	Medium
Extractor fans		✓	Sec	Low
Hairdryers		✓	Sec	Low
Elec. apps (instantaneous)	✓			No control
Entertainment	✓			No control

Source: Hong et al., in J&P, 2011, p.138.



# Simulating UK appliance demand...

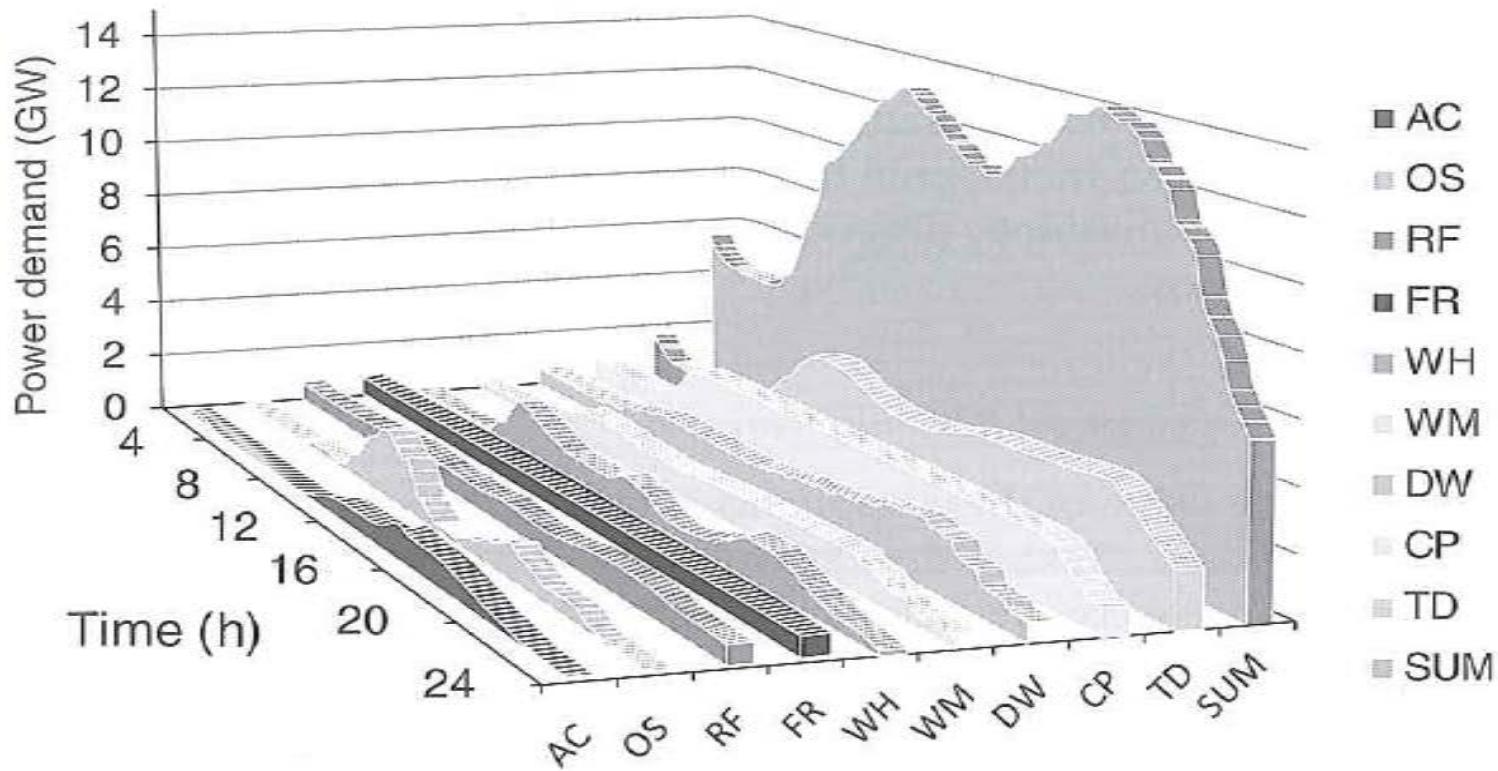


Figure 7.3 Total demand from domestic appliances in the UK.  
Notes: AC = air conditioner; OS = over and stove; RF = refrigerator;  
FR = freezer; WH = electric water heater; WM = washing machine;  
DW = dishwasher; CP = heating circulation pump; TD = tumble dryer;  
SUM = sum of all appliances.

Source: Silva et al. , in J&P, 2011, p.189.

# Potential market for DSM...

Table 7.6 *Annual savings and emission reduction from dynamic demand*

Cost savings per fridge (£/app)				Emission reduction per fridge (kgCO <sub>2</sub> /app)			
Wind	Must-run			Wind	Must-run		
GW	6	8	10	GW	6	8	10
0	2.17	2.22	2.24	0	12.62	9.92	8.43
10	2.92	2.95	2.96	10	13.02	9.88	7.98
20	5.31	6.53	7.98	20	50.49	72.80	101.81
30	25.64	29.26	32.45	30	386.22	448.91	513.97

2008 figures. Typical bill in 2008 is £435. Dynamic demand saves marginal fuel costs, at high wind penetration it saves wind curtailment.

Source: Silva et al. , in J&P, 2011, p.204.

# Cost benefit analysis currently marginal...

Table 7.8 *Investment cost of different smart appliances (taken from Seebach et al., 2009)*

	WM	WD	DW	RF and FR
Investment cost (£/appliance/year)	[2–4]	[2–4]	[2–4]	[6–8]

Source: Seebach et al., 2009.

Investment costs currently high compared with savings.

Source: Silva et al., in J&P, 2011, p.206.



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# Some evidence from DSM trials...

Table 6.7 *Smart pricing trials*

Trial	Timeframe	Sample size	Tariffs	Demand response
California Statewide Pricing Pilot	July 2003 to December 2004	2,500 residential and SMEs	TOU and CPP	Average critical peak reduction of 13%
Illinois Community Energy Cooperative	Started in 2003, ongoing	750 initially; 1,500 by 2005	RTP	Up to 15% peak reduction; 4% energy conservation
Olympic Peninsula Project	Early 2006 to March 2007	112 residential customers	TOU and RTP	Average peak reduction of 15%
Ontario Smart Price Pilot	August 2006 to March 2007	373 residential plus control group of 125	TOU, CPP and RTP	CPP had highest impact on peak reductions (average 8.1%); 6% energy conservation

TOU = time of use; RTP = real-time prices; CPP = critical peak pricing.

In reality uptake an issue and average response lower...

Source: Brophy Haney et al. , in J&P, 2011, p.180.

# Electric vehicles not an energy issue...

Table 8.4 *Projections of demand for electricity from EV and PHEV*

	2020				2030			
	Generating capacity		Projected annual UK demand		Generating capacity		Projected annual UK demand	
	EVs	PHEVs	GWh	%NEP	EVs	PHEVs	GWh	%NEP
Business as usual	70k	200k	400	0.1	500k	2500k	4200	1.1
Mid range	600k	200k	1800	0.5	1600k	2500k	6700	1.7
High range	1200k	350k	3500	1.0	3300k	7900k	17000	4.4

NEP = GB national electric production.

Source: Adapted from BERR and DfT (2008).

“dash’ to electric looks more like a ‘brisk stroll” (Marsden and Hess, in J&P, 2011, p.225)



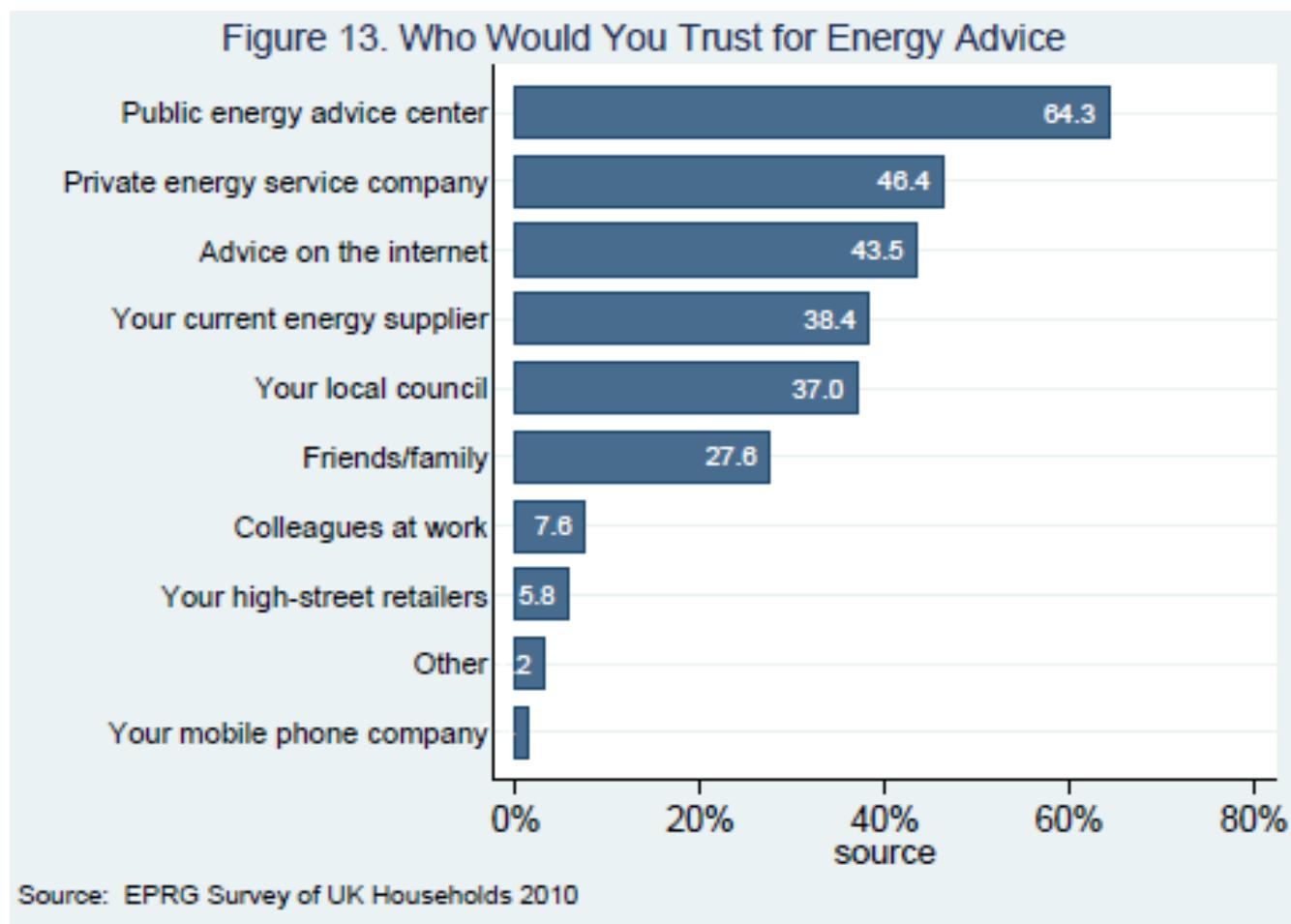
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# **SOCIAL DIMENSIONS**



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# Trust for energy services...



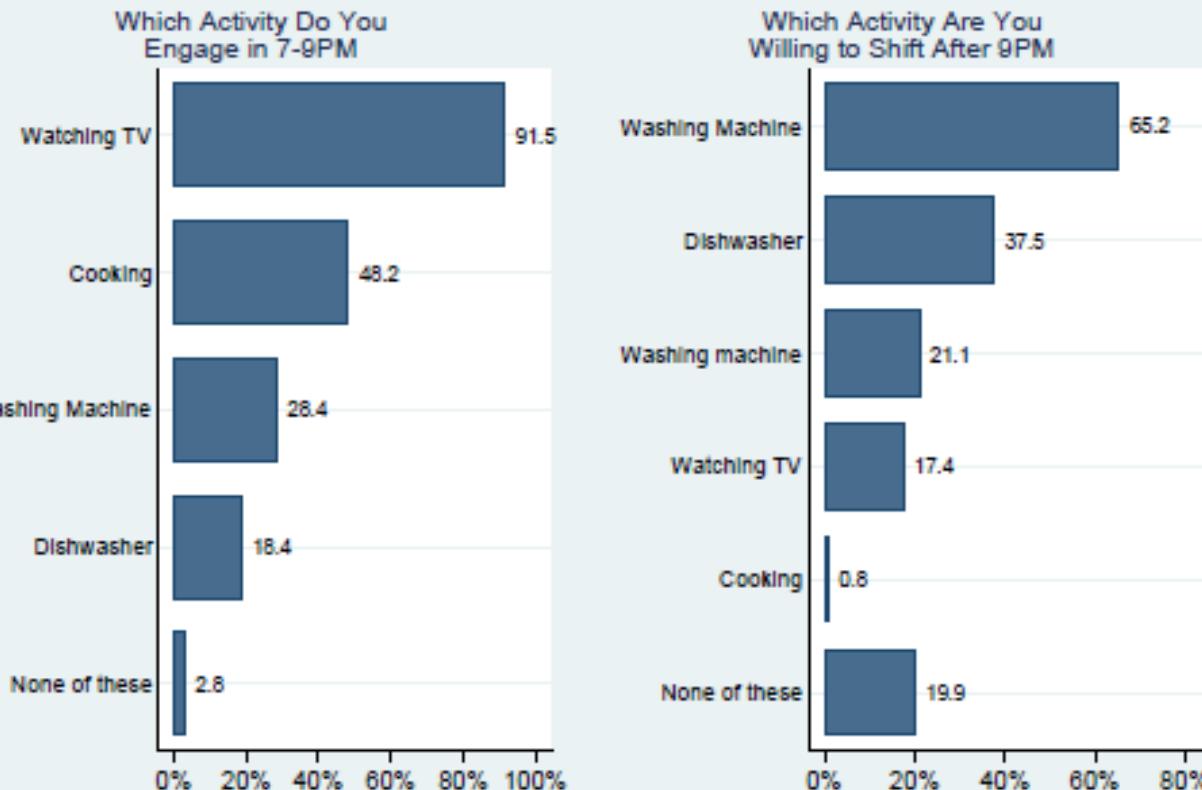
Source: Platchkov et al, 2011, EPRG WP1122.



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# The social acceptability of DSM...

Figure 14. Potential for Load Shifting through TOU Tariffs



Source: EPRG Survey of UK Households 2010

Source: Platchkov et al, 2011, EPRG WP1122.



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# Barriers to local solutions...

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- Upfront capital costs
- Long payback periods
- Increased risk
- Hidden transaction costs
- Complex subsidy system
- Political lock in
- Insufficient ‘know how’
- Policy restrictions
- Principal-agent problems
- Consumer preference problems
- Local environmental opposition

Source: Kelly and Pollitt, in J&P 2011, p.273-274.



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# Fuel poverty is problem for pricing policy...

Table 12.4 *Households in fuel poverty 1996–2010, UK, millions of households*

	96	98	01	02	03	04	05	06	07	08 <sup>#</sup>	09 <sup>#</sup>	10 <sup>#</sup>
Households in fuel poverty	6.5	4.8	2.5	2.2	2.0	2.0	2.5	3.5	4.0	4.5	5	4.6
Vulnerable* households in fuel poverty	5.0	3.5	2.0	1.8	1.5	1.4	2.0	2.75	3.25			

<sup>#</sup> estimates from Neighbourhood Energy Action (House of Commons Business and Enterprise Committee, 2008b; NEA, 2009; Fuel Poverty Advisory Group, 2010).

\* This measure of vulnerability is the one defined in the fuel poverty policy, see footnote 3.

Source: Fuel Poverty Advisory Group (2010).

Vulnerable household = any household with a child, an older person or someone receiving state benefits (75% of households)

Source: Waddams Price, in J&P, 2011, p.307.



# Characteristics of fuel poor...

Table 13.1 *Mean values for different household types*

Mean values	INCOME (£ p.a.)	ENERGY (£ p.a.)	AVERAGE AGE	HHSIZE	CHILDREN	ROOMS	SHARE (in whole sample) %
Whole sample	25,671	728	44	2.5	0.6	4.4	100
Whole sample, fuel poor	6,797 (26.5)*	1,021 (140.3)	49	2.0	0.5	1.8	8.06
Low Income	8,178	624	44	1.8	0.3	1.6	7.27
Low Income, fuel poor	5,830 (71.3)	960 (153.8)	43	2.1	0.5	1.8	2.16
Retired	14,839	620	70	1.6	0.0	4.1	27.12
Retired, fuel poor	6,207 (41.8)	876 (141.2)	72	1.3	0.0	4.1	3.05
Supported	14,879	713	37	2.6	0.7	3.8	6.25
Supported, fuel poor	6,211 (41.7)	954 (133.7)	40	1.9	0.5	3.6	1.22
Female single	15,459	783	19	3.0	1.7	1.3	5.92
Female single, fuel poor	6,996 (45.3)	1,073 (137)	17	2.9	1.8	4.1	1.25

\* Numbers in brackets: percentages of income (energy spending) of different groups of fuel-poor households in relation to overall income (energy spending) in different groups of households, e.g. 26.5 = (6,797/25,671) \* 100.

Source: BHPS survey data.

Source: Jamasb and Meier, in J&P, 2011, p.329.

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# POLICY AND REGULATION



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# National DSM strategies...

- Normative:
  - Appliance controls
  - Building codes
  - Energy efficiency obligations
- Informative:
  - Mandatory labels and certification
  - Mandatory audits
- Economic instruments:
  - Energy performance contracting
- Financial and incentive based measures
  - Taxation, subsidies and grants
  - Public benefit charges
  - Utility based programmes
- Voluntary agreements and partnerships:
  - Labelling and certification
  - Negotiated agreements
- Information and capacity building:
  - Awareness raising
  - Detailed billing and disclosure

Source: Brophy Haney et al., in J&P, 2011, p.357-358.



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# Regulation needs to anticipate demand...

(a) 2010

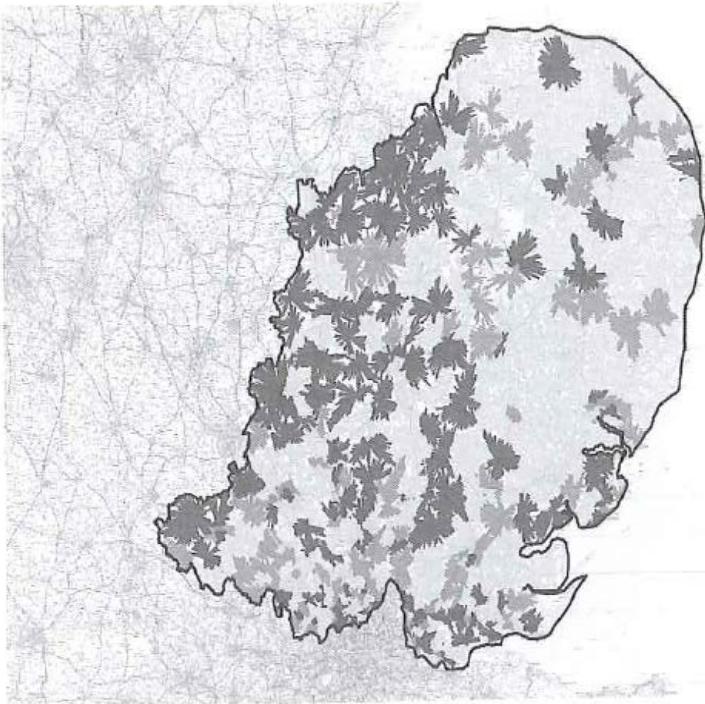


Figure 15.5 Primary substations risk level in 2010, 2015 and 2020.

Scale: 1:1,500,000.

(c) 2020

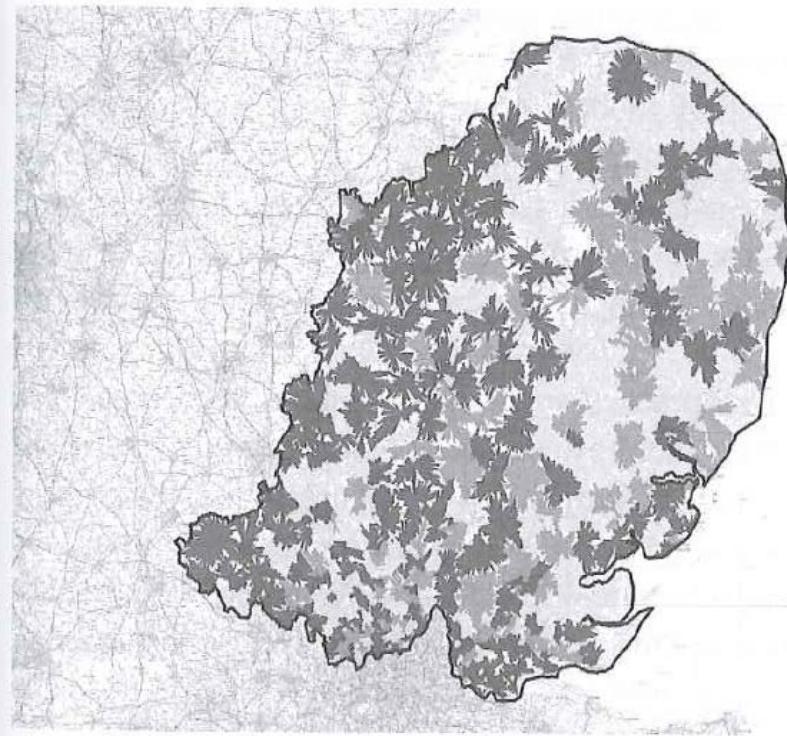


Figure 15.5 (cont.)

Source: Jamasb and Marantes, in J&P, 2011, p.396-397.



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# Higher building standards can help...

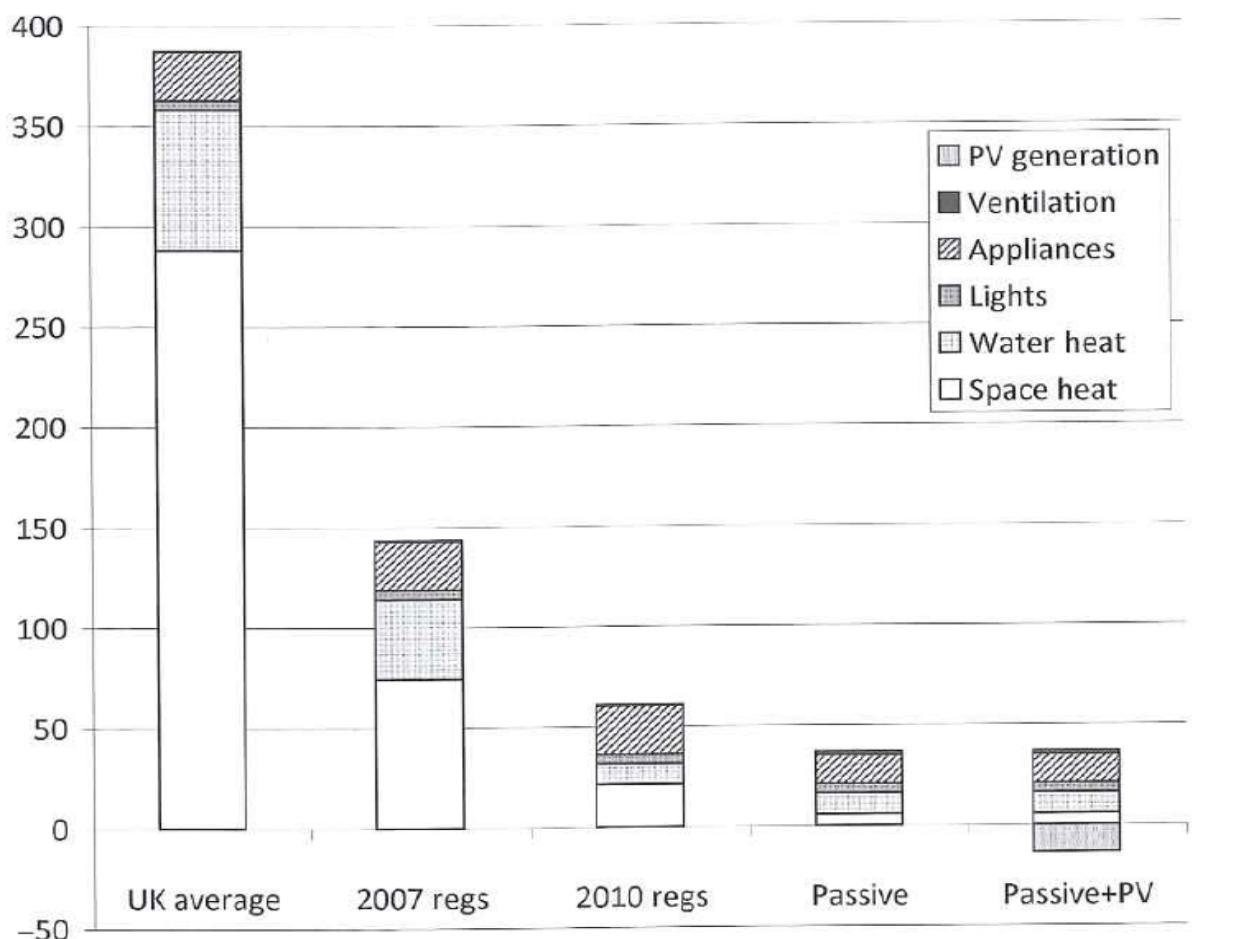


Figure 16.10 Delivered energy (kWh/m<sup>2</sup> p.a.) by fuel type for semi-detached dwelling to different standards.

Source: Clarke et al., in J&P 2011, p.418.

# Pareto improvements exist...

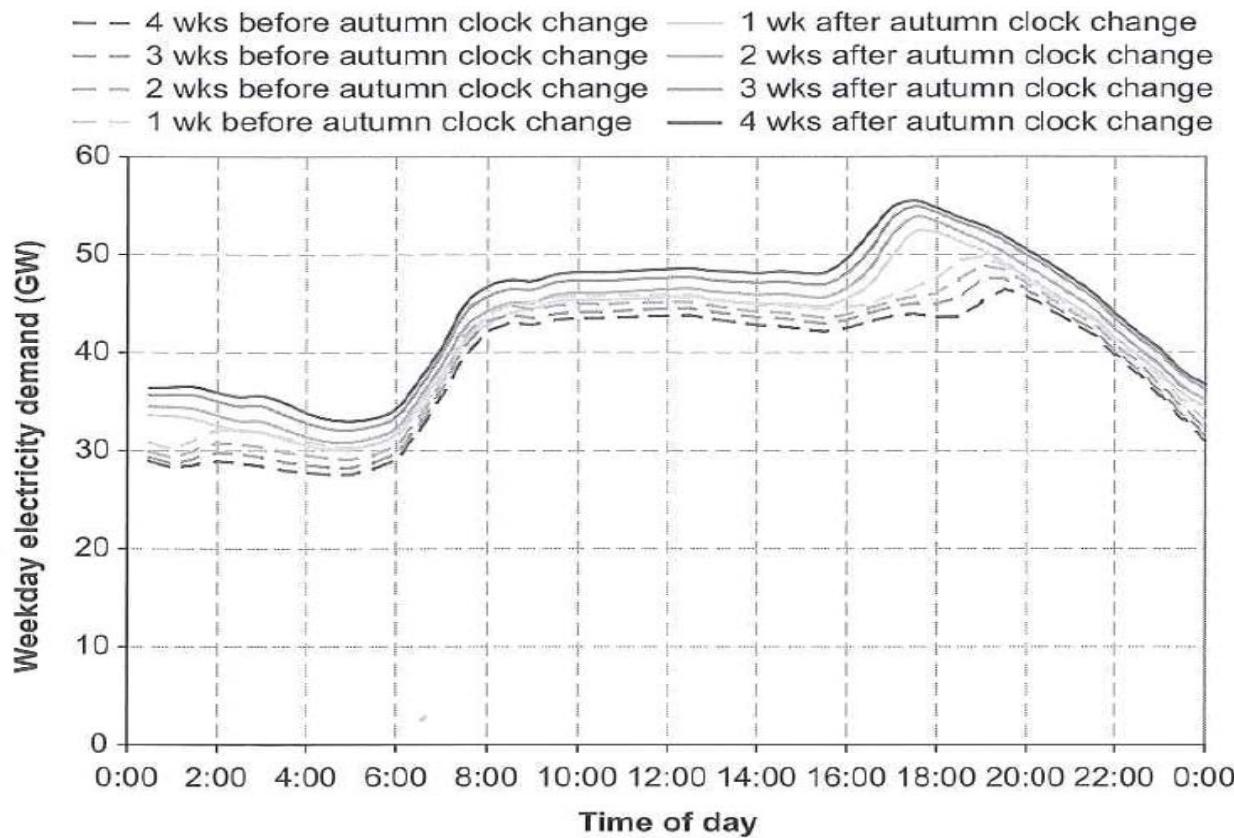


Figure 18.4 Changes in average demand during weeks on autumn clock changes.

GMT+1 in autumn: peak demand down 4.3%, energy -0.32% in November, total annual demand -450 GWh, annual CO<sub>2</sub> -0.375mt.

Source: Chong et al., in J&P, 2011, p.454-455.

# Conclusions 1

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- Innovation needed on the demand side.
- New business models not clear.
- Liberalised market a premise for DSM.
- Social factors important: both in terms of acceptability and energy poverty.



# Conclusions 2

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- A new conception of demand
- Multifaceted as users, customers, and citizens
- Based on:
  - Economic incentives and instruments,
  - Technological solutions, and
  - Provision of information.
- Empower users to control their energy use and spending rather than anticipate uniform behaviour



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***Thank you!***



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