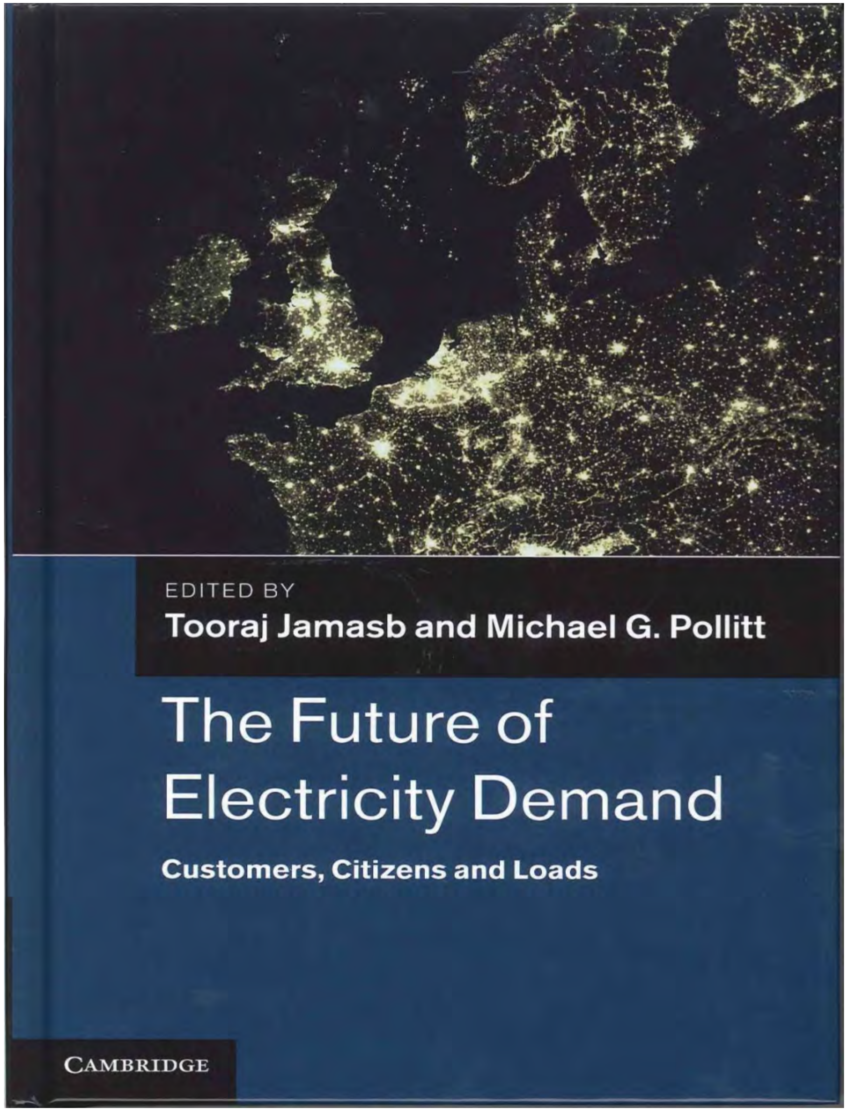



- **Customers**
- **Citizens**
- **Loads**

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

# Background

- Acknowledgments:

  ESRC, EPSRC, Supergen-Flexnet project, and 41 contributing authors

- Outline:
  - Economics
  - Technology
  - Social Dimensions
  - Policy and Regulation

# Some terms

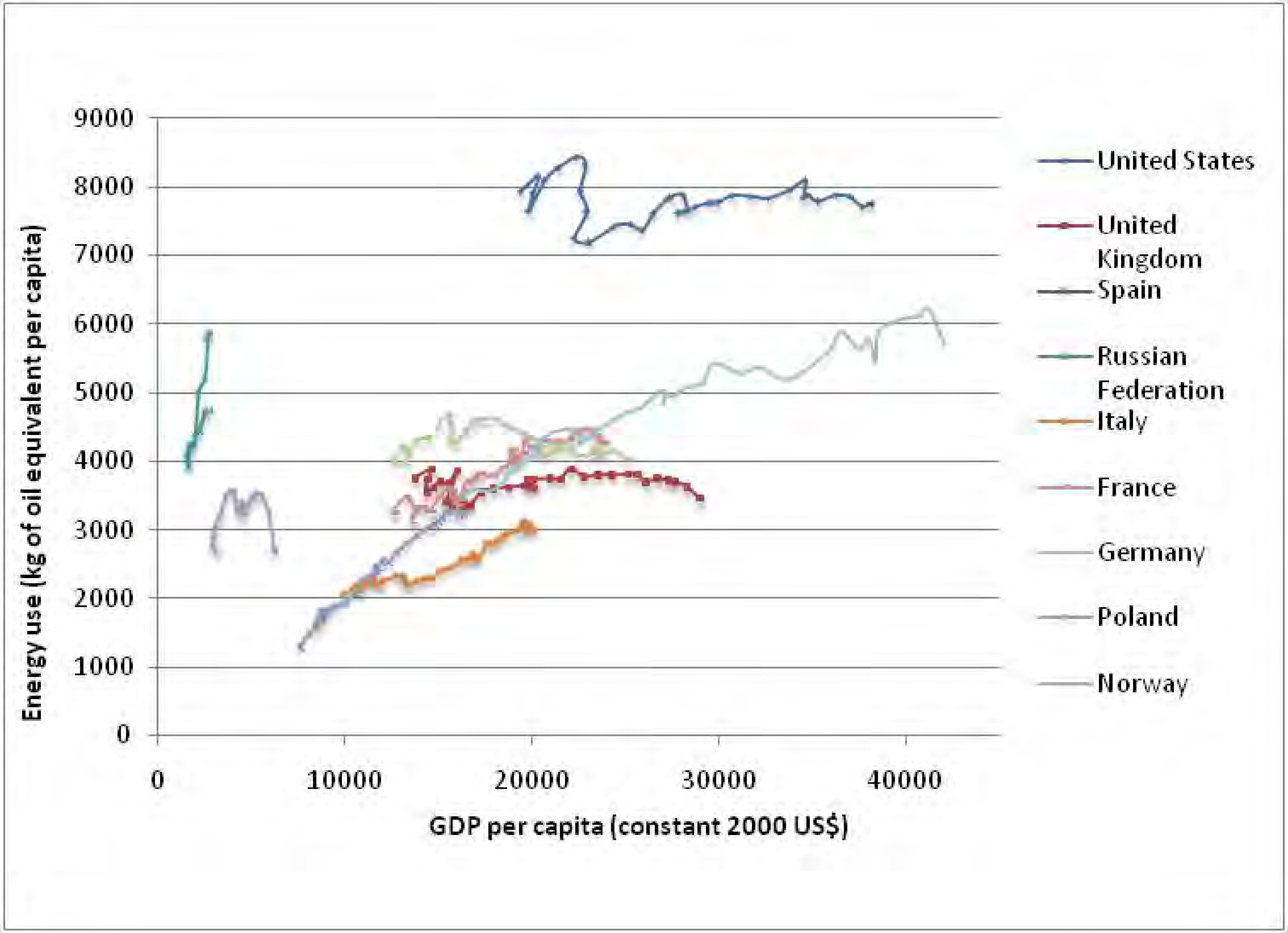
- Demand Reduction
- Demand Side Management (DSM)
  - Links between two.

- 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)

# THE ECONOMICS

# Energy demand is related to income…




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

# Lower demand needs higher prices…

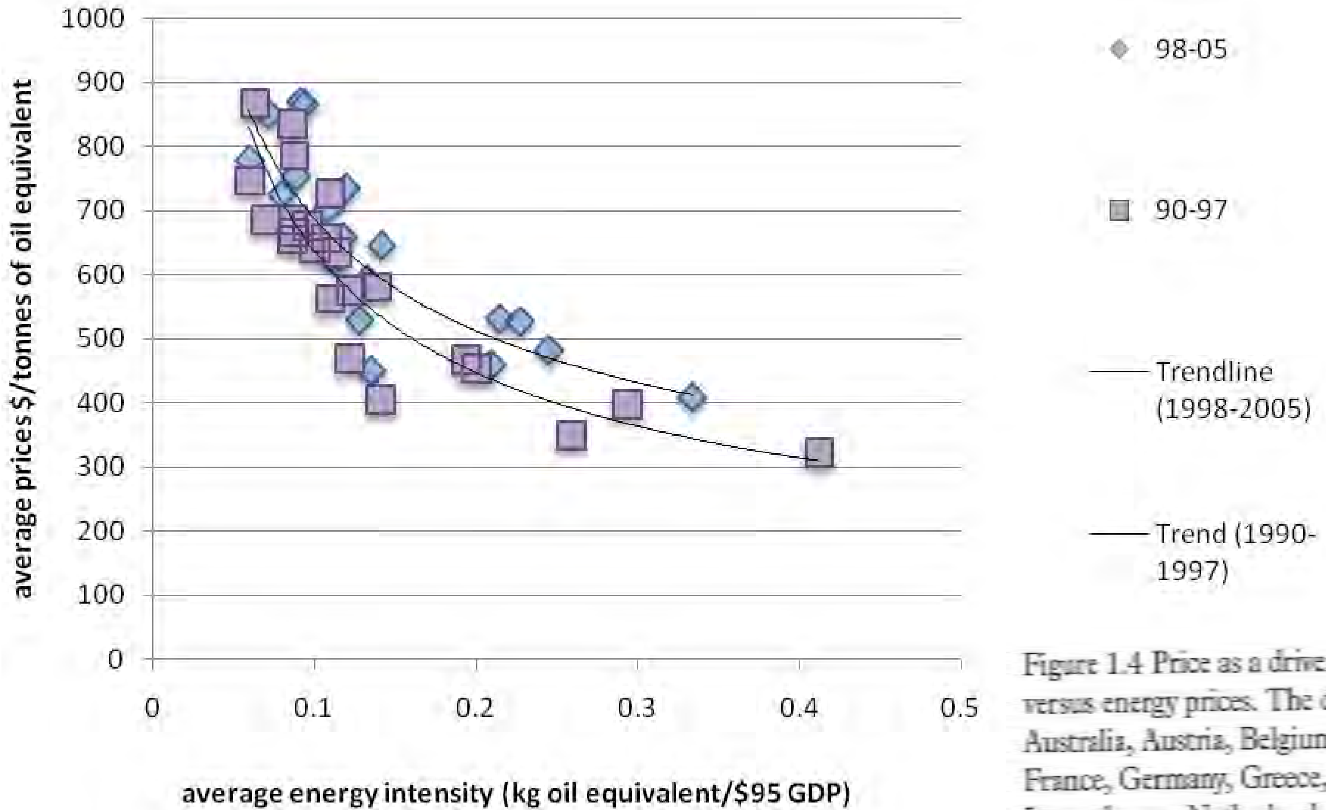



Figure 1.4 Price as a driver of energy consumption – energy intensity versus energy prices. The data points include the following countries: Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Poand, Portugal,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

*Source:* Data from Steinbuks (2010).

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

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# Similar relationship for just electricity…

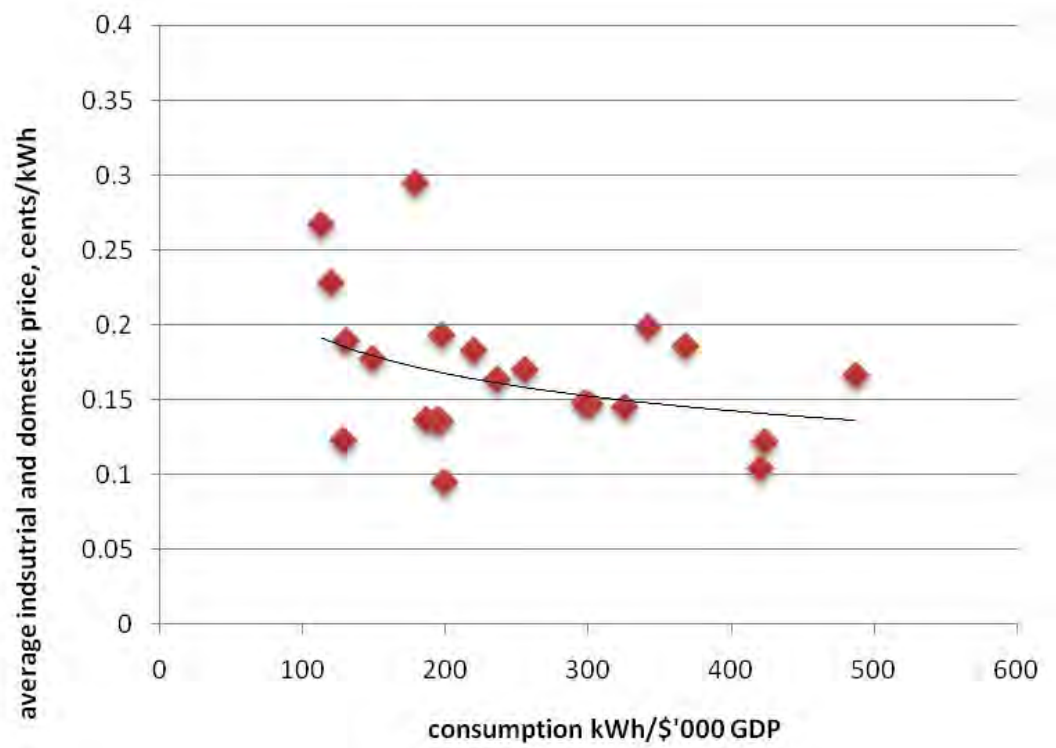



Figure 1.5 Price as a driver of electricity consumption: 2008 data. *Source:* IEA (2010b); Countries: Austria, France, Luxembourg, Slovak Republic, United Kingdom, Belgium, Greece, Netherlands, Spain, United States, Czech Republic, Hungary, Norway, Sweden, Denmark, Ireland, Poland, Switzerland, Finland,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

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

# Variation by energy services…

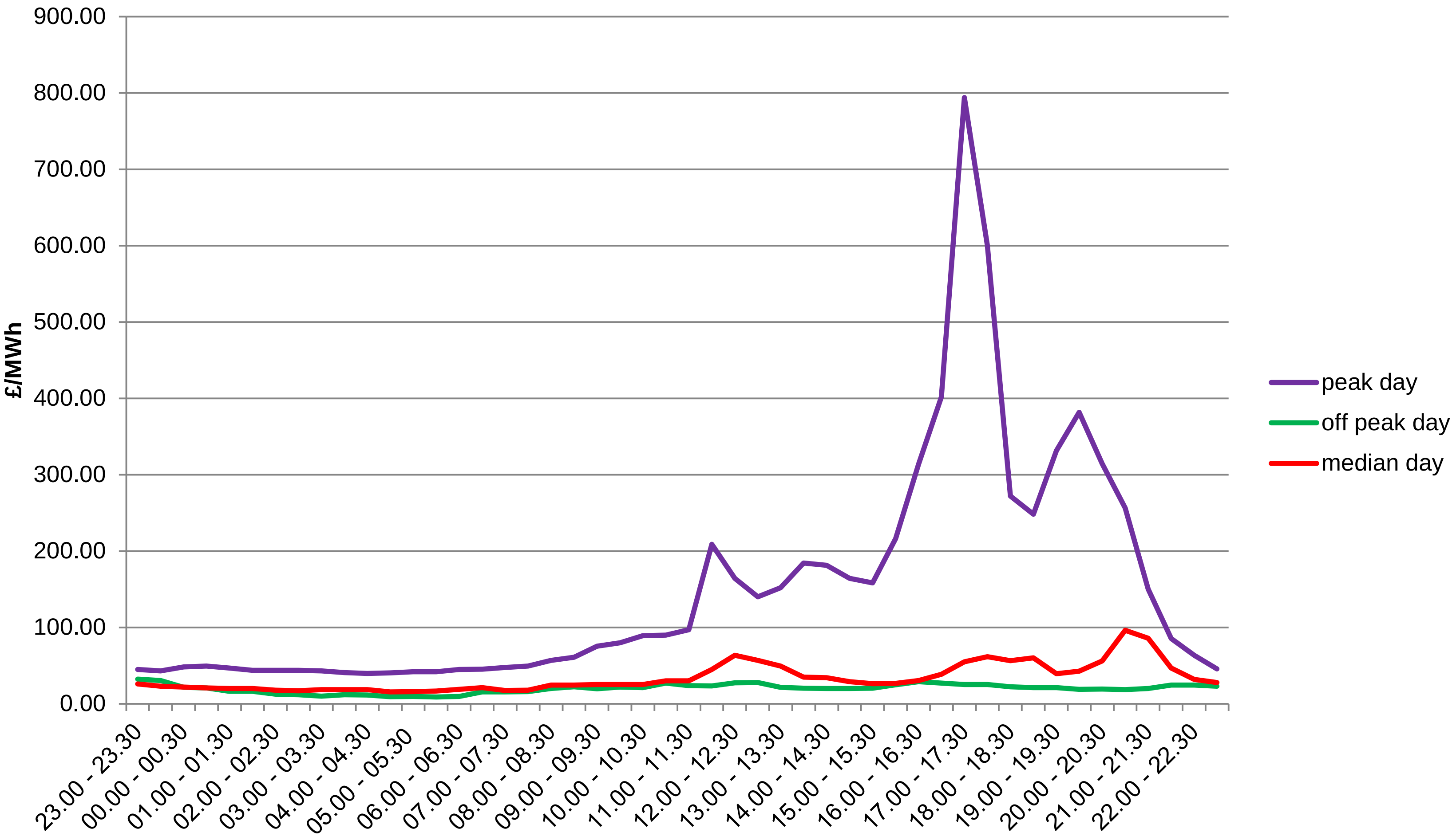
Table 1.2 *Lifetime costs of certain energy-related services*

| | 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.

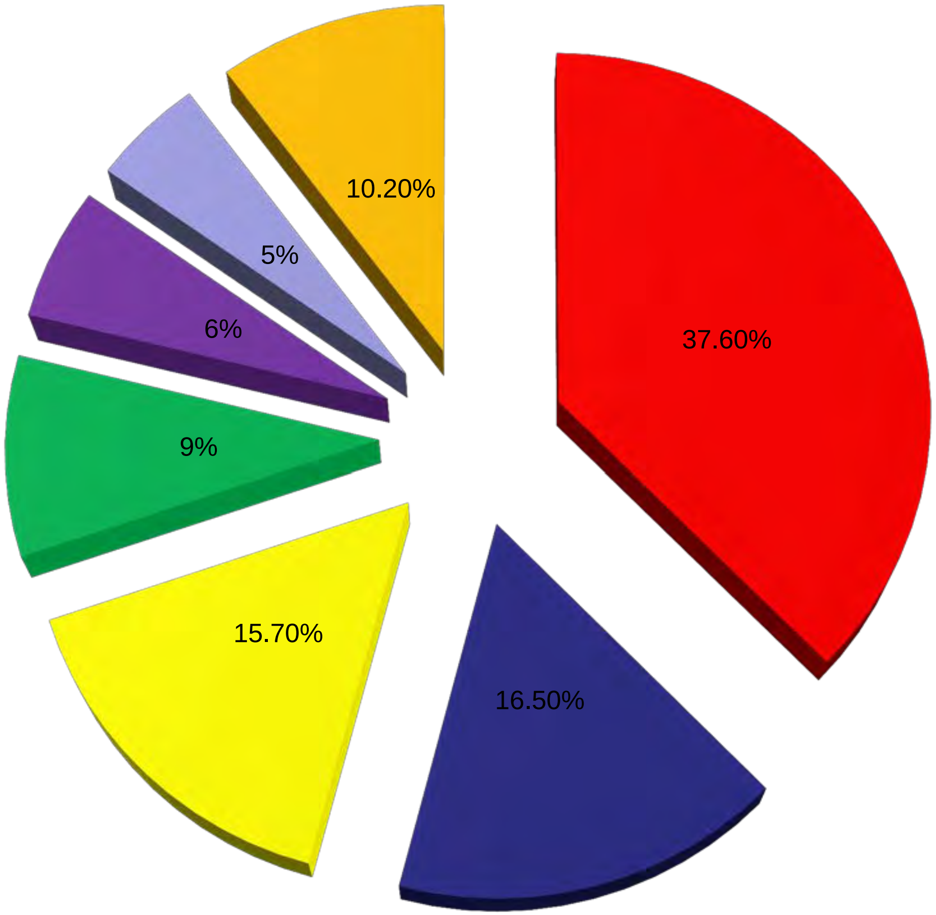
# Scope for household TOU tariffs?




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

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# Household demand at the evening peak




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



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

# TECHNOLOGY

# Lots of technical potential for DSM…

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

| | Control method | | | |
|---|---|---|---|---|
| Load | 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…

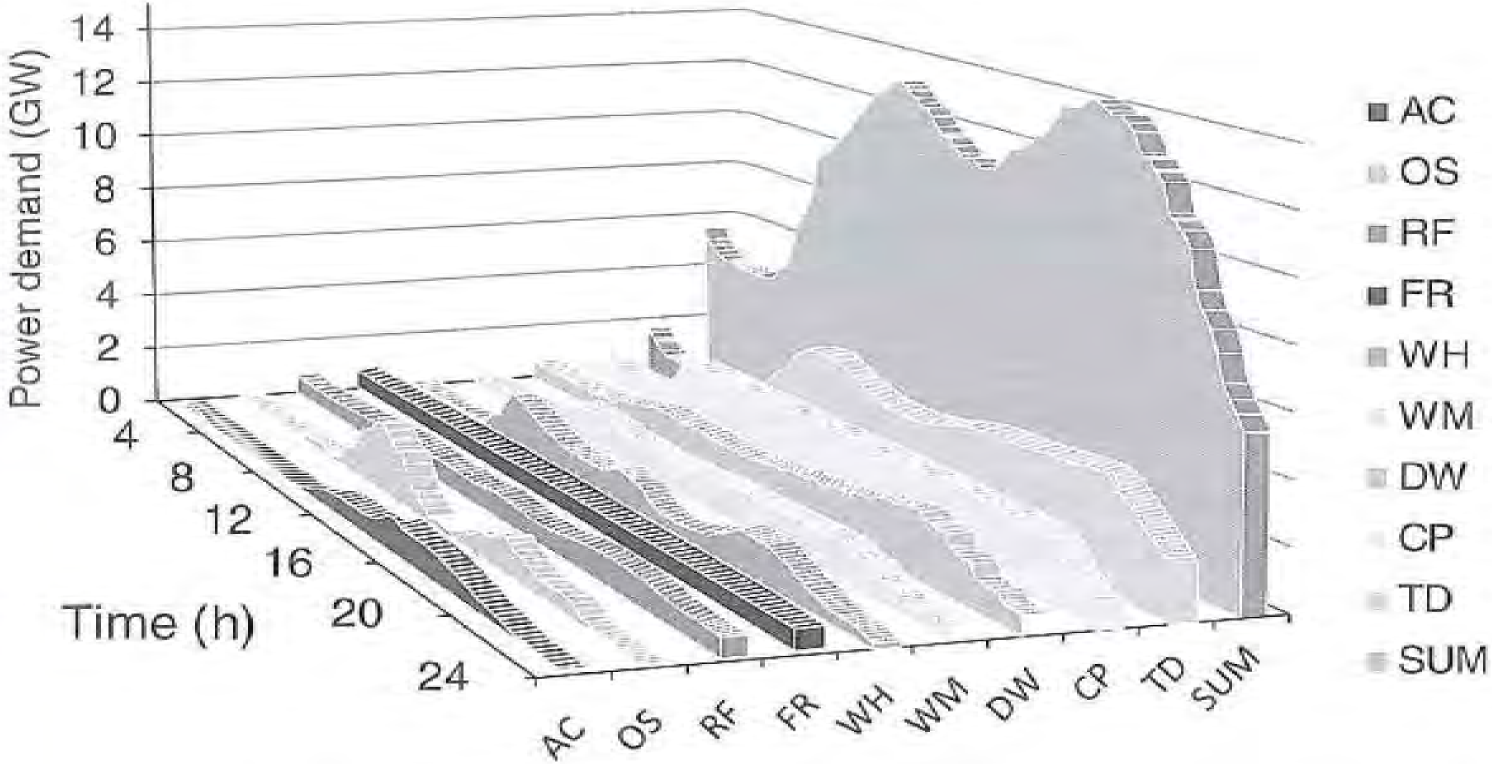



Figure 7.3 Total demand from domestic appliances in the UK. Notes: AC = air conditioner; OS = over and stove; RF = refrigerator; FR = freezer; WH = electric water heater; WM = washing machine; DW = dishwasher; CP = heating circulation pump; TD = tumble dryer; SUM = sum of all appliances.

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 ($kgCO_2$/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.

# 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 | 100GW | | | | 120GW | | | |
| Projected annual UK demand | 360TWh | | | | 390TWh | | | |
| | 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 |

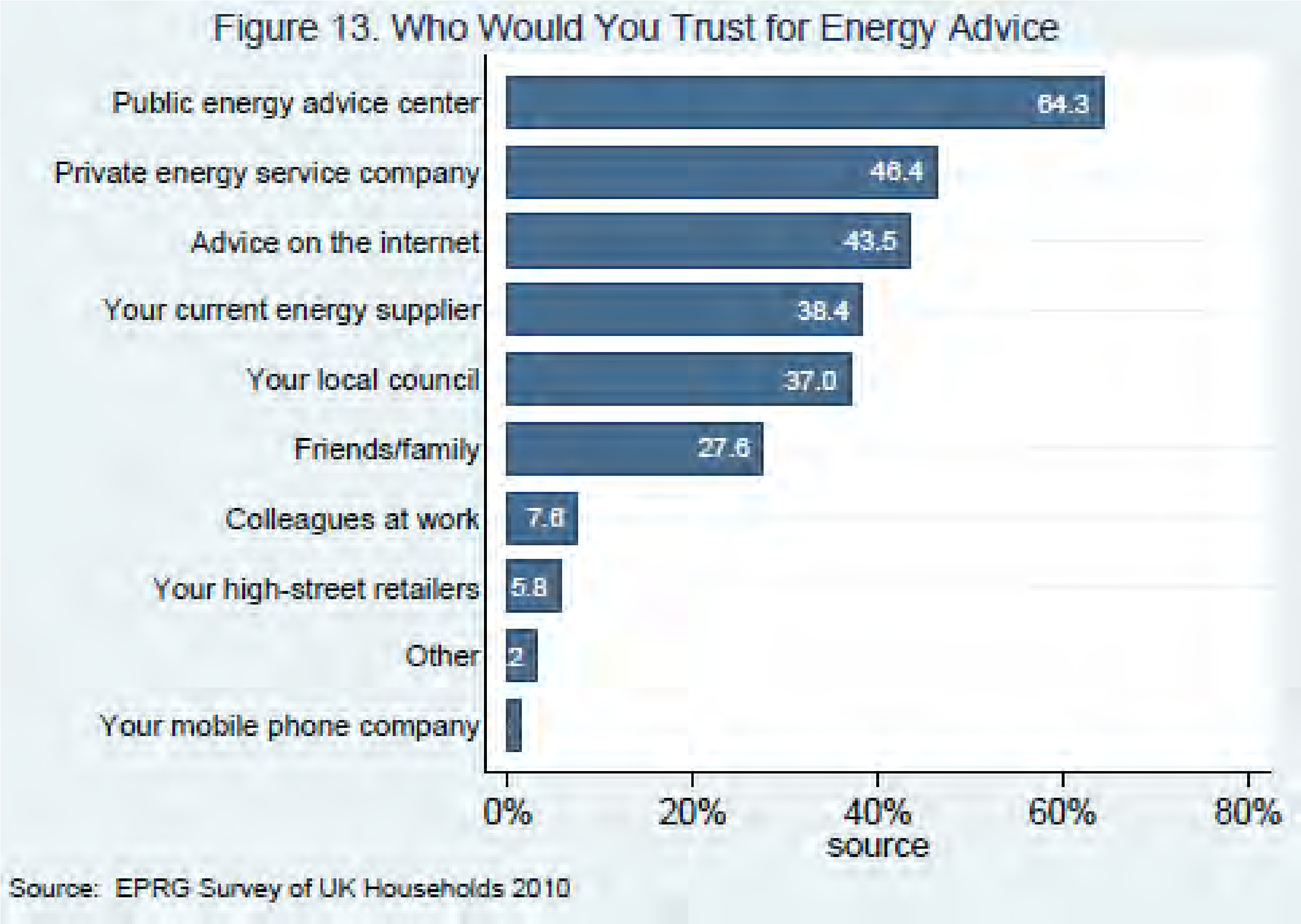
NEP = GB national electric production.
*Source:* Adapted from BERR and DfT (2008).

"dash' to electric looks more like a 'brisk stroll" (Marsden and Hess, in J&P, 2011, p.225)

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# SOCIAL DIMENSIONS

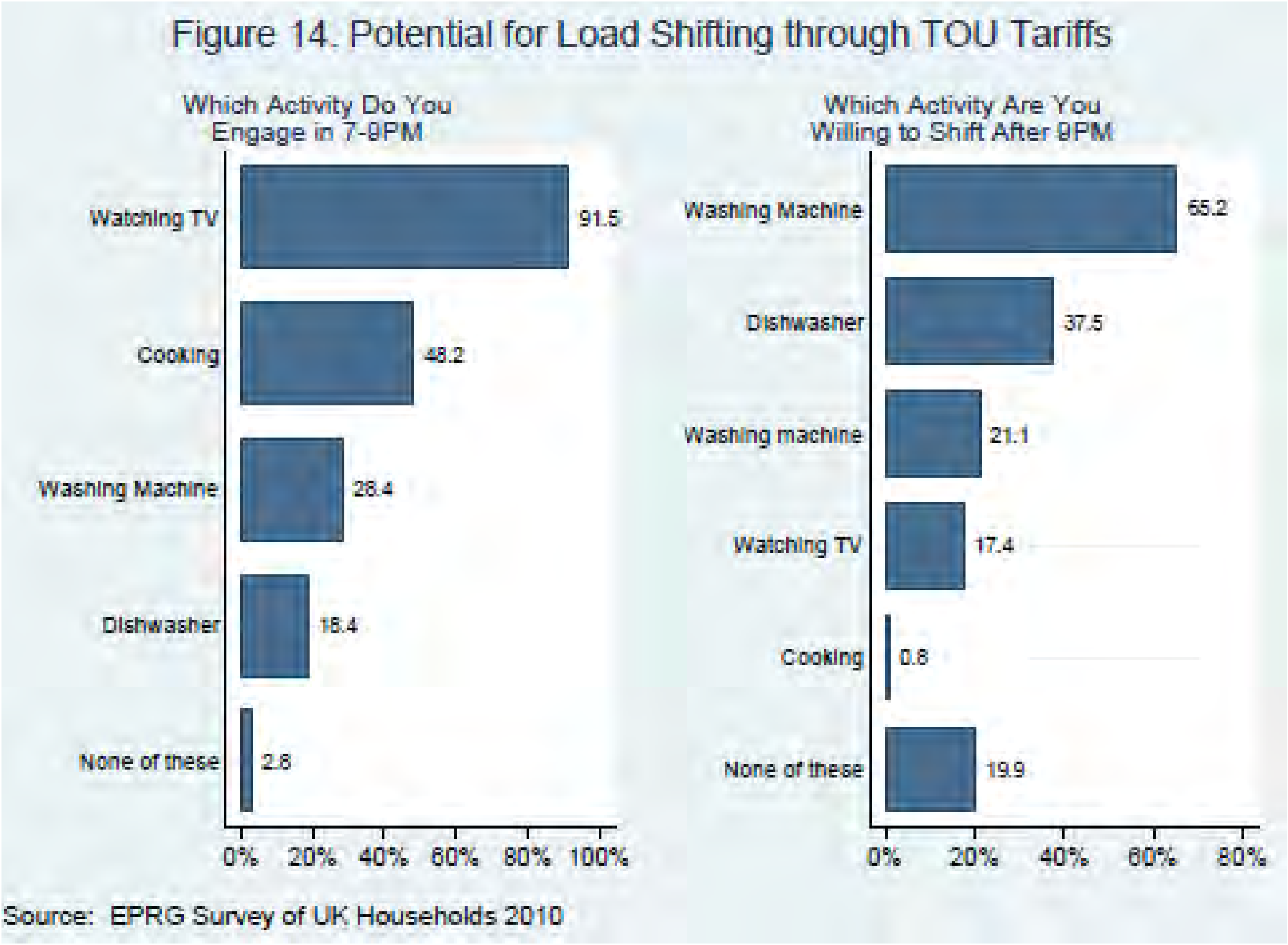
# Trust for energy services…




Source: Platchkov et al, 2011, EPRG WP1122.

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# The social acceptability of DSM…




Source: Platchkov et al, 2011, EPRG WP1122.

# Barriers to local solutions…

- 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.

# 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# | 09# | 10# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | |

# 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.

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# 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.

# POLICY AND REGULATION

# 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.

# Regulation needs to anticipate demand…

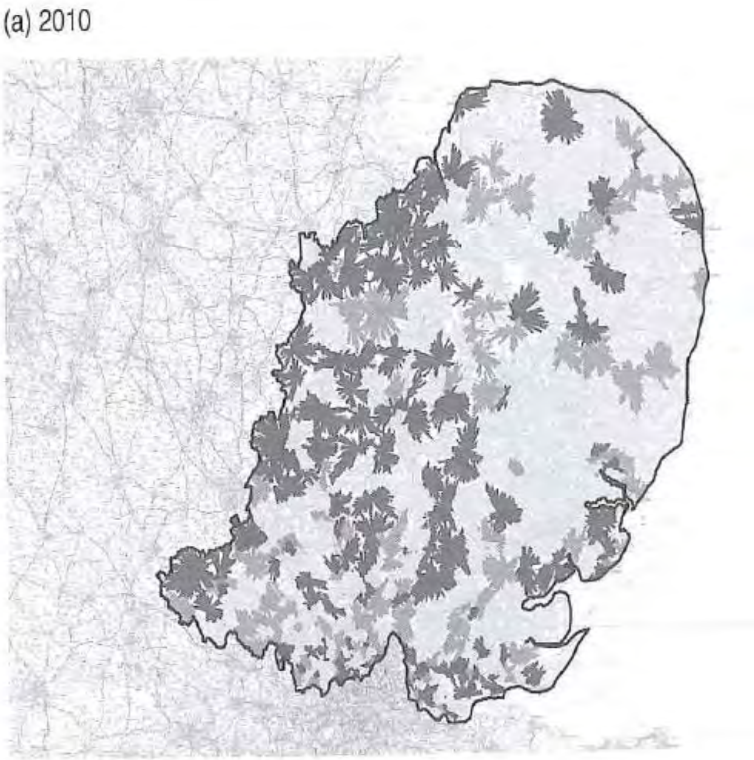



Figure 15.5 Primary substations risk level in 2010, 2015 and 2020.
*Scale:* 1:1,500,000.


Figure 15.5 (*cont.*)

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

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# Higher building standards can help…

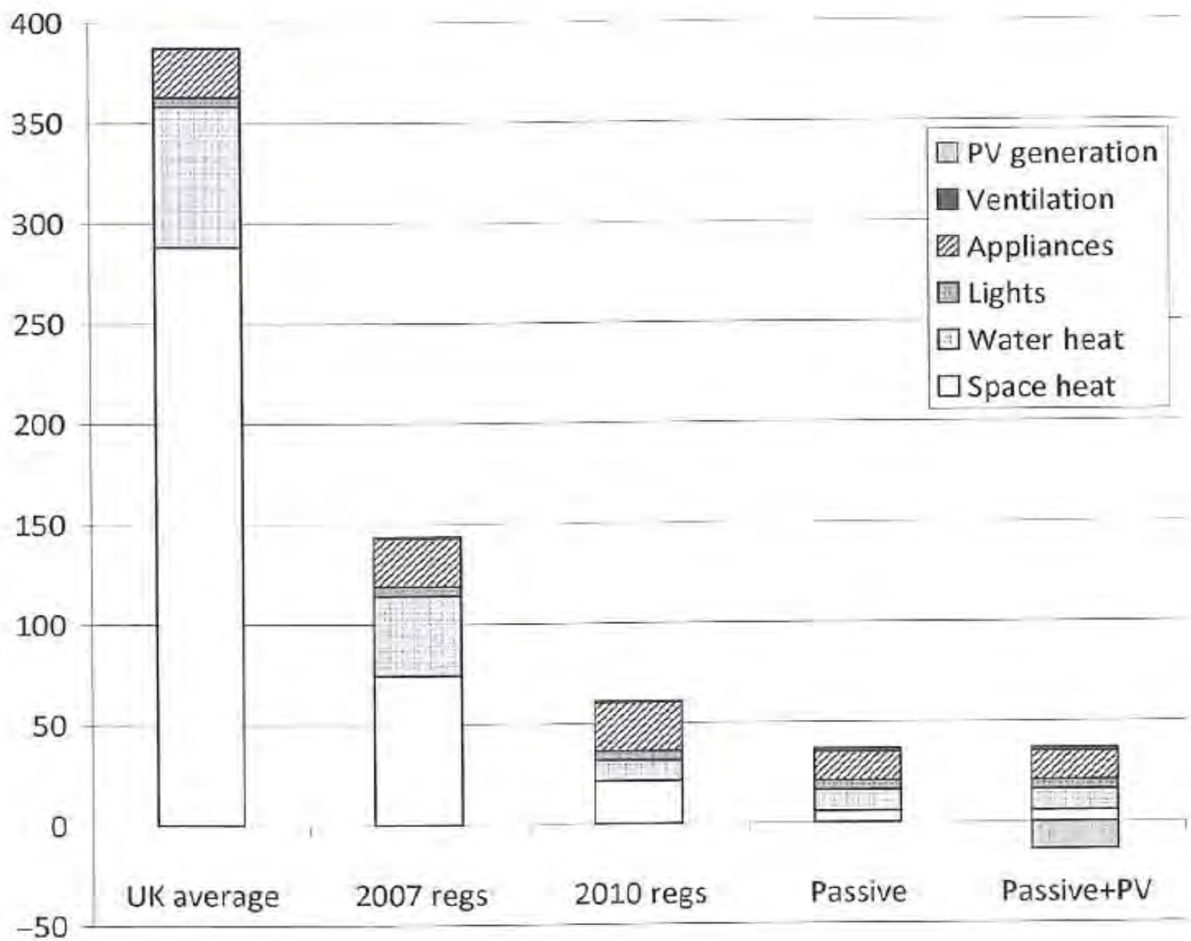



Figure 16.10 Delivered energy (kWh/m² p.a.) by fuel type for semi-detached dwelling to different standards.

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

# Pareto improvements exist…

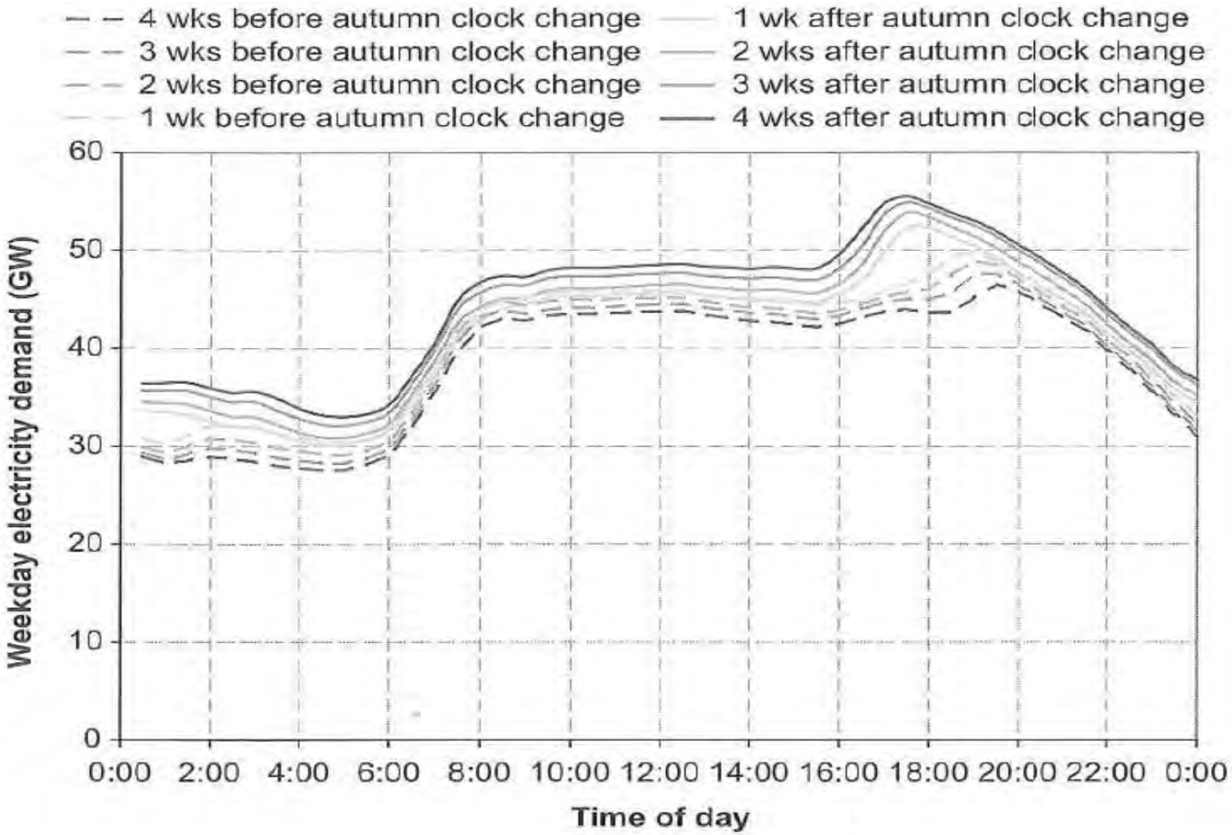



Figure 18.4 Changes in average demand during weeks on autumn clock changes.

GMT+1 in autumn: peak demand down 4.3%, energy -0.32% in November, total annual demand -450 GWh, annual $CO_2$ -0.375mt.

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

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

# Conclusions 1

- 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

- A new conception of demand
- Multifaceted as users, customers, and citizens
- Based on:
  - Economic incentives and insruments,
  - Technological solutions, and
  - Provision of information.

- Empower users to control their energy use and spending rather than anticipate uniform behaviour

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

***Thank you!***