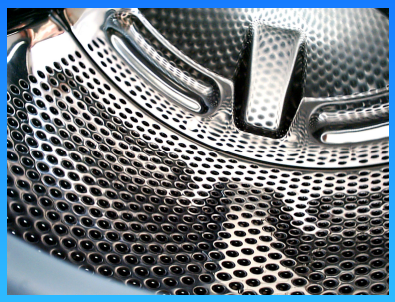
# Lights and Appliances



Andrew Peacock
School of Engineering & Physical Sciences
Heriot Watt University



# Lights and Appliances

UK residential sector energy consumption (2004)

Lights and appliances 14%

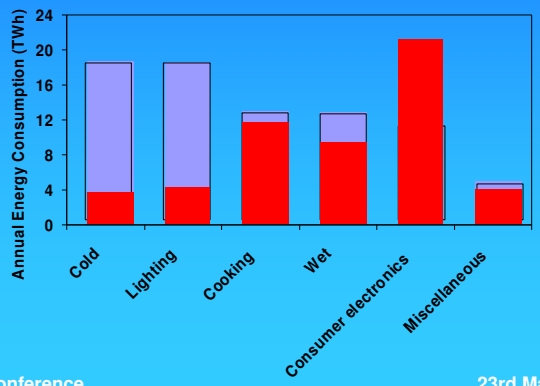
UK residential sector carbon emissions (2004)

Lights and appliances 24%

# Impact of the 40% House Scenario

40% House energy consumption

Annual UK residential sector energy consumption 2004

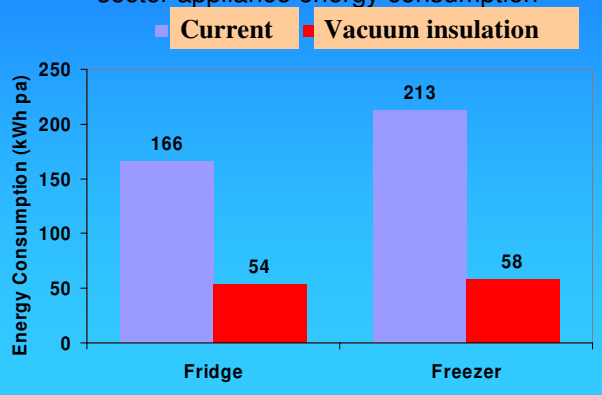





# Key technologies

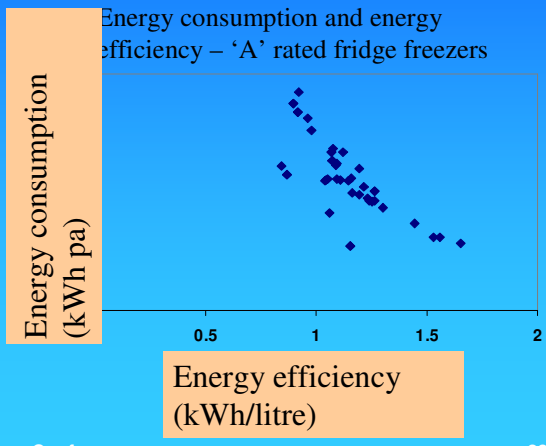
- Cold sector - vacuum insulated panels

Impact of vacuum insulation panels on cold sector appliance energy consumption



# Key Challenges – Cold Sector

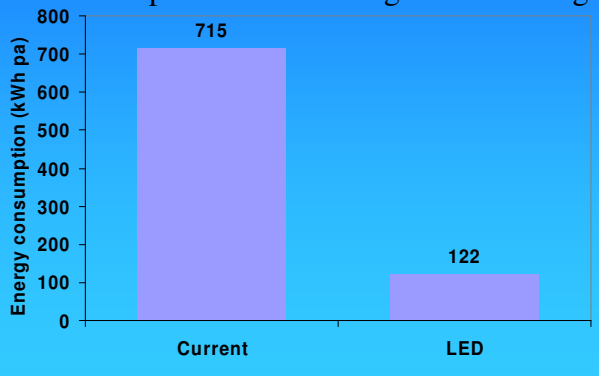
- Weak policy
- Over-emphasis on energy efficiency






# Key Technologies

## LED Lighting




# Key Challenges - Lighting

- Building regulations
- Feedback
- Consumer Awareness
- Manufacturing Design




# Key Challenges – Consumer Electronics

- Increasing appliance ownership
- Manufacturer priorities – Carbon not at the heart of the design process
- Weak policy
- Consumer awareness


# Opportunities

- Rapid and accessible savings
- Largely based on known, proven technologies
- Market transformation as a tool is already established
- Market churn – three full changes of appliances by 2050




# Policy

- Revisions to energy labels in applicable sectors
- Carbon at the heart of the design process e.g. European Energy-using Products (EuP) Directive
- Minimum Standards
- Co-operative Procurement
- Building regulations
- Consumer Feedback and Increased Awareness

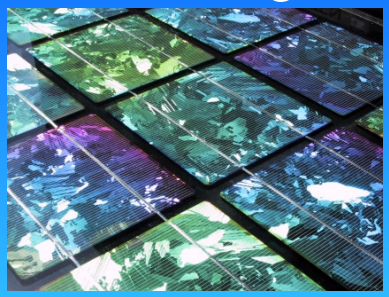
**Overall – LED lights need to be in every home and vacuum insulation panels in every fridge and freezer by 2050**

## Summary of Lights and Appliances in 2050

- Consumption reduced by 44% to 1680 kWh pa
- 50% carbon reductions to 168 kg C per household
- Approximately 70% of carbon savings are as a result of just 2 technology interventions
- Improved service
- Reduced running costs



# Low and Zero Carbon Technologies



Dr Mark Hinnells
Environmental Change Institute
University of Oxford


# Introducing LZC

Low or Zero Carbon Technologies:

- provide space heat, water heating or electricity
- through renewables or combined heat and power
- are integral to the building or community

| | Heat only | Heat and electricity | Electricity only |
|---|---|---|---|
| **Low carbon** | Heat pumps | CHP | - |
| **Zero carbon** | Solar hot water<br>Biomass | Energy from Waste biomass | PV<br>Micro Wind |




# The 40% House philosophy

- Reduced heat load through fabric measures
- 20% homes no space heating demand
- reduced electricity in lights and appliances
- Meet a high proportion of remaining space heat and water heat demand through LZC
- Electricity can either be imported or exported
- Similar to sizing strategy for any given site


# The 40% House challenge

- 1950s no central heating, to 2004 90% central heating
- More building integrated solutions than RCEP 2000, but less than PIU Energy Review 2002
- Not dependent on one technology
- No new technology. Change focused on cost reduction and improved electrical efficiency




# The 40% House Scenario

| | Ownership |
|---|---|
| Community Heating (biomass and CHP) | 20% |
| Stirling Micro-CHP | 21% |
| Fuel Cell Micro-CHP | 18% |
| Heat Pumps | 9% |
| Biomass | 5% |
| PV | 30% |
| Solar Water Heating | 60% |
| Micro Wind | 5% |
| Gas Boilers | 10% |
| Electric Heating | 10% |


# The 40% House Scenario

By 2050

| | | |
|---|---|---|
| Ownership | 53.6 million | 170% |
| Heat supplied | 289 TWh | 82% |
| Electricity generated | 101 TWh | 118% |
| Carbon Savings | One third of the total | |

Could avoid 25GW of new central plant saving around £13bn




# Achieving change: Product Policy

- **Householders will not do this on their own: condensing boilers 5% penetration in 20 years**
- LZC not currently cost effective. Low volumes = high costs
- Future cost determined by investment environment: policy, timescales, certainty, training, incentives, regulation
- Three product replacement cycles
  1. Innovation, market development, training
  2. Building Regs 1st LZC new and refurbished
  3. Building Regs 2st LZC new and refurbished


# Triggering change from now to 2020

- **To 2020 to prove technologies and routes to market, eg ESCOs**
- Requires 30% growth pa for next decade from a very low base
- Technologies and skills can be imported
- Much to learn about programme design




# Financing change: ESCOs

- ESCOs provide energy, plus design build finance operate based on least whole life cost
- Could supply more than half of UK homes by 2050, eg those with community heating and Micro CHP
- Could be partnerships with coherent communities eg LAs, HAs or new build
- Needs withholding of planning consent for power stations that is not CHP or renewable


# Embedding change: Building regulations

- **2020 onwards high volume and lower cost**
- Heating systems to be replaced with LZC
- Replacement of roof requires installation of roof base LZC
- Finance in place via ESCO




# LZCs in 40% House, 2050

- LZC can supply 80%+ of heat and 100%+ of electricity
- Total ownership levels of around 170%
- Perhaps half of households supplied by ESCOs
- A third of savings from LZC, a similar proportion to draft 2005 Building Regs
- Emphasis on cost reduction and routes to markets. Change embedded by regulation later

# Electricity and Peak Load

Professor Marcus Newborough
School of Engineering & Physical Sciences
Heriot Watt University



# Reducing Carbon Intensity of Electricity

- Electricity - high value and high carbon-intensity (kgC/kWh)
- Overall carbon emissions in residential sector reduced via combination of
  - energy demand reduction (energy efficiency)
  - carbon intensity reduction for electricity
- 40% House Scenario reduces carbon intensity via combination of
  - a) supply-side changes
  - b) LZC technology deployment
  - c) demand-side management (DSM) rationale

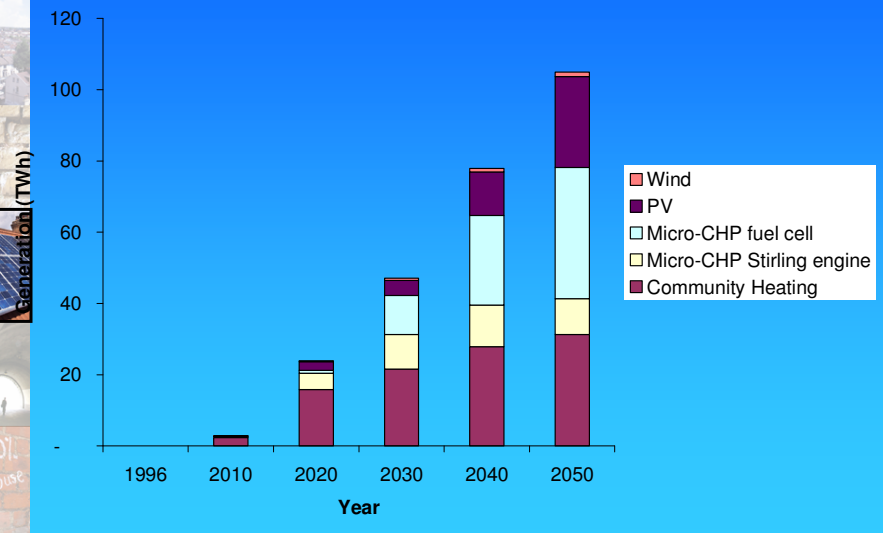
# Supply-Side Changes

- Ageing coal and nuclear plant – gradually decommissioned or removed by legislation
- Phasing out of existing coal plant is of considerable help in reducing carbon intensity
- 40% House Scenario assumes coal and nuclear are replaced with gas plant and a sustained expansion of renewables (wind, marine)
- The carbon intensity of network electricity decreases

  from: 0.11 kgC/kWh (2004) to: 0.1 kgC/kWh (2030 - 2050)



# LZC Technology Deployment

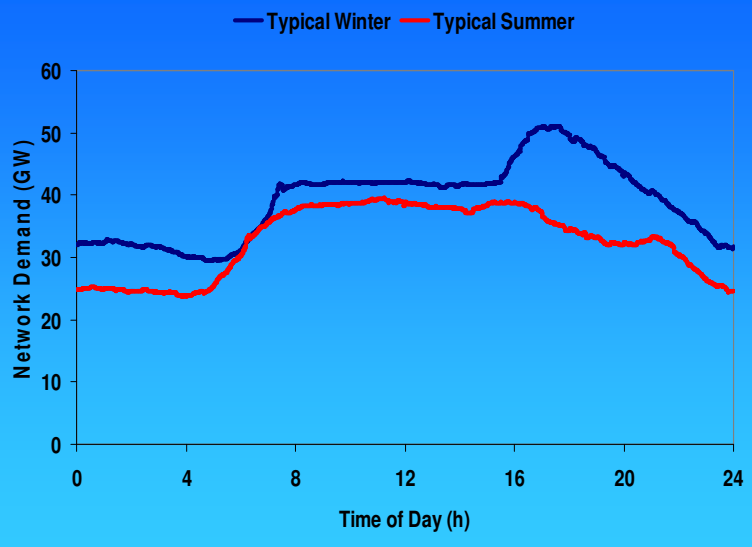


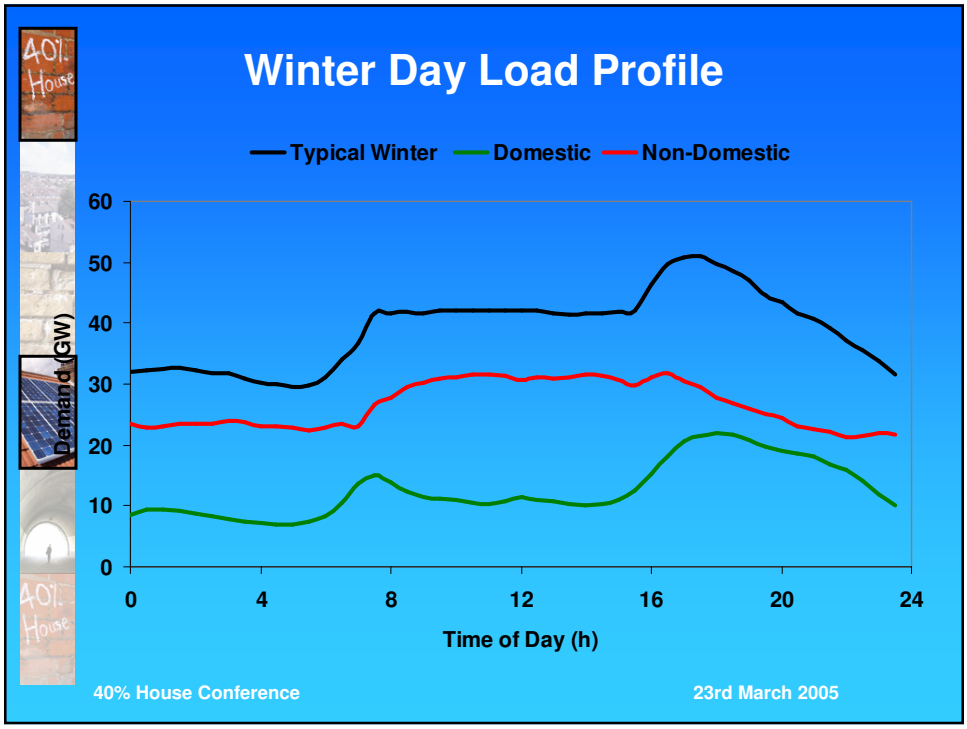
## Demand-Side Management (DSM)

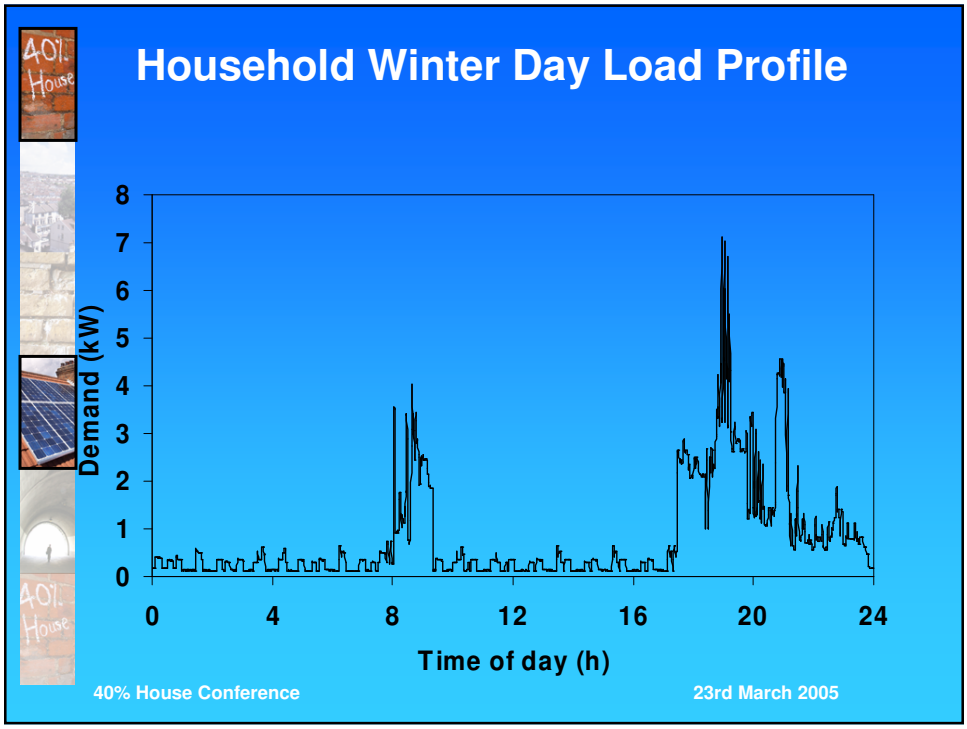
- Integration of renewable power and LZC in the electricity network will perturb the net profile placed on central thermal plant
- Need to curtail the peak and smooth load profiles by developing and applying
  - DSM techniques in general, including energy storage
  - DSM in homes and appliances
  - improved LZC technologies



## National Load Profile




Winter Day Load Profile
Typical Winter
Domestic
Non-Domestic
Demand (GW)
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time of Day (h)
40% House Conference
23rd March 2005


Household Winter Day Load Profile
Demand (kW)
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
Time of day (h)
40% House Conference
23rd March 2005

# DSM in the Home

- Efficiency improvements in

  - peak-time appliances (lighting, televisions)
  - base-load appliances (refrigeration, consumer electronics)

- Smart appliances

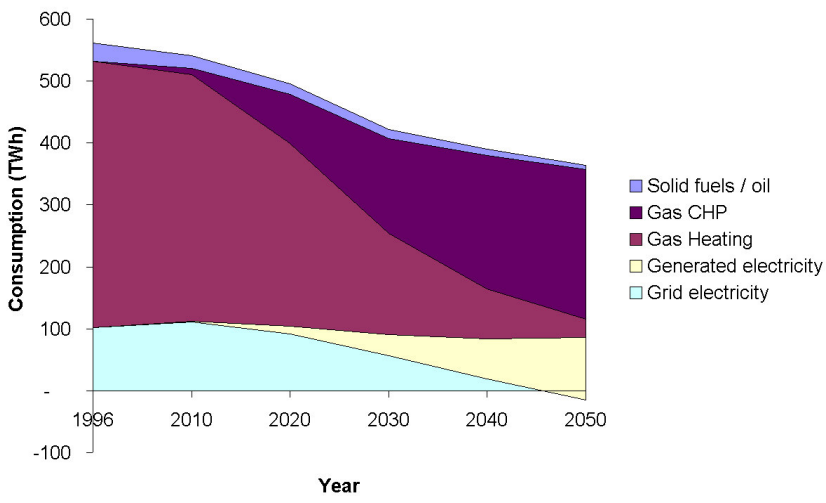
  - "load-conscious" design and control (cookers, laundry, lights)
  - "load shedding" (water heaters, refrigeration)
  - "load shifting" (dishwashers, tumble dryers)

- Intelligent homes

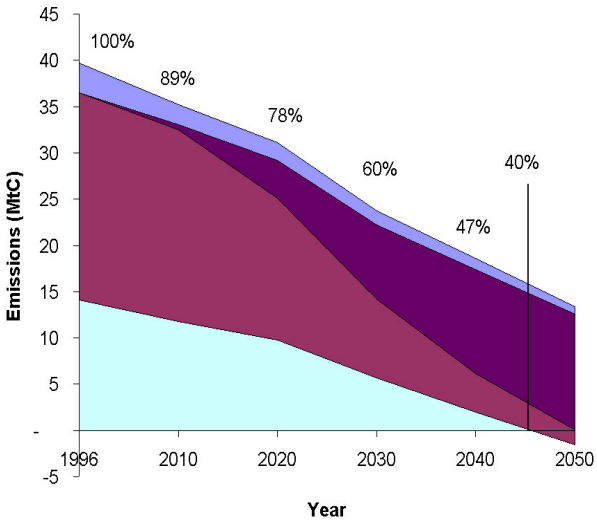
  - load management of smart appliances to minimise coincident peak per dwelling



# 40% House: Energy Consumption



# 40% House: Carbon Emissions






# SS + EE + LZC + DSM = -60%C

- The 40% House Scenario delivers:-

  - electricity of low carbon intensity for use in the home

  - a reduction of ~11 MtC in emissions from electricity

  - a potential reduction in national winter peak load of ~ 25GW by 2050

  - an overall reduction in residential carbon emissions of 60% by ~2045


40% House Conference 23rd March 2005