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International seminar on large scale balancing from Norwegian hydropower, Sand, Norway, 11 – 13 September 2012

ENERGY STORAGE AND FLEXIBILITY OPTIONS FOR THE UK ENERGY SYSTEM

1.
ENERGY INNOVATION

Energy Research Partnership

ERP Objectives

<u>To provide strategic direction to UK energy RDD&D</u> and increase the level, coherence and effectiveness of public-private investment in innovation and commercialisation to achieve energy policy goals.

Co-chairs

- David MacKay, Chief Scientific Advisor, Department of Energy and Climate Change
- Nick Winser, Executive Director, National Grid

Members

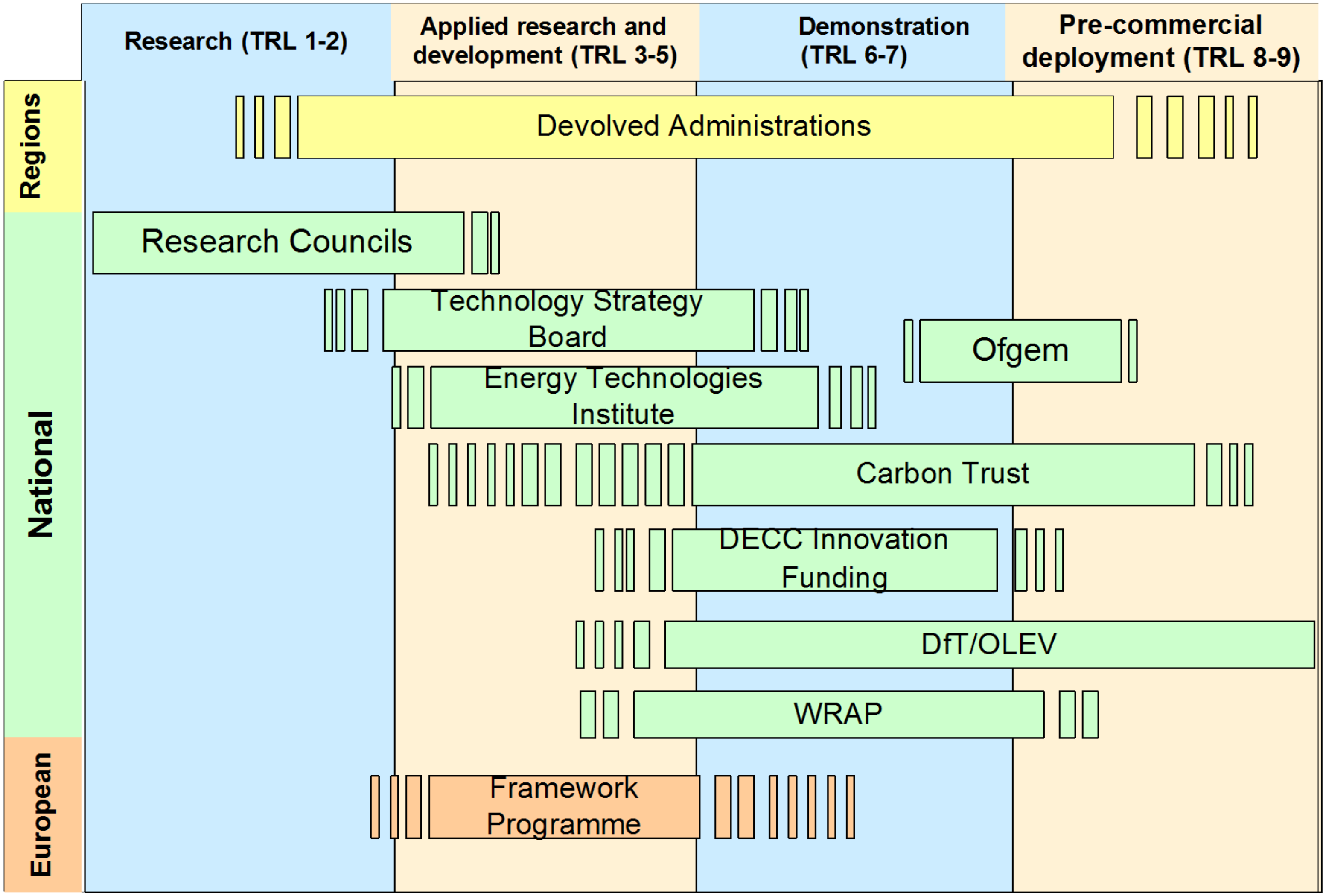
- **Government:** Departments for energy, transport, housing, business; Devolved Administrations for Scotland and Wales
- **Private Sector:** ABB, Atkins, Arup, BP, Doosan Power Systems, Drax Power, E.ON UK, National Grid, Ricardo, SSE, Shell
- **Funders:** Carbon Trust, Energy Technologies Institute, Research Councils, Technology Strategy Board
- **Academic, Regulatory, NGO:** Julian Allwood (University of Cambridge), Friends of the Earth, Ofgem (observers), Royal Academy of Engineering, UKERC

Analysis Team

Head: Jonathan Radcliffe; Executive Analysts: Richard Heap, Mark Workman; Research and admin support: Helen Thomas

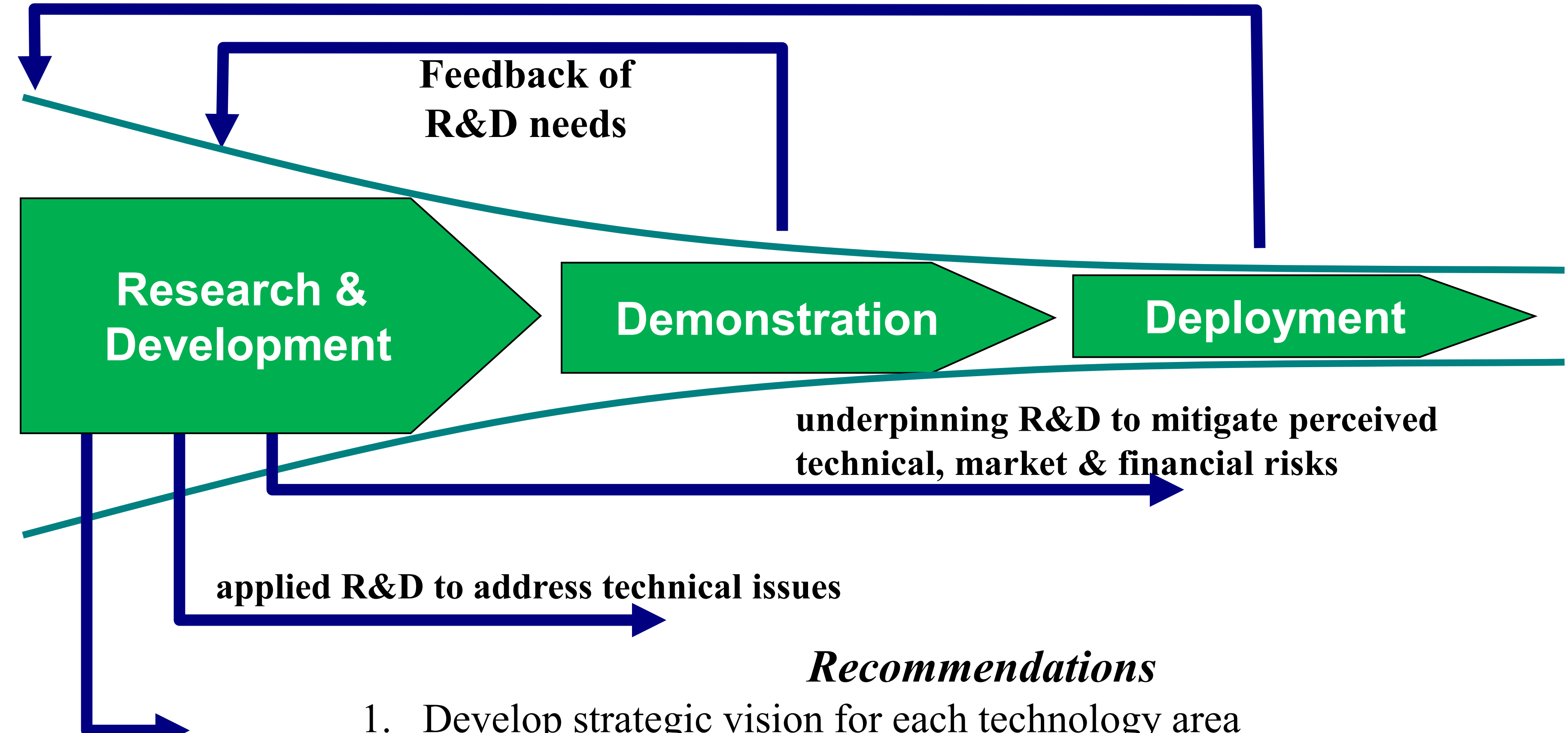
www.energyresearchpartnership.org.uk

Public sector funding 'landscape' for energy innovation



Source: DECC Science and Innovation Strategy, 2012

‘UK Energy Innovation’, May 2007



Basic R&D:
- **speculative, science led**
- **industry needs led**

Recommendations

1. Develop strategic vision for each technology area
2. Better coordination, of support along the innovation chain
3. R&D to be strengthened and more strongly focussed on market need
4. Much stronger joint public/private support for demonstration and early deployment

ERP Energy Storage report, June 2011

Objective:

'to guide public and private sector decision makers when considering the potential role of storage technologies in the future energy system, and therefore what needs to be done now to prepare.'

Scope: technology agnostic, functional approach...

- Storage of electricity and heat
- From grid-scale to domestic-level

http://www.energyresearchpartnership.org.uk/energystorage

Other recent projects:

Nuclear fission

Bioenergy

Hydrogen

International Engagement

2. KEY CHALLENGE: SYSTEM FLEXIBILITY

Need for flexibility

Challenges to match supply and demand will become more acute in pathways to 2050

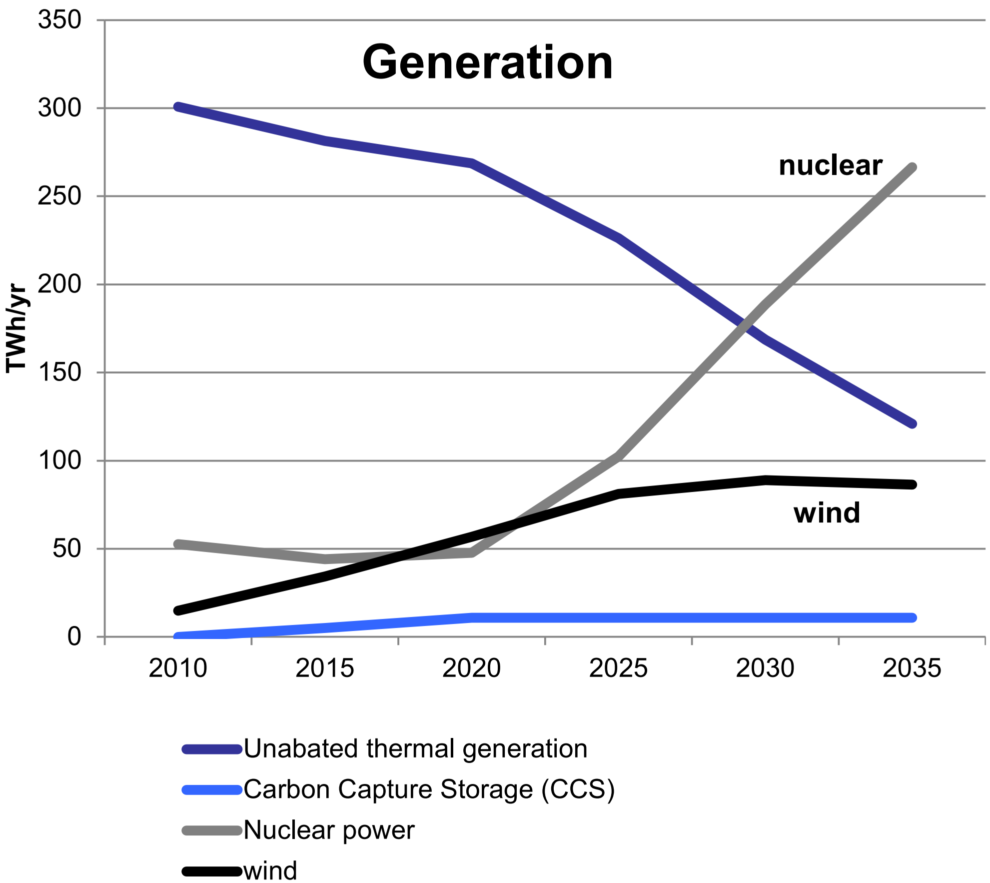
- Large proportion of intermittent generation
- Electrification of heating and transport

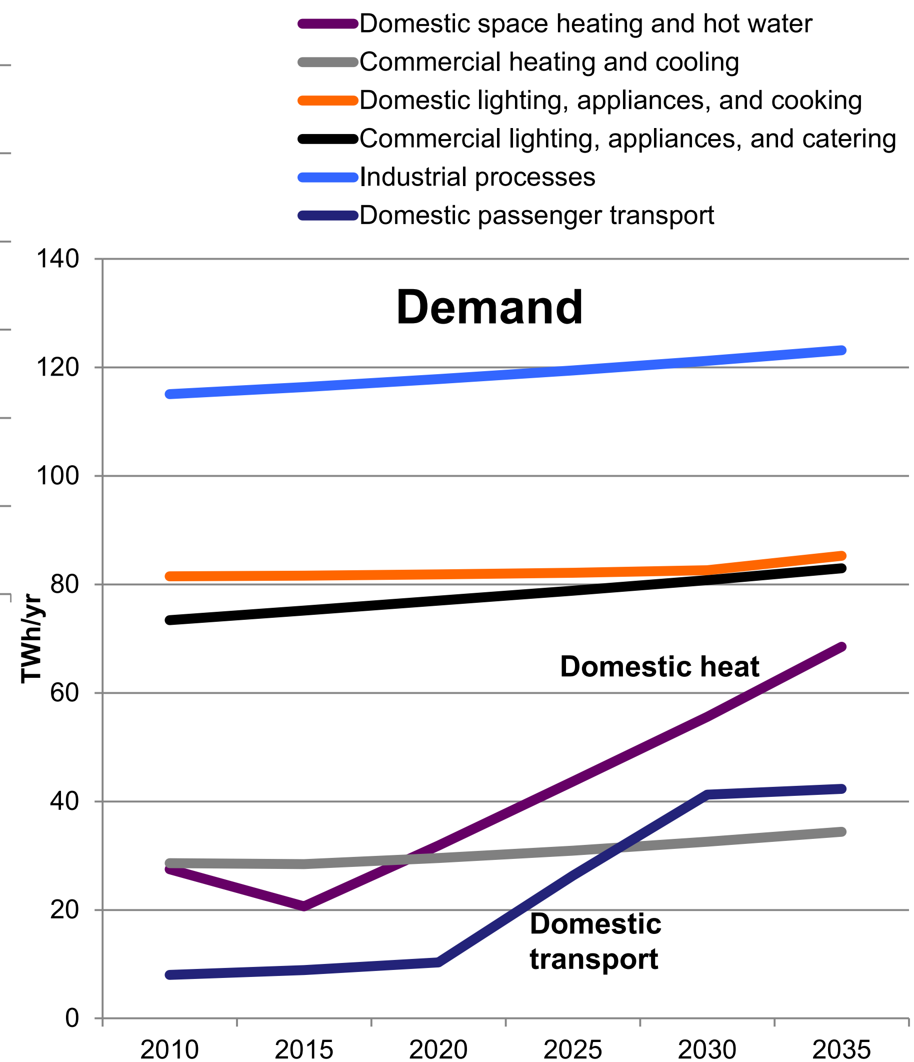
Energy storage is conceptually appealing, giving ability to 'time-shift' supply to times of demand to:

- Reduce generation capacity, especially at peak times
- Provide 'back-up' to intermittent generation
- Make most efficient use of infrastructure capacity
- Respond quickly for power quality

Timescale	Challenge
Seconds	Renewable generation introduces harmonics and affects power supply quality.
Minutes	Rapid ramping to respond to changing supply from wind generation.
Hours	Daily peak for electricity is greater to meet demand for heat.
Hours - days	Variability of wind generation needs back-up supply or demand response.
Months	Increased use of electricity for heat leads to strong seasonal demand profile.

In the transition…
intermittency + electrification

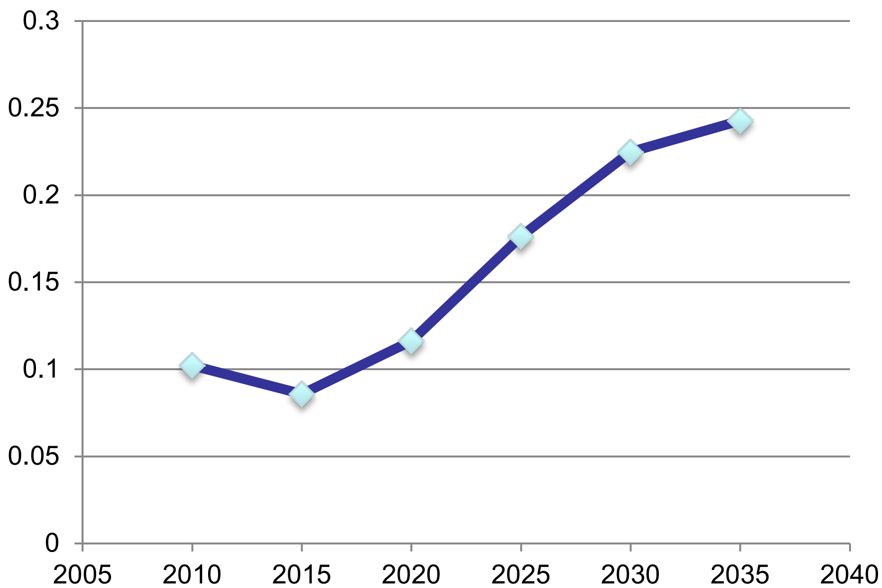




DECC Pathways UK scenario – nuclear, central electric

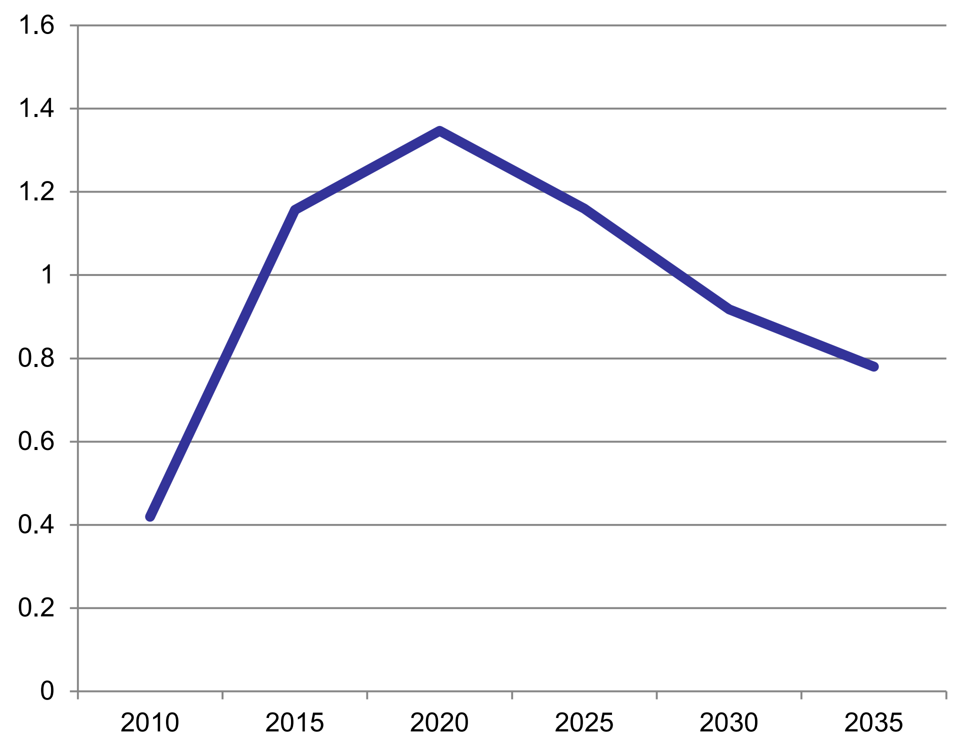
= opportunity for new flexibility options?

Proportion electrified heat + transport of demand for electricity



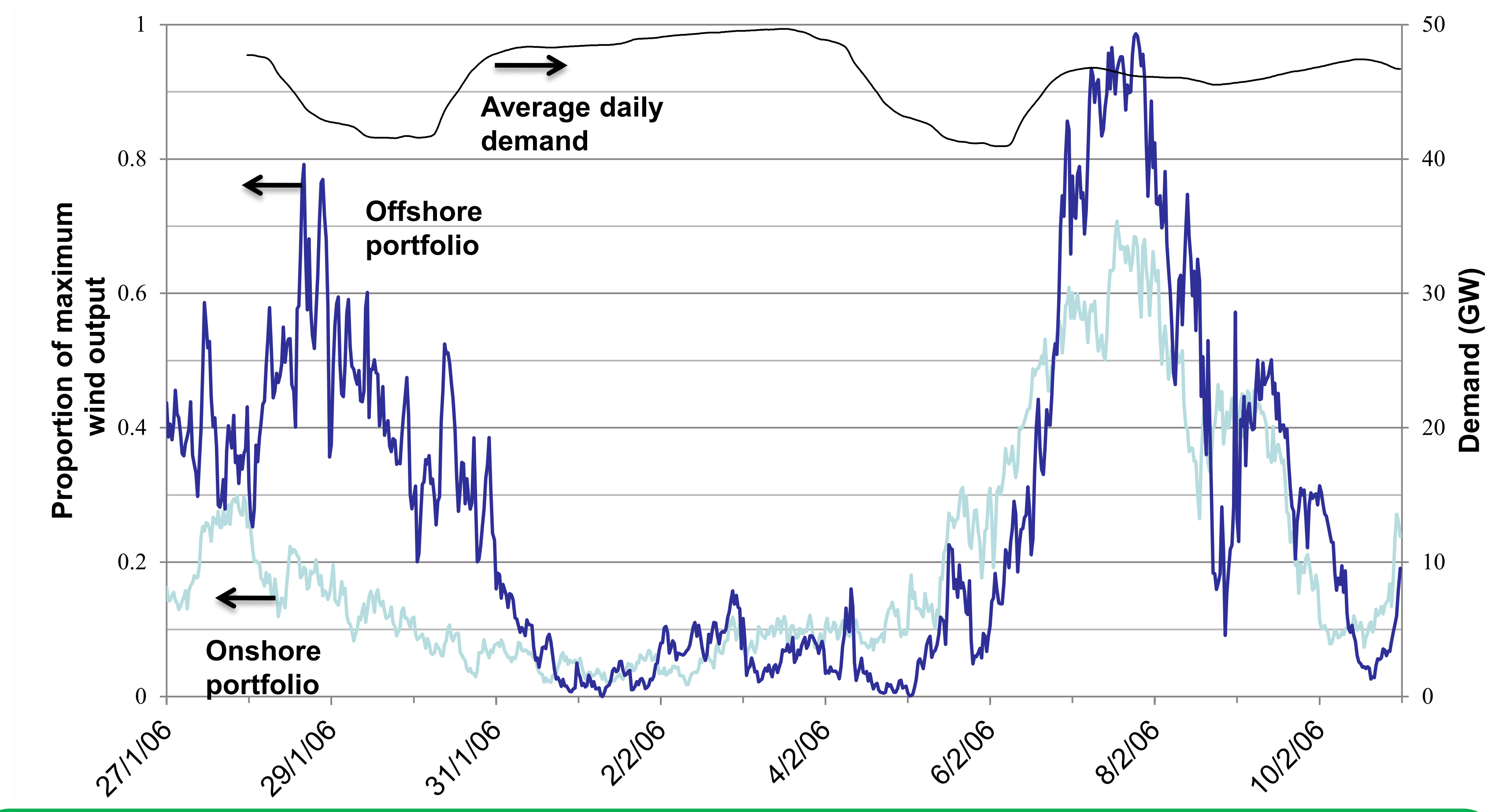
Likely that UK's intermittent generation will expand before possible demand response from EV and HPs are in place

Ratio wind:electrified heat + transport



But risk that gas plant could be built up in the short term and crowd-out the market for new technologies.

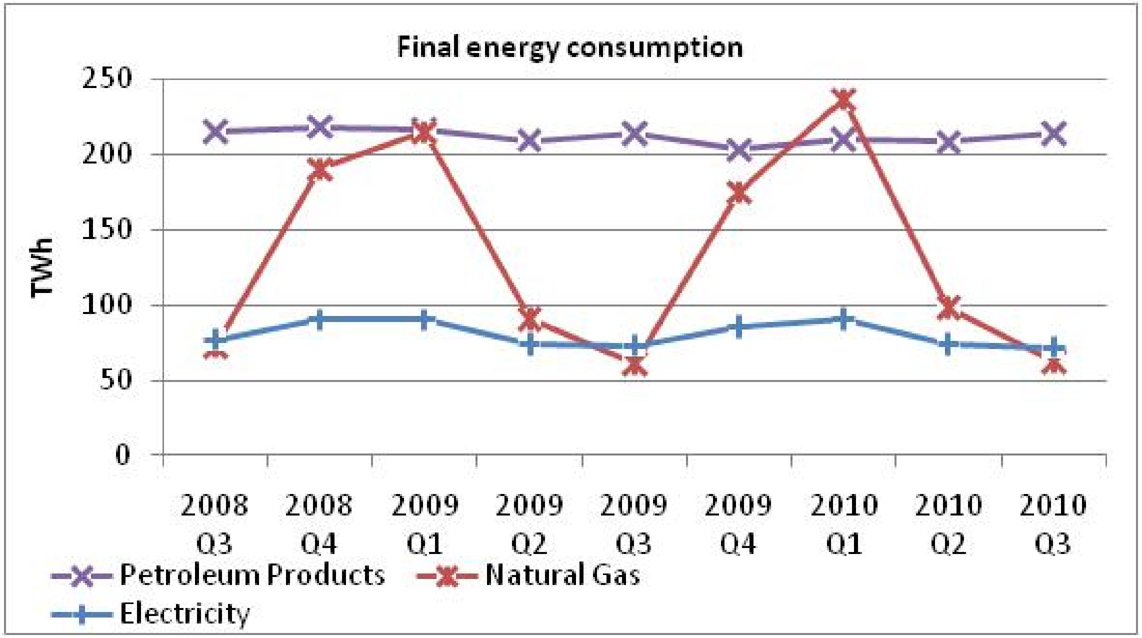
Increase in intermittent generation /1



Peak demand can occur at an extended time of low wind output. Winter 2006 wind data has wind generation 6% of capacity over 5 days when demand totalled 5.7 TWh. Drop from 35% load factor is equivalent to 1TWh ‘gap’. Data from E.ON.

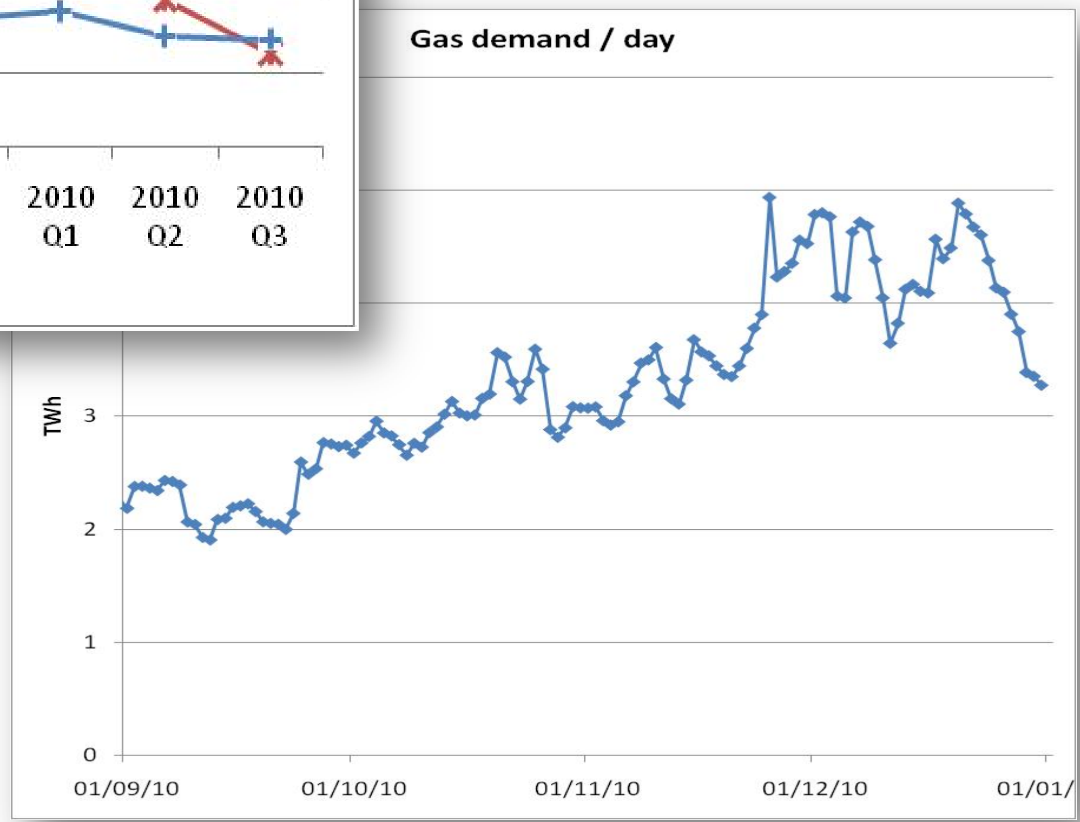
Also short timescale variability and rapid ramping up/down.

Electrification of space heating /1



DECC, 'Energy Trends', 2010

National Grid



Current space heat demand:

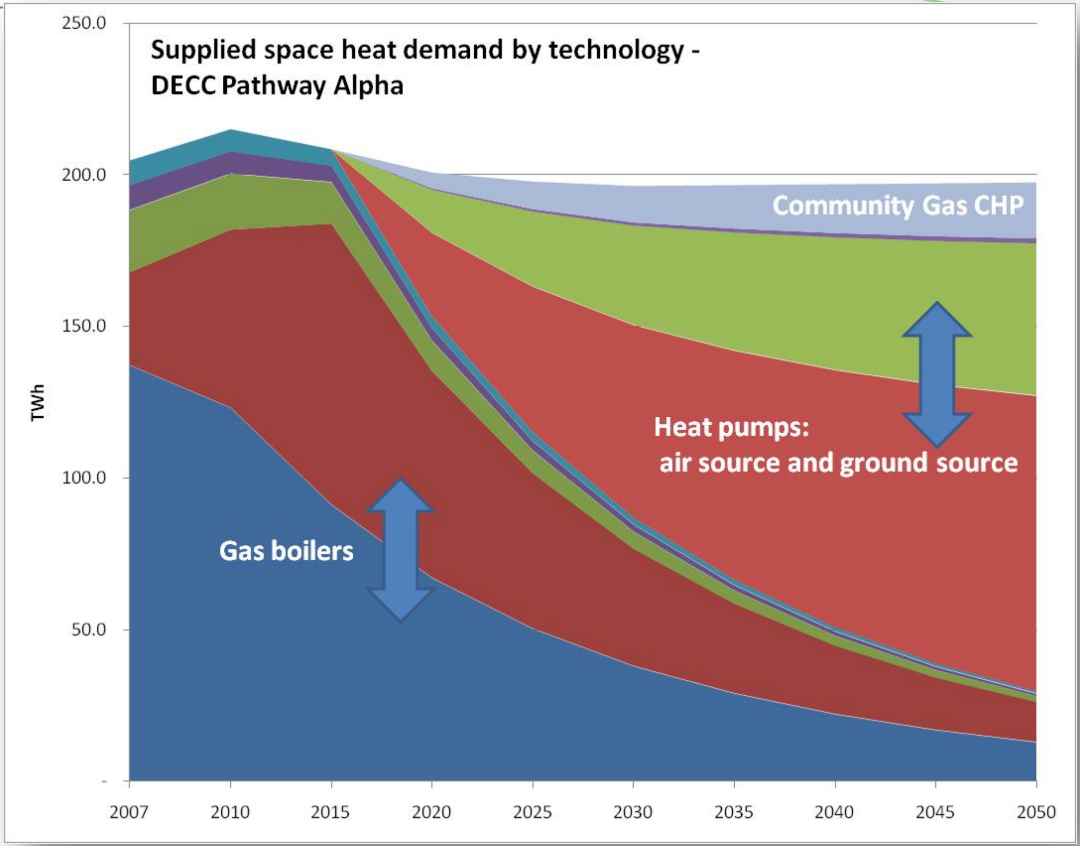
- Predominantly gas (half of gas use is for domestic space heat)
- Strong seasonal profile
- Weather related variation over days
- Daily peaks

Electrification of space heating /2

CCC medium abatement scenario has 6.8m (25%) domestic buildings with heat pumps serving 81TWh heat/year by 2030.

DECC Pathway Alpha has 35TWh electrical generation required in 2030, 47TWh in 2050, for space heating.

→ Seasonal variation of gas demand will shift to electricity.



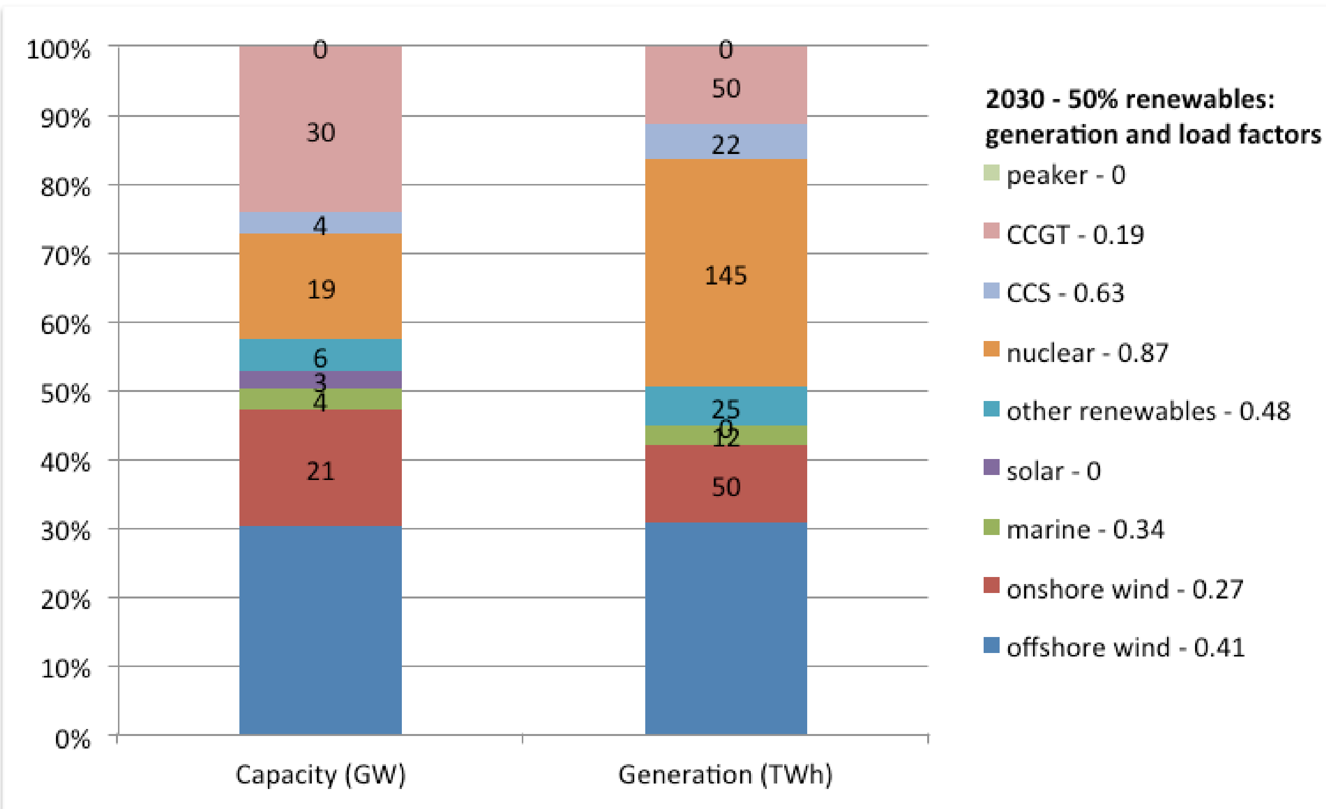
Generation capacity to meet all electrical space heat demand in 2030 (if a smooth distribution) would be ~10GW.

Meeting spikes from weather and evening peak demand could double this.

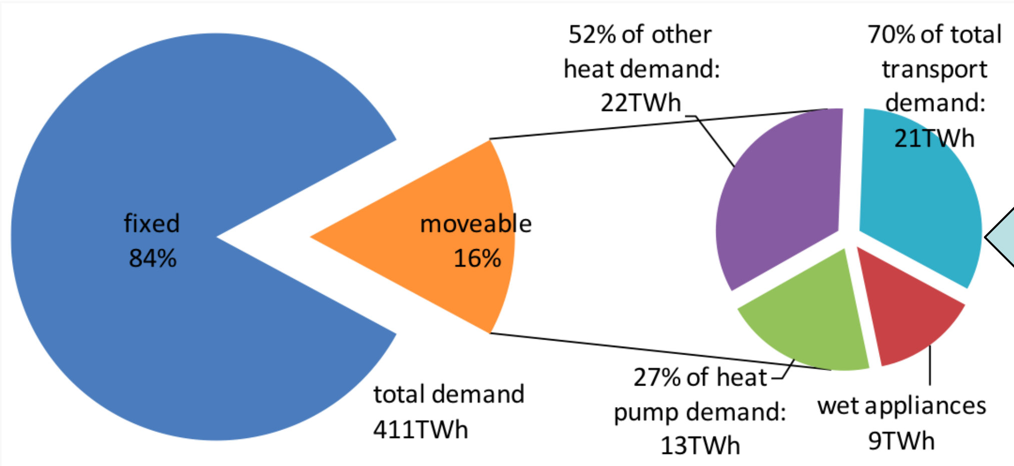
CCC scenario: 50% renewables in 2030

Poyry modelled a scenario for UK's Committee on Climate Change to investigate scope for maintaining security of supply under high share of renewables.

Studied renewable generation levels above that which CCC considers to be most appropriate to meet carbon reduction targets, of around 40%. But found that the costs of managing intermittency would be low relative to the cost of generation.



CCC scenario, 2030, 50% RES:
Flexibility options and challenges



Demand side

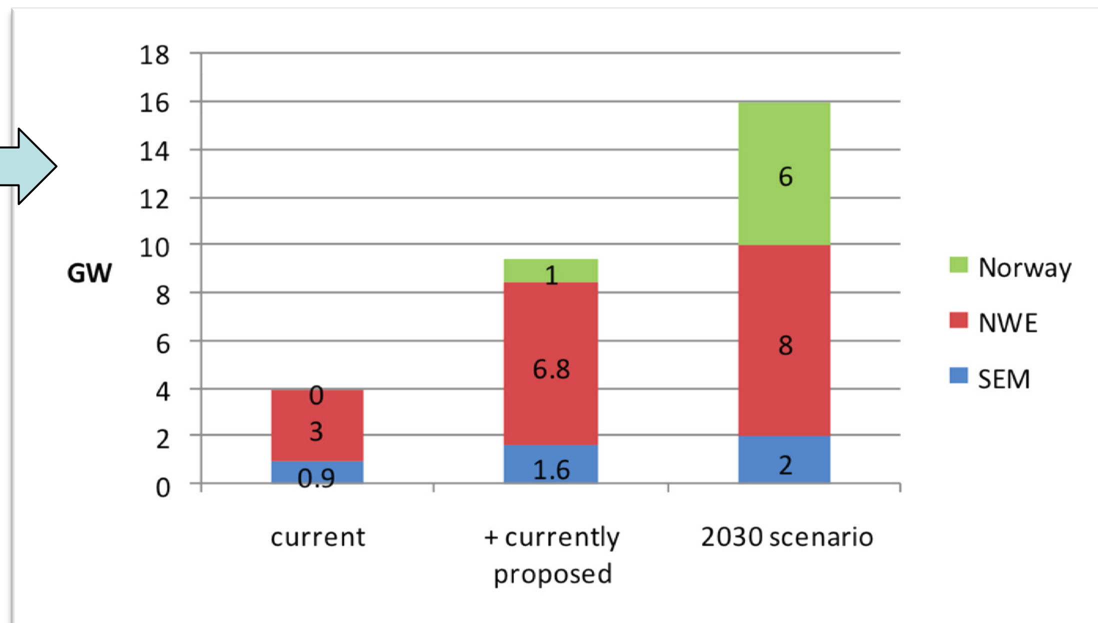
- 16% of demand moveable, primarily thermal storage and EV batteries.
- Dependency on deployment of heat pumps and EVs; with smart meter system capability.

Storage

- Modest increase in capacity to 4GW.

Interconnection

- Increase capacity 4GW → 16GW, with Norwegian PHS key role.
- Valuable system balancing role.
- Questionable whether can provide reliable supplies in wind lull.



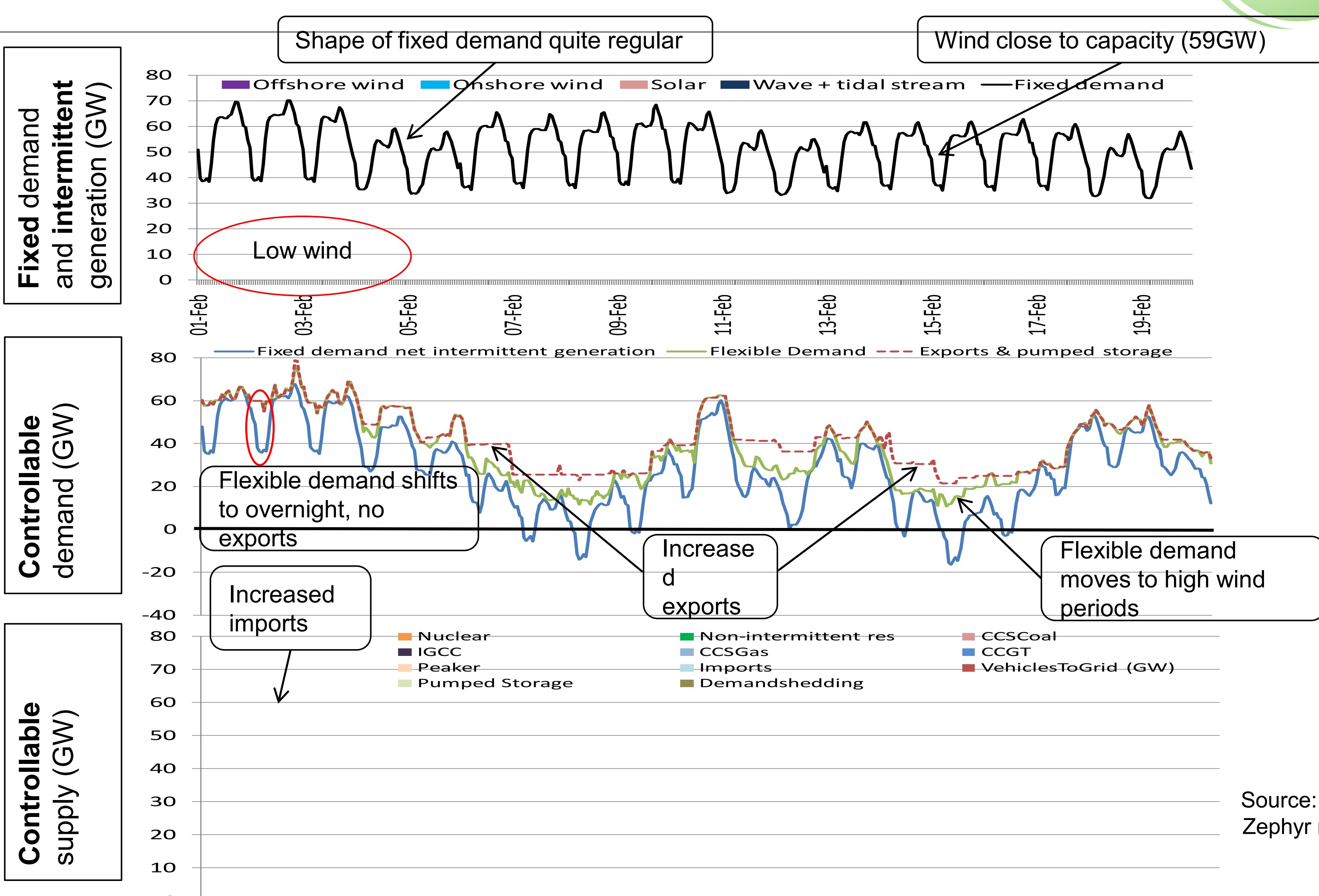
Flexible generation

- No new thermal generation beyond currently planned
- Operating at low load factors <20%

CCC (2011) Renewable Energy Review

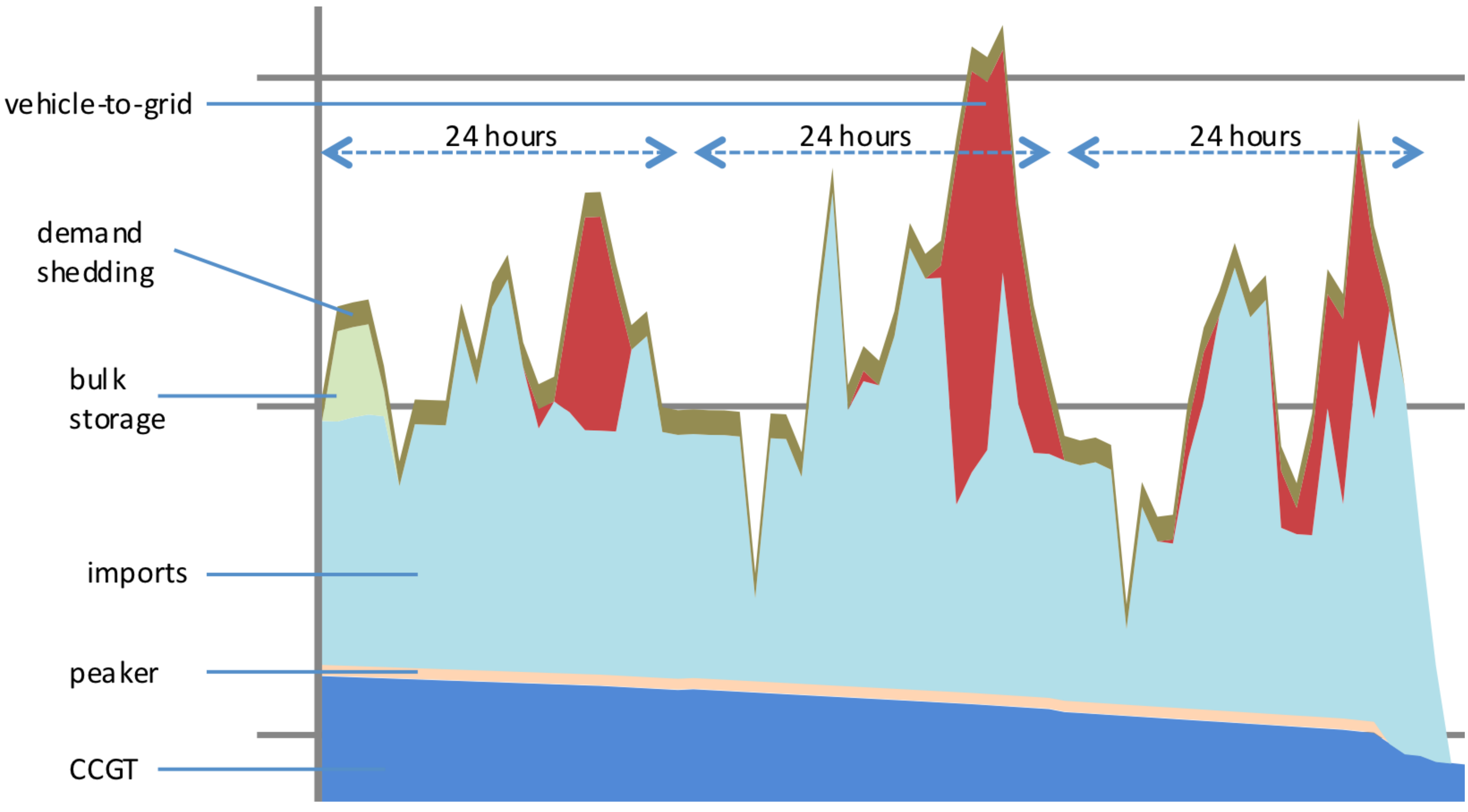
CCC slide: How does the system cope with high renewables?

Snapshot from Feb (2006) with 50% renewables



Source: Poyry Zephyr model

Zooming-in on wind lull…



Case for innovation

Scenarios for managing intermittency may be optimistic about the extent to which ‘new’ technologies can contribute to flexible system operation…

…and the costs do appear very low given the scale of the challenge, and uncertainty of delivering the technologies,

…and the business case for commercialising the technologies is not clear in the current market framework.

But demand side response, interconnection, energy storage and flexible thermal generation are all options for managing intermittency

Conclude:

- **Scale of the challenge must not be underestimated**
- **Strong case for innovation to help deliver flexibility options, and further analysis to improve our understanding** (some priorities below)
- **Risk of missing opportunities to develop technologies in coming years which would enable most efficient low-carbon pathways to be attained.**

Priorities for innovation

Demand side response:

- Thermal storage with space heat – not just domestic HPs
- Ensure strong links between EV pilots and energy system analysis; investigate benefits of vehicle-to-grid
- ‘Smart’ metering systems – ensuring capability from technology and demonstrating effectiveness (at a systems level, and with users)

Interconnection

- Technological, regulatory and political challenges to achieve potential benefits from a ‘meshed’ North Sea network
- Needs high-level commitment to progressing and further studies

Energy storage

- Studies showing most value from distributed (household) storage – need to be demonstrated
- R&D needed to develop lower cost alternatives

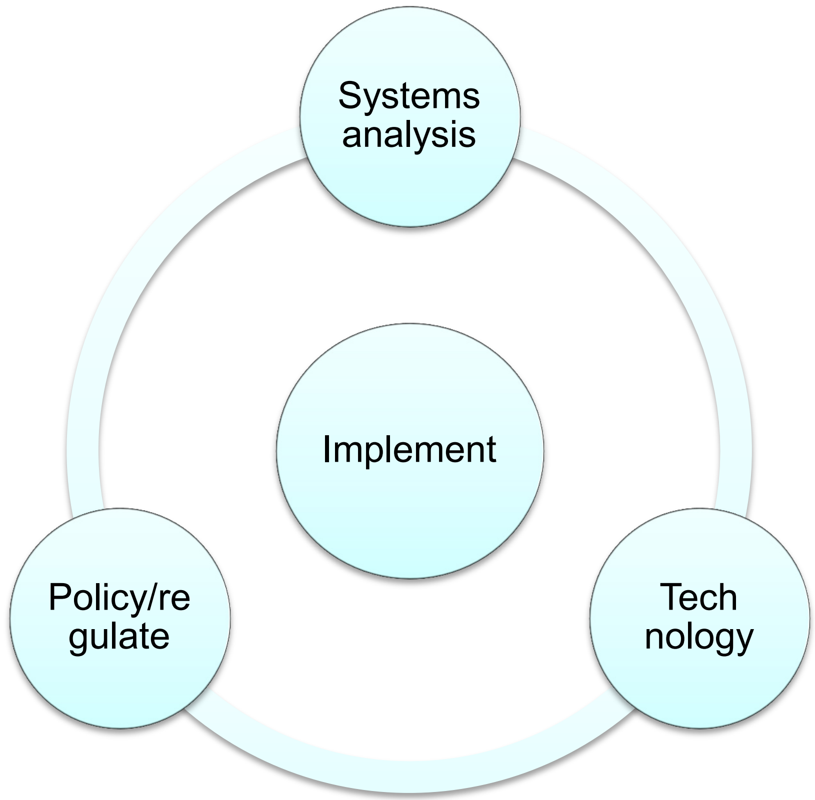
Flexible generation

- Efficient ramping of thermal plant

ERP report *‘Delivering flexibility options for the energy system: priorities for Innovation’ (May 2012)*

Identifying and capturing value

We need to deliver an energy system for 2030+ that is fit for longer term, low carbon pathways. Prepare now, so we can take informed decisions.



New systems analysis is now considering flexibility options more thoroughly. Technology, policy and business sectors need to work together to meet the challenges.

Progress…?

Paper from Department of Energy and Climate Change, published August 2012, 'The Electricity System: assessment of future challenges', looks at whether there are more cost effective ways to operate the system in the future.
Underpinned by analysis from Imperial College

"Technology development is central to the successful evolution of a flexible electricity system…"

- But interconnection still thought of in terms of point-to-point "at least 10GW with mainland Europe might be beneficial as a whole by 2050", but very sensitive to generation mix elsewhere.
- Paper points to work of NSCOGI.

*"**Action**: further development of an evidence base and analysis on the impact on GB under different interconnection scenarios including further exploration of the most appropriate way of developing our interconnection capacity."*

http://www.decc.gov.uk/en/content/cms/meeting_energy/network/strategy/strategy.aspx