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Developing UK energy scenarios from ESME modelling

A presentation to the wholeSEM Annual Conference 2015

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energy technologies institute

What is the ETI?

- The Energy Technologies Institute (ETI) is a public-private partnership between global energy and engineering companies and UK Government

Delivering...

- Targeted development and demonstration of new technologies
- Shared risk
- System level strategic planning

ETI members

bp

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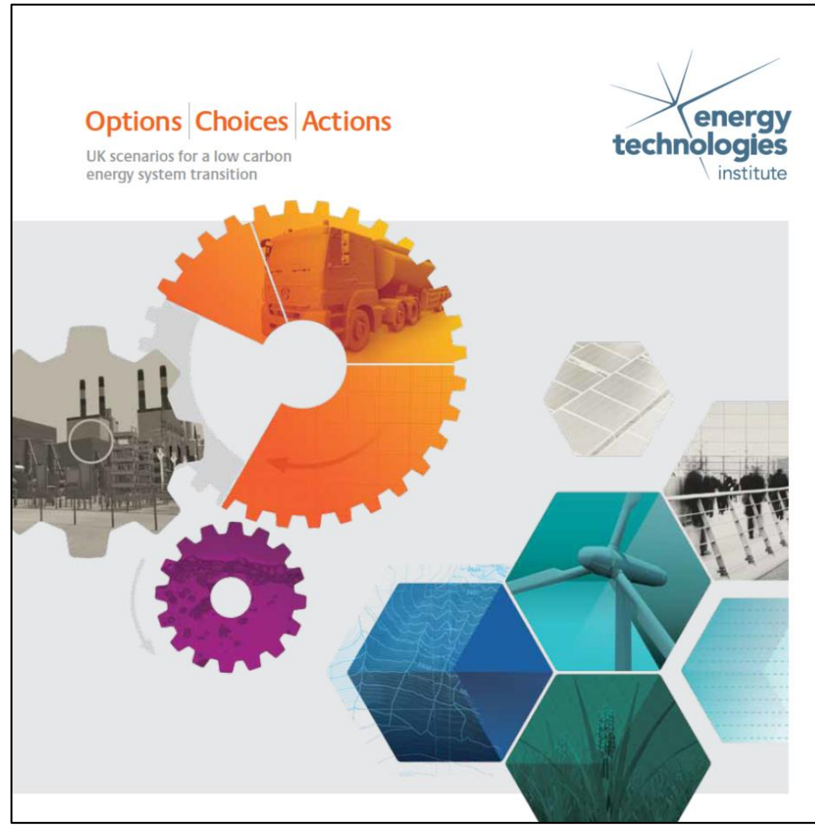
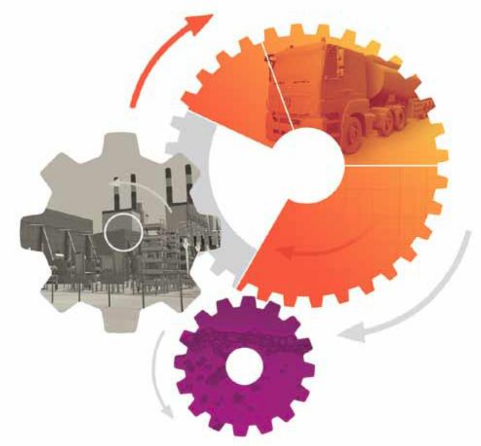
See www.eti.co.uk for more details on our projects

Our scenarios

- Clockwork & Patchwork are scenarios for the whole UK energy system – power, heating, transport, industry & infrastructure
- Bound by Climate Change Act – 80% ghg emissions reduction by 2050
- Building on several years of modelling, analysis and scenario development using ESME – ETI's Energy System Modelling Environment
- Narratives devised in consultation with ETI members and stakeholders: Clockwork is a purist least-cost pathway, Patchwork is am engaging alternative
- Published in March 2015 (link)



CLOCKWORK



Well-coordinated, long term investments allow new energy infrastructure to be installed like clockwork. The regular build of new nuclear, CCS plants and renewables ensures a steady decarbonisation of the power sector. National-level planning enables the deployment of large-scale district heating networks, with the local gas distribution network retiring incrementally from 2040 onwards. By contrast, due to a strong role for emissions offsetting, the transportation system remains in the earlier stages of a transition and people and companies continue to buy and use vehicles in a similar way to today, albeit with regulation and innovation continuing to improve their efficiency.

With central government taking less of a leading role, a patchwork of distinct energy strategies develops at a regional level. Society becomes more actively engaged in decarbonisation, partly by choice and partly in response to higher costs. Popular attention is paid to other social and environmental values, influencing decision-making. There is a more limited role for emissions offsetting, meaning more extensive decarbonisation across all sectors, including transport. Cities and regions compete for central support to meet energy needs which is tailored to local preferences and resources. Over time central government begins to integrate the patchwork of networks to provide national solutions.

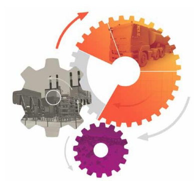
PATCHWORK

INTRODUCING THE

SCENARIOS

For more details and discussion see our booklet on www.eti.co.uk

CLOCKWORK



Institutional Mandate

A national planning approach establishes a framework for energy system decision-making. There is societal acceptance of chosen solutions.

National Scale Infrastructure

A focus is placed on national co-ordination of supply-side generation and shared infrastructure.

Carbon Offsetting

Realising the system-wide value of CCS and biomass in generating negative emissions, provides headroom for other sectors to postpone expensive decarbonisation decisions.

Phased Decarbonisation

Emissions reduction is led by action in the power sector, followed by buildings and finally transport, where regulation drives incremental efficiency improvements in vehicles, including through adoption of plug-in hybrids.

PATCHWORK

Societal Engagement

Alongside decarbonisation, popular concerns over other social and environmental values (including land use and air quality) influence decisions taken on energy system planning at a local level.

Multi-Scale Infrastructure

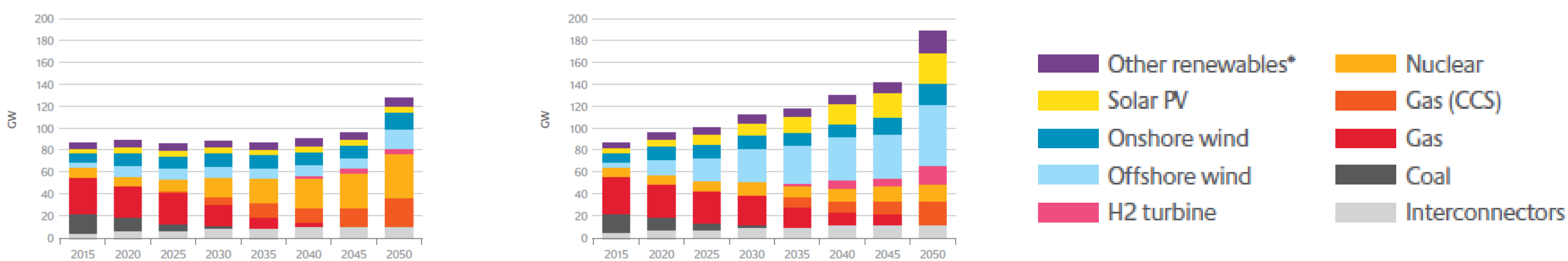
A mixture of national, regional and local approaches continue to deliver a patchwork of low carbon energy infrastructure and supply, with active societal engagement.

Extensive Renewables

A renewables-heavy solution to energy supply is dominated by offshore wind and supported by smaller-scale technologies including the continued growth of solar.

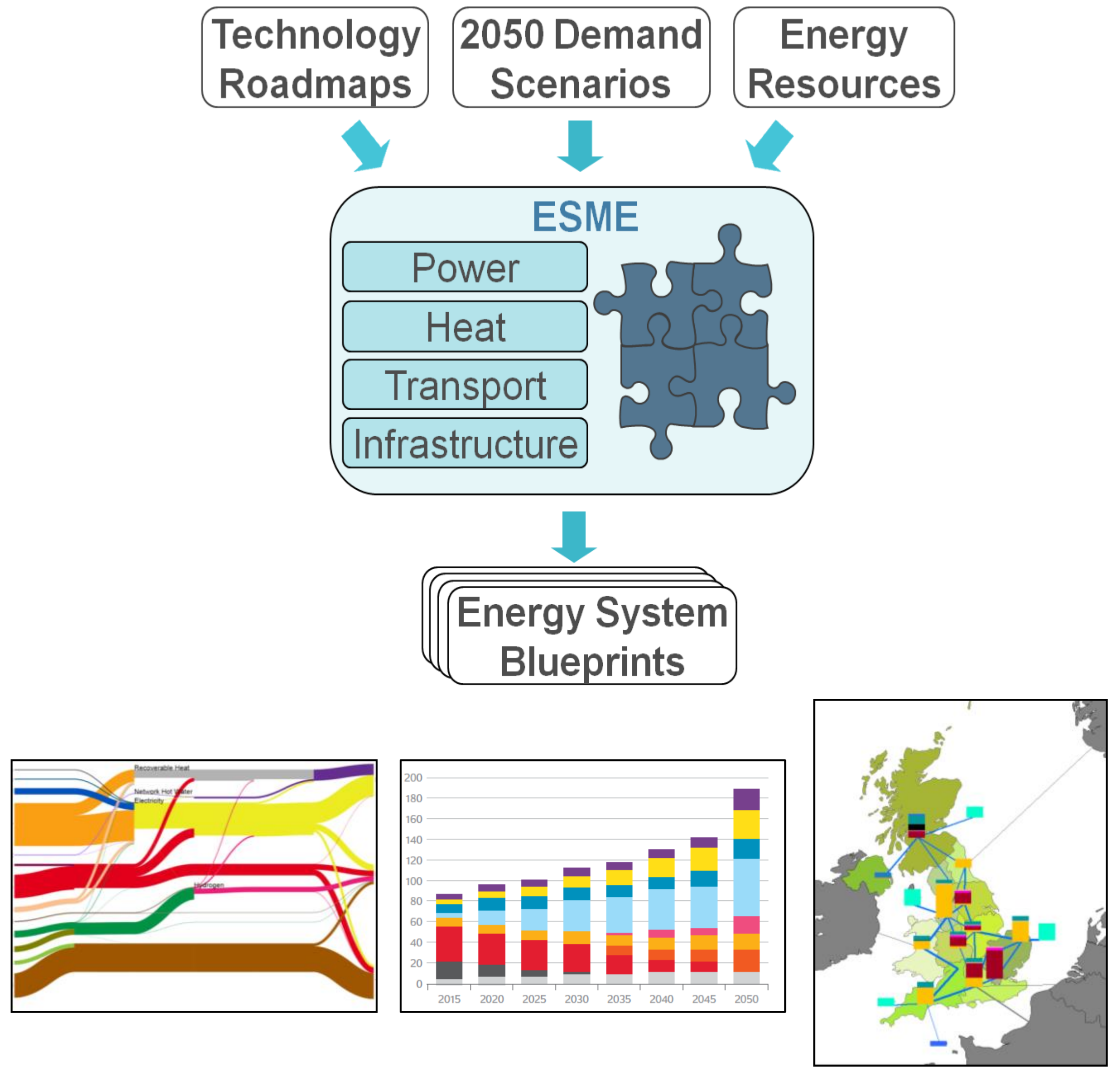
Parallel Decarbonisation

Transformation of the power sector is followed by extensive, parallel abatement action across buildings and transportation, with a substantial uptake of hydrogen fuel cell vehicles and plug-in hybrids.

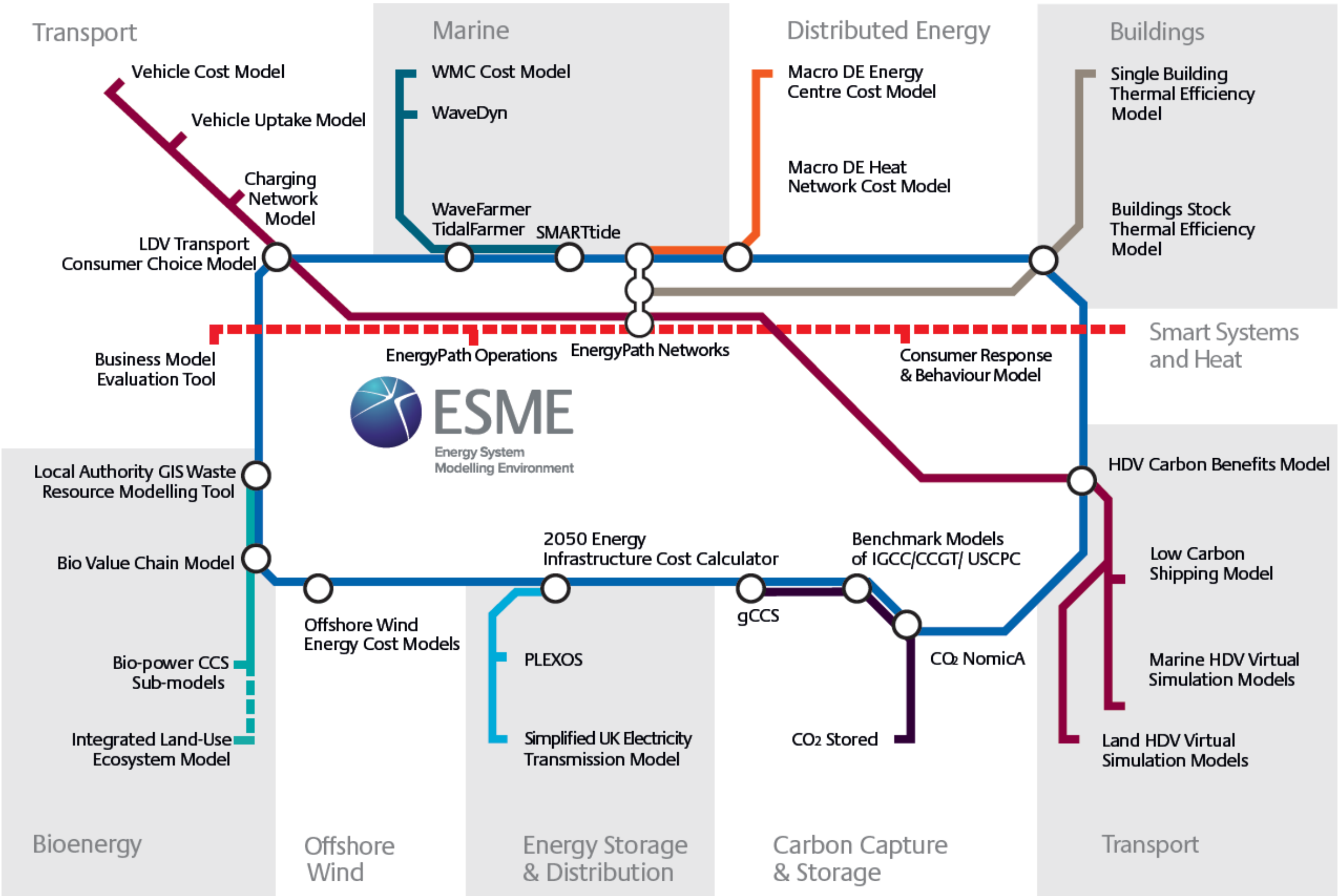


The ESME modelling approach

- Least cost optimisation, policy neutral
- Deployment & utilisation of >250 technologies
- Probabilistic treatment of key uncertainties
- Pathway and supply chain constraints to 2050
- Spatial and temporal resolution sufficient for system engineering



Knowledge from across ETI programme areas is integrated in ESME



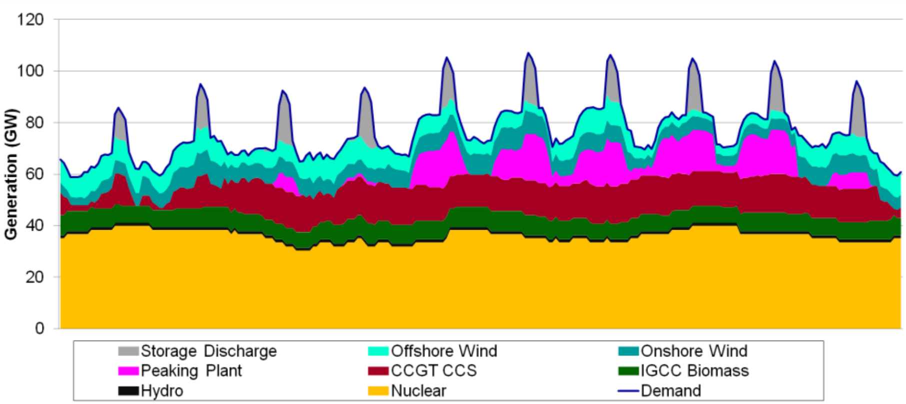
Background ESME modelling

Sensitivity analysis

- Monte Carlo results – ‘no-regret’ options, marginal choices
- 3 future UK demand cases – alternative socio-economic pathways for the UK
- Long list of “No technology X” sensitivities – opportunity cost metric
- Sensitivity to different CO_2 targets
- Sensitivity to improved/accelerated technology development

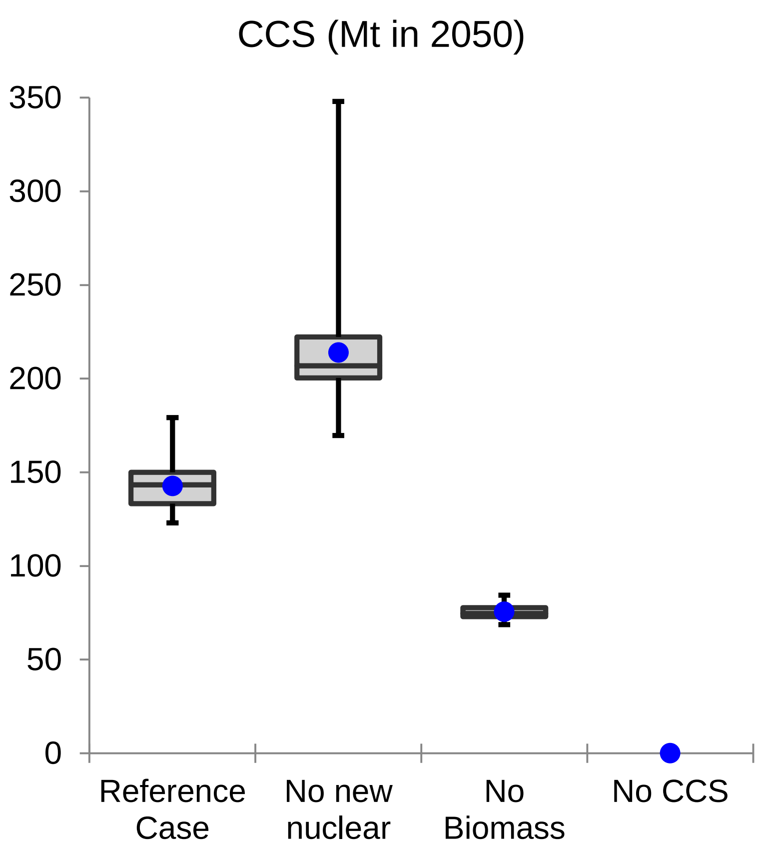
Testing with more detailed tools

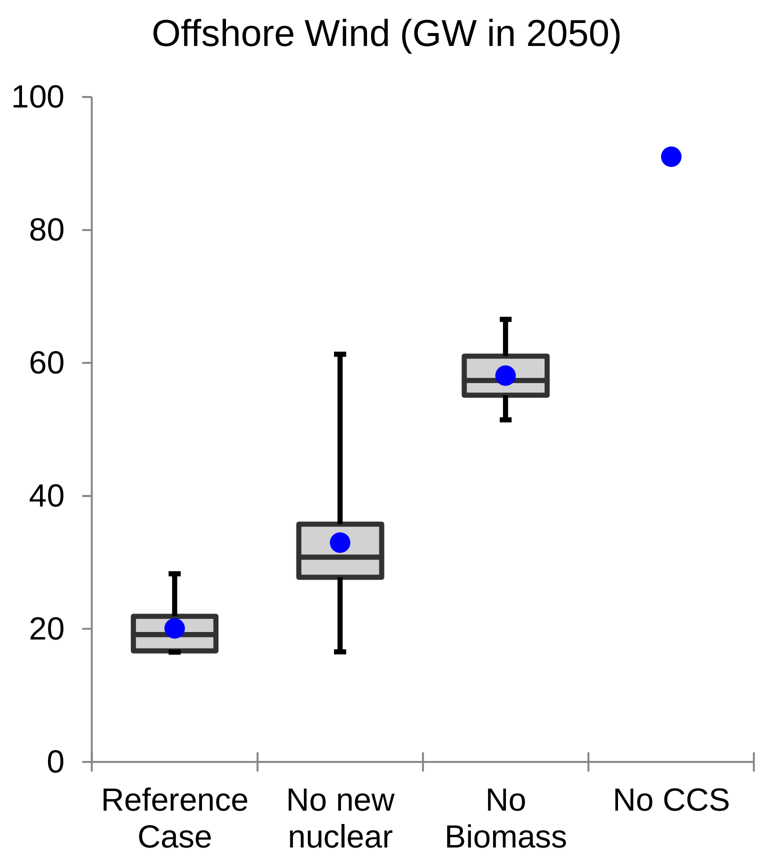
- Dispatch of the ESME electricity system is studied in PLEXOS
- More detailed buildings & heat optimisation
- More detailed peak day optimisation



Technology deployment

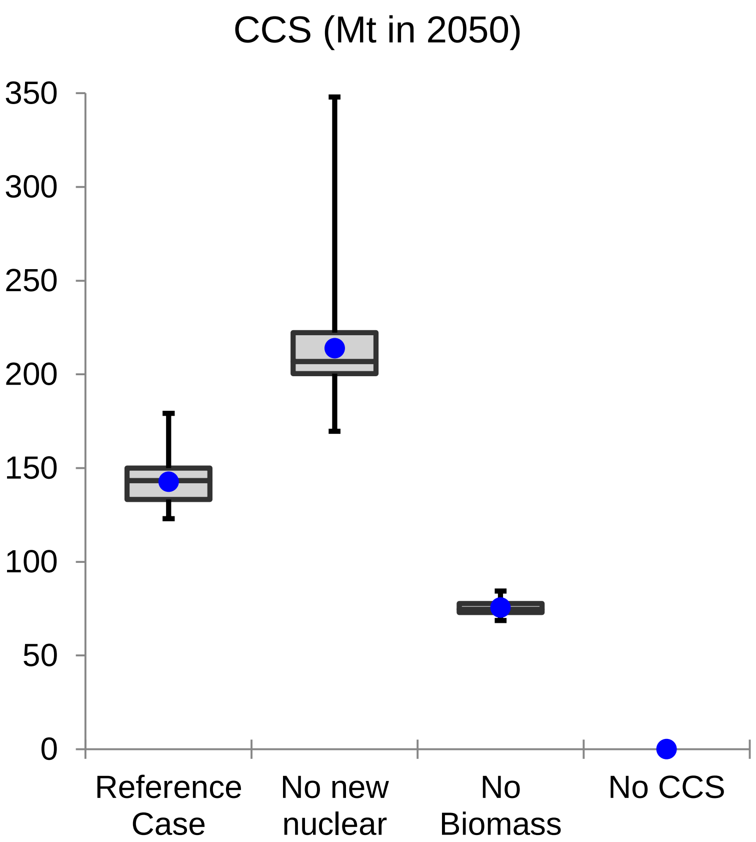
CCS appears a mainstay, offshore wind more variable

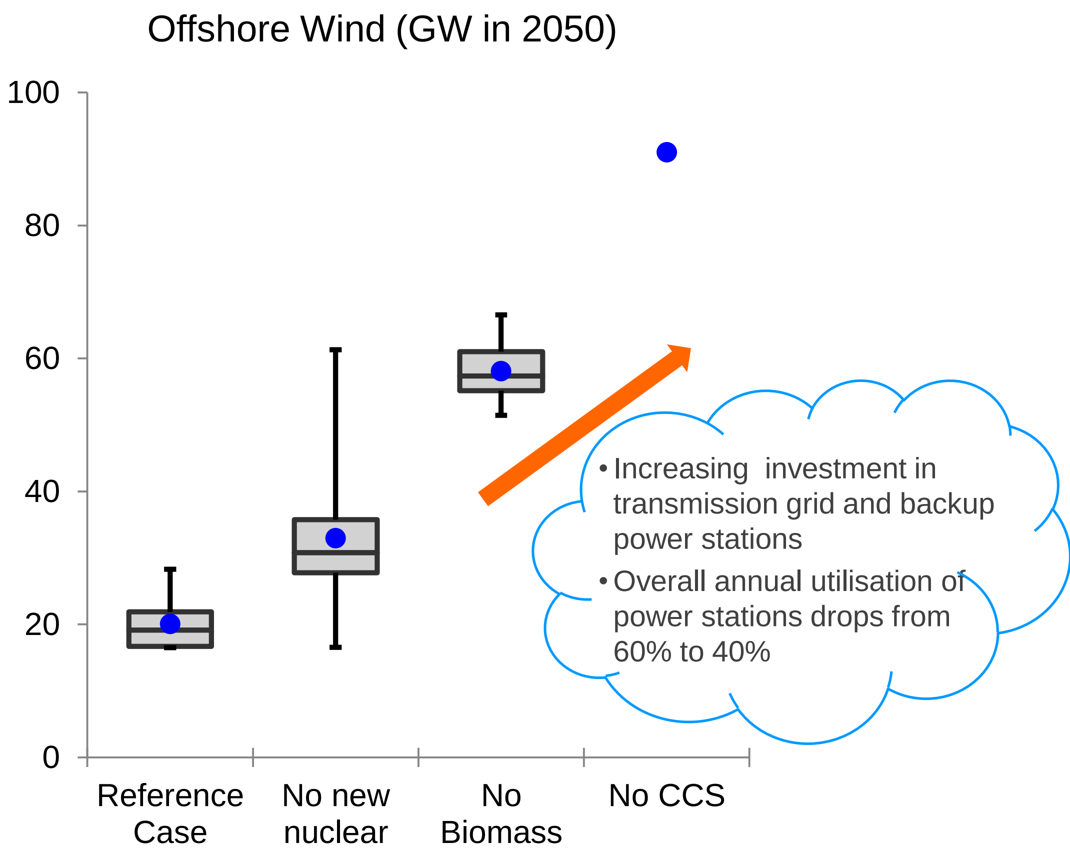




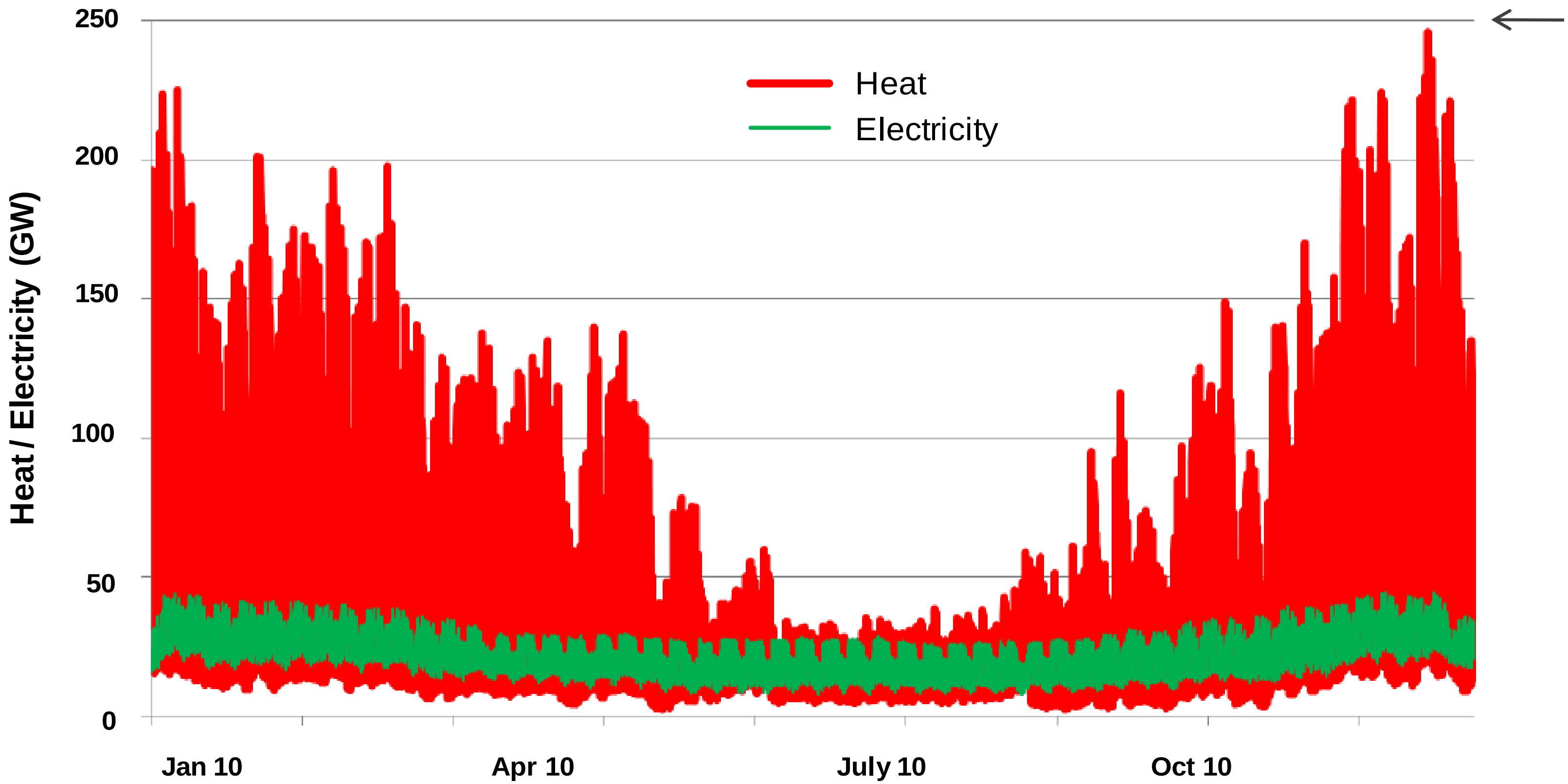
Technology deployment

CCS appears a mainstay, offshore wind more variable



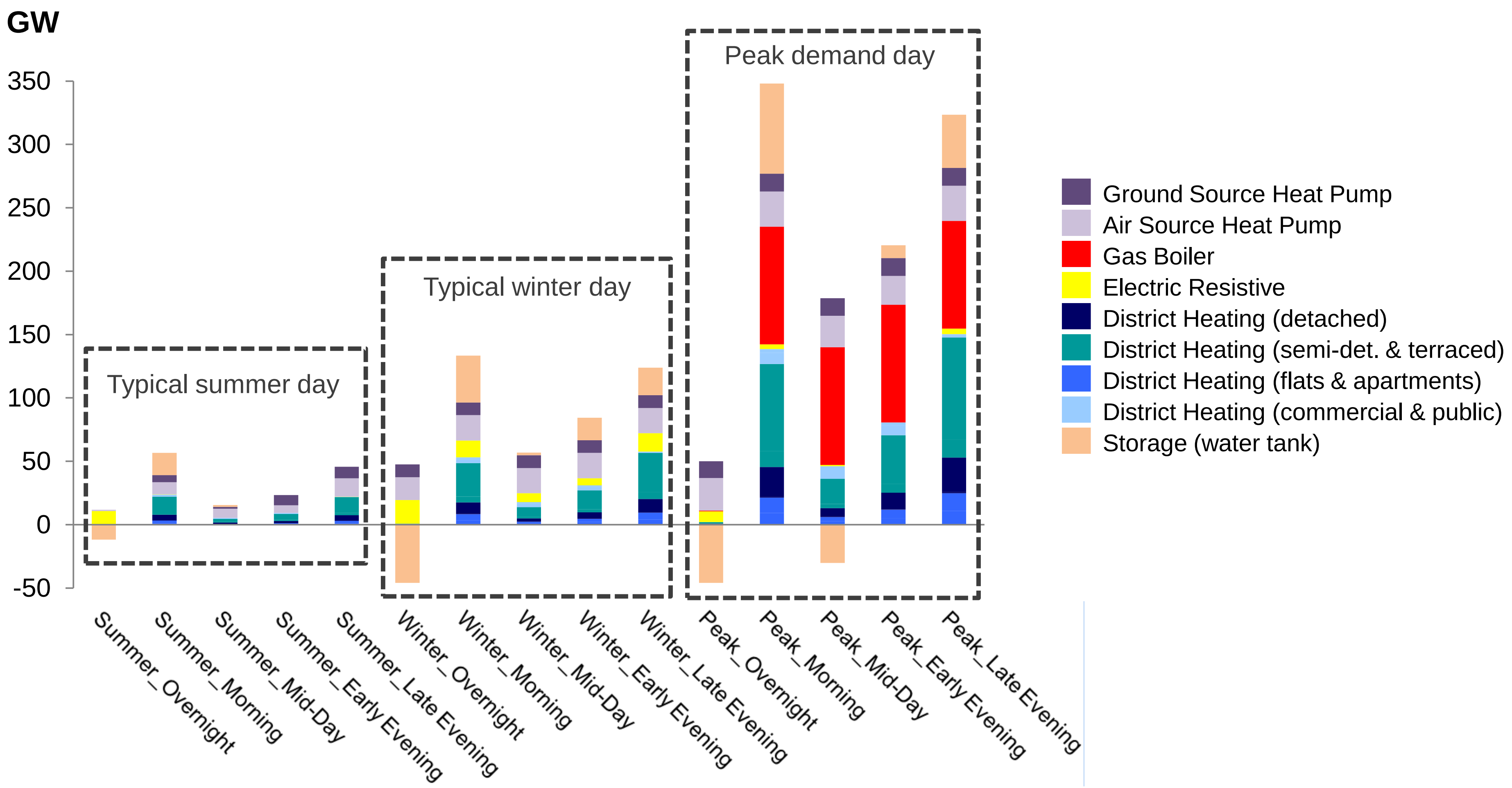


The Challenge of an 'All Electric' scenario



GB 2010 heat and electricity hourly demand variability - commercial & domestic

ESME space heating results: typical vs peak



Executive Summary

1

The UK can achieve an affordable transition to a low carbon energy system over the next 35 years. Our modelling shows abatement costs ranging from 1-2% of GDP by 2050, with potential to achieve the lower end of this range through effective planning

2

The UK must focus on developing and proving a basket of the most promising supply and demand technology options. Developing a basket of options (rather than a single system blueprint) will help to limit inevitable implementation risks

3

Key technology priorities for the UK energy system include: bioenergy, carbon capture and storage, new nuclear, offshore wind, gaseous systems, efficiency of vehicles and efficiency/heat provision for buildings

4

It is critical to focus resources in the next decade on preparing these options for wide-scale deployment. By the mid-2020s crucial decisions must be made regarding infrastructure design for the long-term

5

CCS and bioenergy are especially valuable. The most cost-effective system designs require zero or even "negative" emissions in sectors where decarbonisation is easiest, alleviating pressure in more difficult sectors

6

High levels of intermittent renewables in the power sector and large swings in energy demand can be accommodated at a cost, but this requires a systems level approach to storage technologies, including heat, hydrogen and natural gas in addition to electricity

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