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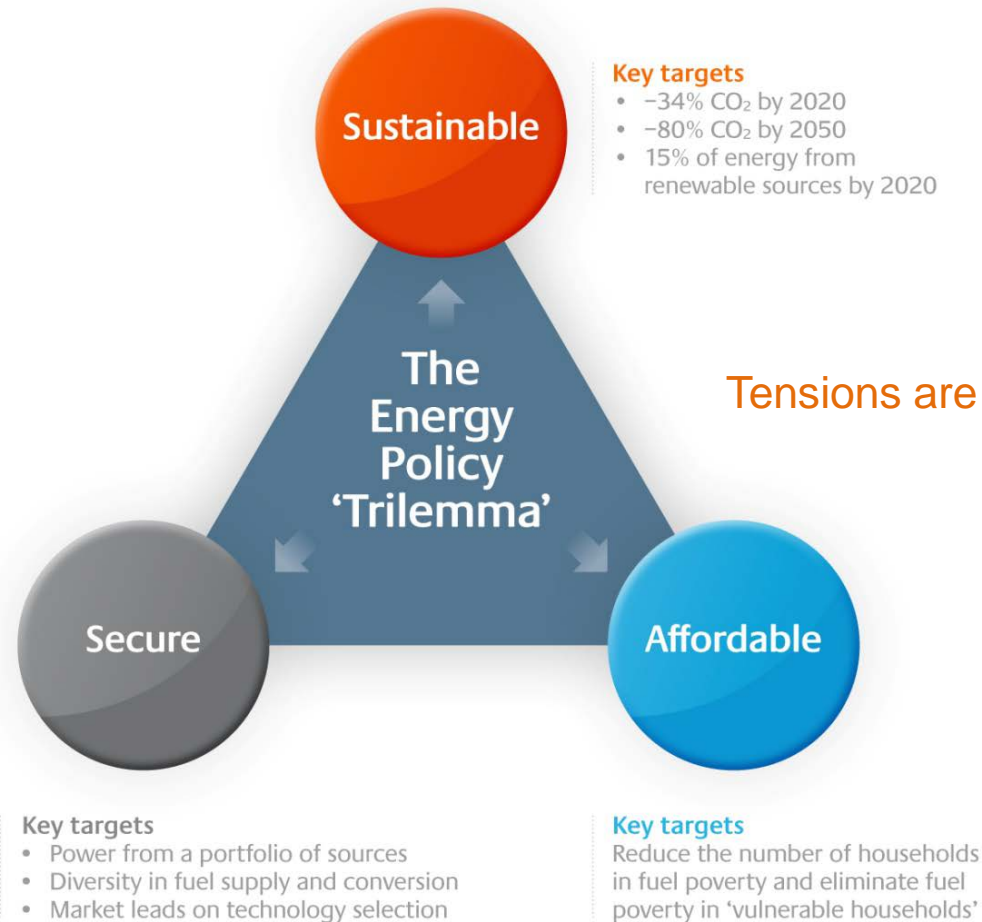
## Options/Choices/Actions on Low Carbon Energy for Local Authorities

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## The UK energy challenge...





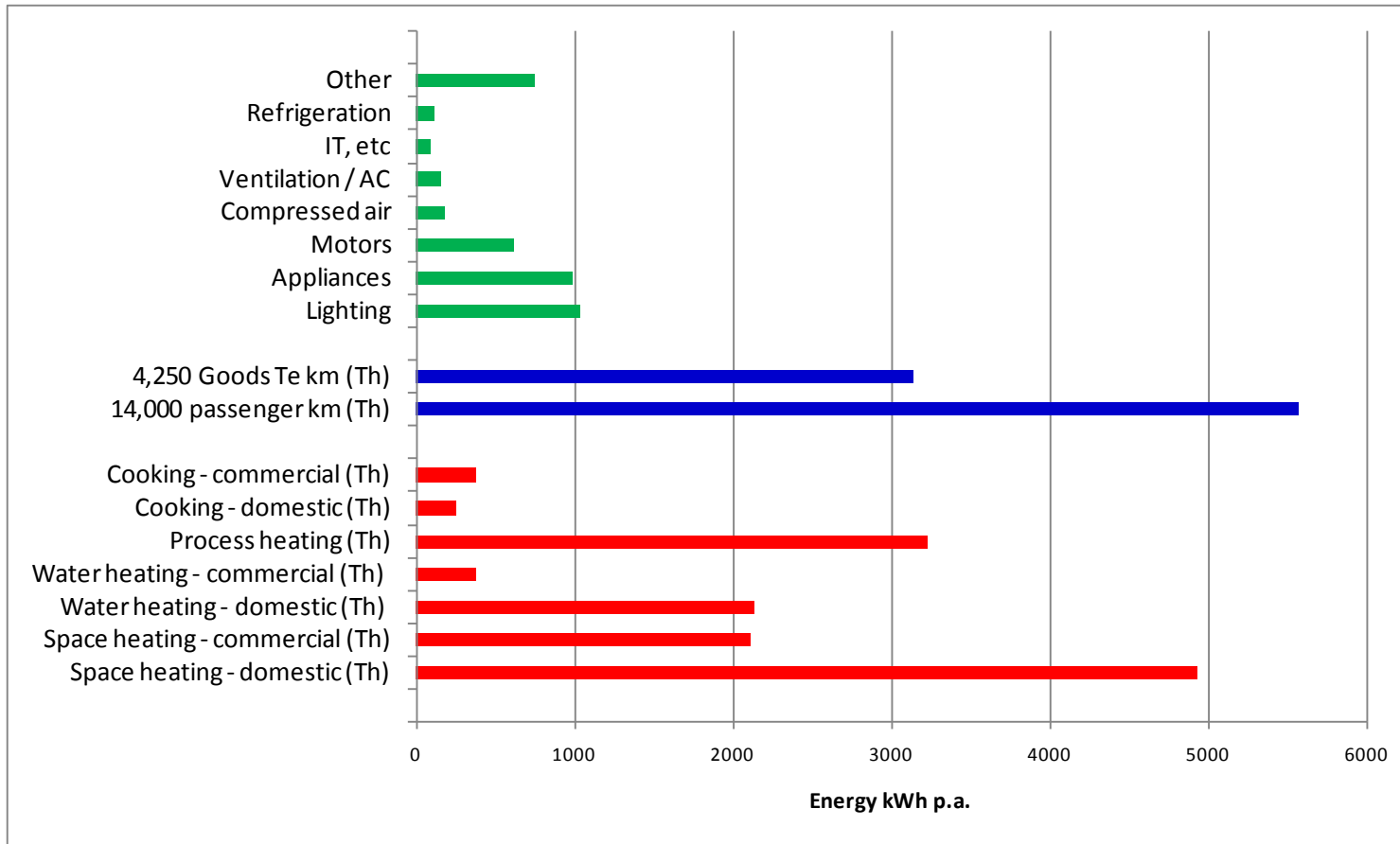
## The UK energy challenge...

Demand is growing, assets are aging, prices are rising... irrespective of a CO<sub>2</sub> reduction target

- 62m people ..... growing to 77m by 2050
- 24m cars ..... growing to 40m by 2050
- 24m domestic dwellings ..... 80% will still be in use in 2050  
total dwellings 38m by 2050
- **Final users spent £124bn on energy in 2010 .... 9% of GDP**
- 2.4m English households in fuel poverty ..... average 'fuel poverty gap' £438  
and increasing
- Over 90GW generation capacity ..... from 1MW to 3.9GW
- Over 200 'significant' power stations ..... average age >20 years
- 50% of power generation capacity ..... in 30 power plants  
average age 30 years



## Individual energy consumption in the UK\* ...

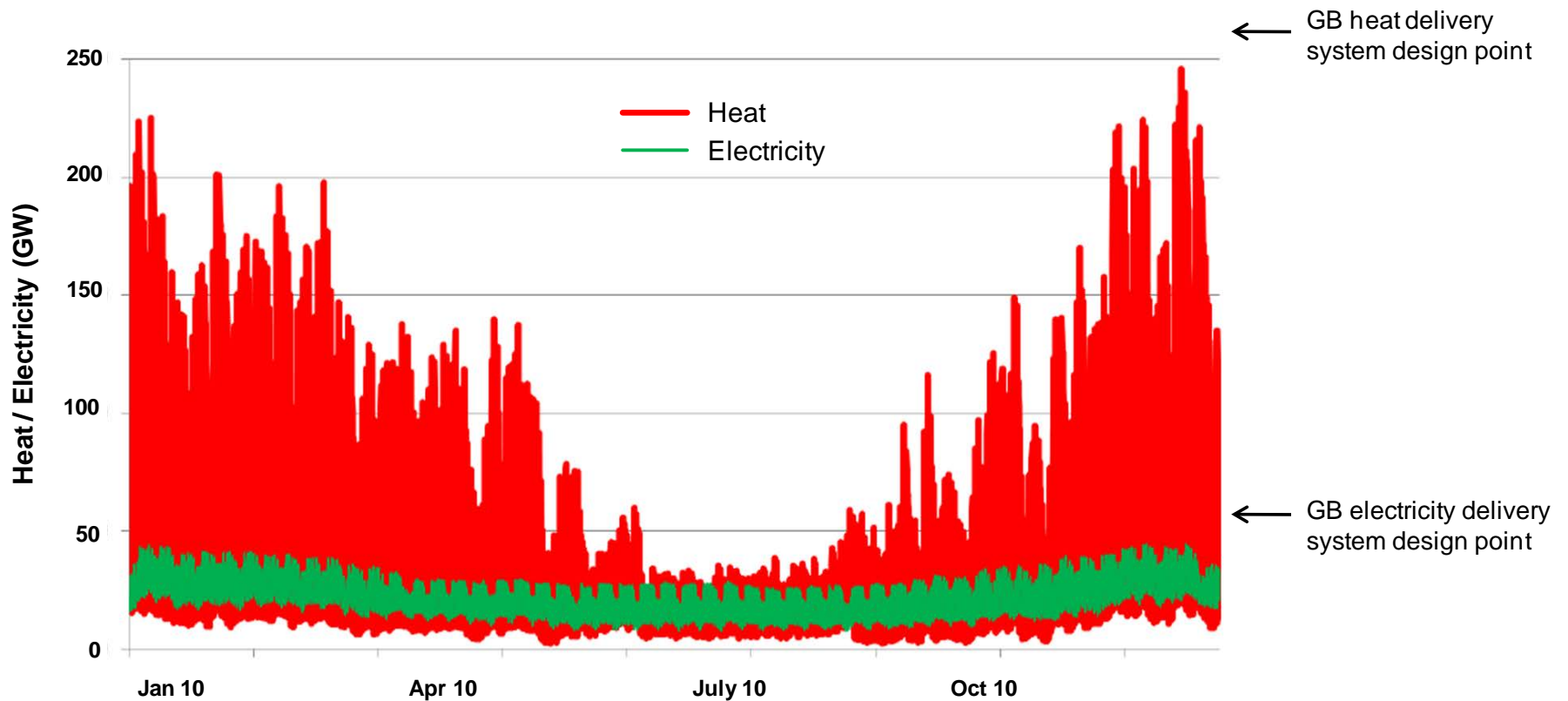


\* 2010 UK consumption divided by 60M (people in the UK)

Notes: 1. Passenger transport figure excludes international air travel  
2. Data excludes heavy industry



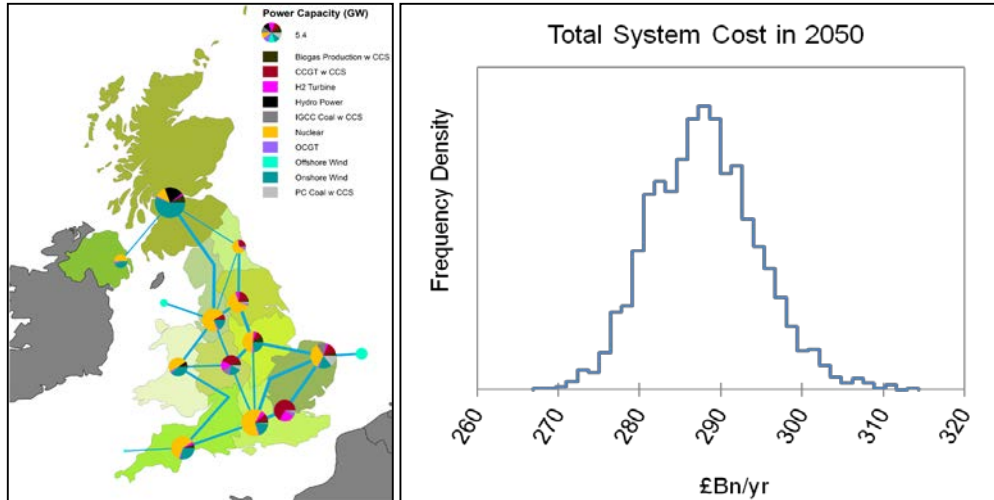
## GB heat and electricity demand variability (commercial & domestic - 2010)



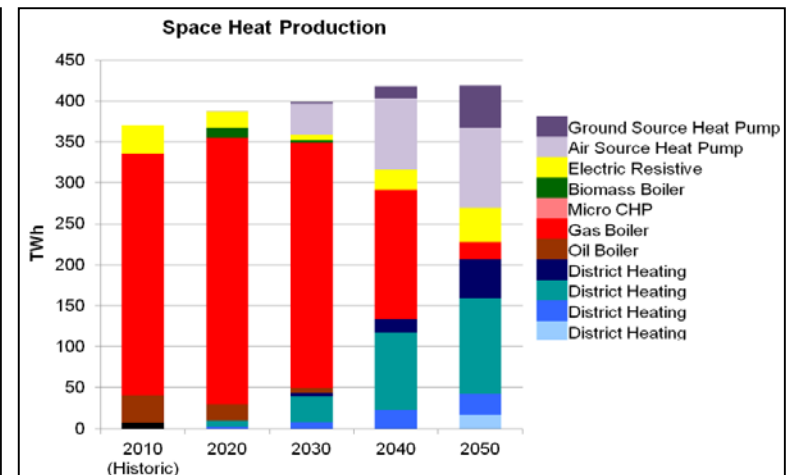
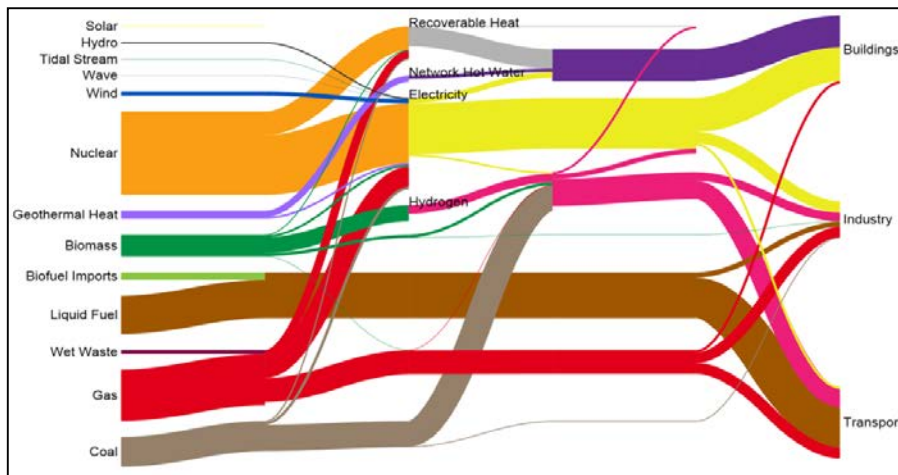
Source: UKERC (2011)



# ESME – ETI’s system design tool...

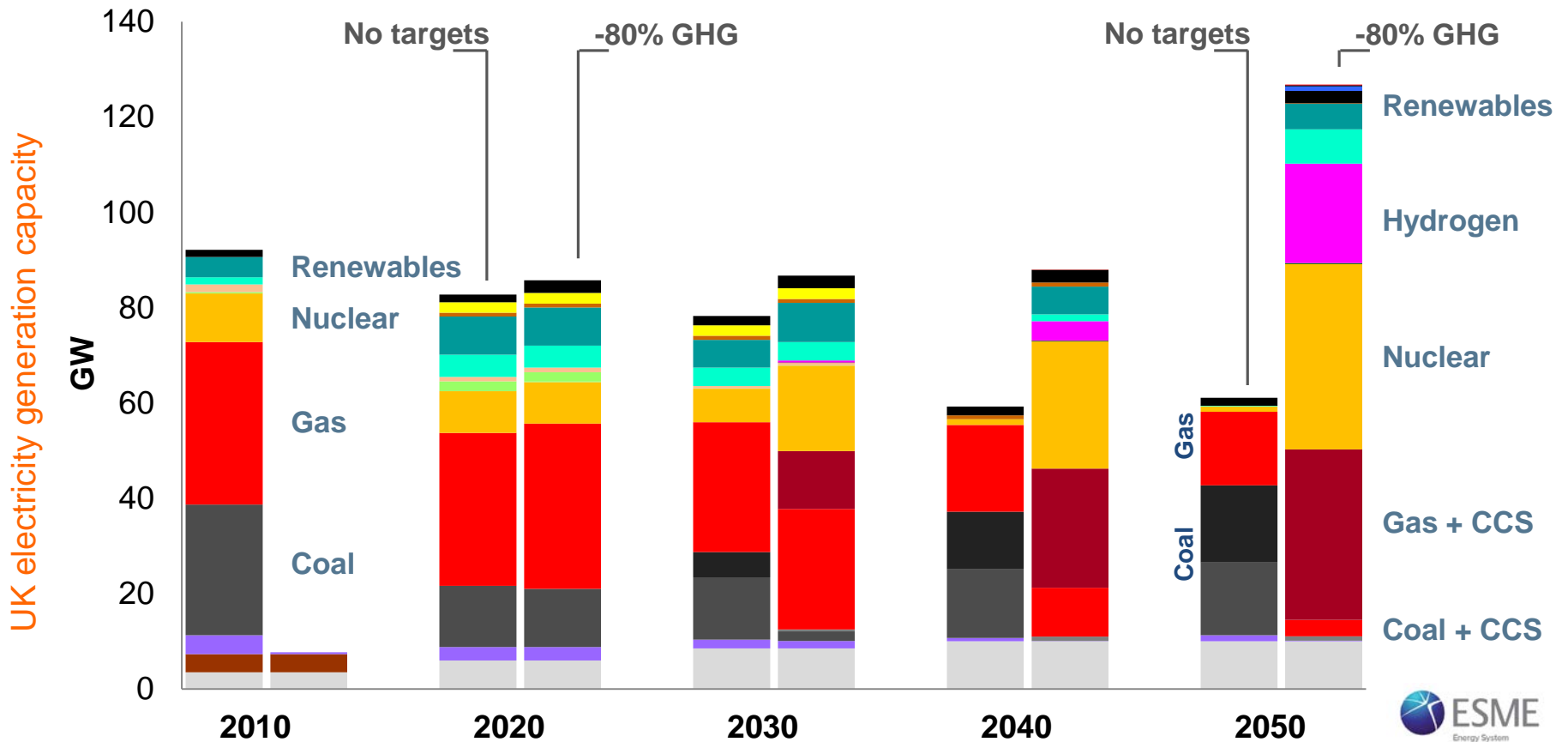


Energy  
System  
Modelling  
Environment



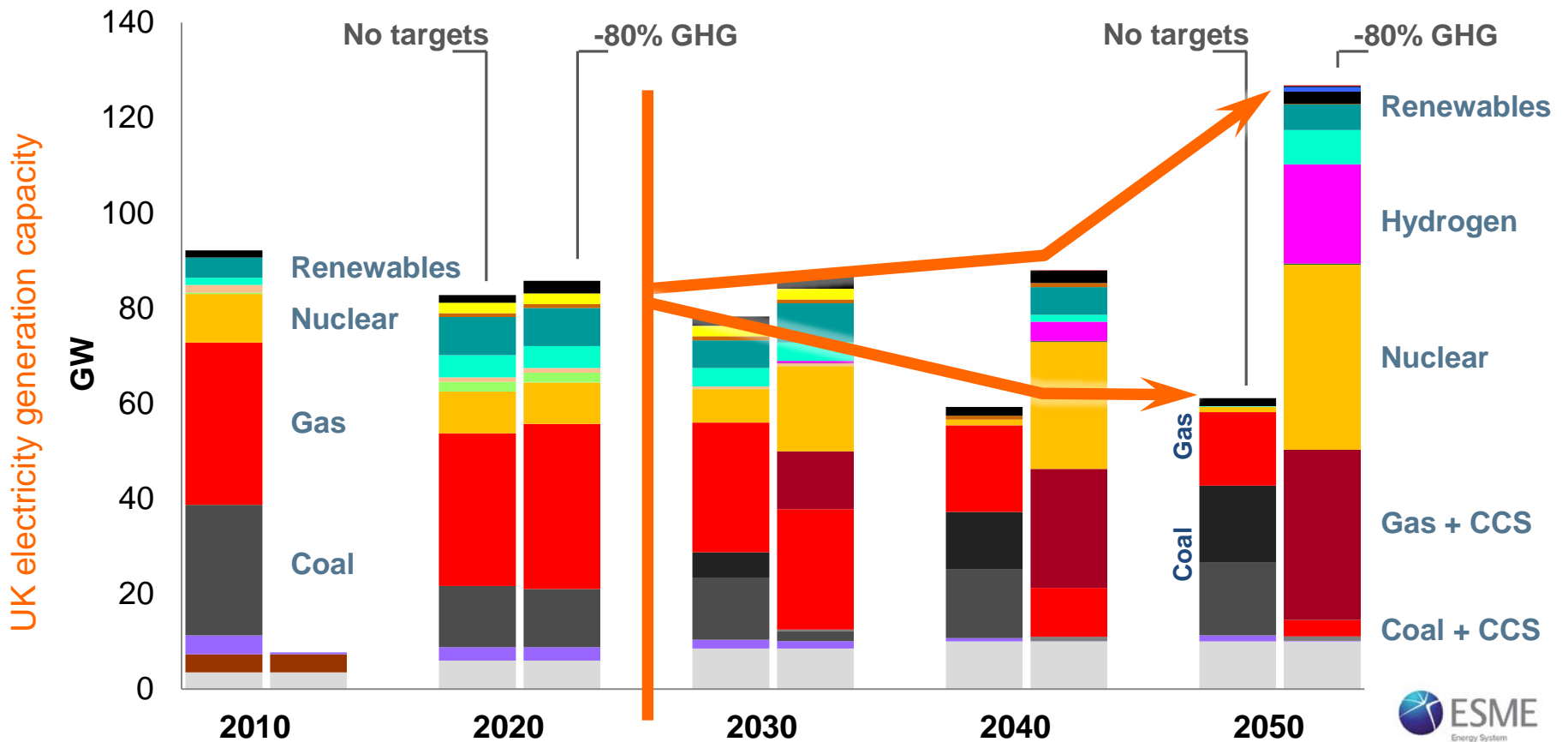


# “No emissions targets” and “-80% GHG in 2050” are very different worlds...





As long as we prepare NOW, decisions on 2050 can wait...  
but not for long



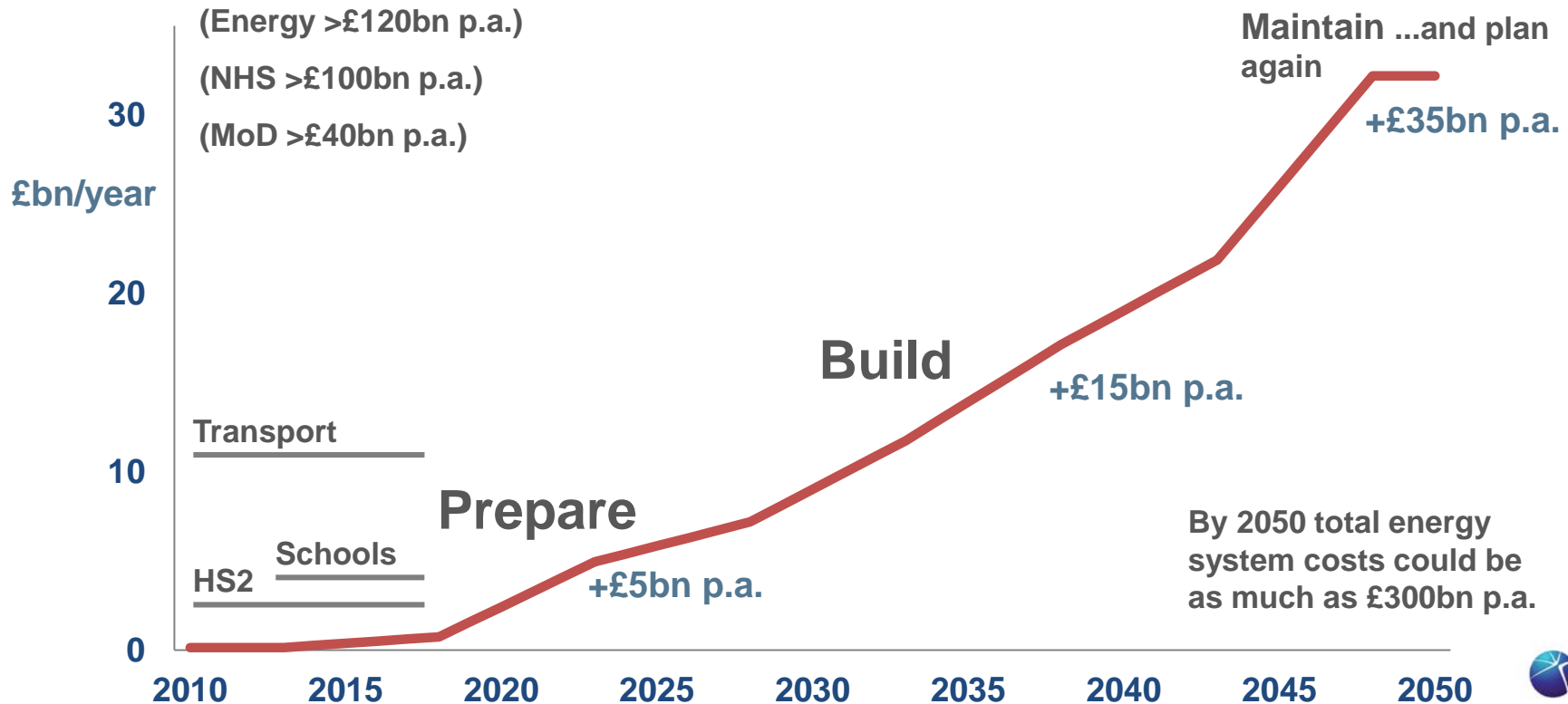




# Prepare over next 10 years

creating platform for infrastructure roll-out and growth

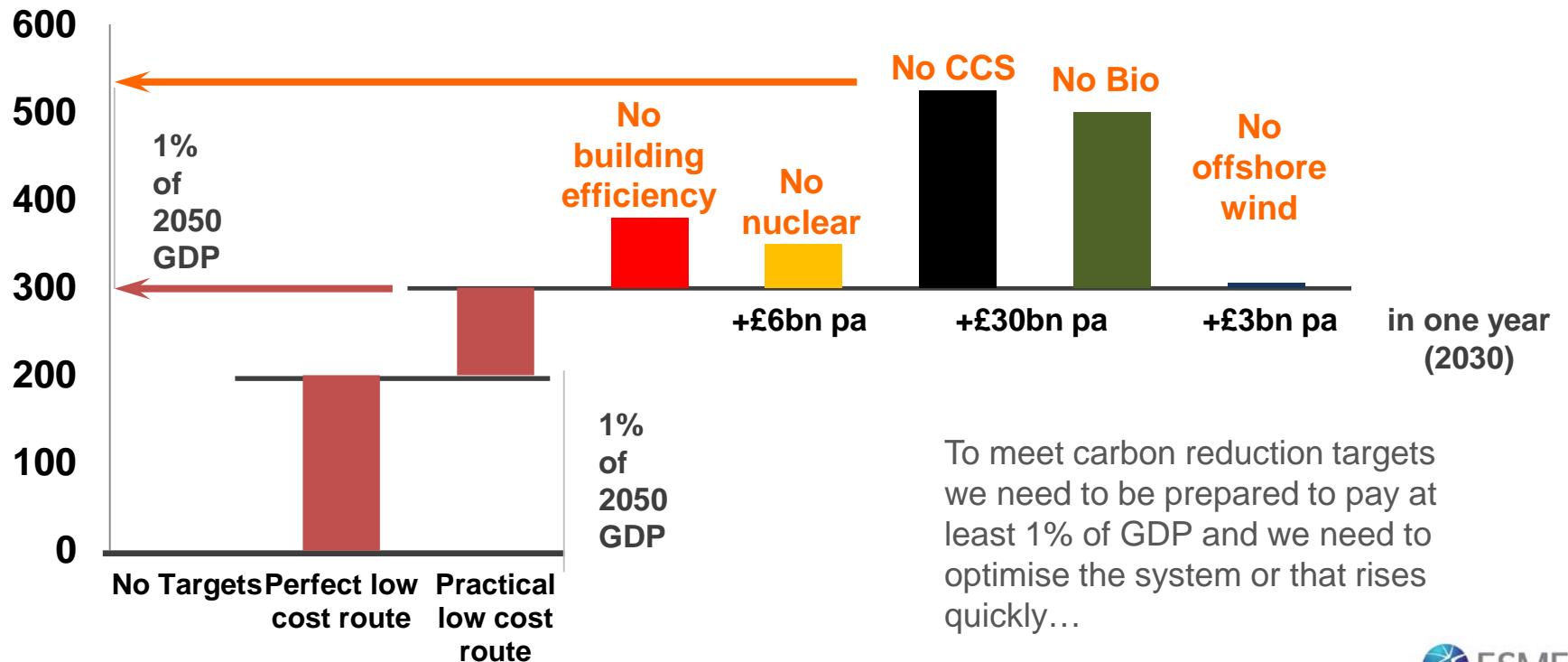
Incremental capital investment in a 'low-carbon' energy infrastructure





# Poor system optimisation doubles the cost of a 2050 UK low carbon energy system

Additional cost of delivering -80% GHG energy system  
NPV £ bn 2010-2050



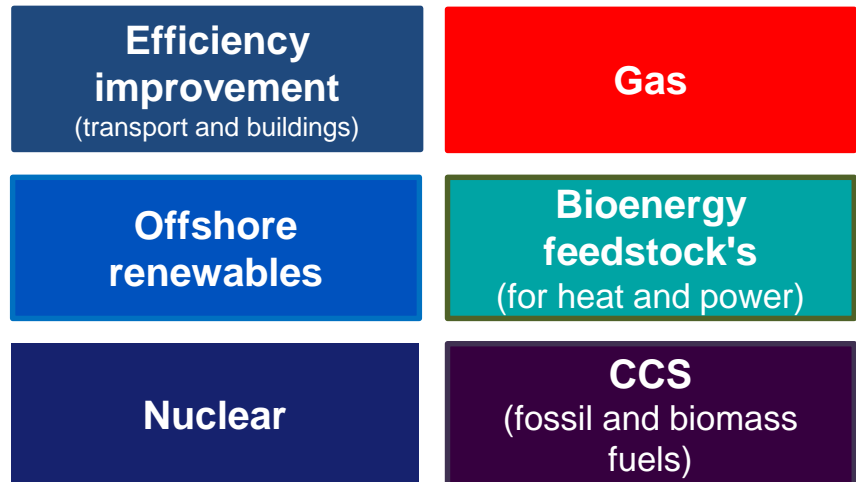


## Key decisions and cost implications

- Direction change between “no targets” and “-80% CO<sub>2</sub>” polarises in mid 2020s
- Key electricity decisions are national policy led programmes
  - **Nuclear new build**
  - **CCS**
- plus... local and individual consumer decisions on other critical areas - with major implications for distribution level infrastructure
  - **Heat delivery**  
(gas, electricity, biomass, district heating)
  - **Transport**  
(liquid fuels, electricity, hydrogen)

**Delay** in launch of major build programmes beyond mid 2020s **leads to cost increases of ~£5bn p.a.** as more costly alternatives are built

There are logical asset replacements (technically and financially) that ensure security, sustainability and lowest system cost



all “no regrets” choices for the next 10 years



## What we need...

- Understanding of the drivers on future development
  - Costs
  - Supply capability and capacity (in a global market)
  - Infrastructure decisions
  - Investor requirements
  - Consumer needs/desires
- Clear market and value opportunities for investors and consumers
- Supportive and stable policy
- Consumer support

But... the future remains uncertain and we need an energy system design that allows for this

- Ready to make informed choices
- A system that creates and retains optionality
- Prepared for investment in a wide scale infrastructure roll-out
- Innovate to drive down cost (technology and business models)
- We need innovative incentives for industry to invest in the UK



## INTRODUCING THE **SCENARIOS**

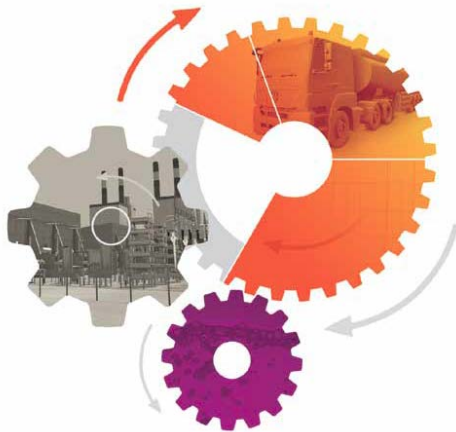
- UK energy system – power, heating, transport, industry & infrastructure
- Bound by Climate Change Act – 80% emissions reduction by 2050
- Building on several years of modelling, analysis and scenario development using ESME
- Devised in consultation with ETI members and stakeholders
- Launched on 4<sup>th</sup> March 2015





## INTRODUCING THE **SCENARIOS**

# CLOCKWORK

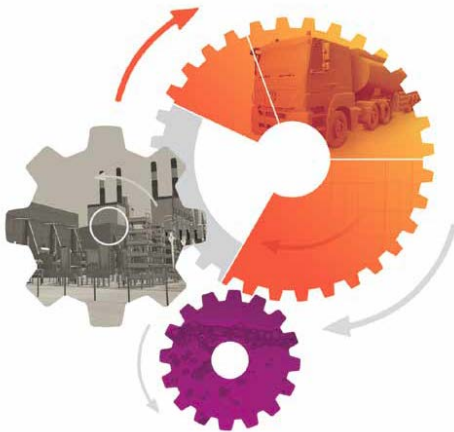


- Well-coordinated, long-term investments allow new energy infrastructure to be installed like clockwork.
- The regular build of new nuclear, CCS plants and renewables ensures a steady decarbonisation of the power sector.
- National-level planning enables the deployment of large-scale district heating networks, with the local gas distribution network retiring incrementally from 2040 onwards.
- A strong role for emissions offsetting means that 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.



## INTRODUCING THE **SCENARIOS**

# 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.



## INTRODUCING THE **SCENARIOS**

- 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**

### **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**

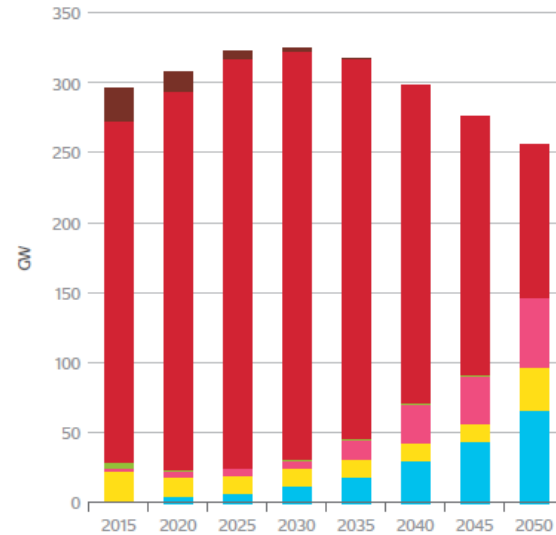
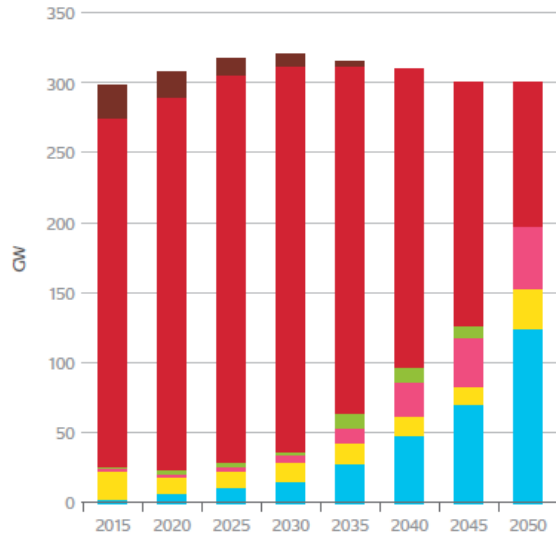
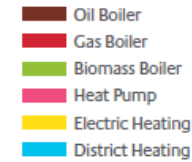
Transformation of the power sector is followed by extensive, parallel abatement action across buildings and transportation, with a substantial uptake of hydrogen fuel cell vehicles and plug-in hybrids.

# PATCHWORK





# SPACE HEAT CAPACITY



## CLOCKWORK

- » Thanks to ongoing efficiency improvements in heat supply technologies, and in building fabric, total heat capacity remains fairly constant despite increasing numbers (and temperatures) of homes
- » District heating rises steadily to provide >40% of peak capacity
- » Biomass boilers play a transitional role, particularly in replacing oil boilers
- » The heat pump market steadily grows to provide around 50GW capacity
- » Gas boilers remain an important part of the energy system in 2050, but are relegated to back up capacity (in parallel with decreasing coverage of the local gas distribution grid)

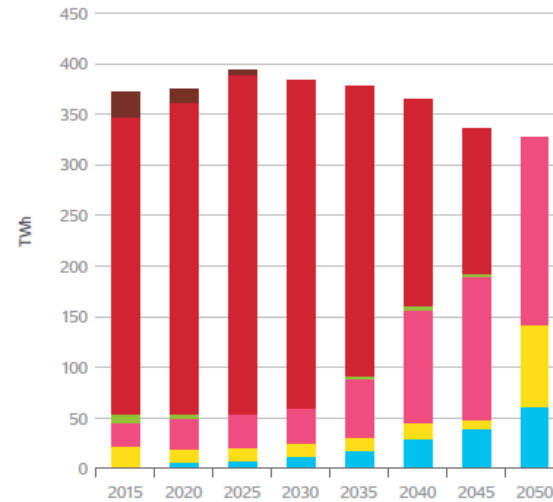
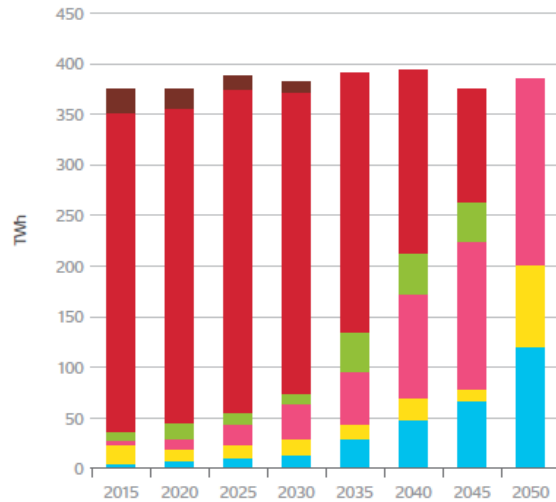
## PATCHWORK

- » Greater urbanisation and improved building fabric along with technology innovation and changing expectations around indoor temperatures all lead to a reduction in peak heat capacity despite a rising population
- » District heating plays a more modest role in patchwork, although still substantially higher than today
- » Heat pumps grow to around 50GW of peak capacity by 2050
- » The local gas distribution network is decommissioned in some regions, but at a national level, gas boilers remain an important part of the heat capacity mix



# SPACE HEAT GENERATION

- Oil Boiler
- Gas Boiler
- Biomass Boiler
- Heat Pump
- Electric Heating
- District Heating



## CLOCKWORK

- » The operation of the heat supply technologies reveals a more profound transformation than capacity figures would suggest
- » With gas relegated to a backup role, the zero carbon technologies dominate heat generation by 2050
- » Although heat pump capacity is much lower than district heating, they are run throughout the day (for maximum effectiveness) meaning their contribution to heat supply is much greater

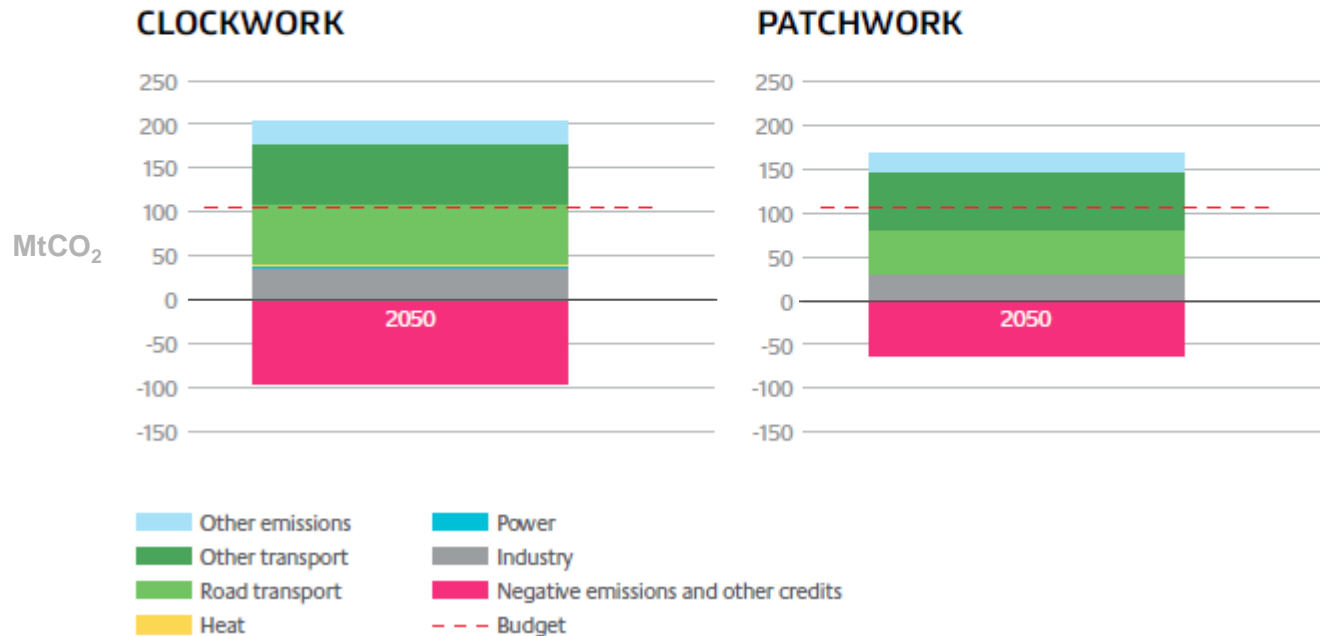
## PATCHWORK

- » Patchwork experiences a drop in space heat demand from 2025 due to the levelling off of indoor temperatures and the retrofit of selective parts of the housing stock
- » With a smaller contribution from district heating, heat pumps provide the majority of heat output by 2050
- » Electric resistive heating becomes a significant provider of heat generation, particularly to top up heat supply in households with modestly sized heat pumps



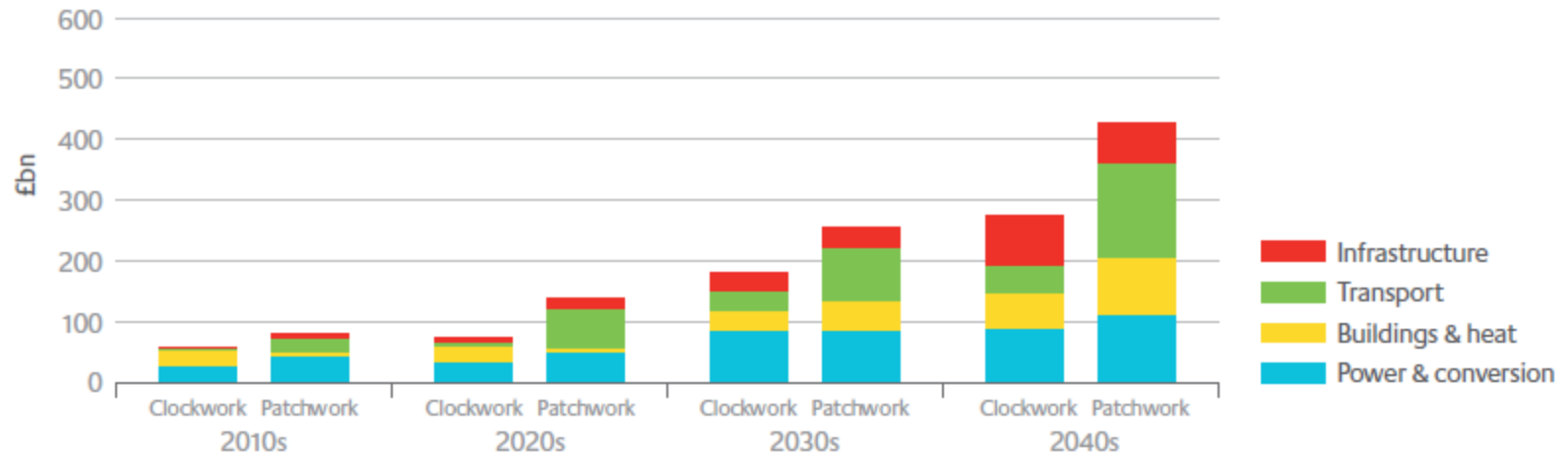
## Comparison of Emissions by Sector

Both scenarios have a 2050 net CO<sub>2</sub> budget of 105Mt. By combining biomass and CCS at greater scale, Clockwork benefits from an additional 30Mt of negative emissions compared to Patchwork. The extra headroom in Clockwork helps to avoid more expensive abatement action such as curbing liquid fuel use in transport.





## Additional capital expenditure required (per decade) to meet targets





## Key Messages from the Scenarios

# 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



## Key Messages from the Scenarios

# 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



# Accelerating Low Carbon Energy Innovation In The UK

The UK needs innovation to help it meet its carbon targets



Successful innovation has several critical components: market confidence, finance, public policy and the capability to innovate

Collaboration and shared understanding is required to help the innovation process



Involving interactions across science, business and government to facilitate knowledge transfer and learning

It is easier to achieve a transition with a shared understanding of the drivers of new low carbon energy technologies



Most low carbon markets are almost entirely driven by public policy but delivered by private sector firms.



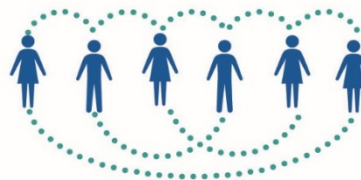
Policy interventions are required to drive innovation in energy and low carbon



business needs certainty so policy stability matters

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Successful innovation systems often involve open and iterative processes, which are complex



They depend on multiple interactions between different actors

Successful innovation in low carbon energy requires new technology capabilities, new markets, new business models together with appropriate changes to the regulatory framework



The slower the pace of energy innovation



the less time the UK will have to transition to a low carbon economy and the more expensive it will be to do so







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