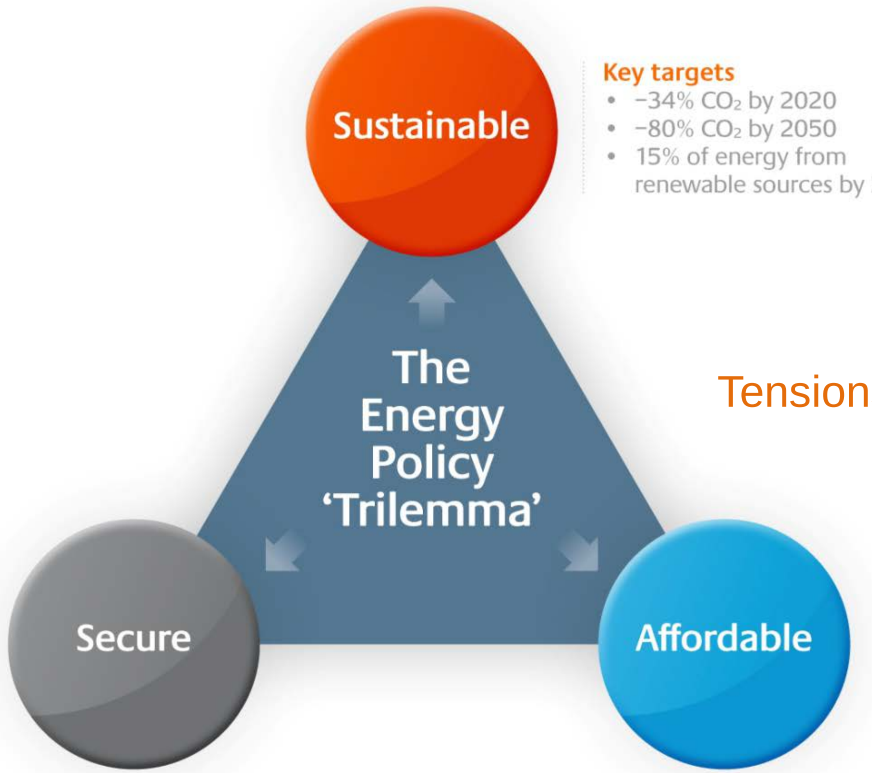
www.eti.co.uk

Transitions to a Low Carbon Energy System

Mike Colechin

The UK energy challenge...



Key targets
- −34% CO_2 by 2020
- −80% CO_2 by 2050
- 15% of energy from renewable sources by 2020

Tensions are increasing...

Key targets
- Power from a portfolio of sources
- Diversity in fuel supply and conversion
- Market leads on technology selection

Key targets
Reduce the number of households in fuel poverty and eliminate fuel poverty in 'vulnerable households'

The UK energy challenge...

Demand is growing, assets are aging, prices are rising... irrespective of a CO_2 reduction target

- 62m people .... growing to 77m by 2050
- 24m cars .... growing to 40m by 2050
- 24m domestic dwellings .... 90% 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 .... and average 'fuel poverty gap' £438 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

What is the ETI?

- The ETI is a public-private partnership between global energy and engineering companies and the UK Government.
- Targeted development, demonstration and de-risking of new technologies for affordable and secure energy
- Shared risk

ETI members

bp

CATERPILLAR

EDF ENERGY

Rolls-Royce

Shell

Department for Business, Energy & Industrial Strategy

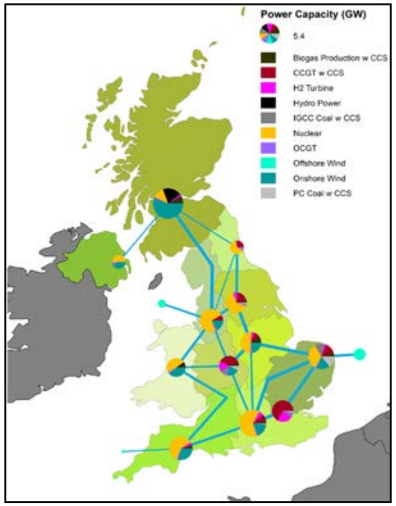
EPSRC Pioneering research and skills

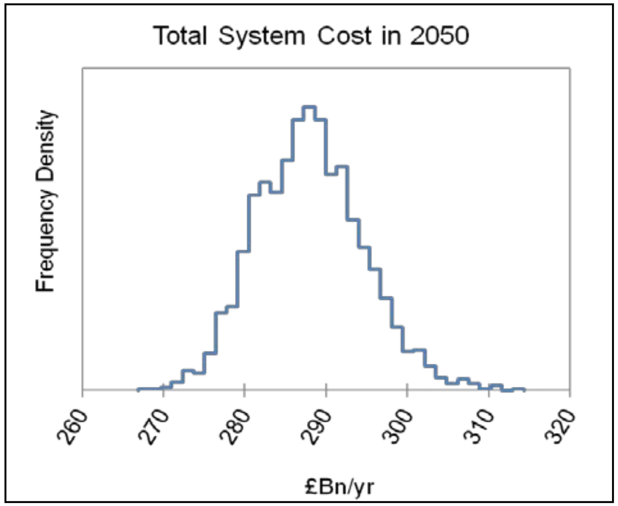
Innovate UK

ETI programme associate

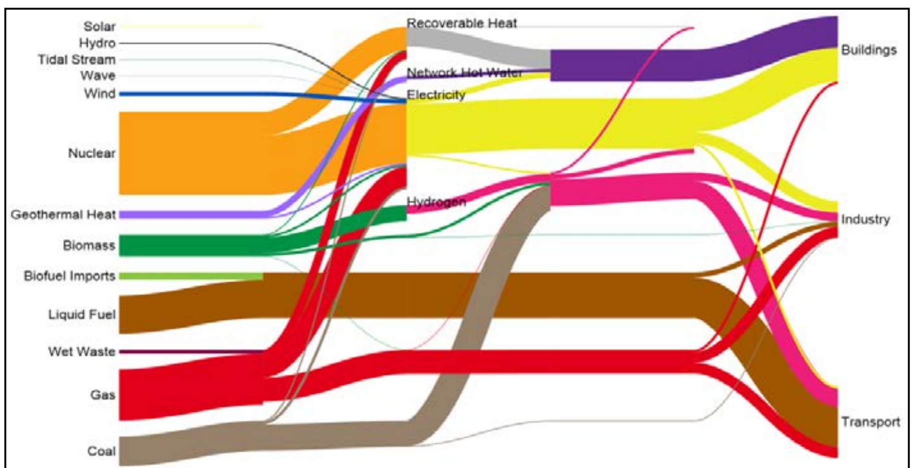
HITACHI Inspire the Next

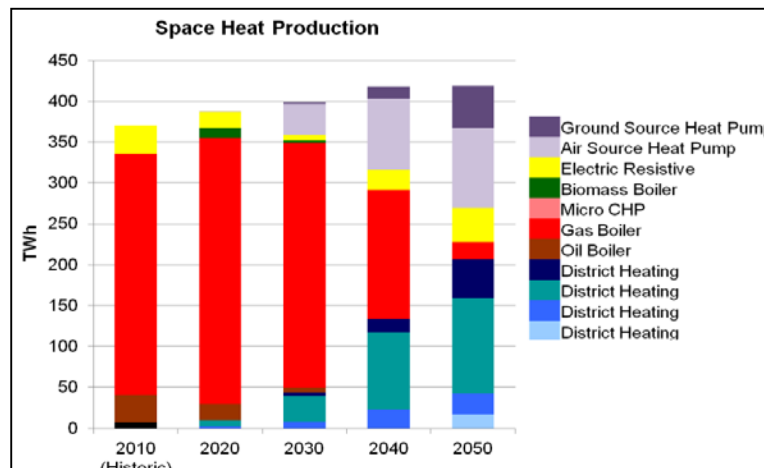
ESME – ETI's system design tool...



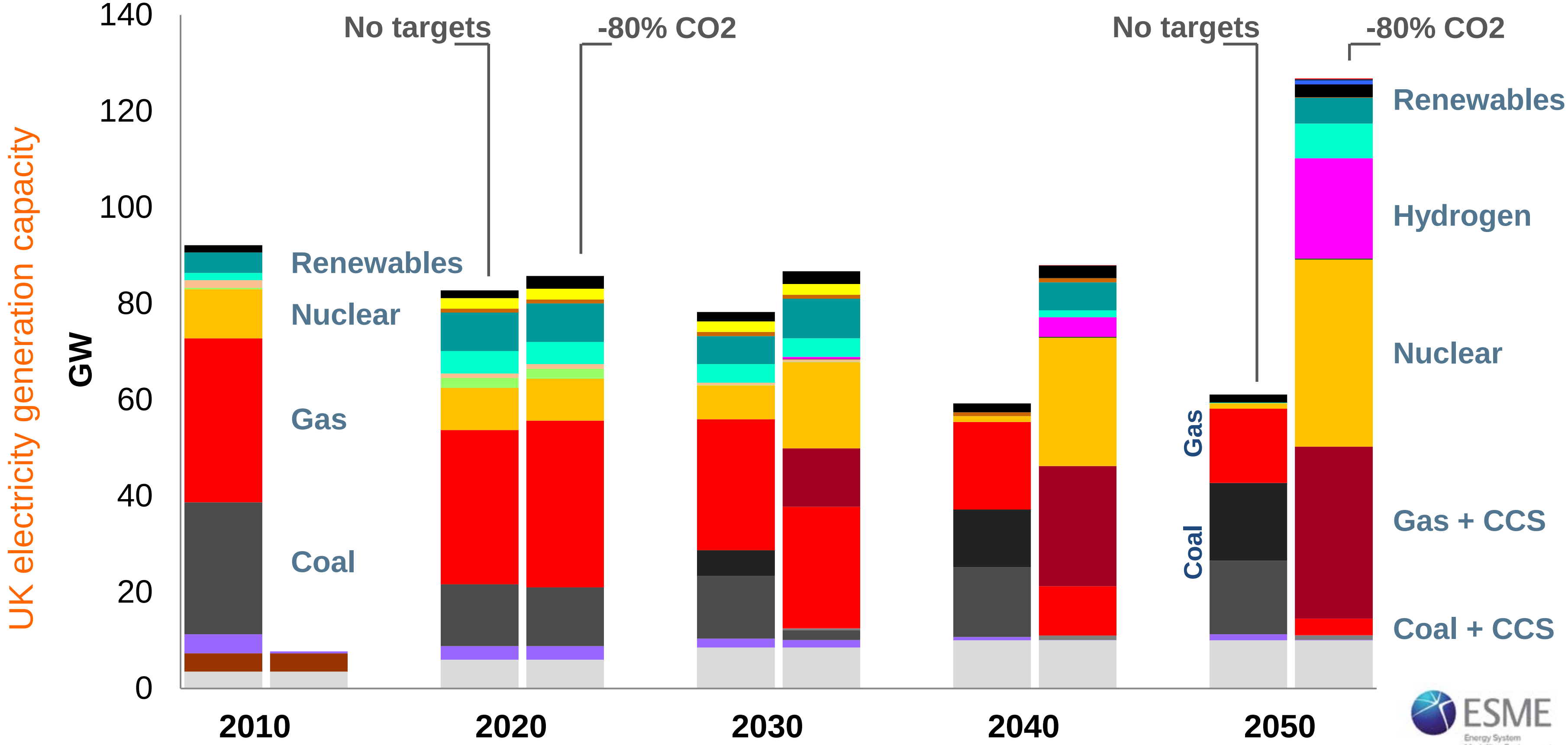


Energy
System
Modelling
Environment

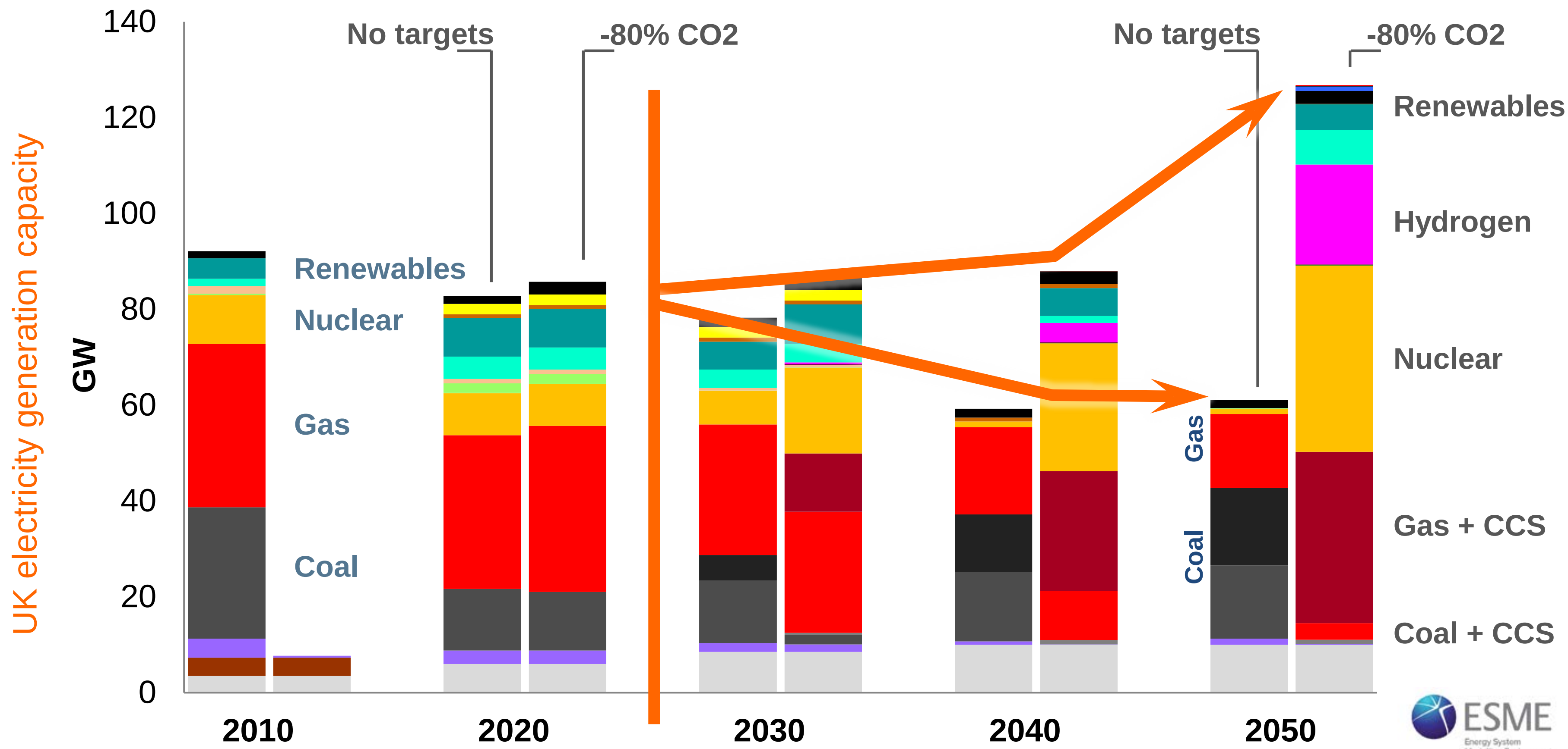




“No emissions targets” and “-80% CO_2 in 2050” are very different worlds…



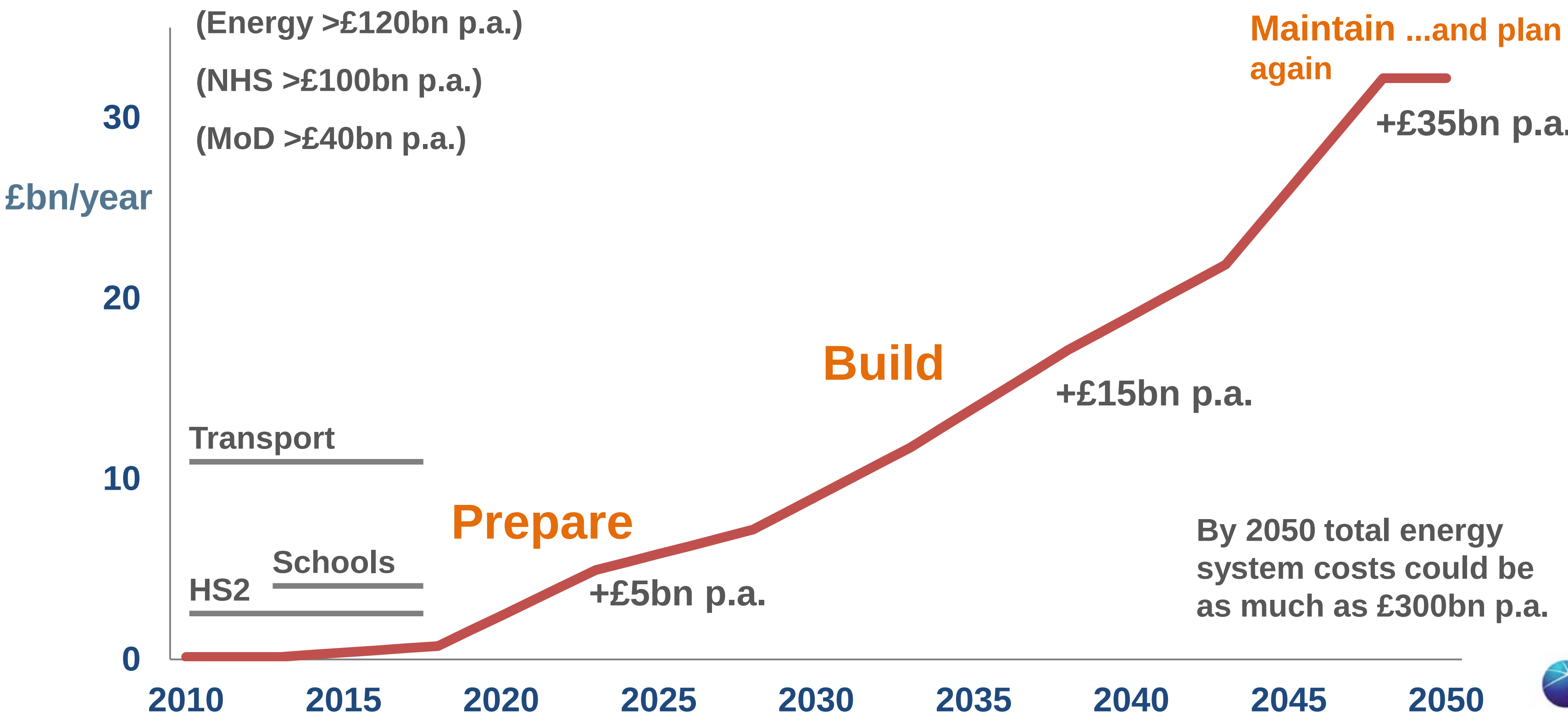
As long as we prepare NOW, decisions on 2050 can wait… but not for long



Prepare over next 10 years

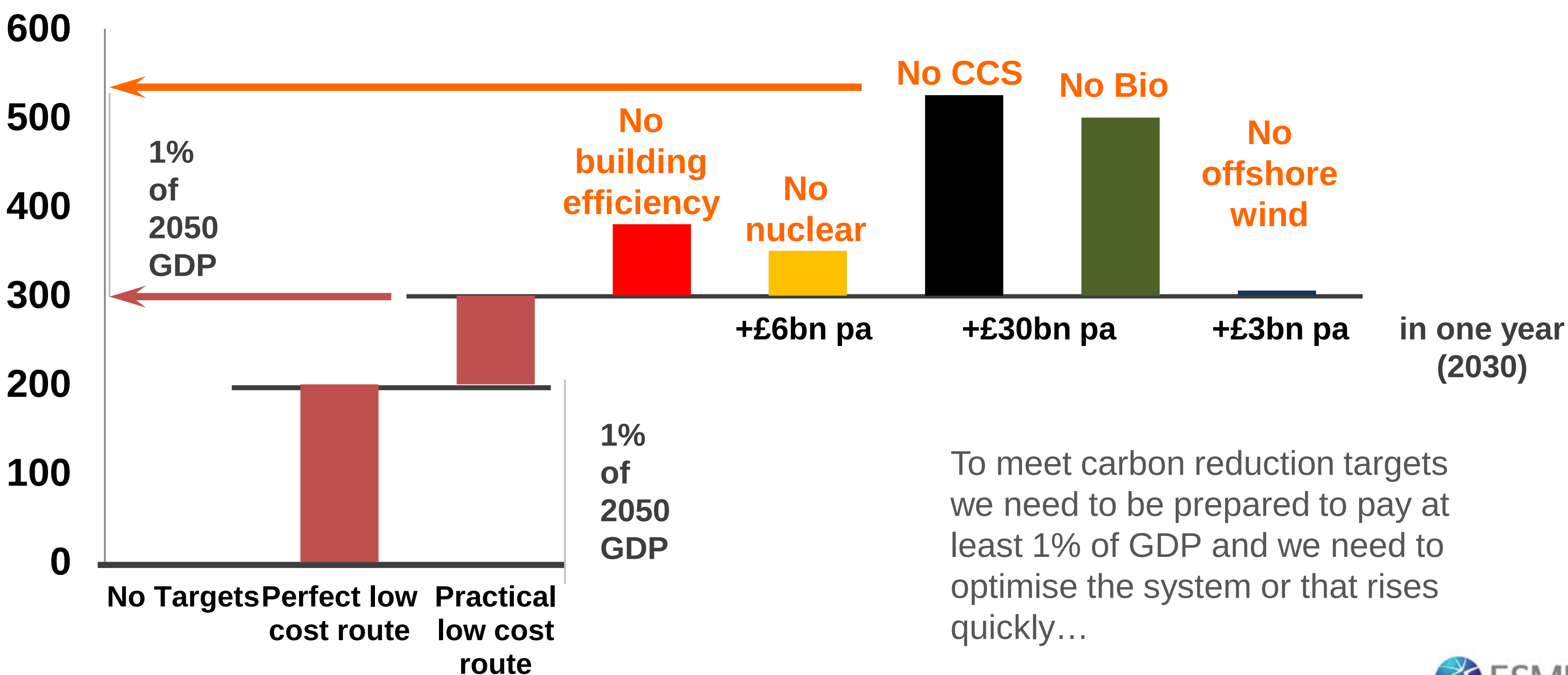
creating platform for infrastructure roll-out and growth

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



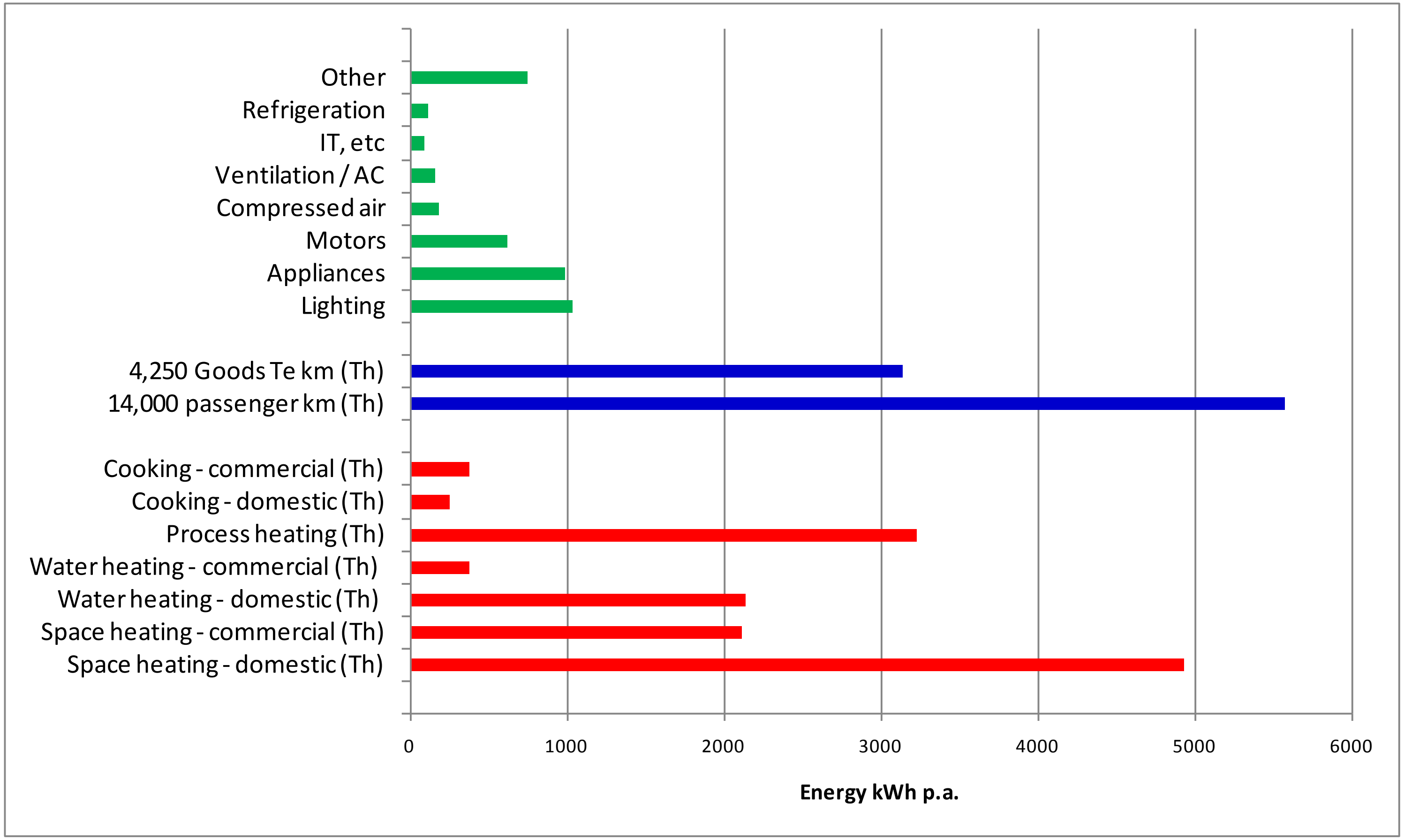
Poor system optimisation doubles the cost of a 2050 UK low carbon energy system

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



To meet carbon reduction targets we need to be prepared to pay at least 1% of GDP and we need to optimise the system or that rises quickly…

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

90%

of the UK's housing stock will still be in use in 2050

20%

contribution of household heating to national carbon emissions

Today fewer than

4%

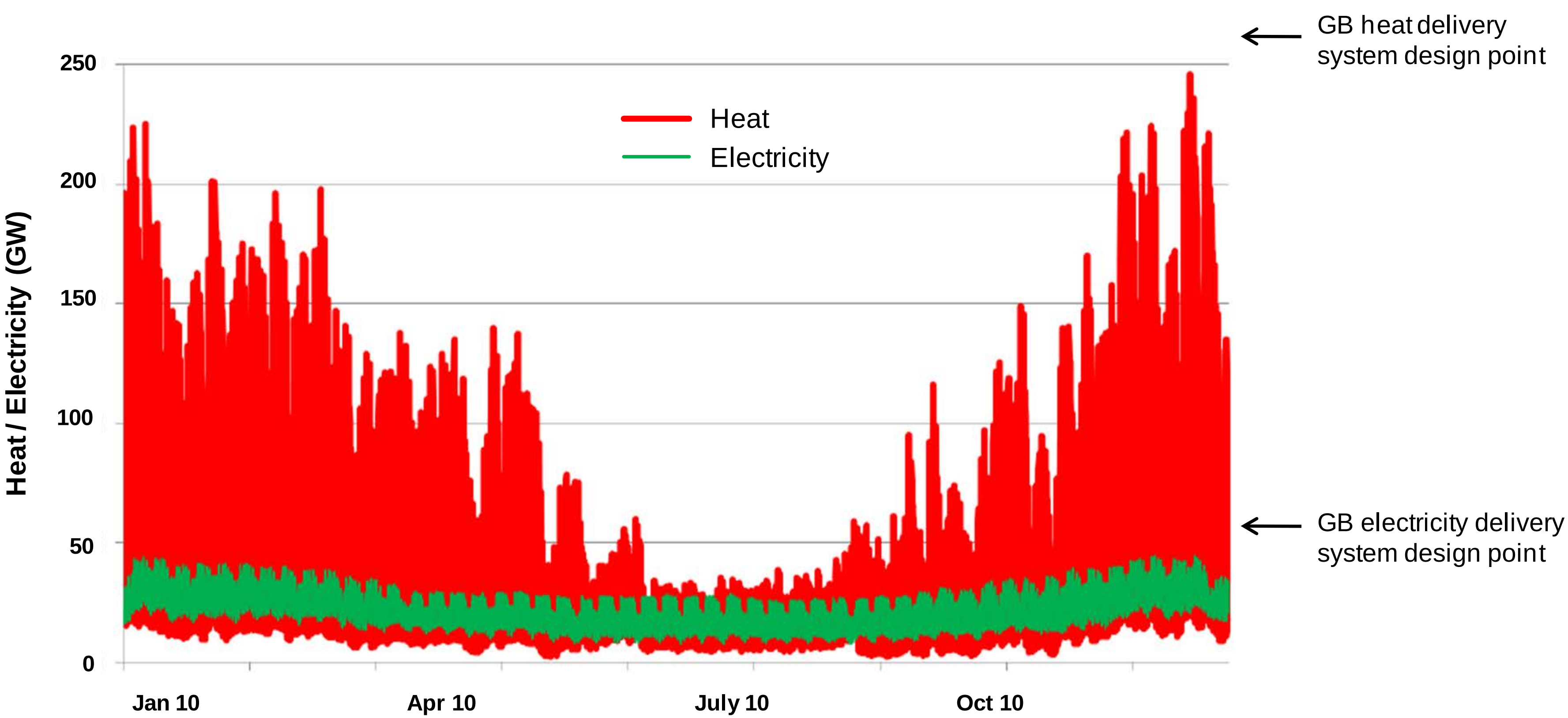
have low carbon heating

and

90%

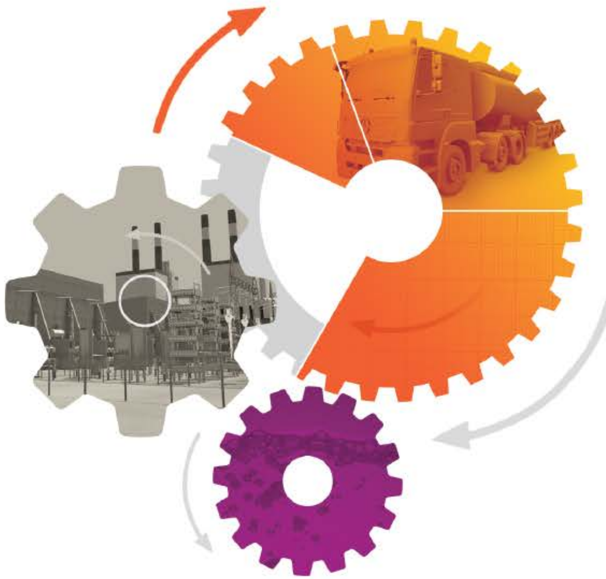
prefer gas central heating given the choice

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



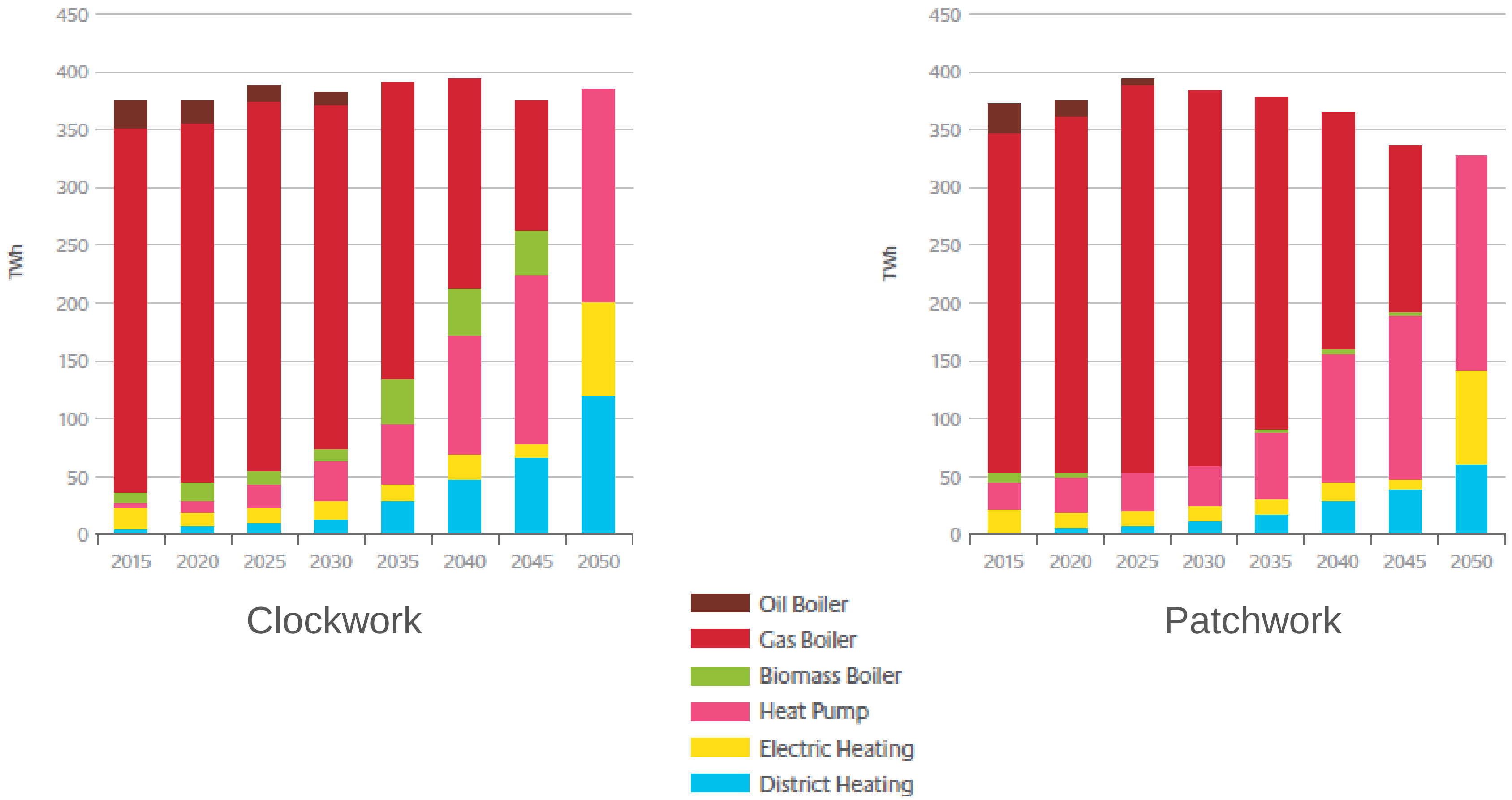
Source: Robert Sansom, Imperial College (2010)

ETI's Clockwork and Patchwork Scenarios

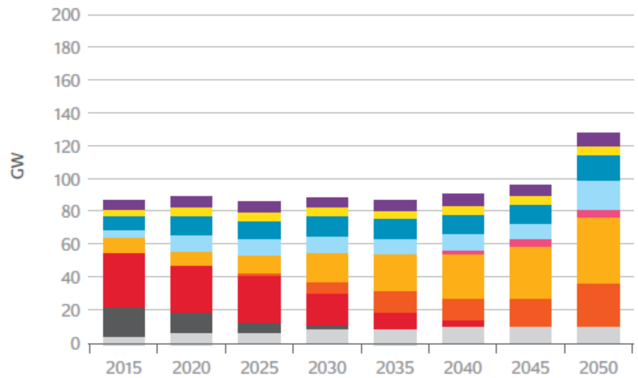


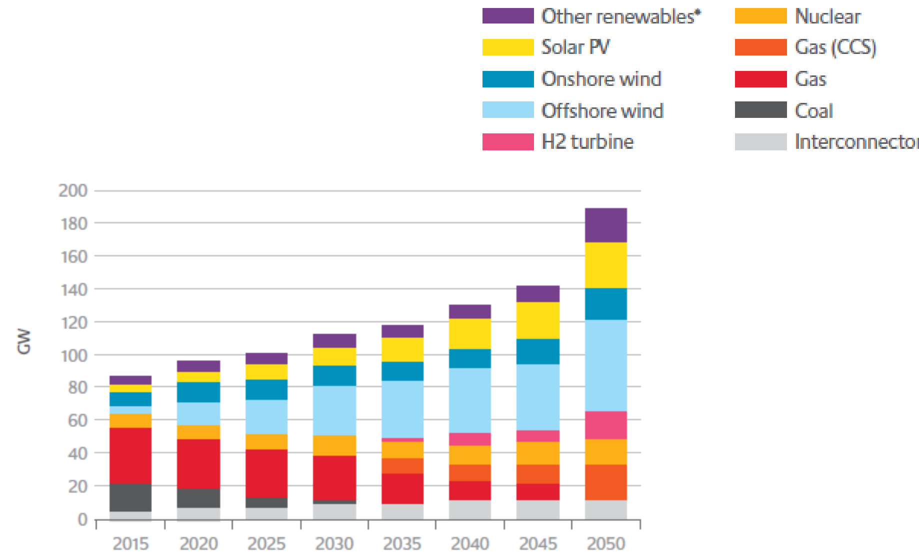
are representative of the challenges the UK faces in a move to low carbon – displaying the scale of the challenge

Space Heat Generation



ELECTRICITY CAPACITY





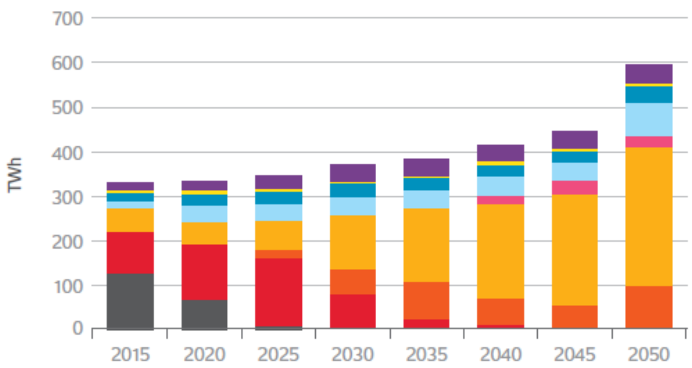
CLOCKWORK

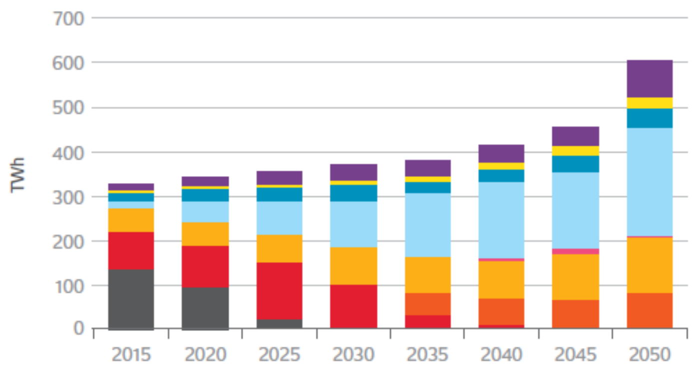
- Nuclear provides 40GW of capacity by 2050
- Existing pipeline of renewables built out to 2020, then maintained, with some further uptake of wind in 2040s
- Gas plants retrofitted/replaced with CCS from 2020s
- Hydrogen takes over from gas for peaking capacity from 2030s
- Total capacity of ~130GW by 2050. Balance between nuclear, CCS and renewables

PATCHWORK

- Nuclear replacement of existing capacity only (16GW)
- CCS delayed until 2030s before replacing unabated gas plants
- Wind power capacity reaches 75GW by 2050, mostly from offshore
- Significant capacity of hydrogen turbines (17GW) required to balance intermittent supply
- Solar provides 28GW, Tidal 10GW and Wave 4GW of capacity by 2050
- Total capacity of ~190GW by 2050, dominated by renewables

ELECTRICITY GENERATION





CLOCKWORK

» Nuclear has the highest load factor of all supply technologies, making the largest contribution to total generation by 2050

» Gas with CCS has a seasonal role, providing baseload through winter and more backup through summer

» Improvements to technology means new offshore wind turbines have a load factor of 50% by 2050, meaning a larger share of generation compared to onshore

PATCHWORK

» Despite its limited capacity, the high load factor of nuclear means it contributes ~20% of electricity generation in 2050

» Of the renewables, offshore wind makes the largest contribution of all technologies, while generation from solar is very modest, given its low load factor of 11% in the UK

Key decisions and cost implications

- Direction change between “no targets” and “-80% CO_2” 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

Efficiency improvement (transport and buildings)

Gas

Offshore renewables

Bioenergy feedstocks (for heat and power)

Nuclear

CCS (fossil and biomass fuels)

all “no regrets” choices for the next 10 years

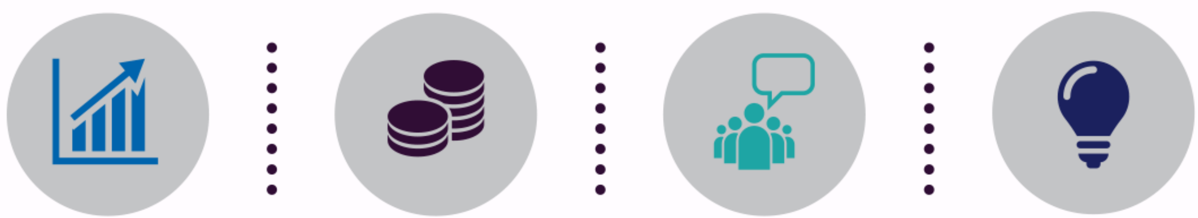
What we need...

- 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

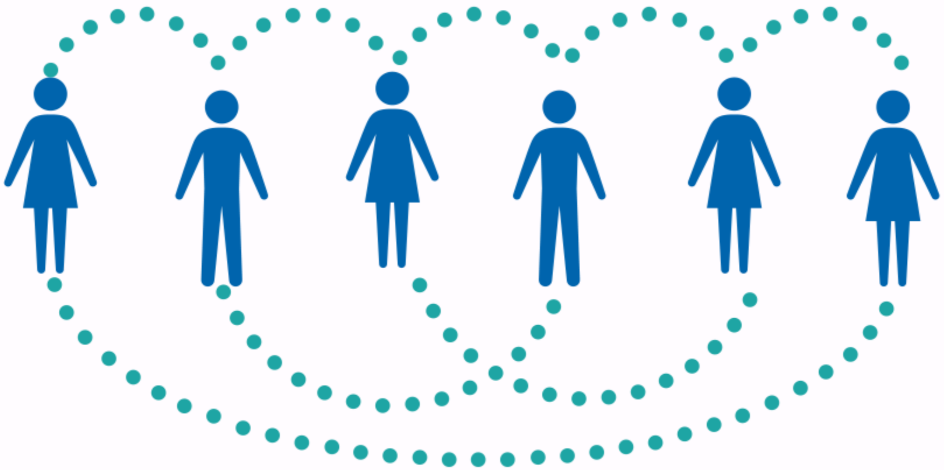
- Ready to make informed choices
- A system that creates and retains optionality
- Prepared for investment in a wide scale infrastructure roll-out
- Innovate to drive down cost (technology and business models)
- We need innovative incentives for industry to invest in the UK

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

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



They depend on multiple interactions between different actors

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

Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

For all general enquiries telephone the ETI on 01509 202020.

For the latest ETI news and announcements email info@eti.co.uk

For more information about the ETI visit www.eti.co.uk

The ETI can also be followed on Twitter @the_ETI