WESTMINSTER ENERGY FORUM

INNOVATION INSIGHTS FROM ENERGY SYSTEM MODELS

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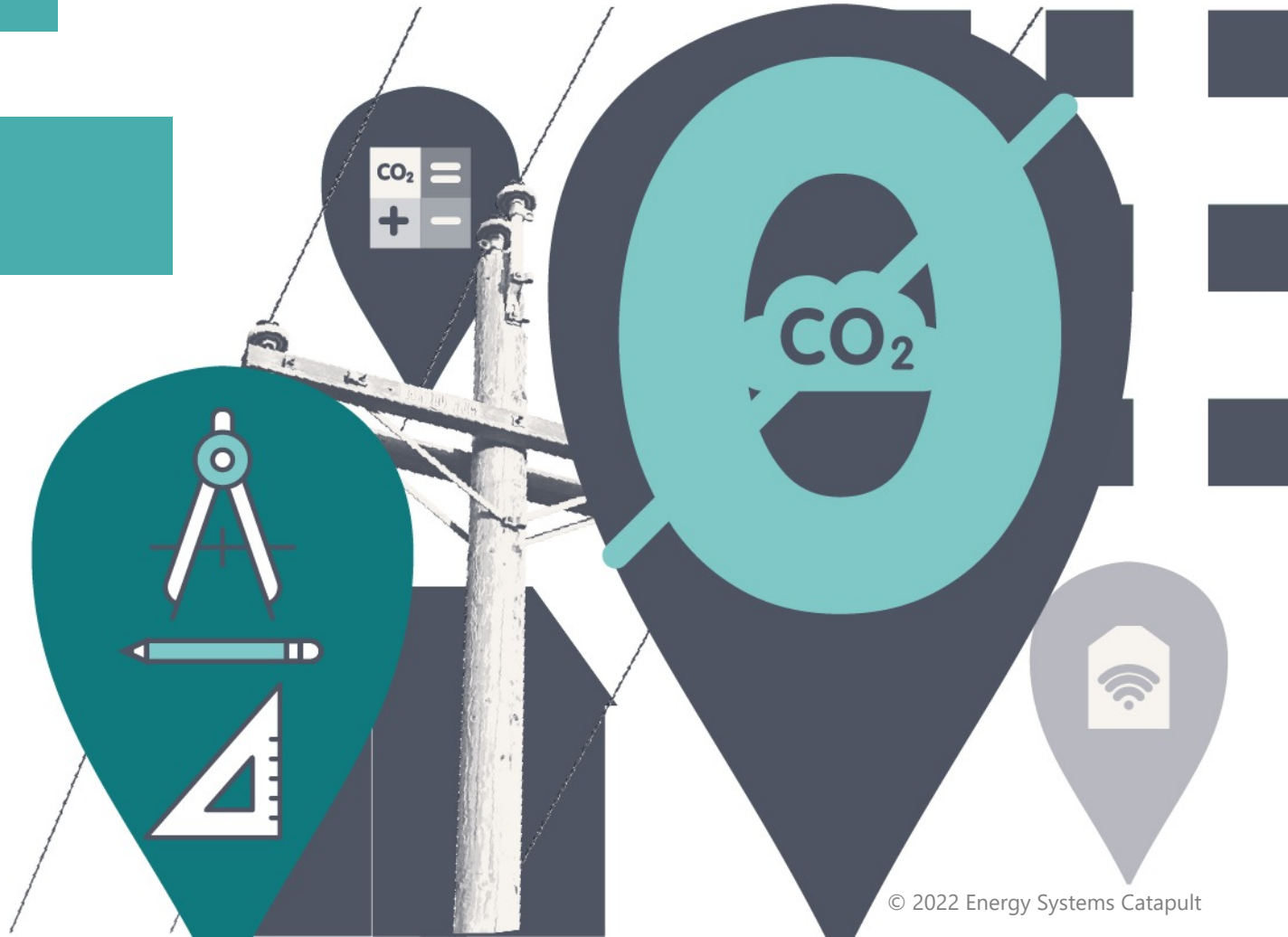
BUSINESS LEADER – WHOLE SYSTEMS AND NETWORKS

06TH APRIL 2022



PROPOSITION

- **THIS NEXT PHASE OF THE TRANSITION WILL SUCCEED OR FAIL ON OUR ABILITY TO ENGAGE CONSUMERS**
- **WE THEREFORE:**
  - **NEED TO SHIFT OUR INNOVATION FOCUS FROM TECHNOLOGY TO BUSINESS MODELS, SERVICES AND TECHNOLOGY**
  - **NEED TO FOCUS REFORMS ON ENABLING BUSINESS MODEL AND SERVICE INNOVATION**

OUR EXPERTISE.

WHOLE SYSTEMS THINKING.

JOINING UP THE SYSTEM FROM SOURCES OF ENERGY TO THE CONSUMER

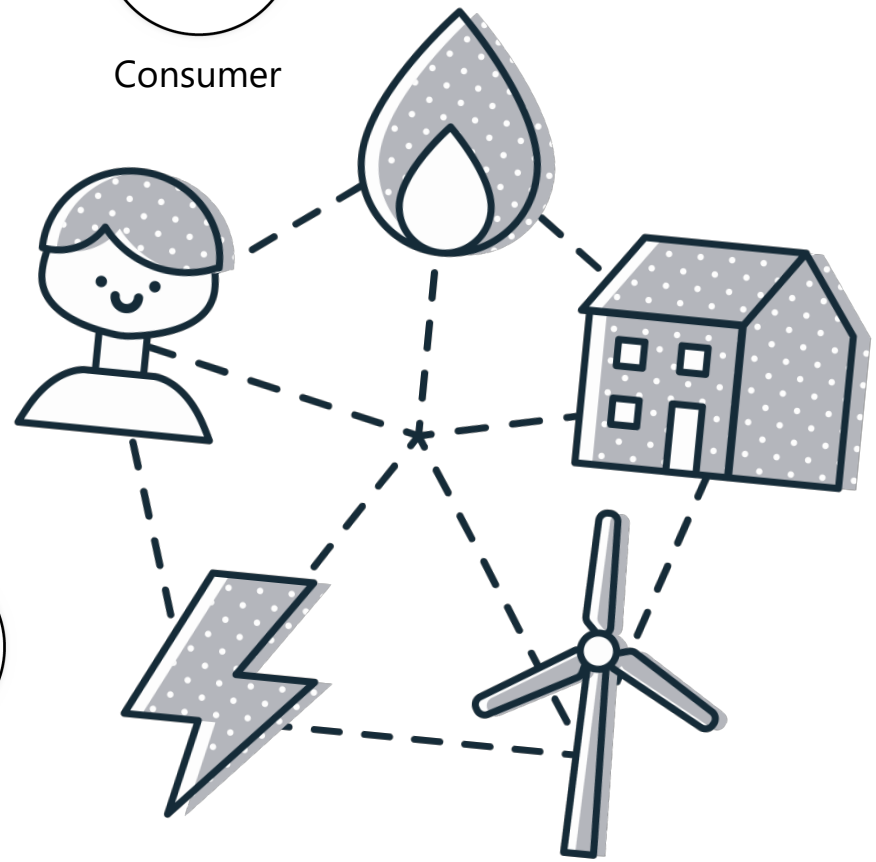
Generation + Transmission + Distribution + Buildings + Consumer

BREAKING DOWN SILOS BETWEEN DIFFERENT PARTS OF THE ENERGY SYSTEM

Electricity + Heat + Transport

JOINING UP PHYSICAL REQUIREMENTS OF THE SYSTEM, WITH POLICY, MARKET AND DIGITAL ARRANGEMENTS

Physical System + Digital System + Market System + Policy



ABOUT US.

WHAT WE DO.

Supporting innovators to commercialise

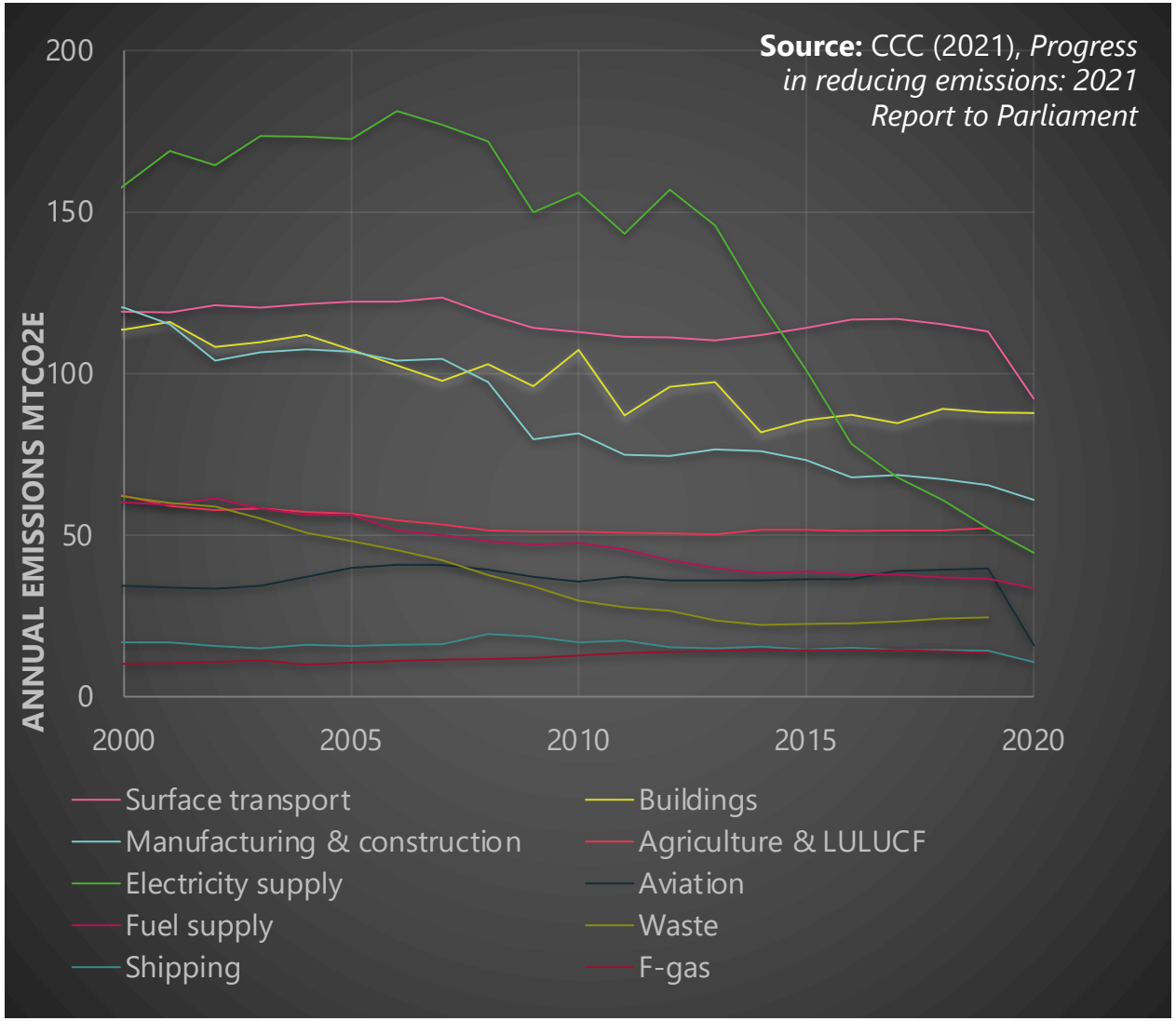
- CONSUMER INSIGHT AND PROPOSITION DESIGN
- BUSINESS MODEL INNOVATION
- HARNESSING DIGITAL AND DATA
- TEST AND DEMONSTRATION
- DELIVERING LARGE SCALE INNOVATION TRIALS

Helping to design the future energy system to unlock innovation

- WHOLE SYSTEM MODELLING
- CLEAN TECH ENGINEERING
- SYSTEM ENGINEERING
- INTEGRATING THE TRANSPORT AND ENERGY SYSTEMS
- MARKETS, POLICY AND REGULATION
- DECARBONISING THE PUBLIC SECTOR ESTATE
- DECARBONISING LOCAL PLACES
- DECARBONISING CAMPUSES, BUSINESS PARKS AND INDUSTRIAL ESTATES

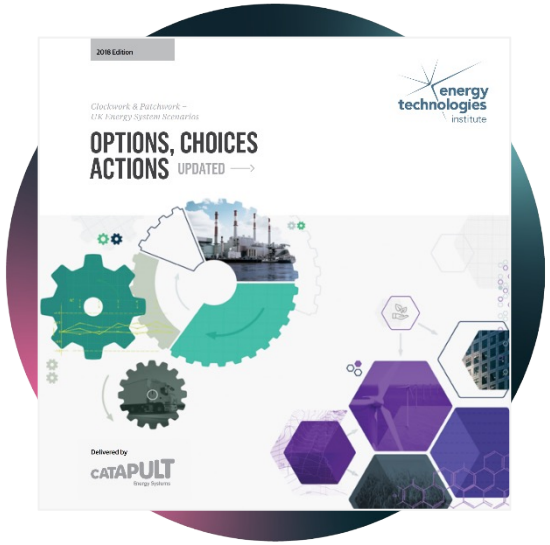
PROGRESS TO DATE HAS BEEN IMPRESSIVE BUT "INVISIBLE" TO CONSUMERS

- Most decarbonisation has occurred in the electricity sector, with some progress in industry
- Limited impact on buildings and waste has flatlined for the last decade
- In the electricity sector, from 2009-2019:
  - Emissions decreased by 65%
  - Grid carbon intensity fell from ~500 gCO_2/kWh to 200 gCO_2/kWh
  - Variable renewable generation went from 9 TWh (3% of total), to 73 TWh in (26%)
- Some progress has also been made in industry related to efficiency and fuel switching
- <u>Both have been largely invisible to consumers.</u>



INNOVATING TO NET ZERO

ESC published one of the first studies looking at the implications of the net zero commitment, building on its previous whole systems publications



ENERGY SYSTEMS MODELLING ENVIRONMENT (ESME)

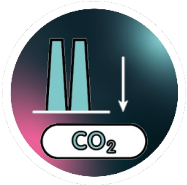
OUR ‘CLOCKWORK’ AND ‘PATCHWORK’ SCENARIOS

Clockwork

More **centralised**, with national strategic solutions. **Negative emissions compensate** for continued emissions from industry, aviation and livestock.

Speculative technology measures:

Biomass



Enhanced capture rates and Direct air carbon capture

Patchwork

More **decentralised**, national solutions more constrained. A greater role for **renewables**, and **more societal change**, less need for offsets.

Speculative social measures:

Aviation

Diet change

Afforestation

INSIGHTS FROM INNOVATING TO NET ZERO

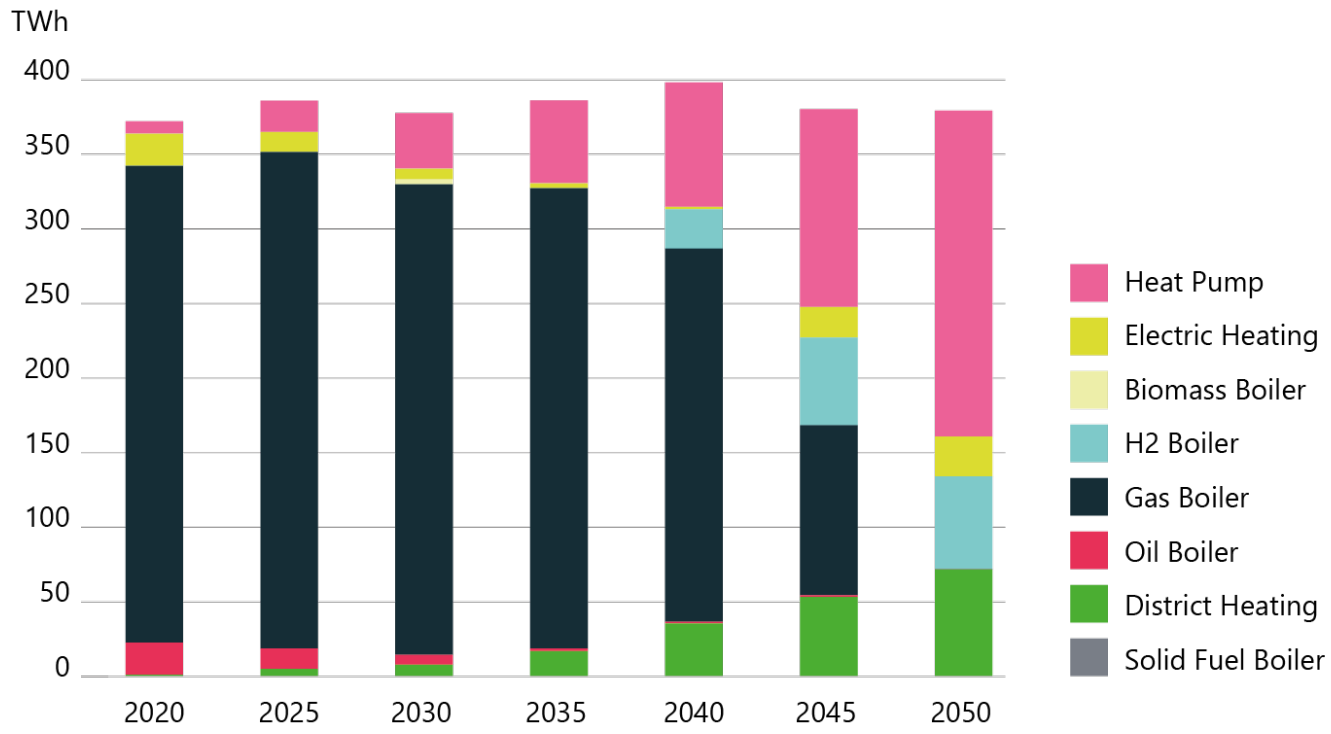
1. Success depends on **innovation across the whole system**: in technology, land use change and behaviour.
2. Net Zero for the UK **before** 2050 **is not possible without highly "speculative" changes** to lifestyle, land use and low carbon technologies.
3. **Negative emissions** (including CCS and bioenergy) are both **essential** to delivering Net Zero.
4. **Land use** must be **optimised to balance** carbon sequestration with other priorities.
5. **Hydrogen** may need to grow from **virtually zero** to **levels equivalent to today's electricity**.
6. **Electricity generation** will need to **double**, with significant uptake of:
   - Offshore/onshore wind and solar
   - Advanced nuclear technologies and small modular nuclear

*These innovations will arrive at different points in the transition and not be available in all locations.

THE SCALE OF THE CHALLENGE FOR SPACE HEATING WAS SIGNIFICANT WHEN MODELLED IN 2020

Clockwork

Space Heat Output



Innovation priorities:

Whole house retrofit packages innovation to reduce cost, improve performance.

Smart multi-zone controls can reduce energy use while maintaining levels of comfort.

Hybrid heat pump and boiler demonstration of integrated solutions.

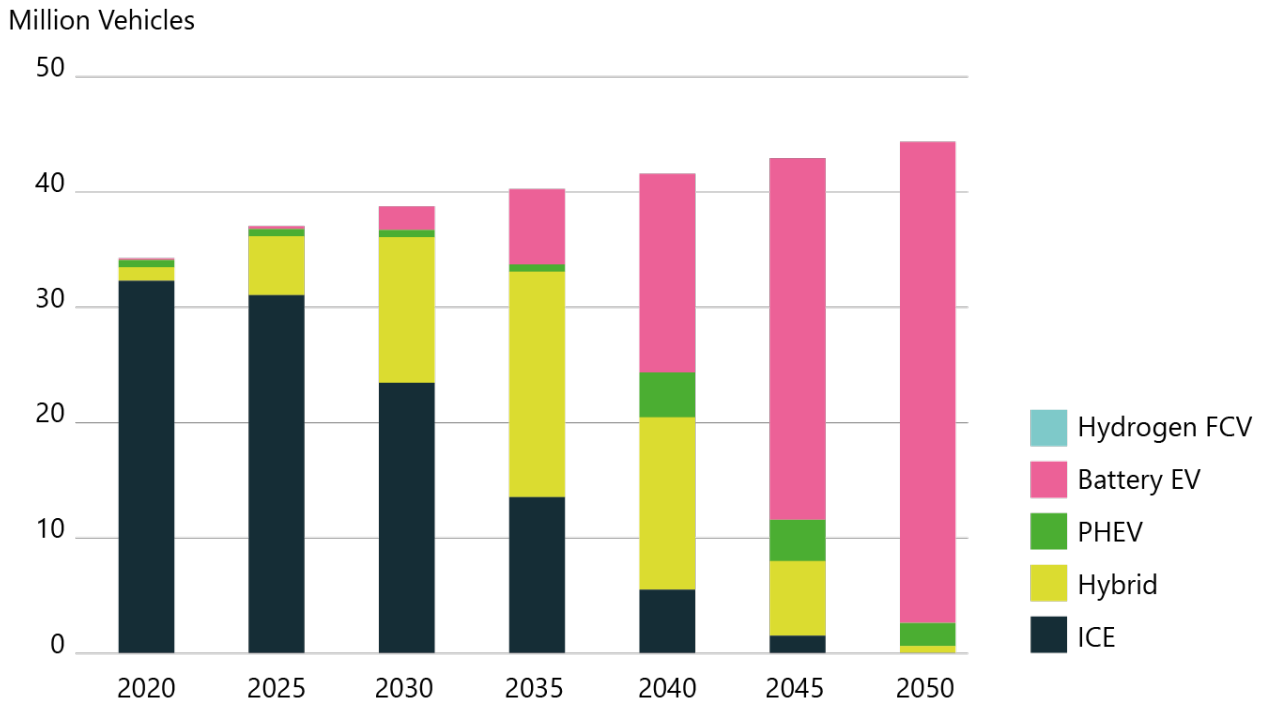
Heat storage with potential to substitute for boilers as back up for heat pumps.

100% hydrogen networks early demonstration essential to maintain this as an option.

THE SCALE OF THE CHALLENGE FOR TRANSPORTATION WAS SIGNIFICANT WHEN MODELLED IN 2020

Clockwork

Deployment of cars



Innovation priorities:

Smart charging can assist with grid integration.

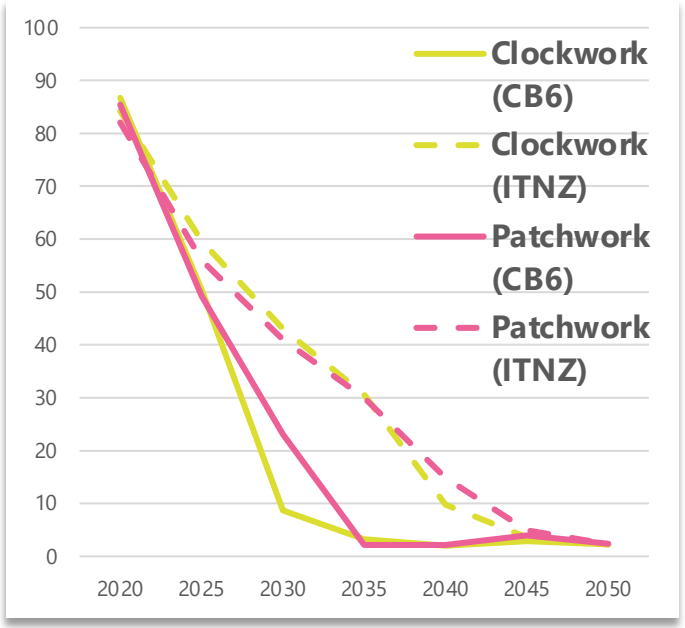
Public charging infrastructure required to support mass adoption.

Hydrogen shipping looks attractive but will require international coordination.

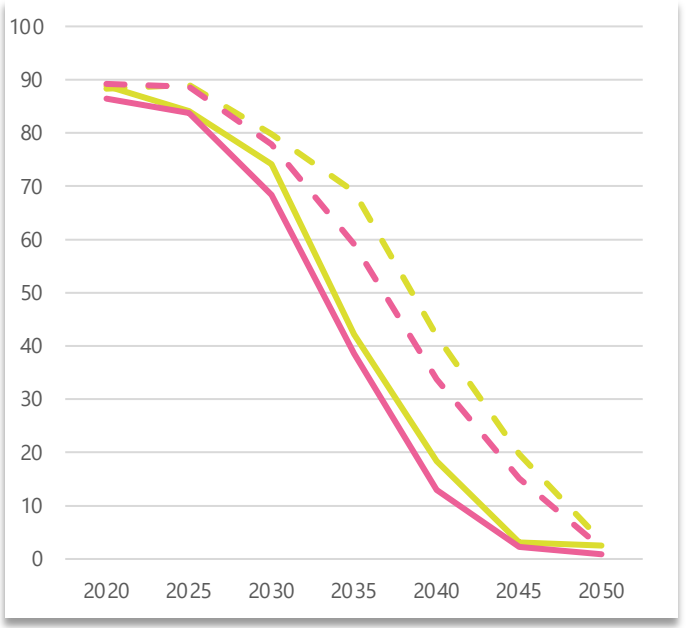
OUR UPDATED MODELLING OF 'CARBON BUDGET 6' SHOWS MORE RAPID ACTION IS REQUIRED

- Our updated modelling for the CCC's 'Carbon budget 6' (CB6) shows even more is required from the electricity, transport and domestic space heating sectors.

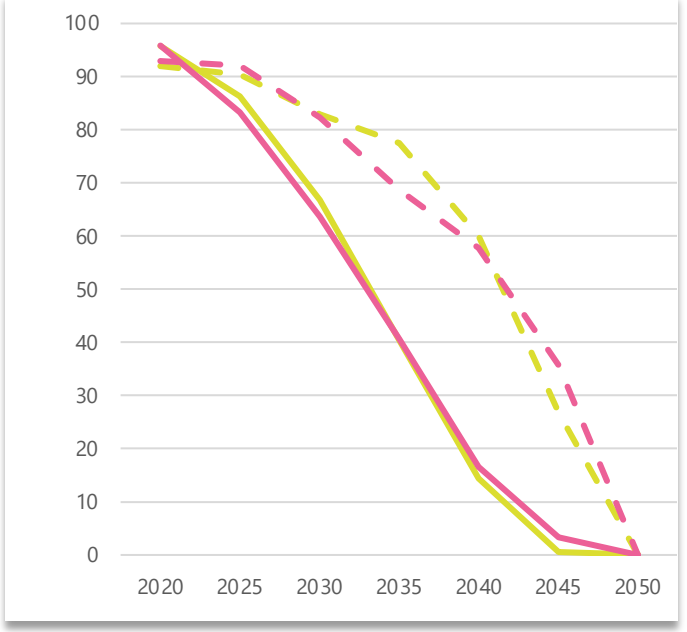
Emissions from Power Sector ($mtCO_2e$, gross)



Emissions from Cars and Vans ($mtCO_2e$)



Emissions from Residential Space Heating ($mtCO_2e$)

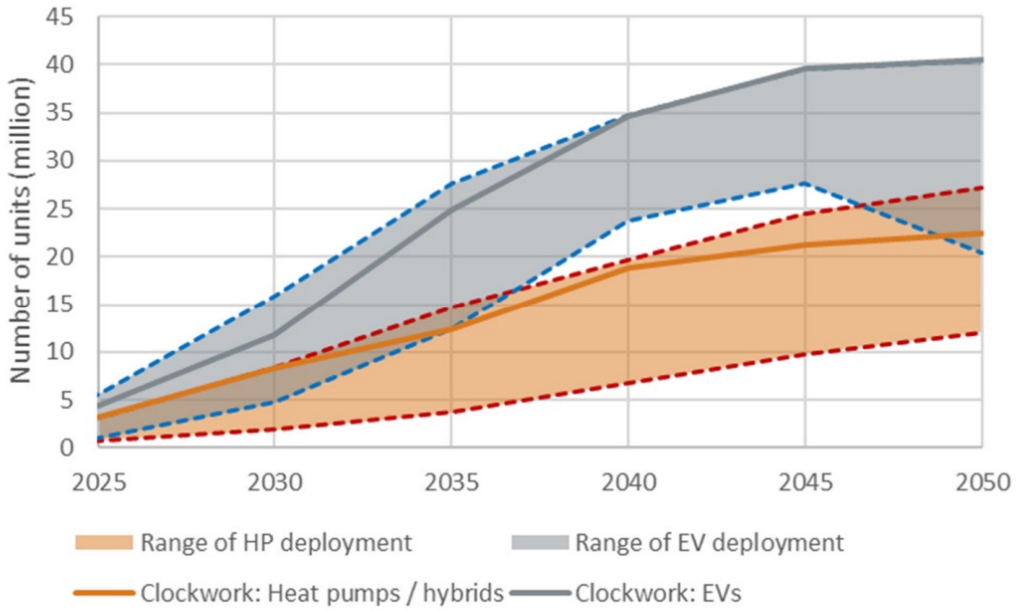


Source: ESC ESME model, updated for 6th Carbon Budget.
Note: Model reflects targets from the CCC's 6th Carbon Budget and 2030 ban on new ICE vehicles.

THE CONSUMER CHALLENGE AND WHAT TO DO ABOUT IT

TWO EXAMPLE CONSUMER CHALLENGES TO OVERCOME

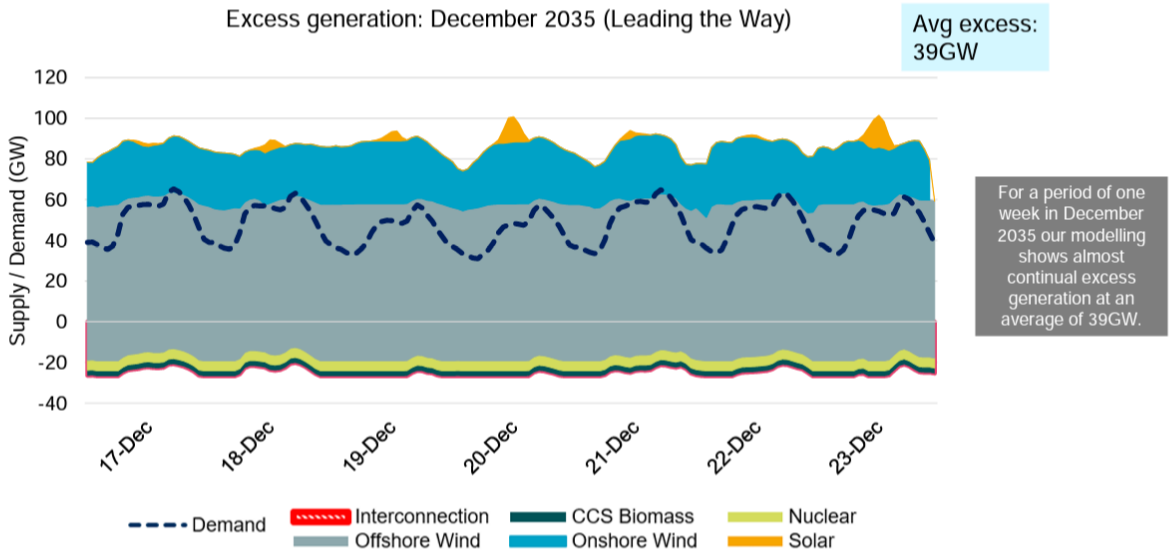
1. Product adoption: Convincing consumers to make significant investments in different technologies that may be disruptive and/or require behaviour change.



Source: BEAMA` (2022), *Growing the Supply Chain for a Net Zero Energy System*

2. Demand-side flexibility: The demand-side of the market will need to be far more flexible to balance the system and provide system services.

There is huge innovation opportunity here, for consumers to offer up assets (e.g., vehicle-to-grid; hot water tanks; battery storage) and be rewarded.



Source: National Grid ESO` (2021), *Autumn Markets Forum Net Zero Market Reform Update*

THIS SCALE OF CHANGE WILL REQUIRE SIGNIFICANT INNOVATION IN RETAIL AND SUPPLY CHAINS

- To get these technologies into the market at **scale** is going to require a **very different set of companies and service offerings** in the retail market. Examples of the products required:
  - Heat-as-a-service
  - Whole home retrofits
  - Financing packages for heat pump installations
  - Green mortgages
- Behind the scenes **retail companies** will need to be far more **data and digitally driven**.
- We need our retail market to be **one of the most innovative sectors of the economy** over the next decade**.** It is **fundamental to unlocking innovation in the demand-side**.
- Without this we will **forego huge opportunities** to unlock real value, **resulting in a much more expensive energy system**.

WE SHOULD FOCUS ON MARKET REFORMS TO ENABLE THIS PRODUCT AND BUSINESS MODEL INNOVATION

There are 2 key things that we need to do to unlock the demand side and ensure consumers are provided with compelling service offerings:

1. **Get the economics right** through **market design** – ensure that it unlocks the demand-side and provides locational signals

   The ESC has written extensively about this in our work on 'Rethinking Electricity Markets' and '6 steps to Zero Carbon Buildings'.

2. Create a **retail market and licencing arrangements** that **allows a diversity** of business models, products and services.

Identifying where the value sits, through whole system modelling is key to prioritising our innovation efforts for technology, **and** market reforms.

Ensuring we **unlock the demand-side** and **bring consumers with us** is fundamental to success in this next phase of the transition.

OUR MISSION

TO UNLEASH INNOVATION AND OPEN NEW MARKETS TO CAPTURE THE CLEAN GROWTH OPPORTUNITY.

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