Decarbonisation - the Emissions Reduction Plan

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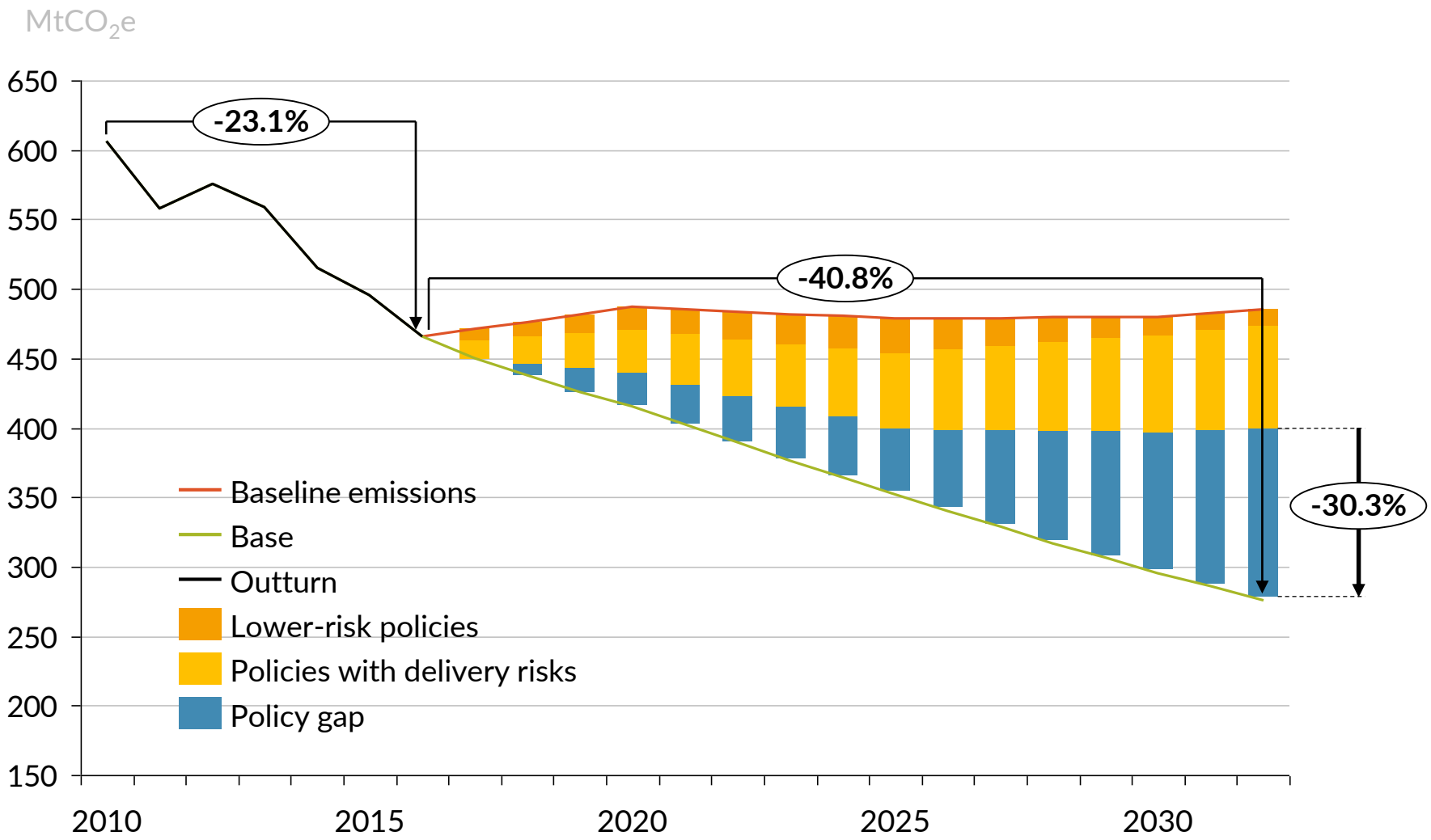
Agenda

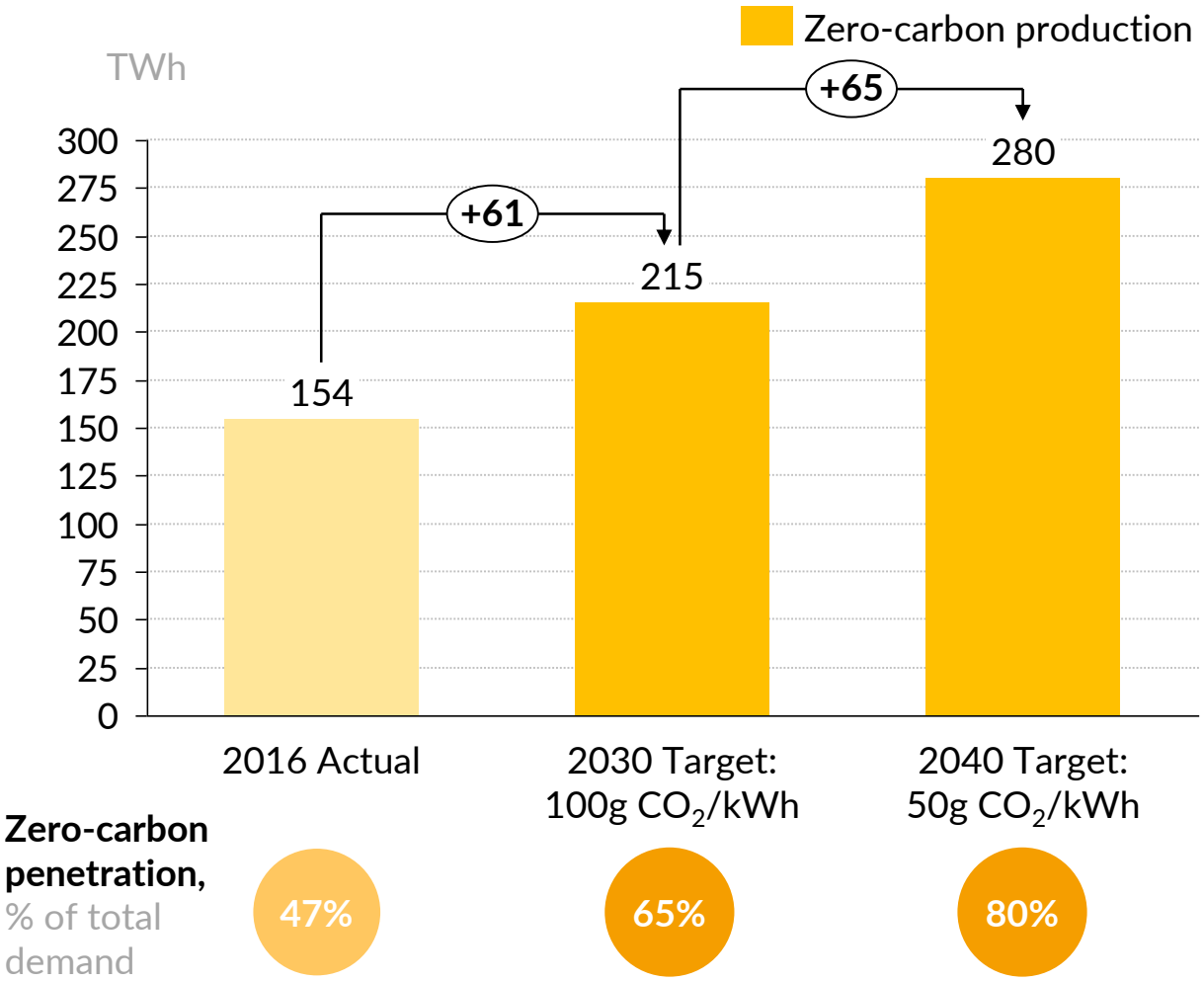
1. New policies are needed to deliver the 4th and 5th carbon budgets
2. The 2030 power sector carbon target is challenging but achievable
3. Mass rollout of EVs will stem increasing emissions from transport
4. Decarbonisation of heat is likely to be difficult and expensive

The UK is off track to deliver the 4th/5th carbon budgets; new policies are needed in the Emissions Reduction Plan



Sources: Aurora Energy Research, The Committee on Climate Change

Meeting power sector targets will require an increase in zero-carbon generation of 60 TWh by 2030

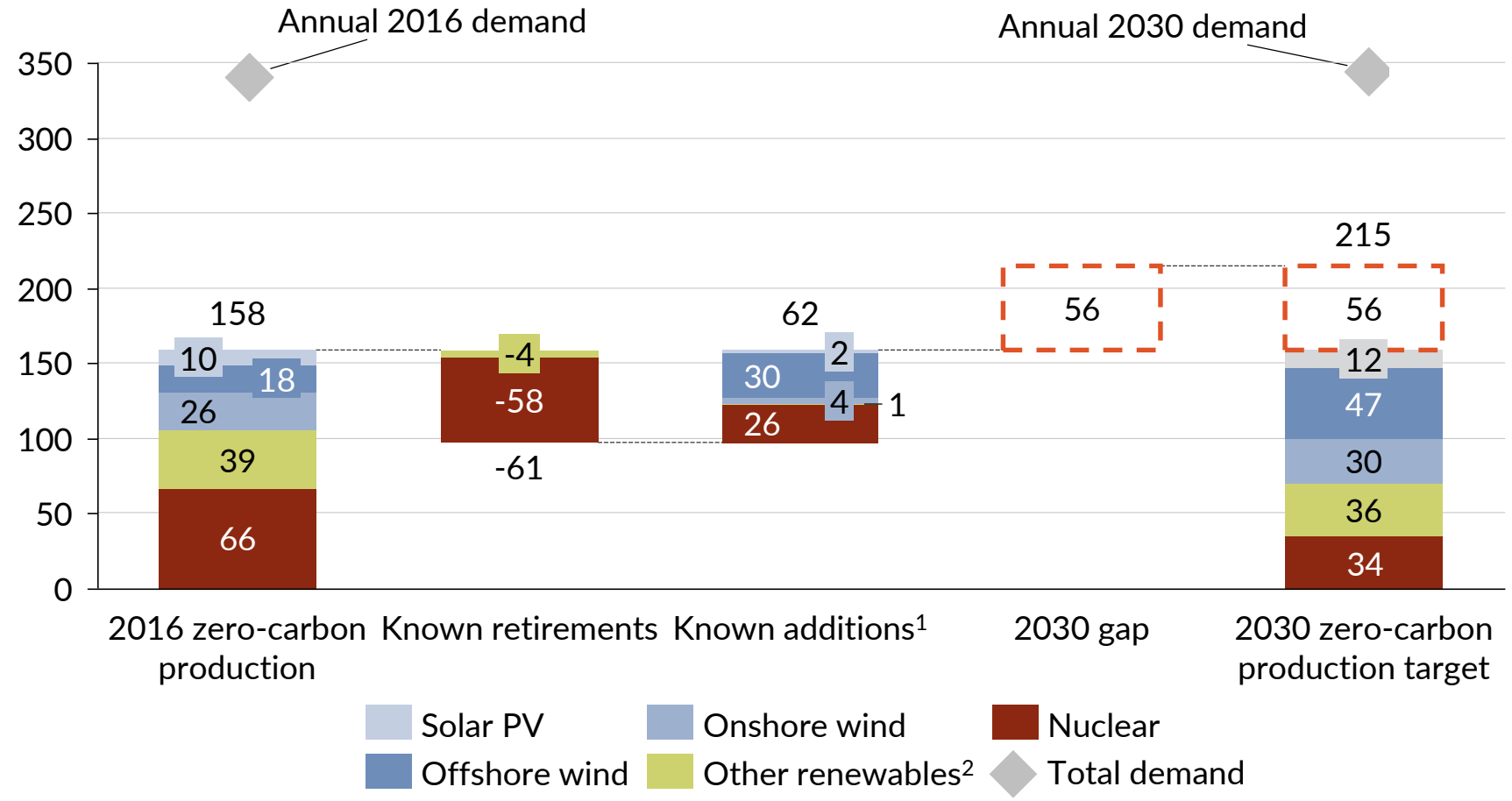


- Roughly 215 TWh of zero-carbon generation will be required to reach the CCC's target of 100g CO_2/kWh by 2030, assuming all coal is phased out by that point
- If anticipated interconnector projects fail to materialise, more zero-carbon GB supply would be necessary
- The mass electrification of heating and transport would boost power demand, increasing amount of zero-carbon capacity required

Sources: Aurora Energy Research, The Committee on Climate Change

This leaves a 50TWh+ shortfall - taking into account Hinkley Point, the latest CfD round, and known retirements

Electricity production,
TWh

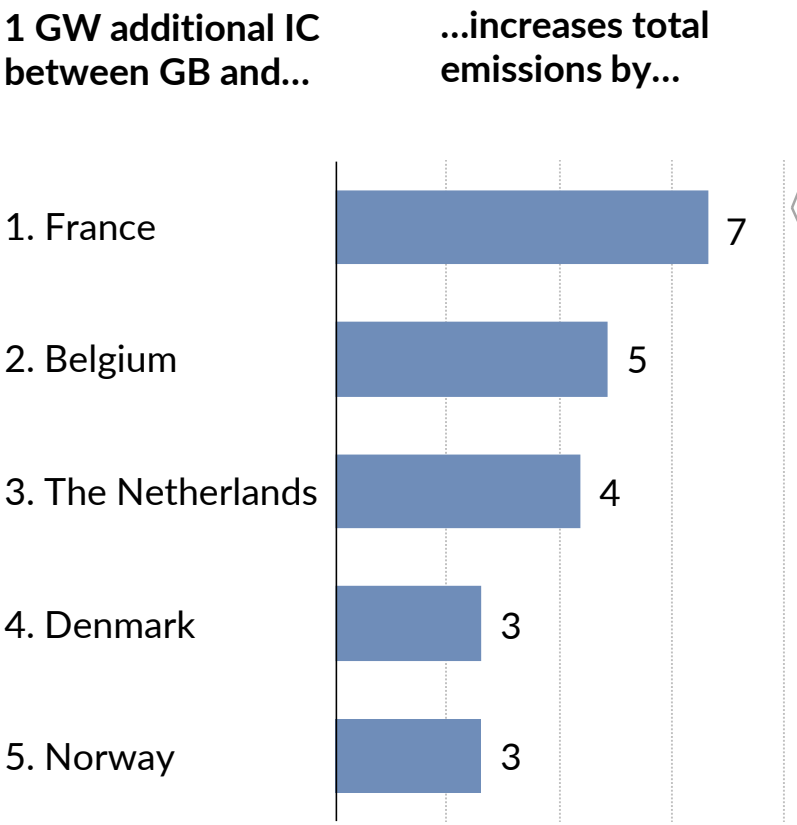


Notes: 1. Reflects generation secured through Renewables Obligation and Contracts for Difference schemes. 2. Other renewables includes bioenergy, hydro, marine.

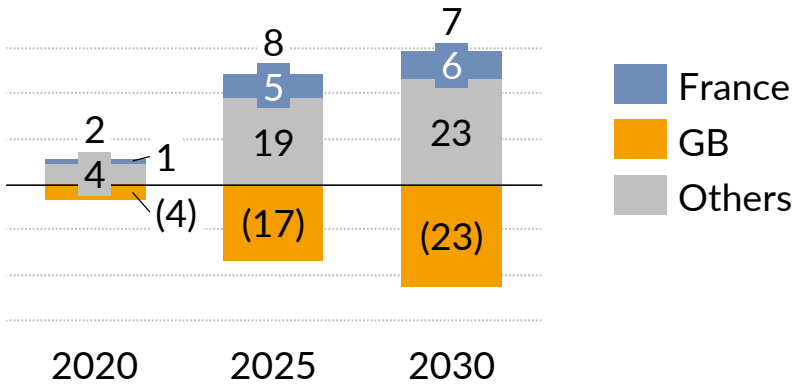
Source: Aurora Energy Research

Interconnectors don't reduce the decarbonisation burden - they simply shift it to other countries

Change in European emissions per 1 GW of IC capacity (2020-30 cumulative $MtCO_2$)

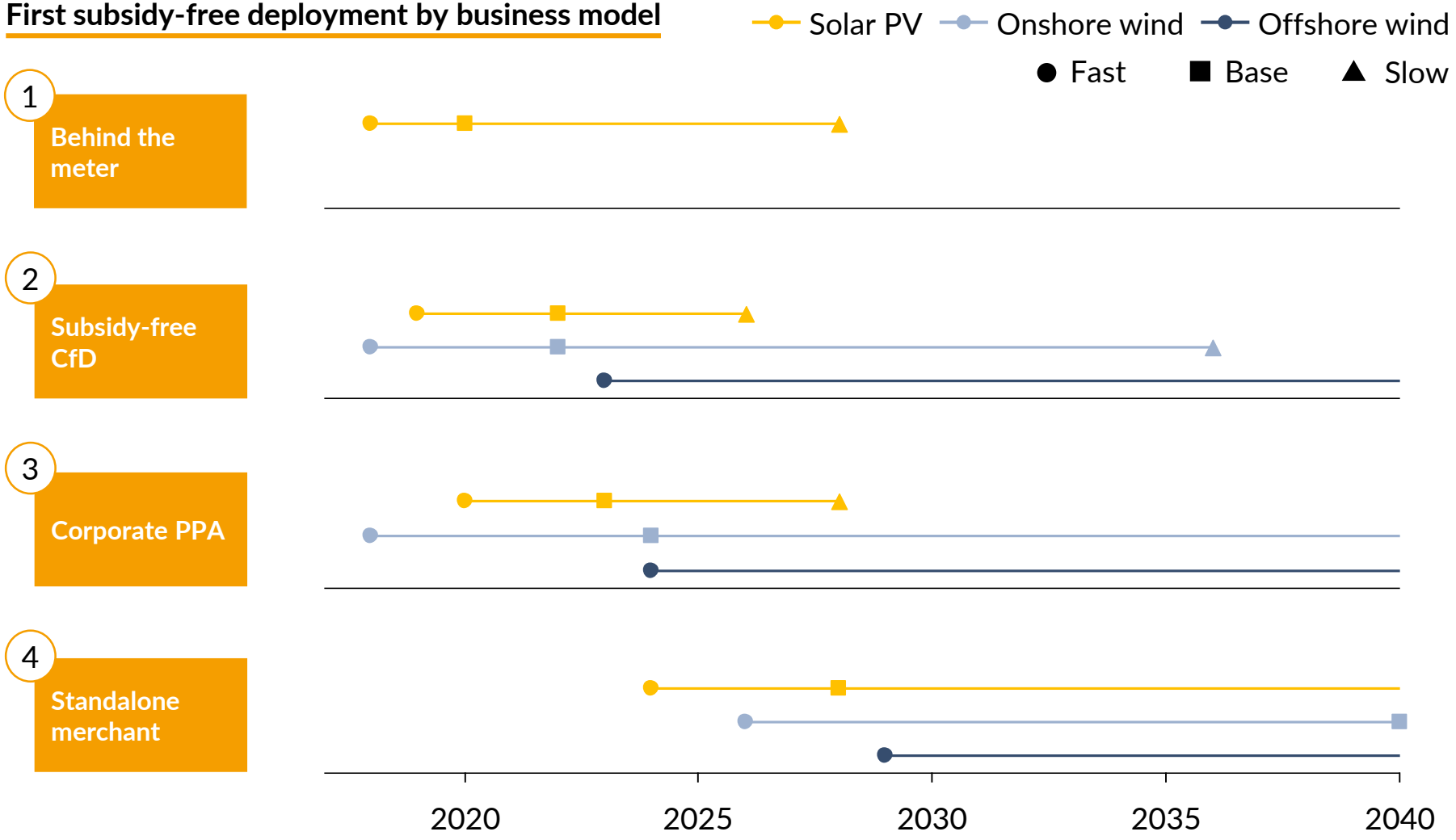


Change in European emissions from 1 GW of IC capacity with France (cumulative $MtCO_2$)



"Subsidy free" renewables could help to fill the void: some business models could be viable from the early 2020s

First subsidy-free deployment by business model



Emergence of subsidy-free renewables

Source: Aurora Energy Research

Growth of renewables requires more flexibility. Three main technologies have emerged to capture this opportunity

Peakers

- Diesel reciprocating engines
- Gas reciprocating engines
- OCGT

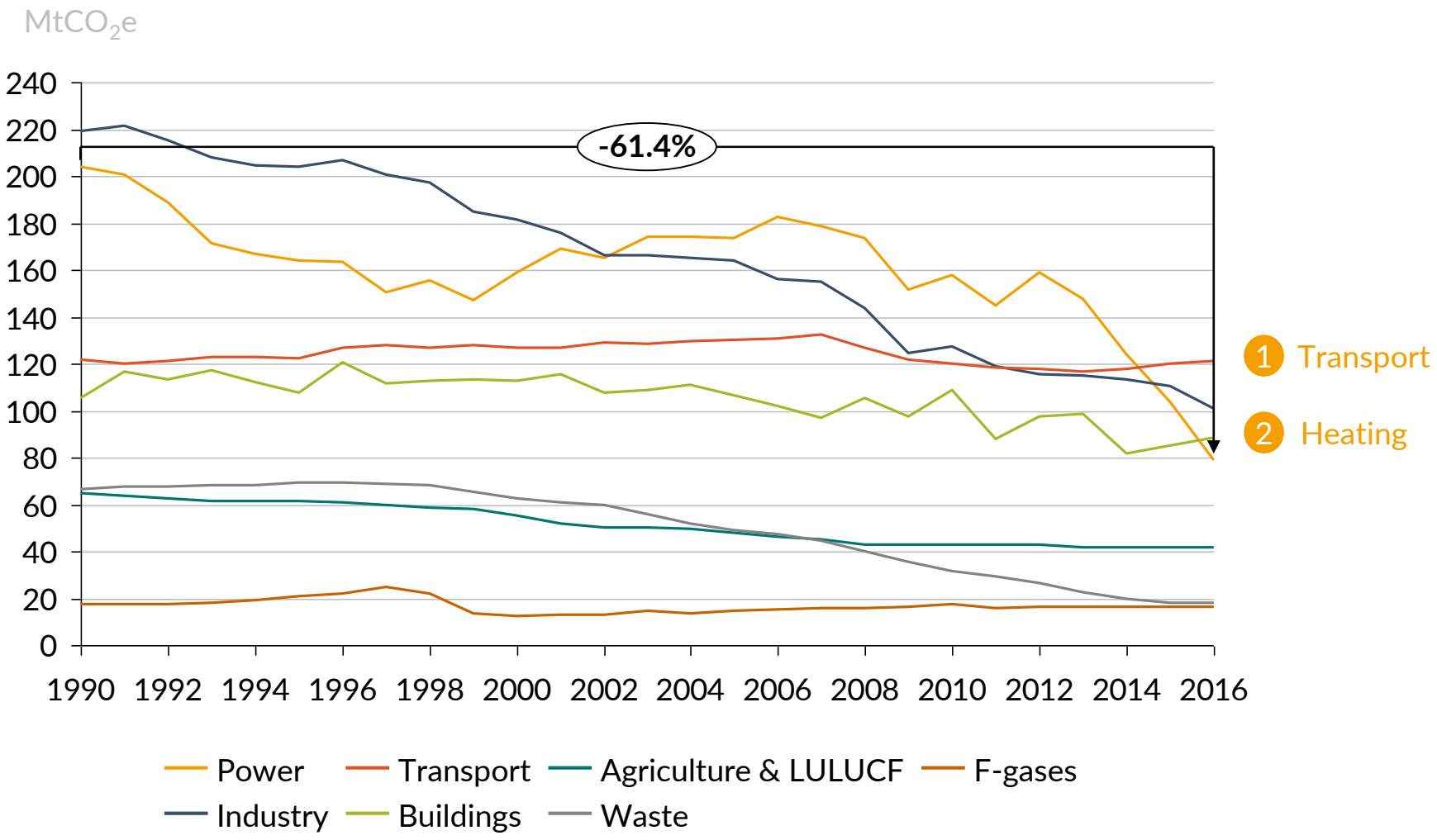
Storage

- Bulk storage
  - Compressed air
  - Pumped hydro
- Small scale
  - Lithium ion
- Emerging technologies
  - Flow batteries

DSR

- Domestic
- Industrial and commercial
  - Refrigeration
  - Air conditioning
  - Manufacturing processes

Progress to reduce power sector emissions far outstrips other sectors such as buildings and transport



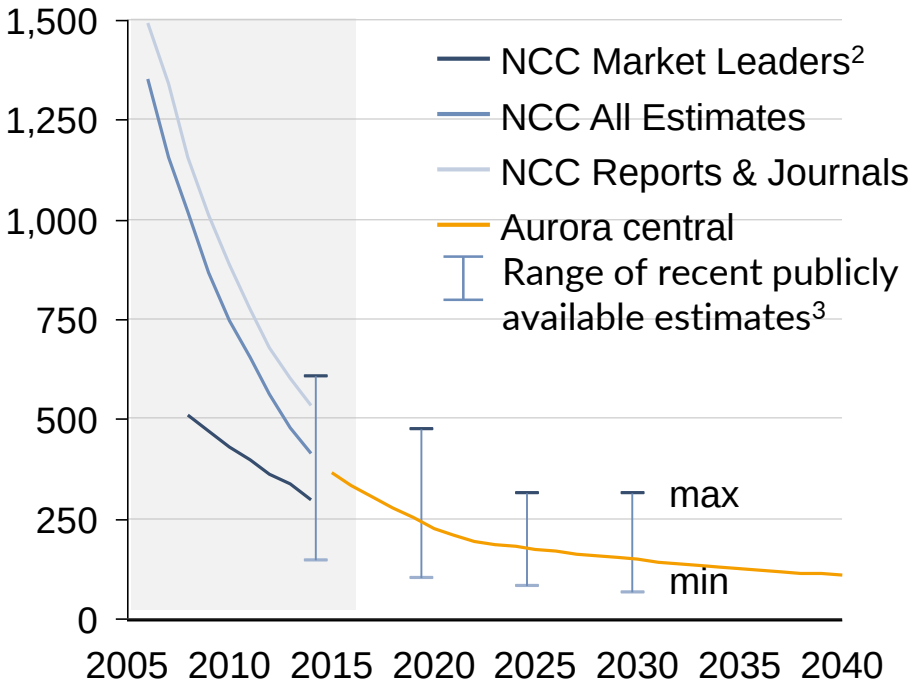
Sources: Aurora Energy Research, The Committee on Climate Change

Battery cost reductions and regulatory push will fuel growth in the number of EVs

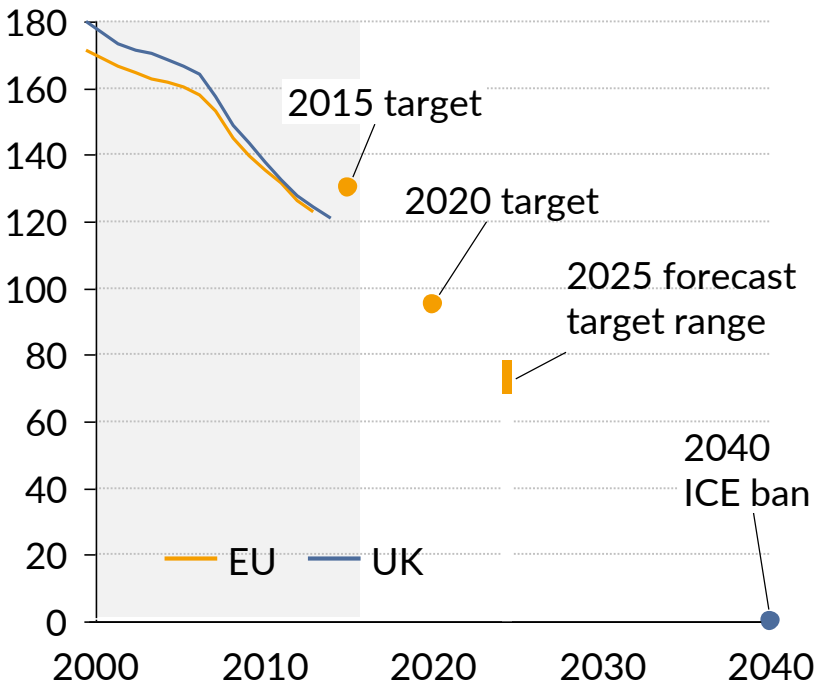
1 While hugely uncertain, battery costs are expected to drop below $150/kWh, enabling competition with ICE[1] vehicles

2 Emission targets for manufacturers will create additional stimulus for supply

Cost of battery pack,
$/kWh



Carbon emissions for an average passenger vehicle in the EU,
g CO_2 per km



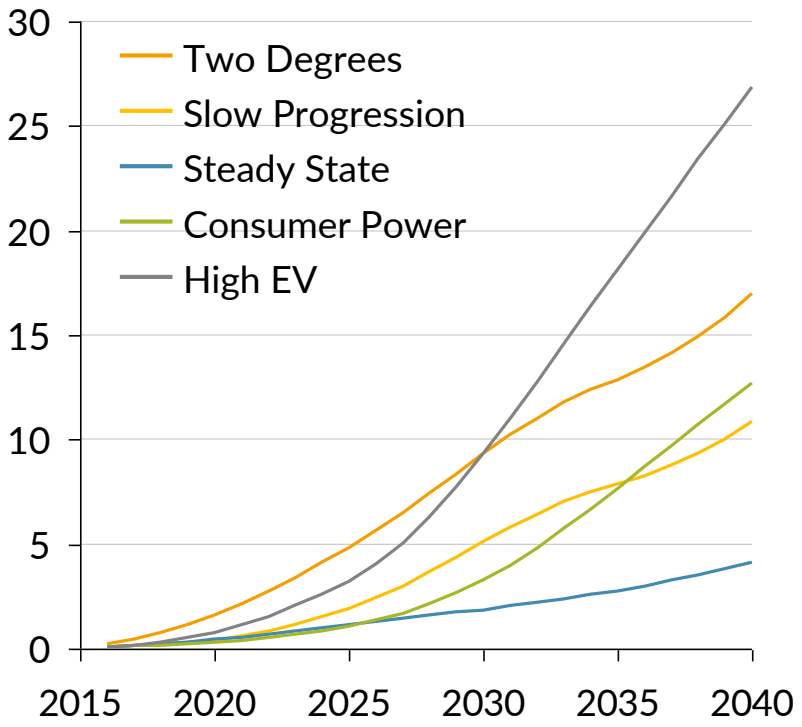
1. Internal Combustion Engine 2. Nature Climate Change (NCC) uses a log-fit of all estimates in the sample. Market leaders include Tesla Model S and Nissan Leaf. 3. Bloomberg, Deutsche Bank and UBS reports on EVs.

Sources: Aurora Energy Research, *Rapidly falling costs of battery packs for electric vehicles*, Nykvist & Nilsson (2015), Nature Climate Change (NCC), Bloomberg, Deutsche Bank, UBS

The pace and scale of EV uptake is uncertain, but could materially increase power demand

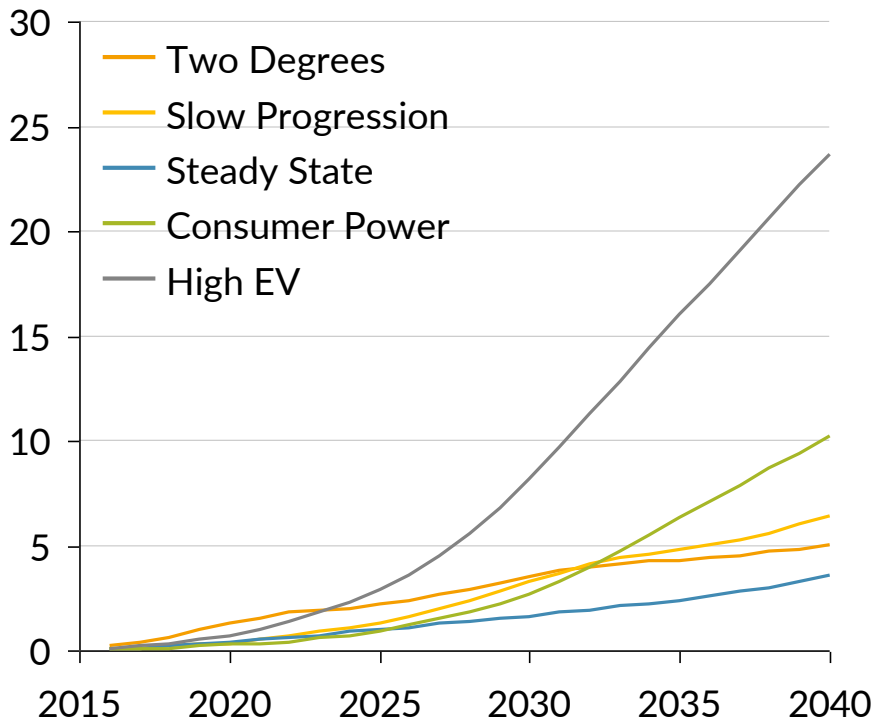
EV uptake scenarios vary widely; National Grid scenarios show 4-27 million EVs by 2040

Total number of EVs in GB[1]



EVs could add up to 24GWs of peak power demand in GB by 2040

Peak power demand for electric vehicles in GB



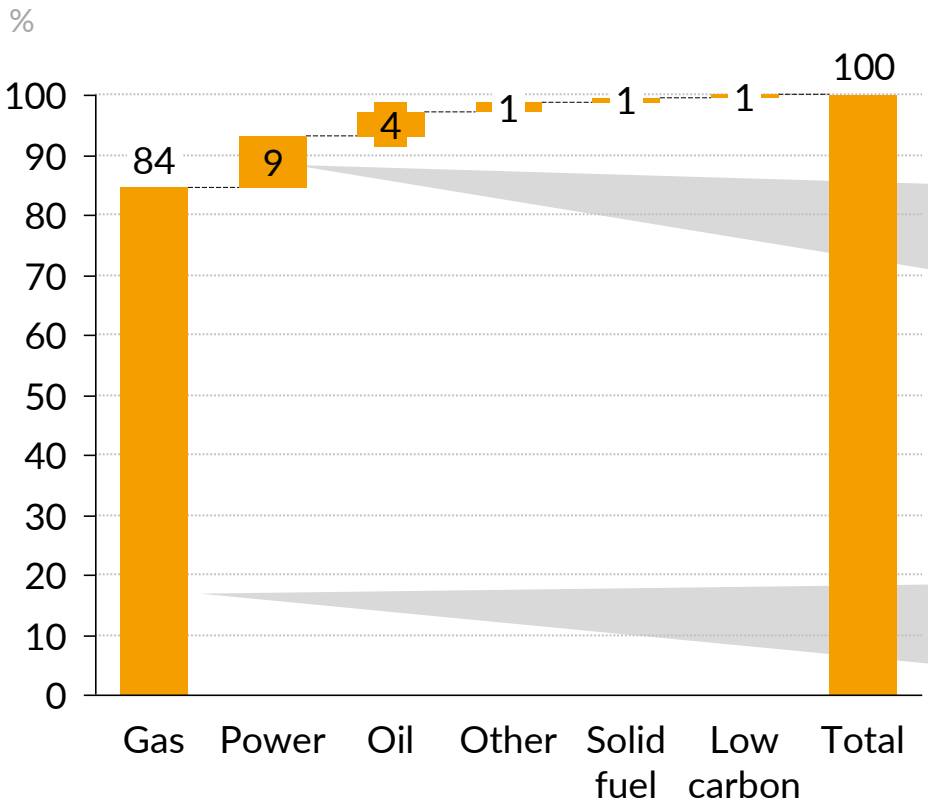
1. Includes Plug-in Hybrids Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs).

Sources: Aurora Energy Research, National Grid,

Economics of electric heat pumps are currently unattractive to households using gas or storage heaters

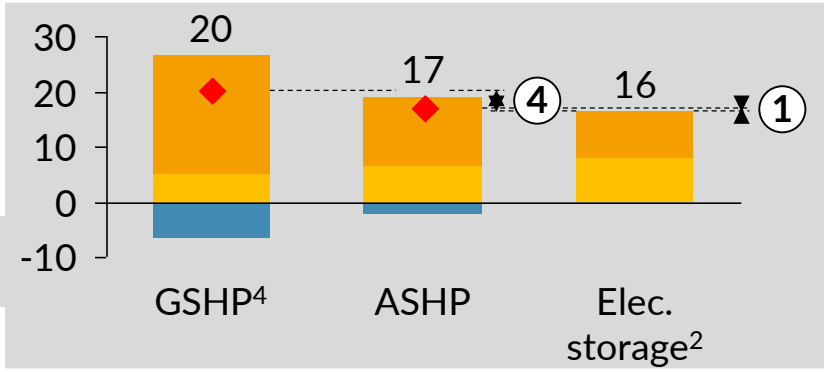
To achieve substantial rollout of electric heat pumps, they would need to eat into the market share of gas and resistive power heating

Residential heating by fuel type

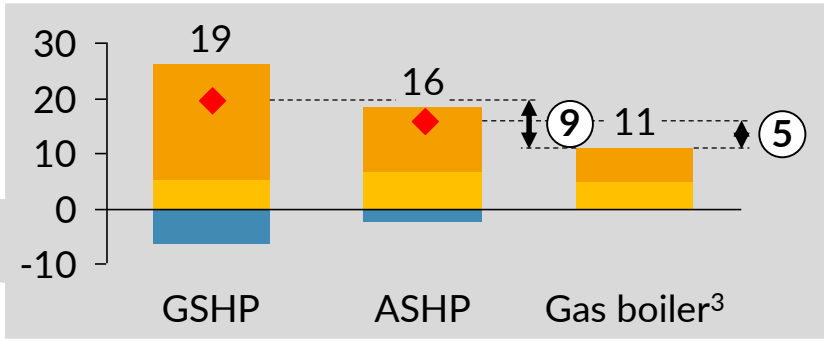


This appears unlikely - their economics are unfavourable, even despite generous subsidies[1]

Cost of switching from elec. storage, £k NPV 2016



Cost of switching from gas boiler, £k NPV 2016

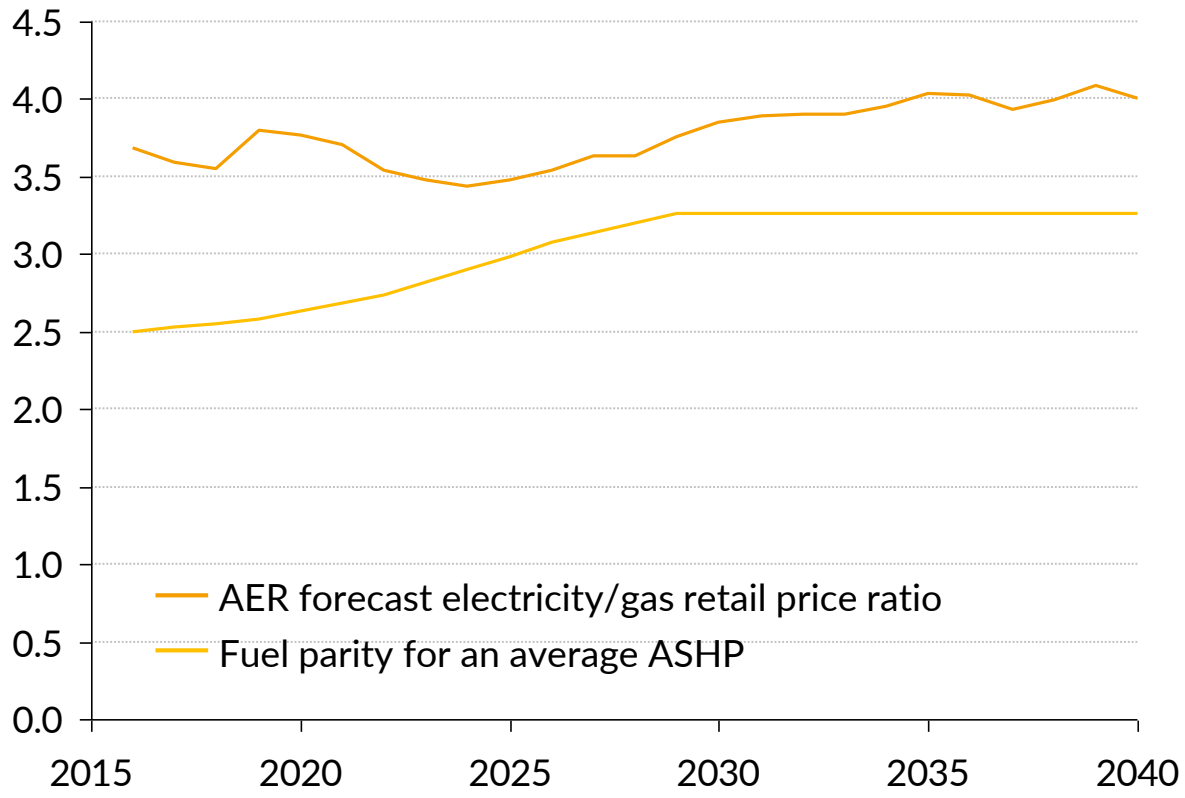


1. Comparison for a 80m2 house. 2. Represents the cost of keeping electric storage. 3. Represents the costs of keeping gas heating. 4. In the vast majority of cases GSHP is unsuitable to replace storage heating, since storage heaters are used predominantly in flats without outside areas necessary to install GSHP. It is included here for indicative purposes.

Source: Aurora Energy Research

Worsening fuel price ratio means heat pumps unlikely to achieve fuel parity with gas boiler without policy intervention

Electricity-to-gas price ratio [per kWh]



- Despite higher efficiencies, heat pump fuel costs remain above the costs of gas heating – driven predominantly by rising costs of electricity subsidies
- Heat pumps are unlikely to replace gas without significant incentivisation
- Aligning the effective carbon prices on electricity and gas could be a game changer, but is politically unlikely
- Other low carbon heating options to investigate include converting the gas grid to hydrogen, gas/electric hybrids, and gas heat pumps.

Source: Aurora Energy Research

Questions for discussion

- What should the Emissions Reduction Plan contain?
- How can Government extend progress beyond the power sector?
- What lessons can be learned from the decarbonisation of the power sector to date?
- How can the Government secure greater emissions reductions from industry, whilst delivering its emerging Industrial Strategy?
- How are policy choices constrained or freed-up by leaving the EU?

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