2050 Energy System - GB

Alex Haffner

Energy Insight Manager

National Grid ESO

ESO Strategic Ambitions

By 2025…

An electricity system than can operate carbon free

A whole system strategy that supports net zero by 2050

Competition everywhere

The ESO is a trusted partner

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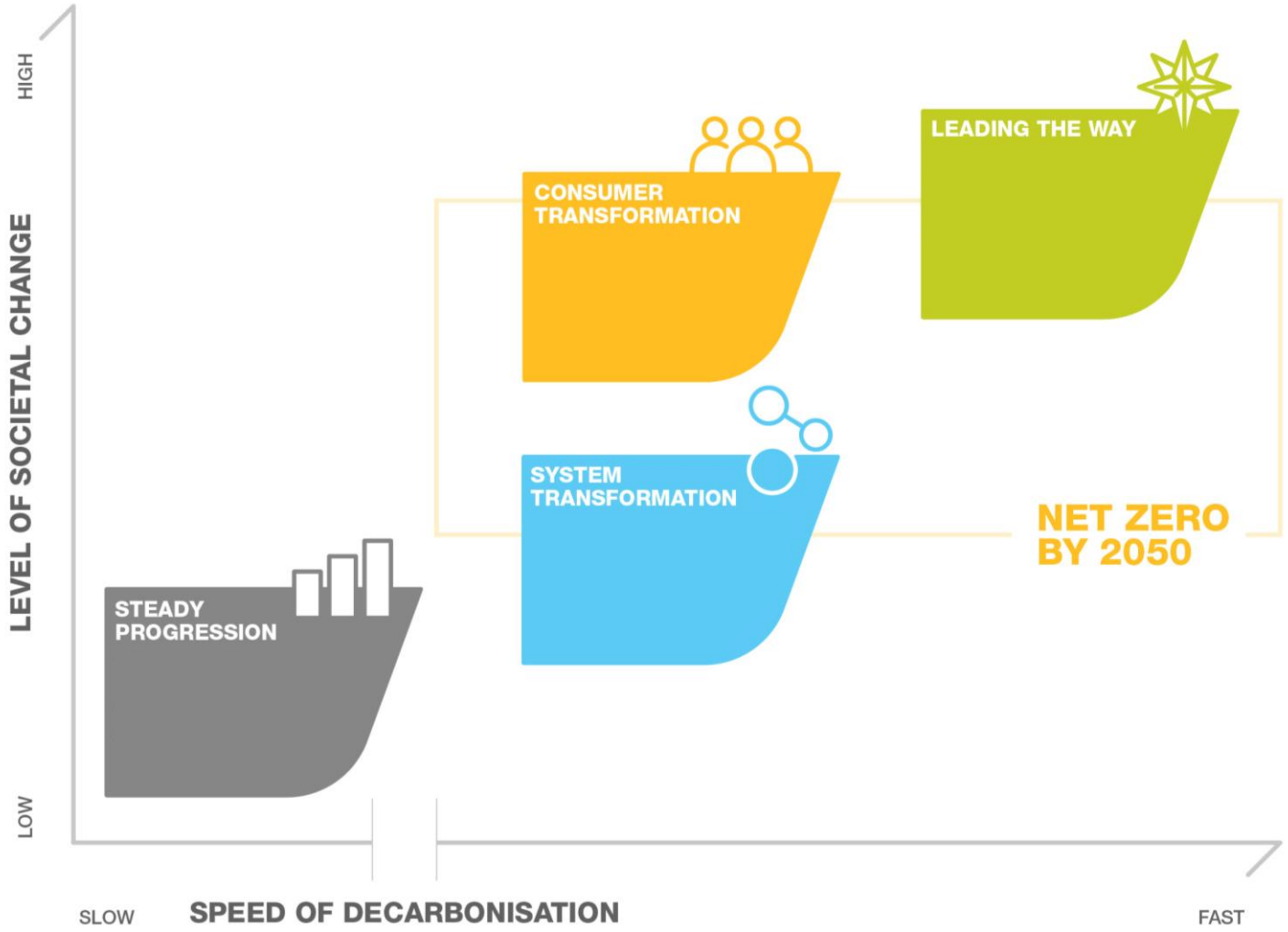
What are the Future Energy Scenarios?



- A range of different, credible ways to decarbonise our energy system towards the 2050 target
- In-depth analysis, stakeholder insight and input from industry specialists
- Collaborative approach ensures breadth and depth of knowledge to develop realistic scenarios for the future of energy
- Used by National Grid ESO and wider energy industry
- Stimulates debate and helps to shape the energy system of the future

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Modelling method

Scenario development

Start

Modelling method

Fixed assumptions and modelling levers

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Whole Energy System Model

Scenario development

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Whole Energy System Model

Energy Demand (all fuels – annual and peak)

- Industrial & Commercial
- Consumer engagement
- Residential appliances
- Residential heating
- Road transport

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Total electricity demand

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Total electricity demand

Electricity Capacity (to meet Security of Supply)

- I/Cs
- Distributed generation
- Transmission generation
- Electricity storage

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Whole Energy System Model

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Total electricity demand

Energy scheduling model (includes hydrogen)

Electricity Capacity (to meet Security of Supply)

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Whole Energy System Model

Total natural gas demand

Total bioenergy demand

Total hydrogen demand

Energy scheduling model (includes hydrogen)

Energy Demand (all fuels – annual and peak)

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Total electricity demand

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Whole Energy System Model

Total natural gas demand

Total bioenergy demand

Total hydrogen demand

Total bioenergy supply

Total hydrogen supply

Total natural gas supply

Energy Demand (all fuels – annual and peak)

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Total electricity demand

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Electricity Capacity (to meet Security of Supply)

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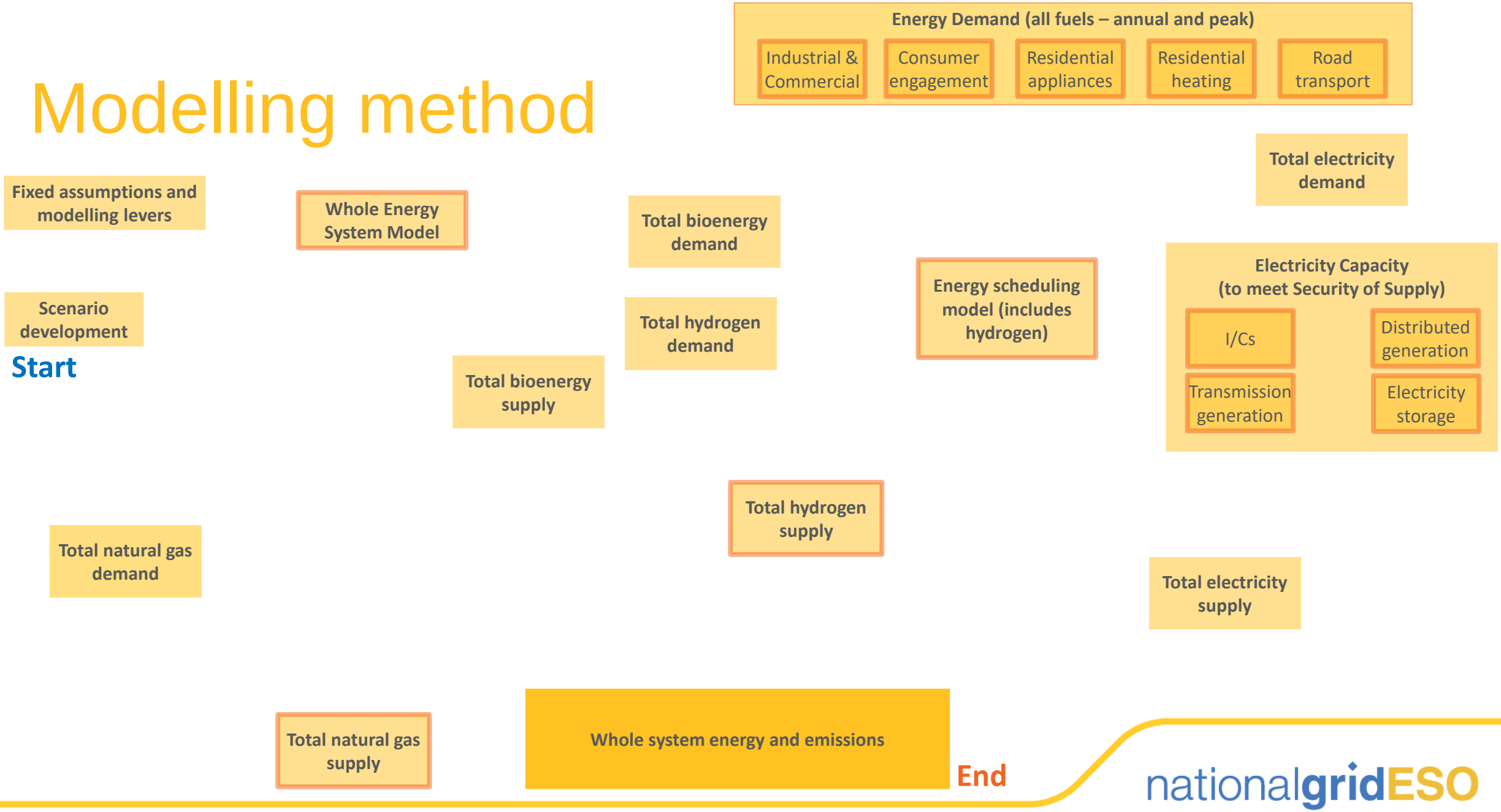
Total electricity supply

Modelling method



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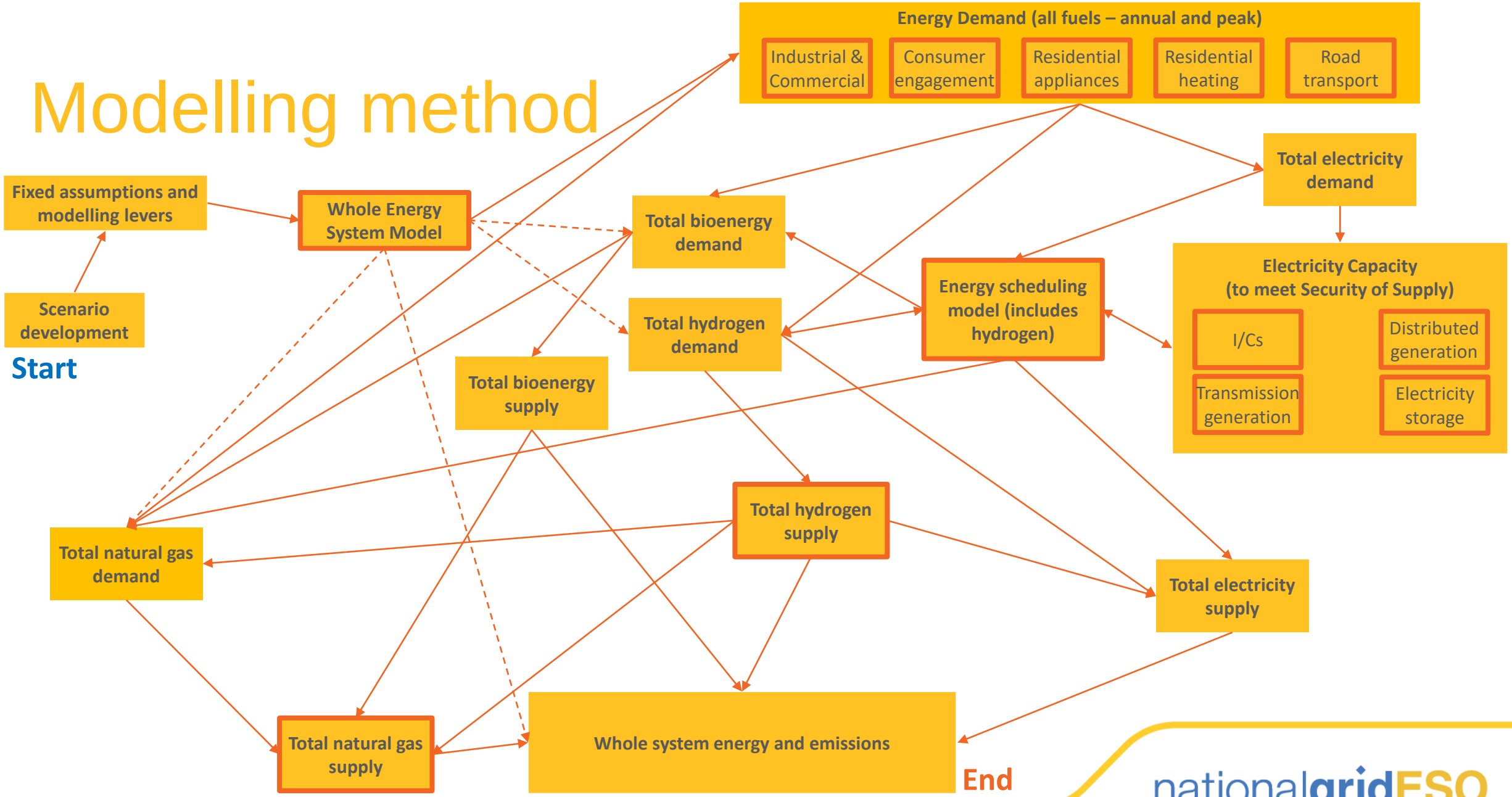
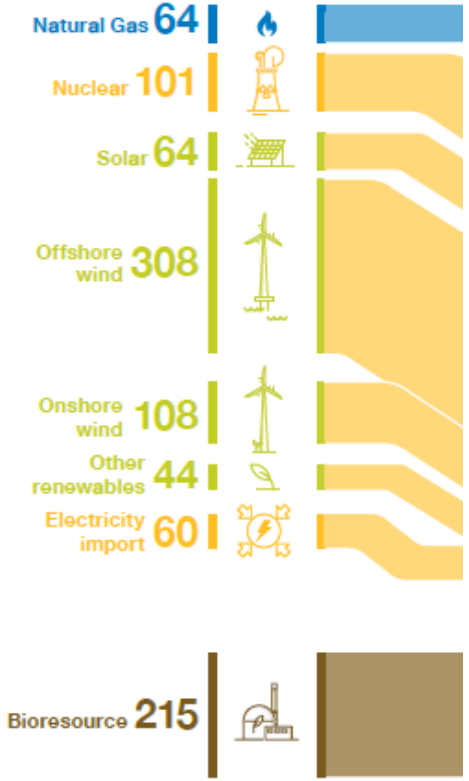


Energy flows in 2050
Consumer Transformation



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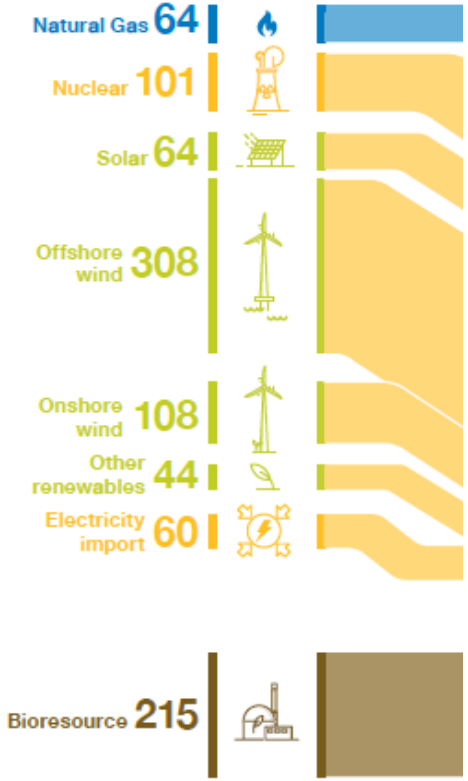

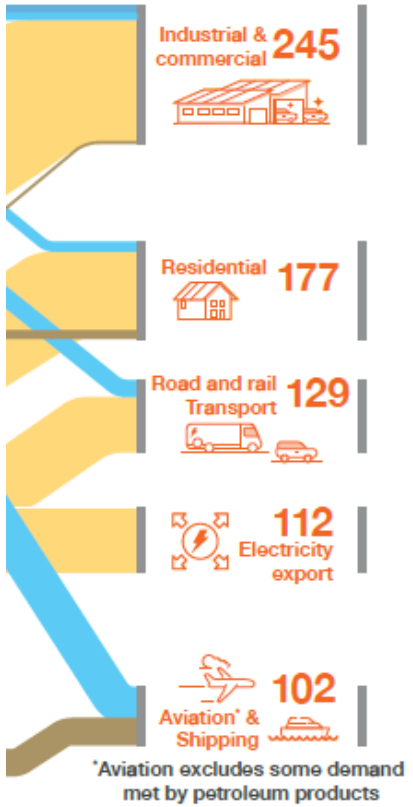

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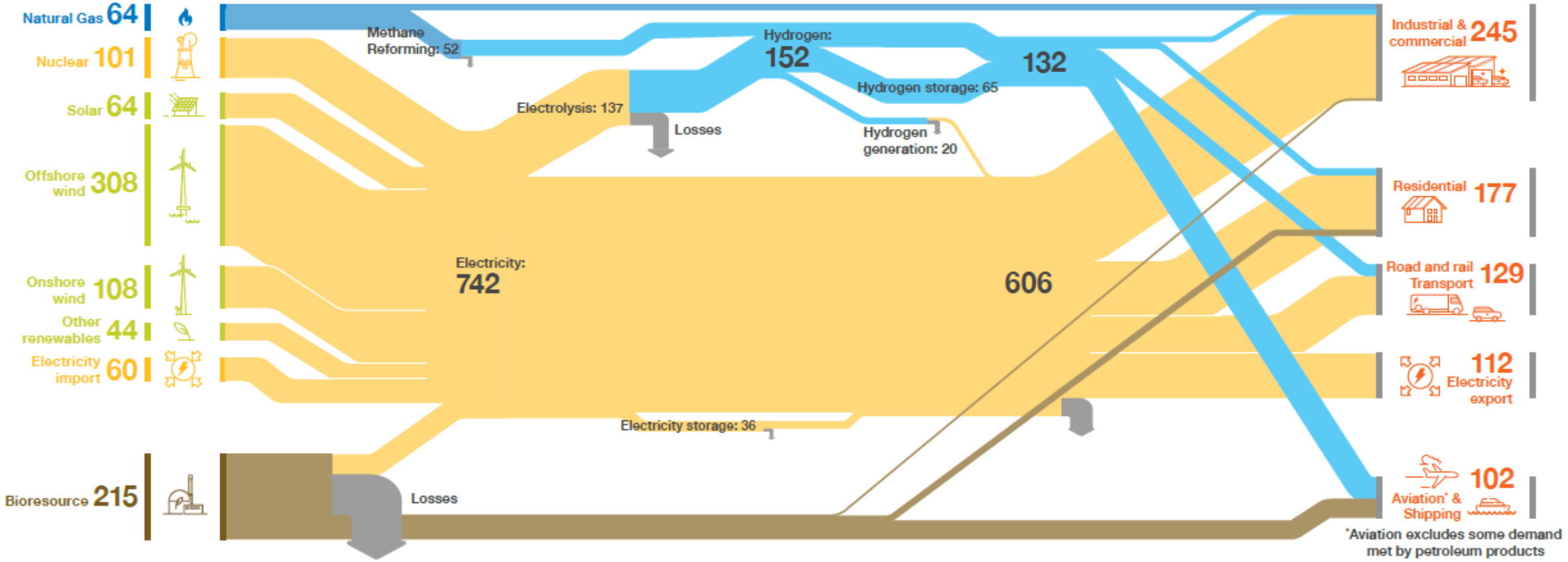
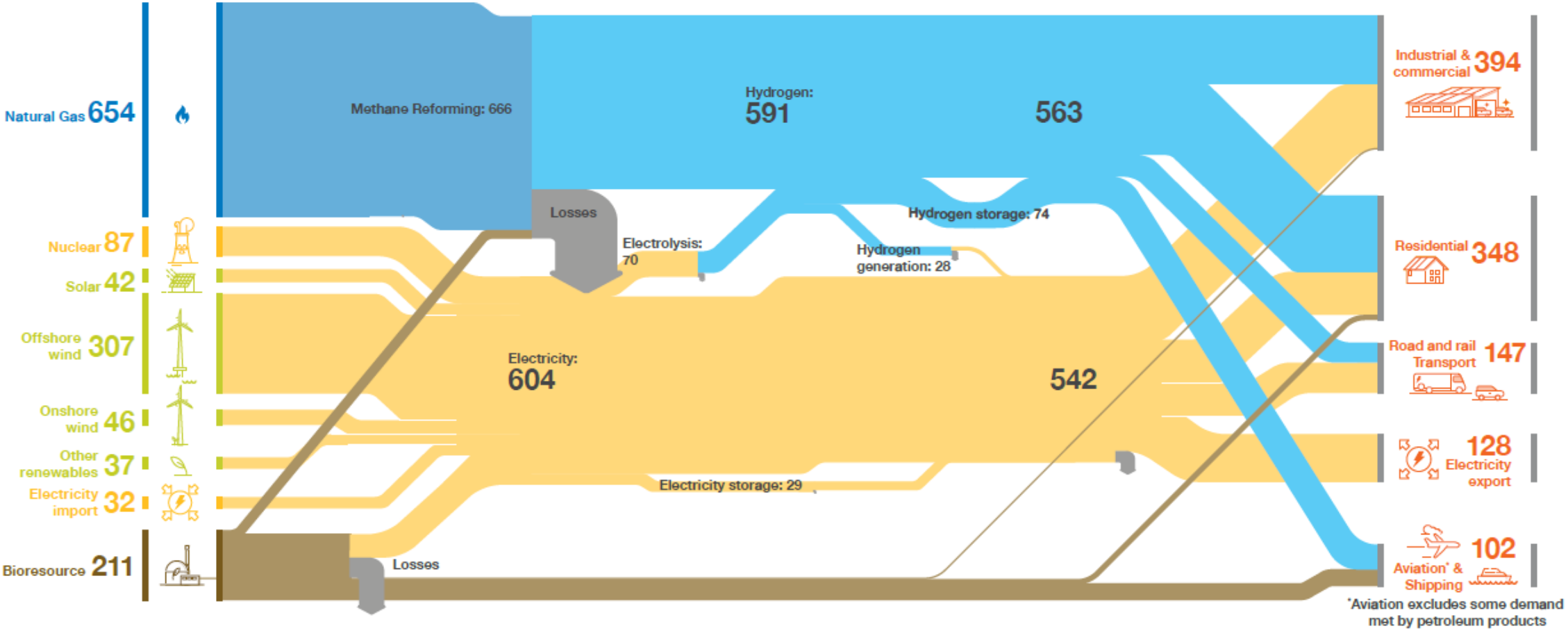
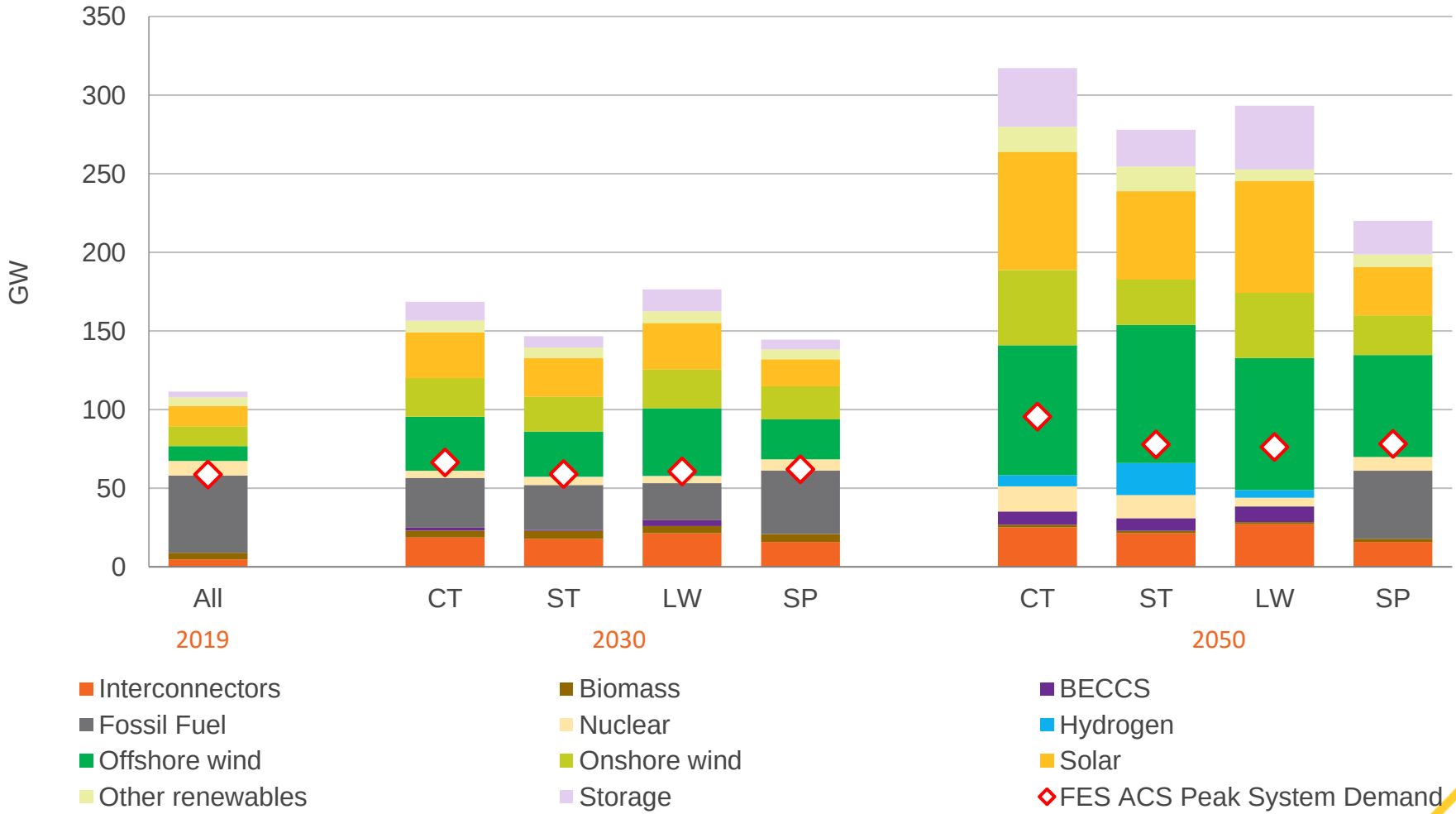


Energy flows in 2050
System Transformation



Changing generation mix



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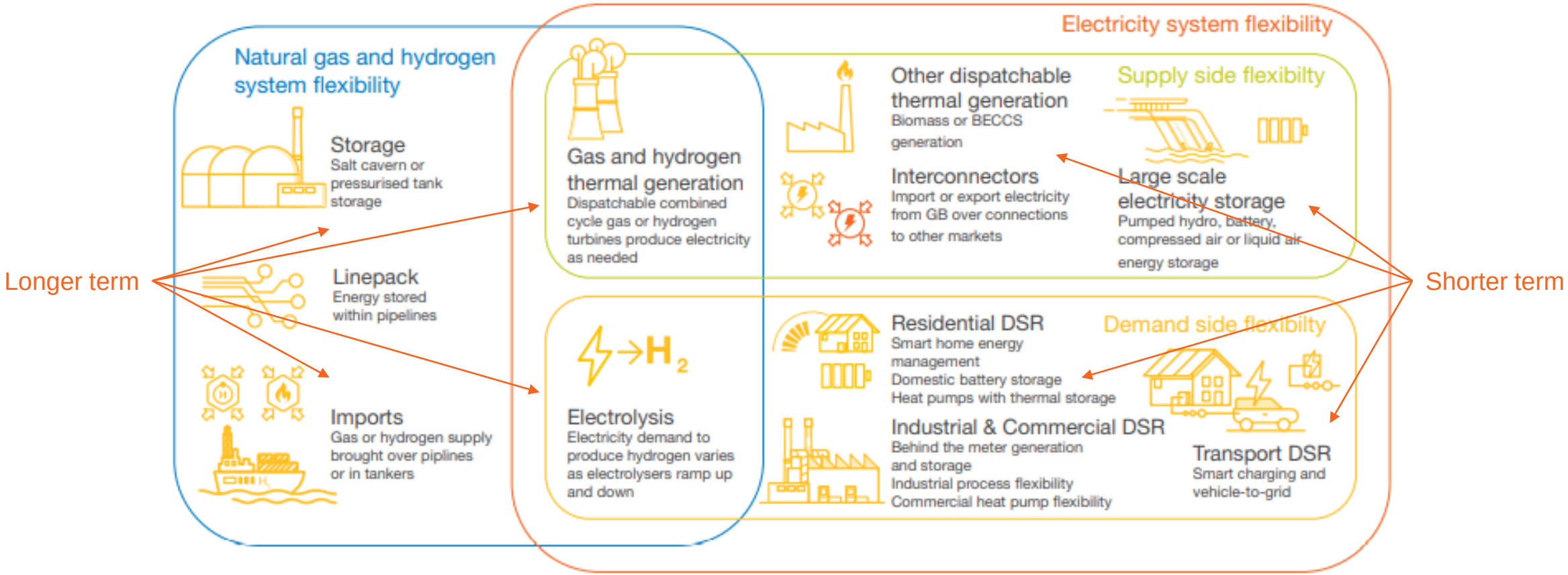
Whole energy system flexibility



Minimum volumes of hydrogen storage across the net zero scenarios in 2050 is **15 TWh**

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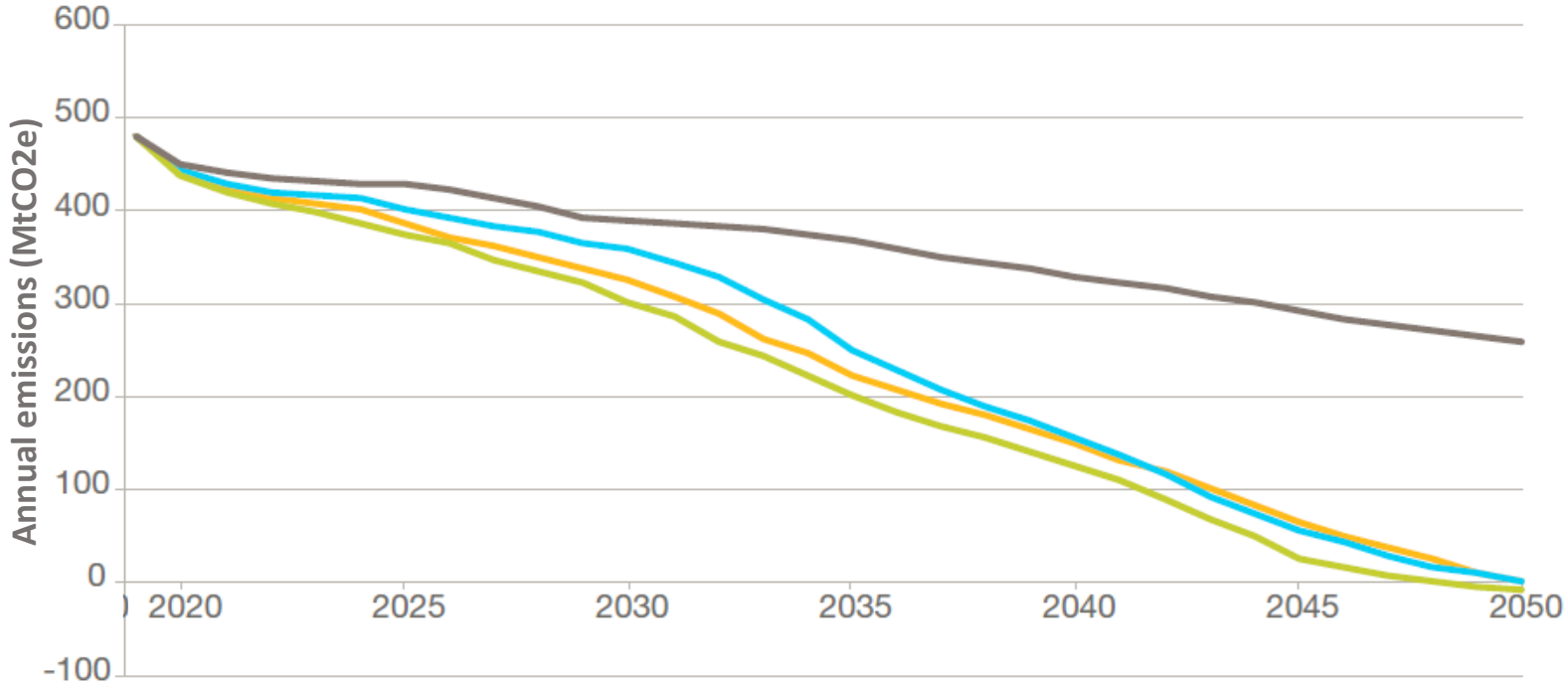
Key messages

Net zero is achievable

Reaching net zero carbon emissions by 2050 is achievable. However, this requires immediate action across all key technologies and policy areas, and full engagement across society and end consumers.



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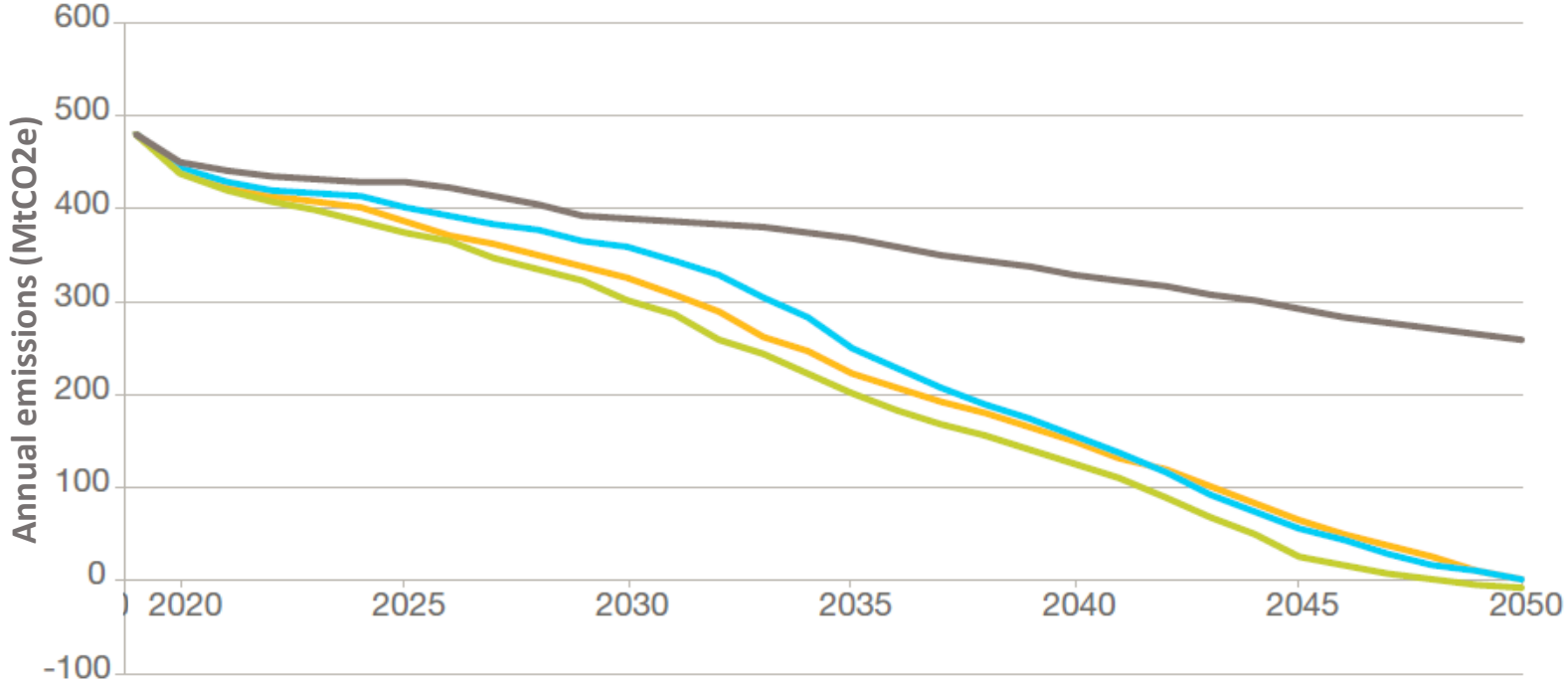

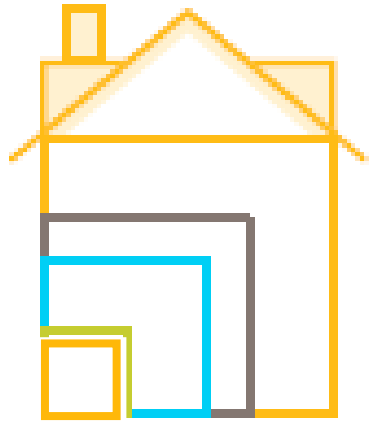

Average home heating energy reduces up to 75%

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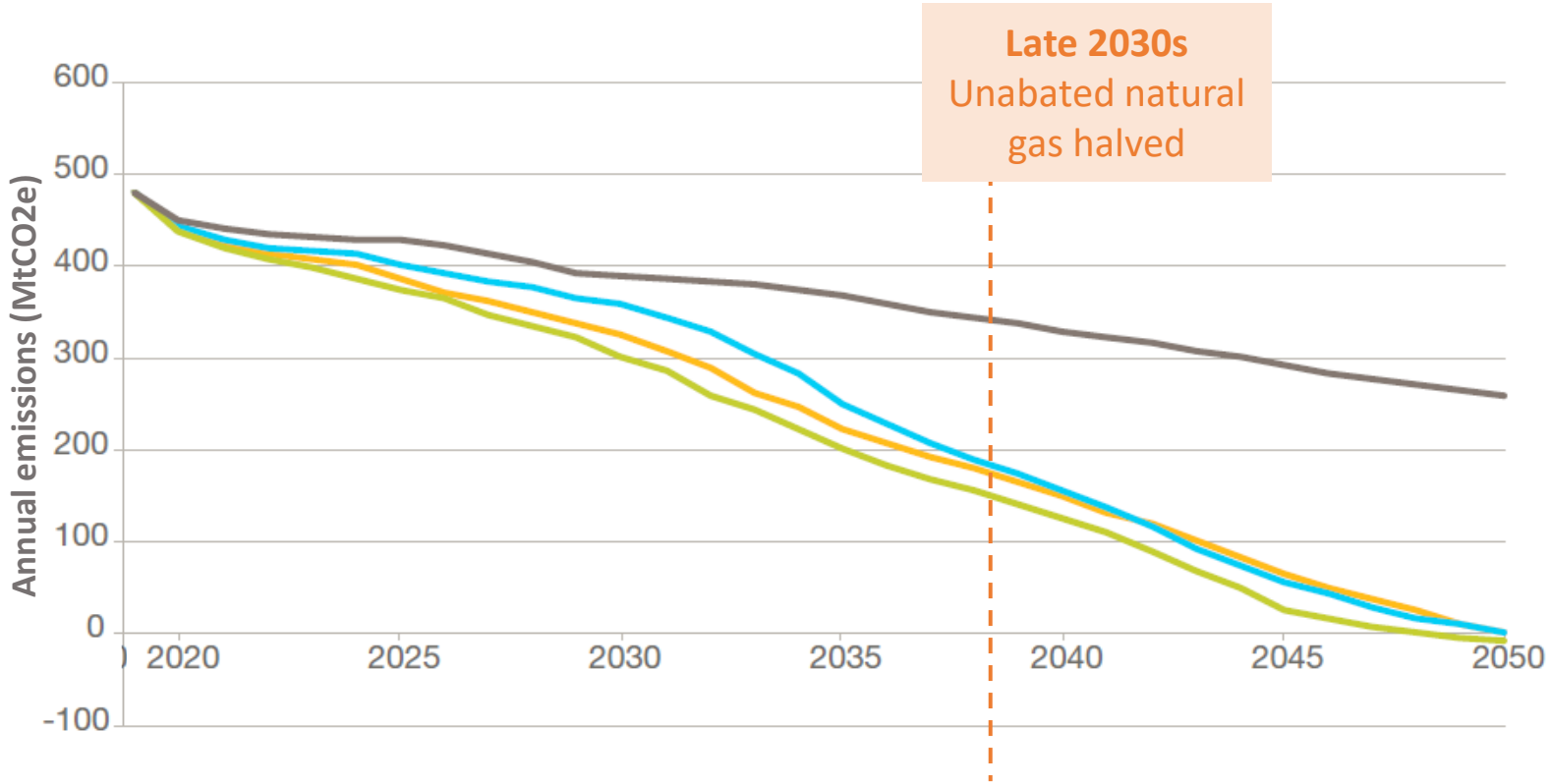

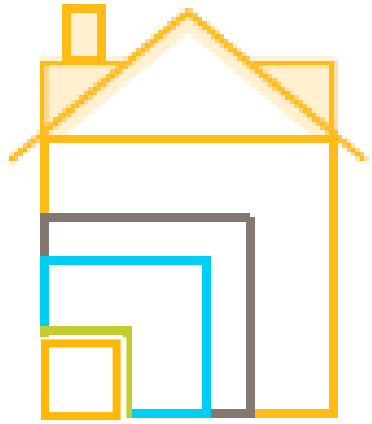

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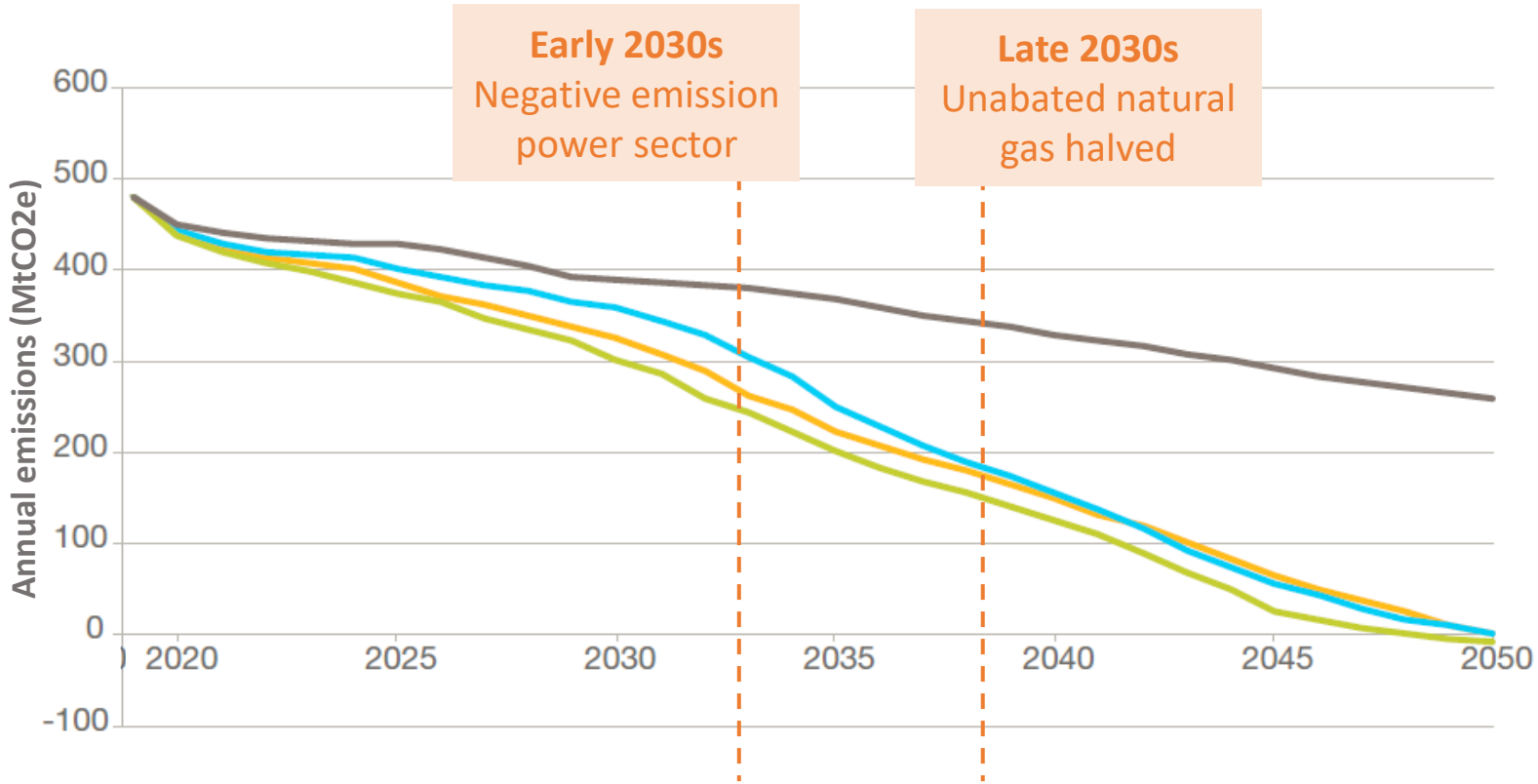

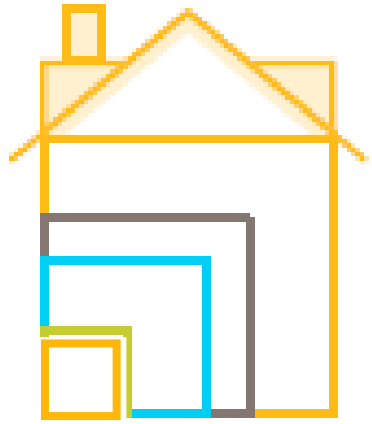

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Key messages

Scaling up new technologies

Hydrogen and carbon capture and storage must be deployed for net zero.
Industrial scale demonstration projects need to be operational this decade.

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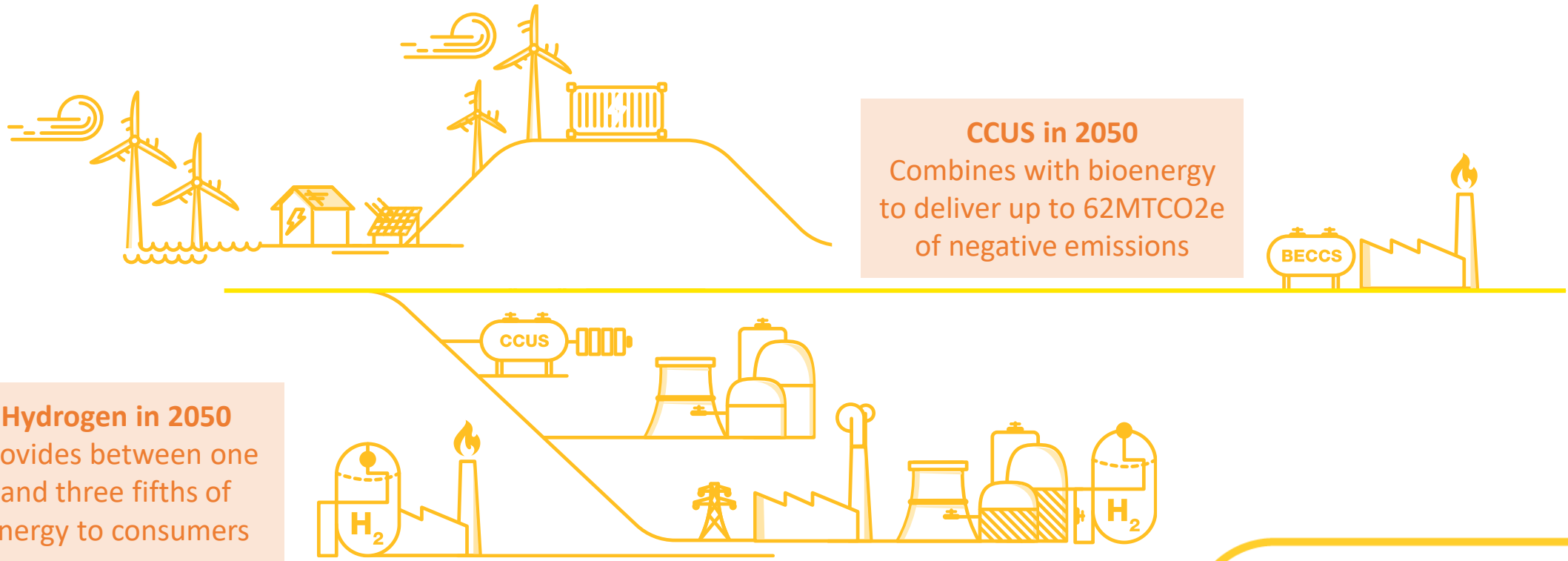

CCUS in 2050
Combines with bioenergy to deliver up to 62MTCO2e of negative emissions

Hydrogen in 2050
Provides between one and three fifths of energy to consumers

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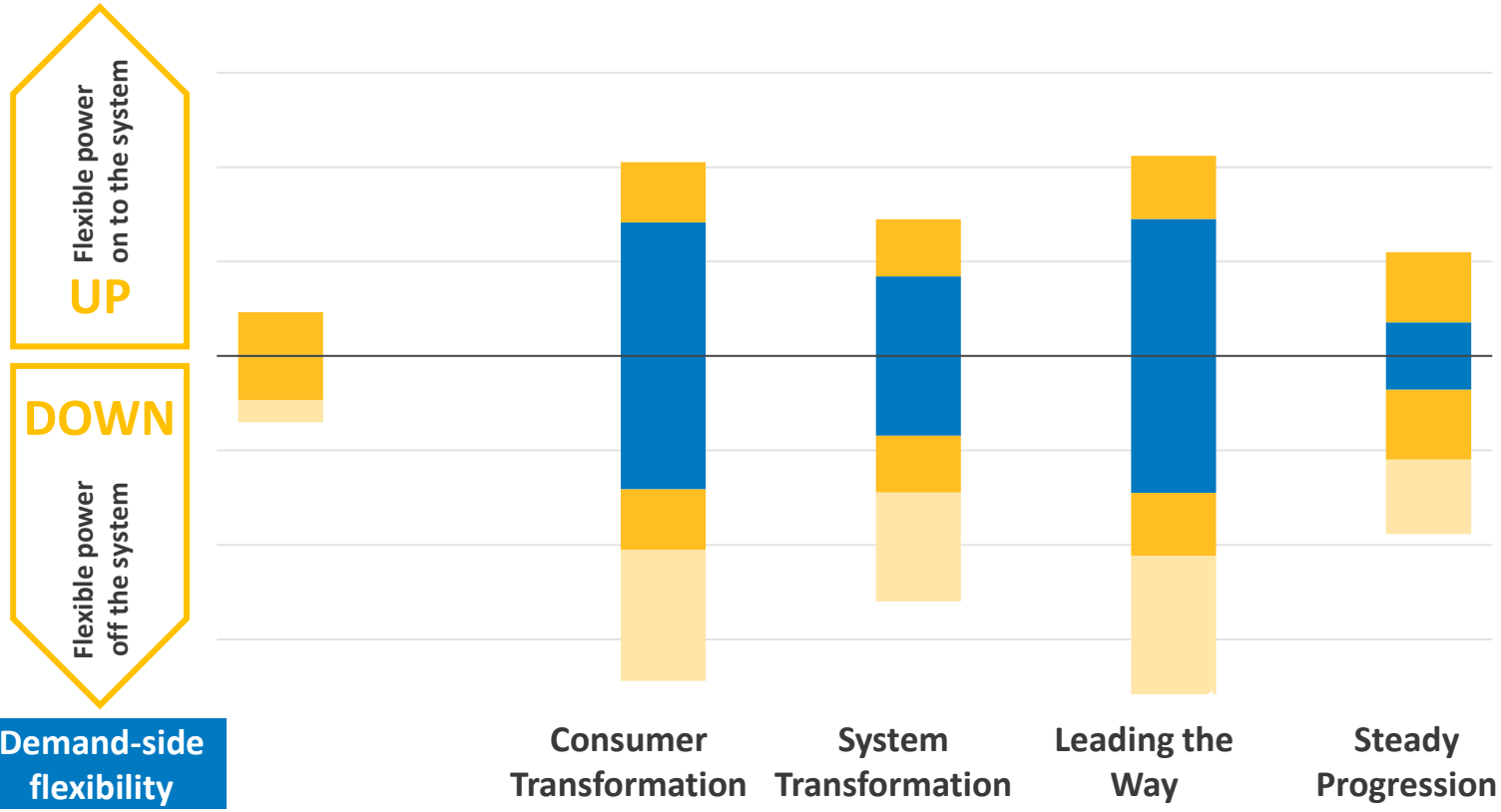
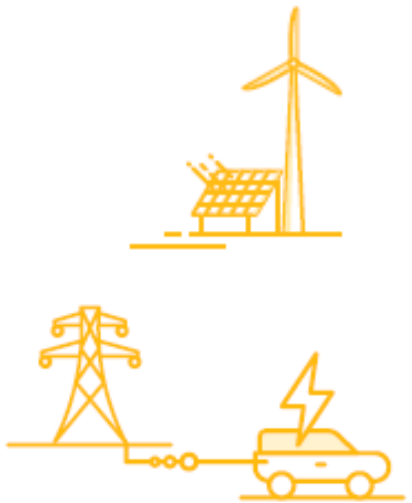
Key messages

The shifting economics of energy

The economics of energy supply and demand fundamentally shift in a net zero world. Markets must evolve to provide incentives for investment in flexibility and zero carbon generation.





Annual new build to 2050
3GW wind
1.4GW solar

Vehicle-to-grid
5.5m vehicles could provide up to 19GW of flexibility

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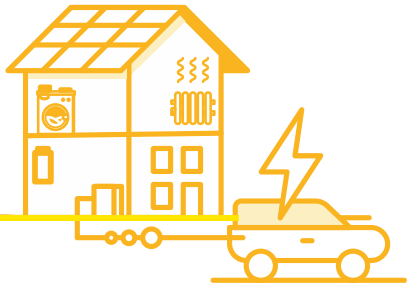
Key messages

Whole system digitalisation

Open data and digitalisation underpin the whole system thinking required to achieve net zero. This is key to navigating increasing complexity at lowest cost for consumers.

Vehicle charging in 2050
Up to 80% of vehicles could smart charge in 2050, and 45% may fully engage in energy markets for vehicle-to-grid services



Smart heating in 2050
Nearly half of homes respond to market signals and shift peak demand with thermal storage or hybrid heat pumps

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FES Costing - approach

Drivers
Power generation capacity (type, GW)
Number of vehicles (#, type)
Fuel consumption (TWh)
Peak demand (GW)
…

×

Cost database
Cost per GW (type, £/kW)
Cost per vehicle (#, type)
Fuel costs (fuel type, TWh)
Network reinforcement cost (£/GW)
…

=

Total energy system costs
(including ….)

- Transport (EVs, hydrogen, fuel costs)
- Heat (new boilers, insulation etc.)
- Power (generation, storage)
- Networks (gas, hydrogen, electricity)
- Other (industrial CCS etc)

All drivers have come from the FES outputs

The Costs used are based on Afry's Cost Database with some updates based on costs published in FES

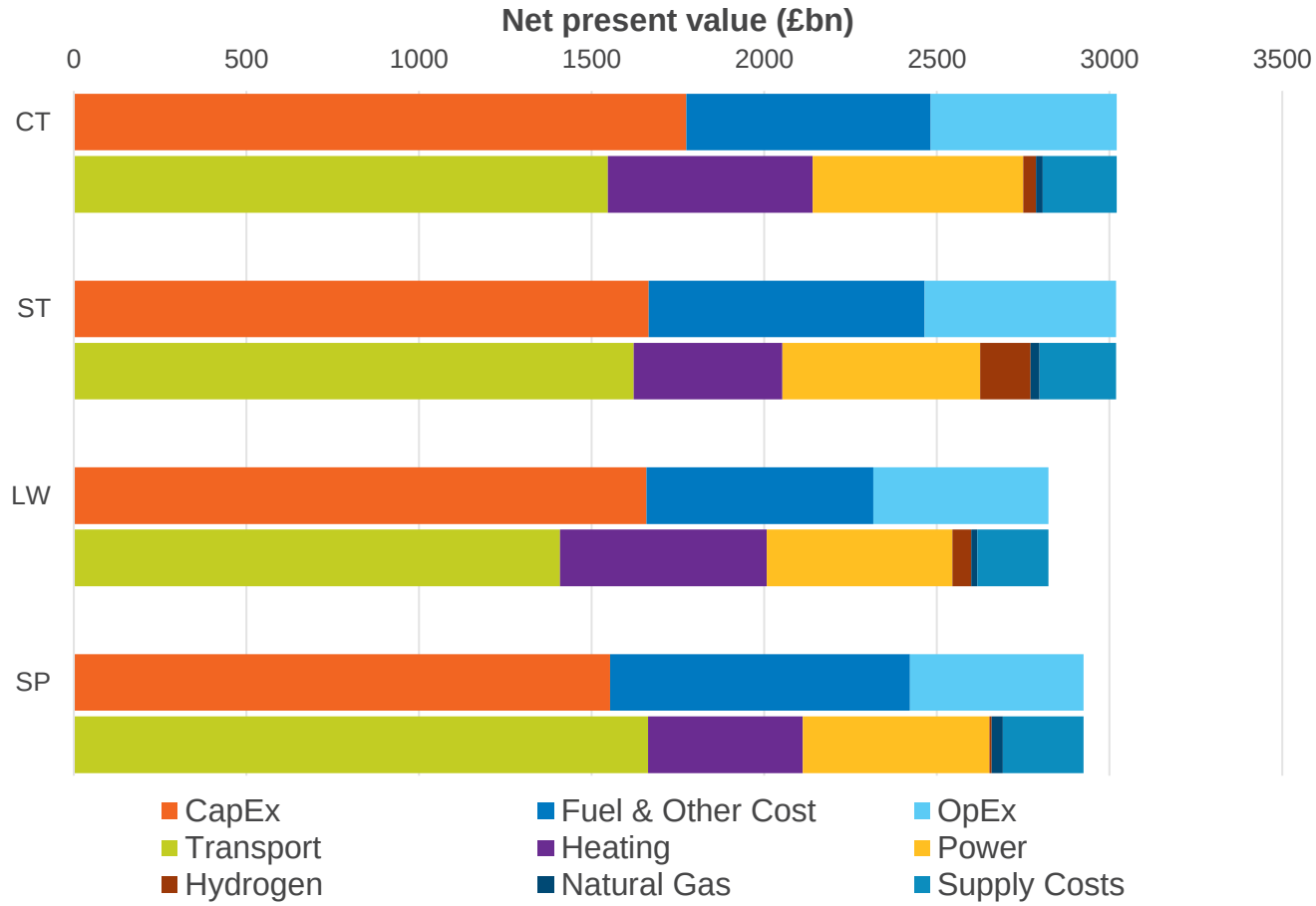
When presenting the net present value a 3.5% social discount rate has been considered as per HM Treasury Greenbook recommendation.

FES assumes an unconstrained network. For the costing project we have included some basic cost assumptions for the networks.

When studying the costs we have included the costs at the point where the driver increases and not spread them over the lifetime of the asset.

FES costing - results

- There is only a 7% difference in overall costs across the scenarios
- Transport and Heating are big factors in the overall costs.
- Increased consumer engagement, negative emissions and energy efficiency drives the cheapest scenario.



FES costing - results

- There is no major cost difference between scenarios until 2045 with cost remaining around the same levels as today.
- Leading the Way shows divergence from the mid 2040s