UK Power Networks
Delivering your electricity

Towards a net zero energy future

Distribution Future Energy Scenarios

Executive summary

Contents

"Understanding the different routes the UK could take to achieve Net Zero is critical to ensure we as a network operator can facilitate this transition in a fair and efficient manner"

Welcome to our summary report for the 2022 UK Power Networks Distribution Future Energy Scenarios (DFES). This summary report is intended to give an overview of what the DFES is, why it's necessary, and to share some of the key insights gained from this piece of work.

Last year was a year of significant change for the UK with regards to decarbonisation, with a number of key developments being announced by the UK Government. Building on the Government's commitments in Energy Whitepaper and Ten Point Plan, we have seen the publication of the UK's Transport Decarbonisation Strategy, Heat and Buildings Strategy, Hydrogen Strategy and of course the overarching Net Zero Strategy. This is in addition to the UK hosting COP26, which saw countries from all over the world make collective agreements to limit climate change. Our role in facilitating the UK's ambition of achieving Net Zero emissions by 2050 will be our defining responsibility over the coming years and decades.

To that end, UK Power Networks is leading the way in facilitating the decarbonisation of heating, the uptake of Electric Vehicles (EVs), and the building of a smart grid for all. Sophisticated forecasting, such as this DFES, will be key in allowing us to facilitate the transition to low-carbon technologies in an efficient and cost-effective way.

Low-carbon technologies have seen significant growth over the past year, and EVs especially are beginning to hit the mass market – in October 2021 almost one in four new vehicles bought in the UK were electric. However, the take-up of low-carbon heating systems has been slower, which is why we are glad to see the publication of the Heat and Buildings strategy, and believe it provides a clearer direction of travel to enable the UK to decarbonise this sector.

Suleman Alli
Director of Strategy
and Customer Services

Executive summary continued

Tackling climate change cannot be done solely at a central Government level however, and over the last year we have seen more and more county councils and local authorities declare climate emergencies and develop their own climate action plans. In some instances, these involve ambitions to become Net Zero ahead of the national 2050 target. We have held extensive engagement sessions with regional governmental bodies across our licence area to better understand their climate plans, and to explain how we plan to facilitate their climate ambitions over the coming years. We aim to ensure that our DFES provides as much value to regional bodies as possible, so we were glad to receive feedback that our DFES forecasts have been useful in informing of some of these climate plans.

Based on engagement with our regional planning stakeholders a key element of our RIIO-ED2 plan is the establishment of a dedicated Local Area Energy Planning team. We believe this will continue and strengthen the working relationships we have with regional governmental bodies and help the facilitation of Net Zero to happen in a just and efficient way.

As with last year, this year's DFES aligns with the scenario framework set out in National Grid's Future Energy Scenarios (FES) work. The scenarios are comparable in terms of the level of societal change and speed of decarbonisation. However, the DFES remain independent forecasts that are bespoke for our region. This alignment is done to make the information comparable across different Distribution Network Operators (DNOs) such as ourselves, as well as National Grid, and therefore more useful to our stakeholders.

We update the DFES annually to ensure we stay up to date on policy and market developments. We are still working to understand the effects on energy usage the COVID-19 pandemic has had, and for how long these effects will endure for. If you have any feedback on the DFES, or can think of ways to improve it, please let us know by via email by contacting **DFES@ukpowernetworks.co.uk**

Forecasts resolved for roughly

11,000

individual areas

Scenarios comparable

across DNOs and National Grid

Why we're developing the DFES

The UK is at the beginning of a period of significant change. As we move away from fossil fuels and towards cleaner low-carbon technologies (LCTs), different areas of the UK will see these technologies installed at different rates, especially over the coming decade.

The speed at which these technologies get adopted in different areas will depend on a variety of factors such as the affluence of an area, the ambition of regional governmental bodies, and the geography of the area.

As different areas decarbonise at different rates, we will start to see clusters of LCTs emerge. For technologies like EVs and electric heat pumps, this represents a challenge for the network in being able to connect these technologies whilst maintaining a safe and reliable source of power. Our goal is to ensure we are not a blocker to achieving Net Zero. However, it takes time to reinforce the network or deploy smart solutions to accommodate any sudden influx of LCTs. Which is why we need geographically specific forecasting to know where these clusters are going to be, allowing us to ensure our network is ready.

Granular forecasts

help predict locations of LCT clusters, allowing us to reinforce the network or deploy smart solutions

Due to rapid developments within the energy sector, we refresh the DFES annually to ensure our forecasts are up to date. Key developments since the publication of the previous DFES that were captured this year include a rapid drop in battery prices, limits in EV supply, and the Governments' ambition to phase out of fossil-fuel generation by 2035.

In addition to the DFES being used by ourselves to plan our network investment strategy. We believe it represents a useful resource for regional governmental bodies to help plan their climate strategies. After our round of engagement last year, we found that 90% of local authorities who responded to our survey said they plan to use DFES data to inform their climate action plans. This is why we continue to make all our DFES work publicly available on our **website**.

This includes:

- **The technical report**, outlining the modelling process for each of the individual drivers forecasted;
- **The forecasts**, in excel format, resolved to a high degree of granularity allowing users to find forecasts specific to their location;
- **The interactive map**, which visualises and animates the forecasts, allowing users to access the data in a more intuitive way; and
- **This summary report**, presenting an overview on the key messages from our DFES work.

What are the DFES?

The Distribution Future Energy Scenarios are a collection of forecasts of key drivers out to 2050, designed to provide an insight into the expected decarbonisation trajectory under different sets of assumptions.

The drivers are collected into scenario "worlds" which describe the policy and market environments in which the forecasts take place. These scenario worlds reflect the variation of factors such as low-carbon subsidies, the availability and viability of hydrogen, and the dates at which existing technologies such as gas boilers are banned. For example, our Consumer Transformation scenario describes a world where consumers engage with the electricity market through smart technologies, and electric heat pumps become the primary heating source. Having these scenario worlds gives us a range of energy pathways to analyse, enabling us to better understand the potential impacts of different policy directions the government may take.

A key element of the DFES, which helps to distinguish it from other forecasts, is the level of granularity they are done at. There are many UK level forecasts of key LCTs, and these all provide valuable insight into the level of uptake we can expect. However, in our various engagement sessions, it was highlighted to us that regionally specific forecasts would be valuable in informing policy decisions and action plans at a local level. We took this feedback on board and made it so that every regional body in our licence area has a forecast for their area. Making the forecasts as granular as possible means that we can also reflect local factors in our modelling. This then informs our investment strategy and aids us in facilitating decarbonisation plans as efficiently as possible.

What drivers are we modelling?

The DFES consists of forecasts of different drivers that will influence the speed and direction of the UK's transition of Net Zero. These include drivers that will directly add load on the network, such as EVs and solar photovoltaic (PV) systems; and those that determine how much load will be added, such as appliance efficiency and battery storage units. All together these drivers provide a comprehensive energy pathway out to 2050 for each of the four scenario worlds.

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Individual drivers and technologies modelled out to 2050

A number of drivers were identified as having a key role in influencing future demand and generation on our networks, these were:

Core Demand
- Building energy efficiency
- Domestic building stock growth
- Industrial and Commercial (I&C) building stock growth

Low-carbon Transport
- Electric vehicles (cars and vans)
- Electric vehicles (buses, coaches, and heavy good vehicles)

Battery Storage
- Domestic battery storage
- I&C behind-the-meter battery storage
- Grid scale battery storage

Decarbonised Heating
- Low-carbon heating technologies
- District heating

Distributed Generation
- Solar photovoltaic (PV)
- Onshore wind

Flexibility
- Electric vehicle smart charging
- Demand Side Response (DSR)

Our licence area and DFES data

We are the UK's biggest electricity distribution operator, delivering power to 8.4 million homes and businesses across London, the East, and South East. Our area of operation consists of three separate regions, called licence areas:

- **Eastern Power Networks (EPN)**
- **London Power Networks (LPN)**
- **South Eastern Power Networks (SPN)**

Note that whilst these three areas are broadly similar to the Governmental Office Regions of East of England, London, and Southeast of England, their boundaries differ considerably and so our licence areas should not be mapped directly to these regions.

When the DFES forecasts were created, we had to decide what level of granularity would be appropriate. Whatever level we chose had to be easily mappable onto regional governmental areas such as a Local or Unitary Authorities, as well as small enough to reflect regional variations and be applicable to individuals. We decided the best geography that would satisfy our requirements would be the standard Office of National Statistics region called Lower Layer Super Output Areas (LSOA). These areas are approximately equivalent to 800 houses and are standardised – meaning they can easily be aggregated up to Local Authority and County Council level.

There are roughly 11,000 LSOAs in our area, and as each driver has a forecast under four scenarios for the next 31 years, there are over 1.3 million data points contained within each forecast.

Eastern Power Networks

We deliver power to the East of England region which extends from the Wash in the east, to North London and the Thames estuary, encompassing a diverse range of urban and rural areas as well as a huge coastline.

London Power Networks

We look after the electricity network for Inner London, with responsibility for delivering power to iconic buildings and businesses as well as high-profile international events throughout the year.

South Eastern Power Networks

We serve South London, Kent, East Sussex and parts of Surrey and West Sussex, covering a rich variety of customers and locations.

How stakeholders have informed our DFES

This is our third DFES, and each year we vary the engagement we do to ensure we consult a wide range of stakeholders and collect as much feedback as we possibly can.

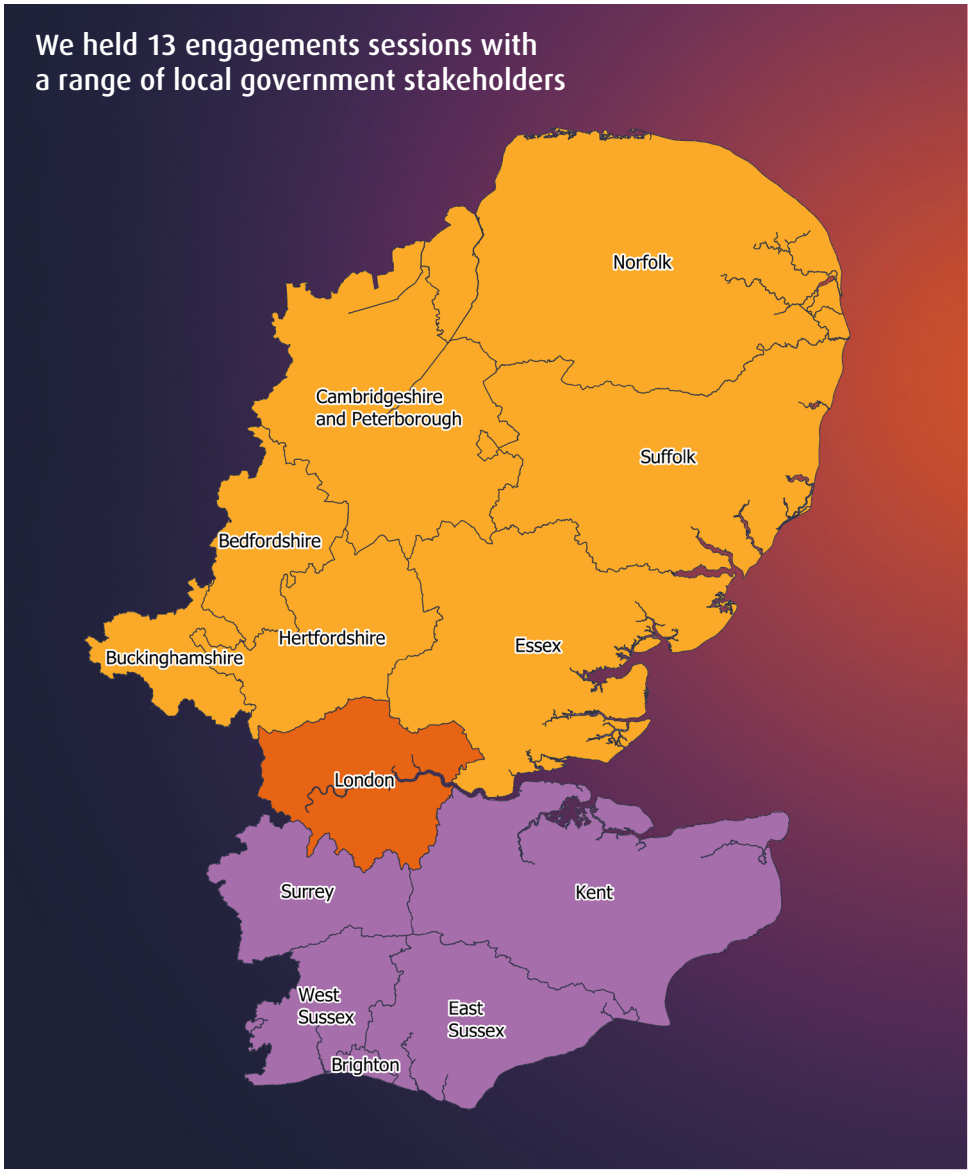
The first year we focused mainly on industry experts to better understand some of the technological and logistical considerations. Last year we focused on regional governmental bodies to better understand the level of ambition in our area. This year we built on last years learnings and engaged with regional governmental bodies again, showing them our expected level of uptake for key LCTs in their area. Feedback varied but overall most believed that our forecasted LCT uptake was in line with what they were expecting.

There are 127 regional planning authorities in our licence area so we segmented our engagement, broadly along county council boundaries, into 13 areas, enabling us to hold bespoke sessions for each area. Additionally, we held three webinars – one for each licence area, to go through our DFES outputs at a higher level.

Over the course of our engagement, we found that more and more regional governmental bodies are developing their own climate action plans and we are working with them to ensure we support them where we can. A key piece of feedback we received was that while some of the users of our Open Data Portal found the detailed DFES data useful, others stated that they would prefer ready-to-use information that matches the resources and capabilities they have available. We provided this in the form of our DFES interactive map, which is available on our Open Data Portal and our website.

> The visualisations are so much easier to interpret than the raw data sets and will be invaluable in developing our plans to support decarbonisation of public transport as part of our ambition to achieve Net Zero carbon emissions for our operations by 2030."

Daire Casey,
West Sussex County Council



Our scenario worlds

The DFES forecasts are collected into four overarching scenario "worlds" that describe how the UK energy system could work. The scenarios range in both their scope and speed of decarbonisation, as well as the level of societal change.

Two of our scenarios, System Transformation and Consumer Transformation, achieve Net Zero by 2050, although they do so in different ways. Consumer Transformation considers a world where consumers engage with the electricity market though smart devices, the UK's heating demand is predominantly met by heat pumps and district heat, and there is widespread small-scale solar generation and battery storage. Meanwhile, System Transformation considers a world where the existing gas grid is repurposed to use hydrogen and other low-carbon gases which meets most of the UK's heating demand, and electricity generation is more centralised in larger solar and wind installations.

Our Steady Progression scenario is used as a counterfactual, what we would expect to see if the UK continues to decarbonise at its historical rate. Gas is still used as the primary heating source and the decarbonisation of large road vehicles does not take place. Needless to say, Steady Progression does not achieve Net Zero by 2050.

Finally, our Leading the Way scenario involves reaching Net Zero as quick as possible, using the best available technologies for each sector. It achieves Net Zero faster than 2050 thanks to a combination of hydrogen, electrification, and consumer engagement.

Four scenario worlds,

exploring business-as-usual, electric, hydrogen, and hybrid options to allow the UK to reach Net Zero by 2050

The four scenario worlds are structured as follows:

Steady Progression:

General progress towards decarbonisation continues; however, the rate of change is not sufficient to meet Net Zero carbon emissions by 2050.

Consumer Transformation:

Meets Net Zero emission by 2050 with significant engagement at an individual level and a high degree of electrification.

System Transformation:

Meets Net Zero driven primarily by centralised initiatives and transformation of existing infrastructure, including the production of low-carbon hydrogen, requiring less change for individuals.

Leading the Way:

Achieves Net Zero before the 2050 target, thanks to use of both electric and hydrogen decarbonisation technologies, as well as a high level of consumer engagement.

Steady Progression

The Steady Progression world sees the least amount of societal change and has the slowest speed of decarbonisation. Significant progress is made towards Net Zero, but ultimately the target is not reached by 2050. The economic recovery from the COVID-19 recession is slow, meaning there is more of an impetus for Government to favour economic stimulus measures which "act now" instead of favouring longer-term green recovery efforts.

Although there is no policy in place to ban conventional internal combustion engine (ICE) vehicles, there is a considerable uptake of EVs, especially once battery prices fall to a point where EVs reach cost parity with ICEs. By 2050, EVs have become the most popular choice of passenger vehicle. However, a lack of widespread access to public charging infrastructure means that some consumers continue to rely on ICE vehicles instead, especially those without access to off-street parking. A lack of viable options for Heavy Duty Vehicles (HDV) also means that the decarbonisation of large road vehicles is much slower.

Net Zero non-compliant

Business-as-usual

2030

3,200,000

Number of electric cars and vans

Key assumptions

Energy efficiency
Low Medium High

Electric vehicles (cars and vans)
Low Medium High

Number of heat pumps
Low Medium High

District heat uptake
Low Medium High

Small scale solar PV
Low Medium High

Large scale solar PV
Low Medium High

Onshore wind
Low Medium High

Domestic battery storage
Low Medium High

Grid-level battery uptake
Low Medium High

Steady Progression continued

Steady progression

Net zero by 2050 ✕

↓

Hydrogen gas grid ✕

↓

Electric cars and vans in 2030
3.2 million

↓

Homes with solar panels in 2030
197,000

↓

Grid scale battery capacity in 2030
2.7 GW

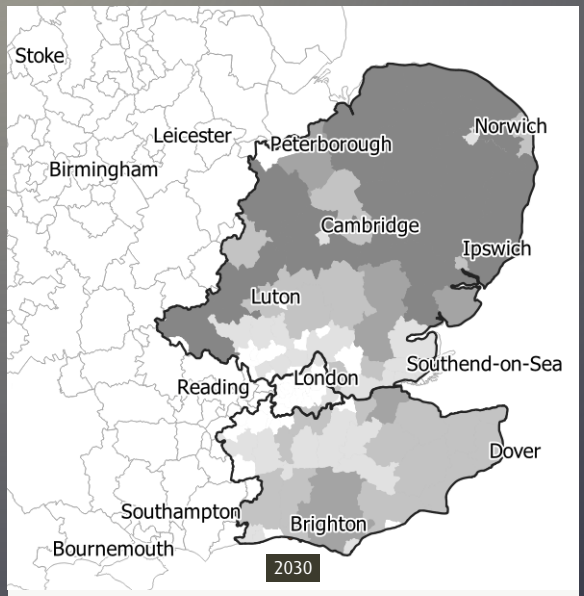
↓

Heat pumps in 2030
62,000

Natural gas continues to be the primary heating fuel and the uptake of heat pumps is limited despite the phase out of oil and other fossil fuel boilers in off-gas properties. With no restrictions on gas boilers, there is low appetite to improve thermal energy efficiency in buildings. This also reduces the uptake of district heat in the Steady Progression world.

There is a slight increase in the renewable generation capacity of the UK, with increases primarily seen in both small- and large-scale solar PV installations. However, the deployment of battery storage systems is limited, meaning there is a lack of grid flexibility to maximise the use of the additional renewable capacity. This results in the need for distributed generators running on combined heat and power, biomass, gas engines and energy-from-waste to serve as reserve capacity during times of high demand. There is a limited interest from the public to participate in the energy market via smart mechanisms such as demand side response and time of use tariffs, meaning that the already low amount of grid flexibility cannot be supported by consumer demand shifting.

Aggregate capacity of domestic solar PV installations



Consumer Transformation

The Consumer Transformation world sees the UK reaches Net Zero by 2050, thanks to widespread electrification of heating, the decarbonisation of the electricity supply, and consumers' willingness to modify their behaviour and engage with new, smart technologies. This scenario sees a great deal of societal change, and many of the decarbonisation efforts are aided by increasing flexibility in the energy system, such as the high uptake of EV smart charging.

This scenario world sees widespread uptake of EVs, especially domestic cars and vans as the Government bans the sales of ICE vehicles in 2030 and plug-in hybrid electric vehicles (PHEV) in 2035. There is also a concerted effort to improve public charging access, and the visible charge point infrastructure means there is a perceived availability of charging for all, even those without off-street parking. The decarbonisation of larger vehicles is slower, but by the mid-2030s there is a wide range of zero-emission HDVs available. By 2050, nearly the entire HDV stock within the UK Power Networks' licence area is zero-emission.

Net Zero compliant

Electrically powered heating

2030

1,120MW

Domestic solar PV capacity

Key assumptions

Energy efficiency
Low Medium High

Electric vehicles (cars and vans)
Low Medium High

Number of heat pumps
Low Medium High

District heat uptake
Low Medium High

Small scale solar PV
Low Medium High

Large scale solar PV
Low Medium High

Onshore wind
Low Medium High

Domestic battery storage
Low Medium High

Grid-level battery uptake
Low Medium High

Consumer Transformation continued

Consumer Transformation

Net zero by 2050 ✓

Hydrogen gas grid ✓

Electric cars and vans in 2030
4.2 million

Homes with solar panels in 2030
374,000

Grid scale battery capacity in 2030
4.5 GW

Heat pumps in 2030
748,000

The Government decides that the electrification of heat is the best way to decarbonise the sector. Policy is put in place meaning that new build homes cannot install gas boilers from 2025 onwards, and gas boilers are banned outright by 2035. There is a nationwide programme of energy efficiency improvements to all buildings, reducing the amount of electricity needed to heat people's homes. Various subsidies designed to make heat pumps more affordable are put in place and are kept in operation until the late 2020s. Viewed as a way of maximising efficiency, there is a strong uptake of district heat, especially in cities and towns. By 2050, the entire domestic housing stock within the UK Power Networks' licence area is electrified.

With both heat and transport getting electrified, there is an obvious requirement for more electricity to be supplied into the grid. This increase in demand is met predominantly through small-scale solar PV and wind installations, which become ever more affordable as their industries grow. As the capacity of small-scale solar grows, so does the amount of domestic and I&C behind-the-meter battery storage capacity. Consumers are keen to utilise the information from their smart meters to participate in various flexibility schemes including time of use tariffs, EV smart charging, and demand-side response programme during system peak times. This results in more flexibility for electricity system operators to utilise, and new revenue streams for consumers willing to engage with them.

Number of domestic heat pumps

System Transformation

In a System Transformation world, the UK reaches its Net Zero target in 2050 by relying on hydrogen to decarbonise the more difficult sectors of heat and heavy transport.

Similar to the Consumer Transformation world, consumers in the System Transformation world have better public charging access and the Government bans the sale of ICE vehicles in 2030 and PHEVs in 2035. Falling battery prices drive up demand for EVs as they reach price parity with ICE vehicles sooner than previously expected, and EV supply is the only limiting constraint in the near term. Global production of hydrogen fuel cells ramps up along with the UK's hydrogen production capacity. Together this enables the large-scale supply of zero-emission HDVs, including buses, coaches and heavy goods vehicles, to be available from mid-2030s. A nation-wide hydrogen refuelling network is implemented, enabling long distance – heavy duty hydrogen transport.

The Government chooses to decarbonise heat in existing buildings by repurposing the existing natural gas grid to distribute low-carbon hydrogen, and installing electric heat pumps in new builds. From the 2040s onwards the gas grid is composed of a mixture of hydrogen and other low-carbon gases, and existing gas boilers are repurposed to run on low-carbon gas blends. Compared to the Consumer Transformation and Leading the Way worlds, there is a lower level of societal change in the System Transformation world, resulting in a slower uptake of heat pumps, district heat and energy efficiency improvements.

Net Zero compliant

Hydrogen gas grid

2030

3.3GW of grid-level battery storage

Key assumptions

	Low	Medium	High
Energy efficiency		●	
Electric vehicles (cars and vans)		●	
Number of heat pumps		●	
District heat uptake		●	
Small scale solar PV		●	
Large scale solar PV		●	
Onshore wind	●		
Domestic battery storage		●	
Grid-level battery uptake		●	

System Transformation continued

System Transformation

Net zero by 2050 ✓

Hydrogen gas grid ✓

Electric cars and vans in 2030
4.2 million

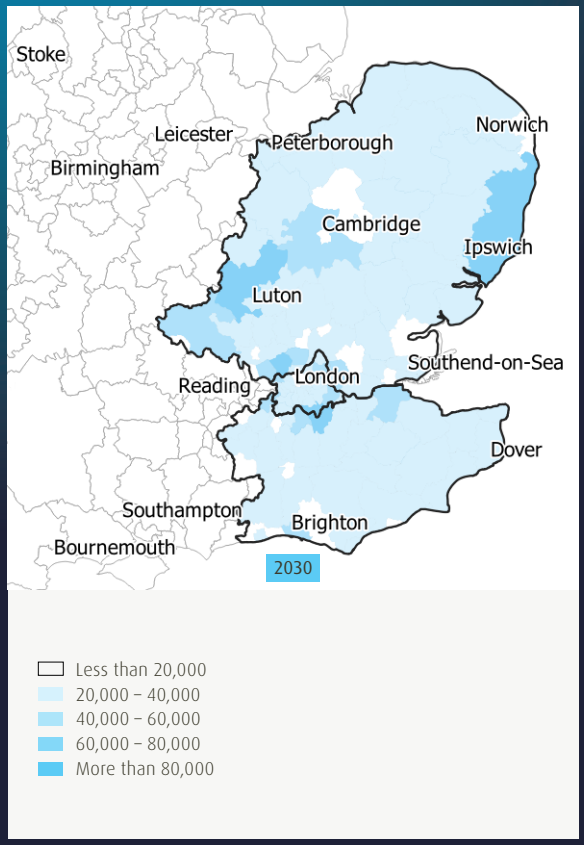
Homes with solar panels in 2030
248,000

Grid scale battery capacity in 2030
3.3 GW

Heat pumps in 2030
347,000

Developments of distributed generation, including solar PV and other renewable generation, are steady along with battery storage in this world. As with EVs, the faster-than-expected reduction in battery prices means more generation is being co-located with battery storage to maximise their ability to participate in the capacity market and electricity price arbitration. Fossil fuel generation such as gas will be phased out to meet the Government's commitment to decarbonise the power system by 2035. With smart meters installed in most people's home, there is also a moderate level of grid flexibility brought by demand side response and EV smart charging.

Number of battery electric cars



Leading the Way

In Leading the Way, the Net Zero target is reached before 2050. This involves the highest level of societal change and utilises state of the art LCTs, both hydrogen and electric, to decarbonise every sector as soon as possible. This results in Leading the Way being the fastest of the scenario worlds to achieve Net Zero.

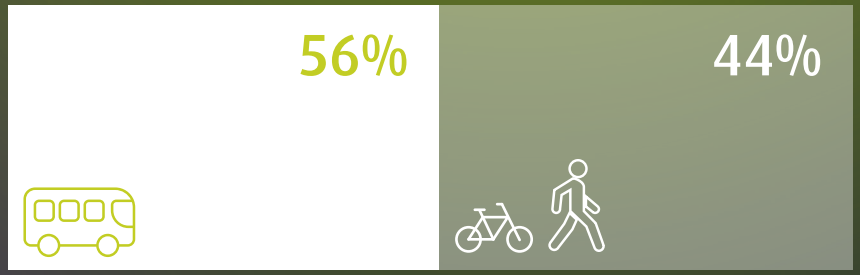
A rapid uptake of EVs is seen in this scenario as all ICE and PHEVs sales are banned from 2030 and 2035 respectively. At the same time consumers are more willing to take public transport and opt for active transport such as cycling and walking, resulting in a reduced demand for domestic cars and vans relative to other scenarios. For HDVs, both batteries and hydrogen fuel cells are developed at scale, and diesel ICE vehicles are completely phased out by the 2040s with the rollout of hydrogen refuelling infrastructure.

The decarbonisation of heat is achieved through a hybrid approach, deploying high numbers of heat pumps as well as converting the existing gas grid to distribute low-carbon hydrogen. This provides a platform for hybrid heat pumps, combining electric heat pumps with hydrogen boilers. With consumers' keen interest to make a difference, there is an early high uptake of heat pumps from the start of 2030s. The uptake of district heat is also high, especially in areas of high heat density, as the society is actively looking for options to decarbonise as quickly as possible.

Increased energy efficiency

Hybrid approach

Leading the Way has 1.2 million fewer cars than the other Net Zero scenarios by 2050. The journeys that would have been taken in a personal car are instead split between active and public transport.



Active transport (included other travel such as private hire cars)

Public transport

Key assumptions

Energy efficiency
Low Medium High

Electric vehicles (cars and vans)
Low Medium High

Number of heat pumps
Low Medium High

District heat uptake
Low Medium High

Small scale solar PV
Low Medium High

Large scale solar PV
Low Medium High

Onshore wind
Low Medium High

Domestic battery storage
Low Medium High

Grid-level battery uptake
Low Medium High

Leading the Way continued

Leading the Way

Net zero by 2050 ✓

Hydrogen gas grid ✓

Electric cars and vans in 2030
4.3 million

Homes with solar panels in 2030
374,000

Grid scale battery capacity in 2030
3.9 GW

Heat pumps in 2030
445,000

The electricity generation required to support the many EVs and heat pumps deployed in this scenario is high and will be met by a more centralised approach than in Consumer Transformation. Most of this capacity will be provided by distributed generation from renewable sources, however in addition to having small-scale solar PV and onshore wind, as in the Consumer Transformation world, there is also a significant number of large-scale solar PV installations. With large-scale solar PV being more popular, and falling battery prices, there is a high uptake of co-located battery storage. Consumers have the tools and motivation to involve themselves in flexibility programmes. There are high levels of domestic battery storage, smart meter uptake, and over 80% of those with EV charging at home taking part in some form of smart charging by 2050.

Number of domestic properties connected to district heat networks

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UK Power Networks Holdings Limited is the holding company
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