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How do renewable energy technologies play a role in achieving our Net Zero goal?

By Sagnik Murthy

The presentation will start shortly

How do renewable energy technologies play a role in achieving our Net Zero goal?

Sagnik Murthy

13th August 2020

UK Power Networks Services

The power to deliver a better future

Who is UK Power Networks Services?

Distinguishing between UK Power Networks (UKPN) and UK Power Networks Services

UK Power Networks
Delivering your electricity

They are a Distribution Network Operator (DNO). They own and maintain electricity cables, plant, equipment and lines across London, the South East and East of **England making sure the lights stay on for over 8 million people**.

UK Power Networks Services
The power to deliver a better future

We are a strategic energy partner of clients who have require their own power system. We design, build, operate & maintain power assets **optimise** clients existing assets, **integrate** new technologies and **deliver** commercial benefits.

- **Aviation**
- **Rail**
- **Utilities**
- **Defence**
- **Logistics and fleet**
- **Manufacturing and industrial**
- **Ports**
- **Public Sector**
- **Commercial and property development**
- **Nuclear**

Solutions through passion and commitment

We are experts in distributed energy solutions and power distribution. We provide end-to-end energy solutions and through the expertise of our people we help you increase the productivity of your assets, decarbonise your infrastructure and enable you to realise your infrastructure as a strategic asset.

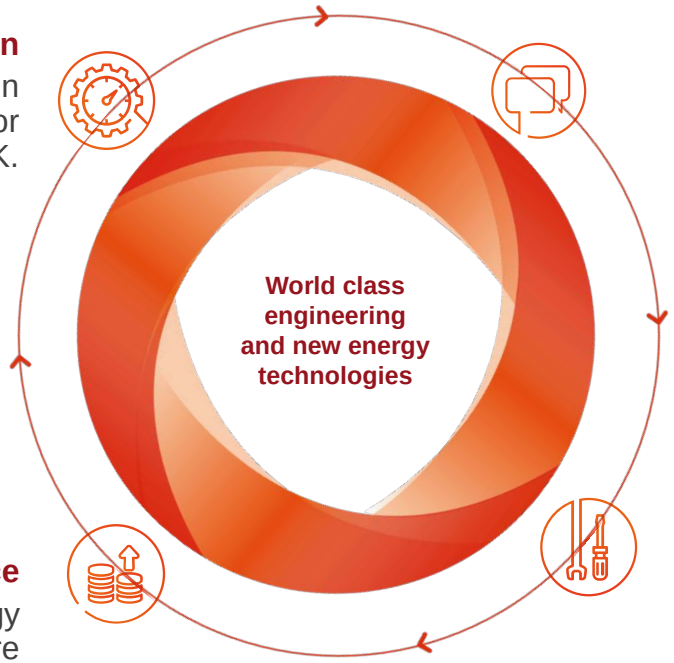
We support our clients through the full lifecycle of delivery

Operate and maintain

We operate and maintain distribution networks for key infrastructure in the UK.

Consulting

We provide strategic insight and aim to deliver your energy strategy through innovative solutions.



Capital finance

We unlock the value of technology to realise your energy infrastructure as a strategic asset.

Design and build

We have track record in constructing and delivering complex high voltage electricity infrastructure.

Slide courtesy of ©UK Power Networks Services 2020

UK Energy Market Trends

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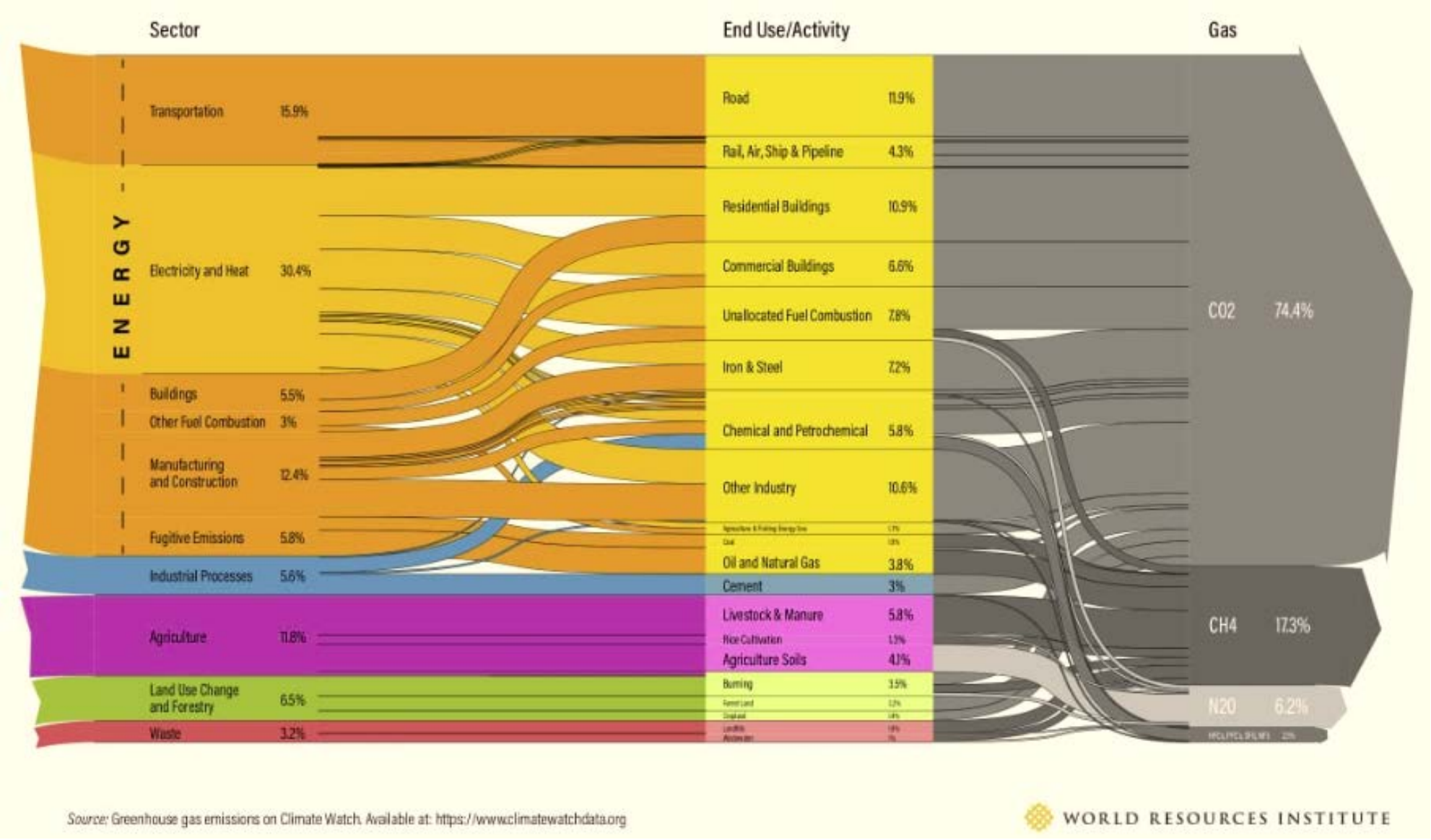
World Greenhouse Gas Emissions in 2016

Total: 49.4 $GtCO_2e$



Source: Greenhouse gas emissions on Climate Watch. Available at: https://www.climatewatchdata.org

WORLD RESOURCES INSTITUTE

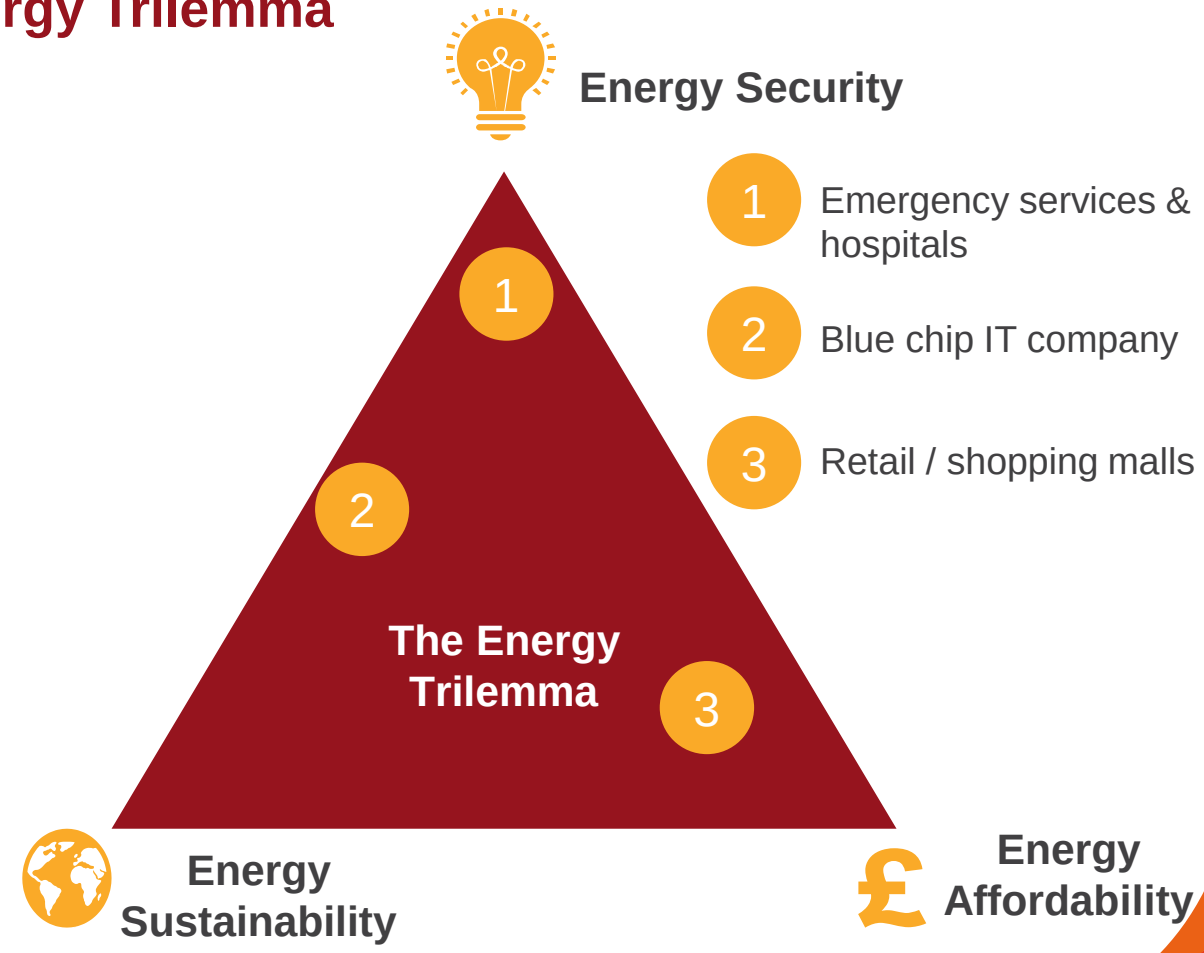
UK Energy Market Trends

Energy Transition to Net Zero 2050 and The Energy Trilemma

In June 2019, Prime Minister set a legal target for the UK to reach net-zero carbon emissions by 2050.

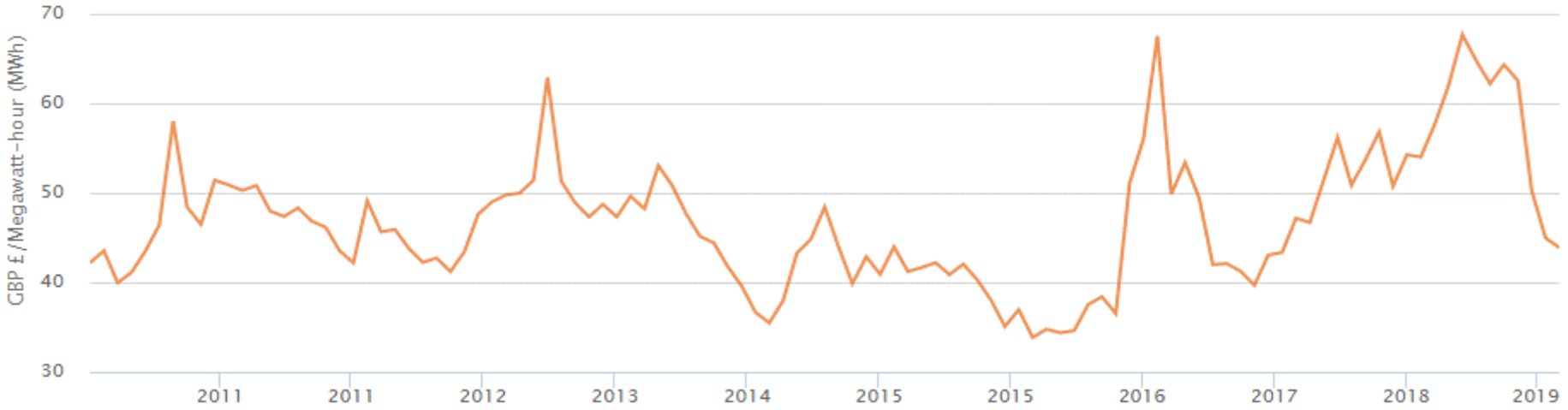
To get to Net Zero 2050, the Committee for Climate Change visualises the scale of the challenge as:

- The existing electricity system will have to grow x2 to x4
- Offshore Wind will grow from 10GW to 75-100GW
- Hydrogen production will have to grow from 27TWh to 370TWh
- CCS from 0 to 180MtCO2
- Afforestation 10,000 to 50,000 hectares pa
- 29 millions existing homes installed with low carbon heat
- Zero carbon cars 250,000 to 35 million
- Large scale landscape change affecting 20% of agricultural land
- Major changes to diet: beef, lamb and dairy consumption halved



UK Energy Market Trends

Price of electricity on the wholesale market



Source: Ofgem; 01 April 2019

Transition to renewable sources

- In recent years, a significant amount of small scale renewable generation assets have been connected to the distribution network
- The renewable sources are intermittent and have made the wholescale electricity prices very volatile
- Renewables have increased the cost of managing and balancing the electricity network

Developing an Energy Strategy

- The changing nature of the market affects the electricity options that industrial businesses could use to source their future requirements
- It is important to recognise trends in the market and assess the feasibility of potential technologies and contractual arrangements

Slide courtesy of UK Power Networks Services

UK Energy Policy Landscape

Changes in the energy landscape

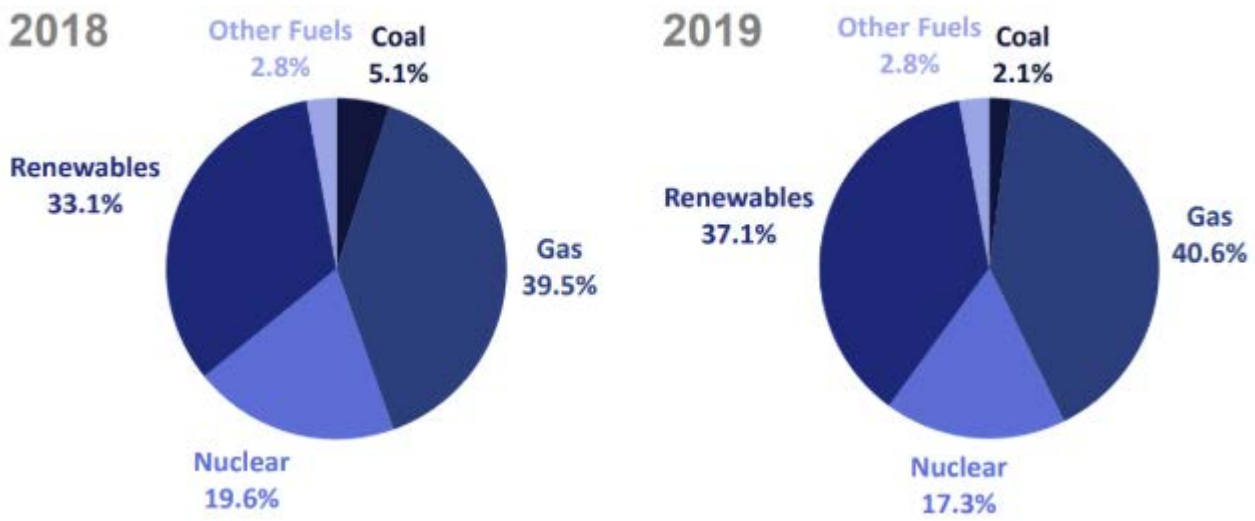
- Cleaner, intermittent and decentralised
- Substantial increase in renewable generation; 34% in 2016 vs 5% in 2014
- More than 25% of generation capacity now connected at the distribution level
- Cost of photovoltaics, wind turbines and batteries has fallen rapidly
- Increase in community-based or local energy solutions

The Westmill Energy Coop is the largest in the UK. Together the local community has rasied more than £20 million for 5 wind turbines and a ground-mounted solar array. Members receive an average of 8% return on their investment.
Source: https://brightonenergy.org.uk/2013/09/20000-grant-to-kick-start-your-own-community-energy-scheme/

UK regulator Ofgem wants to "turn your street green" requires that distribution network operators (DNOs) will still need to make anticipatory investments for the rollout of low-carbon technologies such as heat pumps and electric vehicles. Local Electricity Networks will take forefront going forward

Renewable Generation

Energy generation mix (TWh)



Source: BEIS annual Digest of UK Energy Statistics (DUKES) 2020.

Generation from Renewables

37.1% (121TWh)

Wind and Solar Generation

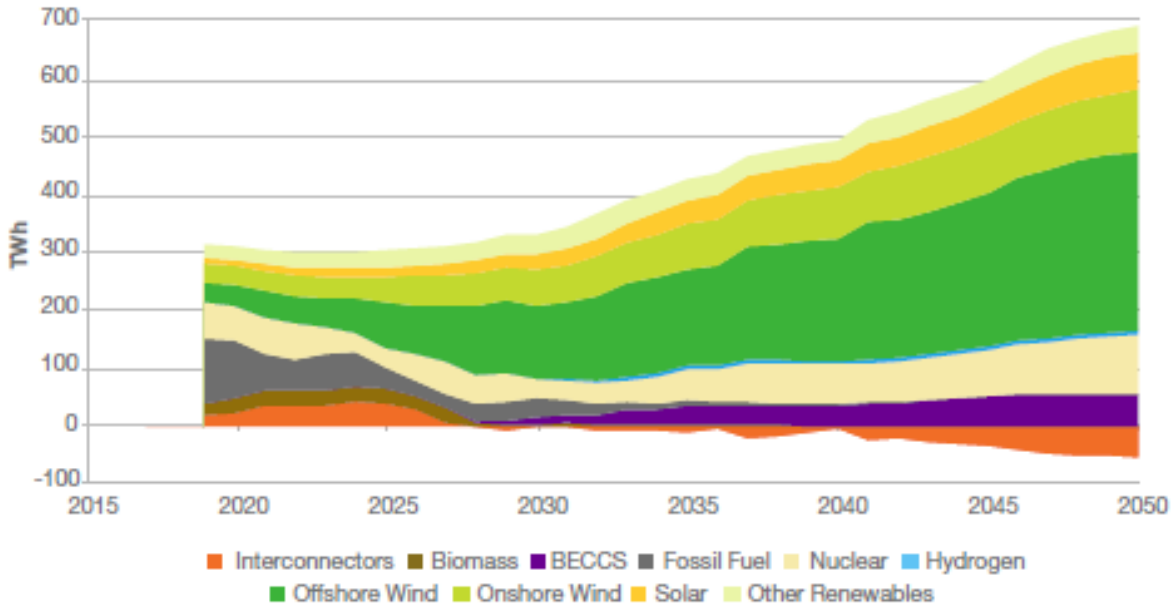
23.8%

Thermal Renewables and Hydro

13.3%

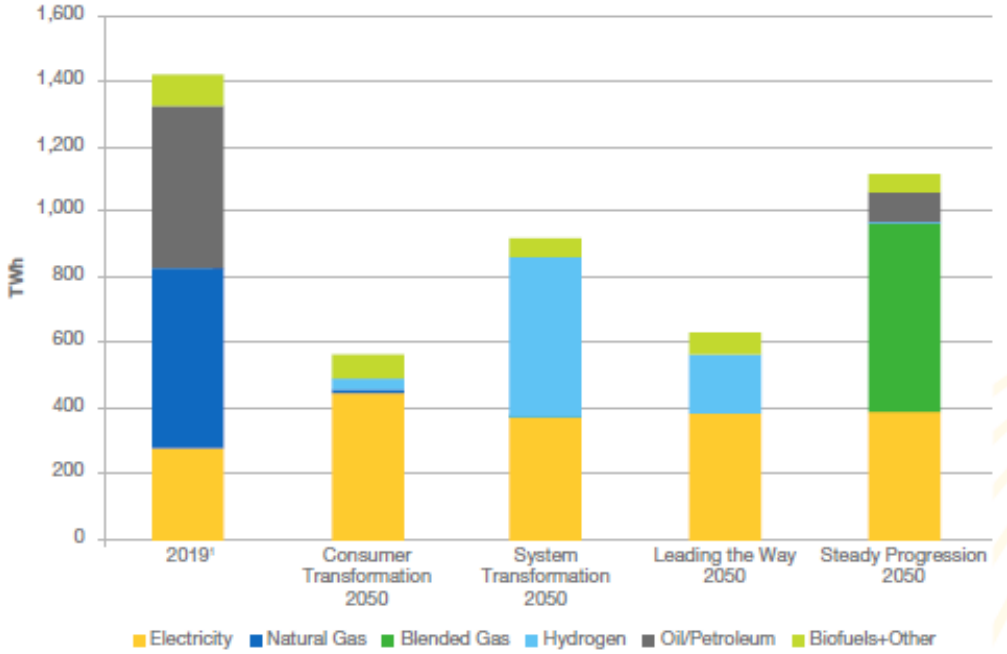
Residential and business users are increasingly deploying renewable energy technologies across their premises

National Grid ESO Future Energy Scenarios



Consumer Transformation | System Transformation | Leading the Way | Steady Progression

In 2050, over 90% of electricity generated comes from 4 technology types: wind, solar, nuclear and bioenergy with carbon capture and storage (BECCS)



Customer demand by Fuel | Customer demand by Sector

Annual end consumer energy demand in 2050. The scenarios with a greater acceptance of societal change have the lowest energy demand, illustrating the impact behavioural change can have on the energy system.

Impact of the Changing Energy Landscape

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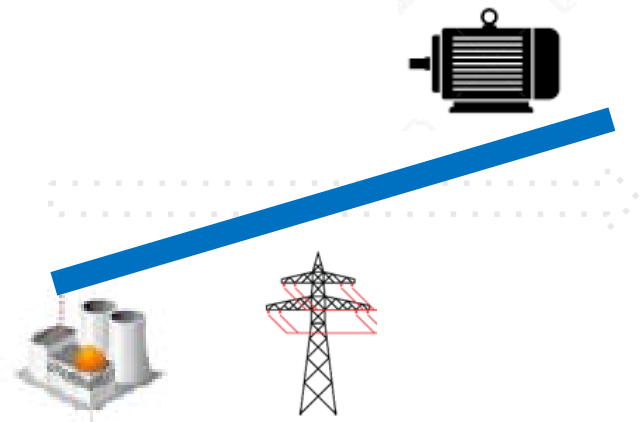
Variability of Distributed Energy Resources

The Challenge

Supply < Demand

Frequency falls below 50Hz

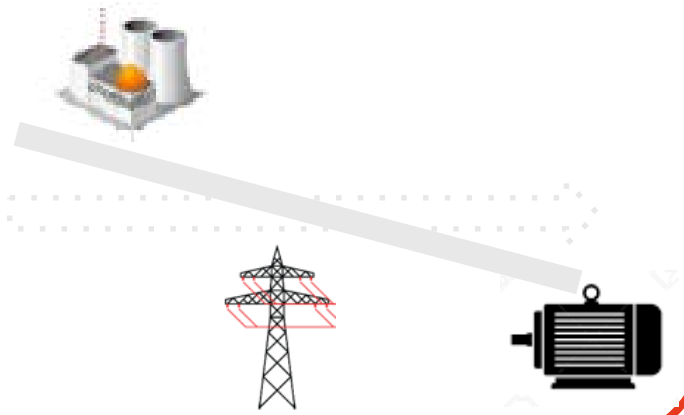


+ Flexibility required

- Increase supply
- Decrease demand

Supply > Demand

Frequency rises above 50Hz



- Flexibility required

- Decrease supply
- Increase demand

Challenges of Balancing the Grid, Synthetic Inertia and Response

Variability of Distributed Energy Resources

The Opportunity .. Demand Side Flexibility

For a reliable electricity system, the supply must always match the demand. All energy users can change their electricity demand in **3 ways**:

Turning down the use of electricity

Changing when they use electricity

Turning on or increasing production from on-site generation

Businesses **can also turn up** their consumption at certain times, for example on windy or sunny days when demand is low but renewables output is high.

New Income Streams from Ancillary Services, Balancing Mechanism and Energy Arbitrage

UK Energy Policy Landscape

Impact of the changing energy landscape

New technologies and solutions continue to crop up to support the evolution of a Decentralised, Digitalised and Decarbonised energy system

Slide courtesy of UK Power Networks Services

Decarbonisation of Transport and Heat

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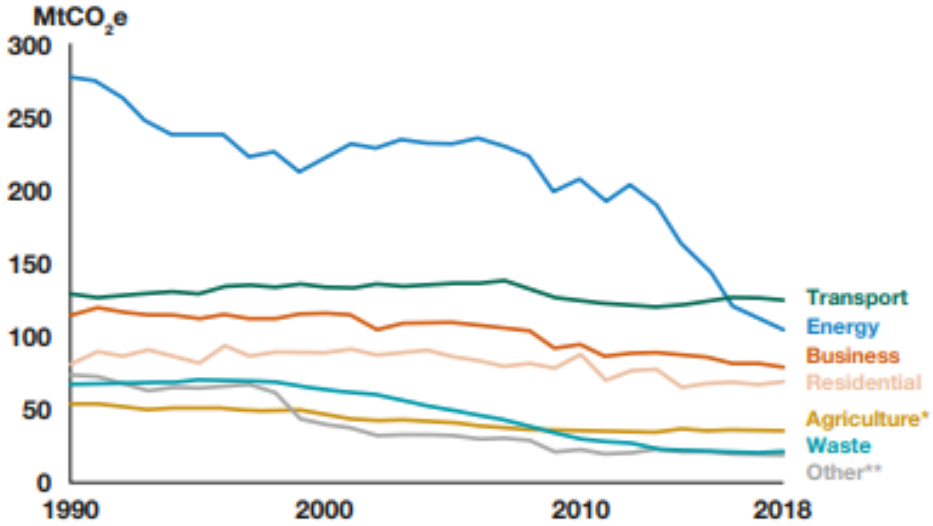
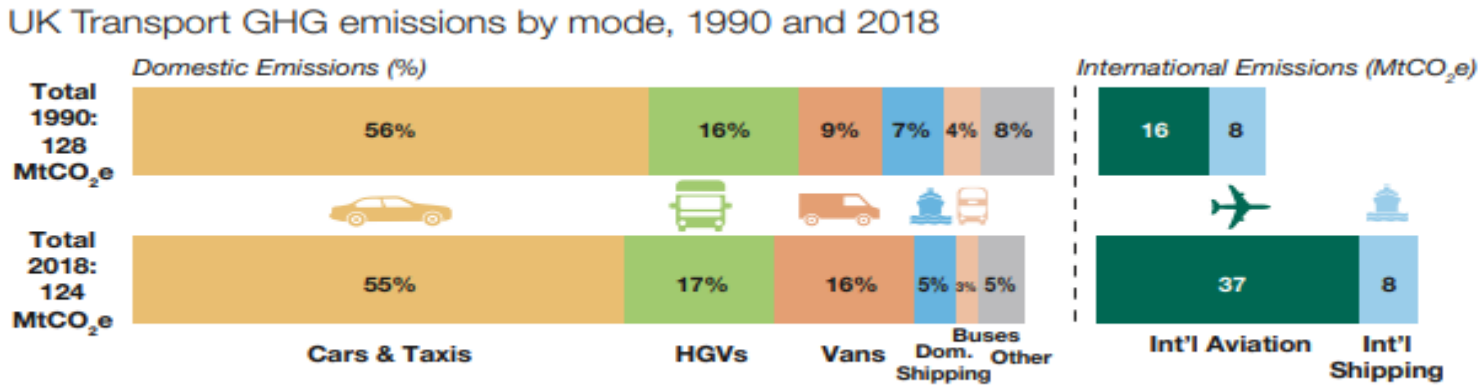
Decarbonisation of Transport and Heat

Electricity decarbonisation is in full swing and what next..

451 million tonnes of CO2 equivalent (MtCO2e) is the total net **domestic greenhouse gas emissions from all UK sectors** in 2018, down 2.1% from 2017.

28% of this came from the transportation sector and this sector will require transformation if the UK is to achieve its target of “net-zero” greenhouse gas emissions by 2050.





Source: 2018 UK greenhouse gas emissions[12]

Battery Electric Vehicles

Transition to all electric

Number of BEVs on the road
Source: National Grid FES 2020

Electricity demand to grow

- Electricity demand would be driven by increased electrification of transport and heating
- UK could have 11 million EVs by 2030
- EVs can support the rollout of renewables – batteries can be used to store excess generation and export to the grid when required

Smart technologies

- Smart charging technologies to shift significant demand to off-peak hours
- By 2050, up to 80 per cent of households with an electric vehicle will smart charge and up to 45 per cent actively provide vehicle-to-grid services, offering up flexible electricity to help manage peaks and fill troughs in demand.

LCVs, Buses and HGVs

Reducing GHG emissions

- In 2018, electric vehicles (EVs) accounted for less than 1% of the 5.1 million vans, trucks and buses on the roads in the UK.
- We are beginning to see the electrification of light commercial vehicles (LCVs), starting with light vans, where the product range is limited, but growing.
- The electrification of road transport could lead to a 30% increase in today's electricity consumption by 2050.
- For larger heavy goods vehicles (HGVs), hydrogen fuel cell powered versions are seen increasingly as the future.
- Britain's first all-electric bus town to pave the way for green communities of the future. *A town with 200 electric buses could save around 7,400 tonnes of CO2 each year, the equivalent to taking 3,700 diesel cars off the road.*
- The key is electric charging infrastructure and hydrogen fuelling infrastructure which be required to enable wider roll out of these cleaner forms of transport. Local government policies will be the catalyst for adoption of electric and hydrogen buses.

UPS Smart Electric Urban Logistics project by UK Power Networks Services

Aviation

Reducing GHG emissions

- International aviation generates 37% of global CO2 emissions
- Before Covid-19, public scrutiny around the emissions and noise created by the aviation industry was at an all-time high.
- Aviation is looking at short-term mitigations to reduce its environmental impact through the procurement of more fuel efficient aircraft *for e.g. the Airbus A320 neo is 13-15% more fuel efficient than existing models.*
- Electric planes: some of the world's biggest industrial names from Boeing to Siemens to Rolls Royce are working on plans to bring electrically powered aircraft to market.
- It is on the ground that the aviation can make a more immediate environment impact by taking advantage of the decentralisation of electricity networks.
  - *At London City airport, UK Power Networks Services are now developing an innovative micro-grid that will integrate solar PV, combine heat and power and smart automation that will not only improve the airport's green credentials, but double the size of the electricity network, delivering the capacity they require in a more sustainable way.*
  - And of course the fleets of buses and servicing vehicles that operate in the perimeter can and are being converted to EVs'.

Maritime

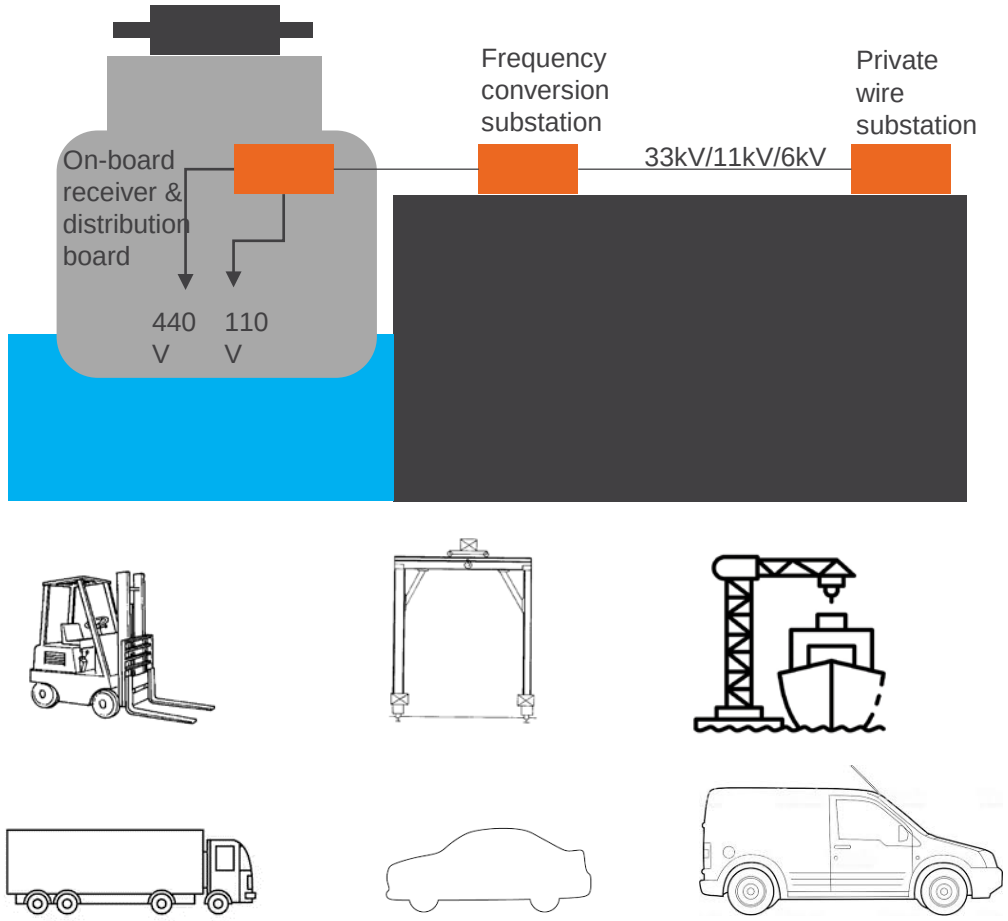
Reducing GHG emissions

Shipping

- Shipping is amongst the only industries not covered by the Paris Agreement on climate change and currently contributes to 8% of global greenhouse gas emissions, burning as it does dirty heavy fuel oil.
- From 1 Jan 2020, IMO regulations require all vessels to utilise low-sulphur fuel or have scrubbers fitted to remove the sulphur emissions
- Ocean going vessels running on low carbon alternative fuels such as hydrogen and ammonia are in development but they are at least a decade away.
- Electric container ships and electric ferries are suitable for short sea shipping routes

Ports

- Electrification of cranes
- Cold Ironing or Shore to Ship.
- Decarbonizing Port Vehicles – electric tractors, forklifts.
- Autonomous Vehicles
- Internet of Things
- Port Automation
- Digitizing and Artificial Intelligence



Slide courtesy of UK Power Networks Services

Rail

Reducing GHG emissions

- The UK rail sector contributes a mere 2.6% of UK's GHG emissions. Railway traction is the biggest emitter of emissions but with all traction electricity supplied by nuclear power, the only emissions in the rail sector come from diesel trains.

- With the Government's announcements to ban all petrol and diesel engines by 2040, the rail sector has to replace the diesel trains with either electric, battery or hydrogen trains.
  - Track electrification is expensive but still the best whole life option for an intensively used railway network
  - Battery Trains with distance of 50km can be used for branch lines where high track electrification costs do not justify the business case
  - Hydrogen trains with a range of up to 600miles are a viable alternative for passenger trains on non-electrified routes.

- Non-traction power involves stations, depots and buildings which can be decarbonised using solar PV in combination with battery storage. Station car parks can also be fitted with EV charging infrastructure to allow rail users to charge their EVs.

- Shifting freight from road to rail, offers a 76% carbon reduction and the industry is innovating with "into the city" concepts, bringing light goods to city centres without the use of vans and trucks.

Battery Train from Hitachi

Alstom Breeze hydrogen train

Hydroflex hydrogen train

Pictures are sourced from websites of Hitachi, Alstom and University of Birmingham

Heat

Reducing GHG emissions

- Currently, heating our homes, businesses and industry is **responsible for a third** of the UK's greenhouse gas emissions.
- Decarbonisation of heat is recognised as one of the biggest challenges we face in meeting our climate targets. The government is aiming to publish a Heat and Buildings Strategy later in 2020: expect this to be delivered as a combination of green gas and heat pumps
- Good Energy is to launch the UK's first ever tariff for heat pumps in autumn 2020. The tariff will help make it more cost-effective to run a heat pump, offering cheaper unit rates at different times of day to ensure consumers can benefit from surplus renewable generation or low demand on the grid.
- The number of heat pumps in the UK is expected to double by 2025, but many think more needs to be done to promote the technology and drive down emissions from heating.
- Air Source Heat Pumps (ASHPs) absorb heat from the outside air, which can then be used for underfloor heating systems, warm air convectors, or to provide warm water for radiators or for the hot water supply.
- As per National Grid Future Energy Scenarios, 2050 could see 20 million heat pumps or 17 million homes with hydrogen boilers, with as many 8 million homes actively managing their heating demands by storing heat and shifting their use outside of peak periods.

Picture courtesy: Keele University. HyDeploy, now well into its pilot period, is a ground-breaking green energy demonstration that is supplying a blend of up to 20% hydrogen by volume with natural gas to 130 homes and faculty buildings at Keele University.
The project is demonstrating that a blend of up to 20% hydrogen can reduce climate-damaging carbon emissions from heating the nation's homes, while at the same time enabling customers to use their gas supply as normal, without any changes needed to gas appliances or pipework.

Picture courtesy: https://www.eco2solar.co.uk/heat-pumps/

The Hydrogen Economy

A silver bullet or part of the mix?

- **Blue Hydrogen** – produced by steam methane reformation where natural gas is treated with high temperature steam. CO2 is a by product. Most of hydrogen produced for industrial processes uses SMR. This is why CCS is required to capture the CO2 produced.

- **Green Hydrogen** – hydrogen produced by electrolysis of water using electricity produced by low carbon energy sources such as offshore wind power or nuclear

- A new study by Aurora Energy Research claims that hydrogen generated from renewable energy and natural gas could provide more than 45 percent of the U.K.'s final energy demand by 2050. Aurora's projections are based on a combination of "blue" and "green" hydrogen, derived from natural gas and renewable electricity, respectively.

- Proponents of the hydrogen economy state that UK hydrogen production needs to be 200-300TWh by 2050 to support our Net Zero 2050 ambitions
  - Hydrogen for heat and Hydrogen for long distance freight e.g. road and shipping
  - Hydrogen as energy storage of excess renewable energy
  - Hydrogen for heavy industry e.g. steel production use of H2 instead of coke

Green Hydrogen generated by electrolysers supplied by UK firm ITM Power is already available at a number of Shell forecourts in the UK. Image: ITM Power

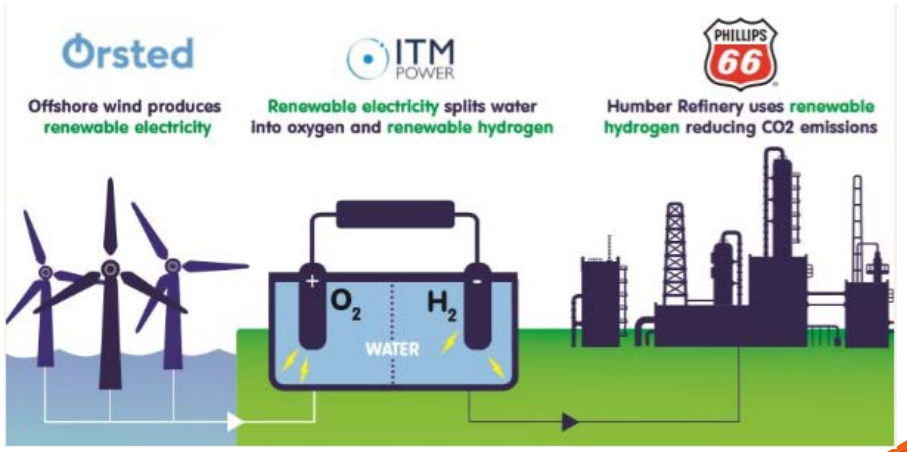


Illustration showing the key components of the Gigastack project. Image ITM Power

Summary

Utilising Renewables and Flexibility

- Reduce the cost of energy
- Help in ensuring price stability
- Help in integrating renewable energy assets
- Integrate energy storage technologies
- Automate network operations
- Provide additional security (enhance local resiliency) and even the ability to work off-grid
- Reduce your carbon footprint
- Generate additional revenue

BUILD TO ADAPT

Bridge on the River Choluteca, Honduras

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