nationalgrid

Future Energy Scenarios in five minutes

July 2017

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Executive summary

National Grid has an important role to play in leading the debate on the energy revolution across the industry and working with our stakeholders to ensure that we have a safe, secure and reliable energy future.

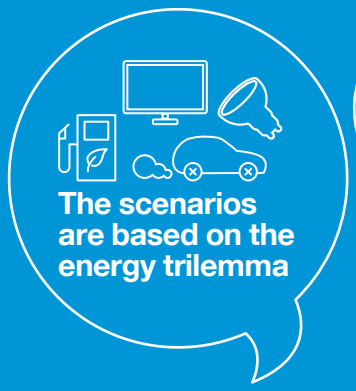
As **System Operator (SO)**, we are perfectly placed to be an impartial enabler, informer and facilitator. The SO publications that we produce every year are intended to be a catalyst for debate, decision making and change, and provide transparency to the wider industry.

The starting point for our SO publications is the *Future Energy Scenarios (FES)*. The *FES* is published every year and involves input from stakeholders across the energy industry. This year we have enhanced our stakeholder engagement activities and we consulted 391 organisations, increasing our engagement from 362 in 2016. The scenarios are based on the energy trilemma (security of supply, sustainability and affordability) and provide credible pathways for the future of energy out to 2050, capturing the uncertainties regarding the future of energy for Great Britain (GB). It is hard to have missed the significant amount of change on economic, political and technological fronts over the past year.

This year's analysis shows us electric vehicles (EVs) could drive large increases in peak demand if we continue to see the sharp uptake past the 2030s and if there is no management of when charging occurs.

Decarbonising heat remains an area that is difficult to progress and our scenarios cover a range of approaches to heating, from incremental to fundamental changes. There is no one solution for the heating dilemma but in our **Two Degrees**, which meets 2050 targets, the use of gas boilers declines considerably by 2050 and is overtaken by heat pumps, supported by improved house heat retention.

We see an increasing diversity of generation sources becoming available and technology driving growth in the future. Innovation in information communication technology (ICT) is allowing new opportunities to emerge such as residential and commercial energy generation, and smart devices that use and provide data to communicate quicker and easier than ever before.



The scenarios are based on the energy trilemma

391
Number of organisations engaged

About FES

What are the Future Energy Scenarios? Why and how do we make them?

What are the Future Energy Scenarios (FES)?

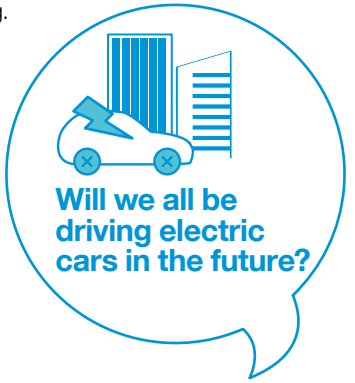
They are a range of credible pathways for the future of energy out to 2050. They reflect the possible sources of, and demands for, gas and electricity in the future, and the implications of this for the energy industry.

Why do we make them?

The scenarios are used within National Grid for network and operability planning and developing other forward-looking views such as charging projections. The scenarios are also used across the energy industry, driving debate and decision making.

How do we make them?

Every year we engage hundreds of stakeholders through workshops, bilateral meetings and webinars. The information we gather supports and inputs into our detailed modelling.



Will we all be driving electric cars in the future?

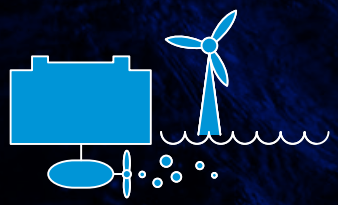
Key messages

1. An energy system with high levels of distributed and renewable generation has become a reality. This growth is set to continue, increasing the complexity of operating a secure and cost-effective energy system.

67 GW
Potential increase in distributed generation capacity by 2050.

The total amount of renewable generating capacity made up 34% of total installed capacity in 2016. This could increase to as much 60% by 2050.

In 2016, installed capacity from distributed generation reached 26 GW. Looking forward to 2050, this could increase to a total of 93 GW.



2. New technologies and evolving business models are rapidly transforming the energy sector. Market and regulatory arrangements need to adapt swiftly to support a flexible energy system with an increasing number of participants.

There are rapid changes in technologies and approaches such as battery storage, electric vehicles and demand side response. Electricity storage capacity could grow rapidly to almost 6 GW by 2020.

Effective facilitation and investment will be required to achieve an agile, coordinated and accessible energy market that delivers value for consumers.

6 GW
Potential amount of electricity storage by 2020.

Key messages

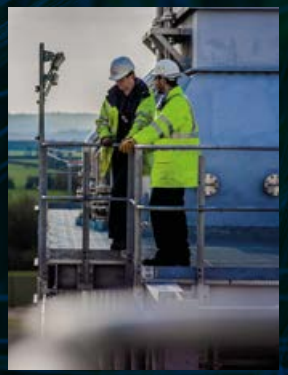
3. Electricity demand has the potential to increase significantly and the shape of demand will also change. This is driven initially by electric vehicles and later on by heat demand. It will require a range of solutions to deliver best value for consumers, including a coordinated approach across the whole system; investment in smart technologies, transmission and distribution infrastructure; and commercial approaches such as consumer behaviour change.

9m
Potential number of electric cars by 2030.

Electricity peak demand could be as high as 85 GW in 2050, compared to around 60 GW today.

There could be as many as 9 million electric vehicles by 2030. Without smart charging this could result in an additional 8 GW of demand at peak times.

4. Gas is critical to security of supply now and as Britain continues the transition to a low carbon future. It will have a long-term role as a flexible, reliable and cost-effective energy source favoured by many consumers.



Gas
Provides twice as much energy as electricity.

Gas supplies more than twice as much energy annually as electricity today and could still provide more energy than electricity in 2050.

In order to meet the 2050 carbon reduction target, decarbonisation of heat needs to pick up pace now. Gas will continue to play an important role in this transition and beyond with new technologies and the potential use of hydrogen.

Our scenarios

Consumer Power

In a **Consumer Power** world there is high economic growth and more money available to spend. Consumers have little inclination to become environmentally friendly. Their behaviour and appetite for the latest gadgets is what drives innovation and technological advancements. Market-led investments mean spending is focused on sources of smaller generation that produce short- to medium-term financial returns.

Two Degrees

Two Degrees has the highest level of prosperity. Increased investment ensures the delivery of high levels of low carbon energy. Consumers make conscious choices to be greener and can afford technology to support them. With highly effective policy interventions in place, this is the only scenario where all UK carbon reduction targets are achieved.

Steady State

In **Steady State** business as usual prevails and the focus is on ensuring security of supply at a low cost for consumers. This is the least affluent of the scenarios and the least green. There is little money or appetite for investing in long-term low carbon technologies, therefore innovation slows.

Slow Progression

In **Slow Progression** low economic growth and affordability compete with the desire to become greener and decrease carbon emissions. With limited money available, the focus is on cost-efficient longer-term environmental policies. Effective policy intervention leads to a mixture of renewable and low carbon technologies and high levels of distributed generation.

The 2017 scenario matrix

Key comparison chart

TD Two Degrees · SP Slow Progression · SS Steady State · CP Consumer Power

		2016	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	≥2039	Maximum potential by 2050
Heating	1 million heat pumps	60k		TD			CP	SP										SS					TD 23 million
Transport	Exceeds 2m electric vehicles	87k		TD					SP		CP			SS									TD 25 million
	Reaches 50,000 natural gas vehicles	700					TD	CP						SP								SS	TD 212,000
Electricity generation	20% electricity output from distributed sources	17%	TD CP	SP										SS									CP 30%
	Hits 40% renewable generation output	25%			TD	CP SP				SS													TD 67%
	First new nuclear power station commissioned	N/A							TD		SP	CP				SS							TD 20GW total installed capacity
Electricity storage*	Exceeds 6GW electricity storage technologies	3.6 GW				TD CP					SP												CP 10.7GW
Electricity interconnection	10GW of electricity import capacity	4 GW			TD	SP CP					SS												TD 20GW
Gas supplies*	10% of supplies from onshore gas production (shale and green gas)	0.20 %					CP				SS											TD	CP 46%
*Scenarios not shown do not reach the level		2016	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	≥2039	

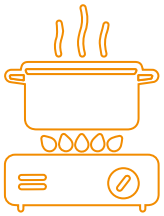
Energy demand overview

GB's gas and electricity demand are highly interlinked with gas supplying the major share of the energy delivered. However the current balance is shifting and the rate of this change will be governed by the green agenda.

The current usage of gas is 40% for residential heating, 30% for industrial and commercial space heating and process heating, and 30% for power station demand. To decarbonise our economy heating needs to move to low carbon sources and this move needs to occur rapidly. As such it will not happen without intervention from government.

If gas demand is to decrease then electricity demand will rise, but this is not only because it takes on heating but also as a result of new technological advancements, in particular electric vehicles (EVs). These new uses of electricity will need to be carefully managed in order to find the most cost optimal, whole system, solution for the consumer, particularly at peak time.

Overall peak demand reaches **85GW** by 2050 in Consumer Power



Steady State sees the highest annual gas demand **at 772TWh** in 2050

In Two Degrees gas demand could be as low as **398TWh** by 2050

Slow Progression produces the lowest annual electricity demand of all the scenarios at **319TWh** in 2022

Gas supply overview

Gas remains a key fuel in the GB energy mix and there is sufficient gas available worldwide to meet GB demand. The source of the supply changes in each scenario and over time as a result of both the gas reserves available and the projected economies.

Gas

Our scenarios present a range of plausible gas supply patterns. Production from the UK Continental Shelf declines in all scenarios and comes to an end before 2050 in all but **Consumer Power**. New sources of gas are developed; shale gas is included in **Consumer Power** and **Steady State**, and green gases in **Two Degrees** and **Slow Progression**. Imports from Norway, continental Europe and via liquefied natural gas remain important in all scenarios as our indigenous production declines.

13% GB
Demand met by green gas in 2050 in Two Degrees

Shale gas reaches
32 bcm
by 2031 in Consumer Power

Electricity supply overview

Much has been discussed in the energy industry regarding the speed and depth of transformation we are witnessing in electricity supply. Technical progress and significant cost reductions in technologies, such as storage and solar panels, have driven major change in a short space of time. We have also seen a continued shift away from non-renewable generation sources, supported by energy policy.

Electricity

Electricity supply in GB is transforming at an unprecedented rate. A clear move towards decentralised and renewable generation is evident in all our scenarios – it is only the pace and extent of this change that differs. The economics of large thermal plants remain challenging, and all unabated coal plants will close by 2025. A number of new gas plants are required under all scenarios. The Capacity Market has encouraged investment in new small-scale thermal plant, but there is some regulatory change and uncertainty for this group of technologies. Technological progress and associated cost falls mean that the economic case for a number of renewable technologies such as solar and offshore wind continue to improve.

Similarly, storage growth is projected to continue at a high rate until the early 2020s, driven primarily by technological advances and commercial factors. However, there is a gap in all scenarios between old nuclear being decommissioned and new nuclear sites being built.

Interconnection capacity increases across all our scenarios. We continue to anticipate a net import of energy annually and at peak in most scenarios and timeframes.

Distributed generation
reaches 50%
of overall generation capacity
by 2050 in
Consumer Power

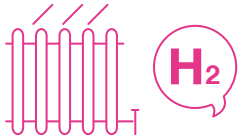
Highest interconnection is in
Two Degrees with
19 GW installed
by 2030

Sensitivities

While our Future Energy Scenarios (FES) are our core energy pathways to 2050, there is a lot of debate across the industry as to what the next technology breakthrough or future policy direction will be. We explore these uncertainties by developing sensitivities which consider a broader range of possible energy pathways.

Decarbonised gas

Is there a way we can keep our gas central heating boilers while reaching the 2050 decarbonisation targets?

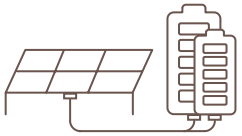


Could hydrogen be used **for heating** and some forms of transport?

- Could we get to zero carbon cities?
- This is a world where gas is the favoured fuel and hydrogen is the source of heating for 1/3 of cities within GB.

Consumer renewables

What would happen if we saw millions of consumers and businesses installing small-scale renewable generation?



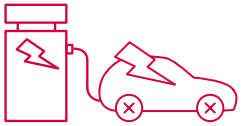
Could we see a world with significantly more generation on the **distribution** network than the transmission network?

- This is a world where generation will be much more decentralised, and renewables such as solar and wind will proliferate.

These sensitivities start with 'what if' questions – what if we rapidly adopted electric vehicles, or heat pumps, or there was a breakthrough in hydrogen technologies?

High electric vehicles

What if tail pipe emissions were seen as the number one contributor to harmful pollution and the cost of batteries decreased significantly?

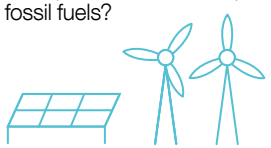


Is there a world where everyone **has an EV** and we prioritise zero carbon transport?

- Could we get to this world without having to change our habits so we can still have a luxuriously large car and charge it when we want and need?
- This is the only sensitivity not targeted to meet the 2050 carbon reduction target.

High electrification

What would happen if society decided that we should pursue a more electric future, with more renewable electricity, to help us reduce our dependency on fossil fuels?



Could we get to a world where **fossil fuel** is almost entirely replaced in power generation, transport and the heating sector?

- This is a world where renewables dominate, specifically wind. And where, interconnectors and storage provide the flexibility to ensure demand can always be met.

Key statistics in 2030

Electricity	2016	TD	SP	SS	CP
Annual demand (TWh)*	328	358	329	323	336
Peak demand (GW)	61	65	61	61	66
Total installed capacity (GW)	99	147	132	116	150
Low carbon capacity (GW)	38	83	68	48	74
Interconnector capacity (GW)	4	19	15	10	17
Total storage capacity (GW)	4	9	7	6	9

Gas	2016	TD	SP	SS	CP
Annual demand (TWh)	817	564	632	851	816
1-in-20 peak demand (GWh/day)	5,148**	4,270	4,729	5,841	5,386
Residential demand (TWh)	333	220	297	325	328
Gas imports (%)	55%	68%	82%	63%	42%
Shale production (bcm/yr)	0	0	0	12.8	29.8

*Including losses
**Based on prior forecast of 2016 peak demand

Continuing the conversation

Email us with your views on *FES* or any of our future of energy documents at:
transmission.ukfes@nationalgrid.com
and one of our experts will get in touch.

Access our current and past *FES* documents, data and multimedia at:
fes.nationalgrid.com

Get involved in the debate on the future of energy and join our LinkedIn group
Future of Energy by National Grid.

Keep up to date on key issues relating to National Grid via our Connecting website:
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