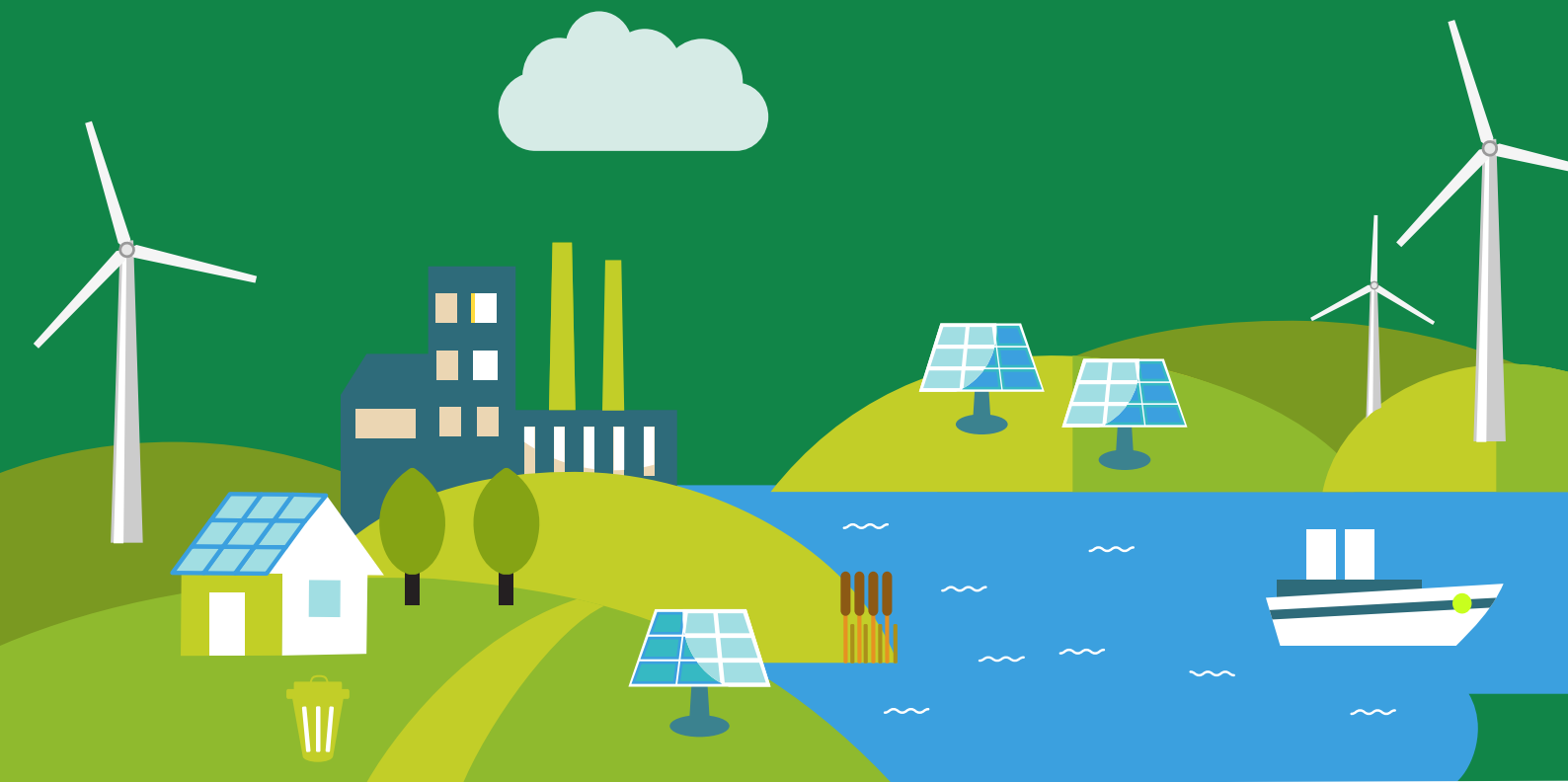


Electricity Transmission

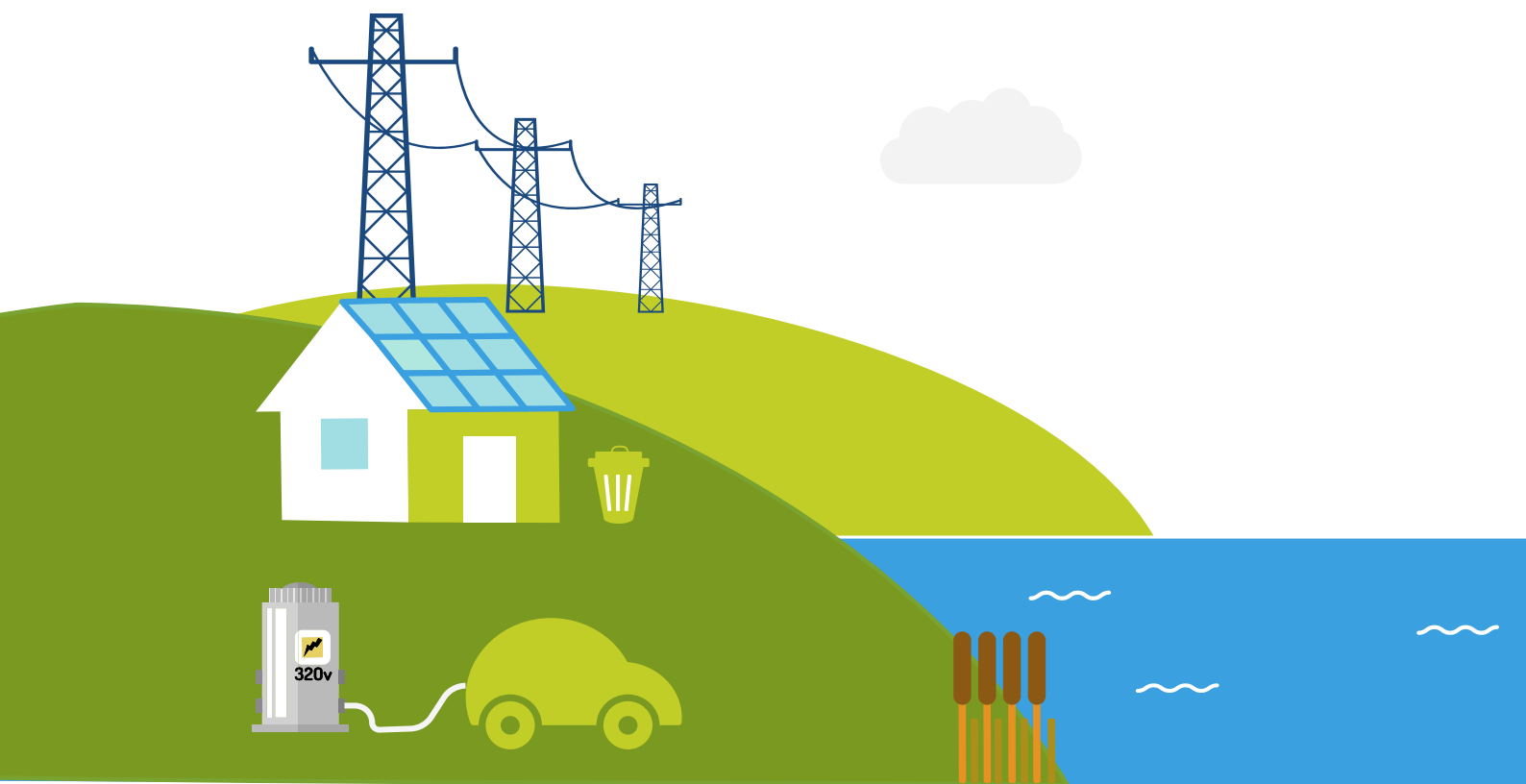
Delivering our environmental future: annual statement

March 2017



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Who we are

National Grid is one of the largest investor-owned energy companies in the world and was named **Responsible Business of the Year 2014 by Business in the Community**. This accolade acknowledges all of our efforts in getting involved with the things that really matter to us and to society.

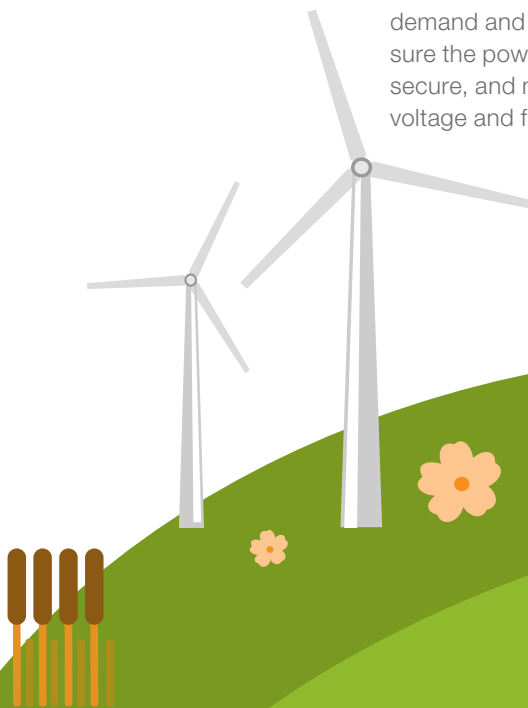
We own and manage the grids that connect people to the energy they need, from whatever the source. In Great Britain and the north-eastern states of the US we run systems that deliver gas and electricity to millions of people, businesses and communities.

In Great Britain, we run the gas and electricity systems that our society is built on, delivering gas and electricity across the country. In the north-eastern US, we connect more than seven million gas and electric customers to vital energy sources, essential for our modern lifestyles.

National Grid Electricity Transmission (NGET) in the UK

Electricity Transmission Owner: We own the high-voltage electricity transmission system in England and Wales. Our electricity assets comprise around 7,200 kilometres of overhead line, about 690 kilometres of underground cable and 337 substations at 241 sites. We maintain these assets and invest in replacing old and building new assets, to preserve an economic, efficient, safe, reliable and environmentally-acceptable transmission network.

Electricity System Operator: We are the Great Britain System Operator, responsible for managing the operations of both the England and Wales transmission system that we own and the two high-voltage electricity transmission networks in Scotland. Day-to-day operation of Great Britain's electricity transmission system involves the continuous real-time matching of demand and generation output, making sure the power system is stable and secure, and maintaining satisfactory voltage and frequency.



Foreword

David Wright

National Grid Electricity Transmission (NGET) has the potential to have an impact on the environment in a number of ways, including directly through our day-to-day operations and construction work, and indirectly through our ability to support the connection and utilisation of low-carbon generation.

Our stakeholders fully expect National Grid to operate sustainably. We are also committed to minimising our environmental impact, both now and in the longer term, and constantly balance that with the need to provide secure and affordable energy for our customers and consumers. Whilst this balance is rarely easy to achieve, our 2017 annual statement shares the strong progress we are making.

During 2016/17, NGET continued to operate as a single entity for both the Transmission Owner (TO) and System Operator (SO). This will change by April 2019 when a new, legally separate Electricity System Operator will be established. For now, it remains appropriate for this statement to showcase how the TO and SO are working together to support Great Britain's transition to a low-carbon economy, and to drive environmental improvements in our operations.

The document recaps our strategy for managing the transition to a low-carbon energy system and operating sustainably, and outlines some of the initiatives that are contributing to its successful delivery. Whilst some of these were completed during 2016/17, most are part of longer-term activities.

I am immensely proud of the numerous advancements we are making. One of these is the creation of a new service in



Throughout the year, we have continued to engage widely with our customers and stakeholders to help us meet our industry's many challenges and targets.

our SO business called 'Demand Turn Up', a demand-side balancing service that encourages large energy users to re-profile their demand to take advantage of the times when transmission demand is low and renewable output high. This service allows us to maximise renewable generation in Great Britain by keeping wind energy on the system, and is more economic than some of our more traditional balancing services.

NGET is also a major landowner, with more than 300 substations. At one of our newest substations, built to connect the Pen y Cymoedd Wind Energy Project at Rhigos in Wales, we continue to work with

Butterfly Conservation, wetland specialists and PONT (Pori, Natur a Threftadaeth – Grazing, Nature and Heritage) to deliver a habitat management plan that will support the restoration of an ancient peat bog and provide bigger and better habitats for rare species.

Underpinning our sustainability progress is a robust innovation strategy. By collaborating with universities, suppliers and other utilities, we remain at the forefront of rolling out new technology solutions.

During 2016/17, we worked closely with GE Grid Solutions to successfully install g³ (Green Gas for Grid) in two gas-insulated busbar sections at our Sellindge substation in Kent. This is a new gas mixture that matches the dielectric strength of SF₆ whilst reducing the global warming potential ratio¹ from 23,900 to 345. If this can be adopted more widely, this will have a significant impact on our carbon footprint.

Throughout the year, we have continued to engage widely with our customers and stakeholders to help us meet our industry's many challenges and targets. By holding face-to-face events, widening involvement in industry processes (such as the development of Future Energy Scenarios) and securing feedback on a range of our publications, we are striving to deliver what is important to you. Given this, I'd very much welcome your views on this annual statement.

David Wright

Director, Electricity Transmission Owner and Group Electricity Chief Engineer

¹ Global warming potential is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide

Context

This report is the National Grid annual executive statement for the Environmental Discretionary Reward (EDR).

National Grid plays a dual role in the transition to a low-carbon economy.

- As the Transmission Owner and System Operator, we connect and support the operation of low-carbon energy (including that embedded in distribution networks). This is described in 'Planning for a low-carbon future'.

- As an infrastructure business, our day-to-day activities in maintaining and constructing assets also have a carbon-related impact. Our work in this area is described in 'National Grid: Our Contribution'.

We also recognise that an environmentally-sustainable approach can benefit from innovative thinking, so 'Leading innovation' is an essential part of our strategy to improve performance.

We have structured this report to show our actions over the last year and our ambitions for the future. We aim to demonstrate our commitment to the environment and welcome the opportunity to share with you the hard work that our people put in, every day, in order to achieve a sustainable future.

National Grid's transition to a low-carbon energy system

Planning for a low-carbon future
- helping decarbonise society's energy needs

National Grid: Our Contribution
- reducing our own environmental impact

Connecting low-carbon generation
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How we'll operate the system in the future
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This graphic shows how our strategies work together to manage our transition to a low-carbon energy system

Planning for a low-carbon future

“Reducing the UK’s carbon emissions and increasing the energy we get from sources like renewables will help to ensure the security and sustainability of our energy supplies for generations to come.”

Quote from Ofgem’s ‘Promoting a sustainable energy future’ infographic²

Our strategy

The electricity market is going through a time of significant and rapid change, caused mainly by the transition to low-carbon energy sources, and energy being produced closer to where it is consumed.

Ofgem described the challenges this raises in its recent paper ‘Imagining tomorrow’s low-carbon energy system’: “The fossil fuels we have relied on in the past offer a low-cost source of energy storage (in the form of the fossil fuels themselves) and are inherently flexible, in that thermal power stations can vary their output as required. Fossil-fired power stations tend to be cheaper to build than other options, but more expensive to run – particularly if we take into account the costs that carbon emissions impose on the rest of us in the form of damaging climate change.

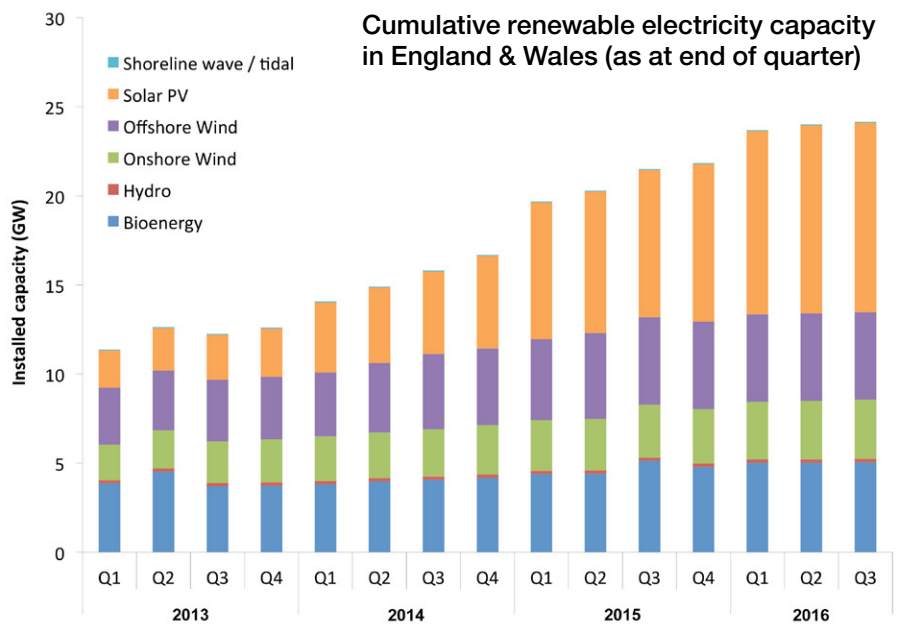
“In contrast, low-carbon power generation tends to be either largely inflexible (such as nuclear) or intermittent (such as wind and solar). Flexibility is expensive without access to coal, oil and gas. Despite the rapidly falling cost of battery storage, it remains several orders of magnitude more expensive than a large pile of coal at a power station as a way of storing energy.

“Low-carbon capacity also tends to be more expensive to build, but on the other hand is cheaper to run. For example, once

built, wind turbines and solar panels produce almost free electricity as long as the sun shines and the wind blows...this shift in the power generation mix presents real challenges for system operation.”³

As the System Operator of the GB transmission network, we have seen and had to deal with the beginnings of

the transition to a low-carbon future. For example, during 2016, the network was operated with no coal plant at times, and we have had as much as 47 per cent of our energy delivered from renewable sources on occasion.



England & Wales data extracted from Chapter 6 of ‘Energy Trends: December 2016’. Figures include installations accredited on all support schemes (Renewables Obligation, Feed in Tariffs, Contracts for Difference), as well as those not eligible for support or commissioned but awaiting support accreditation. This should particularly be noted for solar PV (and onshore wind), where figures consist of many installations across several or all of these categories.
<https://www.gov.uk/government/collections/energy-trends>

² Infographic: www.ofgem.gov.uk/publications-and-updates/infographic-promoting-sustainable-energy-future

³ <https://www.ofgem.gov.uk/news-blog/our-blog/imagining-tomorrows-low-carbon-electricity-system>

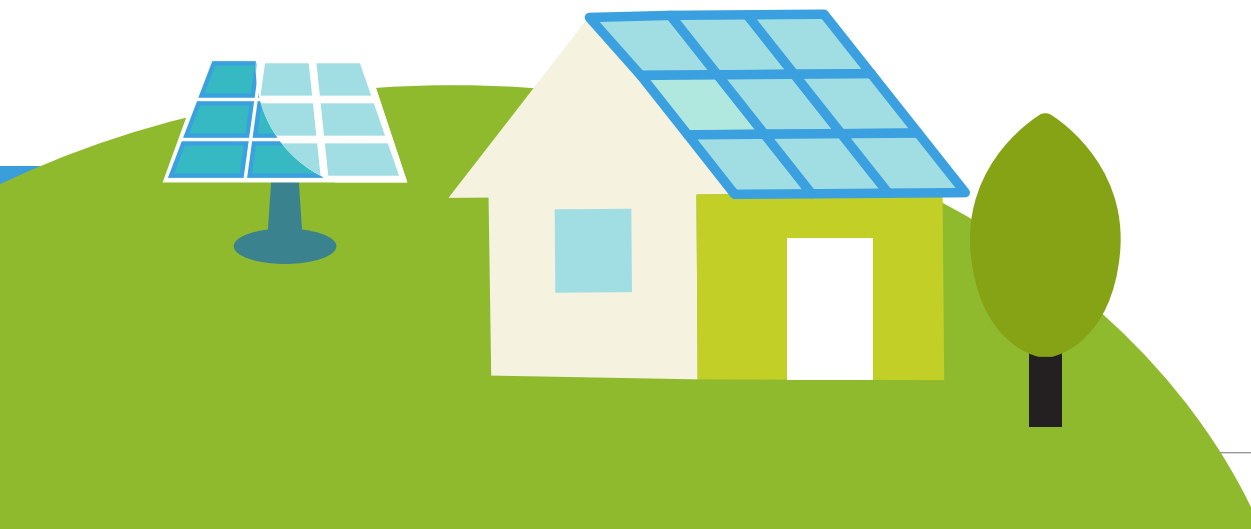


Following on from the huge change in installed solar capacity on the Distribution Network Operators' (DNOs') networks in 2015/16, we have seen this trend continue. Due to the changes made to our processes in 2015/16, we were able to increase the amount of solar generation connected to more than 11GW by the end of March 2017.

We have a duty and a strategy to assist the move to a low-carbon network by supporting connections of all fuel types and technologies that will aid this transition. Once low-carbon generation is connected, we then need to operate the system to take advantage of it when the sun shines and the wind blows, and consequently reduce the consumption of fossil fuels for energy.

Planning for a low-carbon future – helping decarbonise society's energy needs

Connecting low-carbon generation		How we'll operate the system in the future
Maximising opportunities within current technical and commercial frameworks	Changing technical and commercial frameworks to make it easier and quicker to connect	Getting smarter at operating the system
<ul style="list-style-type: none"> - work with DNOs to develop a whole-system planning approach - Statement of Works process - increasing understanding with new market participants 	<ul style="list-style-type: none"> - charging methodology review to level the playing field for low-carbon generation and storage 	<ul style="list-style-type: none"> - increasing demand-side participation (e.g. new services such as Power Responsive) - leveraging energy storage (e.g. Enhanced Frequency Response)



Connecting low-carbon generation



In 2016/17, we have been able to make a further 7.7GW of connection agreements with the GB distributed generation community. These agreements are with a mix of renewable generation and controllable peaking plant that has a capacity mechanism contract. The capacity mechanism-contracted generation helps to make sure that there is security of supply at times of peak demand and little or no renewable output, and is a crucial part of aiding the transition to a low-carbon network.

We have completed a Statement of Works trial with the DNOs and the Energy Networks Association to devise a framework to allow better understanding of existing and future connections. Through creating this visibility, the DNOs have been able to support more new connections than previously thought possible. This trial is now being expanded across Great Britain and will allow the DNOs to understand where the limits are, and to plan connections within these limits.

In parallel with this, we will change some of the standards to which the network is developed. These are defined in the Security and Quality of Supply Standards (SQSS); industry engagement has begun to change these standards to reflect the needs of a transitioning network.

We will continue to develop longer-term processes and policies to make sure we can keep supporting the connection of distributed generation and other technologies such as storage.

CASE STUDY 1 Whole-system planning

Background

Our whole-system planning strategy is designed to allow us to adapt to the fast pace of changes to market drivers, and to support the environmental and economic benefits of embedded renewable and storage technologies.

Effective planning and operation rely on understanding the capabilities and behaviour of generation and demand from varied sources, including renewables from networks across the whole system.

In 2015/16, we made major improvements to our system-planning process in order to meet supply and demand challenges. However, our planning process evolves each year, as underlying economic and technological conditions change.

This year we have begun looking at system planning in a holistic way, initially focusing on regional activities before developing a future industry model.

What have we done this year?

We have introduced a whole-system planning approach to support the delivery of economic and efficient solutions across the transmission-distribution boundary. This has involved:

- investigating whole-system constraints instead of only at transmission level
- co-designing solutions by working across transmission and distribution through regional programmes
- piloting two regional programmes with UKPN SPN and Western Power Distribution
- developing recommendations for design principles for cross-industry processes
- supporting existing working groups and innovation projects, including through the Energy Networks Association

- engaging external stakeholder groups to build consensus and momentum.

Much of this work is about collaboration and sharing of information within the current commercial and regulatory frameworks. This work has already resulted in around 200MW of additional capacity being identified in a small region of the south east of England.

We have introduced a whole-system planning approach to support the delivery of economic and efficient solutions.

What's next?

We aim to progress findings from the above with two regional programme trials to optimise the utilisation of transmission capacity for future renewable connections and allow more renewable generation in both forward planning and operational timescales by the end of 2017. This work will also identify the future code, and commercial and regulatory frameworks, changes required to embed and fund a whole-system planning approach.

Environmental benefits

- Connect and use more renewable and low-carbon energy than would otherwise have been possible without traditional infrastructure investment (the construction of which would have consumed natural resources)

CASE STUDY 2

Technical and regulatory innovation – Transmission and Distribution Interface (TDI) 2.0

Background

As a result of the growing levels of intermittent renewable generation, we're facing increasing operational challenges in managing voltage and thermal limitations for certain network conditions. Currently, this requires constraining out-of-merit transmission-connected generators, which increases system operational costs, and installing reactive compensation devices.

The ability of the transmission network to connect new generation and/or interconnectors is based in part on the available capacity during normal operation, as well as on limitations arising from planned or unplanned events on the network. We have identified several constraints on our network in the south east that can affect operation and limit the amount of energy that can be transferred onto and around the system.

Further generation connection in the south east can be achieved by either significant investment in infrastructure, or by innovative solutions that would address multiple constraints on the transmission network and provide additional network capability for the distribution network.

This project aims to develop technical and commercial solutions to maximise the use of Distributed Energy Resources (DER) to resolve transmission voltage constraints. It will also develop a Distribution System Operator (DSO) route to market for such solutions, co-ordinating activities with the existing System Operation functions.

What have we done this year?

Significant effort has gone into developing this proposal, and a scope of work has been established to address our objectives. The full proposal can be found here:

<https://www.ofgem.gov.uk/ofgem-publications/107804>

In 2016, we were successful in gaining the funding and support to proceed with this innovative project, working in partnership with UKPN.

What's next?

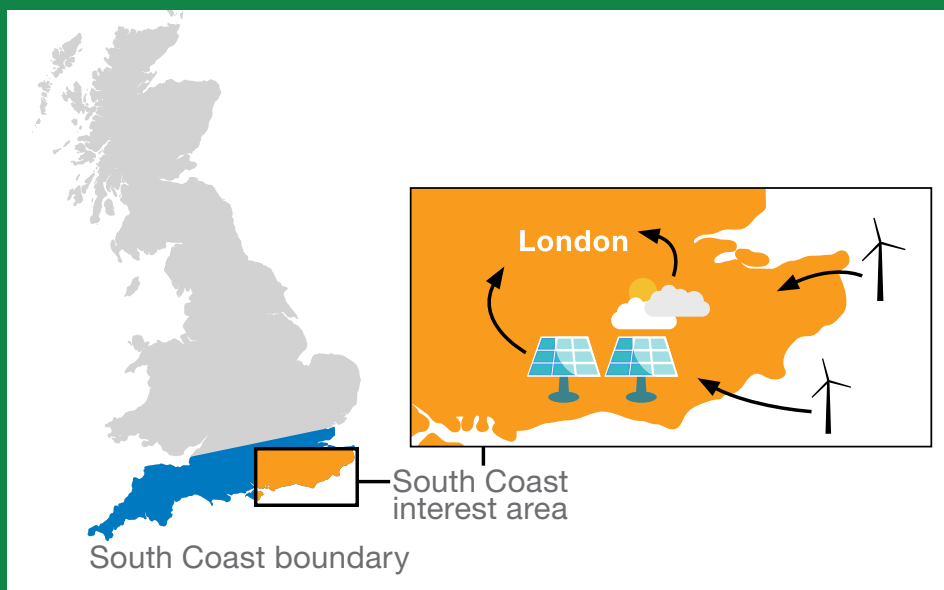
The project will continue throughout 2017, working with UKPN and engaging with Distributed Energy Resources to identify the technical and commercial challenges and solutions, with a view to implementing the findings throughout 2018 and delivering the full project scope in 2019.

If successful, the project would be the world's first trial of a 'whole-system approach' to the generation and storage of power.

It is hoped that this project will create the network capacity to enable the Distribution Network Operator to connect a further 3,720MW of distributed generation in the area by 2050. We believe that this solution will allow for quicker and lower-cost connections than traditional transmission or distribution network investment.

Environmental benefits

- Deployment of 3,720MW of distributed generation, assuming it consists of solely renewable sources, results in an estimated reduction in carbon emissions of 5 MtCO₂ by 2050
- Saving natural resources by reducing the need for new electrical infrastructure



How we'll operate the system in the future

The growth in distributed energy resources, largely consisting of renewables, means that the energy industry must adapt to continue to deliver secure and affordable energy. Through our work in the 'Future Energy Scenarios' and the 'System Operability Framework' documents, we have identified current and future requirements for system services that will allow us to maintain a secure and operable network as we transition to a low-carbon future.

We have begun a number of initiatives that will help us to manage the new network requirements so that more low-carbon generation can be incorporated into the mix.

CASE STUDY 1 Demand Turn Up service

Background

As renewables generate power when it is windy or sunny and this may not coincide with a traditional electricity demand profile, there is value in being able to despatch demand to meet the generation – particularly overnight or on weekend afternoons.

In 2016, we introduced 'Demand Turn Up'. This is a demand-side balancing service that encourages large energy users to re-profile their demand when transmission demand is low and renewable output high.

This service provides us with a more economical alternative to balancing the electricity system than some of our traditional tools and allows us to maximise renewable generation in Great Britain (by keeping wind on the system).

More details can be found here:
<http://nationalgridconnecting.com/new-balance>

What have we done this year?

We successfully operated the service over the summer of 2016, with 323 instructions issued by National Grid and 10,800MWh of Demand Turn Up being delivered due to larger energy users shifting their demand or small generators reducing their output. This enabled renewable generation to run that may not otherwise have been used.

What's next?

The service will continue in 2017, building on previous learning points to further maximise the use of renewable generation such as wind and solar power.

Environmental benefits

- More low-carbon energy is consumed at the time at which it is generated, reducing the need for consuming traditional, fossil fuels. This both saves resources and reduces carbon emissions





CASE STUDY 2

Enhanced Frequency Response (EFR) services

Background

Through our stakeholder-led programme called 'Power Responsive', we are aiming to stimulate increased participation in different forms of flexible technology such as demand-side response and storage. It aims to bring together industry and energy users to work together in a co-ordinated way and make it easier for businesses to get involved.

More details can be found here: <http://nationalgridconnecting.com/faster-smarter-enhanced-frequency-response>

What have we done this year?

In 2016, National Grid ran an auction to identify and contract with 200MW of Enhanced Frequency Response (EFR) services. EFR is a service that achieves 100 per cent active power output at one second (or less) of registering a frequency deviation. This is a new service that improves the management of the system frequency in a world where there is more 'asynchronous' low-carbon generation (such as solar) connected to the network.

For the 200MW required, more than 1.4GW of projects entered the auction with a variety of technologies that could provide this service. The result was that eight projects were allocated contracts

for delivery during 2018. All eight of these projects are some form of battery storage technology. Not only will this service allow for a greater penetration of low-carbon generation, but it will also save consumers an estimated £200 million over four years.

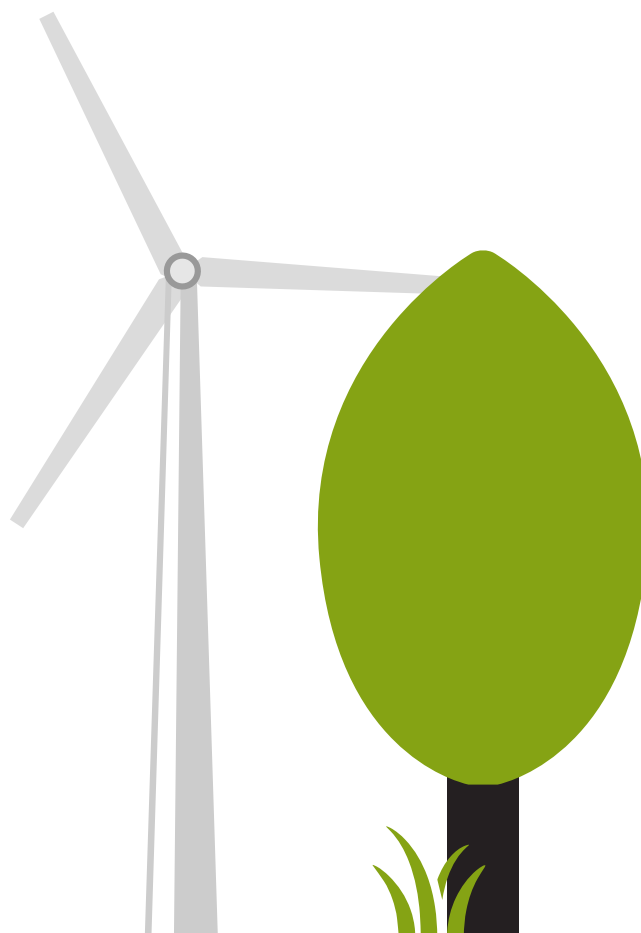
What's next?

The results of the auction are under review and lessons will be learned as we use these contracts in 2018. Through the

Power Responsive programme, we will continue to engage with the industry to look at the future frequency response services we require and to identify clear service definitions and routes to market.

Environmental benefits

- Allows greater penetration of low-carbon generation that would otherwise be limited by the need to maintain system frequency



National Grid: Our Contribution

Our strategy

We launched our environmental sustainability strategy, known as 'Our Contribution', in 2013. In January this year, our Executive agreed to refresh this strategy and set more challenging targets around our climate impact, resource efficiency and the environment.

It focuses on the areas where we can make the greatest contribution to a more sustainable future. We're working to respond to global environmental and social challenges, reduce costs, minimise risk and continue to deliver the service our customers rely on. We believe that sustainable business is good business.

'Our Contribution' outlines our sustainability commitments and targets. We've grouped them into three themes: 'Our climate commitment', 'Responsible resource use' and 'Caring for our natural environment'. These themes sit upon the strong foundation of our Environmental Management System (EMS), and all benefit from innovative thinking.

This strategy sets out our priorities for acting sustainably and creates a framework for embedding this culture within our business.

What's in the refreshed strategy?

In addition to the original targets, Our Contribution now includes:

- a global strategy with regional priorities
- additional environmental targets focused on 2020, giving us a clear three-year action plan
- a clearer line of sight from high-level priorities to local action
- increased employee engagement in sustainability
- a clear message that sustainable business is good business.

Alignment with external factors

In January 2017, National Grid joined more than 80 global businesses to call on the UK Government to demonstrate its commitment to delivering the United Nations Sustainable Development Goals (SDGs)⁴. In future, we will make sure that it is easier to align our environmental reporting with the aims of the SDGs.

The Paris Agreement also entered into force in 2016. This agreement is legally binding. It aims to strengthen the global response to climate change by limiting the global average temperature rise to 2°C. Our 2050 emissions reduction target of 80 per cent by 2050 is aligned to the ambitions of the Paris Agreement. We're working across our whole business to reduce emissions and find new low-carbon solutions: so far we have made a 63 per cent reduction from our 1990 baseline.



This strategy sets out our priorities for acting sustainably and creates a framework for embedding this culture within our business.

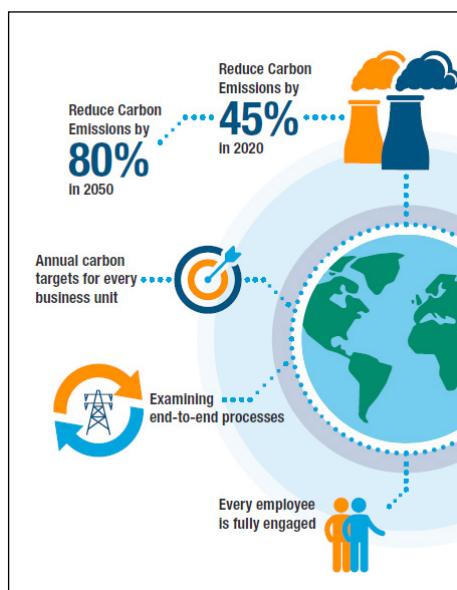
⁴ <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Our climate commitment

We are committed to reducing the greenhouse gas emissions from our processes, operations and offices. By 2050, we have a target to reduce our greenhouse gas emissions by 80 per cent (from a 1990 baseline), with an interim target of a 45 per cent reduction by 2020. So far we have made a 63 per cent reduction from our 1990 baseline, so we are ahead of our target.

We have set each of our business units an annual carbon target. This is to make sure that accountability runs throughout the business, and everyone can see how they can contribute to reducing our emissions.

We've been examining the end-to-end construction and operation of our assets to see where we can reduce greenhouse gas emissions. We're pushing ahead with new trials, such as a low-emission alternative to the insulating gas SF₆, as well as new ways of managing energy in our buildings.



Recognising and sharing best practice

CDP, formerly the Carbon Disclosure Project, is a global disclosure system for investors, companies, cities, states and regions to report and manage their impact on the environment⁵.

In 2016, we made the CDP A-List for our global approach to climate change. The A-List comprises the top nine per cent of more than a thousand companies from around the world that have been identified as leading in their efforts and actions to combat climate change.

Our CDP submission detailed our global approach to climate change including performance, management of climate-related risks, opportunities and innovation, and how our business (both UK and US) is playing a leading role in the decarbonisation of our communities and wider society.

The CDP is an important way for us to demonstrate our plans and performance in carbon management to our investors and other stakeholders.



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⁵ <https://www.cdp.net/en/info/about-us>

CASE STUDY 1

Carbon weighting in decision making

Background

We're starting to include carbon as part of our investment decision-making process. This means we can fully account for the lifetime carbon impact of projects when we make major investment decisions.

As reported in last year's annual statement, we have developed a carbon interface tool (CIT) that allows us to measure the carbon footprint of our projects. This tool has allowed us to develop a useful carbon intensity metric for the amount of carbon equivalent used in the manufacturing and construction of our projects. This is known as 'capital carbon' and is measured in terms of tonnes of CO₂ equivalent emitted per £million spent (tCO₂e/£m). We're on track to reach our 2016/17 capital carbon target of 188 tCO₂e/£m, a 10 per cent reduction from last year's target of 209 tCO₂e/£m.

What have we done so far?

Carbon in the design process

Since 2013, we have estimated the carbon impact of over 200 schemes at the pre-construction phase. Our engineers record where they have adapted their designs to reduce carbon. From the first nine months of this year, our engineers have recorded more than 7,900 tCO₂e of carbon savings.

Carbon in the tendering process

We first included carbon as a weighted element in competitive tenders in the Wimbledon substation scheme in 2015. The winning bidder, Laing O'Rourke, achieved a 23 per cent reduction in carbon and a £3 million reduction in cost from their design. They are on target to

meet this commitment by using low-carbon concrete, recycled steel and reducing the required volume of the insulating gas SF₆.

Based on our positive experience at Wimbledon, we have included carbon as a criterion in ten further tender events for major projects. Analysing the results from our winning suppliers for these events shows the average capital carbon intensity was 175 tCO₂e/£m, but looking at all bidders the average was 190 tCO₂e/£m. This shows that we can deliver a lower-carbon network for our customers by actively engaging with our supply chain.

Sharing best practice

We have shared learning in our own industry, and more widely. As part of the Jacobs Global Sustainability Call series, we have delivered a webinar on the link between reducing carbon and reducing cost. We have also presented our carbon management approach to the Rail Safety and Standard Board (a group that incorporates stakeholders from across the rail industry, including Network Rail) and Northern Utilities (Northern Gas, Yorkshire and Northumbrian Water, and Northern Power Grid). Our approach and case studies have been highlighted by the Infrastructure Carbon Review as an example of best practice.

We were also members of the steering committee that helped develop a new industry standard, 'Carbon management in infrastructure (PAS 2080)'.

Environmental benefits

- We're on track to reach our 2016/17 target of 188 tCO₂e/£m, reducing our carbon footprint
- We've reduced the volumes of raw materials that are used in our construction projects
- We've influenced the wider industry and supply chain to consider low-carbon materials in their projects



Responsible resource use

To build and maintain energy networks that perform safely and reliably, we need to use finite – or non-renewable – resources, such as steel for pylons, aluminium for overhead line conductors and copper in transformers.

As populations and economies grow, we're seeing rising demand for these resources. This not only makes it harder for us to source them, it also leads to price volatility, and increases the environmental impact of extracting them. So, it's important that we make the most of the materials we own and buy.

Circular economy

We support the principles of the circular economy, which aims to maximise the value of materials by designing assets that can be recycled, refurbished and reused at the end of their operational life.

We're integrating these principles into our processes to find more cost-effective and environmentally responsible ways of buying raw materials. We're working hard to increase the amount of these resources that we recycle and reuse, such as overhead line conductors and components from steel pylons.

These principles apply not only to the materials that make up our transmission network, but also to our IT equipment and the waste generated in our offices.

CASE STUDY 1

Giving new life to our old IT equipment

Background

We continue to improve the quality and capability of our IT systems to make sure that they are suitable to meet the challenges of our changing business. As a result, significant quantities of laptops, PCs and other IT equipment can become redundant and require disposal. To make sure there is a sustainable future for this valuable resource stream, we have partnered with IT Efficient (a specialist in refurbishing and remarketing IT resources).

Old IT equipment is returned to IT Efficient, where there are a number of different options: internal redeployment, refurbishment, resale or recycling.

Where reuse or resale is not a viable option, component parts and composite materials (including rare earth metals) are salvaged and sold within secondary commodity markets.

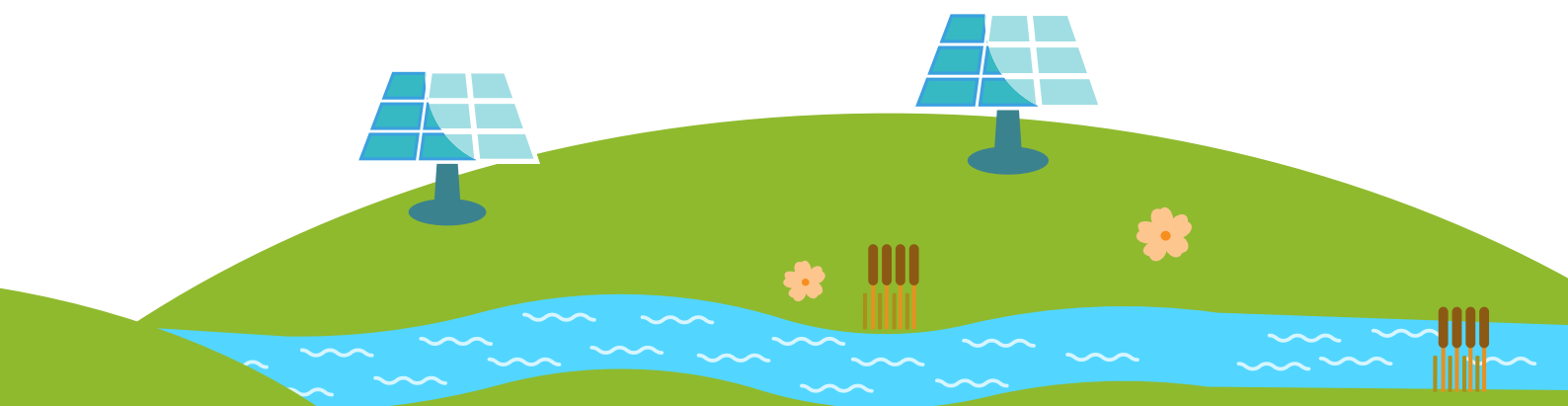
What have we done so far?

In 2016, we collected 3,396 pieces of used IT equipment with 10 per cent reused and 90 per cent broken down and recycled. None of this equipment was sent to landfill.

We made donations valued at more than £12,000 to more than a half a dozen different charities and schools last year, including Girls Incorporated, Reading Cricket Club, SYDNI Centre, Severn Area Rescue Association, our Environmental Education Centres and Streetsbrook Primary School.

Environmental benefits

- Sustainable management of resources
- Avoided emissions associated with the creation of new IT equipment
- Avoidance of landfill
- Provision of secondary raw materials



CASE STUDY 2

Diverting surplus material from landfill

Background

We're working to improve the model for reusing spoil from our infrastructure projects. Spoil can range from the waste material brought up during the course of an excavation to reusable road stone from temporary track-ways and depot sites.

We generate a significant amount of spoil during construction projects. For example, construction work at the Northwest Coastal Connection (in Morecambe Bay) is forecast to generate three million tonnes of spoil, while works on the North Wales Connection could generate 200,000 tonnes of spoil between 2019 and 2023. Traditionally, this surplus material has been disposed of as landfill or put towards quarry restoration.

What have we done this year?

We have built on excellent stakeholder engagement work undertaken for the Northwest Coastal Connection to develop a framework that matches our spoil with environmental stakeholders and therefore the most sustainable and beneficial reuse projects.

We have identified partners who are keen to work with us. These have included the Environment Agency, the Forestry Commission, the Wildlife Trusts and Natural Resources Wales.

What's more, we've taken a flexible approach as reuse opportunities might range from supporting small-scale local river, biodiversity and habitat improvement projects to providing millions of tonnes for flood defence or other infrastructure projects.

What's next?

Our focus is now on continuing to promote the initiative across National Grid and further afield. For example, engagement work with Natural England and Lincolnshire Wildlife Trust has identified two Trust sites in need of surplus aggregates and topsoil for environmental improvement works.

Environmental benefits

- Turning waste into a valuable resource for local communities
- Diverting surplus material from landfill

CASE STUDY 3

Reusing redundant equipment

Background

When our assets come to the end of their useful life and need to be decommissioned, there is a lot of equipment to dismantle and reuse, store or scrap.

In 2015, we launched the MARkit tool, which is our online repository for surplus material that is available and fit for reuse. There are now more than 120 users of the tool across the business. Several external stakeholders also use the tool.

What have we done so far?

In 2015, a gas compressor station at Peterstow was decommissioned. This year the Gas Transmission Owner (GTO) and the Electricity Transmission Owner (ETO) investigated opportunities to reuse the redundant transformers within National Grid.

Thinking beyond traditional business lines identified a home for the three transformers. They will be moving to their new home at the Deeside Project (a decommissioned substation that we're developing into an off-grid testing facility) in 2017. Reusing the transformers will save around £1.5 million and will avoid having to scrap around 150 tonnes of materials (including copper, steel and oil).

Environmental benefits

- More than 150 tonnes of materials saved from one example of reuse, saving natural resources
- Sharing and influencing sustainable approaches within and outside of National Grid



Caring for our natural environment

We own a huge amount of land, including more than 300 substations and the non-operational land that sits around them. This puts us in a unique position to do something with it. It's important that we manage the land we own in ways that deliver the greatest value to us and our stakeholders, and to the wider environments in which we operate.

We're working with local communities and stakeholders to make the best of our green spaces, minimise our environmental impact, benefit local habitats and ecosystems, and deliver cost and risk reductions.

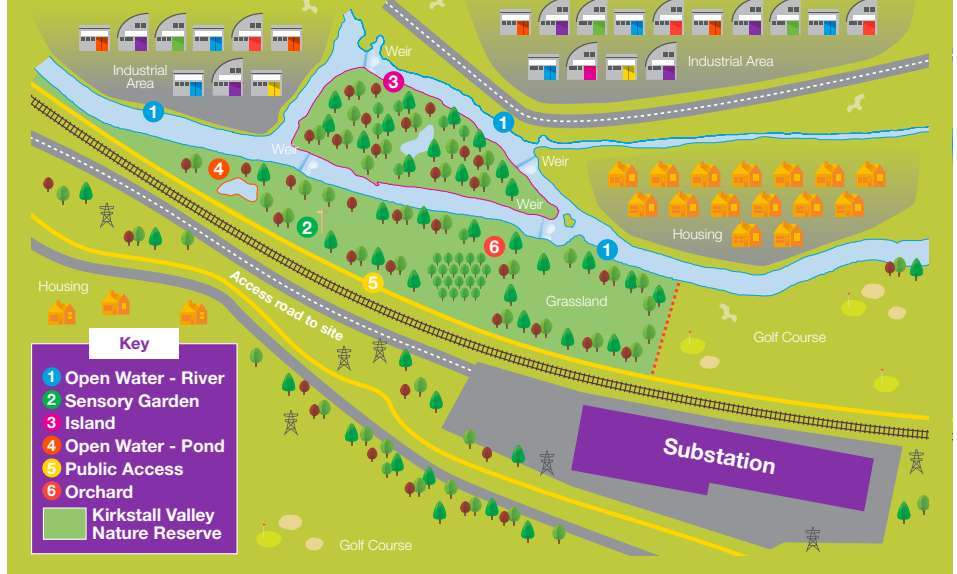
By taking a collaborative approach, we're delivering significant benefits, including improved biodiversity and habitats. We're building national partnerships with groups like the Wildlife Trusts and the British Beekeeping Association so that we make the most of every site and opportunity.



A Natural Grid approach to site management

nationalgrid

Kirkstall Substation



CASE STUDY 1

Natural Grid

Background

Through a programme called 'Natural Grid', we're finding better ways to manage our land, ways that improve the natural environment and create lasting value around our assets. We conduct scenario analysis through a natural capital valuation tool that compares different management options for each site. This helps us to target investment and determine the option that will deliver the greatest social and environmental benefits, and reduce costs and risks.

We don't have all the answers, though. So we work with partners who have a shared interest in the land, such as local Wildlife Trusts, the RSPB, the Environment Agency and Natural England. Together, we build plans that improve habitats and create new spaces for communities to enjoy. We aim to have 50 'Sustainable Action Plans' (SAPs) in place by 2020. So far we're working with partners on 31 sites, of which 20 are Electricity Transmission sites.

What have we done this year?

We were a finalist in the Business in the Community 2016 Asda Environmental Leadership Awards for our Natural Grid programme. Our programme was recognised as a new approach to managing environmental issues and building our business in a 'smart' way.

This year we have also been runner up in the Association of Graduate Recruiters (AGR) Innovation in Business-Led Development award for the Graduate Natural Grid project. The project brought together 43 people from our graduate intake programme who delivered Sustainable Action Plans on our non-operational land holdings, including one at Kirkstall substation.

What's next?

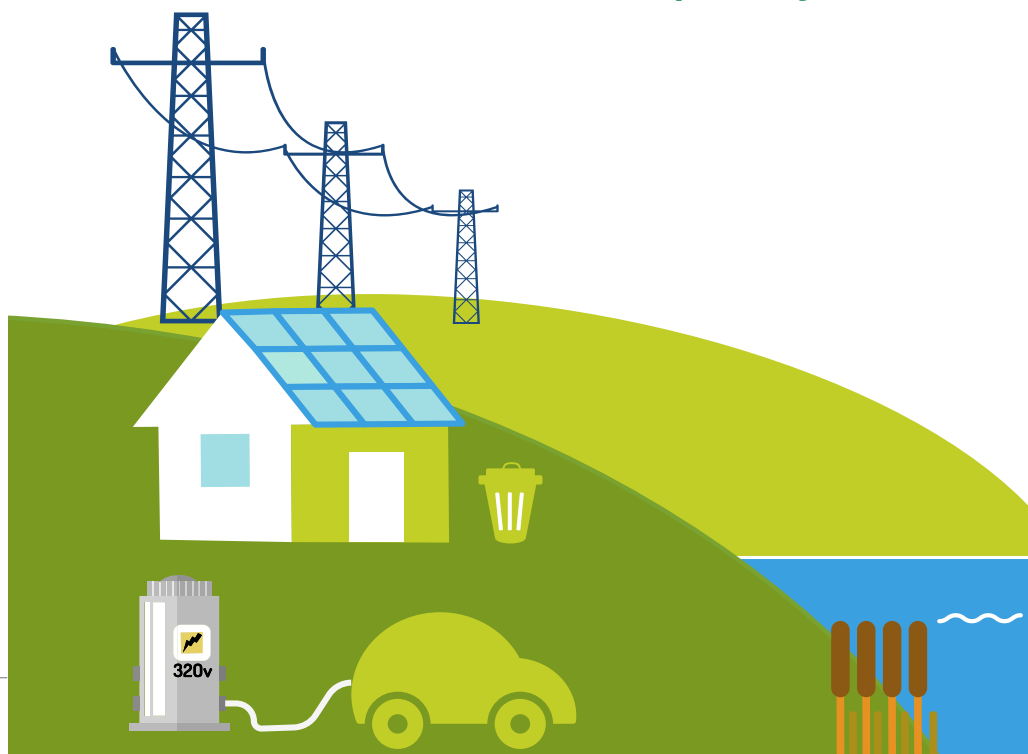
We have rolled out this Natural Grid project to the 2016/2017 graduate intake. As part of this project, nine further Electricity Transmission Owner sites have been shortlisted for a Sustainable Action Plan, along with other sites from across National Grid's businesses.

By introducing sustainability to our graduates at the start of their careers, we hope to permeate the organisation with future leaders who can embed sustainability into our decision-making, integrating it into our processes so that we make the right decisions.

Environmental benefits

- We become more efficient with our land use
- Working in partnerships, we learn from others and are better able to implement innovative environmental projects
- Reducing our carbon impact through managing our land
- Providing green spaces for local communities

Together, we build plans that improve habitats and create new spaces for communities to enjoy. We aim to have 50 'Sustainable Action Plans' in place by 2020.



CASE STUDY 2

Rhigos peat bog restoration

Background

Rhigos is a new substation, built to connect the Pen y Cymoedd Wind Energy Project, which is located on land managed by Natural Resources Wales within Rhondda Cynon Taf and Neath Port Talbot. This 76-turbine development was commissioned in late 2016, and will generate enough electricity to meet the domestic needs of 140,000 homes.

Following completion of the substation, we continue to work with local specialists to deliver a habitat management plan that will restore an ancient peat bog, provide bigger and better habitats for rare species and provide new grazing areas for a local farmer.

What have we done this year?

In October 2016, representatives from the Habitat Management Forum (including Butterfly Conservation and the local council) visited the site to see how effective the site enhancement activities had been in preserving suitable habitats for the rare Marsh Fritillary butterfly and other significant local species which had been abundant historically across the area before industrialisation.

A range of different caterpillars was observed during the visit, including Broom Moth, Knotgrass, Fox Moth and Ruby Tiger, showing that site conditions provide a good environment for caterpillars and butterflies. Although no Marsh Fritillary webs were found on this particular visit, this species is well known for its dynamic population changes and cycles of extinction and re-colonisation. It is important that effective site management is delivered so the site becomes a suitable location for Marsh Fritillaries to recolonise.



What's next?

Working with our wetland specialist, we will continue to monitor the water levels within the peat bog following the installation of the weirs in 2015. A number of large trees are being removed from the bog to help to retain the higher water levels and encourage the development of mosses essential to a healthy peat bog.

As part of our wider management approach at Rhigos, we have also been working with PONT (Pori, Natur a Threftadaeth – Grazing, Nature and Heritage), an organisation funded by the Welsh Government to help to introduce conservation grazing across Wales. Initial grazing in partnership with a local farmer will focus on the conservation area, extending to the newly created grassland areas around the substation in 2017/18 with a view to grazing areas of the peat bog in future.

Environmental benefits

- Reducing the environmental impact of connecting generation
- Creation of new habitats and increasing bio-diversity
- Increased absorption of carbon through peat bog restoration



Excellent environmental management

Our Environmental Management System (EMS) provides a strong foundation for our environmental sustainability strategy. It sets out the processes, procedures and measurement tools we use to manage our day-to-day environmental impact.

New ISO standard

The EMS is independently verified and externally assessed every year. In 2015 the ISO14001 standard was updated to reflect the changing environmental context. This will make sure that companies are not just trying to fix environmental problems in the present but are also considering environmental issues that they will be facing in 2020 and beyond.

We are working towards achieving accreditation against the 2015 standard before the transition period ends in 2018. In order to do that, we must consider the context of the organisation, the external environment in which we operate and the socio-political, economic and technological factors that will have an impact on our business.

We must be able to demonstrate that we have considered the needs and expectations of our stakeholders.

Assurance visits

This year we introduced an assurance visit programme that aims to support our colleagues from across the business with any issues they may have on site. The visits give us the visibility to track how effective the EMS is on the ground, allowing us to constantly improve our system. We set a target in 2016/17 to visit 25 sites. We are on track to meet this target.

Environmental dashboard

We updated our environmental dashboard in January 2017 to include functionality

enhancements and access to information about how the company and individual business functions are performing. These updates were based on stakeholder feedback sessions.

The updated dashboard allows us to look at trends in environmental incidents, and benchmark against other business units and our previous performance. Doing this will allow the business to target problem areas with the aim of proactively reducing incidents.



Recognising and sharing best practice

We continue to use a single, easy-to-understand ETO (Electricity Transmission Owner) Operational Environmental Handbook that we've distributed to all ETO sites. This document helps our operatives identify the risks and opportunities associated with managing our sites and assets. We are reviewing this document and updating it where necessary to incorporate changes in legislation, best practices, and learning from site audits and feedback from operations staff.

We have an Environmental Liaison Group, which is a forum drawn from our substation and overhead lines teams, to discuss and implement environmental best practice within ETO Operations.

We have also developed an Environmental Risk Evaluation tool for substations and cable routes. This uses Geographical Information System data to plot the proximity of our sites and cable assets to environmentally sensitive receptors (for instance water features such as aquifers, source protection zones and water abstraction points). This helps us to evaluate the environmental risk in the event of an incident. We're also using the information proactively to produce site-specific environmental registers.



Leading innovation

Our strategy

Our energy networks are changing, so our success depends on us adapting to these changes. We are doing this by developing and rolling out new technology, faster than ever before.

Our innovation strategy helps us to target our research programme. Our goal is to be an industry leader in innovative technologies, processes and solutions for electricity transmission networks. We achieve this by actively driving innovation to create value for consumers, customers and shareholders in a changing world, focusing on four key themes: managing assets, service delivery, efficient build and corporate responsibility. Our focus on corporate responsibility makes sure environmental sustainability is a major factor in our innovation strategy.

Our collaborative approach keeps us at the forefront of innovation. We value working with our partners to drive growth for National Grid, the UK and the wider industry. This year we have been working closely with suppliers to deliver sustainable innovations and we have started work on a sustainable construction strategy for our new innovation centre at Deeside.

Our goal is to be an industry leader in innovative technologies, processes and solutions for electricity transmission networks.

CASE STUDY 1 Finding alternatives to SF₆

Background

Sulphur hexafluoride (SF₆) is a highly effective electrical insulator used in high-voltage electrical applications. However, it is a greenhouse gas that has a global warming impact of 23,900 times that of carbon dioxide (CO₂), making up a significant proportion of our business's carbon footprint.

What have we done this year?

We have made significant progress with developing low-carbon alternatives to SF₆.

At our Sellindge substation, we have trialled a novel alternative from GE Grid Solutions: g³ (Green Gas for Grid). g³ is a new gas mixture that delivers the same technical benefits as SF₆ while reducing the global warming potential ratio from 23,900 to 345. We have successfully installed and pressurised g³ on two new gas-insulated busbar sections. The equipment has passed its high-voltage test on site and will be energised in April 2017; this will be a worldwide first.

We have also begun exploring the possibility of using alternative gas mixtures in existing equipment. In collaboration with 3M and The University of Manchester, we have constructed a test rig using actual gas-insulated substation components.

What's next?

The test rig for the trial on existing equipment is ready, and we plan to start high-voltage testing in April 2017.

We are also carrying out a tendering exercise that includes the development of an alternative gas for gas-insulated lines with a global warming potential of less than 10.

Environmental benefits

- Using g³ rather than SF₆ reduces the global warming potential from 23,900 to 345
- Reduces our overall carbon footprint, and potentially that of other network owners

Gas-insulated busbar containing g³ at Sellindge



Supergrid transformer containing a synthetic ester



CASE STUDY 2

Replacing mineral oil with a synthetic ester

Background

Traditionally, mineral oils are used as dielectric fluids in transformers at transmission voltages. Mineral oils are highly flammable, so when a transformer fails there is a risk that it will catch on fire, causing air pollution and safety risks. It is also necessary to build large bunds around transformers to prevent mineral oils entering land and waterways, causing environmental damage.

What have we done so far?

We have trialled and commissioned the UK's first 400 kV transformer containing

a synthetic ester, an alternative to mineral oil that is both fire retardant and has far less impact if leaked to the environment.

This project has reduced the environmental risks, and allowed us to install the transformer in a smaller footprint compared to a mineral oil-filled equivalent.

What's next?

Based on this success, we have started a project that aims to validate research into the impact of the synthetic ester on land and waterways. Findings may allow us to revise our policy for fire deluge and bund requirements for our transformers, reducing the amount of concrete used and the overall carbon footprint of new transformer installations.

Environmental benefits

- Using the synthetic ester significantly reduces fire risk and the subsequent air pollution
- Reduces the footprint for transformer installation, minimising land uptake and resource usage
- Minimises the potential impact of leaks on land and waterways

CASE STUDY 3

The Deeside project

Background

The development of a new innovation centre at Deeside will take advantage of a rare opportunity to secure a fully operational substation. The result will be an enduring facility that will help support the transition to low-carbon electricity networks. New ideas can be brought into routine deployment more quickly, reducing the overall cost of re-engineering the network and without affecting consumer security of supply.

This project also delivers on our commitment to environmental sustainability in all three value-creation areas:

- researching and developing new unconventional technologies and practices
- extending the operational life of ageing assets
- accelerating the implementation of innovation.

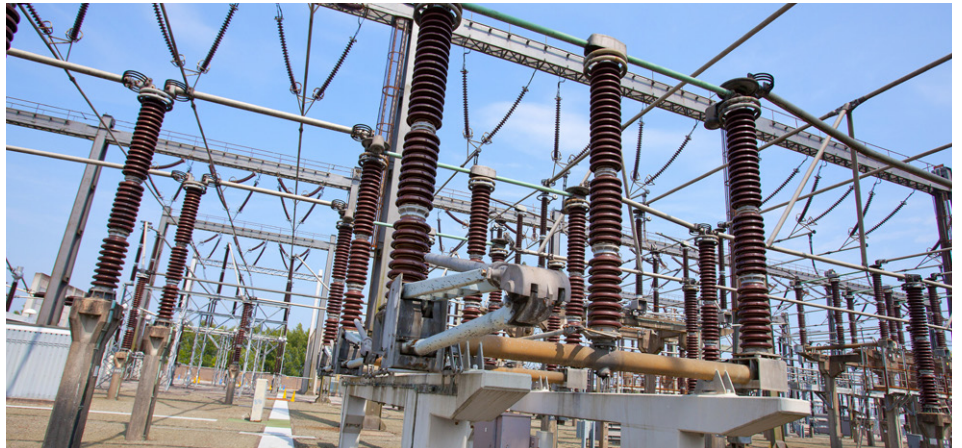
What have we done so far?

We are well underway with both the design of the facility, and development of the innovation programme.



Example of how the office roof may look

An area within the Deeside facility



We are committed to building the facility in the most sustainable way we can. Solar panels will be built on the roof of the innovation centre, supplying electricity to the site offices and welfare facilities. We are also considering how we can utilise rainwater harvesting and develop a ‘green roof’ consisting of grasses and sedum.

We have consulted widely with regards to ideas for projects that we could run at the facility and narrowed the list down to a shortlist of projects that we will commence in the first phase.

What’s next?

We are starting to build the facilities during 2017 and will begin to deliver the first

phase of the innovation programme. Over the course of the project, we will work towards delivering the anticipated financial and carbon benefits. For example, the facility will allow us to develop improved conducting materials and novel insulating materials such as polymers, oils and gases. Many of these technologies have the potential to reduce transmission losses, reduce visual impact and decrease the carbon footprint of our network. We assessed potential carbon savings based on the current portfolio of projects within the innovation programme; the cumulative expected saving in carbon is in excess of one million tonnes of CO₂ by 2050.

Further details about the Deeside project can be found here:

<http://deeside.nationalgrid.co.uk/>

Environmental benefits

- More than one million tCO₂e expected to be saved by 2050 through delivery of the innovation programme
- Positive carbon effect through the use of organic matter during construction
- Energy efficiency through integration of solar power
- Reduced usage of natural resources by rainwater harvesting

Let us know what you think...

We welcome all feedback because it helps us make sure we're focusing on the right areas and delivering the right things.

We'll keep sharing information with you about the projects outlined in this document. We'll do this at events like our customer seminars and operation forums.

In the meantime, we'd really like to receive your answers to the three questions below:

- what do you think our key area of focus should be, to ease the transition to a low-carbon future, and why?

- what do you think our key area of focus should be, to better manage our impact on the environment, and why?

- is there anything else you would like to comment on or share with us?

Please either use the link below to respond, or email your responses to talkingnetworkstransmission@nationalgrid.com

You can also use this email address for queries and to ask for more information.

And here's the link to our survey: <https://www.surveymonkey.co.uk/r/Q5K7L2F2017>



