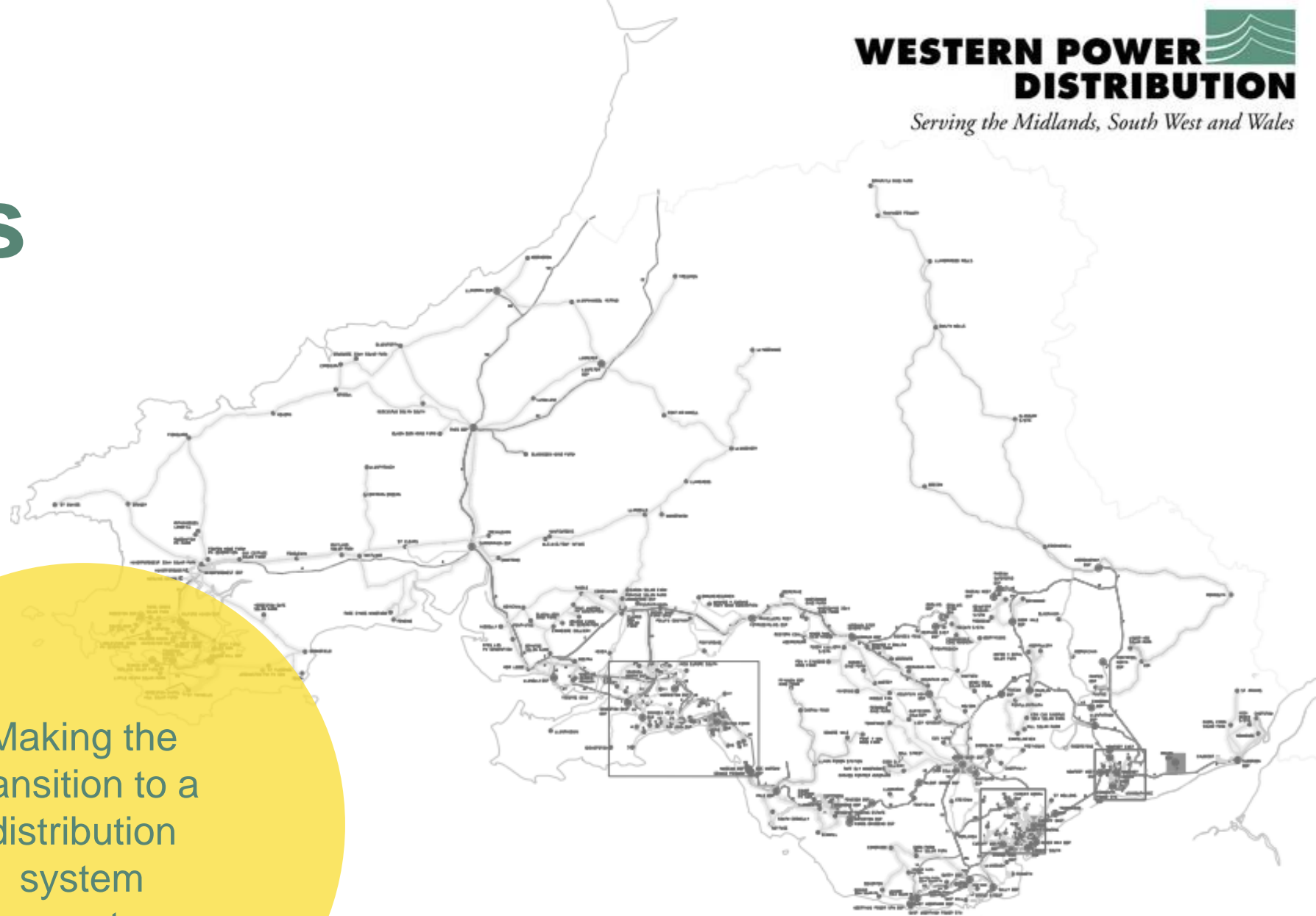


# Meeting the energy needs of South Wales



Investing strategically in the network

Making the transition to a distribution system operator

Innovating through our Future Networks programme

As the way we use and generate energy in Wales changes, so do the requirements of the energy network. WPD has already undertaken steps to meet these requirements; however, we are committed to continuing our work with Government and industry partners to deliver the best possible service for South Wales. Broadly speaking this means doing three things.

1. To make sure the South Wales network is fit for purpose, we have undertaken a bespoke analysis of current and future energy profiles which we are using to **invest strategically in the traditional reinforcement of the network** in the areas that need it.
2. To avoid costly reinforcement where possible and deliver an efficient and economic service to our customers, our Future Networks programme is **finding innovative ways of operating the distribution network, now and in the future**.
3. To move toward a smarter network where energy resources are actively controlled, we are **making strides towards becoming a distribution system operator** with clear goals for progress in 2017.



# Investing strategically in South Wales

## An overview of WPD's 'Shaping Subtransmission to 2030' report

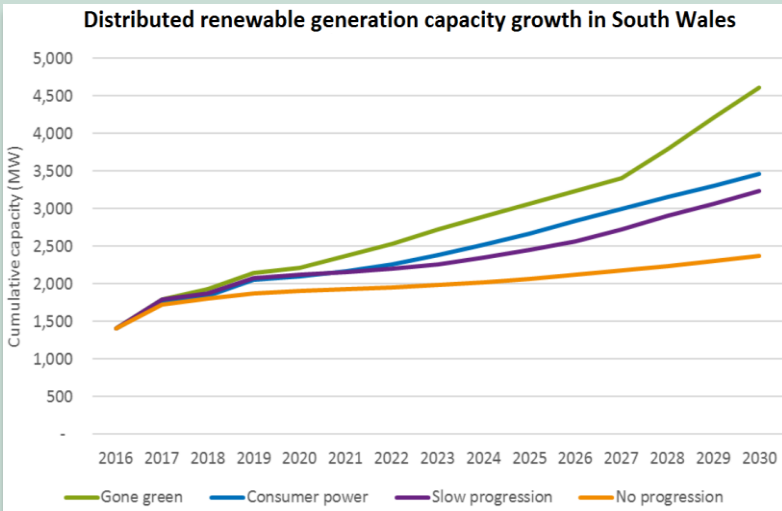
WPD's South Wales licence area has experienced an unprecedented growth in distributed generation, alongside an increasing use of low carbon technologies such as electric vehicles and heat pumps. This is likely to continue in light of recent policy commitments from the Welsh Assembly Government to enable the low carbon transition. To better understand the requirements of the distribution network in South Wales, now and in the future, we have partnered with Regen SW to undertake an analysis of energy demand and generation in South Wales up until 2030.

Using National Grid's Future Energy Scenarios, we analysed the likely growth in distributed generation and low carbon technologies across South Wales and used this to identify where the network needs greater reinforcement as well as where the greater use of Active Network Management (ANM) can alleviate constraints.

### What we did

We divided the South Wales licence area into 91 Electricity Supply Areas and developed localised scenarios for future demand and generation in each, taking into account historic and planned generation developments, local industry, population and natural resources. As shown in the table and graph, we found that we are likely to experience growth in distributed generation and low carbon technologies such as electric vehicles and energy storage under all four scenarios.

We assessed the impact of this growth on WPD's subtransmission network across three onerous cases: a winter peak demand day; a summer maximum generation day; and, a typical spring/autumn day. Below we outline our conclusions.



Technology	Scenario	2016	2020	2025	2030
Commercial storage (MW)	Gone green	-	30.0	100.0	300.0
	Consumer power	-	50.0	200.0	400.0
	Slow progression	-	10.0	30.0	100.0
	No progression	-	-	10.0	20.0
Electric vehicles (peak MW)	Gone green	0.9	9.3	40.1	116.8
	Consumer Power	0.9	7.0	30.1	80.7
	Slow Progression	0.9	4.3	15.2	37.2
	No Progression	0.9	3.7	12.5	29.6
Heat pumps (electrical MW)	Gone green	8.2	19.1	97.1	202.0
	Consumer Power	8.2	15.9	48.7	111.4
	Slow Progression	8.2	14.5	61.4	139.3
	No progression	8.2	10.9	19.0	32.4
Own use storage (MW)	Gone green	-	6.7	33.9	58.0
	Consumer power	-	8.5	35.9	64.3
	Slow Progression	-	4.4	17.9	33.4
	No progression	-	2.1	5.9	15.7

### National Grid's Future Energy Scenarios

#### Consumer power

- Wealthy, market-driven world
- High investment and innovation
- Focus on consumer desires over carbon emissions
- New tech



#### Gone green

- Wealthy world where environmental sustainability is top priority
- Policy interventions and innovation are ambitious and focused on achieving carbon goals



#### No progression

- World focused on low-cost solutions over green ambitions
- Traditional sources of gas and electricity dominate

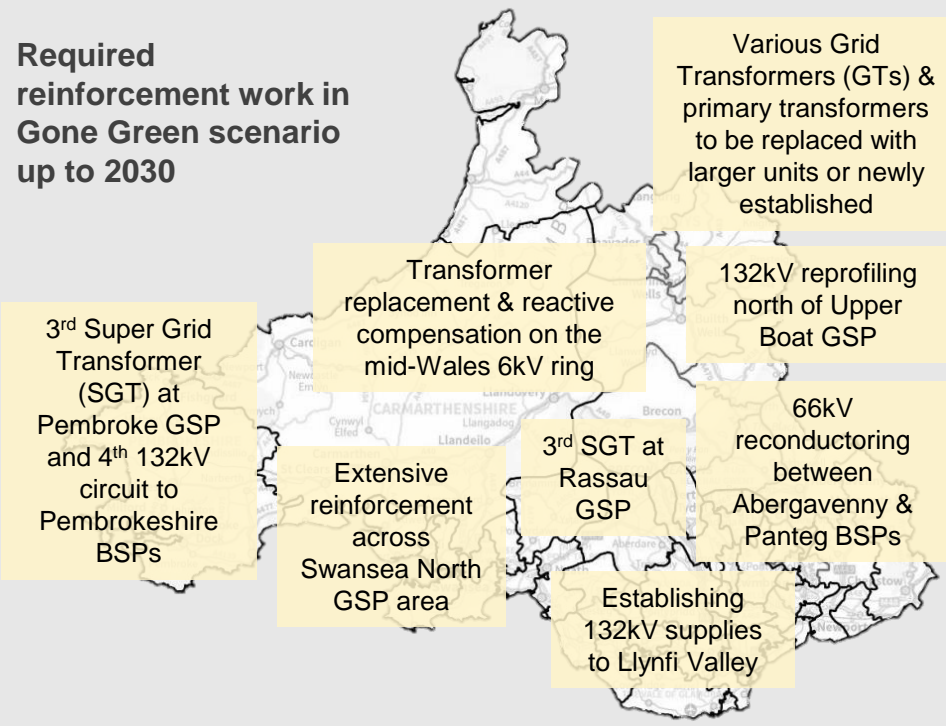


#### Slow progression

- World focused on long-term environmental strategy
- Economic conditions limit ability to transition to low carbon, yet a range of technologies and policies develop



### Required reinforcement work in Gone Green scenario up to 2030



### Conclusions and next steps

The studies confirmed the justification for WPD's planned network reinforcement projects such as reactive compensation in mid-Wales and the reprofiling of various 132kV and 66kV lines. The studies also identified the requirement for significant further reinforcement by 2020 including new transformers, line reconductoring and cable overlays.

Looking beyond 2020 to 2025 and 2030, further reinforcement is required under every scenario. Under the No Progression scenario this is limited to the further 132kV overloading in the Carmarthenshire and West Wales network. In contrast, the Gone Green scenario triggers a more extensive reinforcement programme as outlined in the diagram. It is expected that some – but not all – of this reinforcement could be alleviated by using ANM or other measures to curtail the output of distributed generation.

While the forecast reinforcement requirements were dominated by the connection of distributed generation, the electrification of transport and heating also has an impact. The studies are particularly sensitive to electric vehicle usage patterns, which may change dramatically as electric vehicles enter the mainstream.

Going forward, we recommend that National Grid assess the impact of our scenarios on the transmission network. We intend to revisit this study every two years.

Green ambition



# Innovating to accommodate Wales' low carbon transition

## WPD's Future Networks Programme

The changing energy environment is bringing about unique opportunities and challenges. Exploiting and addressing these through innovation is core to our business strategy. Indeed, we are recognised as market leaders in innovation and service delivery.

Our Future Networks Programme has delivered invaluable insight into how we adapt in light of these changes, and we have adopted many innovative ideas into our day to day operations that ultimately improve the efficiency and effectiveness of the services we deliver to our customers. Our current innovation work focuses on developing the required technology solutions to support the changing needs and requirements of a distribution network, setting us up for the transition to a Distribution System Operator.

### Concluded innovation projects

#### Community Energy Action (Oct 2012 - May 2014)

This project looked at how to effectively communicate with a range of communities to implement demand side response as an alternative to conventional reinforcement of the grid. We worked with ten diverse communities and five energy charities including Ely in Cardiff and Severn Wye Energy Agency, testing a variety of engagement techniques to change energy usage behaviour.

Between January and December 2014, households in Ely connected to local electricity substations were able to see how much energy they were using, and track their collective progress in real time, on a simple website – and how it compared against their target. The idea was quite simply to use less, especially at peak times. The less that people used the more they were able earn in terms of a community reward for their local area. Ely residents earned a total of £3989.75 through taking part.

This project gave us a portfolio of methods and interventions to use with communities who are willing to change their demand curve.



#### Network Templates (Apr 2011 - Jul 2013)

Through our Network Templates project we undertook the **largest network data monitoring project Europe has ever seen**, establishing for the first time how loads at distribution substations vary through the day, week, season and year across various urban, suburban and rural environments. We identified ten templates that accurately characterise load patterns across these areas, which were later verified by analysis in other DNO areas.

Building on the work of the Welsh Assembly Government in encouraging green energy, we assessed the templates for their suitability to incorporate various low carbon technologies. We also analysed the generation connected to the low voltage network, revealing an additional 20% of grid capacity for future connections. We were delighted to celebrate the success of the Network Templates project with representatives from the Welsh Assembly Government, and have since utilised the templates to inform our future network planning across all our licence areas.



### Ongoing innovation projects

#### FREEDOM project – Flexible Residential Energy Efficiency Demand Optimisation and Management (Oct 2016 – Dec 2018)

In partnership with gas network operator Wales & West Utilities, we are undertaking a project to better understand if hybrid heating systems are technically capable, affordable and attractive to customers as a way of heating homes.

We are seeking 50-75 participants in Bridgend to install hybrid heat pumps. By documenting and analysing the outputs of the pilot installations, the system interfaces and customer feedback, we hope to determine:

- The benefits that can be realised by network operators such as network investment deferral and constraint alleviation;
- The benefits that can be realised for domestic consumers such as energy savings and reduction in customer bills;
- The attitudes of participants with new commercial arrangements; and,
- How the new technology contributes to the reduction of carbon emissions.

#### Electric Nation (Apr 2016 - Oct 2019)

By the time 40%-70% of households own electric vehicles at least 32% of the network across the UK will require intervention at a cost of £2.2billion.

Before electric vehicles become truly mass market, we recognise that there is a window of opportunity for the automotive and energy industries to work together to shape norms, expectations and markets so that EVs can meet the needs of both consumers and the electricity network.

Electric Nation is the customer-facing brand of CarConnect, a WPD and Network Innovation Allowance funded project carried out in partnership with EA Technology, DriveElectric, Lucy Electric GridKey and TRL.

The project, which is set to be the largest trial of electric vehicles in the world, will recruit up to 700 EV drivers across our licence areas. Each participant will be provided with a free smart charger in their homes that they get to keep after the trial has concluded.

Through the trial we will develop a tool for modelling the effects of plug-in-vehicles on the electricity network, including the way that charging behaviour is impacted by different battery sizes and charging rates. This will allow us to assess solutions which could avoid traditional network reinforcement.

We will also be carrying out an assessment of the reliability of vehicle-to-grid technology – a system which enables the flow of electricity between plug-in-vehicles and the grid in both directions helping us to better manage supply and demand. The project will then investigate the acceptability to customers of delaying vehicle charging or changing the charging rate.

For further information visit our website:  
<http://www.electricnation.org.uk/>



#### Industrial & Commercial Storage (Aug 2016 - Apr 2019)

This project will trial battery storage technology at four separate WPD depots including at the Lamby Way Depot in Cardiff.

The storage systems will be used to optimise the energy demand of buildings, provide demand–response to the Transmission System Operator, and firm up intermittent generation.

Through this project we aim to identify improvements in cost efficiency, deliver options for customer connections, and provide insights and understanding for WPD on the best use of storage.



# Delivering a smart, flexible network in South Wales

## WPD's transition to a DSO

Our electricity network was initially built to transfer electricity from large central power stations to homes and businesses via the transmission and distribution networks. To keep the power system stable, supply and demand have to balance in real time. This is currently the responsibility of National Grid as the Transmission System Operator.

However, the recent developments we have outlined in this briefing are challenging these traditional roles. Managing these new (often intermittent) ways of generating and using energy will require a greater amount of flexibility in the network – the ability to modify generation and/or consumption patterns in reaction to an external signal (such as a change in price).

The roles of the different parties currently involved in UK energy network and system operation must evolve, exploiting the opportunities presented by new technologies to deliver a cost-effective energy system for consumers. In the short term, DNOs like WPD will need to make strides towards becoming Distribution System Operators (DSOs). This will mean greater interaction between the transmission and distribution networks, and a more active management of the network at the distribution level through the utilisation of smart grid technology.

### WPD'S VISION FOR BECOMING A DSO

- Deliver **local system operation** to increase **network reliability** and **economic outcome**
- Develop **local flexibility** and **ancillary services**
- Become an **active network manager** and benefit from **greater transparency** to improve **asset management and safety**
- Deliver **price efficiency** through more **intelligent network management**
- Use **data analytics** and **communication systems** to provide **greater transparency** supporting **decision making**
- Be a **facilitator** for third party service providers
- Build on **local community** presence and existing **customer relationships**
- Be at the forefront of **technology development**

Enabling us to...

...capture the full **value** of **distributed generation, storage, microgrids, EVs, and demand response** to bring flexibility to the network...

...extend system operation into an **integrated and automated system**...

...and provide **value added services** at an **efficient price** for our customers

### Our vision for the future energy system

Ultimately, we want to see an energy system built and managed in the best interest of our customers.

At a high voltage level, where there is the most congestion from the increase in distributed generation, there will be significant scope for utilising smart grid technologies to create additional flexibility on the network. At a low voltage level, there will be a greater requirement to build and modernise physical infrastructure to accommodate technologies such as electric vehicles. This rewiring exercise is a huge opportunity for high-skilled job creation, with a very low risk of stranded assets.

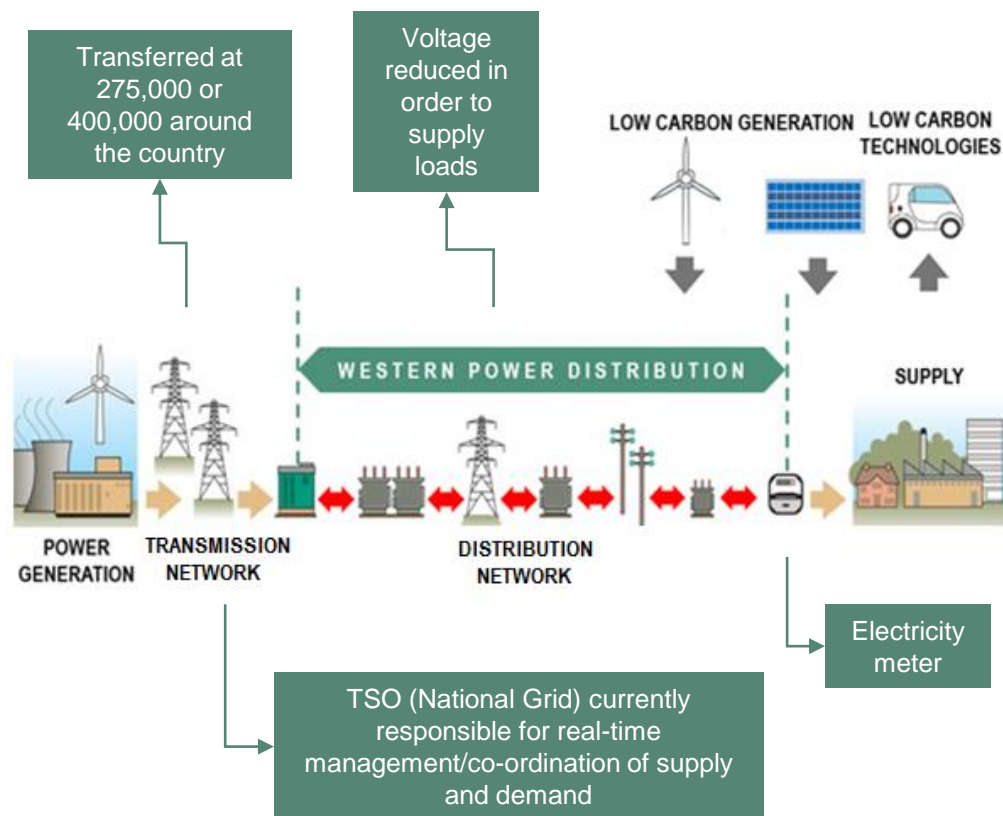
We believe that, because the majority of future flexibility will be connected at a distribution level, it would be most appropriate for regional DSOs to have full operational responsibility for managing constraints on the regional transmission network within limits set by the SO – allowing whole system planning on a regional basis. In practice, this would mean DSOs would be responsible for forecasting energy production and consumption and operating reserve services at a distribution-level to balance the network. There would be much greater cooperation between DSOs and the national SO, with the latter's responsibilities simplified allowing greater focus on centralised reserve for unplanned incidents.



### Making the transition to a DSO

There are two major dimensions to the transition to DSOs. The first is greater control over system operation. Through active management of the network, using local flexibility and ancillary services such as demand side response and reserve power, we will increase network reliability and overall efficiency. The second is to establish new platforms that provide visibility of a) the flexibility required to efficiently manage the network and b) the services available to deliver this flexibility. These platforms could be provided by the DSO or a third party. In this regard we have recently announced a large EU funded project with Centrica to create a local energy market platform in Cornwall. The scope of our involvement is still in detailed development but is likely to include identification of flexibility service requirements and encouraging more efficient use of the local assets.

This project is being delivered under our innovation strategy. The strategy is focused on gaining the knowledge and experience in methods and technologies that can help make our vision of our future role in the energy network a reality. The learning from our innovation projects have informed our operations. For example, innovation projects such as LV Network Templates, the Lincolnshire Low Carbon Hub and FALCON have established that advanced control systems and network monitoring can be applied to existing networks, and, in doing so, the network can gain capacity headroom for both generation and demand. In addition the data can be used to improve investment planning decisions and allow some flexibility in timing reinforcement works, as well as enabling us to offer innovative customer solutions, such as contained within our suite of Alternative Connections and Demand Side Response agreements.



## Our DSO transition business plan

Going forward, we have the following priorities for our transition to a DSO, which have been consulted on at over 20 stakeholder events:

- **Expand existing roll out and application of Active Network Management to higher voltage networks:** WPD is prioritising the application of smart grid technology combined with targeted asset upgrades or reconfiguration at this level. This will release the most network capacity for each pound invested, deliver greater network flexibility and maximise customer connection choice. Indeed, we have already published a programme of deployment for ‘Active Network Management zones’ where we will deploy additional equipment and telecommunications to substations and through which customers will be able to access ‘Alternative Connections’. By 2021, all GSP and BSP areas requiring ANM will be actively managed.
- **Protect the integrity and safety of lower voltage networks:** We will be looking to maximise the use of smart meter data, apply network sensing where relevant, and implement cost-effective simple control schemes, reinforcing the network when flexibility solutions cannot deliver what is required.
- **Co-ordinate with the SO:** We will work with the SO to establish visibility platforms for suppliers, aggregators and customers, allowing the development of flexibility services shared between DSO and SO. This will include the requirement to raise the awareness of demand side response and to help customers to identify multiple revenue streams for the system services they can provide.

We have laid the groundwork for this future cooperation having worked with National Grids TO and SO teams over several years on multiple innovation projects that have greatly influenced business-as-usual operations. In the future, we believe whole system change will be driven through the Energy Network Association (ENA) Transmission and Distribution Interface Steering Group, in which WPD takes a leading role, as well as through further innovation projects with clear outputs for business-as-usual operations. Indeed, the ENA have recently announced the TSO-DSO transition project, through which we will be working closely with other DNOs and National Grid to explore some of the detailed challenges of evolving roles and responsibilities. This will involve developing ideas to:

- Better align regulatory incentives to deliver whole-system benefits;
- Ensure a fair and consistent framework for all flexibility providers;
- Enable long term forecasting of load and generation growth;
- Improve the transparency of planned and anticipated contracted actions between customers; and,
- Provide a whole-systems view on future energy policy.

## An enabling policy and regulatory framework

WPD believe there are several things the UK Government and the Regulator could do to enable industry to deliver the smarter, more flexible energy system set out in the recent Call for Evidence.

Our primary ask of Government is to decide sooner rather than later on the overall framework on the boundary of SO activities between regional DSOs and the National SO, ensuring that its decision is customer-led rather than system-led. The delivery of this framework will not happen overnight, so we also urge the Government to set out a clear roadmap for transition.

Investors will require reassurance of the stability of income from flexibility services in order to invest. We are therefore calling on the Government to work with industry to deliver interim fixed nationwide charging arrangements and commercial terms at both the transmission and distribution level.

As we make the transition to a DSO, Government can also enhance DNOs’ capacity to better manage the network by ensuring that we are not precluded from owning and operating flexibility services. As noted in the Government’s Call for Evidence, multiple innovation projects have proven the technical abilities of flexibility services to assist with network management.

## Benefits for connection customers and energy consumers

Our innovative solutions are achieving accelerated connections and reduced costs by enabling our connection customers to connect new generation to our network, avoiding significant reinforcement costs but using innovative **Alternative Connection** arrangements coupled with new technologies and the acceptance of some curtailment. We can do this with lower overall costs to both the customer and our business (as shown in the table). Alternative Connections are now offered as business-as-usual for all our generation customers, and over the next few years we will be extending this concept to demand and storage connections.

Grid capacity released and avoided costs as a result of WPD-led innovation programmes			
	Mega Volt Amp (grid capacity) released	Avoided costs (£M)	
		Customer	WPD
Active Network Management	20.4	1.25	0.95
Soft Intertrip	40.7	2.58	1.36
Timed Connections	22.1	1.3	0.32

We are establishing a core WPD capability in **Demand Side Response** by developing the necessary technical functions while alleviating winter demand congestion in the South-East Midlands. Through our ‘Flexible Power’ awareness raising campaign, we hope to encourage non-domestic customers to enter new DSR agreements, through which they will be able to access a value stacking service thereby maximising their revenue whilst also creating maximum benefit for the grid.

Many of our projects have delivered valuable knowledge on future mass adoption of **Low Carbon Technologies**. SoLa BRISTOL provided insight into home energy storage and indicated the potential of the technology to flatten load profiles and reduce bills – but only once the cost of storage falls. Other projects have confirmed that there is very limited interest in demand flexibility for existing appliances. However, customers may be more responsive to price signals with new low carbon technologies such as electric vehicles, which will consequently be a focus area for WPD over the coming years. Our Electric Nation project will assess the effects of price signals to encourage electric vehicle charging as well as vehicle-to-grid energy transfer at certain times on consumer behaviour. Similarly, the Connect and Manage project is developing a simple low cost network interface for low carbon technologies that will autonomously prevent the distribution network from overload at peak times. Testing will be carried out with micro-generation, home battery storage and electric cars.



## Next steps

Throughout 2017 we will be undertaking a number of activities internally to transition to a DSO.

We will be building up our technical forecasting capabilities.

We will be continuing our significant programme of fitting additional measuring and monitoring equipment across our networks, laying the foundations for active network management.

Before the publication of the Government’s response to its Call for Evidence, due in Spring 2017, we will be preparing a more detailed plan for our transition to a DSO.