WPD INNOVATION

Transforming the electricity network

Network Innovation Allowance

Annual Report 2021/2022

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WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

a nationalgrid company

Foreword

Welcome to Western Power Distribution's Network Innovation Allowance (NIA) Report for 2021/2022.

Innovation is at the core of our business and we continuously strive to improve the way we deliver our services to customers. Operating a robust, secure and sustainable network whilst adapting it for the changing needs of our customers, calls for us and all Network Operators to continue innovating.

The rapid and continuing uptake of low carbon technologies requires a flexible approach which can accommodate these changes when they arise.

We have already taken significant learning from our innovation portfolio and incorporated it into our business to facilitate this.

For example, outputs from our Electric Nation project have fed into engineering policies and the Network Assessment Tool (NAT) developed by the project is being used across our business.

By carrying out a wide portfolio of innovative projects which build upon what we have already learnt and incorporating successful developments from other DNOs, we can ensure the network will meet all future needs and we will maintain our position as the leading performer in network availability and customer service.

This report outlines some of the key activities we have undertaken in 2021/2022, through the NIA, to deliver against our innovation programme of projects. This has seen us generate significant learning in a number of areas such as understanding the carbon impact of operating and maintaining our network in our ALPACA project and identifying and locating faults before they happen in our Pre-Fix project.

In order to successfully deliver our innovation programme we continue to work with a wide range of project partners from universities, small and medium enterprises through to large multi-national organisations.

We have a number of NIA projects where we work collaboratively with third parties. We have facilitated these throughout our Third Party Call for NIA projects that is now in its fifth year and has to date enabled more than 10 projects.

We are committed to using innovation to drive improvements on the network for our customers and to achieve net zero.

Phil Swift
C.E.O Western Power Distribution

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Key Facts

29
NIA projects delivered

44
organisations took park in our NIA call for ideas

484k
impressions across four social media platforms

£34m+
invested in NIA projects to date

92
project partners and suppliers on our NIA projects

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Executive Summary

This report contains a summary of all our NIA activity within the period from 1st April 2021 to 31st March 2022 for the four licence areas of WPD.

Following on from the successes of the Innovation Funding Incentive (IFI) and Low Carbon Networks Fund (LCNF) mechanisms, Ofgem's continued commitment to innovation is welcomed by Western Power Distribution (WPD), as it facilitates the continued application of research and development projects on the network, which are bringing significant benefits to customers.

Innovation continues to be core to our business strategy. We deliver a wide range of NIA projects to trial and demonstrate new and advanced systems, techniques and technologies to support the delivery of a fast changing and dynamic electricity network.

This year has seen us deliver a portfolio of 29 active NIA projects. Two key projects providing significant learning have been the VENICE project which is helping ensure no one is left behind in the transition to net zero and the FLOWERS project which is working across utilities to explore the potential capacity on South West Water's network for flexibility in the time difference between when the water is pumped, stored and used.

Following the success of our previous NIA Third Party Calls, we ran our fifth call, where we received 66 submissions from 44 organisations. We took two of these ideas forward into our new NIA project, DEFENDER. This project is enabling us to accurately assess the impact of energy efficiency retrofits on current and future network demand, and is also helping us understand the business case for investment in retrofit as an alternative to reinforcing the network.

We remain committed to continuing and increasing our third party involvement within our innovation programme, to enable project outcomes to be taken through to business as usual quickly and effectively. We also welcome Ofgem's decision to retain innovation funding in the form of the NIA in to RIIO-2, enabling the continued innovative focus on the longer term energy system transition and addressing consumer vulnerability.

This report contains a summary of all our NIA activity within the period from 1st April 2021 to 31st March 2022 for the four licence areas of WPD: South West, South Wales, East and West Midlands. This report has been produced in accordance with the Regulatory Instructions and Guidance (RIGs) issued by Ofgem.

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Our Innovation Strategy

Decarbonisation **Excellence** **Value for Money**

Our Innovation Strategy presents the focus areas and values of our innovation team, which are shaped by the challenges of the industry and our ethos as a company.

It was originally produced as part of the RIIO-ED1 business plan and has been updated annually since then to reflect the learning generated from our innovation projects and the changes in the industry. The knowledge and experience we gained through our innovation work is now shaping our plans for the RIIO-ED2 period. At the same time, we have also identified new areas that we should innovate in to ensure that no one is left behind in the energy transition. We believe our focus on these areas will be key in preparing us for RIIO-ED2.

Our Focus Areas

Through our innovation work we aim to find the most efficient ways of addressing the technical challenges of the future electricity network while at the same time, keeping electricity affordable for everyone.

As part of this, we want to understand how we can best support our customers and our communities so that no one is left behind in the energy transition.

To achieve this, our projects are shaped around the key priority areas of Decarbonisation and net zero, Heat and Transport, Data, Communities and Consumer Vulnerability.

Our Values

One of our goals is to be a main contributor to decarbonisation and we aim to achieve this by having a portfolio of projects focused on the right areas.

To deliver our projects successfully, we believe that it is important to work with the best people. We are always looking for new partnerships with organisations and individuals that share the same passion and values as we do so that we can achieve excellence together.

We are passionate about providing value for money to our customers and using our innovation funding the best way possible. We have internal governance processes in place to ensure that we achieve this through the way that we create, manage and deliver our projects.

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Our Innovation Programme

Our Innovation Programme consists of a wide range of innovation projects.

The scale of the work that we do ranges from lower Technology Readiness Level (TRL) projects which are generally concept investigation projects to higher TRL demonstration projects. The higher TRL projects involve real life trials of new technologies, systems and processes.

These projects usually follow smaller projects that we have completed so we can build on the learning previously generated from investigating and assessing those solutions.

In the period between April 2021 – March 2022 we have been delivering 29 NIA projects and 3 NIC projects.

NIA Projects

ACCELERATED (Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution)	NEAT (Network Event & Alarm Transparency)
ACE (Active Creosote Extraction)	Optimal Co-ordination of Active Network Management Schemes and Balancing Services Market
ALARM (Automatic Location of Arc-faults through Remote Monitoring)	Overhead Line Power Pointer
ALPACA (Approach for Long term Planning Accounting for Carbon Assessment)	Peak Heat
ARC-Aid	PNPQA (Primary Networks Power Quality Analysis)
DEFENDER (Demand Forecasting Encapsulating Domestic Efficiency Retrofits)	Pre-Fix
DynaCov (Dynamic Charging of Vehicles)	Presumed Open Data
EDGE-FCLi (Embedded Distribution Generation Electronic Fault Current Limiting Interrupter)	SEAM (Spatially Enabled Asset Management)
Electric Nation - PoweredUp	SHEDD (System HILP Event Demand Disconnection)
EPIC (Energy Planning Integrated with Councils)	SMITN (Smart Meter Innovations and Test Network)
FLOWERS (Flexible Operation of Water Networks Enabling Response Services)	Take Charge
Future Flex	Temporary Event Charging
Harmonic Mitigation	VENICE (Vulnerability and Energy Networks, Identification and Consumption Evaluation)
Intraflex	Wildlife Protection
LTE Connecting Futures	

NIC Projects

EFFS (Electricity Flexibility and Forecasting System)	DC Share	EQUINOX (Equitable Novel Flexibility Exchange)

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Project Highlights: FLOWERS

The Flexible Operation of Water Networks Enabling Response Services (FLOWERS) project is analysing the potential capacity on South West Water's network to embed flexibility capacity within the time difference between when drinking water and waste water is pumped and stored.

Water networks are one of the largest demands for electrical power supplied on distribution networks, estimated at 1TWh across our four license areas. Currently Water and Sewage license holders only deliver limited flexibility to help manage their electrical demand. FLOWERS will explore methods of delivering flexibility and analyse the feasibility of implanting it on South West Water's system. It will define the regulatory requirements for the creation of a flexibility product which can be embedded within electricity network control rooms.

Lessons Learned

A potentially large unforeseen issue with modifying water network pumping capacity may be the infiltration of sea water into coastal water networks. In some cases, the condition of the pipes results in an estimated 90/10 ratio between sea water and waste water in the water network pipes. As such, waste water pumping in these areas is near constant and potential to vary this may be slim.

South West Water's control room is entirely reactive, responding to alarms related to minimum and maximum set points for pumping stations with no forward forecasting or proactive pumping. This presents an opportunity, as the introduction of proactive pumping could have electricity network triggers baked in, but would necessarily require additional software and equipment.

Customer Benefits

It is anticipated that this project will develop a capacity for embedded flexibility with water networks.

It is conservatively estimated that this project can deliver 0.25% of water network demand as flexibility. This amounts to 750MWh of capacity extracted from South West Water's network yearly. Replicated across the breadth of the four license areas, this could unlock upwards of 2.5GWh of flexibility capacity on water networks.

Using data from RIIO-ED1 to estimate the savings from flexibility, an alignment of only 5% of unlocked flexibility capacity with constrained zones would deliver an estimated £2.5m of value to customers from South West Water's network, and £8.5m from all water networks in WPD's license areas.

Planned Implementation

As the FLOWERS project is a feasibility study, its planned implementation is dependant on its final outcomes.

If successful, it is expected that the project will build and trial the system in a future innovation project.

This trial would include further exploring the commercial and regulatory relationships required, demonstrating the scale of flexibility possible and the benefits this brings, ensuring the technical specifications are ready to be used following a successful trial.

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Project Highlights: ALPACA

Infrastructure is associated with over half of UK greenhouse gas emissions (Source: The Infrastructure Carbon Review, 2013), and 30% of this is made up of emissions that we have direct control over, such as construction, operation and maintenance of infrastructure.

Approach for Long term Planning Accounting for Carbon Assessment (ALPACA) is developing a way to measure the carbon dioxide we emit through our activities.

This project is working closely with other teams within our business and our regular suppliers to work out how we will record all the data required to find the total carbon impact, and develop a tool which can compare the carbon impact of different options.

Lessons Learned

So far in this project we have looked at the best practices from various different sectors. This found a suitable and rigorous framework (called PAS 2080), but found that there will need to be more data made available to account for all the carbon which is emitted.

We have also found that the energy transmission companies, notably National Grid, Scottish Power, and Scottish and Southern Energy Networks, have formed a collaborative group to address the carbon emissions that arise with the maintenance and development of their networks.

There is the potential for collaboration with these groups as part of this project.

Customer Benefits

Having a carbon accounting tool will provide a consistent approach to comparing the environmental impact of different design options, and will allow us to inform our network design, construction, and maintenance.

A reduction in carbon impact is expected to pass on benefits to consumers by a reduction in cost, as well as combating climate change, which is a key priority for the nation.

In addition, the development of this tool could lead the way for other companies, both in the power distribution industry and wider, to create their own carbon accounting approach.

Planned Implementation

This project is bringing a new process to our company, which will firstly provide us with an agreed whole-life carbon accounting system to see the actual footprint of our activities.

This will then allow us to weigh up the carbon impact of different options, and be able to choose our designs and products to minimise the carbon emitted wherever practical.

This will require us to gather and record more data about what we do, and require suppliers to report how much carbon is emitted from their work too.

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Project Highlights: VENICE

Consumers will be at the heart of the energy transition. As the energy transition gathers pace it will be vital for all parts of the energy supply chain to support consumers regardless of their situation.

Vulnerability and Energy Networks, Identification and Consumption Evaluation (VENICE) is looking at three distinct challenges: whether smart meter data can be used to predict a change in consumers' usage which may indicate a change in situation, what the impact of the global pandemic has been and whether working from home will persist and finally, whether a community energy scheme can be leveraged to engage the fuel poor in Net Zero.

Lessons Learned

Access to smart meter data is challenging, we have therefore had to be creative in trying to find open sources of data. We have leveraged academia for some of the work.

The team has explored a number of routes to gain access to this information, for future projects doing this research up front would be better overall.

Energy supplier engagement is key in this kind of project. However, this has been more challenging due to the current state of play in the supply market.

Explaining the background to the energy transition is vital, feedback from the Community Energy part of the project has highlighted the need to consistency in communication and a clear and simple message.

Customer Benefits

The potential to be able to highlight changes in vulnerability and target help at those that need it most will be vital.

There is social value in the ability to increase the accuracy of our Priority Service Register (PSR). This sort of project and its outputs if proven could help with achieving that.

The social value of signing new customers up to the PSR has been calculated by each of the networks and WPD, this value is £2.35 per customer added.[1]

Furthermore, using the technology developed under VENICE may also help with developing plans to update our PSR. Targeting help to those who most need it via agencies able to help will be good for all consumers.

[1]Based on the paper: "WPD, Consumer Vulnerability Outcomes, 2018/19, Table 3.3

Planned Implementation

The use of the solutions and insights could be very valuable to communities across GB when the project is completed.

Allowing communities to plan their responses to Net Zero should help shape a viable community response.

Understanding more about the impact of the pandemic and how working from home may persist will help shape our business plans in the future.

Being able to roll out tools to help our communities as they plan for Net Zero will be a key outcome from VENICE and furthermore if they can be used more widely that is good for GB.

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Project Highlights: NEAT

DNOs across the world are experiencing increasing numbers of alarms and events in their control rooms as additional DSO systems are introduced. The underlying cause of events is sometimes difficult to ascertain, increasing the time that is required for supporting new DSO control systems such as Active Network Management (ANM) and System Voltage Optimisation (SVO), and therefore preventing them from operating effectively.

Moreover, there is a risk that the number of alarms is becoming a distraction. Expanding alarm numbers would make it increasingly difficult for control engineers to assess the network and prioritise their actions appropriately. In turn this could lead to a higher risk of error, reduced effectiveness and lower team morale.

The Network Event and Alarm Transparency (NEAT) project is a 2 year NIA project that is developing a tool to analyse the relationship between alarms and events within and across the control room system, specifically those for ANM and SVO. The tool will identify common causes of events, which will be used to put remedial actions in place, including automatic grouping of alarms. Understanding the relationships between system events and alarms will reduce the time spent supporting new DSO related systems and ensure that they can operate optimally.

Lessons Learned

So far, data quality analyses have concluded that the data quality available should be sufficient to support the complex modelling intended for the project, and development of the tool. Similarly, the team have learnt that GDPR compliance and routine data extraction could cause some unexpected delays in obtaining information.

Furthermore, Harmonic have been able to identify several alarm floods, and group these alarm floods into unique clusters, each with a unique alarm profile.

Therefore, the project team have been able to conclude that alarm floods, and alarm flood clustering techniques, can be used to identify patterns among PowerOn alarms. Other learnings captured so far have revolved around technical difficulties and project management techniques.

The system trial is expected to generate much of the learning for the project, specifically by assessing the effectiveness of the NEAT system, and the degree to which the information can be used to improve system reliability.

Customer Benefits

The tool developed in the NEAT project will reduce the time spent supporting DSO related systems and ensure that they can operate optimally, allowing new systems, with network wide benefits, to continue to be developed and implemented across the function. Ultimately, the tool will reduce the associated costs for full time control systems support engineers, reducing customer bills.

By improving the transparency of alarms and events, and determining their root causes, the operation of ANM and SVO schemes will be optimised, thereby reducing the degree to which connected generation is constrained and reducing the subsequent impact on balancing costs. Hence, WPD will be able to deliver a more reliable and modern network for our customers.

Planned Implementation

To date the project has delivered a System Specification Document, a Data Quality Assessment Summary, a System Design Document, a System Build Document and a User Acceptance Testing book.

The system trial will provide insights about how effectively the models can identify patterns in historic and real-time data, and will inform us of the best way to present the information to the user, including the practicalities of running the system, therefore enabling us to plan our implementation.

The learning generated is expected to be applicable to other systems used by other DNOs including those which may not yet have been implemented. The process and prototype tools will be applicable where there are similar datasets to allow the alarms and events to be correlated.

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Project Highlights: DEFENDER

To avoid dependence on fossil fuels, domestic buildings must change to incorporate low carbon heating, smart tariffs, and energy efficiency measures such as insulation.

The interplay between all of these measures is not currently well understood from a forecasting perspective. We suspect that there may be opportunities to promote energy efficiency as a cheaper alternative to reinforcing the network.

Demand Forecasting Encapsulating Domestic Energy Retrofits (DEFENDER) aims to analyse the impact of insulating a home on the amount of power a heat pump needs, using actual domestic data which is used in network forecasting.

It will then look at the scale of possible benefits from promoting the uptake energy efficiency measures within the current market, with an aim to inform our strategy for the predicted widespread uptake of heat pumps.

Lessons Learned

DEFENDER kicked off during March 2022 so is still in its early stages, however the early learning points that support the delivery of the project have been captured.

Investigating potential case study networks where the majority of customers are domestic profile classes found that coastal networks are the most common candidates.

However, there is a risk that weather conditions, and propensity of holiday homes, mean that these areas may not be representative. This will be considered when setting out the criteria for case studies for the project.

International comparisons for the interplay of energy efficiency and heat pumps are difficult, as the heating mix in many comparable countries in Europe includes significantly more direct electric heating. As a result, heat pumps will likely reduce electrical demand in these countries, rather than increase it.

Customer Benefits

This project will benefit customers by considering our role in the uptake of heat pumps. It is analysing if there is a cost-efficient way to allow for widespread connection of heat pumps from our point of view, which would reduce the amount that customers pay in their energy bills.

The project aims to produce a tool which can produce pre- and post-retrofit demand profiles based on up to date smart meter data. The tool will be made open source and may be adapted by customers for a variety of potential benefits, such as for more accurately selecting the size of heat pump to be installed in a home.

More accurate forecasting may also produce a less pessimistic view of demand growth from low carbon heat, saving customer money through reduced future reinforcement costs.

Planned Implementation

DEFENDER is first looking at developing a model of the effect of energy efficiency on the Heat Transfer Coefficient of homes, which is being trained on smart meter data. Clustering techniques will then be used to create demand profiles of archetypal homes in various stages of retrofit. A tool will be built around this which can repeat the algorithms with updated data.

The profiles created will then be used in a network investigation to understand the effect of accounting for energy efficiency in demand forecasting, using a methodology for incorporating energy efficiency assumptions into DFES developed in the project.

Concurrently to this, an economic analysis will use a real options approach to consider the relative costs and benefits of using energy efficiency measures as an alternative to flexibility and network reinforcement. It will appraise where there is the greatest certainty of these benefits and whether this justifies a greater DNO role in retrofitting UK homes.

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Significant Learning

Pre-Fix

The Pre-Fix project is identifying and locating faults on our network before they happen. This is to reduce customer minutes lost and customer interruptions linked to unplanned faults on our HV network. This project is ensuring that the capability is scalable and economic by ensuring interoperability of devices and promoting the use of equipment that we already (or are likely to) purchase, instead of becoming dependant on specialist devices and data platforms.

The project has begun to carry out installations of equipment, and in doing so has created a number of learning points. As a result of the devices that have been installed to date, we have been able to begin observing what anomalies occur in HV underground networks.

Figure 1 demonstrates a waveform that we have repeatedly observed on one 11kV feeder since the beginning of March.

Although there has not yet been any fault clearance on this feeder to verify which asset is responsible, we have been able to relate this characteristic against a signature presented within IEEE PES-TR73, relating to moisture within an underground joint. We will continue to monitor this to increase the certainty in the type of fault occurring.

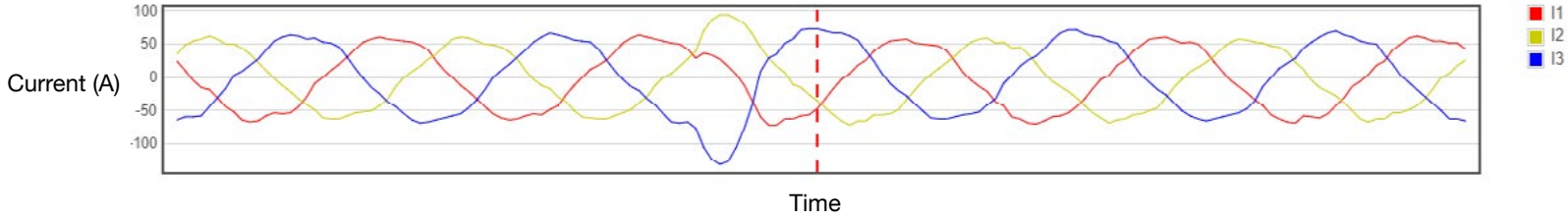

Figure 1: Current Waveform captures in a HV underground network

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Significant Learning

Wildlife Protection

Wildlife Protection aimed to understand how wildlife interacts with overhead networks and what the impact of these interactions are. This project also involved designing a wildlife protection risk assessment app for use on overhead networks and developed and tested a range of mitigation solutions.

Having successfully achieved these aims, outcomes of the project have already begun being rolled out into Business as Usual. The projects trial has provided the learning needed on which devices can be rolled out, how they can be installed and how they will act during their life on the network. Some of the devices are now available within our stores system for use on the network and updates have been made to policies to support their use.

Other changes have already started to be made to the way we build, replace and refurbish our overhead structures following learning from the project. This includes:

1. **Only installing electrical jumper connection to connecting items of electrical plant using covered conductor to significantly reduce the likelihood of wildlife electrocution.**

2. **Review of overhead construction design to make it more wildlife friendly including extending the height of the pole, and leaving extended pole top spaces unfurnished. This would allow birds who use the structures upper portion as a vantage point, to land on the pole top without fear of being electrocuted.**

Figure 2: Drone installation of Bird Flight Diverters

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Implementation

The way we approach innovation is fundamental to delivering our objectives.

We actively involve staff from across the business in the generation of ideas, development of solutions and the implementation of our projects.

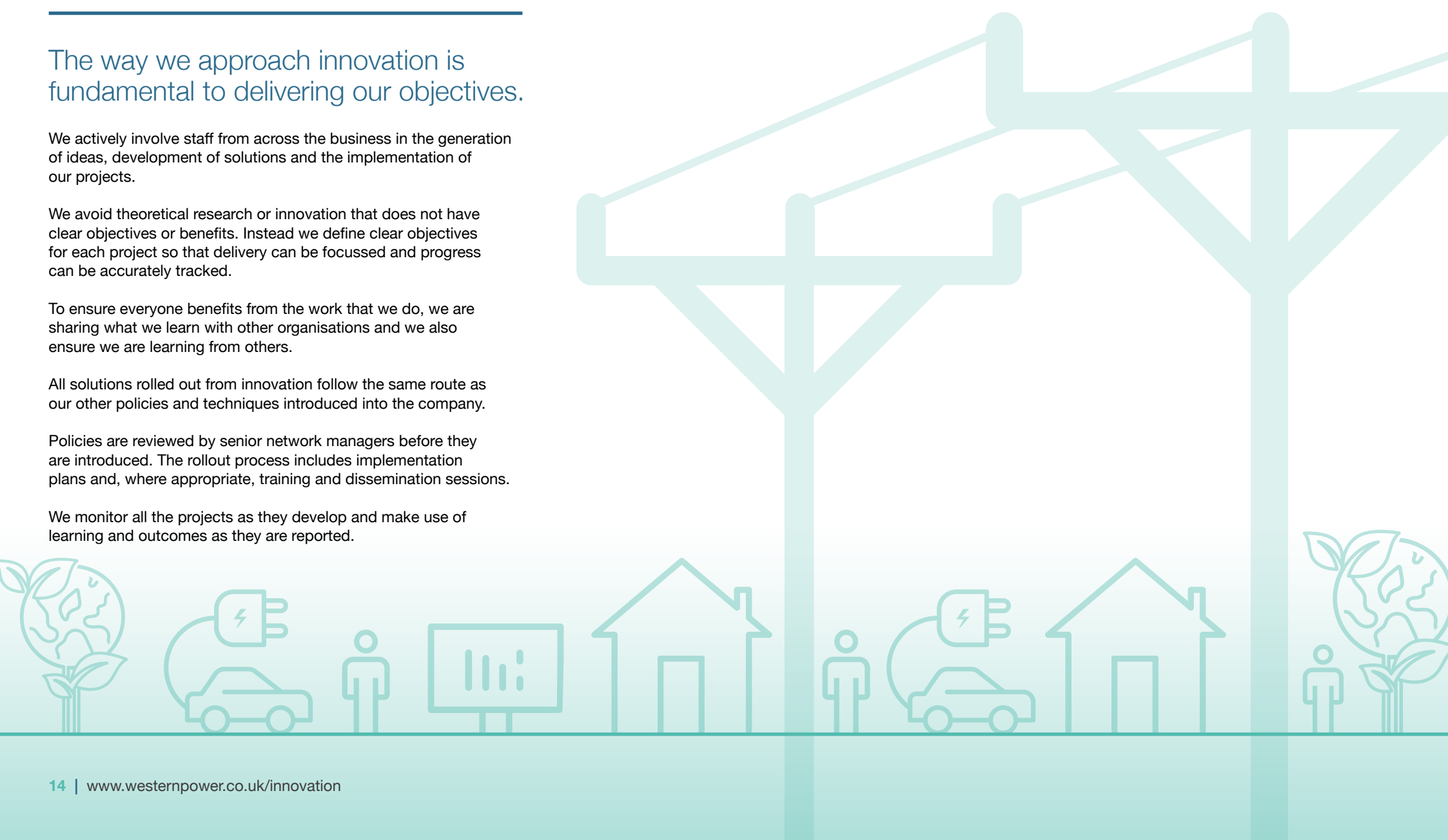
We avoid theoretical research or innovation that does not have clear objectives or benefits. Instead we define clear objectives for each project so that delivery can be focussed and progress can be accurately tracked.

To ensure everyone benefits from the work that we do, we are sharing what we learn with other organisations and we also ensure we are learning from others.

All solutions rolled out from innovation follow the same route as our other policies and techniques introduced into the company.

Policies are reviewed by senior network managers before they are introduced. The rollout process includes implementation plans and, where appropriate, training and dissemination sessions.

We monitor all the projects as they develop and make use of learning and outcomes as they are reported.



2021-2022 NIA Project Spend

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Project	Internal Spend	External Spend	Total Spend in 2021/2022
ACE (Active Creosote Extraction)	£16,322	£127,627	£143,949
ACCELERATED (Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution)	£10,875	£123,723	£134,598
ALARM (Automatic Location of Arc-faults through Remote Monitoring)	£25,376	£78,557	£103,933
ALPACA (Approach for Long term Planning Accounting for Carbon Assessment)	£12,673	£81,690	£94,363
ARC-Aid	£7,403	£34,718	£42,121
DEFENDER (Demand Forecasting Encapsulating Domestic Efficiency Retrofits)	£0	£0	£0
DynaCoV (Dynamic Charging of Vehicles)	£17,605	£270,538	£288,143
Optimal Coordination of Active Network Management Schemes and Balancing Services Market	£4,108	£50,783	£54,891
EDGE-FLCi (Embedded Distribution Generation Electronic Fault Current Limiting Interrupter)	£653	£67,682	£68,335
Electric Nation - PoweredUp	£33,204	£385,575	£418,779
EPIC (Energy Planning Integrated with Councils)	£70,086	£278,228	£348,314
Future Flex	£15,353	£201,396	£216,749
FLOWERS (Flexible Operation of Water Networks Enabling Response Services)	£10,438	£18,881	£29,319
Harmonic Mitigation	£26,789	£172,517	£199,306

2021-2022 NIA Project Spend

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Project	Internal Spend	External Spend	Total Spend in 2021/2022
IntraFlex	£18,708	£234,128	£252,836
LTE Connecting Futures	£75,729	£40,825	£116,554
NEAT (Network Event & Alarm Transparency)	£37,265	£84,523	£121,788
OHL (Overhead Line) Power Pointer	£22,546	£266,772	£289,318
Peak Heat	£0	£211,677	£211,677
Presumed Open Data	£0	£7,075	£7,075
PNPQA (Primary Networks Power Quality Analysis)	£0	£3,448	£3,448
Pre-Fix	£72,050	£683,116	£755,166
SEAM (Spatially Enabled Asset Management)	£14,243	£195,000	£209,243
SHEDD (System HILP Event Demand Disconnection)	£8,491	£135,891	£144,382
SMITN (Smart Meter Innovations and Test Network)	£0	£0	£0
Take Charge	£3,234	£1,522,333	£1,525,567
Temporary Event Charging	£18,262	£53,167	£71,429
VENICE (Vulnerability and Energy Networks, Identification and Consumption Evaluation)	£29,328	£349,003	£378,331
Wildlife Protection	£5,457	£23,550	£29,007
	£529,001	**£5,451,073**	**£6,258,621**

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How to get in touch

Find out more about all our projects, request access to project data and view upcoming innovation events at:

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