WPD INNOVATION

Transforming the electricity network

Network Innovation Allowance

Annual Report 2019/2020

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WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Foreword

Welcome to Western Power Distribution's Network Innovation Allowance (NIA) Report for 2019/20.

At the core of our business is innovation 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, such as learning from our Entire project enabling our Flexible Power activities.

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 2019/20, 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 new technologies connected to our network through the LCT Detection project and the viability of Hydrogen as a source for heat and transport as part of Hydrogen Heat and Fleet.

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 also have a number of NIA projects that are led by third parties, which we have facilitated through our Third Party Call for NIA projects that is now in its third 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

26
Projects delivered

61
submissions to our NIA calls

28,048
hits on our website

£25m+
invested in NIA projects to date

92.1%
of NIA spend with third parties

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Executive Summary

This report contains a summary of all our NIA activity within the period from 1st April 2019 to 31st March 2020 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 26 active NIA projects. Two key projects providing significant learning have been the Presumed Open Data project which identified more than 100 use cases of data that could be shared to provide useful information to third parties and ALARM which has detected more than 1000 events on network feeders that could not have been identified previously.

Following the success of our previous NIA Third Party Calls, we ran our third call, where we received over 60 submissions with ideas on how we can innovate using our existing data. We are taking three of these projects forwards focussing on analysing and improving our Geographical information System and network modelling data and developing new ways of managing our real-time network alarms.

We remain committed to continuing and increasing our third party involvement within our innovation programme to deliver innovation outcomes to be taken through to business as usual as quickly and effectively as possible. 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 2019 to 31st March 2020 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 and 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 that, 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 that by having a portfolio of projects that is focusing 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 that 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 that we can build on the learning previously generated from investigating and assessing those solutions.

In the period between April 2019 – March 2020 we have been delivering 26 NIA projects and 3 NIC projects.

NIA Projects	
Losses Investigation	Multi Asset Demand Execution (MADE)
CarConnect (Electric Nation)	Future Flex
LV Connect & Manage	PCB Sniffer
Entire	Harmonic Mitigation
Smart Energy Isles	Wildlife Protection
Visibility Plugs & Socket	Virtual Monitoring Data (VM -Data)
Primary Networks Power Quality Analysis	IntraFlex
EDGE-FCLi (Embedded Distributed Generation Electronic Fault Current Limiting interrupter)	Automatic Location of Arc-faults through Remote Monitoring (ALARM)
Next Generation Wireless Telecoms Analysis	Electric Nation - PoweredUp
CADET (Curtailment and Dispatch Estimation Toolkit)	Presumed Open Data (POD)
Virtual Statcom	LTE Connecting Futures
OHL (Overhead Line) Power Pointer	Net Zero South Wales - Cross Vector Scenarios
Network Islanding Investigation	ARC Aid

NIC Projects		
EFFS	OpenLV	DC Share

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Project Highlights: Multi Asset Demand Execution (MADE)

The MADE project is looking to better understand the feasibility and value of managing and aggregating multiple Low Carbon Technology (LCT) assets within a single home affordably.

Through the use of advanced algorithms the project aims to unlock value from energy markets. We are looking to understand the value of a single system coordinating across Photovoltaics (PV), Storage, Electric Vehicles and Hybrid Heat Pumps. Led by PassivSystems, the project has analysed data from previous trials to understand the potential value of the coordination to the individual asset owner, the Distribution Network Operator (DNO) and the whole energy system. The technical feasibility is now being tested in a five home technology trial. The results of this trial will then be used to refine the value assessments.

Lessons Learned

Learning has been gathered, and continues to be gathered on the value of coordinated multi-LCT control.

The initial analysis of previous trial data highlighted the significant potential value of coordinated flexibility.

The technology has also been proven in the trial to date. Data is currently being collected from the technical trial to form the basis of a re-run of the initial analysis.

The trial is inherently at a small scale (five homes) and was planned as an initial investigation into the concept. More robust statistical analysis would require a significantly bigger data set.

Customer Benefits

The project has highlighted that coordinated multi-LCT control provides a number of benefits to customers.

These range from benefits delivered directly to asset owner, to wider benefits accruing to DNO customers. Increased coordination of assets can provide customer savings of £260 per annum.

The control can help reduce peak loading by 35-40%. This has wide reaching benefits in the energy system in the order of billions of pounds a year.

DNO reinforcement savings could reach £700m per year when compared to the significant additional spend needed to accommodate non-flexible LCTs.

Planned Implementation

The real world operation of the control systems is still being tested and will feed back into a refinement of the project modelling.

In the meantime, learning has been collected on the technical requirements and challenges associated with the control of multiple assets. These are being fed to the British Standards Institution (BSI) to help inform future standards for integration.

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Project Highlights: Primary Networks Power Quality Analysis (PNPQA)

The harmonic content of waveforms and power quality such as flicker, voltage sags and swells within the primary network was not previously a concern.

The impact of power electronic devices on the harmonics and power quality of the networks isn't very well understood. As more and more LCTs are connected this presents increasing uncertainty.

This project is evaluating how harmonics and power quality can be monitored and analysed in a cost effective way across wide areas of the network. As well as looking at the hardware needed, the project is also looking at the associated software and processes required.

Lessons Learned

Testing of Voltage Transformers (VT) was carried out to validate the accuracy of equipment used for Power Quality (PQ) measurements.

The findings showed that VTs pass through signals at the harmonic frequencies typically measured (up to the 50th) but introduce attenuation in the output magnitude at higher frequencies. New monitors have been installed in areas with both high and low LCT penetration.

The sites in the high LCT area exhibit significant differences in the voltage harmonic magnitudes compared to the low LCT areas as there is some variation in the harmonic aggregate values across the sites.

Customer Benefits

Information about the power quality of existing networks and the power quality characteristics of new LCT connections is vital for the connection of LCTs to the distribution network. Much more granular data in terms of spatial and temporal resolution will be required in the future.

The present monitoring approach of using portable monitors at a few sites for short periods, with site visits to retrieve data, would be labour and cost- intensive to scale up to meet the future power quality monitoring requirements.

Therefore, this project is trialling a much more cost and labour efficient way of delivering the required power quality visibility in order to facilitate customer connections.

Planned Implementation

A total of 46 portable and fixed wall-mounted monitors have been installed across 37 sites. The data gathering and analysis part of the trial has begun and a Standard Technique for power quality installations has been drafted.

Software for automating the processing and analysis of power quality data has been developed.

The software is device agnostic and transparently supports data gathered by the three different power quality monitors being trialled. Power system and LCT models have been constructed for future-looking power system studies of the potential power quality impacts of increased LCTs.

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Project Highlights: Network Islanding Investigation

A network island is defined as a section of network that is able to detach from the main interconnected grid and remain energised by local Distributed Generation (DG).

DNOs currently employ automated protection systems to remove network islands from supply when they are detected. This study, however, has sought to investigate whether intentionally islanding parts of the distribution network in a controlled and safe manner could offer benefits to network customers.

The Network Islanding Investigation project involved research and studies into the technical, legal, regulatory and commercial aspects of islanded networks to understand if this approach could deliver significant benefits for customers.

Lessons Learned

The project established that network islands could be implemented from a technical perspective, with various manufacturers able to provide technologies to facilitate the transition from grid-connected to island operation. The studies also found that on average the typical costs to convert a network to operate safely and securely as an island would be £512k.

The legal and regulatory review concluded that islanding the network could be achievable without changes to the existing regulatory frameworks. However a bottom-up and top-down Cost Benefit Analysis found that this resulted in a negative cumulative Net Present Value in all cases explored.

Customer Benefits

With the trend of generation becoming more de-centralised and customers wishing to consume power from locally installed low carbon generation sources, the study aimed to see if Network Islanding could deliver customer benefits.

In addition, it was foreseen that islanding parts of the network could represent a new mechanism for DNOs to increase network flexibility and assist in the transition to DSO.

Planned Implementation

The project found that it is not possible to achieve financial benefits at the present time from network islanding.

However, further research should be conducted again in the next three years to understand the impact of changes in charging methodologies and other possible revenue streams.

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Project Highlights: Presumed Open Data (POD)

There is a large amount of useful data which is published about the energy sector through mandatory reports, innovation trials and consumer tools.

However, datasets are often published on standalone webpages with limited descriptions. Aligning with the recommendations of the Energy Data Taskforce, the POD project is looking to review data held by WPD to understand the extent that it can be shared with third-parties.

Use cases are being developed using this data. The datasets with the highest value will be processed, standardised, and published so the identified use cases can be fully realised. An Open Data Hub will be delivered to facilitate the hosting and sharing of the data.

Lessons Learned

So far the data discovery phase of the project has been completed. The primary learning is that we have a wealth of valuable information across the organisation, the value of which will be easier to maximise if the barriers to entry are lowered.

Internally we face similar challenges to the wider industry on the acquisition and usage of data, outside of the operational management of assets and the network. Areas that work on specific tasks and use specific datasets are very well defined in their responsibilities, but it is clear that there is value in enabling the functional areas to utilise core data more effectively.

Customer Benefits

To date, the project has documented over 100 data use cases. At a high level, maximising the visibility and value of data could achieve:

- Faster decarbonisation of the energy system through easier identification of connection capacity.
- Provision of a better 'whole of system' view, improving system security.
- Enhancement of third-party interactions, promoting better flexibility response.
- Reduction in customer bills through a more strategic deployment of community-owned LCTs.
- Optimisation of procurement regarding asset location, size, or function.

Planned Implementation

A key deliverable will be the development of the public facing Open Data Hub where:

- All data is stored in one location;
- Appropriate means of access (registration/verification of identity) are required for datasets than can be considered Public or Shared;
- Data can be easily downloaded upon necessary verification; and
- Stakeholders can register to be notified when new data sets are published.

The hub development will exploit techniques that are already available regarding the automation of data correction, meta-tagging, and the flagging of data issues when uploading new data.

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Project Highlights: Virtual Statcom

The Virtual Statcom project is an innovation project that seeks to determine the technical feasibility of increasing the network hosting capacity by optimising the reactive power output of existing generators in the 33kV and 11kV distribution network.

As part of this investigation two main algorithms have been developed. The first is an algorithm to determine the generation and load hosting capacity of a network and the second is an algorithm to optimise the reactive power dispatch of existing generators with the aim to increase hosting capacity.

Lessons Learned

The Virtual Statcom showed that the load capacity of the network can be successfully increased when optimising the reactive power dispatch of DG.

This reinforces the case that real-time network optimisation systems will be essential in enabling Distribution System Operators (DSOs) to make the most out of the existing network and assets. This is key in facilitating the increasing network demand without completing expensive network reinforcement work.

The Virtual Statcom also released some generation capacity, however this capacity benefit depended on the network topology and assets and would need to be combined with other interventions to maximise benefits.

Customer Benefits

Being able to manage and optimise the reactive power output of DG can allow more load to be connected to the distribution network without the need for network reinforcement.

This results in reduced costs to customers while at the same time enabling faster and cheaper connections to the network.

Planned Implementation

In the final phase of the project the Work Package 5 report will make recommendations for the implementation of the developed Virtual Statcom in a real-time system and its trial in a further demonstration project.

We recognise the great potential our developed algorithm has in terms of increasing the capacity of our network and the role it can play in our DSO functions.

We are therefore now planning our future innovation work that will build on this learning.

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Significant Learning

Embedded Distributed Generation Electronic Fault Current Limiting interrupter (EDGE-FCLi)

This year the project has been focussed on the design and testing phase of the FCLi device. Working closely with the manufacturer we have conducted a thorough detailed design review that has allowed us to fully understand the performance and operation of the FCLi.

The learning from this process was critical during the production of the test specification as we were able to clearly define and capture the necessary functional and type tests required for this first of a kind device.

The learning generated has also been shared with UKPN, with whom we are collaborating with on the project. This, combined with our regular progress updates with UKPN, has avoided duplication of effort and will help ensure that the FCLi is rigorously tested before it is connected to the live 11kV network.

The progress towards implementation reached a significant milestone when the FCLi passed the Factory Acceptance Test (FAT) in Israel.

FCLi device being tested

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Significant Learning

Overhead Line Power Pointer (OHLPP)

The project has offered valuable learning and understanding of directional power flows through distribution networks. The Smart Navigator 2.0 monitoring solution has been developed and optimised for use in UK distribution networks.

Several months of operational data (including power flow direction, load current, conductor temperature, and directional fault information) has been captured during field trials on 11kV and 33kV systems across the West Midlands network.

This has revealed clusters of embedded generation along feeders and has provided visibility of load profiles, short-term interruptions, conductor temperatures and operational phase imbalance.

The real-time temperature of phase conductors has provided an opportunity to demonstrate the application of a post-fault rating algorithm which aims to provide managed release of latent overhead line capacity during outages.

Overhead Power Pointers installed on the 33kV network.

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Significant Learning

Automatic Location of Arc-faults through Remote Monitoring (ALARM)

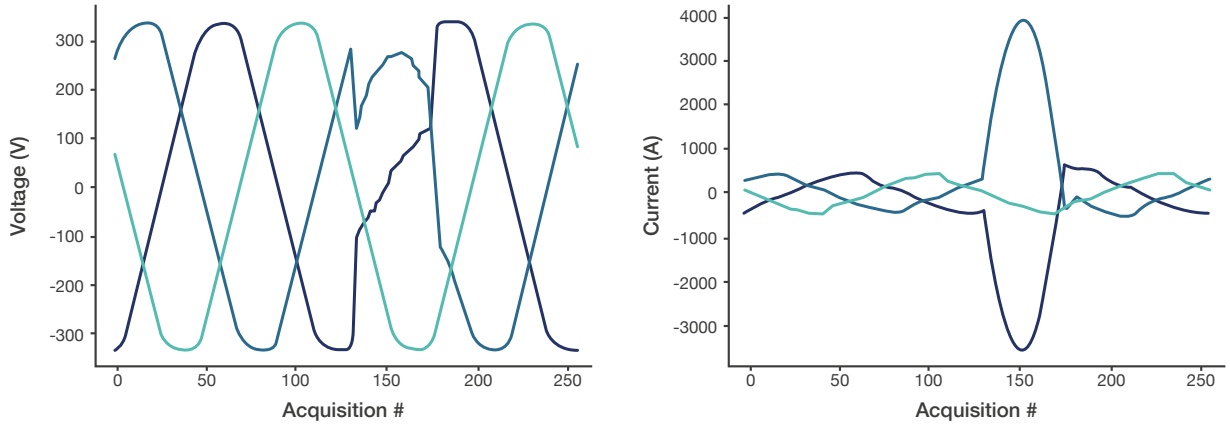
The ALARM project is looking to investigate the potential of a lower cost substation monitor to identify and locate non-fuse operating transient cable faults.

This is a two phase project. At the end of March 2020, Phase One equipment had been installed at 25 sites and been in service for approximately one month.

By the end of March:

- Events had been captured at all 25 sites, useful project data was successfully being accumulated.
- Refinements to the assessment method had been identified and introduced.
- One highly tentative “defect” location had been shared with the local field team for information.

Feeder 1 - Phase 1



Illustrative event

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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.

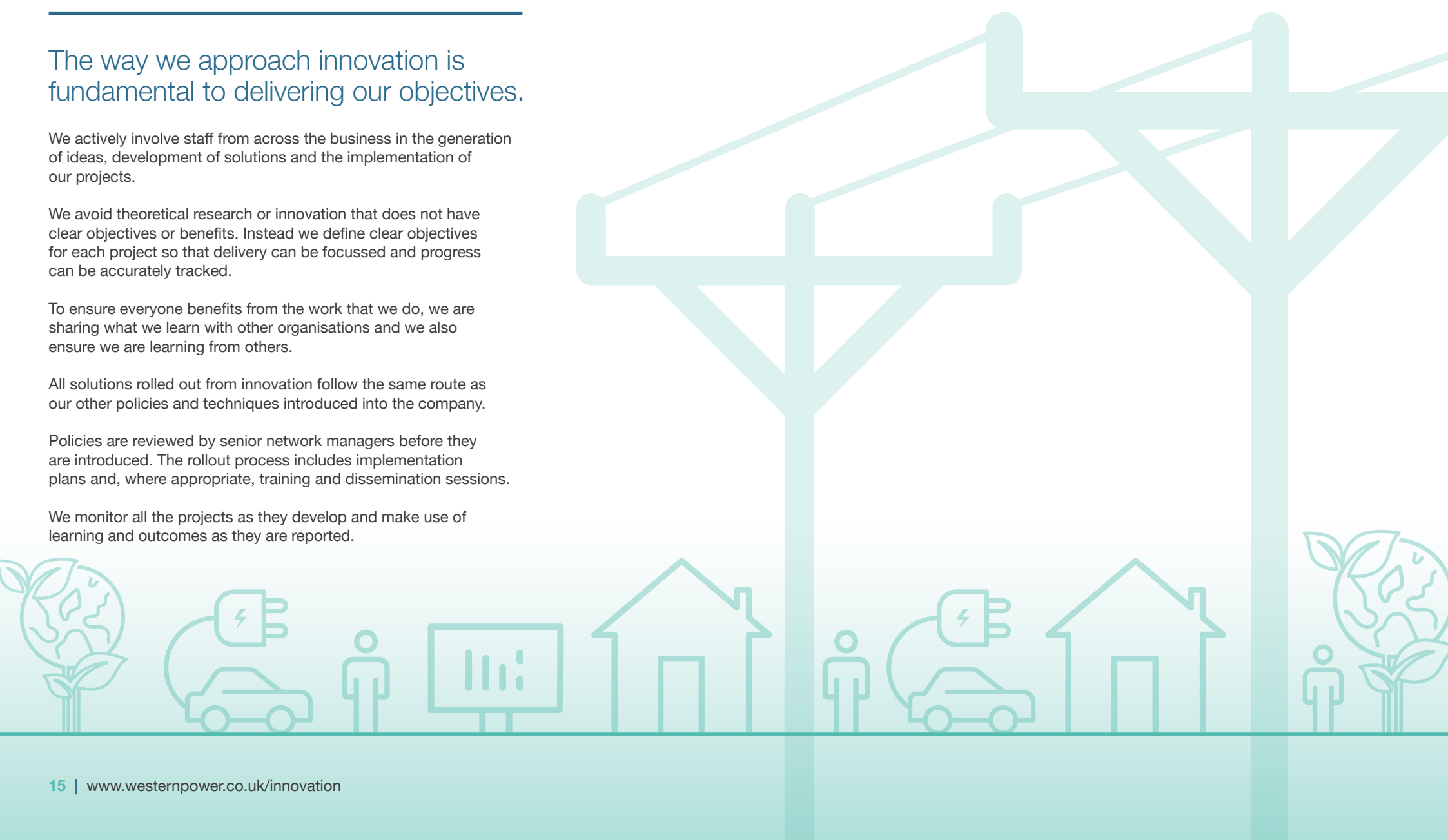
We avoid theoretical research or innovation that does not have clear objectives or benefits. Instead we define clear objectives for each project so that delivery can be focussed and progress can be accurately tracked.

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.



2019-2020 NIA Project Spend

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Project	Internal Spend	External Spend	Total Spend in 2019/2020
ALARM	£38,424.90	£51,466.00	£89,890.90
ARC Aid	£0.00	£47,885.76	£47,885.76
CADET	£3,373.91	£2,887.50	£6,261.41
CarConnect (Electric Nation)	£14,044.70	£404,978.19	£419,022.89
EDGE-FCLi	£47,585.93	£861,366.45	£908,952.38
Electric Nation - PoweredUp	£10,673.94	£533,950.00	£544,623.94
Entire	£11,753.99	£4,852.96	£16,606.95
Future Flex	£7,945.37	£76,519.96	£84,465.33
Harmonic Mitigation	£20,176.34	£48,732.50	£68,908.84
IntraFlex	£15,847.01	£85,502.84	£101,349.85
LV Connect & Manage	£4,797.32	£166,291.75	£171,089.07
Losses Investigation	£14,050.22	£17,080.20	£31,130.42
LTE| Connecting Futures	£43,066.58	£196,984.77	£240,051.35

2019-2020 NIA Project Spend

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Project	Internal Spend	External Spend	Total Spend in 2019/2020
MADE	£39,485.62	£1,146,520.00	£1,186,005.62
Next Generation Wireless	£22,856.20	£66,574.40	£89,430.60
Network Islanding Investigation	£14,552.33	£130,477.88	£145,030.21
Net Zero South Wales	£1,174.55	£45,500.00	£46,674.55
OHL Power Pointer	£69,062.25	£652,494.92	£721,557.17
Visibility Plugs & Socket	£36,994.03	£9,634.94	£46,628.97
PCB Sniffer	£7,653.27	£65,030.00	£72,683.27
Presumed Open Data	£10,410.42	£0.00	£10,410.42
Primary Networks Power Quality Analysis	£30,899.43	£429,865.53	£460,764.96
Smart Energy Isles	£26,464.57	£0.00	£26,464.57
Virtual Monitoring Data	£27,176.52	£1,061,059.98	£1,088,236.50
Virtual Statcom	£15,757.48	£169,100.00	£184,857.48
Wildlife Protection	£2,012.36	£0.00	£2,012.36
	£536,239.24	**£6,274,756.53**	**£6,810,995.77**

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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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