WPD INNOVATION
Transforming the electricity network

Network Innovation Allowance

Annual Report 2020/2021

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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 2020/21.

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 Low Voltage (LV) Network Templates project feeding into our network analysis processes and unlocking 500MW of extra capacity on our LV network.

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 2020/21, 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 impact of decarbonisation and electrification of heating in our Peak Heat project and better integrating with the wider energy industry and local authorities with our EPIC 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 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 fourth 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

23
organisations took part in our first ever communities and consumer vulnerability NIA call for ideas

30,805
hits on our website

£30m+
invested in NIA projects to date

78
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 2020 to 31st March 2021 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 Take Charge project which could enable rapid Electric Vehicle (EV) charging at GB's over 90 Motorway Service Areas (MSA) and SEAM which has used Machine Learning (ML) to reduce gaps found in Geographic Information Systems (GIS) data used by all utilities.

Following the success of our previous NIA Third Party Calls, we ran our fourth call, where we received 24 submissions from 23 organisations with ideas on how we can work with communities and vulnerable customers. We are taking 3 of these ideas forward into a new NIA project, looking to better understand the impact of Covid19 on electricity networks, help identify vulnerable customers to ensure there are no gaps in our Priority Service Register (PSR), and understand what can be done in helping all of our customers in meeting net zero.

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 2020 to 31st March 2021 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 2020 – March 2021 we have been delivering 26 NIA projects and 3 NIC projects.

NIA Projects	
ALARM (Automatic Location of Arc-faults through Remote Monitoring)	Net Zero South Wales
ARC Aid	OHL (Overhead Line) Power Pointer
DynaCov (Dynamic Charging of Vehicles)	PCB Sniffer
Optimal Coordination of Active Network Management Schemes and Balancing Services Market	Peak Heat
EDGE-FCLi (Embedded Distributed Generation Electronic Fault Current Limiting interrupter)	Presumed Open Data
Electric Nation - PoweredUp	PNPQA (Primary Networks Power Quality Analysis)
EPIC (Energy Planning Integrated with Councils)	SEAM (Spatially Enabled Asset Management)
Future Flex	SHEDD (System HILP Event Demand Disconnection)
Harmonic Mitigation	Take Charge
IntraFlex	Temporary Event Charging
LTE | Connecting Futures	Virtual Monitoring Data
MADE (Multi Asset Demand Execution)	Virtual Statcom
NEAT (Network Event and Alarm Transparency)	Wildlife Protection

NIC Projects		
EFFS	OpenLV	DC Share

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Project Highlights: Take Charge

The Take Charge project is designing, building, installing and trialling a brand new standardised package solution to deliver large capacity rapid EV charging to MSAs, in a far more cost and time efficient manner when compared with traditional solutions.

We recognise that Rapid EV charging is becoming increasingly important as manufactures aim to minimise charge times and make EVs as convenient as possible for customers, and MSAs are a key charging location for customers looking to undertake long journeys. This will mean that these sites will require significantly increased power supplies.

Lessons Learned

EV charging demand patterns for rapid charging will not follow previous trends seen. The method of charging is significantly different from home charging and the low dwell times demonstrate the need for power transfer in a short space of time.

MSA site locations cause varying challenges in the application of rapid EV charging. Their layout and position can enable major obstacles including railways or bridges, whilst access from one or two sides of the motorway dictates the amount of use installed chargers will receive. For this reason when selecting a trial site, access from both sites of the motorway became part of the criteria.

While designing the solution, learning included best practices for the transport before installation, connection point voltage, and earthing design. By moving away from LV charge point installations and the use of standard network assets, the number of charger installations can be significantly increased.

Customer Benefits

The standardised package solutions developed as part of the Take Charge project will provide financial benefits to all customers.

The traditional option for providing this level of electricity supply, a primary substation, would have a high cost and would be time consuming to construct and commission. The new package solution developed as part of this project is expected to save £0.5m per installation, and take significantly less time to install.

With the incentives in place to decarbonise transport, it is likely that there will be ever increasing need for rapid charging, both at MSAs and at other areas within towns and cities. The benefits of this solution will therefore be replicable in a large number of areas, including at the 91 MSA sites within Great Britain. GB roll out is expected to lead to £33.3m savings if the solution was installed at 75% of these sites.

Planned Implementation

The outcome of the Take Charge project will be a new standardised package solution for providing large capacity network connections fit for meeting rapid EV charging demands. This solution will be scalable across our and other DNOs networks, where demand for rapid EV charging sites will continue to increase.

The project is currently transitioning into its build phase, before we trial the solution at Exeter MSA. Exeter MSA was determined to be the most suitable site for this trial due to its location, number of customers and proximity to a suitable 33 kV Point of Connection (PoC).

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Project Highlights: Temporary Event Charging

The Temporary Event Charging project is a feasibility study that is designing and developing solutions for charging EVs at a range of events.

Currently events provide limited charging points and existing charging methods include utilisation of diesel generation or making permanent network connections which is not economically viable for a short period of use.

We began the project by selecting and developing case studies including large music festivals and sporting events, and using event engagement and background research to realise their need for charging and the expected demand that this will bring. We are now designing solutions for each of these case studies which will build into cost benefit analysis. The outcome of this will determine whether a future trial project should take place.

Lessons Learned

During the case study development phase of the project learning has included justification for charging at temporary events based on vehicle numbers, distance travelled and EV range considerations, and the differences between internal combustion vehicles ability to quickly refuel in a local fuel station when compared to the longer times for EV charging and availability of charging points.

Work looking at how temporary connections can fit within policy and design practices has demonstrated similarities with existing methods in place for fault restoration. This will enable learning from the project to feed into potential future decarbonised fault restoration practices but also will allow the project to build on existing technologies including temporary transformers and switchgear.

Learning has also taken place on how best to engage with events during the COVID19 pandemic when cancellations and working from home have limited responses. Early engagement ensured that most events engaged but contact with parking management companies and local councils has enabled any gaps in data for each case study to be filled.

Customer Benefits

With existing methods of providing EV charging at events making use of fossil fuelled generation or permanent network connections, significant benefits for our customers can be provided by implementing the alternative solutions we are developing within this project, including at the 500 music festivals that take place annually across the UK.

These will provide a cost saving to DNO customers, who would have met a proportion of the traditional network connection and reinforcement costs required for EV charger installations.

This project will also help build customer confidence in the transition to low carbon transport, as it demonstrates that EV charging will be able to take place at events travelled to by car, and will facilitate a reduction in carbon emissions of up to 14.7 tonnes of CO_2e at the largest of these events.

Planned Implementation

This project may lead to a future trial of providing EV charging at temporary events based on the findings of this feasibility study.

We would look to building upon our learning within this feasibility study to demonstrate the method required for providing EV charging without the need for onsite diesel generation and would be replicable at large events across the country.

We would look to carry out this trial at an event within our license areas, but the methods used could be applied at the vast array of temporary events that take place across the country.

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Project Highlights: Energy Planning Integrated with Councils (EPIC)

EPIC is developing a process for working with local authorities to create Local Energy Plans. These are used to determine a wider view of what will change on our network and the investments we will need to make in different timeframes.

While we use some local authority information in our planning assumptions, we do not reflect their long term plans in our energy scenarios. Comparing planned investments for the local authority, electricity and gas network will enable the production of an Integrated Investment Plan.

The project will also develop new tools to support automated analysis of HV networks using Python and Sincal.

Lessons Learned

Current learning to date has been in relation to the work being undertaken by the Open Networks project and the degree to which this aligns with the data structures to be used within EPIC. The Open Networks project 2020 Work Stream 5 Product 4 had considered the benefits of Regional data gathering in order to reduce duplication of effort in providing the same data to different parties and also to ensure consistency of approach.

This had highlighted the difficulties that result from different parties having different timescales for their regular activities so that if data was refreshed annually it may already be somewhat out of date by the time one party was ready to use it. It assessed two potential options which were a centralised data collection service and co-ordinated regional data sharing. As both options have their advantages and disadvantages, at this stage neither has been adopted as the standard.

Customer Benefits

Co-ordinated investment planning enabled by EPIC will provide benefits to customers through reduced reinforcement costs and improved support for decarbonisation. Customers will be able to value and have greater confidence in the plans being made on their behalf by utilities and their local authorities, and there will be greater certainty on any new developments they wish to be a part of that require interaction between these parties.

Customer cost savings will also be present as a result of the improved planning process. Significant amounts of investment on the network relate to reinforcement activity's, and better coordinated planning will give a clear view on what will be needed and coordination between utilities and local authorities will hopefully reduce the overall reinforcement required. If this improved planning reduces our reinforcement costs by only one half of one percent this equates to £925k saving by 2023.

Planned Implementation

The EPIC project will build on the existing process used to define Distribution Future Energy Scenarios (DFES) and analyse their impact which is currently used to create our shaping sub-transmission reports (which consider the 132kV and EHV networks). It will determine how to create a local energy plan and the impact this will have upon LV and HV networks by disaggregating the DFES for LV and HV networks and combing this with local authority information.

We will also be able to use the automated analysis and investment options tooling to build future investment strategies, making analysis repeatable and minimising the required resource.

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Project Highlights: ARC-Aid

Arc Suppression Coils (ASCs) are the predominant neutral earthing system at 33kV and 11kV in Cornwall.

It is sometimes difficult to locate earth faults on ASC systems, often requiring physical line patrols, or control engineers to carry out switching operations on the network to home in on the fault location.

The Arc-Aid project is a joint project led by UK Power Networks (UKPN) trialling a new advanced overhead line monitoring solution 'MetrySense-5000' to help locate earth faults quicker than traditional methods, by providing real time fault location capability and measurement data to our control centre. We are implementing a joint trial with UKPN to assess if this method improves network performance through reduced Customer Interruptions (CIs) and Customer Minutes Lost (CMLs).

Lessons Learned

MetrySense-5000 sensors have been successfully type tested at the PNDC in Glasgow, UK. The tests showed that that the sensor units were able to successfully detect and locate all applied faults including all high impedance faults including a 10 kΩ phase-to-earth fault impedance with a fault current of less than 400 mA.

Furthermore, the MetrySense system has detected several transient earth fault events throughout the live trial on our 33kV network in Cornwall. This has provided important data for the manufacturer Metrycom to configure and tune their fault detection algorithms.

The MetrySense-5000 advanced sensors provide a cost-effective solution for accurate measurement of various electrical parameters at remote locations on the distribution network. The project team has also learnt that the devices can be installed easily on the overhead lines, both under outage and under live line conditions.

Customer Benefits

The MetrySense-5000 advanced sensors are specifically designed to detect and locate earth faults on ASC networks. The measurement data is processed by sophisticated algorithms that can tell our control engineers the location of earth faults in real time.

This reduces the time it takes for us to isolate faulted feeders and restore customer supplies, leading to reduced CIs and CMLs. In addition, faster location reduces the risk associated with holding earth faults on the network for prolonged durations.

It is projected that a roll-out of the solution across 18 of our Bulk Supply Point (BSP) substations could save up to £6.3m in CIs and CMLs.

Planned Implementation

So far in the project we have installed 16 out of a total of 20 MetrySense-5000 sets. These sensors are connected via the cellular network and the data is being continually monitored for earth faults.

The next phase of the project is to install the remaining four radio connected sensors.

We will then integrate all sensor data into our central control systems and make the fault location functionality available to our control engineers.

The trial is due to conclude at the end of the year after which we will review the performance of the solution relative to the expected benefits.

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Project Highlights: Future Flex

The Future Flex project is developing second generation DSO flexibility services with a focus on domestic scale.

This is broadening the pool of potential providers and enabling the coordination of larger home loads including electric vehicles, smart and hybrid heating and battery storage to benefit the distribution network.

We are achieving this by understanding limitations in place relating to domestic flexibility, and developing and testing solutions for mitigating these. The project has therefore been carried out in three phases: participant engagement, solution definition and trials.

We have been undertaking trials of multiple approaches to domestic flexibility. These were developed following workshops in Bristol and London to identify what the barriers to providing domestic flexibility were and what solutions should be trialled within the project.

Lessons Learned

It has been found that the value to customers of providing flexibility services is low and uncertain, with the equipment required to take park being prohibitive in some cases. This has led to limited consumer engagement and limited awareness of domestic flexibility.

The types of demand found within homes mean the overall flexibility capacity per home is limited. This means that a large number of homes are required to have significant impact, and engagement seen and the lengthy process required for on boarding mean that this is likely not feasible.

A number of data challenges have been presented during the course of the project. These range from GDPR requirements leading to the possibility of double counting homes, and the availability, accuracy and granularity of demand data not being ready to accommodate domestic flexibility.

Customer Benefits

Increased use of flexibility services will lead to significant reductions in network reinforcement required. The role out of domestic flexibility will make use of a number of home loads that can play a part in optimising the running of the network whilst engaging customers in helping meet net zero.

The benefits can therefore been seen for all customers on the network as well as those that are participating in the services. The reduction in reinforcement needed will reduce costs for the network operator and ultimately lead to savings on consumers bills. Those customers participating in the trial will receive revenue for the services they take part in and will see further savings on their energy bills.

It is expected that the overall customer savings from flexibility could reach £16.7bn per year.

Planned Implementation

During the course of the trials and later design stages of the Future Flex project, plans for Business as Usual (BaU) implementation of domestic flexibility services will be put in place. This will build upon learning found within the trial periods and aim to demonstrate how domestic flexibility can be used in the future.

These changes will include meeting the need for registration, asset validation and payments with personal data challenges to be addressed, rather than the existing long process that is in place, and the contract for getting involved in flexibility services will need to be reviewed to ensure it is understandable for participants and that they no longer need support to ensure they are able to engage.

Significant Learning

Spatially Enabled Asset Management (SEAM)

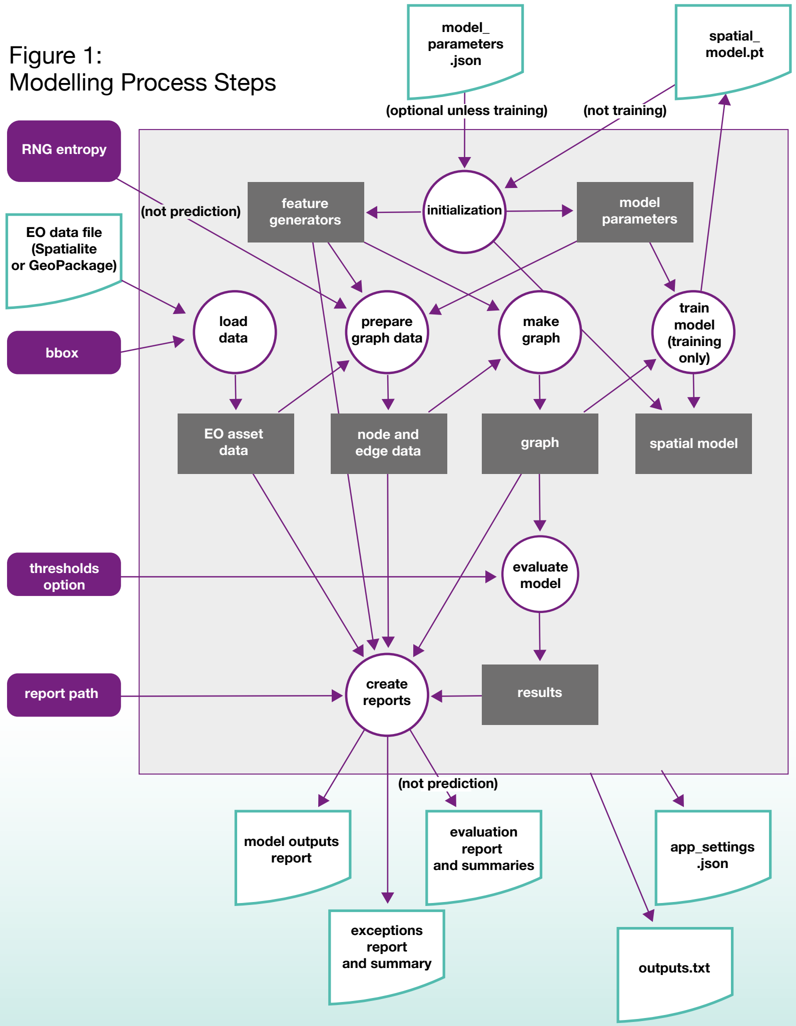
The SEAM project is using Machine Learning (ML) techniques to look for and reduce gaps in GIS used by utilities. The ML model will be trained using an existing dataset and then the ability of this model to successfully identify and correct data issues will be evaluated.

Early indications demonstrate that the data quality within WPD is suitable to support Machine Learning approaches. As the data used by Scottish Power Energy Networks was also able to support Machine Learning approaches it is likely that the data for other DNOs would also support these approaches.

Learning so far has demonstrated the value of data dictionaries in understanding the various system data sets that are available for building models. These are being compiled within WPD as part of the Presumed Open Data project.

When developing models it has been found that rules-based algorithms are preferable to data-driven ones. These are easier to verify and understand, and the outputs tend to be more likely to be correct.

Figure 1:
Modelling Process Steps



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Significant Learning

Peak Heat

This year saw the kick off of the Peak Heat project. The project aims to understand the resultant load profiles of new electricity loads and technology shifts associated with the uptake of domestic heat electrification, the impact they may have on networks, and the opportunities they present for flexibility.

The first Work Package of the project involves the development of typical housing archetypes for which the heat and electrical demands can be established. In order to develop the archetypes, we determined three primary substation areas to investigate. The primary substations were chosen based on the following criteria:

1. Have high heat pump uptake rates

2. Already have limited headroom

3. Cover a range of geographies

The above criteria were chosen as they represent primary substations where an increase in demand due to the uptake of heat electrification is expected, the network is already somewhat constrained and may require future reinforcement to support a larger demand, and they represented a range of different housing types (e.g. larger proportion of flats in urban areas).

Energy Performance Certificate (EPC) data would be obtained for the postcode areas supplied by the selected primary substations, and processing and interpretation of that data will lead to the development of the housing archetypes.

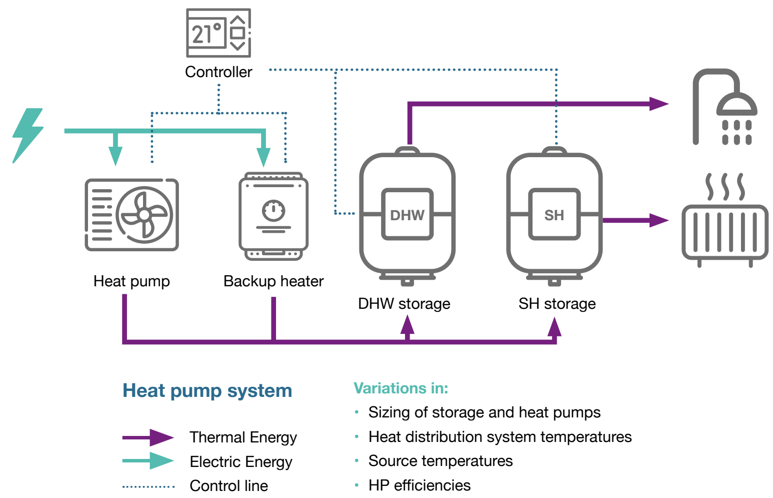

Figure 2: Heat Pump System Diagram

Significant Learning

Harmonic Mitigation

The Harmonic Mitigation project aims to develop an algorithm that can improve the network's harmonic levels by controlling existing distributed generation inverters.

There are four work packages involved with this project, 3 involving modelling and simulation with the final work package using a physical inverter in a controlled laboratory environment.

Simulation results have shown that the voltage Total Harmonic Distortion (THD) measured at the networks BSP can be significantly reduced when the inverters use harmonic compensation as an ancillary service. The control algorithm has been finely tuned so that transformer losses and the rated output current of the inverters are not exceeded.

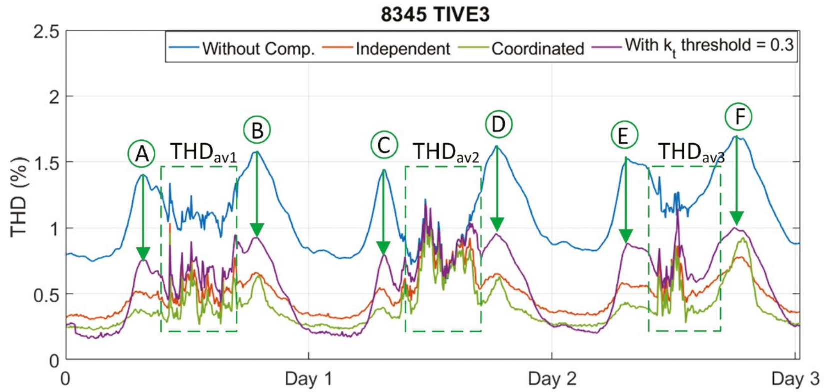

Figure 3:
Voltage THD at network BSP before and after Active Filter (AF) algorithm implementation

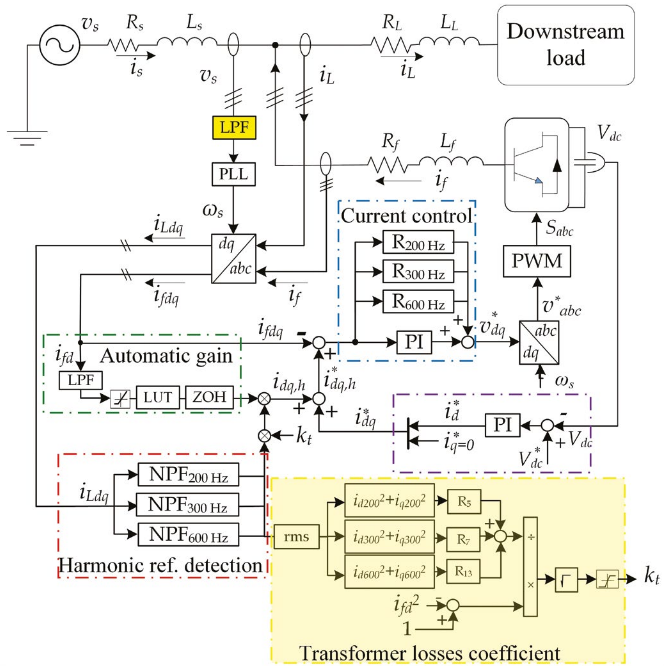

Figure 4: Control Algorithm

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.

2020-2021 NIA Project Spend

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Project	Internal Spend	External Spend	Total spend in 2020/21
ALARM (Automatic Location of Arc-faults through Remote Monitoring	£95,609.91	£80,449.21	£176,059.12
ARC Aid	£10,018.95	£81,874.00	£91,892.95
DynaCov (Dynamic Charging of Vehicles)	£7,125.35	£136,511.00	£143,636.35
Optimal Coordination of Active Network Management Schemes and Balancing Services Market	£10,432.77	£95,809.83	£106,242.60
EDGE-FCLi (Embedded Distributed Generation Electronic Fault Current Limiting interrupter)	£136.10	£247,130.04	£247,266.14
Electric Nation - PoweredUp	£35,849.70	£1,230,049.00	£1,265,898.70
EPIC (Energy Planning Integrated with Councils)	£4,804.58	£9,000.00	£13,804.58
Future Flex	£44,916.25	£317,875.50	£362,791.75
Harmonic Mitigation	£42,423.62	£74,276.25	£116,699.87
IntraFlex	£46,763.78	£228,632.61	£275,396.39
LTE | Connecting Futures	£220,709.63	£417,147.00	£637,856.63
MADE (Multi Asset Demand Execution)	£36,364.54	£210,481.00	£246,845.54
NEAT (Network Event and Alarm Transparency)	£17,407.13	£94,725.26	£112,132.39

2020-2021 NIA Project Spend

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Project	Internal Spend	External Spend	Total spend in 2020/21
Net Zero South Wales	£12,992.69	£6,000.00	£18,992.69
OHL (Overhead Line) Power Pointer	£26,924.81	£123,143.56	£150,068.37
PCB Sniffer	£0.00	£33,600.00	£33,600.00
Peak Heat	£0.00	£4,383.13	£4,383.13
Presumed Open Data	£53,511.87	£453,495.00	£507,006.87
PNPQA (Primary Networks Power Quality Analysis)	£31,132.08	£250,134.04	£281,266.12
SEAM (Spatially Enabled Asset Management)	£16,733.08	£155,000.00	£171,733.08
SHEDD (System HILP Event Demand Disconnection)	£20,560.08	£10,000.00	£30,560.08
Take Charge	£0.00	£216,541.28	£216,541.28
Temporary Event Charging	£8,632.48	£26,066.28	£34,698.76
Virtual Monitoring Data	£8,315.74	£0.00	£8,315.74
Virtual Statcom	£0.00	£54,127.50	£54,127.50
Wildlife Protection	£21,213.12	£20,788.00	£42,001.12
	£772,578.26	**£4,577,239.49**	**£5,349,817.75**

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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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