



Accelerating whole energy systems innovation

Spearheading the transition to a decarbonised future





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About PNDC

As a pioneer and leader in whole energy systems innovation for over a decade, PNDC and its partners are spearheading the transition to a decarbonised future, helping to de-risk, accelerate and scale novel technologies, navigate policy, and drive systemic change to realise a net zero world.

As one of the University of Strathclyde's industry-facing innovation centres, PNDC plays a central role in driving collaboration between academia, industry and policy makers and is at the forefront of accelerating the de-risking, development and deployment of innovative solutions to support the decarbonisation of heat and transport, as well as enabling the continued evolution and resilience of power networks.



Having celebrated its 10th anniversary in 2023, PNDC was founded in 2013 through support from the University of Strathclyde, The Scottish Funding Council, Scottish Enterprise, SP Energy Networks and Scottish and Southern Energy. As the first of its kind in Europe, PNDC was established in response to growing industry needs and market demands for secure and reliable low carbon solutions and advanced technologies for the electricity sector. In the subsequent years, PNDC has evolved to provide a real-world platform for validating and accelerating whole energy system technologies through multiple collaboration models and open access facility provision for engagement with the innovation ecosystem.

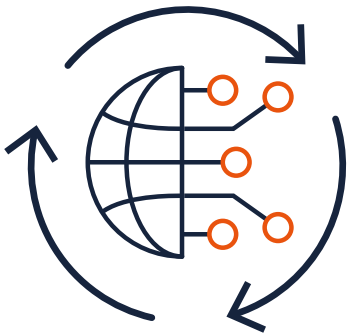


Focus areas

As one of the UK's premier industrial-facing collaboration hubs focussed on whole systems and net zero innovation, PNDC has three primary focus areas – the Advancement of Power Networks, the Decarbonisation of Transport, and the Decarbonisation of Heat.

Through our focus areas, PNDC offers a distinct combination of highly qualified technical specialists and industry-leading whole systems demonstration and test facilities, providing a platform for highly successful collaborations for the benefit of our partners in industry, government and academia.





Advancement of Power Networks

The Advancement of Power Networks focus area concentrates primarily on accelerating and de-risking innovations that support the significant changes in electricity generation and demand characteristics resulting from the net zero transition. Particular effort will continue to be placed on solutions that increase power systems robustness and security, support the digitalisation of the entire power network sector, and facilitate the greater flexibility and participation of demand-side innovations in the energy transition.



Decarbonisation of Transport

The Decarbonisation of Transport focus area concentrates on accelerating and de-risking novel low carbon transport systems for land, marine and aero transport sectors. This covers vehicle charging infrastructure innovations and onboard systems, focusing on new electric drive trains and onboard systems, including fuel cells, batteries, and power electronics, machines and drives (PEMD) components. The advancement of electric vehicle grid integration and energy system flexibility is another central component of this focus area.



Decarbonisation of Heat

The Decarbonisation of Heat focus area concentrates primarily on accelerating and de-risking novel low carbon heating solutions, particularly domestic/small commercial scale markets and technologies such as heat pumps, hydrogen boilers and solar thermal. By leveraging our evolving capability and expanding facilities, PNDC's collaborative R&D program supports integrating novel low carbon heating technologies into the wider energy system, their control and scheduling, and the impact of consumer behaviour on technology development.

Partnerships

PNDC engages with its partners to develop and share knowledge, skills, expertise and insights to maximise impact and accelerate commercialisation pathways across shared innovation priorities and strategic focus areas.

We create and deliver high-impact, high-value innovation project ideas through collaboration with academia, government and industry. We provide insights into leading, relevant use case applications and market adjacencies for whole systems submissions.



Benefits of PNDC partnership:

Participation in PNDC innovation theme forums provides a platform for knowledge exchange, driving collaborative working and co-creation of projects, stimulating innovation and avoiding duplication of innovation investments.

Commercial rate discounts are available for access to PNDC's representative test, demonstration and simulation facilities, which allows partners to develop an evidence base for the performance of their products, providing investors and the wider supply chain confidence in the market-readiness of their technologies and solutions.

Annually agreed key performance indicators (KPIs) are set to leverage investment for partners, drive impact, and increase the number of partner connections to relevant organisations.

As one of the University of Strathclyde's industry-facing innovation centres, PNDC provides access to leading-edge research and academic excellence through knowledge exchange professionals. In a flourishing innovation ecosystem, the multidisciplinary collaboration enables PNDC and its partners to accelerate innovation through collaborative practice and complementary capabilities, preconditions of any successful partnership.



Please get in touch to discuss our tailored partnership offerings for strategic, innovation and development partners.



Innovation themes

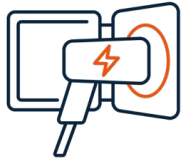
PNDC promotes knowledge sharing and project co-creation to maximise benefits and learning across all its partners. Within the framework of the Focus Areas, several Innovation Forums provide a focus for discussion and engagement between PNDC, its industrial partners, University academics, and other external stakeholders on specific technical and innovation topics, providing a platform for driving collaborative working through deep knowledge exchange and fresh thinking to the innovation challenges ahead.

Typical innovation theme forum events include:

- ▶ Discussing emerging innovation requirements, stakeholder needs, and topics of interest to inform new areas of opportunity for collaborative innovation activity between PNDC, its partners and other stakeholders.
- ▶ Generating and refining ideas for specific collaborative innovation projects and providing a focus for project co-creation with stakeholders.
- ▶ Maximising the value of coordinated project activities and outputs for stakeholders and partners.
- ▶ Providing input to steer collaborative projects in delivery and disseminating project outputs.
- ▶ Providing the opportunity for invited innovators to showcase new ideas and discuss opportunities for wider innovation and collaboration.

PNDC partners are able to participate in Innovation Forums within the partnership framework. Other organisations and stakeholders may be invited to Innovation Forums by the Forum Lead in line with the subject matter being discussed or at the request of PNDC partners. Other invitees generally comprise sector and domain experts from industry, government, academia and other research organisations.

The Innovation Themes currently include:



**Electrification
of Transport**



**Electrification
of Heat**



**Integrated
Energy Systems**



**Communications
& Cyber Security**



**Future Control
Room**



**Digital
Substation**

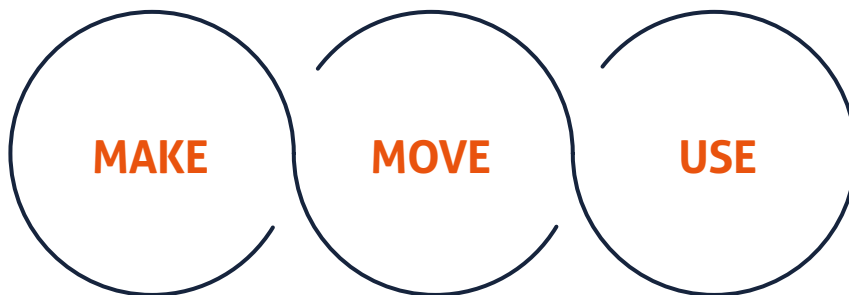


**Asset
Management**



**Protection
& Control**

Stimulating innovation in hydrogen technologies



As a cross-cutting theme intersecting with the Innovation Themes, PNDC's evolving hydrogen expertise is stimulating innovation in novel hydrogen technologies and systems. By engaging with industry to provide research support and conduct analysis of the challenges and opportunities for technology, PNDC is appraising the technical viability, innovation requirements, and scale-up challenges of hydrogen technologies through system modelling, real-time simulation, and network emulation.

Career opportunities

A supportive and dynamic environment

PNDC's internationally represented management, research, and technical teams combine a wealth of ideas and global expertise to accelerate the development of whole systems technologies and solutions in a supportive and dynamic environment. We upskill our team through continuous professional development (CPD) and bespoke training, providing a range of tools and services to elevate the team's collective expertise to innovate and maximise its real-world impact.

Equality, diversity and inclusion

We are committed to achieving and promoting equality of opportunity in our research and working environments, in line with the University of Strathclyde's Access, Equality and Inclusion service.





Kathleen Goldie, Commercial Director at PNDC

I really enjoy working with a team and in an environment that has the potential to be a significant enabler for the UK (and the world's) energy transition. I like the variety in my role for the work we do over several sectors including marine, aerospace and energy, to name a few. I love the people at PNDC, a fantastic and diverse bunch of personalities and skillsets.



Ryan Sims, Research & Development Lead at PNDC

The PNDC team really is the friendliest and most supportive you could ask for. It's a large contributor to why it is such a great place to research, test and demonstrate innovative ideas. I enjoy working closely with our members and all the innovative companies that come through the centre. Their insights and market knowledge are a great resource for our work.



Dr Stephen Ugwuanyi, Research & Development Engineer at PNDC

What I enjoy most is the work-life balance, the opportunity for growth, the flexibility of the role, and the impact of PNDC research output on tackling societal challenges. When you have the opportunity to visit or work with PNDC, you will understand that every PNDC staff member is as unique as PNDC's research capabilities.



Dr Si Chen, Research & Development Engineer at PNDC

PNDC fosters an inclusive and supportive environment where a culture of respect and inclusivity promotes psychological safety for female engineers and those from diverse backgrounds. The unique and comprehensive test and demonstration environment also guarantees the safety and security in engineering. I encourage more young women and girls to pursue careers in engineering.

Case studies





Case study 1

Kensa: Highly Flexible Storage Heat Pump (HFSHP)



Aim

Demonstrate the ability of a heat pump with integrated chemical thermal stores to meet domestic hot water and space heating loads and provide flexibility/load shifting capability.



Approach

- ▶ Thermal modelling of reference case and prototype Heat Pump systems.
- ▶ Scenario development (networks, buildings, max demand).
- ▶ Install prototype HFSHP at PNDC.
- ▶ Conduct Hardware-In-Loop testing of agreed scenarios.
- ▶ Report on performance and benefits.



Case study 2

Pumped Thermal Energy Storage (PTES)



Aim

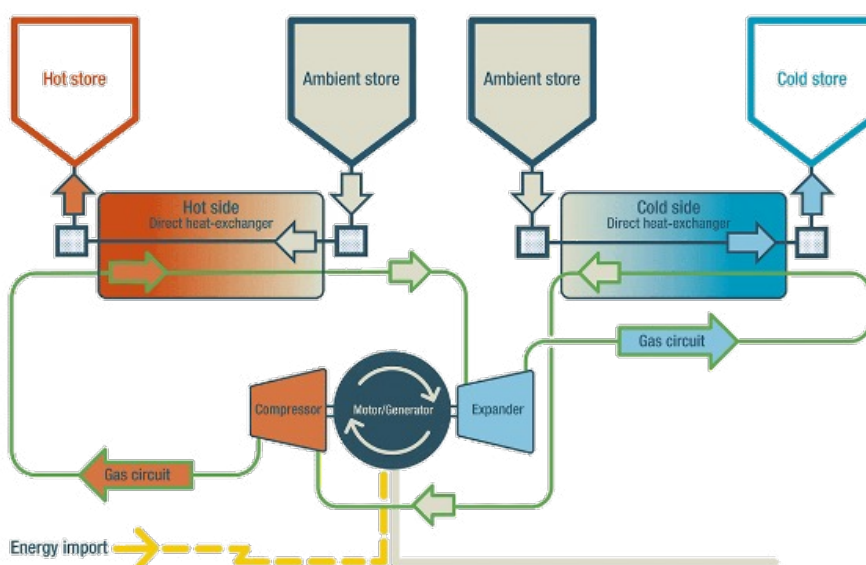
Support de-risking of the SynchroStor PTES to enable grid integration.



Approach

- ▶ Market study and simulation of market opportunities.
- ▶ Specification and input for system controller development.
- ▶ Dissemination (conferences/events).

SynchroStor Charge



Schematic of PTES system during charge (storing energy) © Copyright 2023 – SynchroStor

Thermal Management of Ship Systems



Aim

Evaluate Phase Change Material (PCM) module for implementation as part of ship thermal storage systems.



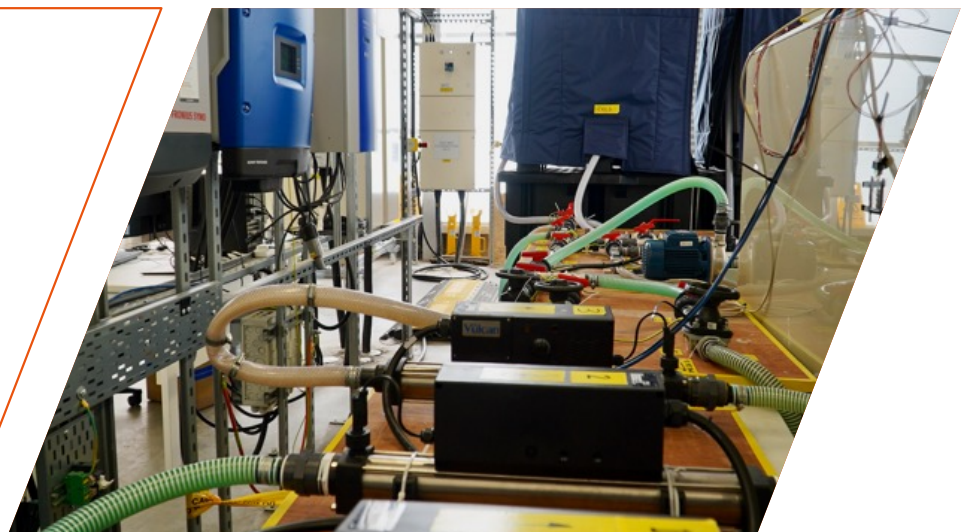
Project scope

- ▶ Prepare an experimental test plan.
- ▶ Implement single module testing to validate the model and inform larger scale test rig development.
- ▶ Instrument and run full test rig development.
- ▶ Support analysis and preparation of findings from test rig scenario test.



Ministry
of Defence

babcock™



Case study 4

EXTEND: Longer Duration Energy Storage Demonstration



Aim

Develop, build and trial the EXTEND solution in 100 homes across the UK, evaluating the effects of a fleet of such storage systems on the electricity network.



Project scope

- ▶ Thermal modelling of reference case and prototype energy storage system.
- ▶ Scenario development (networks, buildings, max demand).
- ▶ Whole Energy Systems Accelerator (WESA) interface build and initial testing.
- ▶ Testing of agreed scenarios.



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 **Ripple**

CATAPULT
Energy Systems

 **Fischer**



 **myenergi**

Neighbourhood Green



Aim

Assess future normal domestic loads and After Diversity Maximum Demand (ADMD) and its impact on the grid.



Approach

- ▶ Gather historic data/insight from Living Lab homes and other trials.
- ▶ Real world trial at 60 homes with at least one form of low carbon technologies (LCT) to monitor energy usage over time.
- ▶ Virtual clustering of living lab homes and assessing the impacts in different weather conditions including extreme scenarios at PNDC.



Key learnings

- ▶ Under severe weather, HPs run at full capacity almost throughout the day, i.e. there is no diversity in demand.
 - ▶ 20% HPs on UK GDN results in transformer overloading by 20%.
 - ▶ 50% HP results in transformer overload by 60% and a hotspot temperature of around 150 degrees, which reduces the transformer life significantly.

Case study 6

Opportunity for Renewable Integration with Offshore Networks



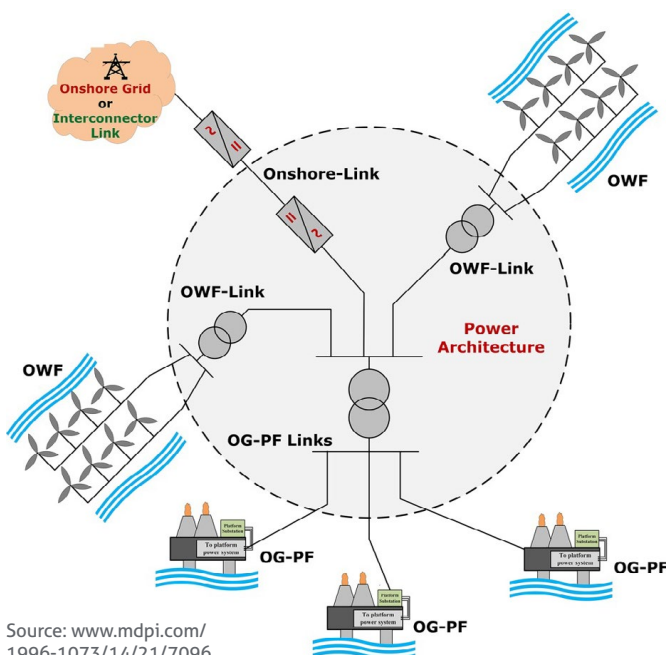
Aim

Support the development of an energy hub concept.



Approach

- ▶ Characterise the power systems on platforms and their operational requirements.
- ▶ Identify the opportunities for interconnecting offshore power, considering renewables.
- ▶ Develop suitable power architectures through consideration of system requirements.



Source: www.mdpi.com/1996-1073/14/21/7096



Digital Substation Laboratory



Accelerating the modernisation of the distribution grid

Platform for integration and validation of virtualised substation solutions:

- ▶ Vendor-agnostic
- ▶ Interoperability
- ▶ Resilience
- ▶ Scalability
- ▶ Security

Opportunity to integrate with other platforms for demonstrating digital grid technologies:

- ▶ Future control room
- ▶ Monitoring/IoT
- ▶ Cloud services
- ▶ Wireless/wired communication

Technology	Capability
Virtualisation	vSphere/vCenter
Compute	Dell server cluster
Communications & Security	Siemens substation switches and routers, 5G; Omicron IDS
Testing	RTDS, Omicron protocol analyser, Apposite traffic/link emulation



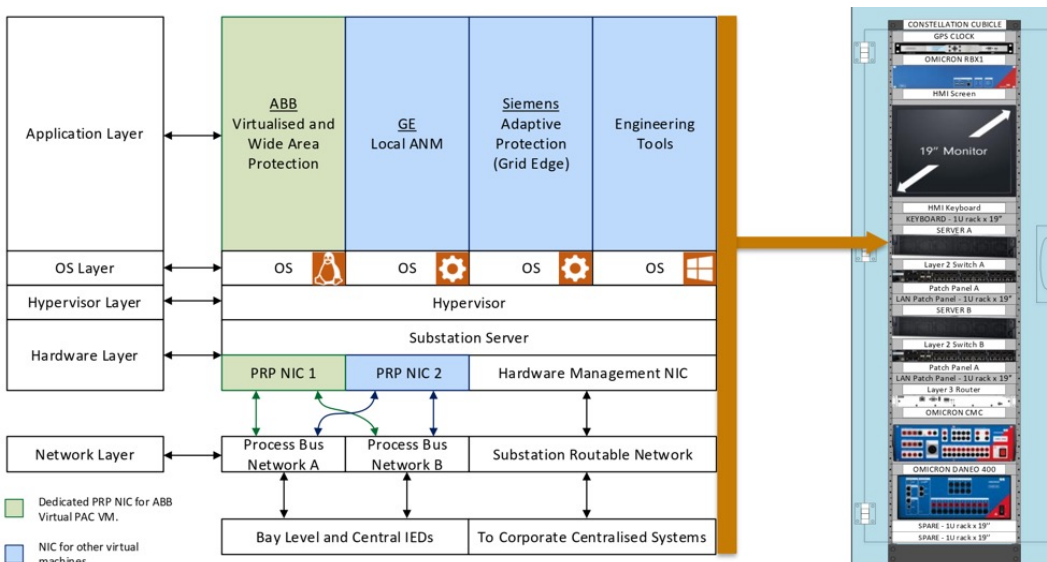
Case study 8

Constellation Project



Pioneering intelligence in smart substations

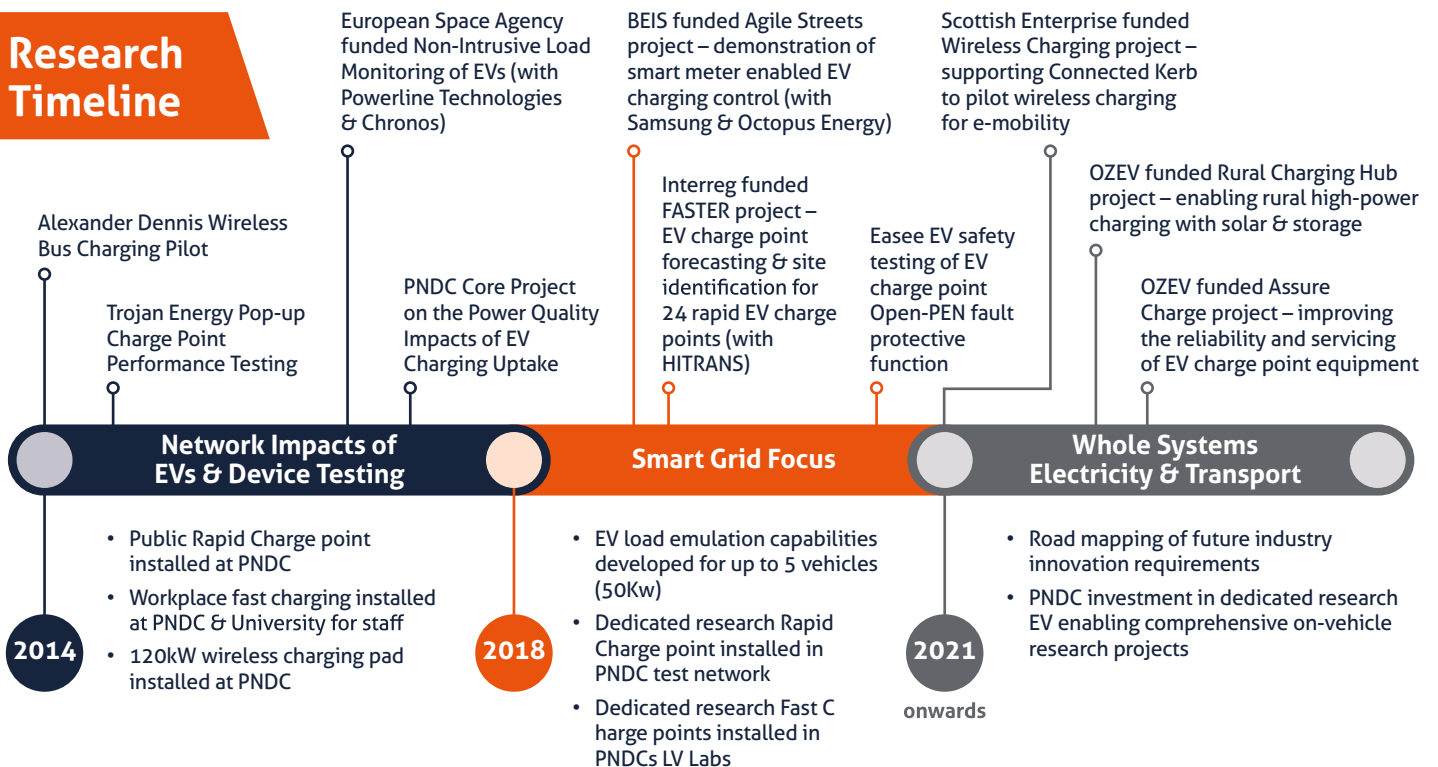
- ▶ £17.8M NIC-funded project led by UKPN.
- ▶ Demonstration of a virtualised 33kV substation – world 1st!
- ▶ PNDC leads.
 - ▶ WS3: trials and analysis.
 - ▶ WS4: open innovation competition.
- ▶ Delivered two academic insights activities on protection and communications.
- ▶ PNDC is currently in the integration phase, leading to trials by Q3/Q4 2023.



Case study 9

Electrification of Transport

Research Timeline



HV Systems Project



Aim

This project supports the development and testing of the UK's first ground-up hydrogen fuel cell electric heavy goods vehicle (HGV) - the flagship project for the £4.8m DER-IC – Scotland equipment enabling MW-scale testing of power electronics, machines and drives (PEMD).



Approach

Accelerating route to market, whole vehicle power system development and supplier validation through:

- 1. Power hardware modelling**
- 2. Subsystem testing and analysis**
- 3. HGV testing and analysis**



Key learnings

Hydrogen Vehicle Systems (HVS) battery system is now on site for testing & ongoing support of control system development.



©Hydrogen Vehicle Systems Limited

Future Control Room (NIA)



Accelerating the evolution of the control room

- ▶ Project outputs have helped **contribute to ED2 submissions** being prepared and offered ideas that could form a basis for future control system research and innovation projects.
- ▶ In the long term, the findings will contribute to a **smooth transition from DNO to DSO**, which positively impacts customers socially and environmentally.
- ▶ The project performed at PND **informed infrastructure investment for DSOs** in the Future Control Room, accelerating the evolution of the control room to enable transition to net zero in line with the UK government's 2035 and 2050 targets.
- ▶ The findings from this NIA have fed into the SIF Trinity project – discovery phase (completed) and alpha phase (live since Oct 2023).



Case study 12

Constellation Project



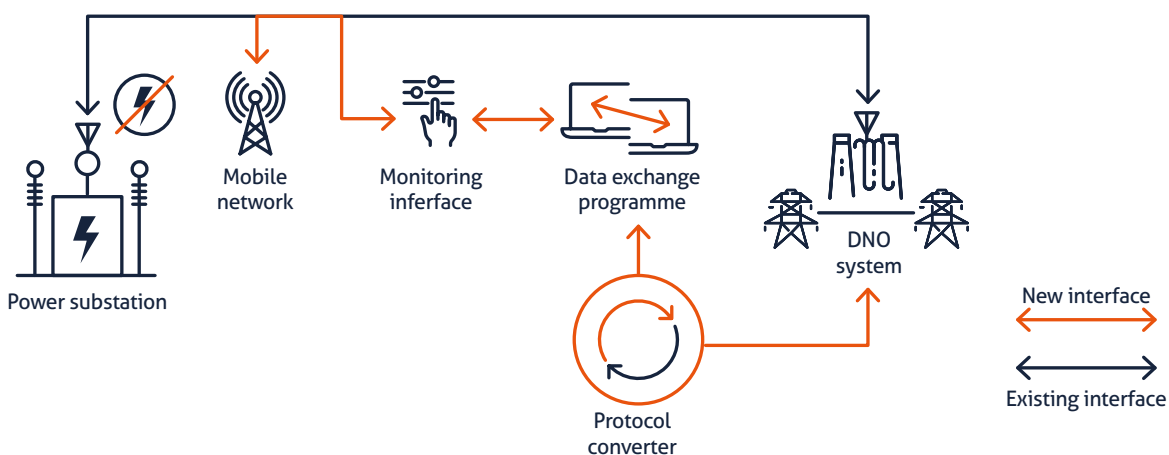
Aim

Increase **communication resilience** through sharing data between mobile and utility networks.



Approach

- ▶ Engaging with stakeholders to establish requirements.
- ▶ Develop a proof-of-concept 5G network connected to a Utility Control Monitoring System.
- ▶ Asset to cell ID mapping to increase visibility of affected systems/users in an outage - Priority Services Register (PSR) consumers, blue light services, and restoration team coordination.



GET IN TOUCH

Find out more about our work or talk to us about opportunities for collaboration, including PNDC membership.

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PNDC is one of the multi-award-winning University of Strathclyde's industry-facing innovation centres. The University of Strathclyde is a charitable body, registered in Scotland, number SC015263.

