The Subsidy Control Act 2022 will provide a new legal framework for subsidies in the UK from the 4 January 2023. Some funding rules for future grant opportunities may change. Specific competition guidance for new competitions will be updated from January.

Project details

Application team

SCOTTISH POWER ENERGY NETWORKS HOLDINGS LIMITED (Lead)

Organisation details

Type	Business

Team members

Full name	Email	EDI survey
Kiron Dutton	kdutton@spenergynetworks.co.uk	Complete
michael green	michael.green@scottishpower.com	Complete

Newcastle University

Organisation details

Type	Research

Team members

Full name	Email	EDI survey
Matthew Deakin	Matthew.Deakin@newcastle.ac.uk	Complete

UK POWER NETWORKS (OPERATIONS) LIMITED

Organisation details

Organisation details

Type	Business

Team members

Full name	Email	EDI survey
Peter Lang	peter.lang@ukpowernetworks.co.uk	Complete

INTEGRATED POWERTECH LIMITED

Organisation details

Type	Business

Team members

Full name	Email	EDI survey
Wenlong Ming	wenlongming@gmail.com	Complete

Application details

Competition name
Ofgem Round 2: Discovery - Improving energy system resilience and robustness

Application name
D-suite

When do you wish to start your project?
1 April 2023

Project duration in months
3 months

Has this application been previously submitted to Innovate UK?
No

Project description

Describe your project briefly and be clear about what makes it innovative.

As record numbers of electric vehicles, renewable energy sources and heat pumps are introduced to our energy system, the coming 5 years will be crucial in

repurposing the existing infrastructure, recognising the scale of transformation required and the leading role networks will play in enabling that vision for decarbonisation.

LV Network (400Volts) is analogous to the capillary network of our energy system and **serves as the direct interface with our evolving customer requirements and the grid.** The Distribution Future Energy Scenarios (DFES) (https://www.spenerynetworks.co.uk/pages/distribution future energy scenarios.aspx) and innovation projects like the New Thames Valley Vision have shown that the LV network is the part of the network that will be most stressed as the uptake of Low Carbon Technologies (LCT) increases.

To make our LV network future-ready, we require not only enhanced LV network monitoring, but also new technologies and strategies to optimise the use of available network capacity and facilitate an advanced flexible energy system.

Meeting the criteria of Improving Energy System Resilience, this proposal plays a pivotal role in future-proofing our LV networks. SP Energy Networks partnered with UKPN and both Newcastle and Cardiff Universities, leveraging the latest innovations from the field of power-electronics, including but not limited to the following technologies:

- LV Distribution Statcom (D-Statcom)
- LV Distribution Soft Open Point (D-SOP)
- Distributed Smart Transformer (D-ST)
- LV Distribution Harmonic Filter (D-HF)

The proposal presents a timely, risk-mitigated and proportional research investment by putting together a strong team with track record on power electronic technology and distribution networks. While the focus of SIF-Discovery is feasibility, **the innovation of our overall proposal include:**

- Optimised design of several D-Suite power electronic devices suitable for LV deployment
- Detailed operational and public safety requirements, protection considerations and overall network interface requirement in the hardware design
- Coordinated control algorithm and its supporting infrastructure to maximise the existing network utilisation
- Holistic and systematic approach to identify the niche scenarios for the future network planning and investment and
- Introducing new tools and IPR publicly available to stimulate the competition at supply chain

Given the scale of challenge that repurposing LV network presents and the associated timescale within which that transformation is needed, this SIF Discovery proposal lays a solid foundation for delivering a SIF-Beta project which addresses a significant and urgent need for our customers.

Application questions

1. Applicants location (not scored)

You must state the name of your organisation along with your full registered address.

SP Energy Networks

320 St. Vincent Street

Glasgow

Scotland

G2 5AD

2. Project short description (not scored)

This is a two-part question.

Our proposal is ambitious in its scope but carefully planned to ensure delivery of SMART goals at different SIF-Phases. It is focused on addressing the necessary transformation of the LV network. The Discovery phase comprises the elaboration of a feasibility study which, recognising the latest advances in power electronic technology and the most recent learnings from relevant innovation projects, analyses the costs and benefits of deploying D-suite devices, which in-turn lays a solid foundation for the successful trial and roll-out in the later phases of SIF.

D-Suite - YouTube (https://www.youtube.com/watch?v=qYZNuAtW0Z4)

3. Project summary

Provide a summary of your project and describe:

This proposal meets the criteria of Improving Energy System Resilience and Robustness. Our partnership with UKPN, as well as with Newcastle and Cardiff Universities and their spin-off will contribute over 15% funding, minimising public investment risk and maximising its impact.

Innovation involved, users, and how proposal addresses the requirements:

LV networks have been conventionally passive, designed for demand and generation conditions assumed using historic data. Previous innovation projects like the New Thames Valley Vision[1] and LV Network Solutions[2] have shown that LV networks will be the most stressed part of the electricity network as LCT uptake increases. Besides much improved LV network monitoring, we require new

technologies and strategies to optimise use of available capacity and facilitate a truly flexible distribution network.

Therefore, it becomes increasingly important to identify, design and roll out new power electronics integrated in the LV network to ensure a stable, reliable, and smart supply. Such high volume, low rated devices should factor in operational safety requirements, future-proof and ready to support the customer requirements if a cyber safe and sophisticated control algorithm is in place.

Bespoke academic research into the application of power electronic (PE) devices on LV network might well already exist. **Our innovation is a comprehensive and focussed industry-led study** and demonstration to synthesise these learnings and leverage their benefit on our networks. **Our innovative approach comprises a holistic examination of the network needs along with PE technology advancement,** resulting in the elaboration of a blueprint and a practical handbook for network planning, investment, and operation so that our energy system reliability and robustness can be improved in an affordable manner.

Project Consortium and their capability:

SPEN carries out innovation in a transparent, responsible, and open manner. Our partners: UKPN, and Newcastle and Cardiff Universities and the colleagues nominated to join the delivery team have track record in their research and collaboration with the industry, particularly power-electronics. The details can be found in the Skills&Expertise in the ProjectManagementBook uploaded.

They are our gateway to enhance our delivery capability and bring into the partnership to create opportunities and support business growth in other sectors.

SIF- Discovery is the right and proportional mechanism to enable us to carry out further verification on the research landscape, manufacturer engagements, business cases to lay a solid foundation for future phases.

[1]Ofgem: ntvv_consolidated_submission_Q.pdf (ofgem.gov.uk) (https://www.ofgem.gov.uk/sites/default/files/docs/2Q15/02/ntvv consolidated_subiTiission 0 ,P_df)

[21LVNetworkSolutions (enwl) (https://www.enwl.co.uk/go-net-zero/innovation/smaller-projects/low-carbon-networks-fund/low-voltage-network-solutions/)

> **Uploaded blank - optional resources.pdf**
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> blank - optional resources.pdf (opens in a new window) (/aDDlication/10060423/form/question/28916/forminput/76395/file/471547/download).

4. Innovation justification

What value will your project deliver? Why is it suitable to be funded by the Strategic Innovation Fund rather than other sources?

The record numbers of electric vehicles, renewable energy sources and heat pumps being introduced to our energy system has created an opportunity for new technologies that have not been conventionally considered.

Following our assessment of the energy innovation landscape (as attached), it has become clear that **there has been limited research on the LV focused power electronic technologies.** This might be due to the perception of the cost and size of power electronic devices. Medium Voltage (33kV or 11kV) has been the typical limit where the business case can be easily found.

The new knowledge our proposal will bring includes:

1. Optimised design of several D-Suite power electronic devices suitable for LV deployment that are capable of operating in a coordinated control regime or a stand-alone control solution;

2. Detailed operational and public safety requirements, protection considerations and overall network interface requirement in the hardware design;

3. Coordinated control algorithm to maximise the existing network utilisation;

4. Holistic and systematic approach to identify the niche scenarios for a practical guidance for the future network planning and investment; and

5. First GB demonstration of a resilient D-Suite enabled LV network (SIF-Beta).

Compared with conventional solutions, we will better address both thermal and voltage issues that we increasingly experience in LV networks. The TRL of this project is approximately 4-5, and will **benefit from dedicated innovation support** to uplift the readiness of the following technologies:

-LV Distributed STATCOM (D-STATCOM). This technology has never been deployed in UK network;

-Distributed Soft Open Point (D-SOP) -- We aim to build up on the technology developed by UKPN to trial a more flexible and controllable solution;

-Distributed Smart Transformer (D-ST) -- We build up on learnings from LV Engine project to fit a partially rated power electronics within slim design distribution transformer; and

-Distributed Harmonic Filter (D-HF) -- There are number of solutions in the market that needs further developments for LV applications.

In addition to those well-established ENA and IEC standards for network interfaces, insulation requirements etc. **we will particularly ensure the**

compliance with safety requirements in power electronics specified in IEC 62477 and for monitoring equipment in BS EN 61010. **IT and OT cyber security of the control system is also need adequately implemented** based on those specified in IEC 62433, recommendations by ENA OT/IT taskforce and our updated ED2 internally developed cybersecurity requirements.

D-Suite Innovation Justification.pdf (opens in a new window) (/application/10060423/form/question/28917/forminput/76400/file/471213/download).

5. Benefits Part 1

Benefits Part 1

from our initial studies as part of the proposal preparation and the literature review, it is clear that we can realise the following benefits:

- **Financial -** future reductions in the cost of operating the network
- **Financial** - cost savings per annum on energy bills for consumers
- **Financial** - cost savings per annum for users of network services

1. we will be able to use the existing assets and maximise their value by avoiding / deferring the reinforcement. **Increased capacity to connect DER** without reinforcement:
2. based on the studies in Denmark [1], 5% to 40% more of PV generation can be integrated without triggering reinforcement. This can be estimated to be £10k per annum per feeder, providing additional income for our community[2].

- **Environmental** - carbon reduction - direct CO2 savings per annum against a business-as-usual counterfactual
- **Environmental** - carbon reduction - indirect CO2 savings per annum against a business-as-usual counterfactual

1. we will not only increase the renewable connectivity, but also contribute to loss reduction
2. **Reduced losses** due to the optimised voltage profile and local power balancing. The studies for different topologies in the LV networks demonstrated 2%-6.4% reduced losses[3], representing a realistic saving for GB customers about £4m per annum[4].

- **Revenues -** improved access to revenues for users of network services

1. see financial benefits, the network being able to handle increased load will allow for faster access to the network for both generators and consumers.

- **New to market -** products, processes, and services

1. see Question 9: route to market, customers may benefit from price reduction new devices such as D-Statcoms can potentially generate a new market and stimulate competition.

[1] Voltage regulation in LV grids by coordinated volt-var control strategies, Miguel Juamperez, Guangya Yang, Soren Bakhoj KJAR, 2014, Power System Clean Energy

[2] If 100kVA 11kV/0.4kV transformer to feed the LV, it would mean 20kVA on average:

20kVA * 33% * 12hours *365days*£0.34/kwh= £10k per annum per feed, as the additional income for the community [based on electricity price: £0.34/kwh: Energy bills support factsheet - GOV.UK (www.gov.uk) (https://www.gov.uk/government/publications/energy-bills-support/energy-bills-support-factsheet-8-september-2022)]

[3] Optimal D-STATCOM Placement Tool for Low Voltage Grids, Gregorio Fernandez et al, Energies, July, 2021

[4] Annual Transmission losses(L)=26GWh, Ratio of energy lost in distribution compared to transmission(R)=2, estimated price per 1 GWh(P)=£200k estimated applicable circuits(C)=4%, sensitivity(S)=1%, L*R*P*C*S=£4m, [Energy Trends: UK electricity - GOV.UK (www.gov.uk) (https://www.gov.uk/government/statistics/electricity-section-5-energy-trends)]

6. Benefits Part 2

How will your project deliver net benefits to consumers?

Metrics and quantitative measurements

Financial

The project will model the amount of capacity headroom released and the number of years reinforcement will be deferred based on LOT uptake scenario modelling on typical LV connections. The tangible benefits to the network operation can be estimated by customer minutes lost and customer interruption reduction based on historical examples.

Environmental

Carbon reduction can be measured by the renewable electricity generated due to earlier access to the network and the reduced emissions associated with deferred/eliminated need for reinforcement.

Revenues

As previously mentioned, the revenues can be generated from the additional renewable electricity supplied to the network in a timely manner.

New to Market

Increased market market competition can be measured by the publicly shared IPR, the number of suppliers and options available.

We have fully considered the financial risk to customers and we are confident that realisation of innovation benefits can be achieved with the project demonstration phase (SIF-Beta) and its future roll out.

Within the trial period, where demonstration will be deployed on the identified circuits (the tasks of SIF-Alpha), **the project should benefit the customers by providing additional LOT connection flexibility and associated financial and carbon benefits.**

Within the future roll-out, following the trial period, **the technology will benefit electricity customers by providing similar benefits to those circuits that meet the criteria developed at a national level.** With the volume advantages, electricity customers can also benefit from the cheaper products and more market competition by shared IPR invested.

7. Project plan and milestones

What is your project plan? What are your milestones?

A robust project management mechanism has been put in place to safeguard the project delivery and protect public investment. This has been reflected in our attached Gantt Chart and Risk Register. Due to the short duration of the Discovery phase, the project team has agreed to work together earlier wherever we can- this will mitigate the delivery risk and demonstrate commitment.

The main work packages, their lead resources and outputs are listed as:

WP1: Customer requirements and the future LV network core functions

Led by: Planning Department and SP Energy Networks Districts.

supported by: UKPN

Scope: To leverage the insights and professional analysis from the network owner, so that all the use cases can be identified.

Output and success Criteria: a list of key parameters required to identify the use cases such as: potential network topologies, connection criteria and demand/load growth forecast.

Funding: £19,252

WP2: Literature review on the power electronic technology and supplier engagements

Led by: Dr. Matt Deakin, RAEng Research Fellow, Newcastle University [University Consortium].

Scope: Leverage existing experience and finding from previous investment in the power electronic technology, to identify research gaps (opportunities) and inform technology development. This workpackage will interact with Workpackage 1 and fed-in Workpackage 3.

Output and success Criteria: Report of the landscape of PE devices suitable for UK LV Networks, including a list of potential suppliers (supply chain engagement).

Funding: £30,651

WP3: Initial Design of D-Suite, including H&S and Cyber considerations

Led by: Dr. Wenlong Ming, Integrated Energy, Cardiff University [University Consortium].

Supported by: UKPN

Scope: Carry out the initial design specifications based on the engineering, H&S and cyber considerations, such as corresponding standards including but not limited to:

power quality standard EN50160, G55, Grid Code

This work package will also carry out initial market due diligence and provide the list of potential suppliers.

Output and success Criteria: Design specification of hardware and control Algorithm with reference to the industrial standards.

Funding: £41,727

WP4: Commercialisation planning.

Led by: Innovation Team, SPEN.

Supported by: UKPN

Scope: working closely with project partners, leverage the networks at UKRI, identify the feasible route to market the project outcome and maximise the impact.

Output and success Criteria: road map of commercialisation, IPR policy

Funding: £17,453

WP5: Project Management, Future Partnership, Knowledge Sharing and Next Phase.

Led by: Innovation Team, SPEN.

Supported by: UKPN

Output and success Criteria: a robust proposal for SIF-Alpha and its timely submission

Funding: £22,792

D-Suite Project Plan.pdf (opens in a new window) (/application/10060423/form/question/28920/forminput/76418/file/471291/download).

D-$uite Risk Register.pdf (opens in a new window) (/application/10060423/form/question/28920/forminput/76418/file/471292/download).

8. Regulatory barriers (not scored)

What would you consider to be the regulatory barriers for fully embedding your expected project outcomes into business as usual?

No regulatory barriers have been identified. Both UKPN and SPEN's regulation teams will continue to monitor the situation and capture any possible regulatory barriers if they appear.

9. Route to market

How will your idea become business as usual within your network and across the other networks? What considerations have your Project Partners made for the commercialisation strategy for this innovation?

Reducing the cost of Power Electronic Devices (PED) is a challenge the whole industry faces. By 2030, PED will cost half of their current price[1], incentivising their use as a method to reduce losses and **encouraging Ball adoption.** The wider deployment of power electronic devices in the distributed network **will not undermine competitive markets,** only increasing the supply chain competition by demonstrating the commercial potential at an international level, hopefully enhancing The UK's role.

Our **initial market research** through the Network Innovation Allowance[2] showed that while several companies claim that they have the technical capability to supply the D-suite for LV networks, there are no commercial products and few demonstrations of optimal design and operation. Currently, D-suite's technology readiness level (TRL) is approximately 4-5. This project aims to increase the D-suite's TRL to 6-7 by the end of the Beta-Phase to experimentally prepare and test the D-suite in a real-world environment.

The proposal team aims to tackle the innovation commercialisation by technology push and end-user pull:

1. Technology Push, managed by **The University Consortium,** to optimise the design of hardware and control philosophy, taking onboard the latest engineering developments and operational needs from DNOs.
2. End-user Pull, managed by **SPEN** and supported by **UKPN,** to challenge the technology boundary with a clear purpose to improve its competitiveness and facilitate its application at LV. Network licensees, owners and operators will be the primary customer segment for this innovation, and they could own, operate, and purchase D-Suite type products following a successful beta phase delivery.

D-suite can be an attractive solution for DNOs because this project will provide:

- A clear understanding about benefits (capital, operational, social, etc.) of LV power electronic solutions.
- A set of criteria on which products can be best used.
- Significant learning in terms of the optimum design and operation of LV power electronics technologies.
- A clear understanding about technical/commercial requirements for integrating existing LV AC assets with LV power electronics solutions.

As early adopters of the D-suite, we will continue to carry out extensive market research and due diligence to identify capable suppliers at international level. This will stimulate competition in the supply chain, attract more private investment and support innovators to cross the chasm between early adoption and an early majority which will consequently **reduce the cost and risk from adopting LV power electronics technology.**

[11 Taking Stock of SiC (https://www.pgcconsultancy.com/post/taking-stock-of-sic-part-1-a-review-of-sic-cost-competitiveness-and-a-roadmap-to-lower-costs) (https://www.pgcconsultancy.com/post/taking-stock-of-sic-part-1-a-review-of-sic-cost-competitiveness-and-a-roadmap-to-lower-costs)

[21 Underground Substation (https://smarter.energynetworks.org/projects/nia_spen_QQ61/)

10. Intellectual Property Rights (not scored)

What are the Intellectual Property Rights (IPR) arrangements for your project?

The proposal will comply with the default SIF governance regarding IPR. i.e., any relevant foreground IPR will be owned and shared by electricity licensees.

11. Costs and value for money

How much will the project cost for this Discovery Phase and how does it represent value for money for the consumer?

D-suite will investigate, design, and implement a suite of smart LV power electronic solutions with innovative functionality and data-sharing arrangements to optimise low carbon electricity generation. Therefore, **it offers value for money to electricity consumers and provides a wide range of learning opportunities for project partners** through these innovative methods.

This SIF- Discovery phase comes with a funding request of £132k, with an additional £25k contribution from the project consortium, representing a de-risked technology investment request of only 85% of the total budget. The other 15% include Royal Academy Fellowship grants and the existing UKRI investment in the project partners. As a leading licensee, SP Energy Networks will contribute £5k from its business investment. This cash contribution is on top of SPEN's commitment during the interval between Discovery and Alpha.

Therefore, value for money is a core element of the D-Suite proposal since it contributes:

1. a strong consortium with well leveraged knowledge, investment, facilicities and commitments
2. an experienced innovation project management team at SPEN as the backup to safeguard the project delivery
3. the feasible output to generate direct benefits to the communities when roll out to the GB level by reducing the electricity distribution losses and increasing household renewable connections at:

A.£4m reduced losses per annum

B.£1Ok per LV Feeder per annum

12. Project Management Template (not scored)

You must upload your completed Project Management Template.

Uploaded

D_Suite_ProjectManageBook.xlsx (opens in a new window) (/application/10060423/form/question/28925/forminput/76448/file/472562/download).

The finances of all project partners are included in this summary.

Return to your project finances (/application/10060423/form/section/11654/) to complete or make changes to your organisation's financial information.

	Total costs (£)	Funding sought (£)	Contribution to project (%)	Contribution to project (£)	Contributions in kind (£)
SCOTTISH POWER ENERGY NETWORKS HOLDINGS LIMITED ✔ Lead organisation	**48,145**	43,330	10.00%	4,815	4,815

		Total costs (£)	Funding sought (£)	Contribution to project (%)	Contribution to project (£)	Contributions in kind (£)
Newcastle University Partner	*	**42,119**	33,994	19.29%	8,125	8,125
UK POWER NETWORKS (OPERATIONS) LIMITED Partner		**2,550**	1	99.96%	2,549	2,549
INTEGRATED POWERTECH LIMITED Partner		**64,300**	54,550	15.16%	9,750	9,750
Total		**£157,114**	131,875		25,239	25,239

Funding breakdown

	Total	Labour (£)	Materials (£)	Subcontracting (£)	Travel and subsistence (£)	Other costs (£)
SCOTTISH POWER ENERGY NETWORKS HOLDINGS LIMITED Lead organisation View finances (/application/10060423/form/FINANCE)	**£48,145**	40,125	0	0	8,020	0
Newcastle University Partner	**£42,119**	38,981	0	0	3,138	0
UK POWER NETWORKS (OPERATIONS) LIMITED Partner	**£2,550**	2,550	0	0	0	0
INTEGRATED POWERTECH LIMITED Partner	**£64,300**	39,000	17,500	0	4,000	3,800
Total	**£157,114**	120,656	17,500	0	15,158	3,800

SIF Governance Document

SIF Governance Document

Partner	SIF Governance Document	Status
SCOTTISH POWER ENERGY NETWORKS HOLDINGS LIMITED (Lead)	Third Party (/aDDlication/10060423/form/terms-and-conditions/organisation/28411/question/28804)	Accepted
Newcastle University	Third Party (ZaDplication/10060423/form/terms-and-conditions/organisation/118/question/288Q4)	Accepted
UK POWER NETWORKS (OPERATIONS) LIMITED	Third Party (ZaDDlication/1006Q423/form/terms-and-conditions/organisation/19843/question/28804)	Accepted
INTEGRATED POWERTECH LIMITED	Third Party (ZaDDlication/10Q6Q423/form/terms-and-conditionsZorganisationZ73734ZquestionZ28804)	Accepted