ELECTRICITY NETWORK INNOVATION COMPETITION 2020

REPORT AND RECOMMENDATIONS

Prepared for

THE GAS & ELECTRICITY MARKETS AUTHORITY

By

THE ELECTRICITY NETWORK INNOVATION COMPETITION EXPERT PANEL

October 2020

1 INTRODUCTION

This report prepared by the Electricity Network Innovation Competition (Electricity NIC) Expert Panel sets out the Panel's recommendations to the Gas and Electricity Markets Authority on the portfolio of projects to be funded in the 2020 NIC funding round.

Panel Membership

Members of the Electricity NIC 2020 Expert Panel (the Panel) are:

- Jo Armstrong (Chair)
- Maxine Frerk
- Mike Kay
- Jiggy Lloyd
- Julian Wayne

Electricity NIC 2020 proposals

There were five submissions made to the 2020 Electricity NIC which, collectively, bid for £64.75 million of the £70 million available NIC funding. Full details of each submission will be available on the Ofgem website.

The names of the Funding Licensee, titles of the submissions, the total project costs and the amount requested from the NIC Fund are as follows:

Project	Funding Licensee	Project Cost (£m)	NIC Request (£m)
Constellation	South Eastern Power Networks (UKPN)	17.82	14.38
QUEST	Electricity North West (ENWL)	9.67	7.95
FLEXR	Northern Powergrid (NPg)	10.54	9.27
Proteus	National Grid Electricity Transmission (NGET)	28.04	25.03
RICA	National Grid Electricity Transmission (NGET)	9.13	8.12

Evaluation methodology

The Panel followed the evaluation process set out in the Electricity Network Innovation Competition Governance Document (v3 2017). Initial submissions were received by Ofgem and were screened by Ofgem staff for compliance with the requirements set out for the Initial Screening Process. Consultants (Aecom) were appointed by Ofgem to assist in the review process. The Panel and the Consultants met the Funding Licensees early in the evaluation process to allow the project teams to present their submissions. The Panel and the Consultants met the Funding Licensees a second time to allow them to clarify points and address matters of concern to the Panel. Throughout the process the Consultants and the Panel sent each of the Funding Licensees a number of questions with the purpose of clarifying the submissions and highlighting areas of concern.

Following these meetings, the Panel met to review each of the submissions in the context of the criteria set out in the Governance Document. In evaluating the submissions, the Panel took into account all of the documents that had been made available: the submissions, their appendices, the Consultants' advice as well as any additional information that had been submitted via Ofgem or the Consultants from the Funding Licensees (including answers to supplementary questions); they also took account of information from meetings that were held with the Funding Licensees and any material provided during those meetings. Finally, the Panel reviewed resubmitted bids that updated the original; by providing points of clarification raised at the bilateral sessions as well as correcting any factual errors (note: no material changes to the proposals can be included in these resubmissions). Based on this evaluation, the Panel reviewed the projects against the criteria in the Governance Document. This report sets out the Panel's recommendations to the Authority.

The evaluation criteria used by the Panel to review each submission are as follows (see the full Governance Document for details):

a. Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers
b. Provides value for money to electricity customers
c. Generates knowledge that can be shared amongst all relevant Network Licensees
d. Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or Demonstration Project to demonstrate its effectiveness

e. Involvement of other Project Partners and External Funding

f. Relevance and timing

g. Demonstration of a robust methodology and that the Project is ready to implement

This report should be read together with the Funding Licensees' submissions and the other information that is published concurrently with these on the Ofgem website. This report sets out the results of the Panel's deliberations and its recommendations for the Authority. As such it is primarily concerned with the views of the Panel; all the details of the projects are contained in the other published documents.

2 EVALUATION OF SUBMISSIONS

The following section provides the Panel's assessment of the factors that underpinned its recommendations.

2.1 CONSTELLATION

Licensee	South Eastern Power Networks (UKPN)(UKPN)
Total Project Cost	£17.82m
NIC Requested	£14.38m

The proposal

Project Constellation aims to enable the transition to Net Zero by transforming the existing network management and control systems, through the introduction of local intelligence at a substation level. It is a simplified and focused evolution of a proposal which was unsuccessful in NIC 2019.

The Project seeks to develop a decentralised intelligence and control system at a substation level. This will include the ability for substations to communicate directly with each other, via 5G. This arrangement is in contrast to the centralised control and communication systems currently used by DNOs. The arrangement that the Project proposes can be used for a number of use cases, although UKPN has chosen two use-cases (Methods) to justify the Project:

- Method 1: Using this arrangement to provide resilience to distributed energy resources (DER) operation in the event of loss of communications from the central Active Network Management system;
- Method 2a: Using this arrangement to override the Loss of Mains (LoM) protection on individual DER sites;
- Method 2b: Using this arrangement to dynamically update the settings of directional overcurrent (DOC) protection.

The project appears to be well-packaged, with key partners identified for developing the hardware and software.

The project proposes that, as part of the development and implementation of the solution, there should be offline trials at the Power Networks Demonstration Centre (PNDC), followed by

demonstrations in the network in the Maidstone and Lewes areas. This should confirm whether or not the anticipated distributed energy capacity improvements are achievable.

Although very focused at this stage, there is the potential to implement a range of other network optimisation initiatives using the same hardware and software. The idea of innovative apps created by third parties which was present in the 2019 submission has not been abandoned, but it is no longer a key justification for the project. The Panel noted the potential for this project to deliver benefits during an islanding scenario in a similar way to the SSEN RaaS project funded in 2019. However, again UKPN were not using such a use-case as a key justification or in benefits calculations.

Panel's Assessment of the criteria

(a) Financial, Carbon and Capacity Benefits

Financial benefits

The financial benefits that are projected to accrue to customers from Constellation will inevitably be dependent on the chosen technology solution and how it is deployed. The proposal outlines a wide array of such end use cases, although just two are used to justify the Project financially. The financial case offered is based on the development and deployment of a future-proof architecture for control and data management applications that allow both decentralised state estimation and generation forecasting at a substation level and, adaptive wide area protection functions with low-latency communication links.

The Panel consider that the Project's chosen counterfactual of existing centralised control is appropriate.

The two use cases are estimated to deliver NPV benefits of £131million by 2030 rising to £764 million by 2050. To reach breakeven requires the solution to be deployed on around 175 primary and grid substations across GB (with UKPN themselves having 1,200) and around 340 DER sites; these equate to roughly 9% of all possible DER deployments and 5% of eligible primary and grid substations.

Carbon and Capacity Benefits

UKPN estimate that with full rollout to GB by 2050, the capacity benefit will total 4.3GVA; 2.9GVA of this will be existing capacity that is protected (ie DER capacity no longer subject to unnecessary curtailment) and the rest additional capacity available for new DER connections The estimate of

protected capacity is based on historic data and experience (largely over the last 3 years) concerning curtailment events, whose applicability to the next 30 years is deeply uncertain. Nevertheless, the Panel agrees that capacity benefits are likely given forecast increases in DER, and that this will benefit the DER sector in reducing loss of revenue and/or increasing opportunities for connection. Additional benefits for those parts of the sector providing services such as voltage or frequency control are possible, for the reasons elaborated in c) and d) below. Although support from the DER sector was not specifically evident in UKPN's submission (which was disappointing), the Panel is satisfied that it would be forthcoming together with a willingness to provide the necessary cooperation required in the trials.

The forecast capacity benefit would generate a carbon saving of 17.8 million tonnes CO_2e by 2050 and any carbon costs would be minimal or negative in comparison with current practice.

(b) Value for Money

The Panel noted that the costs of the project had increased significantly since the 2019 bid but were satisfied that this was justified by an extension to the scale and scope of the project. The Panel consider that the scale of the Project trials is appropriate. The carbon and financial benefits set out above, plus the longer-term potential of a de-centralised approach, support this project providing value for money. A competitive procurement process would be used for elements of the project where several potential suppliers are available. Existing partners were providing a reduction on their standard day rates.

(c) Generates new knowledge

The Panel believes that Constellation could be a route to significant valuable new knowledge in relation to how the control of GB distribution systems needs to evolve to cope with a transformed energy system with significant intelligence embedded both locally in the distribution system itself, as well as in (potentially) millions of smart and/or active devices installed in customers' premises. The Panel consider that this new knowledge is applicable to other Network Licensees. The Panel recognizes the possible limitations of the development of traditional distribution network control systems using large scale, centralized, sophisticated computing facilities which rely on reliable and resilient communications to all parts of the network that need to be monitored and controlled. Constellation is a counter concept, somewhat less reliant on resilient communications, and where the processing power is distributed. Such an approach would seem to have some inherent advantages

over the current centralized model in that it is far less susceptible to a single point of failure, or to the failure of communications.

The hardware to implement Constellation seems to be readily available, but there will be essential learning in adapting and deploying it for the first time in a GB DNO. In particular the Panel recognizes the stated benefits of developing:

- The detailed architecture of the approach
- The commissioning, testing, and monitoring approach
- Overall management of distributed control resources.

The Panel believes that the Constellation approach will be a foundation for the development of other system management and control functions that rely on or benefit from autonomous real time actions based on local conditions. The Panel notes that Table 18 in UKPN's submission identifies a first tranche of such applications.

(d) Is Innovative

The development of a distributed system management approach as proposed by Constellation has not been undertaken in GB before and the Panel is not aware of any such development in a distribution system internationally; as such the Panel considers this Project is innovative. There are many practical challenges to solve in achieving a successful implementation, and the Panel believes that the Constellation submission has identified many of these. The Panel considers that the scale of the Project means it meets the criteria of being a limited demonstration project. The Panel considers that given the unproven nature of this Project, UKPN is unlikely to develop it without innovation funding.

The Panel believes that the core functions in Constellation will be building blocks for many applications, including those in Table 18 of the submission, plus others not yet identified.

The Panel is unsure whether the details of Method 2's objectives will result in the full benefits accruing to the project. However the Panel firmly believes that the Project benefit arises not only from the immediate applications, but also as a foundation for the continuing development of sophisticated distributed control functions.

(e) Involvement of other Partners and external funding

The project appears to be well-developed, with key partners identified for developing the hardware and software. In addition to UKPN's £1.627 million, other partners making a financial contribution to the project costs are ABB (£228k), GE (£344k), Siemens (£658k), Vodafone (£145k) and the University of Strathclyde PNDC (£175k). Two other DNOs, SSEN and SPEN, are involved and contributing through their participation in the PNDC.

The Panel noted the lack of early engagement with DER but is satisfied this will be addressed in the course of the project; the availability of a willing DER generator will be a factor in selection of trial sites and, as a last resort, DER connections can be simulated.

(f) Relevance and Timing

Given the rapid growth in distribution control system capability already underway, but seemingly all based on centralized systems, it is very relevant and timely to investigate other architectures. There has been a theoretical debate for some time about the pros and cons of centralized versus distributed control systems. As stated in (d), as far as the Panel knows Constellation would be the first practical implementation of a distributed control system in a distribution system, opening up the opportunity for more effective and efficient distribution network control, and could be a key reference installation for understanding the merits of the debate.

(g) Robustness of Methodology and ready to implement

The Panel was generally comfortable with UKPN's implementation plans for Constellation. A worry regarding the availability of 5G communications was explored, following the Government's decision to ban communication providers from buying Huawei equipment from 2021. The Panel was satisfied that UKPN can manage this risk within the timing of Vodafone's revised plans for 5G rollout, and within Constellation's contingency budget should additional trial communication hardware become necessary.

Conclusion

The Panel found the Constellation proposal offers the sector substantial, systemic opportunities including strategic benefits beyond those outlined in the two use cases proposed.

As a consequence, the Panel is recommending CONSTELLATION to be funded by the Authority.

2.2 QUEST

Licensee	Electricity North West (ENWL)
Total Project Cost	£9.67m
NIC Requested	£7.95m

The proposal

ENWL (and other DNOs) has turned a number of innovation projects into business as usual (BaU) for the control of voltage. This is increasingly necessary as the largely passive control using equipment remote from where the voltage is measured becomes inefficient. This in turn is driven by the dynamic voltage and power flow changes in modern networks with the increase in embedded generation. Some active network management (ANM) schemes also control the voltage at points in the network. To ensure that adjacent voltage control schemes do not interact, cumulative time and voltage margins are used to allow them to respond in an ordered manner. These margins mean that the full voltage range capability of the network cannot be used.

QUEST will integrate these standalone discrete voltage control schemes into a single scheme using ENWL's Network Management System (NMS). It will develop a novel distribution network-wide, fully co-ordinated, overarching system to manage voltages and balance centralised and decentralised control hierarchies. This should reduce cumulative design margins and free up network capacity. The role of voltage self-regulation by demand and generation will be investigated, noting that many embedded generators are currently run with fixed output voltages.

The project will create and deliver:

- Centralised Overarching Software (Schneider Electric)
- Decentralised Control using Active Network Management Technology (SGS)
- Install and Configure Intelligent AVC relays at BSP and Primary substations (Fundamentals Ltd)
- Intelligent voltage control equipment at distribution substations using standard remote control units
- Modelling

In addition, there is acceptance of the need to collaborate with the ESO to explore how QUEST might be used to support the ESO network operations.

A trial site has been identified where different modes of operation will be tested over 12 months. The trials will be carried out to determine how the command arbitration in QUEST will work for 13 potential combinations of the following voltage management techniques:

- Passive (traditional) voltage control
- Active LV voltage optimisation using centrally controlled devices
- Active EHV/HV voltage optimisation using centrally controlled devices
- ANM/flexible services delivered by controlling DERs.

Panel's Assessment of the criteria

(a) Financial, Carbon and Capacity Benefits

Financial benefits

The financial benefits arise from delaying or mitigating the need for reinforcement to release over 2,200MVA of capacity alongside a reduction in losses. Together they would generate £51 million NPV benefits by 2030, rising to £266 million by 2050.

The benefits of QUEST are based on a number of assumptions, specifically:

- that optimisation is possible to the degree envisaged;
- that the optimisation releases the capacity envisioned;
- that the voltage dependence of load continues to match the QUEST assumptions; and
- that other DNOs will be able to match/achieve ENWL's optimization given the very different network management systems in use.

The extent to which these assumptions turn out to be valid will feed directly into the benefits that QUEST can deliver, and the Panel welcomed the inclusion of an additional deliverable to test one in particular: the voltage dependence of future loads such as electric vehicles and heat pumps.

Notwithstanding the uncertainty of the scale of the benefits, the breakeven for a representative licence area would be 2030, with application to 23 primary substations.

The Panel were content that ENWL's chosen counterfactual of network reinforcement and flexibility services was appropriate.

Carbon and Capacity Benefits

The capacity released by QUEST (predicted by ENWL to be 2238 MVA by 2050) would enable more low carbon technology (LCT) devices to connect to the network, and to do so more quickly in those instances where the alternative would be reinforcement of the network. ENWL have not attempted to predict the carbon saving that this would represent but it can be assumed that additional capacity for LCTs would help meet the target of Net Zero. LCT operators may also benefit from lower connection costs.

Carbon savings of 51,500 tonnes CO_2e arising from lower distribution losses are forecast following GB rollout by 2050. ENWL also refer to the much more significant carbon savings (potentially more than 1 million tonnes CO_2e) that could be realised as a result of customers' reduced consumption.

These estimates are all dependent on the assumptions referred to above, in particular that concerning the constancy or otherwise of the voltage:demand relationship which may be sensitive to wider introduction of LCTs such as heat pumps and electric vehicle chargers. ENWL's initial sensitivity analysis suggests the reduction in demand could be lower than forecast and, as noted above, they propose to include research into this relationship in the project. This project research will help address the main area of uncertainty around the scale of capacity and carbon benefits .

(b) Value for Money

The business case for QUEST shows it providing value for money. The Panel were pleased that the Project will in part use existing hardware. The costs of QUEST for ENWL do however include ANM equipment which other DNOs have already rolled out. The Panel also noted the potential for QUEST to lead to increased CLASS revenues for ENWL. Under current arrangements these would be shared with customers, at least for the remainder of the RIIO-ED1 period (a decision is yet to be made by Ofgem on CLASS revenue in the RIIO-ED2 period). The inclusion of the additional research (on the voltage:demand relationship) on a self-funded basis enhances the value for money of the proposal.

(c) Generates new knowledge

The optimization of voltage profiles across networks operating at different voltages appears to be a new approach on distribution networks, and so would generate new knowledge. The Panel consider that this new knowledge is applicable to other Network Licensees given they face the same challenges. The approach offers the ability to maximize the use of existing assets before investment

or other mitigations are required. The underlying analysis and algorithms are novel. QUEST will develop these and test them, discovering the practical and economic limits of such techniques.

The QUEST financial benefits depend on a general reduction of the voltage supplied to customers, and a reduced consumption of real power as a result. This approach of itself is not new or innovative; it is the extent to which it can be maximised within the other constraints on network operation which is new.

It is also noted that the reduction in system losses claimed by QUEST is just a natural accompaniment to reduced power flows; QUEST does not appear to be attempting to include loss optimization in the management of system voltages.

(d) Is Innovative

Historically voltage control schemes have been designed within a static hierarchy of actions within defined network segments and assumed system conditions. The QUEST method moves beyond the historic approach and integrates voltage control between the historic network segments and optimises the overall voltage profile of the network in real time. The Panel considers that this is innovative as it has not been done before.

The Panel consider that the scale of the Project means it meets the criteria of being a limited demonstration project. The Panel consider that given the unproven nature of this Project, ENWL is unlikely to develop it without innovation funding as it would not be viewed as a BaU fundable investment.

(e) Involvement of other Partners and external funding

Partners making a financial contribution to the project costs are National Grid ESO (8.7k), Schneider Electric (330k), Fundamentals Ltd (£127.5k), Smarter Grid Solutions (£201.3k) and Impact Research (£7.6k).

Schneider Electric may have a marginally increased opportunity to sell its centralised software module, though it is expected competitors will develop and sell their own equivalent solutions. The first mover advantage for project partners will deliver a reasonable return for this contribution.

As noted below, given the particular challenge here of ensuring the findings are implementable in other networks, the Panel would have liked to see another DNO involved as a partner.

(f) Relevance and Timing

The Panel is unaware of any specific issue that is driving the development of QUEST. However the Panel recognizes QUEST as one more tool to help DNOs accommodate the development of distributed energy resources and the growth in decarbonized heat and transport as part of the move to Net Zero. Assuming QUEST lives up to its projected utility and value, it will be a technique that can be used appropriately to help minimize or delay DNOs' investment in upgraded network assets. Given this and the forecast impacts of the decarbonisation of heat and transport, the Panel considers this project is relevant and timely.

The Panel had concerns as to how likely it is that other DNOs, who all have different network management systems to ENWL's, will be able or incentivized to implement the method in the software of their network management systems. Whilst the involvement of another DNO in the project would have helped address that concern, SGS have experience of other DNO ANM systems, and the wider learning from the project will have general applicability even if the specific technology solution does not.

(g) Robustness of Methodology and ready to implement

The implementation plans for QUEST seem appropriately complete and robust. The Panel discussed the way that ENWL has structured the project in terms of algorithm development followed by moving straight to field trials. Having considered this in the context of similar technology developments the Panel concluded that the delivery risks would be manageable.

Conclusion

The Panel recognizes that QUEST develops distribution network voltage control in ways that have not been attempted before. The Panel can foresee that the solution will be potentially useful in managing distribution networks as they become more active in the future, having to optimize system conditions accommodating many more LCTs, and minimizing the resultant investment needs.

The Panel therefore is recommending QUEST to be funded by the Authority.

2.3 FLEXR

Licensee	Northern Powergrid (NPg)
Total Project Cost	£10.54m
NIC Requested	£9.27m

The proposal

This project will create a platform for sharing DNO and distributed energy resources (DER) data to improve the efficiency with which flexibility markets are managed. If the relevant information is made available, it would also allow better analysis of investment opportunities for distributed resources, greater whole system coordination, and would enhance the connections process. These aims will be achieved by standardising the way DNO data, and data relating to the DERs connected to them, is made available and by having it available in a single place. Differences in the way DNOs provide data is often quoted as a key restriction on the quality of investment decisions and the development of flexibility markets. This Project is in line with the strategic direction set by Ofgem and government for improved access to DNO data.

The project also has the potential to deliver as yet unspecified customer and operating benefits though the sector collaborating and revealing currently undisclosed DNO and DER data sets.

The project will evolve through three phases: Definition, Discovery and Agile-based Software Delivery. The Project will:

- Design, build and operate the Flexr Portal to allow market access to network DER/DNO asset data
- Involve the near real-time integration of the five participating DNOs' data
- Enable Common Flexibility Market Services by automating and standardising communication and data
- Be governed by an Agile Flexr Governance Framework, an implementation of commercial principles for service levels and charging arrangements

The platform will be developed using Amazon Web Services (AWS) solutions and it is proposed that the platform be hosted on UK based AWS servers.

This project proposal comes after the Energy Data Task Force (EDTF) published its report in 2019, which pushed for greater data availability. In addition, Ofgem, BEIS, and InnovateUK have initiated three pathfinder projects (competitively awarded), the Modernising Energy Data Access (MEDA) projects. These projects will deliver their initial findings in mid-2021. Flexr is built on the recommendations of the EDTF but is not part of the MEDA programme.

Flexr follows from a "minimum viable product" project that has combined the data of two DNOs.

Panel's Assessment of the criteria

(a) Financial, Carbon and Capacity Benefits

Financial benefits

The financial benefits at the GB level are projected to amount to £79 million by 2040, rising to £100 million by 2050. It is worth noting that by 2030, the GB-level benefits are projected to be £9.6 million, ie, less than the value of the project and only marginally more than the NIC funding being requested.

There are three value streams anticipated to be generated:

- Efficient data sharing – eliminating manual processing and delivering DNO open data;
- Increased data sharing – enhancing visibility of lower capacity DERs and improved DSO operations and planning;
- Increased data sharing – facilitating flexibility markets.

These value streams are expected to help identify and facilitate least cost solutions.

The Panel felt the counterfactual (network invesment) was too static and so produced an over-estimate of possible financial benefits likely to accrue to Flexr, ie, the counterfactual does not properly reflect the reality that market-based flexibility markets are already emerging and the trend for ever greater data provision by DNOs is already evident. The project sponsors themselves stated at the second bilateral that without Flexr *"there is every likelihood that another solution seeking similar outcomes would be progressed in the absence of NIC funding*".

An alternative counterfactual presented as a sensitivity in response to this challenge was based on an acceleration of 3 years in the benefit stream, ie, the alternative counterfactual assumes that this project would happen without NIC funding, but three years later. The Panel considered this alternative counterfactual to be more reasonable but felt that could still be over-stating the benefits, depending how regulatory requirements for data access develop.

In their consultation on the sector specific methodology for ED2, Ofgem have proposed a Licence Obligation requiring use of data to meet the expectations of Data Best Practice guidance. The draft of this guidance includes delivering the EDTF recommendation for treating data as "presumed open" and carrying out a data triage process to identify and manage sensitivities associated with the data. The goal of this Licence Obligation is to ensure decision-making processes relating to data are transparent. It is also to ensure that data exchanges between market actors are "friction free". In the panel's view this, together with an emphasis on the importance of co-ordination, would position development of data provision services as proposed in Flexr more clearly as BaU for the companies.

While the benefits calculation acknowledges that Flexr will "facilitate increased participation in flexibility markets, thus, increasing market competition and liquidity" the benefit is calculated through comparison with "more expensive hardware-based solutions". Flexibility markets are already emerging, as are market platforms to facilitate them (eg Picloflex). However, the Panel believes there will still be benefits arising from increased data provision namely, extension of markets, increased participation in those markets and reduced cost of participation.

Carbon and Capacity Benefits

Access to reliable and comprehensive data is of benefit to current and potential operators of DER who, in turn, are important players in the delivery of GB's Net Zero electricity supply. The potential benefit of this project to the DER sector is suggested in the proposal by letters of support from sector representatives although not, regrettably, by the direct participation of one or more DER operators.

Such benefits are, however, very dependent on data quality and coverage. From a low-carbon point of view, significant benefits are likely to arise from data concerning the LV network and activities that lie "behind the meter". NPg acknowledge and the Panel concurs that the probability of Flexr not being able to provide data at this level is very high. (Potential issues include GDPR, project governance arrangements and how DER operators balance commercial considerations against the merits of openness). There will likely be instances in which better data enables capacity sought by DER

operators to be identified and provided more quickly than would otherwise the case, and this will confer a carbon benefit if it advances a low carbon connection, but it is otherwise difficult to identify significant carbon benefits arising uniquely as a consequence of this project.

NGET have suggested that, by facilitating the provision of more non-network solutions, there will be a GB-wide carbon benefit of 138,000 tonnes CO_2e by 2050 . The Panel believes this figure needs to be treated with caution. As with the financial benefits, it is entirely dependent on the choice of counterfactual.

(b) Value for Money

The unique and trusted position ElectraLink holds in the management of GB energy market data gives it a significant cost advantage in the Flexr project. The combination of ElectraLink, Allotrope technology and Endava would offer customers value for money, having worked together on the Proof of Concept work (that was already funded by customers).

Endeva was selected for the Flexr Phase 1 through a competitive selection process.

(c) Generates new knowledge

The project should generate knowledge for the whole sector. It aims to standardise DNO and DER data from a variety of legacy and new systems and projects. Knowledge on how to share and standardise data from different DNO data systems would be new, as would the knowledge that the data itself may provide. Benefits of this latter type of knowledge may include DER owners, who may better understand opportunities to use their assets to provide services. The knowledge that will arise from DER participation is less certain, given that the willingness of DER owners to participate has not yet been explored.

However there are significant overlaps and potential synergies with the MEDA projects. These overlaps would potentially limit the new knowledge described above. Coordination during the data discovery, stakeholder engagement and system definition phases would be particularly important for efficiency.

(d) Is Innovative

The Panel is unconvinced of the stated innovative element of this project, namely data standardisation and data sharing and integration between other DNOs over cloud-based platforms,

including the necessary governance arrangements. These are and have been common approaches, adopted and applied by businesses in other sectors. The fact that DNOs are still seeking a reason to collaborate on such a basic element that is essential to ensure efficient and effective energy markets is surprising. While the project will of course have to deal with some new and potentially tricky issues, this does not meet the bar for being considered innovative.

The Panel is also not convinced that this could be viewed as a "limited development or demonstration project", given the scale of the project. Given that it seeks to implement a comprehensive solution across five of the six GB DNOs for a wide range of data, with little left to do once it is complete, it appears more like a rollout of a complete solution rather than a limited demonstration project.

The Panel noted that a comparable project - INSPIRE - was rejected by the NIC in 2016. Given the importance that DNOs and Ofgem are suggesting should be attached to data management, the Panel urges Ofgem to establish a strategic approach to addressing this issue. DNOs should not have to seek NIC funding for what is essentially a BAU investment.

(e) Involvement of other Partners and external funding

The project lead will be ElectraLink Ltd, the DNOs' data provision and service partner and will be making a financial contribution of £211k.

Given the nature of this project, the Panel felt that formal partnering of five DNOs on this proposal was a minimum requirement for it to be reassured of successful delivery.

The Panel is concerned about the lack of any formal DER participants given that Flexr would be used to surface DER data. The Panel is also concerned about the omission of the ESO, given the significant weight placed on whole system co-ordination.

(f) Relevance and Timing

There is growing recognition of the important role that data will play in the net zero transition and following the EDTF recommendations, the need for open access to DNO data has been given much greater prominence. As such, the Panel considers that this Project is highly relevant. However, there are other significant projects being taken forward through MEDA.

(g) Robustness of Methodology and ready to implement

The Panel were largely comfortable on the project timing and methodology given it was building on the experience and results of the phase 1 Proof of Concept project also lead by the ElectraLink team. It accepts that it is seeking input from users on what data should be prioritised. However, the Panel is less assured on the robustness of the proposed Definition, Discovery and Agile-based Software Delivery approach and the absence of clear stage gates.

The expectation that the outcome will result in a monopoly service may be inevitable and acceptable, given that users want a single platform for all DNO data. Effective governance arrangements may be possible (such as those established for the ElectraLink managed Data Transfer Service) and which the project proposes to develop further. However, the Panel were concerned about ElectraLink's stated intent (combined with the enduring IPR arrangements) to leverage its role for potential additional remunerative business opportunities.

Conclusion

Whilst the Panel found the project of interest, welcomed collaboration on the development of sector data, and agree that the solution the project was seeking to develop was timely and should offer significant customer benefits, it was wholly unconvinced that the NIC is the appropriate route to funding its development.

The key concerns are the lack of innovation, the fact the project goes beyond limited development and, the dependence of the benefits on the chosen counterfactual.

Consequently, the Panel is not recommending Flexr to be funded as a NIC project by the Authority, but would urge all DNOs and Ofgem to explore how else such a project could be delivered.

2.4 PROTEUS

Licensee	National Grid Electricity Transmission (NGET)
Total Project Cost	£28.04m
NIC Requested	£25.03m

The proposal

The project aims to develop, design, build and test a full-scale virtual synchronous machine (VSM) by applying controls that have been developed in theory to imitate a new synchronous condenser. It is hoped that this will mimic rotating synchronous generators from a power system stability perspective, but with lower internal losses and fewer installations needed to achieve similar performance.

Distributed generation is mainly non-synchronous, so it typically does not have the power system stabilisation characteristics of rotating synchronous generators. Much research has been done on the feasibility of introducing these characteristics to any power electronic converter based distributed generation, but development into practical applications has been low. NGET does not consider VSM technology to be ready for commercial operation at transmission scale in the GB network. To advance the technology, NGET proposes three methods:

- Demonstration: Engineering design and deployment of a live trial system, in collaboration with suppliers and stakeholders.
- Research: Assessing performance of the trial and developing a roll-out map, in collaboration with academic and research institutions.
- Validation: Testing models against a real implementation, and checking various assumptions regarding technical performance, costs and benefits.

Measured against NGET's suggested counterfactual of system stabilization provided by synchronous condensers, NGET estimate £880m of benefits to customers (in reduced system balancing costs) out to 2050. The project will enable NGET to inform the definition of VSM services presently under development by the ESO, and potentially to sell those services too. However the practical learning will be shared and has the potential to benefit wider market participants as well.

Panel's Assessment of the criteria

(a) Financial, Carbon and Capacity Benefits

Financial benefits

The financial benefits are anticipated to arise from reduced losses and lower capital costs when compared to installing synchronous condensers.

The total possible deployments across the GB network is estimated to be 153 units, with a central case of 50 and a low of 11, (and all being deployed between 2027 and 2031). Whilst the single Licensee application is assumed to breakeven in 2029, the high upfront capital costs of any roll out configuration means the scheme reaches breakeven no earlier than 2034.

By 2030 the financial benefits are assessed to be £200 million, based on the central estimate of 50 deployments across GB, which rises to £880 million by 2050. It is worth noting the sensitivity provided that illustrates the case where counterfactual stability services costs fall 20% every contract renewal period (ie, every 6 years), produces a negative NPV by 2030 of £(168 million), rising to £96 million by 2040 and £362 million by 2050.

The Panel were not convinced by the benefits case presented, for two reasons. Firstly, the project submission states that the primary network requirement driver for VSM from 2025-2050 is vector shift, yet long-term system operability outlooks do not highlight vector shift as a major network issue. Given this absence of evidence, the Panel could not be convinced by the magnitude of the VSM needs case. Related to this, the second area of concern was the assumption that the benefit from an individual VSM unit was constant out to 2050. The Panel were not convinced by this as an assumption, given that the ongoing Grid Code work means it is likely that other providers may be able to offer VSM capabilities in that period. These additional providers would reduce the need, and so benefit, of dedicated VSM.

The Panel accepted the argument that the requirement for inertia is another driver for VSM. However the Panel had concerns about the counterfactual assumption that the fastest available frequency response service out to 2050 would have a response time of 0.5-1 second. Given response times already being sought in other markets, this assumption feels unreasonable, with the result that the inertia needs case for VSM would be overstated.

Carbon and Capacity Benefits

The lack of stabilisation capability is one of many factors that can limit the introduction of distributed low-carbon generation into the GB network. Proteus would offer an alternative means of providing such stabilisation (in place of synchronous condensers) and hence could help meet Net Zero targets. However, the extent of this benefit cannot realistically be estimated.

There is greater certainty about the scope for carbon benefits resulting from reduced losses. In comparison with synchronous condensers, VSMs would result in 80% less losses (and 90% if compared on a capacity basis). Assuming a roll-out of 50 units in GB, this would generate a carbon saving of 243,000 tonnes CO_2e by 2050 and at a significantly lower carbon cost.

Although NGET have referred to wider benefits to the renewable generation sector arising from greater confidence in the technology, the Panel is not convinced such a benefit would be exclusive to this project (see c) below).

VSMs would not bring about any additional capacity in the network compared to synchronous condensers.

Other environmental considerations

There are significant noise issues associated with synchronous condensers; VSMs would be significantly less noisy, cause less vibration and require less maintenance.

Each installation would occupy about. 0.25 hectares; such space is be available at the sites selected for the trials and NGET do not foresee any planning difficulties with rollout to other sites in the longer-term.

(b) Value for Money

Approximately 80% of the Project cost is for procurement of equipment presently available in the market (namely a STATCOM) The Panel questioned why NGET could not simply make use of an existing statcom and accept that the risks of carrying out such a trial on live equipment render that an unacceptable option. The Panel also noted that NGET would have a functioning statcom at the end of the project enabling them to save on totex in future. NGET argued that they had no plans for further statcoms until T3 and Ofgem could adjust allowances at that point if appropriate.

The Panel was also concerned that customers would be funding a manufacturer to develop a product for the global market. NGET said it will procure the statcom development competitively in order to recoup some of these benefits for customers.

The Panel had concerns that NGET procuring and owning the VSM was not necessarily an appropriate way forward. The Panel would have preferred to see NGET specifying the network services required and procuring those from the market, rather than specifying and owning the technology solution itself. This route leaves more of the development risk being borne by GB customers rather than manufacturers' shareholders.

(c) Generates new knowledge

Proteus claims to generate little new fundamental knowledge about the detailed design of VSM techniques. Instead it will be generating knowledge about the construction and deployment of VSM technologies and capabilities at the scale appropriate to the GB transmission system (and to other transmission systems globally).

The Panel considers that new knowledge will arise from the detailed specification of the device, from its manufacture and installation. The first and third of these will accrue to NGET, with manufacturing learning generally remaining with the selected manufacturer and not as IP available to the project.

The Panel is also very aware of the detailed specification being formally developed by the ESO for VSM devices in GB. Although the adoption of VSM requirements is not expected to be mandatory, it opens up the way for invertor-based generation and storage to provide system stability services. The Panel is concerned that this will both undercut NGET's Proteus business case (as stability services will be provided to a greater extent by the market) and provide an existing development path for the technology such that VSM statcoms will be provided by manufacturers as a specific application of the overall technology development.

The Panel agrees with NGET that the knowledge gained from Proteus will be of use in the specification and procurement of subsequent VSM statcoms, and that it will be advantageous for NGET, and indirectly for GB customers, to have the GB specification at the forefront of manufacturers' development and marketing of VSM devices.

The first practical installation of a VSM device in GB will generate useful information that the ESO will need to test its developing Grid Code VSM specification against. The Proteus project could be the first such practical implementation and could therefore deliver the first key validation and refinement of the ESO's specification.

(d) Is Innovative

NGET's innovation is related to the development of the detailed specification for the statcom and its installation and integration with the system at this scale. NGET will also gain knowledge of the operating costs, losses, maintenance costs etc over the longer term.

The Panel consider that the scale of the Project means it meets the criteria of being a limited demonstration project. The Panel consider that given the unproven nature of this Project, NGET is unlikely to develop it without innovation funding.

(e) Involvement of other Partners and external funding

There are no other project partners making a financial contribution to the Proteus bid. The Panel was unclear as to why, if the potential benefits are as proposed, no other potential end users were convinced enough to make a financial contribution to the project. The Panel was particularly disappointed at the lack of active involvement by the ESO given the synergies with their own work on the Stability Pathfinder and the Grid Code Working Group, and joint responsibilities around ensuring system stability. While the ESO and SHET will sit on a technical advisory board, the ESO's involvement is so central that the Panel do not consider it appropriate for the project to proceed without a much stronger the ESO involvement and greater clarity around respective roles.

(f) Relevance and Timing

The need to develop VSM technology, and for new generation (and possibly compensation equipment) using the approach, has been recognized for some time internationally. However to date there have been no installations of the scale that would be useful and/or economic in GB. Arguably GB's needs for the technology are relatively urgent compared to many jurisdictions internationally. However the timing of NGET's proposal seems inopportune given the ongoing VSM specification development by the ESO and others internationally.

The Panel were also concerned that Vector Shift is the primary problem that NGET expect the VSM technology to help resolve from 2025 onwards. At present there is very little understanding in the

sector as to the nature of the vector shift problem. The ESO has not identified this specifically as an emerging issue in its system operability outlooks.

(g) Robustness of Methodology and ready to implement

The Panel notes that NGET have developed thorough plans for the project. However the project relies on NGET going to market to select a partner to design and build a suitable statcom. Although the international manufacturing market is well engaged in general in the development of VSM technology, it remains uncertain how the market will respond to NGET's tender.

Conclusion

The Panel is not convinced of the project benefits given the lack of evidence presented around the vector shift needs case and how this might drive this project.

The Panel is also uncomfortable that NGET has not demonstrated a more certain link between their proposal and the current ESO work on a VSM specification for the GB Grid Code and the lack of ESO involvement in this bid.

Finally, the Panel is also not convinced that the NGET approach will ensure value for money and appropriate risk transfer to manufacturers.

Consequently, the Panel is not recommending PROTEUS to be funded by the Authority.

2.5 RICA

Licensee	National Grid Electricity Transmission (NGET)
Total Project Cost	£9.13m
NIC Requested	£8.12m

The proposal

This project aims to develop a method of using insulated crossarms (ICA) to increase the voltage rating on existing 275kV overhead line towers to 400kV. This will allow increased power to be transmitted on existing routes without replacing the towers. The method proposed involves replacing existing metallic cross-arms with insulated composite cross arms. The project hopes to accelerate the TRL of ICAs in this application from 6 to 8 and enable retro-fitted insulated crossarm (RICA) to be considered as BAU for transmission owners.

The project follows on from IFI and NIA National Grid and SSE (respectively) projects. The latter installed the cross-arms on 132kV towers at two test locations, one of which was energised. The close-out report indicated that the next stage would be to install the cross-arms on operational towers.

This project will progress the previous work by developing design, construction and maintenance policies, specifications and procedures and exploring all the equipment and accessories available in the market. If successful, the deliverable will be ICAs suitable for whole routes (ie terminal, angle, and suspension towers) for three tower models.

Panel's Assessment of the criteria

(a) Financial, Carbon and Capacity Benefits

Financial benefits

The financial benefits arise from a quicker removal of network constraints, meaning that the ESO is not paying constraint payments for as long a period. No financial benefits were assumed from a capital cost perspective – NGET's calculations assumed that RICA will have the same capital cost as a new build tower (the counterfactual). The Panel considers that this is a conservative assumption as it seems likely that there would also be cost savings going forward once standards and ways of working are established. The project also opens the door to upgrades to Ultra High Voltage networks in future.

A GB-wide roll out is projected to generate NPV benefits of minus £16m by 2030, rising to plus £286 million by 2050. This is based on the assumption that the technology could be applied to 6 routes, based on current projections. One element of the RICA project would be to develop the evaluation criteria to help in preparing future business cases for use of this technology.

The Panel questioned the use of a new build overhead line as the counterfactual. It was accepted that while the appropriate counterfactual would vary by project, that could only be determined once the full Network Options Appraisal process had been worked through for a project. The Panel considers that a new build line is an appropriate counterfactual as, whilst there are other alternatives (such as high temperature low sag conductors), only a new build line provides comparable levels of network capacity.

Carbon and Capacity Benefits

If deployed on the proposed 6 routes in GB, instead of new OHLs which are expected to take two years longer to deliver, RICA will provide a carbon benefit to the extent that the additional capacity is taken up by low-carbon sources of generation replacing conventional sources. NGET have not quantified this benefit; the Panel notes that by 2048 it will be minimal.

NGET have stated that a reduction in losses, in comparison with the counterfactual of a new OHL, will generate a saving of 39,500 tonnes CO_2e by 2050. They have assumed that the carbon cost of RICAs is the same as that of a new OHLs. They have suggested and the Panel agrees that this is a conservative approach; carbon cost of RICA is likely to be lower than the counterfactual.

Other environmental considerations

Overall, it is highly likely that the uprating of an existing line using RICAs will give rise to less community disturbance and land-use and biodiversity impacts than the creation of a new OHL (given that safety and operational factors prevent construction of new OHLs along existing alignments). However, at any specific location, stakeholder views may differ; the disturbance due to an upgrade will be especially unwelcome if the upgrade is perceived to rule-out the possibility (however remote) of a line being rerouted. Stakeholder consultation forms part of the proposal; the planned approach plus measures to check compliance with health protection standards gives the Panel comfort that these considerations should not jeopardise the project.

The possible secondary application of RICAs, tower lowering, is suggested as an option for visual improvement projects (VIP) in NGET's future business plans. The Panel notes that this is tentative and that the design of RICAs forms part of the project; nevertheless it is surprised that, in compiling their bid, NGET have not sought the views of their Stakeholder Advisory Group for VIP projects (a standing body with knowledge of tower design) to add confidence to the assertions concerning visual impact.

(b) Value for Money

The supplier will be selected through a competitive procurement to ensure value for money.
The business case shows the project delivers value for customers and NGET have put additional governance in place to ensure customers would not be funding costs that have been allowed in BaU totex.

(c) Generates new knowledge

The new knowledge generated will be primarily around the operational challenges including safe installation of the equipment on one arm of the tower while the other remains live (to avoid the need for outages). The project will also test the technology on a wider range of tower types than has been done previously and will monitor in service performance.

The Panel initially had concerns that this did not generate sufficient new knowledge in addition to the preceding IFI and NIA work, but are now satisfied that this criteria is met given the difference in scope between this Project and that preceding work.

The Panel notes that NGET has identified three routes in Scotland where the solution can be deployed although the Panel notes that two of these are 132kV towers of PL16 design, and not of the same design as NGET's towers and so may not be applicable for deployment.

(d) Is Innovative

While there have been technical trials here and overseas, the practical challenges around safety and the full range of tower arrangements have not been tested on GB tower designs to the extent necessary to allow this technology to be considered as a viable option when alternative network options are assessed. A pilot of the technology would allow it to be considered as a proven option for future projects.

The Panel consider that the scale of the Project means it meets the criterion of being a limited demonstration project. The Panel consider that given the unproven nature of this Project, NGET is unlikely to develop it without innovation funding, or to be able at this stage to propose it in a NOA process to secure funding under the RIIO mechanism.

(e) Involvement of other Partners and external funding

The Panel was disappointed to see no other partners were willing to make a financial contribution to the project.

The membership of ESO, SPEN and SSE (alongside academics) on the proposed Technical Advisory Board is second-best but reassuring given, we were told, they helped shape the proposal.

(f) Relevance and Timing

Given the very significant growth projections associated with reaching net zero, the ability to quickly and cost effectively to increase capacity on transmission routes is relevant and timely.

(g) Robustness of Methodology and ready to implement

The Panel notes that the project has a well developed implementation plan, building on previous development work.

The Panel notes that there are questions around Deeside, which NGET had proposed to use as a testing site, given that Ofgem's Draft Determinations for RIIO2 do not provide funding for Deeside. NGET's contingency would be to use an overseas test site.

Conclusion

The Panel recognizes the solution as potentially a useful approach to solve network problems that would otherwise risk significant delays in implementation, with other attendant downsides, specifically higher costs and increased CO_2 emissions, in decarbonizing the UK's energy systems. The Panel also welcomes the potential for avoiding community disturbance in constructing new lines.

The Panel therefore is recommending RICA to be funded by the Authority.

3 RECOMMENDATIONS FOR FUNDING

In summary, based on these evaluations the Panel makes the following funding recommendations to the Authority, subject to the various conditions outlined above:

Recommended for funding

Project	Licensee	NIC Request (£m)
CONSTELLATION	South Eastern Power Networks (UKPN)	14.38
QUEST	Electricity North West (ENWL)	7.95
RICA	National Grid Electricity Transmission (NGET)	8.12

Unable to recommend funding

Project	Licensee	NIC Request (£m)
FLEXR	Northern Powergrid	9.27
PROTEUS	National Grid Electricity Transmission (NGET)	25.03

4 ISSUES FOR FUTURE COMPETITIONS

Reflecting on this year's projects the Panel would like to highlight a few issues for Ofgem and the companies to consider in designing the successor to NIC and in any future innovation funding submission.

NIC Governance Benefits

As Ofgem seeks to develop the successor to the NIC funding approach, the Panel feels strongly that there are elements of the current approach that are valuable and would merit careful consideration for inclusion in whatever successor proposal is rolled out:

i. The scrutiny of the proposal by an independent Panel has significant value; it ensures a far greater understanding of what is actually being proposed whilst also offering insights for project sponsors that is valued ahead of individual projects being implemented;
ii. The detailed governance arrangements that imposes public scrutiny and on-going monitoring on at least an annual basis helps to increase the sector's understanding of wider project learning and effectively holds licensees to account;
iii. Submitting NIC bids (at ISP and formal NIC submission stages) provides opportunities for the regulator to get a better feel for issues arising in the sector outside of the formal regulatory debate and so helps reduce some of the inevitable information asymmetries.

Third Party Calls and VFM

The Panel would like to highlight some of the challenges it has faced with assessing third party led proposals. It accepts there is no simple route to ensuring VFM where third party suppliers may be able to secure financial benefits that have not been subjected to market testing ex ante. However, the Panel has concerns where customers' money is being used primarily to build a third party's business rather than to generate wider market learning for customers' benefit. What is essential, therefore is that both the ISP and the NIC assessment stages include, explicit assessment of how the non-DNO partners were subjected to meaningful market testing of both their product prices and their day rates. It is also essential that bids are very clear around IP and how market arrangements could be expected to develop in the future.

Involvement of multiple network companies

The Panel continues to be concerned about the potential for single Party proposals to be submitted. The Panel takes greater comfort when collaboration between licensees is a formal arrangement;

having a financial obligation increases the likelihood of roll-out as BaU. However, if single licensee schemes are allowed to progress through the ISP, there is less incentive to collaborate. The Panel does take this into account when assessing the projects; all other things being equal, without a formal collaboration the Panel has less evidence to support recommending a project where other factors make it a marginal call.

What remains unclear to the Panel is the extent to which the knowledge and experience gained from previous and on-going innovation projects is being fully integrated into new projects and in project implementation strategies. It suggests Ofgem undertakes an assessment of the number and type of projects that have resulted in BaU developments.

5 ACKNOWLEDGEMENTS

As in previous years, the Panel fully recognises the amount of work required to make NIC bids, including the time and effort taken to provide the Panel with answers to all questions posed. Consequently, the Panel would like to thank all the companies for their active engagement both in their written answers and at the bilateral meetings.

The Panel is also particularly grateful to the Ofgem team that provided exceptional support to the Panel. Their technical and administrative input along with the technical support of the Consultants AECOM ensured the Panel was able to undertake full and effective scrutiny of the NIC proposals.