Innovation Portfolio 2019

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Contents

1 Introduction

This report sets out EirGrid's innovation projects for 2019. The basis for this report follows a decision paper from the Commission for Regulation of Utilities (CRU) titled "Reporting and Incentives under Price Review 4" (CER/18/087). Decision 11 sets out CRU's objective in putting in place a more formal process is to track the use by the TSO of innovation projects, to help support and accelerate progress against the strategic objectives.

While we continually seek out innovative ways of solving the challenges we face, for example the DS3 programme, we believe that those works are adequately funded and incentivised under PR4. This report focuses on the innovation projects that were not originally considered under PR4 and that support the progress against the strategic incentives. The innovation projects are:

- Voltage Uprate Project
- Composite Pole ProjectThe QTP (Qualifier Trial Process) 2019Control Centre Tools ProjectProject Management – Innovation & Research Fund FlexTech Initiative The QTP (Qualifier Trial Process) 2020'Greenstart' Project

1.1 EirGrid approach to Innovation

As an organisation we recognise the need to anticipate, shape and facilitate the direction of the industry. In doing so we can ensure we are fully equipped to deliver on our licence requirements of ensuring the safe secure economic planning and operation of the transmission system.

Fulfilling our responsibilities of planning and managing the transmission system will continue to become increasingly complex with further evolution of the energy industry to a more decarbonised energy system, driven predominantly by intermittent wind electricity generation. Among these challenges is the anticipated increase in the level of distributed generation, with ongoing connection of wind and the growth of new technologies such as photovoltaic (PV) and electricity storage. Demand is also set to be more active and dynamic with ongoing drive for energy efficiency through demand side participation.

We continue to seek out innovative ways of solving some of the problems we face today and in the future. As an organisation we believe we can deliver greatest value and benefit for our customers by identifying innovative solutions to real challenges and delivering these into our business activities. We believe that by focusing on how we can use our existing grid better, enable sustainable energy users and reduce the impact our infrastructure has on the

environment we can drive positive change for both customers and wider society. To fully realise the benefits of our focus we must ensure we can translate solutions into workable models, policies and procedures for both the organisation and industry. With this in mind, our Innovation Focus Areas have been identified in the following section.

2 Innovation Focus Areas

2.1 Evolving User Facilitation

As the power system requires an increasingly dynamic approach, we must ensure we are positioned to both facilitate new types of users and manage their impact on the system. We will proactively develop policy both internally and externally to enable business model development for new user types that support energy efficiency and sustainability such as active demand, PV and electricity storage. By ensuring we are equipped to manage such users we can be positioned to utilise them in managing intermittent generation and network congestion amongst other issues as much as is reasonably possible.

2.2 Enhanced Grid Utilisation

Enhanced grid utilisation focuses on how we can get more out of our existing infrastructure which has the potential to deliver cost savings for customers by negating the requirement to build additional infrastructure. This includes both the application of devices which can be added to the network along with changes in operational and planning practices which have the potential to enable the enhanced efficient use of existing infrastructure. Such technologies and practices have the potential to drive greater utilisation work by redirecting power flow from heavily loaded circuits to circuits that are less loaded. This could provide EirGrid with greater ability to manage system congestion and has the potential to suppress the short term need for infrastructure build, reduce constraint costs and facilitating connection to the grid.

2.3 Reduced Community & Environmental Impact

We must be mindful of the impact we have on the environment and we seek out innovative ways to adapt how we approach the deployment of infrastructure so we can minimise the impact on the local environment.

2.4 Control Centre Evolution

The All-Island system is undergoing a paradigm shift in terms of the technologies connecting to the system, the services they provide and the real-time operation of the electricity system required to maintain a safe, secure system that is operated economically. In order to deliver value to the customer, it is essential that the control centre is identified as a strategic asset and is equipped with the tools necessary to enable real-time operational change. As a result the objective of DS3 Control Centre Tools (CCT) project is to deliver a suite of state of the art control centre tools that will facilitate the operational changes required to integrate and

operate in real time the highest levels of renewable energy anywhere in the world. The control centre evolution plan focuses on delivery of tools to facilitate all major work areas including, DS3, Innovation, DS3 System Services and Operational requirements.

3 Projects that have been completed in 2019

No new innovation projects were completed in 2019. It is important to note that the majority of EirGrid's work in the area of innovation is based on multi-year projects and while the system is in a period of rapid change, the innovation projects that will help enable the energy transition often involve multiple stakeholders and timeframe of greater than a year.

3.1 Projects that are in progress

3.1.1 Voltage Uprate

Scope: To type test 2 tower types – a single circuit suspension and a double circuit suspension tower to enable the potential conversion of existing 220kV lines to 400kV by replacing the top portion of the suspension towers with an alternative configuration.

Rationale: The conversion of 220kV lines to 400kV lines has the potential to unlock significant benefits for electricity customers, electricity generators, electricity customers and wider society. Increasing the capacity of the grid improves the attractiveness of renewable energy developments, reduces the amount of renewable electricity generation that is constrained and will ultimately contribute towards achieving renewable energy targets. If successful, voltage uprate could present an alternative to installing new green field 400kV infrastructure. Voltage uprate could if viable potentially deliver enhanced grid capability in a shorter period of time when compared to large greenfield 400kV infrastructure.

As outlined above, the research and development phase for deploying a new tower design on the transmission mission requires years of engineering researching, design work, testing, trialing and piloting before the technology is considered business as usual for EirGrid and ESB Networks. The successful completion of the type testing of the single circuit and double circuit towers has facilitated progression into the trialing stage which is currently being planned. A trial on a dead-line is planned for 2020/2021. A successful trial will increase the knowledge and confidence level of the technology in order to further progress this technology for consideration on the transmission system.

Cost: €575,000 (Innovation spend from PR4 Innovation allowance)

Impact: The addition of the technology to the innovation toolbox for use in future network development. Achieve project agreement with the Transmission Asset Owner (TAO) to enter into the construction phase.

Future Potential: Increases to grid capacity are required to provide renewable generators access to the grid so that they can supply electricity when it is generated. Adding these solutions to the technology toolbox is the final step in ensuring they can be used in future grid development projects; this will alleviate the need for the building of network infrastructure and could unlock savings for customers as a result.

3.1.2 Composite Poles

Scope: Type testing of composite 220kV towers. Composite poles are lighter than comparable components made from wood steel and concrete and have the following physical benefits:

- Light duty equipment leading to lower logistical costs
- Fast construction timelines due to modular nature of the material.
- Reduced maintenance and long service life

Rationale:

EirGrid is seeking to increase the number of transmission options which have a reduced environmental and social impact while maintaining deliverability and cost. One of these options under research and development is the application of composite poles on the transmission system.

Increasing the capacity of the grid improves the attractiveness of renewable energy developments, reduces the amount of renewable electricity generation that is constrained and will ultimately contribute towards achieving renewable energy targets. In addition, the faster construction times would if rolled out in the future result in outcomes and outputs being delivered to the end customer. .

Cost: €613,000

Impact: On validation of the poles through successful type testing, including destructive testing, the feasibility study will deliver the planning application and design information to allow these structures to be added to the toolbox for infrastructure development. Only proven technologies can included in the toolbox, if composite poles become a proven technology they may be used in planning of the transmission system. This technology is an innovative alternative solution to traditional steel lattice and wood pole structures. This facilitates higher capacity power flows in the existing corridor.

Future Potential: These innovative infrastructure solutions will potentially unlock cost savings to the end customer through the use of more cost efficient infrastructure which is lighter to transport and should require less maintenance. The faster construction timelines also have the potential to better utilisation and enhancement of the existing infrastructure capability in a more timely manner, delivering better outcomes for customers.

As with the tower voltage uprate technology, there are a number of engineering activities that are required before the technology becomes business as usual. Following the type testing of the composite poles, it is envisaged that a construction trial will be planned in the future to increase the knowledge of staff and to determine the erection and maintenance procedures. The composite pole may in the future be considered for replacement of small sections of OHL infrastructure, or for use in complex construction scenarios and depending on performance and review in the longer term could be considered for larger infrastructure projects.

3.1.3 QTP 2019

Scope: Facilitating new technologies to provide System Services on the system to increase competitive pressures on the long-term costs of System Service provision to the consumer by expanding the range of Service Providers. This will improve the technical capability of the generation fleet and the system more generally by facilitating capability valuable to the system at high levels of renewable penetration therefore delivering value to consumers and a secure, sustainable power system.

Summary of DS3 System Services Products:

Service Name	Acronym	Short Description
Synchronous Inertial Response	SIR	Provision of Inertia from synchronous machines that can operate with low minimum generation point.
Fast Frequency Response	FFR	MW delivered between 2 and 10 seconds in response to automated frequency trigger
Primary Operating Reserve	POR	MW delivered between 5 and 15 seconds in response to automated frequency trigger
Secondary Operating Reserve	SOR	MW delivered between 15 to 90 seconds in response to automated frequency trigger
Tertiary Operating Reserve 1	TOR1	MW delivered between 90 seconds to 5 minutes in response to automated frequency trigger
Tertiary Operating Reserve 2	TOR2	MW delivered between 5 minutes to 20 minutes in response to a control / dispatch instruction
Replacement Reserve – Synchronised	RRS	MW delivered between 20 minutes to 1 hour in response to a control / dispatch instruction

Replacement Reserve – Desynchronised	RRD	MW delivered between 20 minutes to 1 hour in response to a control / dispatch instruction from a zero megawatt starting position.
Ramping Margin 1	RM1	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
Ramping Margin 3	RM3	
Ramping Margin 8	RM8	
Fast Post Fault Active Power Recovery	FPFAPR	Active power recovery within 250 ms of a voltage fault
Steady State Reactive Power	SSRP	Reactive power response within 40ms of a voltage fault
Dynamic Reactive Response	DRR	MVAr capability during large (>30%) voltage dips

Rationale: This will enable safe, secure and resilient power system operation across future energy scenarios, including higher levels of non-synchronous renewable generation.

Cost: Payment for the trials to trial participants to date amounts to €47,911[1], the total payment to the trial participants, is expected to be €200,000 when the trial period ends in March 2021.

Impact: EirGrid and SONI published the 2019 DS3 System Services Qualification Trial Process (QTP) on the 8th March 2019.The tender is split up into 4 lots:

Lot 1: Solar Technology Trial
Objective of the trial is to prove solar technology capable of providing a range of the DS3 System Service products and identify any operational complexities.

Lot 2: Aggregated Residential Services
Objective is to focus on the provision of DS3 System Services from residential homes.

Lot 3: Other Technology

[1] The total amount of €200,000 refers to the volume of services and one off payments to the trial participants for the duration of the trial 2019-2021.

The objective is to prove “Other Technology” capable of providing a range of DS3 System Service products and identifying any operational complexities.

Lot 4: Alternative Communication Method

The objective is to trial a new telecommunications method which meets the shifting needs of the industry.

Future Potential: The 2019 trial is designed to be bespoke with a focus on innovative technologies and strategy. The 2019 QTP includes trials to demonstrate capability in the reserve, ramping and fast-acting services. The 12 month trials will be concluded in September 2020 and the 18 month trial will be concluded in March 2021, after which the results will be compiled and published. This will allow new and evolving technologies to demonstrate their capabilities for providing services and support to the system at high levels of renewable generation. The QTP is a route to market for participants. Participants, that demonstrates that they can provide a response to an event in line with the DS3 System Services definition, may qualify for participation in the system service procurements.

3.1.4 Control Centre Tools

Scope: Decision Making Tools to be live in the Control Centre by 2020 include:

- Look-Ahead WSAT[2]: enables Grid Controllers[3] to analyse the stability of the power system in the near future, facilitating optimal system operation with higher levels of wind integration
- Voltage Trajectory Tool: enables Grid Controllers to assess the impact of varying sources of reactive power across the power system to ensure that local voltage management issues are managed. Enhanced voltage control management capability in the control centre is critical to facilitate increased levels of SNSP[4].
- Ramping Tool: enables Grid Controllers to accurately schedule and dispatch the Ramping Margin services[5], and manage changing demand and generation profiles, with increased wind integration.

[2] **Wind Security Assessment Tool (WSAT)** is a bespoke software tool, developed for the EirGrid Group, to give a real-time indication of the effect of wind generation.
[3] **Grid Controllers** operate the grid from National Control Centres (NCCs) in Dublin and Belfast. The NCCs, carry out the intricate task of matching electricity production to customer demand.
[4] **System Non-Synchronous Penetration (SNSP)** is a real-time measure of the percentage of generation that comes from non-synchronous sources, such as wind & interconnector imports, relative to the system demand
[5] **A Ramping Margin service** is the increased MW output that can be delivered with a good degree of certainty for a given time horizon.

Rationale: The evolving power system requires new principles and practices of operation, with the resultant requirement for development and implementation of new control centre tools and capabilities. In keeping with the natural flow of DS3 from system performance to system policies to system tools, many of the new tools requirements will be driven by the outputs of other DS3 workstreams, especially those in the policy area. The evolving I-SEM design also drives the requirement for new tools.

Cost: Zero -The Control Centre Tools project is a capital project[6]

Impact: Voltage Trajectory Tool, Ramping Tool and Look-Ahead WSAT tools have been fully scoped and development of the tools has been initiated.

Future Potential: This DS3 Control Centre Tools project will deliver a suite of Control Centre Tools to enhance the stability analysis, voltage control and frequency management capability of the control centre. This capability enhancement is necessary to increase the levels of instantaneous renewable generation on the system (SNSP). A core objective of the TSO and the DS3 Programme is facilitating levels of SNSP up to 75% in order to meet public policy.

[6] The Control Centre Tools project is a capital project valued at €3m funded as part of the PR4 DS3 allowance.

3.1.5 Project Management - Innovation & Research Fund

Scope: To drive value for customers through RES integration by effectively managing the research and innovation fund.

Rationale: Engaging in and focusing innovation and research in the areas of Evolving User Facilitation, Enhanced Grid Utilisation, Control Centre Evolution and Reduced Community & Environmental Impact ensures that EirGrid is fully equipped to fulfil EirGrid's duties and broader strategic objectives, to meet public policy objectives as well as increasing the knowledge and expertise of staff. In addition, research and innovation drives value for customers.

Cost: €226,000
This is an annual cost of EirGrid's participation in academic and industry research groups as outlined in the following section. This cost also allows EirGrid to host PhD and Masters Students who are conducting research in relevant areas that are of mutual benefit for EirGrid.

3.1.5.1 Horizon 2020

EU-SysFlex is a consortium of European energy companies, led by EirGrid. It has been awarded over €20 million by the EU to fund research into the development of renewable energy. EU-SysFlex will identify issues associated with integrating large amounts of renewable energy and provide practical assistance to power system operators across Europe. It will also create a long-term roadmap to facilitate the large-scale integration of renewable energy.

EirGrid has also contributed to the RealValue, PROMOTioN and MIGRATE H2020 projects.

3.1.5.2 RealValue

The RealValue project aimed to demonstrate how local small-scale energy storage, optimised across the EU energy system with advanced ICT, could bring benefits to all market participants. Demonstrating the ability of small-scale energy storage devices to provide vital system services could help to facilitate the integration of increasing levels of renewable generation.

3.1.5.3 PROMOTioN

PROMOTioN is a Horizon 2020 funded project aiming to investigate the benefits of meshed offshore transmission grids to the European electricity market. The goal is to develop and demonstrate three key technologies for use in offshore grids. Furthermore, proposals for a regulatory and financial framework will be developed that support coordinated planning, construction and operation of integrated offshore infrastructures, including an offshore grid deployment plan for the future offshore grid system in Europe. EirGrid's involvement in PROMOTioN lies in contributing to the pace and structure of offshore wind and grid development and the technical standards which can facilitate further interconnection in the future.

3.1.5.4 MIGRATE

The MIGRATE consortium was made up of members from 13 countries. The objective of MIGRATE was to develop and validate innovative, technology-based solutions in view of managing the pan-European electricity system experiencing a proliferation of Power Electronics (PE) devices involved in connecting generation, particularly renewable generation, and consumption sites. Such solutions are necessary to develop a future power system with exceptionally high levels of renewable penetration. MIGRATE allowed EirGrid to showcase, on a pan-European scale, our previous and current work in facilitating high levels of renewables.

3.1.5.5 ESIPP (The Energy Systems Integration Partnership Programme)

The benefit for EirGrid of being involved in this proposal is to have insight to the next generation of weather, gas and water related inter-linkages to the electricity system to understand if any improvements or advantages can be availed of. It also allows EirGrid to steer the direction on the research.

3.1.5.6 IRDG

EirGrid is a member of the Industry Research and Development Group (IRDG), a non-profit, business-led Innovation Network of member companies and colleges, working together to drive excellence in Innovation within Ireland's industry to create growth, jobs and prosperity.

3.1.5.7 EPRI (Electric Power Research Institute)

EirGrid and EPRI have engaged in a strategic research partnership with mutual benefits for both companies through collaborative projects. EirGrid benefits from EPRI's wealth of international knowledge, by allowing staff to draw on industry experts for guidance, support and validation in many areas of work throughout the company. The partnership has allowed EirGrid to access information on a range of topics, such as Data Centre modelling, Risk Based Planning techniques, Blockchain industry developments, Oscillations, ROCOF events and Flexibility. EPRI have benefited from using the All-Island power system as a test case for new modelling tools, and from gaining information from EirGrid on operating a power system with very high instantaneous non-synchronous generation.

3.1.5.8 MaREI (Centre for Marine and Renewable Energy)

As a strategic Industry partner, EirGrid has representation on MaREI's Industry Advisory Committee and opportunity for representation on the Governance committee. This allows for input into activities and strategic direction of the centre. It also allows EirGrid to stay informed of technological progress and gives opportunities to work collaboratively with researchers and in industry supply chains and allows EirGrid to participate in R&D opportunities (through national, EU and international projects). The partnership between MaREI and EirGird allows for important strategic research consideration in relation to transmission on the island.

3.1.5.9 Research PhDs

Close collaboration with academia and research institutes ensures that research conducted is relevant and of mutual benefit for EirGrid and our collaborators. To facilitate this collaboration with academia EirGrid has hosted a number of PhD and Masters Students.

Future Potential:

As projects move through the innovation process and reach completion stage, the learnings from the project are compiled into a close out report and the information is disseminated by publishing the report on the EirGrid website. Where the innovation relates to network development technology, proven technologies are added to the technology toolbox and are utilised for future grid development projects.

However, upon completion, not all innovation projects are ready to transition to BAU, in these cases the TSO identifies whether there are opportunities to extend an innovation project to additional benefits.

By effectively managing the innovation and research fund EirGrid will continue to drive value for our customers by creating opportunities to influence the direction of research and investigate trial projects that solve the increasingly complex challenges associated with an evolving energy industry.

4 Projects being initiated

4.1 FlexTech

Scope: The FlexTech Integration Initiative, “Action 24” of the Climate Action Plan, will provide a comprehensive platform through which we engage with industry, Regulators and our System Operator partners

Rationale: The FlexTech initiative is designed to maximise opportunities for effective use of new and existing technologies and to identify and break down key barriers to the integration of renewables. By working at a pan European level, EirGrid will have access to knowledge available to other TSOs in Europe. This aims to enable the delivery of pan European solutions to deliver the aims of the Clean Energy Package.

Cost: The TSO resourcing of this initiative is funded through the EU-SysFlex budget

Impact: FlexTech is a key enabler in delivering the energy transition and enabling Ireland to reach its public policy objectives. It will streamline the approach for customers and stakeholders to engage with both of the system operators (TSO and DSO), this provides an efficient mechanism to break down barriers and diversify the range of technologies that can support the energy transition.

Future Potential: The FlexTech Integration Initiative will provide a structured approach to identify capability gaps, define the enduring review process, prioritise focus areas and develop solutions in line with the TSO’s strategic objectives. In addition to the external benefits, the intended internal structure will allow for greater cross functional collaboration on key challenges, cross pollination of ideas and knowledge as well as greater efficiency in how we tap into the expertise within the organisation.

4.2 QTP 2020

Scope: Facilitating new technologies to provide System Services on the system to increase competitive pressures on the long-term costs of System Service provision to the consumer by expanding the range of Service Providers.

Rationale: This will enable safe, secure and resilient power system operation across future energy scenarios, including higher levels of non-synchronous renewable generation.

Cost: In total a budget of €450k was approved for the 2019 and 2020 trials. The TSO resourcing of the trial is funded through the EU-SysFlex budget and the participants' payment for the trial period is funded through DS3 System Services regulated arrangements.

Impact: Once the trials have been concluded, results will be compiled and published. This will allow new and evolving technologies to demonstrate their capabilities for providing services and support to the system at high levels of renewable generation.

Future Potential: In response to the FlexTech consultation, the TSO is currently examining a number of technology types for the 2020 QTP. The trial will be designed to be bespoke with a focus on innovative technologies. The 2020 QTP will focus on Preventability, Distribution Impact, Portfolio Arrangements and Standard & Compliance trials to demonstrate capability in the reserve, ramping and fast-acting services. A key element of the trials will be identifying operational barriers for the further integration of new technologies. This will allow new and evolving technologies to demonstrate their capabilities for providing services and support to the system at high levels of renewable generation. As previously stated, the QTP is a route to market for participants. Participants who demonstrate that they can provide a response to an event in line with the DS3 System Services definition, may qualify to participate in the system service procurements.

5 Potential Future Innovation

5.1 Greenstart

Scope:

The aim of the project is to first study the part of the network that will be tested in detail. Based on the studies, EPRI will develop a test plan in collaboration with the selected windfarm and blackstart generation specialists. Once the test plan has been agreed, the actual test will be scheduled and performed. Following the successful completion of the test, the aim is to develop a framework for studying the use of renewable energy resources in system restoration plans for the entire transmission system.

Rationale:

The objective of this project is to demonstrate the performance of wind farms in the restoration process and to identify through modeling and simulation, how the adoption of this practice supports restoration plan development in a low-carbon future.

Cost: €95,715 + REFIT * Day Ahead Forecast while under test.

Impact:

This project will lead to the development of easy to use metrics which can be referred to during actual system restoration. EPRI will carry out a study of the Irish network using the Optimal Blackstart Capability (OBC) tool. This tool analyses the network to optimize the generators that should be considered for blackstart

Future Potential: Utilising renewables in this way to speed up the restoration process will reduce the economic impact of grid outages, improve system resiliency and continue to break down barriers to increased penetrations of renewable generation in accordance with Ireland's National Renewable Energy Action Plan (NREAP) and Irelands 2020 and 2030 renewable energy targets.

EirGrid's expects that there will be an evolution of the DS3 programme and the associated projects in order to support the energy transition. There will be a continued focus on the innovation areas of Evolving User Facilitation, Enhanced Grid Utilisation, Control Centre

Evolution and Reduced Community & Environmental Impact in order to deliver on decarbonisation and the national renewable targets.

Furthermore EirGrid expects that requirements for future innovation and research will be fully realised as part of the on-going price control review process. EirGrid is committed to embracing change and innovation to make a real difference and to realise our broader strategy.