Innovation Portfolio 2020

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1 Introduction

This report sets out EirGrid's innovation projects for 2020. The basis for this report follows the requirement under the Commission for Regulation of Utilities (CRU) decision paper "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.

This report will conclude the innovation project reporting under PR4. Future reports will follow the requirement, including consultation on same under "PR5 Regulatory Framework, Incentive and Reporting" (CRU/20/154). The projects of focus in this report are projects not originally considered under PR4, however projects identified as those which support delivery of PR4 strategic objectives. The innovation projects covered by this report are the following:

- Voltage Uprate Project
- Composite Pole Project
- The QTP (Qualification Trial Process) 2018/2019
- Control Centre Tools Project
- FlexTech Initiative
- Project Management – Innovation & Research Fund
- The QTP (Qualification Trial Process) 2020/2021 - Greenstart

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 non synchronous technology such as 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.

In addition to bringing forward innovative projects, in 2020, EirGrid established a dedicated Innovation & Research department to ensure continued and enhanced focus on delivering innovation to support delivery of our 2030 objectives and beyond. In support of this, EirGrid is developing a new Innovation and Research Strategy to be completed later this year.

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 and 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 Innovation Projects

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, trialling 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 trialling stage. Project Agreement for the works associated with these trials was reached with the ESB Networks as Transmission Asset Owner (TAO) in April 2020. The contract for the supply of the insulated crossarms was awarded by ESB in January 2021 and works required to commence a trial on a 220 kV overhead line are due to commence in April 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. Achieved Project Agreement with the 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 be 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.

In 2020, a scope of works for a constructability trial at Portlaoise training school was prepared for this project. Additionally, an evaluation of a selection of overhead lines (OHL), which are currently being scoped for refurbishment for adopting the composite poles technology was completed.

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 enable better utilisation and enhancement of the existing infrastructure capability in a timelier 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 2018/2019

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: €200,000

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
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.

The Qualification Trials continued throughout 2020, due to the impacts of Covid-19, some of the trials have been extended. The solar trial originally planned for completion in September of 2020 is now expected to conclude in April 2021. The residential trials are scheduled to be completed in April 2021. Finally, the communications trials will continue until Q3 of 2021. EirGrid issued a tender for 2020 QTP in September of last year. However, no tender applications were received. The TSO is currently reviewing projects with industry stakeholders to identify what may be initiated as part of the 2021 trials. Section 5.1 provides details of one of the trials under consideration.

Future Potential: The 2018/2019 trial is designed to be bespoke with a focus on innovative technologies and strategy. The 2018/2019 QTP includes trials to demonstrate capability in the reserve, ramping and fast-acting services. The QTP learnings and outcomes report for both solar and residential trials is scheduled to be published in June 2021. Going forward the TSO is investigating the potential to expand the current scope of the trials beyond System Services to identify and breakdown the barriers that exist in facilitating further levels of renewable generation.

3.1.4 Control Centre Tools

Scope: Decision Making Tools currently being developed in the Control Centre include:

- **Look-Ahead Security Assessment Tool (LSAT)**: enables Grid Controllers[1] 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 (VTT):** 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[2].
- **Ramping Margin Tool (RMT)**: enables Grid Controllers to accurately schedule and dispatch the Ramping Margin services[3], and manage changing demand and generation profiles, with increased wind integration.

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[4]

[1] **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.
[2] **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
[3] **A Ramping Margin service** is the increased MW output that can be delivered with a good degree of certainty for a given time horizon.
[4] The Control Centre Tools project is a capital project valued at €3m funded as part of the PR4 DS3 allowance.

Impact: The Look-Ahead Security Assessment Tool went live in the control rooms of Belfast and Dublin in December 2020. The tool is a world first which enables operation of the All Island power system with world leading levels of variable renewable generation in a safe and secure manner while minimising the level of constraint and curtailment of wind and solar. Thus, LSAT is a key contributor in the path towards decarbonisation of the electricity sector.

An Interim Ramping Margin Tool went live in the control centres in SONI and EirGrid in September 2020 and the development and deployment of the Enduring Ramping Margin Tool is underway. This tool enables grid controllers to accurately schedule the ramping margin reserve services, thereby enabling more effective management of changing demand and generation profiles with increased wind and solar integration. The Voltage Trajectory Tool has been scoped and development of the tool is underway.

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.

3.1.5 FlexTech

Scope: The FlexTech Integration Initiative 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.

In July 2020, EirGrid published The FlexTech Response to Consultation[5]. The response included the 12-month priority areas and also the medium and long-term goals (3 years).

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.

[5] https://www.eirgridgroup.com/site-files/library/EirGrid/FlexTech-Response-to-consultation.pdf

4 Project Management - Innovation & Research Fund

Scope: To drive value for customers through renewable electricity 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.

4.1 Horizon 2020

EU-SysFlex

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.

The project consortium has progressed extremely well and has delivered all expected deliverables to the EU Commission in 2020. The innovative technical work being delivered by EirGrid under EU SysFlex is a critical input to solving 2030's future system operation challenges. In mid-2020, led by EirGrid, the EU SysFlex consortium successfully completed its second Periodic Review with the EU Commission.

EirGrid participated in a number of other Horizon 2020 projects including RealValue, PROMOTioN and MIGRATE, all of which have now been closed out.

4.2 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.

4.3 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.

4.4 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.

4.5 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.

4.6 Research PhDs

Close collaboration with academia and research institutes ensures that research conducted is relevant and of mutual benefit for EirGrid and our collaborators. No PhD or Masters students were hosted in EirGrid in 2020 but EirGrid remains open to hosting students to facilitate this collaboration going forward.

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.

5 Projects being initiated

5.1 QTP2020/2021 - 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 modelling 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.
The trial is scheduled to initiate in May 2021.

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.