ESB NETWORKS

INNOVATING TO TRANSFORM THE ELECTRICITY NETWORK

DOC-101220-FZM

CONTENTS

FOREWORD

In ESB Networks, we are very clear that the challenge of enabling a low-carbon Ireland powered by renewable electricity requires extensive and collaborative innovation.

This report describes how ESB Networks is working together with customers, industry, the Transmission System Operator (TSO), technology providers, academics and research institutions to develop and implement new ideas, innovative concepts and technologies that will support the Irish Government's Climate Action Plan and provide enduring benefits for our customers and communities.

ESB Networks' vision for innovation is driven by our purpose to lead the transition to a low-carbon future. This means delivering a sustainable, affordable and reliable electricity system for Ireland that connects and accommodates far higher levels of renewable generation and enables electrification, so that clean electricity can displace carbon from heat, transport and the economy.

With the encouragement of the Commission for the Regulation of Utilities (CRU), ESB Networks developed its Innovation Strategy to support this transition to the network of the future and strengthen the culture of innovation and collaboration needed to deliver this energy transition for the benefit of customers. Our current portfolio has over 30 innovation projects with potential lifecycle benefits in excess of €50m.

We are proud to be able to collaborate with local communities on innovation projects in the Dingle Peninsula, Limerick City and the Aran Islands, as we explore the impact and capabilities of new low-carbon and supporting technologies. In these projects, we are testing and trialling potential solutions to help us develop the decarbonised, decentralised and digitised electricity system of the future. We are also working with customers and communities to better understand the impact of and interaction with changing technologies and new, developing energy systems.

Through 2020, ESB Networks engaged with stakeholders via a number of channels. These included a public industry consultation on our innovation activities, our Spring and Autumn Innovation Webinar Series and a range of targeted engagements with industry stakeholders and electricity suppliers. We also held innovation consultations in 2020 on initiatives to support microgeneration and the electrification of heat and transport.

We remain committed to conducting annual public consultations on our innovation activities. Our February 2020 consultation on innovation provided us with an opportunity to validate and calibrate our approach and to disseminate learnings with key stakeholders. We were delighted to receive submissions from a wide range of sectors including renewable energy, flexibility (both demand response and battery storage), academia and research, industry equipment and solutions suppliers, electricity suppliers, government departments and agencies, industry consultants and our colleagues in the TSO. This feedback informed a number of responses and actions which are summarised in this report and outlined in the response paper on our website.

A stakeholder survey carried out in October showed that 93% of the 45 respondents believed their understanding of ESB Networks' innovation projects and activities had increased or somewhat increased over the previous 12 months, so we welcome your comments and feedback on the activities highlighted in this document. We look forward to continuing this engagement and to working collaboratively and innovatively with you as, together, we connect and accommodate even higher levels of renewable generation and facilitate the distribution of clean electricity to support the decarbonisation of heat, transport and the economy.

Paddy Hayes

Managing Director
ESB Networks *Jan 2021*

1 INNOVATION IN ESB NETWORKS

1.1 INTRODUCTION

This report describes how ESB Networks, working together with customers, industry (including the TSO), technology providers, academics and research institutions, is implementing new ideas, innovative concepts and technologies that will support climate action and provide enduring benefits for our customers and communities. Throughout this document, we will share our approach to innovation including our overall innovation framework, strategy, governance, processes, dissemination, feedback and progress. We will also give you an insight into our innovation project portfolio that spans across our three roadmaps.

ESB Networks published our last annual consultation, 'Innovation for the Network of the Future' in February 2020 and invited feedback from interested parties. Stakeholder feedback was received from 19 respondents across nine sectors. We received positive feedback and support from the respondents in relation to many of our ideas, pipeline projects and active projects. We also received support in relation to some changes that were made in 2019, such as the consolidation of our eight roadmaps to three, the broadening of our definition of the term 'prosumer', the launch of our Innovation Forum (now our Innovation Webinar Series), the new section on Innovation Projects on our website, the strengthening of our governance structure and framework, and the introduction of an enhanced Cost Benefit Analysis (CBA) tool. Many respondents welcomed ESB Networks' plan to issue calls for expressions of interest to seek potential partners for specific innovation projects.

The stakeholder feedback received from the public consultation fell within four broad categories:

1. Suggestions to improve the Innovation Strategy Framework employed by ESB Networks.
2. Suggestions to improve ESB Networks' approach to dissemination, engagement and collaboration.
3. Suggestions to enhance innovation projects currently being conducted by ESB Networks.
4. New ideas/proposals for innovation projects which are not in the current innovation portfolio.

ESB Networks published a Response Paper to the feedback on our website - ESB Networks Response Paper On Innovation for the Network of the Future 2020. Many of the actions committed to in this Response Paper have been covered in the content of this report and further actions to address stakeholder feedback have been highlighted.

The purpose of this consultation, similarly to our last, is to encourage our stakeholders to share your ideas with us, to challenge our approach and in turn to continue to hold us to account. We want to hear your views on how ESB Networks delivers innovation and whether we are focusing on the right innovation projects.

Please send your comments and feedback to **innovationfeedback@esbnetworks.ie**

1.2 OUR INNOVATION VISION, VALUES AND MISSION

At ESB Networks, our vision is to continuously innovate towards a sustainable low-carbon energy future for our customers and for Ireland. Our vision and values serve as the foundation of our innovation strategy, informing every new idea and the development of every project.

Figure 1.1: ESB Networks' Values

In support of Ireland's commitment to the Climate Action Plan (CAP), United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, our Innovation Strategy has been developed to facilitate Ireland achieving its climate change targets for 2030 and beyond to net zero by 2050. The Irish Government's Programme for Government has set even more ambitious targets to reduce greenhouse gas emissions by 7% per annum up to 2030.

Our definition of innovation is to implement new ideas for the enduring benefit of our customers and business.
Our innovation activities operate across three broad horizons of innovation:

- Incremental – the innovation builds on existing systems, equipment or processes.
- Breakthrough – the innovation potentially provides new systems, equipment or processes.
- Radical – business-altering innovation. (None of the projects underway fall into this category.)

We prioritise Technology Readiness Level (TRL) 7 or higher in our innovation projects, as we believe this level of ambition is appropriate to give best value to our customers in view of the scale of resources available within a utility of our size. ESB Networks is in a position to leverage research carried out in academic/research institutions, which includes research at lower TRL levels, and we will continue to support academic research in Ireland through funding and sponsorship such as our support of Marine and Renewable Energy Ireland (MaREI) and University College Dublin's (UCD's) Energy Systems Integration Partnership Programme (ESIPP). This research has a role in Ireland's transition to a low-carbon economy and is key to building the necessary skills in Ireland. While we prioritise innovation projects with a TRL 7 or higher, this does not preclude lower TRL levels should a relevant project be proposed.

ESB Networks looks to embed innovation across the business and is not confining innovation to our "dedicated innovation teams". We are developing a culture of innovation which is encouraged across the organisation as we seek to challenge the status quo to find new and innovative approaches to how we carry out our business and operate our systems, which will ultimately benefit all our customers, irrespective of how or where they interact with the energy system.


SB Networks
Forum

1.3 OUR INNOVATION STRATEGY AND SCOPE

1.3.1 Innovation Strategy Framework

COVID-19 and the resultant lockdown and restrictions have had a major impact on society in Ireland. It is also likely to leave some lasting impacts on the way we organise society and use energy. Furthermore, the fundamental challenges posed by climate change remain. These changes to our society pose significant challenges for the operation of the distribution system but also present new opportunities to innovate and continually review how we plan, develop and operate the distribution system to deliver the network of the future.

The adoption of new materials, technologies and concepts, digitalisation and big data analytics have the potential to create greater efficiencies, while electrifying the heat and transport sectors will offer a range of new opportunities for our customers to engage with the energy system. For example, the use of 'non-wires solutions', where feasible, could reduce the time and cost of providing increased effective capability on the distribution system for load and generation. Also, the facilitation of 'non-traditional market arrangements' such as peer-to-peer trading, microgrids, etc. may deliver better value for our customers. Comprehensively understanding the capabilities and limitations of these new technologies and concepts through a combination of trials and analysis will ensure that ESB Networks will be able to deliver an energy system which will enable Ireland's transition to a low-carbon society.

In order to cost-effectively deliver this objective, robust processes associated with the identification of innovative opportunities for our customers and stakeholders are a key part of ESB Networks' Innovation Strategy. This requires us to consider the disruptive trends and identify how we see the energy landscape developing in the next decade and beyond. We anticipate radical changes in electricity generation, consumption and storage, including increasing levels of generation at the domestic level and the emergence of prosumers who will actively participate in the generation of the electrical power system. In order to realise this vision, we have developed an Innovation Strategy Framework (see Figure 1.3) to manage every stage of the development and implementation of our strategic initiatives, from setting the vision to establishing Business-As-Usual (BAU)[1]. In developing this Framework and our Innovation Strategy Cycle (see Figure 1.4), we reviewed best practice from other jurisdictions, worked with external consultants, engaged in workshops with representative groups from across ESB Networks and sought feedback from stakeholders to create a solution for our organisation. This framework respects that our customers, who support the cost of these projects, expect efficient and effective dividends from the innovation process. It recognises the risks and uncertainties inherent in investing in trialling untested innovation ideas and ensures an appropriate level of oversight.

[1] ESB Networks, Innovating for a Brighter Future - ESB Networks' Innovation Strategy 2017

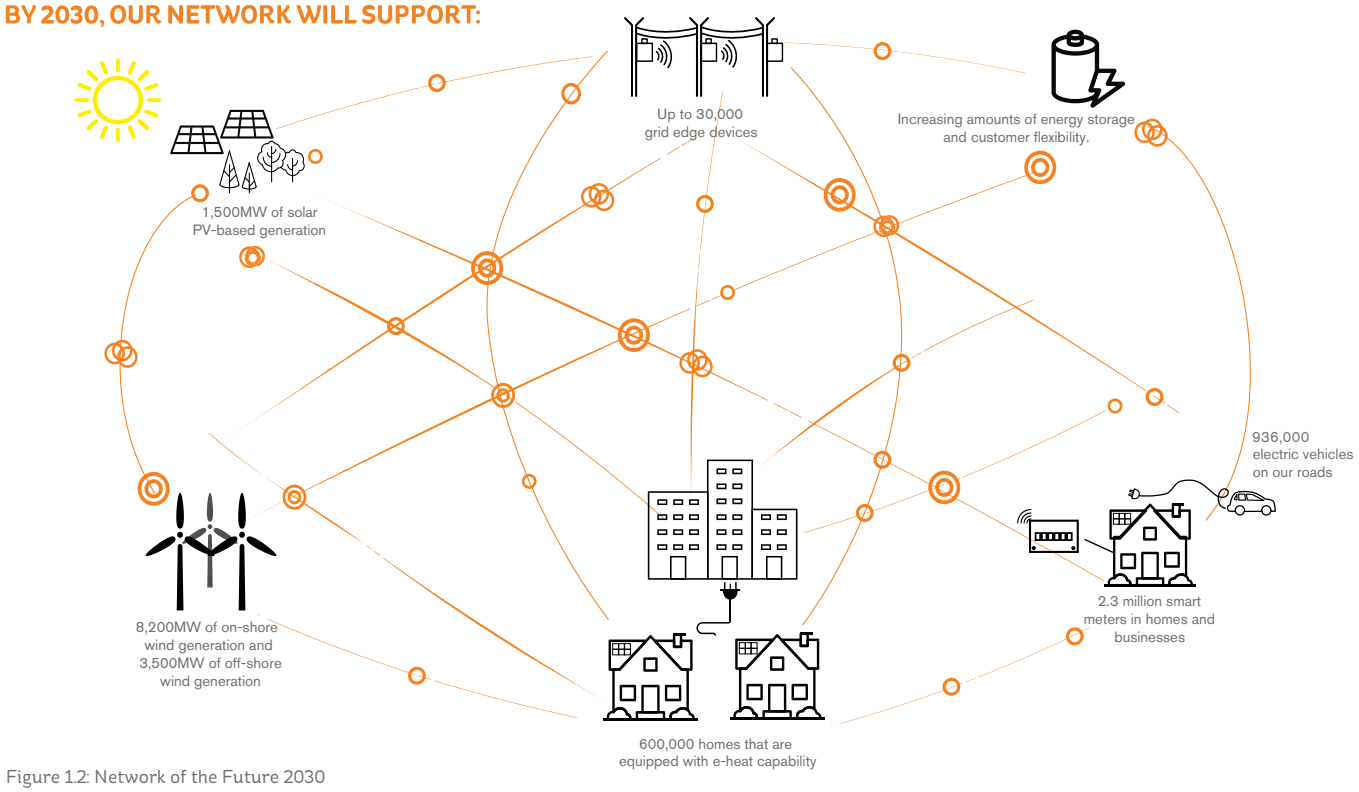

Figure 1.2: Network of the Future 2030

Governance		
• The Innovation Governance Framework outlines the governance of our Innovation Strategy • Governance is provided through our Connecting Futures Board (CFB) that owns the Innovation Strategy and operates to the terms of reference approved by the Managing Director of ESB Networks • The Innovation Steering Group is responsible for progressing issues that arise at a project level and has delegated authority from the CFB for approval of investment appraisals, certain project decisions, reports and change requests		
Project Identification and Evaluation →	**Delivery of Innovation Projects** →	**Transition to BAU and Dissemination of Learnings**
Process		
• Identifying project ideas beyond Business-As-Usual • Project prioritisation and initial assessment • Impact assessment framework • Detailed project evaluation, benefit assessment, scoping and objective setting • Strategic validation through collaboration with stakeholders and third parties	• Ongoing project assessment process to monitor project status, evolution and outcomes • Risk assessment and mitigation planning as appropriate • Active engagement with partners and wider stakeholders • Progressive project evaluation to determine project continuation, cancellation or merge with others as appropriate	• Develop and monitor transition plans to completion • Identify opportunities to extend an innovation project to achieve additional benefits • Disseminate learnings into BAU operations and/or decision-making • Disseminate learnings to industry and stakeholders
Reporting		
• Ranking of Ideas Generated • Project Proposal • Investment Appraisal • Webinars/Public Consultations	• Progress and Close-Out Reports • Hand-Over Pack • Webinars/Public Consultations	• Transition Plans • Industry Papers and Conferences • Webinars/Public Consultations
Assessment and Tracking of Benefits		
Creation	**Delivery**	**Transition to BAU**
• Qualitative and Quantitative Benefit Assessment • Cost Benefit Analysis • Measures of Success	• Qualitative and Quantitative Benefit Assessment • Cost Benefit Analysis • Measured Data from Pilots • Trial of Methods/Technologies	• Transition of Qualitative and Quantitative Benefits to BAU • Ongoing Tracking and Assessment of Benefits

Figure 1.3: Innovation Strategy Framework

1.3.2 Our Innovation Process

To effectively implement our Innovation Strategy, we have developed an end-to-end process for the management of innovation initiatives across our business areas. This process is part of our Innovation Strategy Cycle (see Figure 1.4) and has three main stages:

1. Project identification and evaluation;
2. Delivery of innovation projects; and
3. Transition to BAU and dissemination of learnings.

The structure of our innovation framework and ongoing efforts in collaboration and planning allow us to identify a comprehensive number of potential projects. Proactive engagement with stakeholders and continuous monitoring of the environment we operate in have helped to determine when projects warrant cancellation, expansion or consolidation with projects of similar strategic objectives. This reflects the dynamic nature of innovation and the fact that ESB Networks has developed a high-performing culture of innovation that values the pursuit of new ideas and opportunities.

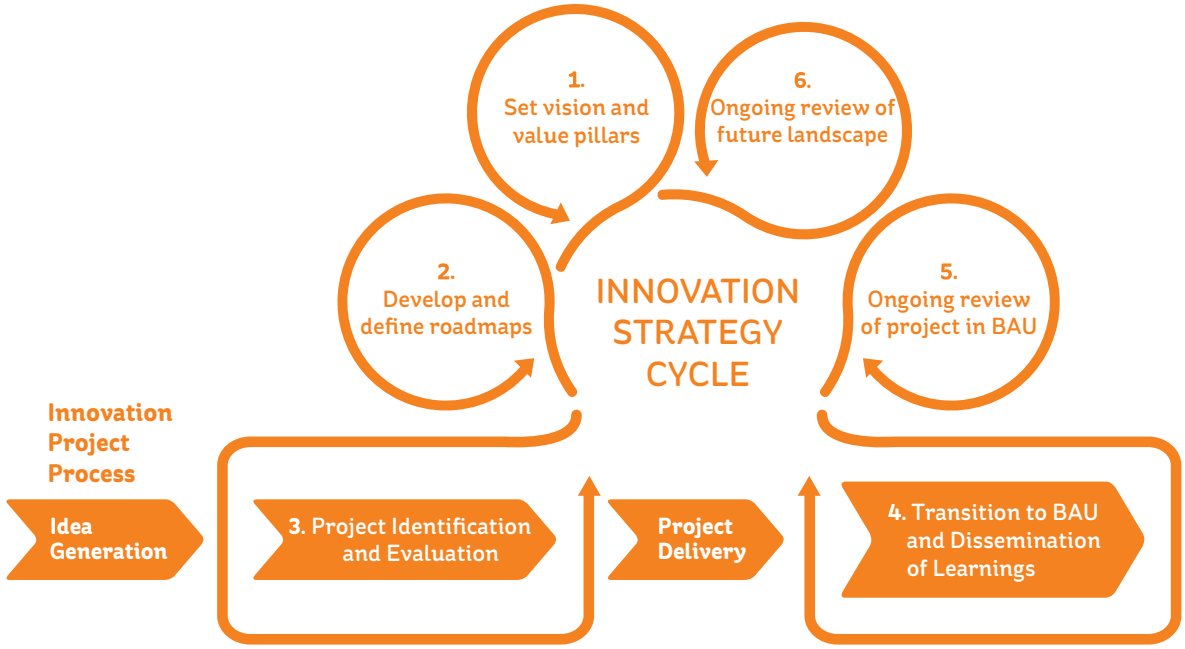

Figure 1.4: Innovation Strategy Cycle

1.3.3 Three Roadmaps: A Progression Plan To 2030 And Beyond

Our innovation strategy framework has been designed to be flexible enough to cater for the changing requirements of our business and society. The innovation framework has been applied to a balanced portfolio of projects covering three roadmaps:

Future Customer - Empowering and Supporting Customers and the Economy

Climate Action - Decarbonising Electricity, Heat and Transport

Network Resilience – Efficient, Secure, Reliable Electricity

These roadmaps align with our new business strategy, our PR5 objectives and the objectives outlined by the CRU under the Strategic Innovation Fund (SIF). ESB Networks acknowledges the need to be flexible to address future challenges which may emerge. We expect to see refinements to the projects included in each roadmap as policy priorities emerge, changes in customer behaviour manifest themselves and as forecasts for generation, flexibility and low-carbon load become more certain. In order to better reflect project groupings and to capture the objectives of each group, it has been decided that from 2021 onwards, our three Innovation roadmaps will be known as Innovation pillars. It is felt that the term better captures the idea that pillars remain constant and supporting, even though the constituent projects are dynamic.

1.3.4 Innovation KPIs Dashboard

ESB Networks' innovation efforts are broad-ranging and involve collaboration with several organisations. In order to provide the Innovation Steering Group with information about the extent of our innovation efforts, in addition to quarterly reports, a set of Key Performance Indicators (KPIs) has been developed.

Figure 1.5: Innovation KPIs Dashboard

- Of the **276** innovation ideas examined in 2020, 30 projects are in active delivery with a further six approved for delivery. 13 more are classed as pipeline projects and a further 205 projects were examined as part of our fast follower process. Over 22 more ideas were considered from various sources.
- **81** external company collaborations – a review of project and engagement records show that ESB Networks is actively collaborating with 81 organisations across a wide range of industry sectors.
- **94** staff working on innovation projects.
- **€60m** potential financial impact of ideas – this figure is compiled from the savings calculated by each project. See Section 4.2 for more detail.

1.4 GOVERNANCE AND RISK MANAGEMENT

Risk assessment and mitigation are essential to ensure that ESB Networks delivers value to network users and consumers. An integral part of managing risk and ensuring the operational success of innovation projects is maintaining an appropriate level of governance. This is provided through our Connecting Futures Board (CFB) and the Innovation Steering Group (ISG). The governance of our Innovation Strategy includes oversight of the processes which will allow ESB Networks to effectively identify, assess, monitor, prioritise and deliver the portfolio of innovation projects in accordance with our vision and values. It ensures that innovation is implemented at the right pace, is proportional to both customer and network needs, and realises nett value and benefits for all customers. Our Innovation Governance Framework document sets out the roles and responsibilities of individuals that are part of the innovation governance structure as illustrated in Figure 1.6 below. It also defines the communication channels that are expected, so that the members and Chairs of the CFB and the ISG are provided with comprehensive documentation that details project status and information.

The Sponsor of our Innovation Strategy is the Managing Director of ESB Networks, who is a member of the Senior Leadership Team. The Sponsor has ultimate accountability to ESB Networks' organisation for the successful delivery of the innovation project portfolio.

The CFB is a cross-functional group of ESB Networks senior managers that provides a common governance structure for the Business, Innovation, Customer and Digital Strategies on behalf of the Senior Leadership Team. The CFB is accountable for the overall success and governance of the innovation project portfolio. The CFB owns the Innovation Strategy and operates to the Terms of Reference approved by the Managing Director of ESB Networks. The CFB is responsible for providing guidance, coordination and decision-making regarding innovation roadmap and project direction, issues affecting delivery and changes affecting key project or roadmap outcomes.

The ISG is made up of a cross-functional group of ESB Networks managers and external advisers and is responsible for progressing issues that arise at a project level. The ISG draws upon the external advice and views of two external advisors - Lisa Vaughan, Business Development Director at Engineers Ireland and Ian Bailie, Network Development Manager at NIE Networks - in relation to projects or issues that arise. The ISG has delegated authority from the CFB for approval of investment appraisals, project proposals, project initiation documents, significant change requests and close-out/progress reports.

The common aim of the CFB and ISG is to ensure the collaborative implementation of new ideas that will provide enduring benefits for our customers.

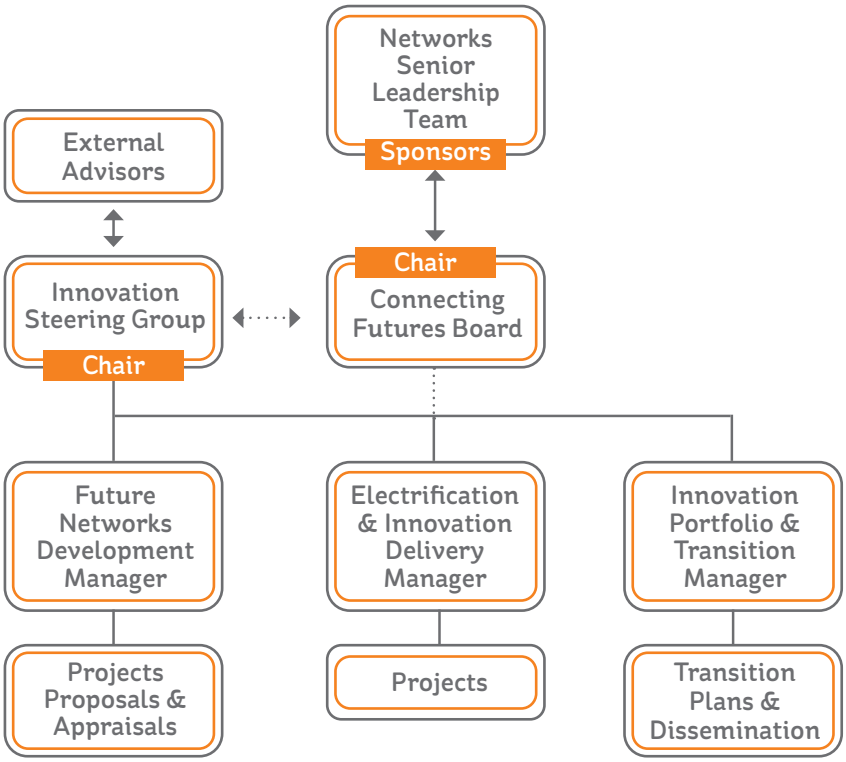

Figure 1.6: Innovation Governance Organisational Structure

1.5 STRENGTHENING INNOVATION CULTURE, EXPERTISE AND CAPACITY BUILDING

ESB Networks has already developed one of the world's most progressive and reliable electricity networks, which facilitates changes to how Ireland's electricity is produced and consumed. To ensure that the changing needs of the environment, government and society are met, ESB Networks continues to work towards the model of innovating further and innovating faster. In order to do this, we must ensure we have the right people, with the right skills and expertise, in the right place, at the right time. To meet this challenge, ESB Networks continues to enhance innovation expertise and capacity building internally through a number of different initiatives. These initiatives provide staff with appropriate training, knowledge and experience, and provide opportunities to learn about and engage on the ongoing innovation projects and international research being collaborated on.

ESB Networks Internal Innovation Community

ESB Networks Internal Innovation Community is made up of ESB Networks staff members involved in innovation across the business. Since March 2020, in place of our face-to-face forums, they come together on a regular basis to present on and participate in webinars. These webinars are used to keep staff informed of ongoing innovation activities and to encourage open discussion and feedback on our current innovation projects and potential innovation opportunities arising in different areas in ESB Networks. In 2020, we held c. 20 internal webinars; examples of some of the topics were the RESERVE Project, the Autonomous Control of Distributed Energy Resources, the Intelligent Secondary Substation Transformer Monitoring Project, and Emerging Technologies to Address Climate Change.

Research institutes such as MaREI and UCD's Energy Institute also delivered a series of webinars to our staff throughout the course of 2020 to enable knowledge transfer on several topics from subject matter experts. Topics included the use of blockchain in energy systems, the impact of heat pumps on the distribution system, data visualisation, community engagement and the diffusion of sustainability, and the opportunities provided by power electronics in future low-carbon power systems.

ESB Networks Hubsite and Yammer

ESB Networks' Internal Hub is an internal intranet communication hub and is used to communicate and share information with colleagues throughout the business across a range of areas. Yammer is a social networking platform incorporated into Office 365 to openly connect and engage across an organisation. ESB Networks uses Yammer to connect and engage with colleagues across a range of social and professional groups.

In 2020, a new section on the Hubsite, 'Innovation in ESB Networks' and a new Yammer Group, 'Innovation in ESB Networks' were both launched as platforms for ESB Networks staff to network, collaborate and share knowledge internally about innovation projects and activities in ESB Networks and the wider industry.

Training and Development Programmes

ESB Networks has devised a comprehensive Graduate Engineering Training and Development Programme to enable new starters to reach their full potential and to develop all aspects of their competencies. The programme includes modules titled Innovation, Design Thinking, The Smart Grid, Renewable Technologies and Emerging Technologies. A large portfolio of technical courses is available online and at our Networks Training Centre in Portlaoise. Our performance management process ensures staff identify gaps in skillsets and competencies on an annual basis and selects the appropriate internal and/or external training and experience to address those gaps. The innovation team is also in the process of developing proposals where ESB Networks can leverage existing partnerships (such as with the Energy Institute in UCD) to provide relevant training. ESB Networks also promotes ongoing professional development through membership and support of professional institutions such as Engineers Ireland, the Irish Management Institute and CIGRE. We have recently developed an online portal to support staff to plan and gain their chartership through Engineers Ireland. These training and development initiatives give our staff the knowledge and skillsets to innovatively build, maintain and operate the electricity network of the future for the whole of Ireland.

The Innovation Academy

In 2020, ESB Networks encouraged applications from staff to participate in the UCD-led Innovation Academy training programme, and this collaboration continues in 2021. It is delivered via a highly experiential and practical, action-based learning process built around the four pillars of creativity, collaboration, curiosity and communication. The programme is designed to build competency in customer-centric innovation. It applies design thinking and other innovation techniques to explore new solution options to real business problems facing ESB Networks. Upon completion, proposed solution concepts are considered further by ESB Networks and, where appropriate, these are progressed as projects within the business lines. For example, some of the areas that the teams looked at in 2020 were: ways to decarbonise the heating sector, opportunities in remote monitoring systems to support the management of demands of the grid of the future, and ways to improve customer visibility of the renewable connections process. The programme fosters a wealth of knowledge transfer and supports ESB Networks ambition in facilitating the transition to a low-carbon future by allowing us to explore, take risks and continue to innovate.


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X_Potential - Promoting Innovation from Within

X_Potential is a structured innovation programme, run over a thirteen-week period, supported by the innovation start-up hub, Dogpatch Labs and external innovation mentors, with visible senior management sponsorship. The training programme is designed to enable the X_Potential teams to explore innovative ideas to help create new potential business solutions. For example, one of the X_Potential ESB Networks teams in 2020 focused on using deep learning technologies to automate the review and assessment of vast volumes of asset inspection data, triggering information-based actions. Their objective was to reduce the operational costs and increase productivity in ESB Networks' asset inspection process, and ultimately resell the solution as a packaged Software as a Service (SaaS) to other Utilities and Telcos around the world.

Free Electrons Programme furthers our Innovation Strategy

Free Electrons is the global energy start-up accelerator programme that connects the world's most innovative start-ups with ten leading global utility companies to co-create the future of energy.

Through the Free Electrons Programme, ESB Networks continues to investigate new technologies and conduct pilot projects to build strong relationships with start-ups and other utilities, which will allow us to identify new opportunities to improve performance and reduce costs. The utility partners in Free Electrons are leaders in the clean energy transition, covering more than 40 countries and with access to over 80 million end customers worldwide.

Now in its fifth year, Free Electrons is known as the world's most innovative programme for promising energy start-ups. The Free Electrons members are American Electric Power (USA), AusNet Services (Australia), CLP (Hong Kong), DEWA (Dubai), EDP (Portugal), ESB (Ireland), Eon (Germany), Origin Energy (Australia), SP Group (Singapore) and Tokyo Electric Power Company (Japan).

Further initiatives that are in place in ESB Networks to strengthen innovation expertise and capacity building are detailed under Collaboration, Engagement and Dissemination in Section 2 of this report.

X_Potential Incubator Programme

X_Potential Outcomes

X_Potential Support Structure

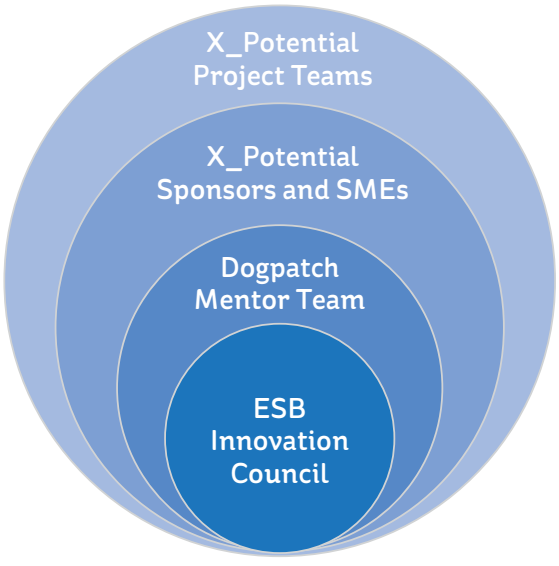

Figure 1.7: X_Potential Incubator Programme


Francis Street 110kV Station

1.6 PERFORMANCE IMPROVEMENT

ESB Networks, as an organisation, continuously seeks to assess perfomance and implement performance improvement programmes to ensure we are not just striving to but crucially are delivering on core objectives that will see us evolve as Distribution System Operator (DSO), support all of the network requirements and technologies, and deliver both value and service for all our customers now and in the future. In this same way, as a principle of how the innovation function and team are operated in ESB Networks, we seek to build on efforts to date and to continue to consider and improve on all aspects to our approach on innovation.

1.6.1 Innovation Audit 2020

In January 2020, ESB Networks commissioned an independent audit on the innovation systems and innovation governance of ESB Networks. The purpose of this was to make a comprehensive assessment of all aspects of how innovation is run as a function in ESB Networks; to identify gaps and make specific recommendations on how performance improvements could be made to both further embed and step-change operations and activities.

In Q1 2020, Dr. Frank Devitt, Associate Professor of Design Innovation at Maynooth University, conducted an audit for ESB Networks covering this scope. The methodology consisted of a wide-ranging documentation review, alongside interviews with personnel, comprising members of the Innovation Team, business unit management and senior leaders. The audit included an assessment of ESB Networks' innovation activities and operations against international best practice and comparable industry norms.

It was noted as a whole that, as an organisation, ESB Networks is clearly in transition from past operation in an environment with system size, performance and technology all changing by way of evolution. The new paradigm of revolution is characterised by rapid trends towards distributed and renewable energy sources, digital technology and data analytics capability, with very large changes in load flows and customer behaviour associated with, for example, the electrification of heat and transport. A positive sense was noted of acceptance by ESB Networks of the need to adapt to this rapidly changing environment, and substantial steps to do so are being made. In the previous 12 months, significant revisions to the Innovation Strategy Framework structure and processes were noteworthy and acknowledged by Dr. Devitt as being progressive. In this, Dr. Devitt noted consideration of feedback received from external stakeholders and through other party engagement, with evidence of a robust and tangible response to feedback and industry being treated by ESB Networks in an ongoing way. An important callout was the fact that ESB Networks, as an organisation, realises that the necessary transformation is in fact a 'journey', where progress will be achieved by continuous adaption and flexibility. It is in this vein that a number of recommendations were made as a conclusion to the audit and its suite of findings.

The Innovation Management Team considered the gaps/activities/areas of improvement that were highlighted in the audit recommendations, and distilled them into four groups to be actioned as an overall performance improvement programme.

The Innovation Team then set about working to advance the specific actions under each of the four projects to address the various Devitt recommendations and ideas, and their implementation across the Innovation function in ESB Networks. Four project teams called Working Groups (WGs), each with their own specific scope, were set up to achieve this in a concerted manner. The aim was that the WGs would collectively come up with meaningful and achievable ways to address the recommendations issued and to instigate change, improve our function and the way we work as a team. This approach was deliberate in that it involves everyone across the full Innovation Team and creates a sense of ownership and energy. Additionally, the WGs were designed to be cross-populated teams in order to maximise diversity and perspective share, allow for communication beyond immediate teams and maximise sharing of experience.

Addressing the groupings of recommendations, the four WG projects are:

1. **WG1**: Assessing Breakthrough and Radical Projects – the scope of this project was to look at defining and scoping ways to have clarity and deliver on ESB Networks' innovation mandate with better engagement across all fora, so as to be able to demonstrate (and measure) progress.
2. **WG2**: Defining and Scoping of a Number of Innovation-Centric Objectives – linked to the three innovation roadmaps, the scope of this project was to develop a number of objectives that facilitate better understanding of how various innovation projects (either in development or underway) align to the big picture.
3. **WG3**: The Way we Work Together – the scope of this project is to define and develop new tools, leverage various systems, platforms and IT-based workspaces to collate Innovation Team working practices and project detail across the entire function.
4. **WG4**: Governance and Continued Process Improvements – the scope of this project encompassed four core elements: firstly, reviewing various aspects of the Governance Structure to ensure both fit-for-purpose and embedding of continual improvement philosophy; secondly, ensuring the formulation of a protocol for specifying measures of success and expected qualitative/quantitative benefits, learnings and project outcomes for innovation projects from the onset, all of which were to feed into relevant project templates; thirdly, developing the practice and habitual consultation with business owners to ensure and embed their early and continual buy-in; and finally, developing a process by which feedback from our external Innovation Stakeholder Panel could be considered and embedded.


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Throughout summer 2020, each of the WGs developed their projects and various progress meetings (staged from development of a Minimum Viable Product (MVP), decision gateway and then onward development) were held with the full Innovation Team and management. Subsequent to this, the Innovation Management Team met and agreed the actions to be delivered, the resourcing requirements and a phased implementation approach through to end of 2020 and into 2021. WG1, WG2 and WG4 successfully completed their scope of work by the end of 2020, while WG3 commenced implementation in Jan 2021; this project has a larger scope of work and will be delivered in 2021.

The Innovation Management Team considered this two-phased approach to be the best way to proceed with both implementing the recommendations for improvement, in view of resource level/effort, and indeed capturing this in the first instance as a body of the completed work for year end 2020 reporting.

1.6.2 Innovation Management Framework Assessment

In 2015, a UK innovation consultancy was engaged to undertake an initial assessment of innovation maturity using their standardised methodology across ESB Group. This innovation maturity assessment methodology has been adopted by each ESB Business Unit since 2018 to ensure a consistent measure of innovation performance. The framework assesses innovation maturity across a range of criteria as seen in Figure 1.8 below. The assessment uses a scoring of 1 to 4 based on the level of maturity.

In line with this approach, ESB Networks undertook an Innovation Maturity Assessment in 2020 based on a review by ESB Networks managers from across the organisation along with external innovation specialists. Workshops were then held to review these scores with all assessors to ensure consistency of approach. In 2020, ESB Networks increased its score across all categories and increased its total overall score to 71.1%. The output of the assessment included recommendations and highlighted areas for improvement, particularly in the areas of people and culture, and metrics. These recommendations will feed into the performance improvement initiatives that are ongoing in the innovation function.

Figure 1.8: Innovation Maturity Assessment Criteria

2 COLLABORATION, ENGAGEMENT AND DISSEMINATION

2.1 COLLABORATION AND ENGAGEMENT

Stakeholder collaboration and engagement are essential parts of our Innovation Strategy and take place at each step of our innovation process. ESB Networks collaborates with a wide range of stakeholders including academic institutions, government entities and organisations, industry trade associations, electricity suppliers and generators, as well as new energy actors such as Demand-Side Units (DSUs) and battery storage providers. We acknowledge that the challenges posed by the transition to a low-carbon economy are substantial, and a collaborative approach to addressing these challenges is essential. We believe we have a role to support our external partners' research and innovation activities that are likely to make contributions to Ireland's targets for decarbonisation. Furthermore, we acknowledge that enabling the connection of greater levels of renewables, electrification of heat and transport and active energy citizens can only be achieved by collaborating and engaging with our external partners, stakeholder and customers.

In late 2020, ESB Networks launched the Active System Management (ASM) project to fundamentally and innovatively transform how we manage and operate the electricity distribution system. This will involve actively managing demand and generation within an overall market framework, to enable distribution renewables, communities and demand response and storage providers to actively participate in the electricity system. Given its transformational role across our business and the need for its implementation as Business-As-Usual in the medium term, this initiative has been established as a dedicated multi-year project as per the approach taken with the Smart Meters Rollout, and will involve extensive collaboration with stakeholders over the coming years.

In the feedback to our last consultation on innovation, we noted the request for the ability for stakeholders and customers to apply for representation on external stakeholder advisory groups. As a result, we established an Innovation Stakeholder Panel to provide a platform to enable open discussion and feedback with stakeholders from across all industry sectors on our innovation strategy, projects and activities. Following a call for expressions of interest in October 2020, 19 members across 10 stakeholder sectors were selected based on a number of criteria including diversity of sector and experience. In November 2020, the Terms of Reference were published on our website and in December 2020, the first Innovation Stakeholder Panel meeting was held. During this meeting, presentations and interactive discussions were held on ESB Networks' innovation projects and activities and on the topic of electrification of heat and transport. We also had an open feedback session with the panel members as to how we can make the panel a success.

2.2 COLLABORATION AND ENGAGEMENT WITH ACADEMIA AND RESEARCH ORGANISATIONS

ESB Networks continues to have extensive engagements with academia across all areas of energy innovation. In order to better understand the choices our customers are making and the choices they would like to see us make, we have been working with UCD and the MaREI at University College Cork (UCC) on, for example, the Dingle Project, to better understand what techniques are most effective in diffusing active energy citizen behaviours across society.

To understand the digital services and platforms of the future energy system and how they can support customer interaction, we have been working with Technological University (TU) Dublin and Waterford Institute of Technology (WIT). To understand the future tools and services that we could use to enhance reliability on our networks, we are working with University Limerick (UL) on Autonomous Drone Technologies. To understand the capabilities, services and roles of customer sited Distributed Energy Resources (DERs), we are working with UCD's Energy Institute in their Integrated Energy Laboratory. We also concluded research into fault location technologies as part of the SOGNO project in which we collaborated with over 20 European partners to bring better fault performance to our network.

Other academic and research institutions that ESB Networks collaborates with include:

- UCD, WIT Telecommunications Software and Systems Group (TSSG), LIT, UL, UCC MaREI and National Microelectronics Applications Centre, NUIG
- International Energy Research Centre (IERC), Ireland
- EA Technology, UK
- Tipperary Energy Agency (TEA), Ireland
- Norges Teknisk-Naturvitenskapelige Universitet (NTNU), Norway
- Novogrid, Ireland
- Polito - Politecnico di Torino - Polytechnic University of Turin, Italy
- Universitatea Politehnica Din Bucuresti (UPB) - Technical University of Bucharest, Romania
- Rheinisch - Westfaelische Technische Hochschule Aachen (RWTH) - German Research University
- University of Bologna, Italy
- Teeside University, UK
- University of the Aegean, Greece
- Tekniker, Spain
- Fraunhofer Institute, Germany
- Uppsala University, Sweden
- Austrian Institute of Technology
- Institut Mihajlo Pupin, Serbia
- Université de la Réunion, Réunion, French Overseas Department

2.3 COLLABORATION WITH IRISH AND INTERNATIONAL ORGANISATIONS

ESB Networks also undertakes significant external collaboration with Irish electricity suppliers, generators and other external international parties/companies to support their research and development. It can be said that, as standard, the majority of our projects feature an element of industry involvement and various levels of collaboration.

2.3.1 Active collaboration

During 2020, we collaborated with these international organisations:

- Utilities: Western Power Distribution, Northern Ireland Electricity, Scottish and Southern Energy Networks, Electricity Northwest, AusNet and Edison Electric.
- ENA (Energy Networks Association) – workshops and conferences including ENA's Open Networks Project which is looking to the development of the DSO to cater for future requirements.
- Two dedicated intra-utility MoUs on innovation with:
  - NIE Networks
  - New York Power Authority and EirGrid with EPRI acting as secretariat.

ESB Networks also actively collaborated with these Irish organisations in 2020:

- Industry representative bodies – quarterly meeting with DRAI and IWEA; providing keynote and panel speakers to the IWEA Annual Conference.
- Commission for the Regulation of Utilities (CRU) – in relation to various innovation activities, PR4, PR5 and project-specific issues such as Load Indices (an output from the Smarter HV and MV Customer Connections project).
- During 2020, we issued letters of support for research proposals, issued for various grant funding applications (and the award of which is as yet unknown):
  - UCD for their 'Intelligent Data Harvesting for Multi-Scale Building Stock Classification and Energy Performance Prediction' project.
  - UCC / MaREI for their 'OPENGRID' project.
  - The NRG Learning Hub – a border region partnership investigating clean energy and innovative technologies amongst other activities.
  - IERC's 'HI Storage' project.
  - Interreg Tentacl(es) 2 project.
  - EU H2020 / Cordis 'Cyber resilience of EPES containing legacy systems' project.
- Bord Gáis Energy (BGE) and TEA – discussed the Dingle Electrification Project and Air Source Heat Pumps
- ESB Networks is a member of the National Standards Authority of Ireland's (NSAI's) Technical Committee 20 on Smart Grids, Renewables, Electric Vehicles (EVs), Energy Efficiency and Energy Storage.
- As part of the development of the Electrification of Heat and Transport Strategy, we engaged with external stakeholders to inform the development of the innovation strategy itself.
  - We held a number of bilateral meetings with key stakeholders including Sustainable Energy Authority of Ireland (SEAI) and the Local Government Management Agency.
  - We issued a consultation on the draft Electrification of Heat and Transport Strategy.
  - We held a webinar and Q&A session on the draft Electrification of Heat and Transport Strategy.
- ESB Networks was part of the Advisory Group for Engineers Ireland's 'State of Ireland 2020' with the report published in October 2020.

In Q4 2020, in parallel to several other joint working groups and initiatives, ESB Networks, in our role as Transmission Asset Owner, worked collaboratively with the TSO to review new technologies for use in their Technology Toolbox for future transmission network planning and development. A programme for each asset category (Overhead Lines, Underground Cables and Stations) is currently under development to outline the steps required to transition these technologies to Business-As-Usual. This Technology Toolbox will facilitate the increase in renewable connections, hand in hand with the transition to a low-carbon energy system. ESB Networks will continue working with the TSO into 2021 and beyond to achieve the CAP 70% renewable energy target for 2030.

2.3.2 Presentations, Conferences and Workshops

ESB Networks personnel attended and presented at meetings, conferences and workshops during the year with a view to sharing innovation project learnings and strategy:

Organisation(s)	Type	Topic
Government Departments, Industry Lobby Groups, Suppliers, Generator Owners and Academics	Webinar	Series of innovation topics – see Section 2.6 below
RECI and Engineers Ireland	Briefing	Electrification of heat and transport, microgeneration, community energy projects and aspects of the Dingle Electrification Project
Annual Power Summit, Croke Park	Panel Session	Integration of renewable energy systems
CODEMA (Dublin Local Authorities Energy Management Agency) and Dublin Chamber	Briefings	Energy zones, district heating, energy policy for county and regional development plans, heat maps, capacity in Dublin, innovation and our electrification of heat and transport strategy
EPRI	Workshops	Power Delivery and Utilisation Winter Advisory Meetings - Awarded an innovation Technology Transfer Award for the Network Resilience Innovation Project. Attendance at the European Workshop week (online)
450 MHz Alliance, EU Joint Research Council, EUTC and Tech UK	Telecoms Conferences	Shared learnings from 'National Radio Access Network' Project
Engineers Ireland	'Festival'	Promoting STEM subjects
ABB	Presentation	New innovation technologies
CIRED	Workshop	How to Implement Flexibility in the Distribution System
Eurelectric	Workshop	DSO development
CIGRE Sessions	Workshops / Seminars	TSO-DSO Co-Operation – Control Centre Tools Requirements ESB Networks Smart Grid Spectrum Licence Control Centre Tools for Flexibility CIGRE Study Committee – provided subject matter experts Presentation on delivering electrification and innovation during the pandemic
UCD ESSIP	Workshops	Energy Systems Integration
Distribution Code Review Panel (DCRP)	Presentations	Regular presentations on innovation projects at the quarterly DCRP meetings
ENA – ENIC	Conference	Attendance at the Energy Networks Association's (ENA's) Energy Networks Innovation Conference (ENIC); this conference was previously known as the Low-Carbon Networks and Innovation Conference
Network	Conference Presentation and Panel Session	Presentation at the Network Asset Performance Conference: Co-innovating with Customers to Develop a Network Asset Base to Enable Decarbonisation Panel Session: Optimising Asset Performance for the Long-Term
Edison Electric Institute	Webinar	The Dingle Electrification Project: Innovation for Ireland's Energy Transition

Table 2.1: Presentations, Conferences and Workshops

2.3.3 Publications

In 2020, ESB Networks personnel authored or co-authored a number of peer-reviewed, published papers and articles. These are listed below with ESB Networks personnel in bold:

1. **Hearne Tony**, Corcoran David, Val Escudero M., Delaney C., Rafferty M., (2020); Co-ordinated Approach between TSO and DSO for the Utilisation of Voltage Control Resources using Distributed Wind Generation in Ireland; CIGRE E-Sessions
2. **Hearne Tony, Pollock Jonathan**, Morais H., Reilly J.; TSO-DSO Co-Operation – Control Centre Tools Requirements; CIGRE E-Sessions
3. **Walsh Tony**, Burges Karsten, Warncke Kristina, Gschrey Barbara; Power Transformer Efficiency – Survey Results and Assessment of Efficiency Implementation; 5th International Colloquium on Transformer Research and Asset Management. Lecture Notes Book Chapter Electrical Engineering (LNEE volume 671)
4. **Walsh Tony** and working group contributors; ENTSO's 2020 TYNDP Scenarios Consultation; Eurelectric Response Paper
5. Carroll Paula (UCD), **Lyons Pádraig**, Chesser Mike (UCD); Air Source Heat Pumps Field Studies: A Systemic Literature Review; Elsevier – Renewable and Sustainable Energy Reviews
6. Carroll Paula (UCD), Chesser Mike (UCD), **Lyons Pádraig**, O'Reilly Padraic; Probability Density Distributions for Household Air Source Heat Pump Electricity Demand; 10th International Conference on Sustainable Energy Information Technology (SEIT), Leuven, Belgium; Vol.175, 2020:468-475
7. **McGeough Karen** and CIGRE D2 working group contributors; Book Chapter: Information Systems and Telecoms; CIGRE Green Book: Electricity Supply Systems of the Future; CIGRE D2 Working Group
8. Carroll Paula (UCD), Chesser Mike (UCD), **Lyons Pádraig**, O'Reilly Padraic; The Impact of Extreme Weather on Electricity Demand from Homes Heated by Air Source Heat Pumps; 8th Conference on Renewable Energy Systems, Istanbul
9. **Lyons Pádraig, Hearne Tony**; Impact of Fast DS3 System Services on the Operation and Planning of the Distribution System; ESB Q3 Ezine
10. **Mulvey Paddy**; National Radio Access Network Project, Trials and Spectrum Acquisition; ESB Q1 Ezine
11. **Pukhrem Shivananda**, Chandran Chittesh Veni, Basu Malabika; Application of Demand Response to Improve Voltage Regulation with High DG penetration; Electric Power Systems Research Volume 189.
12. **ESB Networks**; Assessment of the scope for Higher Penetrations of Distributed Generation on the Low Voltage Distribution Network, published to ESB Networks' website, July 2020
13. **ESB Networks**; The Dingle Electrification Project: Sharing the Learnings from the Peer-to-Peer Energy Trading Objective, published to ESB Networks' website, December 2020

2.4 COLLABORATION CASE STUDY: SOGNO

ESB Networks aims to bring advancements in technologies and processes made in other jurisdictions to customers. One of the ways this is done is by engaging with European-funded projects such as the SOGNO Horizon 2020 project. This project comprises a consortium partnership of 13 organisations that include European and Irish energy, telecoms and research organisations.

The SOGNO project was completed in 2020. The main objective was to present and demonstrate a completely new model of automation of electrical distribution systems, based on the delivery of "automation as a service". This concept builds upon the use of limited (and low-cost) hardware in the field and the full virtualisation of the substation intelligence in the cloud. To successfully demonstrate the value and the practical feasibility of the concept, five power system services were designed, tested and validated in DSO field trials and laboratory trials in Estonia, Germany, Ireland, and Romania to TRL 6.

As part of the trial in Ireland, ESB Networks supported project partners (RWTH Aachen, Gridhound and TSSG) to pilot state-estimation, power quality evaluation and FLISR (Fault Location, Isolation and Service Restoration) technology on areas of the Irish distribution system. To enable this pilot, ESB Networks deployed distribution system monitoring technology from Altea and MAC, as well as ESB Networks' own SCADA system, to provide data to the algorithms running in real-time in the cloud. These trials were critical to delivering the learning objectives of the overall project.

While the SOGNO project's final reporting documentation will be approved and made available through the SOGNO website, ESB Networks has published the SOGNO Project Close-Out Report that relates specifically to its involvement in the Co. Waterford and Co. Westmeath trial sites.

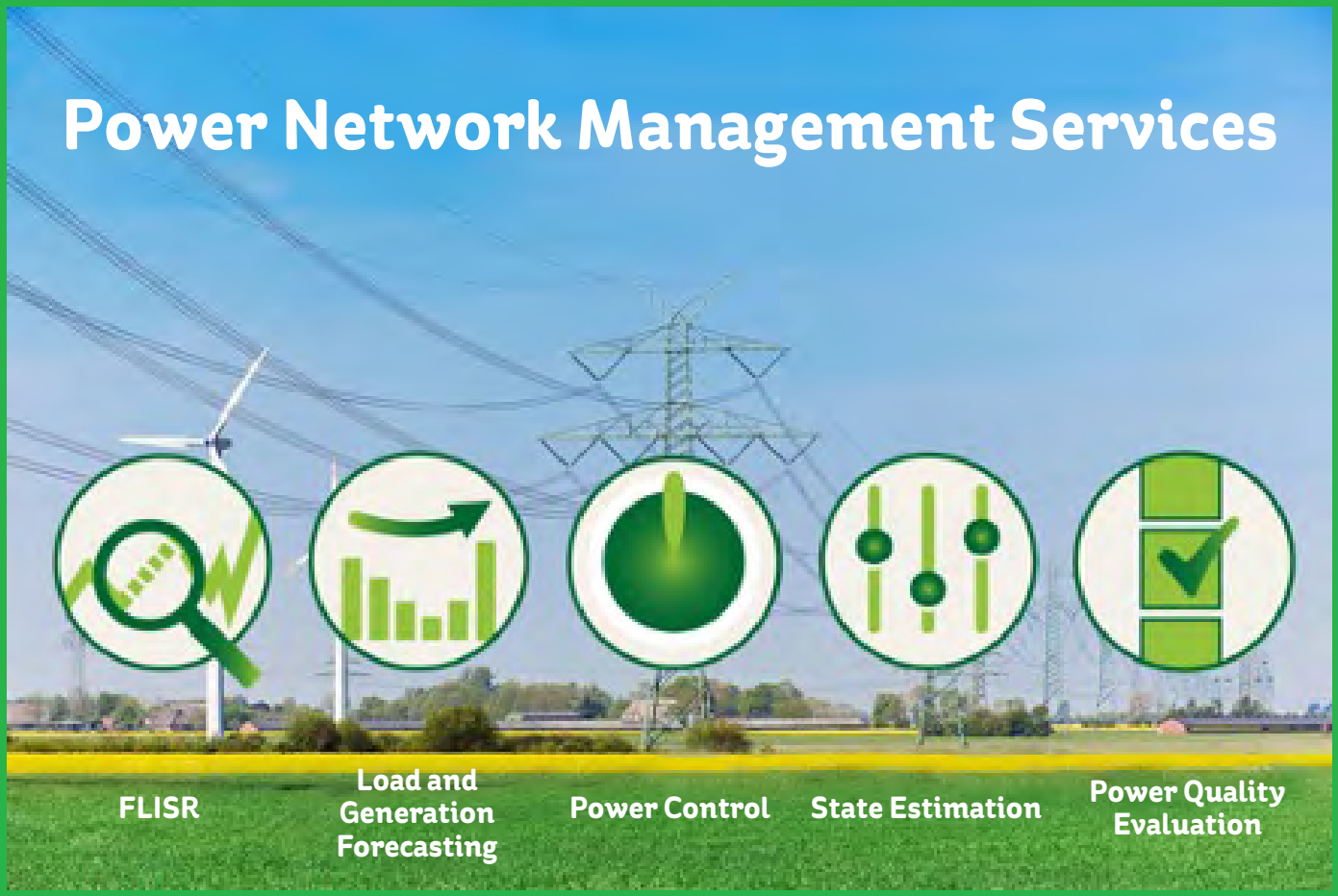


Figure 2.1: SOGNO Network Management

2.5 DISSEMINATION OF KNOWLEDGE AND LEARNINGS

The distribution system is evolving to support Ireland's transition to a low-carbon economy. Throughout this transition, ESB Networks will ensure that customers and stakeholders remain at the centre of our business. Listening to and engaging with customers is key to understanding their needs and preferences as to how we develop the network and deliver services.

At a range of industry events throughout 2020 and through a variety of channels, ESB Networks focused on engaging with our stakeholders who were either impacted by our innovation activities, or who may have had an influence on them. The purpose was varied, ranging from seeking feedback to informing terms of references and project approaches, to sharing updates on project progress and plans, to disseminating knowledge and learnings from projects to the wider industry. These channels of engagement included bilateral meetings, our revamped website, public consultations and our Innovation Webinar Series.

2.5.1 Bilateral Meetings with Stakeholders

As part of our ongoing engagement with stakeholders throughout 2020, we held various bilateral meetings and workshops as outlined in section 2.3.2. We received 19 responses to our Innovation Consultation, 'The Network of the Future', which had been published in February 2020. As part of our response to this feedback, we offered bilateral meetings to each of the respondents and extended the offer to additional interested stakeholders. As a result of this, we held several interactive sessions with stakeholders including Energia, MaREI, TU Dublin, DRAI and SSE Airtricity.

In order to encourage a deeper engagement with electricity suppliers, ESB Networks had organised an interactive session with suppliers in December 2019 with the aim of getting feedback on our innovation activities. One of the key takeaways was that the group were interested in how suppliers can collaborate further with ESB Networks. In response to this, we offered a session with each supplier's innovation team. This offer was extended via the Electricity Association of Ireland to any suppliers outside those represented at the meeting. As a result, we held several bilateral meetings with electricity suppliers in Q2 and Q3 2020 to bring them up to speed on our innovation activities, to hear about the challenges suppliers are facing and the solutions they are working on, and to look at potential areas where we may work together in the future.

2.5.2 ESB Networks' Website

During 2020, the innovation section of ESB Networks' website was revamped and updated to increase transparency of our innovation activities. This included revamped sections on ESB Networks' innovation projects including the Dingle Electrification Project, and a new section on electrification. The section on ESB Networks' innovation projects was developed to include our latest Innovation Consultation and our pipeline projects. Eight additional innovation project reports along with two project-specific videos on the RESERVE and SOGNO Projects were uploaded. Project reports will continue to be published under the relevant roadmaps as they become available. The purpose of this is to continually disseminate the learnings and benefits from our completed and ongoing innovation projects to industry and stakeholders. A new section on electrification went live in July 2020 to inform the public on how ESB Networks is facilitating the electrification of heat and transport. This section guides the public to relevant information on EVs, Photo-Voltaic (PV) systems and heat pumps. Also, in response to stakeholder feedback to our last innovation consultation, we have published a Project Portfolio Summary Report to share high-level project data on our current innovation projects with stakeholders.

The 2020 website improvement initiative aligns with our Stakeholder Survey results, where stakeholders ranked our website second to webinars as the preferred channel for dissemination of information on our innovation activities. For more information on Innovation in ESB Networks, please visit our recently updated innovation section of our website, Innovation in ESB Networks

2.5.3 Public Consultations

ESB Networks is committed to consulting publicly about its innovation activities annually. Last year we published the following public consultations:

1. Innovation for the Network of the Future – Feb 2020
2. Microgeneration Framework Consultation – May 2020
3. As part of the HV and MV Smarter Customer Connections Project:
   a. Distribution System Security and Planning Standards – September 2020
   b. Non-Wires Alternatives to Network Development – September 2020
   c. Non-Firm Access Connections for Distribution Connected Distributed Generators – September 2020
4. MV Customer Connection Standard Module – Electric Vehicle Charging Hubs in Urban Environment – July 2020
5. Electrification of Heat and Transport Strategy – October 2020

6. New Solutions for Distribution System Interfaces for Public On-Street EV Charging – December 2020
7. MV Customer Connection - MV EGIP Standard Module Substation – December 2020
8. Capacity Provision for Growth in Microgeneration Connections – December 2020

Following a number of requests through our consultation feedback and bilateral meetings with stakeholders, ESB Networks plans to publish an industry consultation on our Open Data Policy in 2021, where we will welcome feedback on our proposed approach to sharing data.

2.6 DISSEMINATION OF LEARNINGS CASE STUDY: INNOVATION WEBINAR SERIES

In November 2019, ESB Networks hosted its first Innovation Forum, an event which allowed us to share information and discuss our innovation projects and activities with our stakeholders. This, the inaugural event, was the first of our Spring and Autumn Innovation Forum series, with another that was scheduled for April 2020.

Unfortunately, due to the timing and impact of COVID-19, we were unable to proceed as planned with this event. However, in the spirit of innovation we looked at how best to continue our engagement opportunities, resulting in the rollout of our Innovation Webinar Series.

In spring 2020, we held our first Innovation Webinar Series, featuring the webinar topics listed below, which were selected based on stakeholder requests and consultation feedback. Representatives from government, industry, academia and representative associations attended and participated throughout the series.

#	Spring Innovation Webinar Series
1	ESB Networks' Network Flexibility Project
2	The Dingle Electrification Project - Peer-to-Peer Trial
3	ESB Networks' Innovation Project Identification and Evaluation

Table 2.2: Spring Innovation Webinar Series

When planning for our Autumn 2020 Innovation webinar series, to best serve our stakeholders and to ensure that we were hosting webinars on topics that were of interest to them, we issued a survey providing 11 topic options, allowing stakeholders to vote on their preferences.

The Autumn Webinar Series then reflected the top five topics chosen by our stakeholders, listed below. We also asked our stakeholders whether they wanted these webinars delivered all in one session, or through one webinar per week. 73% selected one per week, and as a result, the series was scheduled and delivered in this way.

#	Autumn Innovation Webinar Series
1	Compact Standard Modules for Electric Vehicle Charging Infrastructure Connections
2	Electrification of Transport
3	Active System Management Programme - Delivering the Future DSO
4	Interactive Session on ESB Networks' Pipeline of Innovation Projects
5	The SOGNO Project – Smart Monitoring for Increased Resilience

Table 2.3: Autumn Innovation Webinar Series

The five successful webinars were hosted over a five-week period and came to a close on October 15th. Throughout and at each stage of the webinar series, we sought feedback and engagement using an interactive presentation tool which has informed our innovation projects and activities. The feedback showed that webinars are the preferred choice of communication channel for dissemination, and the innovation webinar series successfully increased stakeholders' awareness and understanding. A stakeholder survey carried out in October showed that 93% of the 45 respondents believed their understanding of ESB Networks' innovation projects and activities had increased or somewhat increased over the previous 12 months.

We look forward to continuing the Spring and Autumn Innovation Webinar series in 2021, with the selection of topics being developed through engagement with our stakeholders.

3 PROJECT IDENTIFICATION AND EVALUATION

3.1 OVERVIEW OF PROJECT IDENTIFICATION AND EVALUATION

The process from idea identification to project delivery includes project identification, evaluation, scoping and approval stages:

Figure 3.1: Project Identification and Evaluation

1. **Identifying Project Ideas Beyond Business-As-Usual**
   - Innovation ideas are initially reviewed to ensure that the scope of the idea proposed is to trial a technology or concept that is beyond BAU.
2. **Project Prioritisation and Initial Assessment**
   - Innovation ideas then go through an initial assessment and prioritisation for further investigation and scoping against five criteria: Lifecycle Savings Potential; Time Frame/Complexity; Core Competencies; Strategic Fit and Innovation Type; and Customer Need and Demand.
3. **Impact Assessment Framework**
   - As projects move from pipeline to scoping, an Impact Assessment Framework is applied to evaluate the impact across six strategic areas:
     - Safety;
     - Network Reliability and Resilience;
     - Facilitating Growth and New Connections;
     - Customer and New Market Services;
     - Environment; and
     - Social and Sector Learning.
4. **Detailed Project Evaluation and Benefit Assessment**
   - Once the ideas have passed these early reviews and assessments, they are scoped out and an investment appraisal is developed for each project. The investment appraisal includes a detailed benefit analysis; this is a qualitative and a quantitative analysis where possible. If the investment appraisal deems the project viable, then a project proposal is developed with clear project objectives for recommendation to the ISG for transition to project delivery stage.
5. **Strategic Validation Through Collaboration with Stakeholders and Third Parties**
   - Innovation ideas and projects are validated throughout the project lifecycle through collaboration with stakeholders and third parties.

Given the interest shown in feedback to our consultation 'Innovation for the Network of the Future' on the above process and our CBA methodology, we held a dedicated webinar on our Project Identification and Evaluation process in May, where we brought a sample project through the various steps, from Project Prioritisation and Initial Assessment right through to a detailed CBA. Through an online poll at this webinar, we learnt that 46% of our stakeholders felt that our governance and our identification and evaluation process was in line with industry best practice, while 54% felt we were somewhat in line.

3.2 IDENTIFYING PROJECT IDEAS BEYOND BUSINESS-AS-USUAL

The innovation framework that ESB Networks has put in place requires those proposing innovation projects, and in particular incremental innovation, to reflect on whether their idea is over and above BAU and would not be done by the business in the normal course of events.

This report deals with innovation as defined in the Oslo Manual as a technological innovation, a business process innovation or an innovatory combination of a business process and technological change. Innovation is not considered to be a minor change or routine improvement in BAU. Such changes, which may be quite worthwhile and deliver significant economic benefit, are not covered in this report.

The project proposers/sponsors assess their innovation idea using standard templates and as such are required to consider the following:

1. What are the benefits/savings potentially associated with the project? These benefits may, where appropriate, be considered from a whole system perspective.
2. What options or alternatives exist?
3. What are others in industry doing about the same issue?
4. What are the risks associated with not pursuing it?

The assessment process and appraisal of the innovation idea, including reflecting on these four questions, provides ESB Networks with the confidence that the approved innovation projects have exceeded an appropriate hurdle threshold and are beyond simple Business-As-Usual. It also enables us to prioritise our innovation projects.

It should be noted that later in the evaluation and approval process, project proposals may be rejected by the Innovation Steering Group as they may be deemed insufficiently innovative. In these cases, they can continue to be executed as BAU projects.

3.3 INNOVATION PIPELINE IDEAS

New innovation ideas are sourced from a variety of channels, e.g. from stakeholder engagements, including responses to public consultation; from the innovation teams' activities; more broadly, from staff within the business; and from potential collaborators and partners contacting ESB Networks directly.

Innovation pipeline ideas are project ideas that have been deemed to be beyond BAU and thus to be innovative. These ideas have not gone through the Project Prioritisation and Initial Assessment process stage, but are under consideration by ESB Networks. Our current project ideas are listed below with their assigned ESB Networks Project Reference Numbers:

Future Customer

- Assess Performance of Existing Commercial Battery Installation in Regard to Facilitating Increased DER (ref: 165)
- Investigate Scope for Managed Charging in Connection Contracts (ref: 200)
- Trial Future Grid Approach to Transformer Load Monitoring Using Smart Meters (ref: 166)
- Active Power Curtailment for Overvoltage Prevention in Microgenerators (ref: 176)
- Export Limitations on Microgeneration (refs: 110, 111, 203)
- Identify New Use Case for Smart Meters and Smart Meter Data (ref: 140)
- Investigate Feasibility of Dynamic EV Charging to Defer Conventional Network Reinforcement (ref: 199)
- Trial Future Grid Approach to Transformer Load Monitoring Using Smart Meters (ref: 166)
- Investigate Feasibility of Three-Phase Connections for Upgrades to Domestic Premises with High Loads (ref: 175)

Climate Action

- Modification of MV Voltage Drop Calculations by New Load Models Validated by Trial Data (ref: 110)
- Investigating the Impact on Rapid EV Charge Points on Power Quality of the Distribution System (ref: 167)
- Optimal Voltage Management Across Voltage Levels MV to LV Distribution Networks (UCD ESIPP) (ref: 212)

Network Resilience

- Application of Real Options to Alternative Network Investment Decisions (UCD ESIPP) (ref: 217)
- Develop Dynamic Line Ratings (DLR) for HV using Westnetz approach (ref: 190)
- Source and Trial an LV Pole Mounted Sectionalising Switch Which can be used to Reconfigure LV Overhead Networks (ref: 115)
- Trial of Fused Minipillar (to ensure correct protection on long, heavily loaded LV Cables using graded sub-fusing on the network) (ref: 198)
- Consider Development of 15 and 33kVA Ester Filled SP Transformers with Scope for Short Term Overloading. (ref: 114)
- Investigate Scope Available for Use of Single-Phase MV/LV Transformers with Voltages in Excess of 244V (ref: 201)
- Investigate Scope for Dynamic Rating of MV/LV Transformers (ref: 116)
- Application of Real Options to Alternative Network Investment Decisions (UCD ESIPP) (ref: 217)

3.4 PROJECT PRIORITISATION AND INITIAL ASSESSMENT

3.4.1 Overview of Project Prioritisation and Initial Assessment

In order to carry out an initial assessment and preliminary ranking of project ideas, prior to more detailed consideration, a simple set of criteria outlined below is used to score the projects.

Life Cycle Savings Potential	The potential for a project to generate revenue/cost savings within five years. In general, the revenue/cost savings are to ESB Networks on the basis that ESB Networks represents customer's interests, but significant savings to other stakeholders within the electrical energy system from innovations/changes in practice by ESB Networks would also be considered if they provide an overall societal benefit.
Time Frame / Complexity	How soon can we get the product/service out in the market, or how complex/difficult will the project be?
Core Competencies	What capabilities can be leveraged internally; processes, assets and values?
Strategic Fit and Innovation Type	Horizon 1, considered to be core strategy. Horizon 2, natural evolution of services that ESB Networks could offer in adjacent areas (called out in strategy). Horizon 3, products or services not traditionally associated with ESB Networks and transformative (not explicitly called out in strategy).
Risk	What is the expected level of risk of the project in relation to the likelihood of project completion and the delivery of expected benefits in relation to costs?
Customer Need and Demand	How relevant is the product/service potentially and is there known demand within five years?

Table 3.1: Initial Assessment Criteria

A screening matrix (see Table 3.2 below) for shortlisting project ideas is used. The process is intended to provide clarity to the assessors and allow a common evaluation method for projects across all roadmaps and areas. During subsequent consideration, other requirements may emerge which change the ranking, e.g. one project may have little direct benefit itself but may be an enabler of other projects with significant benefits.

Weighting	Score	1	2	3	4	5
4	Lifecycle Savings Potential	Under €200k	€200 - €500k	€500 - €750k	€750-€1,000k	Over €1,000k
1	Time Frame/ Complexity	Over 5 years	4 to 5 Years	3 - 4 Years	2 - 3 Years	Under 2 Years
3	Core Competencies	100% External	75% External	50% External	25% External	0% External
4	Strategic Fit and Innovation Type	Unaligned		Adjacent		Core
4	Risk	High		Medium		Low
5	Customer Need and Demand	Under 10%	10 - 25%	25 - 50%	51 - 75%	Over 75%

Table 3.2: Screening Matrix for Initial Assessment of Project Ideas

The projects which emerge from this initial screening process are then subjected to a Detailed Project Evaluation and Benefit Assessment in the next stage to confirm that they will provide long-term value to our customers and/or our other stakeholders.

3.4.2 Process Improvements for 2021

During 2020, we received feedback via webinars, bilateral meetings and consultations in relation to the appropriate split between Incremental, Breakthrough and Radical innovation projects and the TRL levels ESB Networks should prioritise.

Furthermore, the Innovation Audit report suggested that the screening process for Incremental innovation projects, as opposed to Breakthrough or Radical ones, should be different. This report observed that, for Incremental innovation projects, most screening criteria can be accurately evaluated so that the risks are low, the time for implementation is short and the benefits can be estimated correctly. Furthermore, development of Incremental ideas will typically lie within ESB Networks' core competence and capabilities.

In contrast for Breakthrough or Radical projects, it was observed that the current screening approach might be inappropriate as the concepts associated are new and much less predictable; forecasting their success is very difficult and hence they will have higher risk and longer timescales. They are likely to require competencies outside ESB Networks' capability and may require greater involvement of other stakeholders. However, such ideas, when successful, can yield very high returns.

The Audit also highlighted that it might be useful if ESB Networks was to set a broad target split between Incremental, Breakthrough and Radical innovation projects that would be considered appropriate for an organisation of its size and resources. For example, a split of 70%:15%:15% between the three categories might be considered, and this would also be broadly in line with the poll response we received from participants at our webinar in October 2020 on ESB Networks' Pipeline of Innovation Projects.

Based on this feedback, we are proposing to have separate screening processes for Incremental and for Breakthrough and Radical innovation projects. It is expected that the number of Breakthrough and Radical projects to be screened will be much less; therefore, it will be possible to use a more qualitative form of assessment.

Whilst the exact metrics for the screening process have yet to be finalised, a high-level view of the criteria which ESB Networks are considering for the assessment of Breakthrough and Radical ideas is shown below in Table 3.3. We would welcome feedback from our stakeholders on this approach.

Criteria	Description
Idea/Project Sponsor	In Breakthrough / Radical projects, there is relatively little prior knowledge. Therefore, the reputation, track record and knowledge of the ideas sponsor is a critical part of the innovation idea/project assessment.
Feasibility / Realisability	Is the idea understandable and intuitively understandable as a good idea? Are the technical and economic assumptions underpinning the idea or project correct? Will it lead to other opportunities? Will it develop core competencies? Does it require competencies outside ESB Networks and are appropriate partners available to provide those competencies?
Meets Customer Needs	Does the idea meet a customer need or requirement? Ideas/concepts/technologies are more likely to be successful if they meet existing or future customer needs.
Scalability	Can the idea be scaled? The value of the idea is greatly increased if it can scale in volume and scope.
Degree of Fit to ESB Networks' Strategy	ESB Networks' strategy is designed to meet national requirements within areas of ESB Networks' responsibility – if not aligned with ESB Networks' Strategy, then it is possibly a project for another entity to carry out.
Costs / Benefits and Resource Availability	Costs and benefits should be proportional to the risk involved and should be within the budgets and resources available to ESB Networks.

Table 3.3: Proposed Initial Assessment Criteria for Breakthrough and Radical Project Ideas

An interesting aspect of this review was that, in assessing the benefits of Incremental projects, they tend to lie primarily within ESB Networks, whereas for Breakthrough projects, they are probably shared between other stakeholders and ESB Networks, e.g. 'Flexibility' might benefit ESB Networks from investment deferral but also benefit customers selling flexibility services (see Figure 3.2 below). Accordingly, it was decided that the return expected would be more heavily weighted towards the Societal return rather than the return to ESB Networks.

In response to stakeholder feedback from our last innovation consultation, we reviewed the suggestion of applying a System Readiness Level (SRL) to the shortlisting process for project ideas in place of the TRL scale currently used.

Following an assessment by the innovation team of both SRL and TRL, we propose to initially screen and shortlist project proposals applying a TRL. This is an international standard, and most project proposals can be given a TRL according to well-established criteria, whereas SRL is much less widely used. Application of the SRL would require a more detailed assessment of each project at screening stage to assess whether they would fit into ESB Networks' ecosystem, and this would be excessive for initial screening. On selected projects where an investment appraisal is carried out, the concepts of SRL are already incorporated along with many other factors, but at this stage we believe SRL screening is not required as multiple issues are considered in the Investment Assessment, including 'readiness' levels.

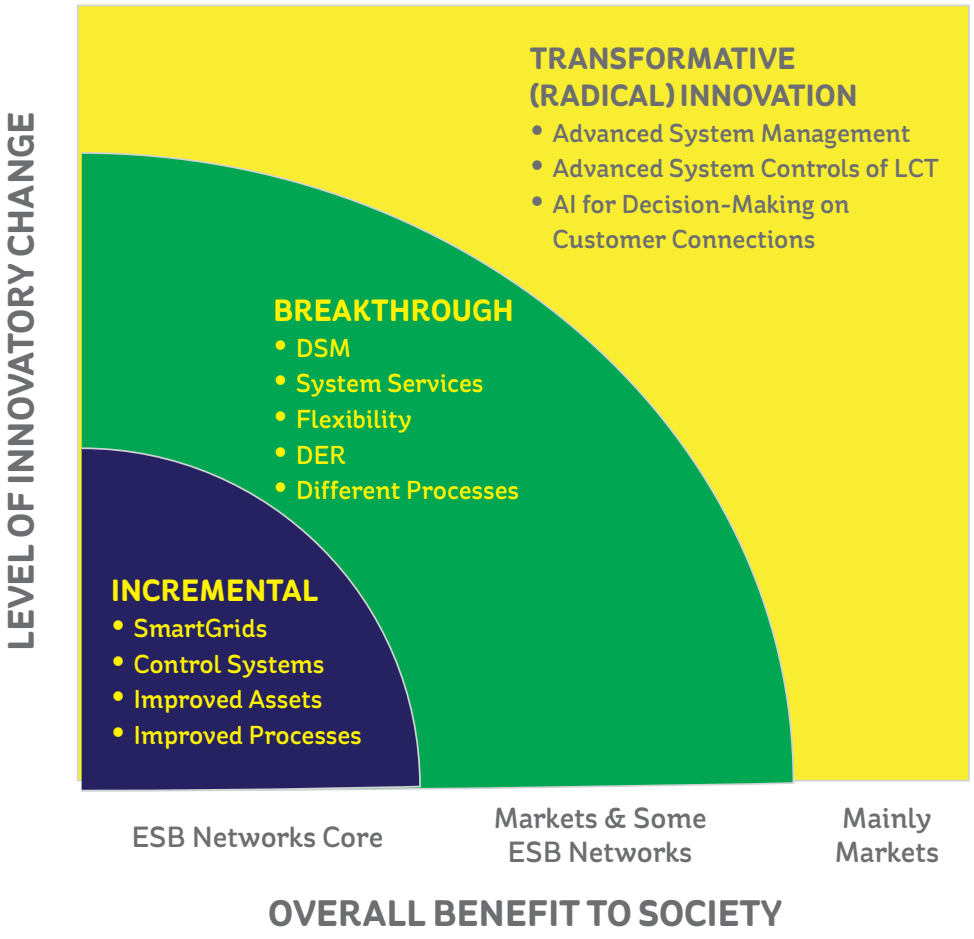


Figure 3.2: Impacts of Incremental, Breakthrough and Radical Projects

3.5 PIPELINE PROJECTS

Projects that have come through the initial assessment and are currently in ESB Networks' pipeline of possible future innovation projects are listed below. These pipeline projects have been proposed as they address the challenges identified by our Innovation Strategy and provide benefits to customers. However, they are in the pipeline and have not been formally evaluated and approved as innovation projects. We anticipate that a number of these pipeline projects which are interrelated and fall under the area of active system management will be implemented under the overarching ASM project. A list of the projects which were in the pipeline in 2020 are listed below:

Pipeline project	Project description
Novel Use of Drone Technology and Artificial Intelligence for Line Patrolling (ref: 150)	Informal trials of a drone in Dublin South would indicate promise for the use of drones for quick response damage assessment during fault hunting/fault follow up, investigation of intermittent faults on overhead lines and follow-up quality checks on timber management contracts. Further development where drones will be flown Beyond Visual Line of Sight (BVLOS) and artificial intelligence (AI) will be used to assess the data captured to optimise the patrolling process. An Investment Appraisal (IA) is currently being prepared to assess this proposal, taking into account recent experience with experimental use of drones by ESB Networks staff.
Identification of Network Configurations for Active Network Management (ANM) (ref: 151)	Using existing infrastructure and enabling quicker connections for generation are critical in enabling the targets set in the Climate Action Plan for electricity generation from renewable resources. Active Network Management has been identified as having the potential to achieve the objectives cost-effectively with limited impact on the volume of renewable generation produced.
Development of Robust Low Voltage (LV) Models for the Future Network Planning and Operations Required to Facilitate Active Energy Citizens (ref: 152)	ESB Networks, in common with most utilities worldwide, does not have a detailed, accurate geographical or electrical model of its LV networks and thus significant visibility of its LV infrastructure. ESB Networks proposes to develop an innovative framework that will assist in the creation of LV models and assess the potential of a variety of sources of data that might be used to inform and populate the LV models.
Developing and Trialling Novel Approaches to Manage LV Flexibility (ref: 154)	ESB Networks is currently collaborating with the TSO on planning trials for LV-connected flexibility. Significant volumes or clusters of flexibility in LV networks could result in congestion in areas of the LV network. Costs are dependent on the deployment location, and delivering an optimum solution in all cases is complex. In order to understand the capability of smart management solutions, trials would be carried out to assess their capability and practical implementation.
Framework for the Optimal Coordination of Network Management Systems (NMS) and Distributed Energy Resources (DER) (ref: 205)	Network capacity is a finite resource and should be used to maximise societal benefits. The scope for innovative connection methods, demand-side response and flexibility will strongly depend on the access rights of loads/generators being optimal and delivering the greatest benefit to the overall energy system. This project would consider these principles and what might be applied in other areas, such as in the allocation of hybrid connections or in peer-to-peer trading. The IA for this project is currently under development.

Pipeline project	Project description
Congestion Management and Capacity Allocation using Operational Management System (OMS) (ref: 156)	Demand-Side Units (DSUs) are aggregated market players, and they comprise a portfolio of Individual Demand Sites (IDSs), which are usually distribution connected. The activation of some of these sites can potentially cause congestion on the distribution system. To mitigate against this, sites are instructed to refrain from activating these sites for the summer months. However, this approach results in some IDs being unavailable for long periods during those summer months. To reduce these periods of unavailability, ESB Networks and NIE Networks have agreed a joint use case and are collaborating with an OMS vendor. There would be a trial programme involving the procurement and testing of the Distributed Energy Resource Management System (DERMS) module, together with a phased transition from the current connectivity model, to a fully populated electrical model with load flow and state estimation.
Development of Optimised LV Design Framework to Enable a Unified Mobile Support Application (ref: 157)	To best deliver designs, ESB Networks staff use a number of tools and applications to extract data from the organisation's databases and make assessments of key planning metrics such as voltage drop and transformer capacity. Providing an application that unifies and simplifies these processes should ensure consistency of approach and enable them to complete the design more efficiently and accurately. Providing this support to ESB Networks staff will become more critical in the future as the challenges in LV design become more varied (electrification of heat and transport, impact of harmonics, microgeneration and flexibility) and the solutions become more numerous and complex (both physical and flexibility solutions such as new transformer options, Demand-Side Response (DSR), new connection options etc.).
Developing 400MHz Spectrum Use for Smart Grid Applications (ref: 158)	ESB Networks has acquired a licence for the use of the 400MHz spectrum to deploy private, secure, resilient communications at a national level, using cost-effective radio equipment to facilitate the rollout of Smart Grids. To deliver best value to our customers, ESB Networks needs to leverage the benefits from the use of this secure spectrum in terms of standardised communications interfaces and modules on ESB Networks' infrastructure. This project aims to investigate this further and develop solutions for implementation, including power quality monitoring, non-secure network access, active network management, MV/LV substation load and generation monitoring, active coordination of EV charging, and microgeneration.
Electrification Uptake Data Analytics Forecasting (ref: 160)	The distribution network has considerable capacity to accommodate electrified heat and transport; however, there will be areas of the network which are already heavily loaded or where clusters of EVs or heat pumps emerge that will require smart solutions or reinforcement. This project will focus on developing and refining sophisticated forecasting tools to predict where the network may need support. There are several datasets that feed into this forecasting tool and thus we are looking to collaborate with external stakeholders, including SEAI and the Economic and Social Research Institute (ESRI), to support this development. The datasets that will support the development of the forecast models include: • Domestic electricity revenue meter data • SEAI grant data including electric charge point installations and heat pump installations • CSO socio-demographic data • Smart meter data (as appropriate and legal) • Qualitative and quantitative data from academia • Trials and pilot data from other jurisdictions • EV and heat pump sales data

Pipeline project	Project description
Provision of Optimised Design for 38kV Arc Suppression Coil (ASC) to Support RES Connections (ref: 164)	This project aims to investigate different modifications to the design of the Arc Suppression Coils (ASCs) and the changeover switch for wind farm connections in order to facilitate a reduced cost of connection and improve system protection for our generation customers. This project requires scoping with a change in the specification to be drafted, but new ASCs will only become available after the next procurement tender.
Voltage Allocation Between MV and LV (ref: 102)	Network reinforcement is required when the voltage drops below standard, with the level of voltage drop being proportional to the load. This means that adding additional load such as EVs and heat pumps will cause greater voltage drop and hence drive a need for more reinforcement. However, an alternative approach to reinforcement on the LV system would be instead to improve voltage regulation on the MV system which could be more cost-effective. This project looks at the possibilities of using MV voltage regulators to more tightly manage MV voltage excursions and hence allow greater increased LV voltage regulation, with less need for reinforcement.
Impact and Facilitation of Microgeneration in Various Scenarios (ref: 202)	Generation connected at LV results in voltage rise and in an increase in harmonics on the LV system, so that at higher penetration levels, power quality standards may be breached. Understanding when and where microgeneration will occur will be key to the development of a strategy to cost-effectively enable these connections. This key output of this project is a strategy to innovatively enable and manage the connection of microgeneration up to 2030 and beyond.
Assessment of LV Rural Overhead Infrastructure for Upgrade to 1,000V (ref: 42)	In Finland and parts of Norway, where domestic electrical load is very high and fed on an overhead LV network, it has been found to be economical to convert areas of LV to operate close to 1,000V. This gives a very large increase in power due to the squaring effect of the voltage and improves the strength of the network in relation to power quality equipment. In turn, it does not tend to produce issues such as high harmonic voltages or large voltage dips. LV Overhead lines are normally voltage rated up to 1,000V, so the main issues for assessment are those surrounding economic feasibility.

Table 3.4: Pipeline Projects

3.6 IMPACT ASSESSMENT FRAMEWORK

As part of the investment appraisal process, ESB Networks has developed an impact assessment framework. This is a set of scorecard metrics (see Table 3.5) used to evaluate the impact of the proposed initiative across six strategic areas: Safety; Network Reliability and Resilience; Facilitating Growth and New Connections; Customer and New Market Services; Environment; and Social and Sector Learning. Each innovation opportunity is assessed against the six strategic areas as either Significant, Moderate, Minor or Non-Applicable.

Project Impact Scorecard Metrics	Description
Safety	Safety to staff, contractors and general public
Network Reliability and Resilience	Improved continuity, reduced outages and Customer Minutes Lost (CML)
Facilitating Growth and New Connections	Growth in electricity consumption and additional connections to system
Customer and New Market Services	Consumer, prosumer, cost of supply, future peer-to-peer trading, facilitating future market services and models
Environment	Climate change and climate change adaptation, external impacts
Social and Sector Learning	Customer service, public policy, ESB Networks' role in leading transition to lower-carbon economy

Table 3.5: Impact Assessment Framework – Six Strategic Areas

3.7 DETAILED PROJECT EVALUATION AND BENEFIT ASSESSMENT

Innovative technologies or concepts which have the potential to support a lower-carbon energy system, reduce costs for customers, and improve system reliability are sought by the Future Networks Development team. Our Innovation Strategy Framework and innovation process acknowledges that the cost of our innovation projects which investigate these ideas is supported by our customers. Therefore, robust governance and risk management is in place to ensure projects run efficiently and effectively, and deliver value for money.

Our thorough approach to screening has been outlined in earlier sections. All projects need to successfully go through the project pipeline selection process and a standard investment appraisal before any technologies or concepts are trialled. This approach limits the risk of conducting trials which may not provide benefits or savings.

At this stage in the process, the project scope and investment appraisal are developed. In order to assess project benefits and establish clearly defined measures of success at the outset, qualitative and, where possible, quantitative analysis of the costs and benefits of all innovation projects are carried out. These are captured in the investment appraisals and / or dedicated CBAs. The assessment and tracking of benefits continue throughout each stage of the project lifecycle.

We undertake CBAs in a consistent and transparent manner based on discounted cashflows. Our CBAs demonstrate a positive cost benefit when the resulting Cost Benefit Ratio (CBR) is greater than one. In situations where ESB Networks considers qualitative assessments only, success is measured by clearly defined project objectives, outputs and benefits recorded at investment appraisal stage. These defined outputs and benefits are then used as the baseline metric to measure success throughout the project lifecycle.

3.8 STRATEGIC VALIDATION THROUGH COLLABORATION WITH STAKEHOLDERS AND THIRD PARTIES

As detailed in Section 2, our customers and key partners including the CRU, national and EU government departments, local communities, the TSO, academia and industry are key stakeholders throughout the identification, delivery and transition to BAU of a project. As part of project evaluation, where appropriate we engage with key external stakeholders to ensure alignment with their needs and requirements to enable the transition to a low-carbon economy. This can take the form of engaging with projects initiated externally, e.g. +CityxChange or the Wind Farm Reactive Power Optimisation Trial, or it might take the form of bilateral meetings, webinars and consultation events which took place, for example, as part of the MV Customer Connection Standard Module for EV Charging Hubs Project (see Section 3.9).

3.9 VALIDATION CASE STUDY: MV CUSTOMER CONNECTION STANDARD MODULE – ELECTRIC VEHICLE CHARGING HUBS

The objective of this project is to evaluate new innovation approaches for MV/LV substations for large EV charging customers. This will explore the use of modular solutions (see Figure 3.3) to increase the efficiency and speed of EV customer connections. This approach will reduce the overall footprint of the substation and also reduce construction on site when comparing to a conventional MV block-built substation building.

It is acknowledged that the design and implementation of a new standard of MV/LV substation cannot be done in isolation. To support this activity, a number of engagement activities have been completed with stakeholders to validate the objectives and proposed solutions in this project. In July 2020, ESB Networks held a meeting with Western Power Distribution to learn about how they are dealing with the increased demand in EV charging in the United Kingdom. As well as engaging with other utilities, we have also engaged with EV charging customers to learn about what challenges they are facing as the advancement in EV charging technology increases.

After engagement with other utilities, EV charging customers and vendors, ESB Networks created a consultation document, MV Customer Connection Standard Module – Electric Vehicle Charging Hubs in Urban Environment in August 2020 and made this available on our public website in August 2020. The consultation document briefly outlined the challenges ESB Networks and customers face with the increased demand in EV charging, the proposed solution ESB Networks was offering, and details of a proposed trial(s) with a customer. Consultation closed on the 30th of September 2020.

During the consultation period, as part of ESB Networks' Autumn Webinar Series, a webinar was held on the 17th of September. Stakeholders were invited to both answer and ask questions during the webinar via an interactive presentation tool. The collaborative engagement, both from the consultation document and from the webinar, provided the project team with further opportunities to validate the proposed solution and listen to feedback from stakeholders.

ESB Networks has received written expressions of interest from two customers who are looking to participate in a trial in early 2021. The project team will now work closely with these two customers for the upcoming trials.

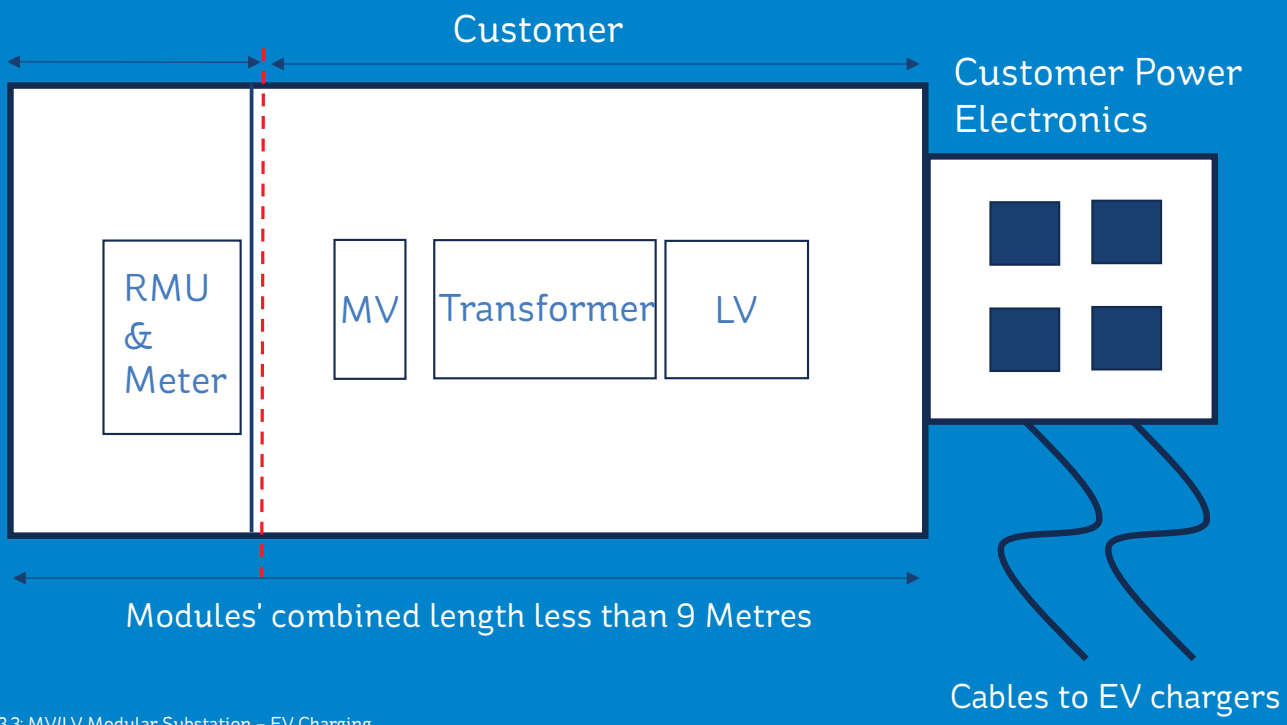


Figure 3.3: MV/LV Modular Substation – EV Charging

3.10 FAST FOLLOWER APPROACH

ESB Networks 'Fast Follower' approach reviews new solutions/ technologies that have been trialled by other utilities and which may be feasibly transferred for use by ESB Networks in Ireland.

This approach seeks to leverage research and innovation that has already been implemented by other comparator utilities. It offers opportunities to adopt and/or adapt such solutions for Irish circumstances, cognisant of the fact that the Irish electricity network has characteristics that are not necessarily replicated elsewhere. These somewhat unique characteristics include the challenges associated with having almost six times as much overhead line rural network per capita as most other European countries, combined with having large amounts of non-synchronous generation on an islanded system with substantially less interconnection than the vast majority of comparable jurisdictions. As such, a simple 'Plug and Play' approach to innovation outcomes successfully achieved elsewhere may not always be applicable on our system. Nevertheless, given the size of our organisation in the context of global innovation efforts, ESB Networks believes it worthwhile to leverage successful innovation outcomes from others wherever possible, and that it should offer value for money for our customers.

In some situations, ESB Networks may not be in a position to directly implement suitably identified 'Fast Follower' projects. It may still be required to trial the solution due to particular characteristics of the Irish system, but significantly reduce the trial scope and timeline in doing so, thereby making best use of our innovation resources.

The essence of the 'Fast Follower' approach is to identify successful innovations that have been successfully implemented in other utilities and then replicate them within ESB Networks. Firstly, sources of such potential 'Fast Follower' ideas must be found, and the ideas assessed to establish if they are suitable for transposition to ESB Networks. Other utilities have technical requirements which may be subtly different to those of ESB Networks, so the apparent success of an idea elsewhere does not directly establish whether it will be suitable for use in Ireland.

An initially identified source of possible 'Fast Follower' ideas were the innovation projects carried out by many UK utilities as part of an OFGEM innovation initiative, where documentation is relatively accessible. There was a large volume of projects documented, generally of large size, with some projects completed, some in process and some abandoned. It was decided to filter the project list down to projects at TRL 7 or above, as these would be commercially available and had a higher chance of success. This resulted in over 130 individual projects that had to be read through and assessed to come up with three projects (less than 3%) which were deemed suitable for use as a 'Fast Follower'. These included:

(a) Use of a thermal camera to establish the location in the ground of recent LV Faults;

(b) Use of a phase identification device to establish the phase feeding a remote premises; and

(c) Use of geotagged photographs from customers identifying the location of network faults and the equipment involved, facilitating faster reconnection.

Taking on board feedback from our last consultation, we decided in the next stage of this fast follower review to expand beyond UK projects to utilities in other jurisdictions such as Australia and Asia. This next stage of our review will commence in 2021.

3.11 FAST FOLLOWER CASE STUDY: SSE NETWORKS TOUCAN PROJECT

A particular case which illustrates the transposition of a Fast Follower Innovation is the example of the UK Distribution Network Operator (DNO) SSE Networks (SSEN) Innovation Toucan project which used thermal cameras to identify the location of an LV fault on an underground cable, where the fault tends to heat up the surrounding ground creating 'hotspots'. This means that if underground cable fault 'hotspots' can be identified on the ground by using the thermal camera to identify the fault location, it would avoid unnecessary digging and save time in locating and subsequently repairing the fault.

Following the fast follower review, contact was established with SSEN in the UK, who provided a review of the trials they had undertaken, and the success with their innovation project which had subsequently transitioned into Business-as-Usual in SSEN. During the NIA funded project, SSEN carried out an initial assessment of thermal imaging cameras using modelled pavements with different backfill materials, each with an embedded cable, before establishing the heating effect arising from an LV fault created on a test network.

SSEN used this test platform for extensive testing on over a dozen thermal imaging cameras to establish which was both most appropriate for detecting hotspots and user-friendly for staff. They found that one of the cheaper and simpler thermal imaging cameras was best.

Having established the likelihood of success, SSEN then carried out extensive field trials to prove the concept and the fault location process using a selection of low-cost cameras. The trials successfully proved the concept and process worked, identifying a relatively low-cost camera which is effectively paid for from the cost savings associated with detecting the location of one cable fault. They then instituted it as a standard tool and process within their fault location policy.

Figure 3.4: Thermal Cameras

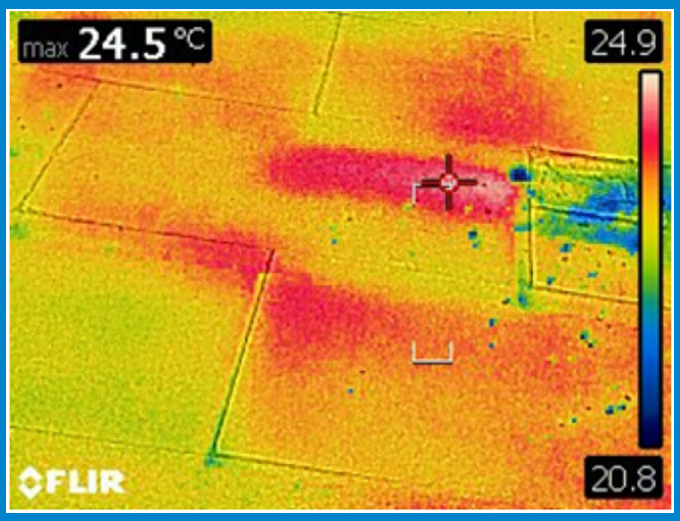


Figure 3.5: Thermal Fault Hotspot

From an ESB Networks perspective, the benefits of this innovation project which took SSEN three years to complete are available to ESB Networks to be immediately implemented as a 'Fast Follower' project. The first batch of cameras have been purchased to start the Fast Follower implementation process.

3.12 PROJECT PROPOSAL TO TRIAL / PILOT

Following successful completion of the assessments outlined in the earlier sections, an innovation pipeline idea can make the transition to an innovation trial or pilot project with an approved scope and clear measurable deliverables. In some cases, an innovation trial or pilot project may not be required and the 'Fast Follower' approach may be used.

Our robust approach to project identification and evaluation enables us to deliver the optimum mix of projects that have CBRs (Cost Benefit Ratios) greater than one, provide maximum impact and deliver long-term benefits to the operation of a low-carbon electricity system powering the decarbonisation of domestic heat and transport.

4 INNOVATION PROJECT PORTFOLIO AND DELIVERY

4.1 DELIVERY OF INNOVATION PROJECTS

All of the innovation activities undertaken by ESB Networks are guided by the Innovation Strategy Framework that is in place since 2018, providing an appropriate level of process, governance and accountability across the entire innovation lifecycle, from the setting of vision through to the transition to BAU. It includes our Innovation Strategy Cycle and our Innovation Governance Framework. It recognises the particular risks and uncertainties inherent in investing in innovation projects that trial or pilot new technologies or concepts for the distribution system. The strategy seeks to quickly establish the viability of new technologies or concepts, in order to minimise unnecessary costs, by using a robust selection and evaluation process that deselects innovation projects that evaluate technologies or concepts that are unlikely to deliver enduring value to our customers, and prioritises those that are more likely to deliver benefits in the short- to medium-term when transitioned to Business-As-Usual (BAU). Throughout both 2019 and 2020, ESB Networks continued to develop its process and portfolio of innovation projects as per our innovation strategy, which is aligned to the SIF incentive mechanism objectives.

Having received appropriate assessment and scrutiny by the Future Networks Manager and the ISG, projects are prioritised according to our governance framework outlined in Section 1.4. Following this defined process and rigour, innovation projects are then passed to the Delivery Team as and when they are approved by the Innovation Steering Group (ISG). Section 1.3 details our innovation process. Where resources and time allow, those projects with the highest priority are attended to first.

In general, projects approved for delivery are then assigned to a Project Manager in one of two ways. Firstly, a Project Manager who becomes free after completing a previous project may be tasked to lead a new project for delivery. The project managers available to the Delivery Team are experienced Project Managers who have completed several innovation projects. They also have a breadth of experience that includes other engineering and energy infrastructure projects. They are specialists in their fields, familiar with best-practice Project Management methodologies, and are well placed to adopt the most suitable methodology and approach to deliver the designated project. Alternatively, a project may be assigned to a specific business unit for execution and delivery. In this case, the project is not delivered by the innovation team as it is deemed that the business unit is the most suitable and best-placed vehicle to do so. In this case, the Innovation Secretariat functions as the interface with the business, whereby project tracking, reporting and dissemination are all managed, with the detail of the innovation activities captured, recorded and relayed accordingly.

Project risks are usually identified and called out in the investment appraisal stage, and these are reviewed by the Project Manager at delivery stage kick-off. As projects progress, those risks are monitored, mitigated and reported. Where additional risks emerge or are identified by the Project Manager in the project delivery stage – depending on the scale and scope of the project – these are added to the risk log and where these are significant, the ISG is notified. This approach ensures appropriate risk management principles are applied throughout.

4.2 ASSESSMENT OF BENEFITS AGAINST COST

Projects that are approved by the ISG will have had an investment appraisal completed for them, and the benefits anticipated at completion will be identified. Project Managers report on these as the project proceeds and note their achievement, or otherwise, in regular periodic project reports.

Savings from innovations trialled and piloted in our innovation projects are tracked, and a rolling overall figure is compiled. We have estimated that the lifetime savings that could accrue from our current portfolio of projects underway is €60m. This figure includes:

- Projects that afford one-off savings to ESB Networks
- Projects that deliver an ongoing multi-year saving to ESB Networks
- Projects where the savings are proportional to the actual uptake of the product. On a conservative basis, low uptake assumptions have been made to determine the savings for these projects
- Projects that provide a saving to the customer (without any saving for the company).

Some projects make only a small or no financial contribution to overall monetary savings; however, they make significant contributions to society, knowledge accumulation and learnings.

4.3 INNOVATION PROJECT PORTFOLIO OVERVIEW

The Innovation Steering Group (ISG) receives a report on a quarterly basis that outlines the status of each innovation project. The report contains some graphs (see example in Figure 4.1) which allow board members to quickly see project statuses and understand how the innovation programme is progressing.

4.4 FUTURE CUSTOMER ROADMAP

Empowering and Supporting Customers and the Economy: This roadmap consists of projects that focus on enabling customers to transition from a passive customer to an active energy citizen. Key activities will be enabling energy communities, facilitating the connection of microgeneration and energy storage, and investigating how we can enable customers to actively participate in the energy market and provide energy system services.

The following outlines the portfolio of projects either undertaken or underway by ESB Networks and which are attributable to the Future Customer Roadmap.

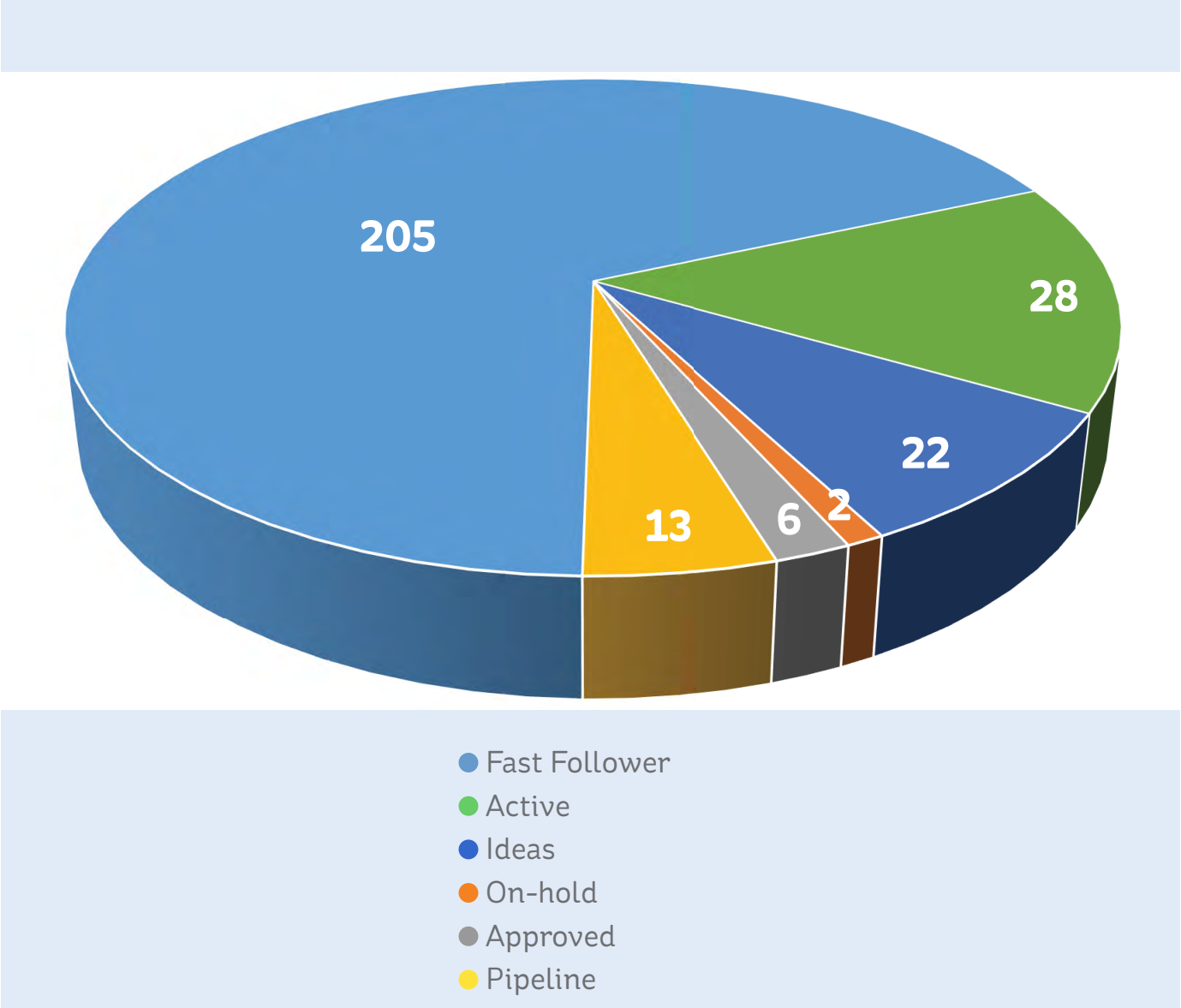


Figure 4.1: Q3, 2020 - Breakdown of Project Status

4.4.1 Dingle Electrification Project (ref: 59)

Status: Ongoing **Project Timeline: Q1 '18 – Q1 '22**

Key partners / stakeholders: MaREI, Molteic (Dingle Creativity and Innovation Hub), and the Tipperary Energy Agency

Overview: The Dingle Electrification Project will see the deployment and implementation of a range of new technologies to evaluate their capability to support the development of a smart, resilient, low-carbon electricity system. An important element of this project is the opportunity it allows ESB Networks to collaborate with local communities, as we explore both the impact and capabilities of new, low-carbon technologies and how customers and communities interact with these new energy systems.

ESB Networks sought to develop a peer-to-peer (P2P) energy trading trial to understand the role that P2P has to play in enabling the Active Energy Citizen and the operation of Local Energy Communities, and the adopting of renewable technologies. ESB Networks also wanted to gain an understanding of the impact of P2P from a network facilitation perspective. The development of the trial methodology during 2020 culminated in the issuing of an expression of interest which, unfortunately, attracted a poor response and did not result in the appointment of a trial partner. As the appointment of an electricity supplier partner was a prerequisite for ESB Networks, it was decided not to proceed with the trial.

A report, The Dingle Electrification Project: Sharing the Learnings from the Peer-to-Peer Energy Trading Objective has been published which details the significant learnings obtained and efforts made in relation to our P2P activities during 2019 and 2020. ESB Networks remains open to considering, where invited, its future participation in supplier-led P2P energy trials, in order to help understand the impact of P2P on the operation of the distribution network.

Throughout 2020 and early 2021, significant progress was made in preparation for the flexibility trials which will take place during 2021:

- Smart EV charge-points were procured and installed at the premises of the five Dingle Ambassadors and ten more EV trial participants were selected after a call for expressions of interest
- Deep retrofits of three of the Dingle Ambassadors' premises have been completed and controllable heat pumps have been installed in all five properties
- Clear learning objectives from the Flexibility Trials have been defined
- The Digital Platform, which will be used to optimise and control the range of distributed energy resources (DER) participating in the trial, has been procured and is being configured to support these trials.

Significant progress was made throughout 2020 on the installation and commissioning of technologies on the LV and MV networks to support the network reliability objective of the project:

- LV Mapping of the Dingle Electrification Project area
- LV monitoring devices installed at key transformer locations
- Smart Fault Passage Indicator (FPIs) installed on the network, and the extent to which they help to reduce outage durations, will continue to be assessed
- Recloser upgrades and SCADA integration – reduce network switching time and outage durations.

The effectiveness of these technologies in improving customer confidence in the reliability of the network continues to be assessed. There were also several activities progressed throughout 2020 to help understand the effectiveness of behaviours and the mechanisms required to transition individuals and communities to Active Energy Citizens:

- Information sessions on Solar PV, electrification of heating and electricity network resilience were delivered through podcasts with the support of Radio Kerry
- Contributions provided to local newspaper articles on active energy citizens and project progress
- Funding of energy mentor training, as a first step to building enduring capability across the community
- Webinars held to share project and diffusion learnings with interested stakeholders
- Local energy-related events sponsored across the community.

ESB Networks is keen to support the identification of those techniques and activities that are most successful in diffusing active energy citizen behaviours across society, through the various trials and activities being undertaken by the Dingle Electrification Project.

For more information on the Dingle Electrification Project, please visit our website link: ESB Networks' Dingle Project

4.4.2 SERVO Modeller (ref: 23)

Status: Ongoing **Project Timeline: Q4 '17 – Q2 '21**

Key partners / stakeholders: ESB Networks Asset Development

Overview: SERVO Modeller is an IT-based project, the aim of which is twofold. Firstly, it is to develop a sandbox data lake to allow research projects that generate data access to a single location for data storage in a uniform and structured way. This then enables dashboards and reporting on the data for trial evaluation. Secondly, it is to act as a testbed software platform to deliver use cases on ESB Networks' data and evaluate the DSO requirements for interconnected data sources into the future.

The SERVO Modeller platform has successfully been used to interface with the primary Supervisory, Control And Data Acquisition (SCADA) system and MV90 billing data to provide users with visualisations of large data sets from most of ESB Networks' substations. A progress report relating to SERVO Modeller and the associated transition into the Business-As-Usual of the SERVO planner application was published to the ESB Networks' website in June 2020 (SERVO Modeller Innovation Progress Report).

4.4.3 StoreNet – Customer Side Energy Storage (ref: 45)

Status: Ongoing **Project Timeline: Q2 '16 – Q1 '21**

Key partners / stakeholders: IERC, Solo Energy and Electric Ireland

Overview: Led by IERC, the StoreNet project comprises a consortium of partners which includes ESB Networks, SMS plc (previously Solo Energy) and Electric Ireland. The project aims to validate the performance of twenty 10kWh 4kW Battery Energy Management Systems (BEMS) on the distribution network. The batteries are installed in residential premises in the townland of Ballyferriter, west of Dingle town, Co. Kerry.

A trial programme evaluating the performance of the BEMS was carried in 2020. The trials investigated the capability of the BEMS to provide peak shaving and reactive power management. Further trials, including a 'Full Battery Discharge Test', took place in December 2020 and may help to understand how the BEMS can support local grid voltage. A final report for this project is expected in 2021.

4.4.4 Exploration of ASHPs for Ireland's Residential Heating Needs (ref: 74)

Status: Ongoing **Project Timeline: Q1 '19 – Q2 '21**

Key partners / stakeholders: ESB Networks / UCD

Overview: Air source heat pumps are a suitable domestic heating alternative, particularly to replace oil-fired systems. However, consumers may need to be convinced of their effectiveness and usability if they are to be widely adopted. A clearer understanding of heat pumps will help policymakers and governmental agencies define policy in the overall energy balance challenge. This project aims to provide the basis for evidence-led policies on the electrification of heating in Ireland by conducting a field study and attitudes survey.

This project is leveraging data from the Superhomes Project and Limerick Institute of Technology is now a partner on the project (Superhomes Innovation Close-Out Report). Two journal papers and a conference paper documenting the findings of the project have been published. Furthermore, follow-on research investigating the power quality impacts of heat pumps on distribution networks is currently underway, with power quality meters installed at three homes with heat pumps.

4.4.5 Positive City Exchange (+CityxChange) (ref. 75)

Status: Ongoing **Project Timeline: Q4 '18 – Q3 '23**

Key partners / stakeholders: Limerick City and County Council, Trondheim Municipality, IES and MPower

Overview: Through active citizen engagement, the Positive City Exchange Project is developing a series of demonstration projects on how today's cities can become smart, positive energy cities of the future. Positive City Exchange (+CityxChange) is a European Union (EU) Horizon 2020 Smart City Lighthouse project. The consortium consists of 32 partners, led by the lighthouse cities Limerick and Trondheim in Norway and five other follower cities, Alba Iulia (Romania), Pisek (Czech Republic), Sestao (Spain), Smolyan (Bulgaria) and Voru (Estonia). This is the first such award to an Irish city.

In Limerick, a community energy concept will be trialled with the use of intelligent meters, innovative new renewable generators (including hydrokinetic energy), electrical energy storage, digital tools and citizen participation to create a Distributed Positive Energy Block (DPEB) and District. ESB Networks' focus will be to support the integration of the DPEB into the distribution network and provide regulatory and technical advice needed to enable concepts such as peer-to-peer energy trading and the Energy Community Utility (ECU) to be trialled.

During the year, project activities were impacted as a result of COVID-19 restrictions and delays were encountered, mainly in the community engagement elements of the project.

The project remains active with monthly meetings held in relation to the planning and delivery of the Limerick pilots. In 2020, ESB Networks contributed to the development of a 'Framework for Community Grid' report, and plans for supporting community grid participants to plan their retrofits and install generation at their premises by advising on grants and finance are currently under development.

4.4.6 Development of Modularised Metering and Control for RES Connections (ref:81)

Status: Ongoing **Project Timeline: Q1 '19 – Q1 '22**

Overview: There are three parts to the project. Project A supports the connection of further renewable generation to the network by facilitating a faster connection of embedded generation, including solar, to the distribution system. This can be achieved by developing an MV EGIP (Embedded Generation Interface Protection) Standard Module solution that will allow for generation connections of between 1 and 20 MVA (subject to local system capacity) to ESB Networks' MV System. At the core of the proposal is the development of a standardised prefabricated substation module that can be deployed readymade to site, allowing for faster renewable connections to the system.

Introducing an alternative connection option for MV customers requires significant stakeholder consultation. The project published its MV EGIP Standard Module Connection public consultation in December and held a public webinar to garner feedback from stakeholders. A copy of the consultation document is available from ESB Networks' website (MV Customer Connection – MV EGIP Standard Module Substation). A showcase unit will be installed at the ESB Networks National Training Centre, Portlaoise in 2021.

Project B supports connections at HV stations that do not anticipate having a generator connection. The prefabricated, modularised, fully-equipped format is retained; however, it excludes any generator protection capabilities. This element of the project focuses on the specifications, including spare capacity, for standard HV substations.

Project C aims to evaluate new and innovative approaches to MV substation design where large EV chargers are expected to connect. The project aims to explore the use of modular solutions to increase the efficiency and speed of (large) EV charger connections. This approach will reduce the overall footprint of the substation and reduce construction effort when compared to a conventional MV block-built substation building.

The project has engaged with customers to identify challenges and to propose solutions. Customer feedback has also been sought through a public consultation in August 2020 entitled "MV Customer Connection Standard Module – Electric Vehicle Charging Hubs in Urban Environment". A webinar was held during the consultation on the 17th of September to further engage and listen to stakeholders' feedback. As a result of these engagements, a trial site is planned for 2021.

4.4.7 200kVA+ Ester Pole Mounted Transformer (ref: 98)

Status: Ongoing **Project Timeline: Q1 '19 – Q2 '21**

Key partners / stakeholders: ESB Networks / UCD

Overview: Existing 200kVA pole-mounted transformers are used mainly in small towns and villages. They tend to be heavily loaded as conventional upgrade alternatives are challenging to implement due to the limited availability of sites, their expense and the length of time needed to install. With the electrification of heat and transport, these substations may become overloaded, potentially resulting in expensive and delayed reinforcement.

This project proposes to investigate the feasibility of replacing 200kVA power mounted transformers with larger capacity units using ester to provide insulation and cooling, while observing physical loading limits on the pole and equipment dimensions.

Design work to produce a suitable transformer unit took place during 2020; however, initial testing of prototypes indicated that the maximum rating was 270kVA which was below the anticipated 300kVA rating. Nevertheless, this is a significant and useful increase.

4.4.8 Improved ADMD Estimates for Domestic Customer (ref: 169)

Status: Ongoing **Project Timeline: Q1 '19 – Q2 '22**

Key partners / stakeholders: ESB Networks / UCD

Overview: Pending the availability of smart meter data, the only way of estimating load on a MV/LV transformer supplying a housing scheme is by multiplying the number of customers by a standard After Diversity Maximum Demand (ADMD), to form a load estimate. The headroom then available for EVs and heat pumps is the difference between the estimated load and the transformer rating.

Therefore, if the ADMD varies, so can the estimated headroom. This project will deploy monitoring on representative housing schemes in order to derive an ADMD for different house types and socio-economic areas. This will enable us to identify with more certainty those substations most likely to require uprating.

Temperature and current monitoring equipment is currently being installed on 100 substations to provide the data that will support the ADMD assessments.

4.4.9 Using Real Options for Establishing Investment Justification for Change in ADMD (ref: 170)

Status: Ongoing **Project Timeline: Q1 '19 – Q2 '22**

Key partners / stakeholders: ESB Networks / UCD

Overview: Justifying an increase in the average customer's power requirements used to plan new housing scheme loads can be done relatively simply using conventional investment evaluation techniques.

However, carrying out a sensitivity analysis can be considerably more complicated, depending on the variation allowed in the input factors. This trial calculation will be used to assess whether Real Options can be used in an understandable way to assess the low voltage network investment options associated with catering for ADMD growth and thus give an insight into the use of Real Options for more complex analysis. Initial engagement has taken place with UCD with the majority of project outputs expected in 2021.

4.4.10 Estimation of Allowable Loading on 15 and 33kVA Single Phase Transformers Based on Annual kWh Throughput (ref: 172)

Status: Ongoing **Project Timeline: Q1 '19 – Q1 '22**

Key partners / stakeholders: ESB Networks

Overview: Without dedicated monitoring devices or aggregated smart meter data, it is not possible to directly measure the loading on existing 15 and 33kVA transformers. This has not been a problem in the past as load growth patterns were relatively static. However, with the introduction of EVs and heat pumps, there is likely to be a significant increase in load on existing transformers, and the capability of the transformer to deal with such loads needs to be assessed.

The approach proposed for the interim is to establish what levels of kWh throughput have been tolerated by large cohorts of transformers, as this establishes a relationship between loads which have been used for many years without damage to the transformer. This would infer that the higher values of these kWh loadings would align with transformer rating, so that addition of an EV or heat pump would then add a predictable amount to the peak and be acceptable pending the introduction of smart meters in about 3 years' time.

Temperature and current monitoring equipment is currently being installed on these transformers to measure the kWh on each cohort of substations that will estimate the upper levels of power throughput commonly experienced on these subs. This will then give an estimate of the upper power limits that these transformers can accommodate. This relates to actual peak loading assessments.

Approved Pipeline Projects

4.4.11 5G Docklands (ref: 99)

Overview: Local Authorities in Dublin have set up a mobile phone and broadband task force to examine the possibility of using street furniture and local-authority-owned public lighting poles to mount equipment that would provide 5G mobile services to the public. The trial involves the connection to ESB Networks assets, and a key concern is the establishment of safe zones that act to keep personnel at a safe distance from live equipment. Where this isn't possible, the project will need to consider training and the creation of a procedure for technicians to carry out installation works.

Some preliminary investigations have taken place and project documentation is to be submitted.

4.4.12 Microgrids (ref: 101)

Overview: Microgrids are used in three ways:

(a) Providing a self-sustaining microgrid when the link to the main grid becomes unavailable;

(b) Linking to the main grid for stability but producing most of its own power through local renewables; and

(c) By a community that imports most of its energy from the main grid but benefits from a bulk tariff by reducing its peak demand. Additional peak demand is satisfied from its microgrid.

For some applications such as islands, the economic impacts and potential benefits need to be fully understood. In one European island community, it was found uneconomical to eliminate standby diesel generators entirely as the amount of renewable energy that would have to substitute in the event of unsuitable weather (cloud/still air) was high.

The key output of this project will either be an assessment of the economic surplus generated for society, or whether it is mainly the case that fixed costs will be redistributed to other customers.

4.4.13 P2P and System Wide Economic Analysis (ref: 103)

Overview: Peer-to-peer (P2P) trading of energy is not yet well understood. This project aims to assess where the economic surplus arises and whether there is a justified redistribution of other costs, or whether other savings arise from how tariffs operate. It is suggested that those experiencing a reduction in costs as well as those experiencing an increase in costs are identified and that those costs are quantified.

Understanding the actual overall societal benefits that arise from P2P energy trading would be worthwhile, particularly if the idea only redistributes costs without providing or identifying an economic surplus. Similarly, a small economic surplus would likely not support investment in dedicated equipment to implement, but would instead require implementation using software, with energy transported over the existing network.

4.4.14 Real option pricing of flexibility (ref: 104)

Overview: 'Flexibility' as a service can potentially deliver benefits to ESB Networks in terms of investment deferral or by allowing time for greater certainty to be obtained by waiting before committing to an investment. Currently, the method by which flexibility is assessed is on the full value of the project deferral; however, there are other factors that should be included in the assessment.

In addition to the Net Present Value (NPV) of the cash flows, the NPVs of various options foregone should also be included. Additionally, variation in costs linked to each option's probability and the discount rate also becomes important if it is accepted that flexibility merely defers instead of eliminates reinforcement.

This project, which is to be undertaken by UCD with ESB Networks' direct support, aims to review existing approaches and propose a robust and repeatable process that provides many of the benefits while eliminating complexity.

4.4.15 Investigation of Three-Winding Transformers (ref: 106)

Overview: This project aims to assess the scope for the use of Three-Winding Transformers on ESB Networks. Transformers with 110kV, 38kV and MV windings could be used to replace existing 110/38kV transformers and so provide two 20MVA stations in city centre sites without the need to buy new sites/buildings. These transformer types have been introduced in Christchurch in New Zealand and Belfast, and previously once by ESB Networks, approximately 20 years ago.

Anticipated benefits include:

- Avoid expensive site acquisitions while making a speedier upgrade
- The new transformers can be equipped with tap changers, most likely on the 38kV side
- The approach has the potential to provide additional capacity in spatially challenged locations such as city centres.

4.5 CLIMATE ACTION ROADMAP

Decarbonising Electricity, Heat and Transport: This roadmap focuses on delivering the innovations that will ensure that ESB Networks cost-effectively delivers the right infrastructure at the right time for a decarbonised energy system, supporting the integration of significantly increased levels of renewables and electrified heat and transport on the system.

The following outlines the portfolio of projects undertaken by ESB Networks under the Climate Action Roadmap.

4.5.1 Introduction of 1MVA Unit Substation (ref: 62)

Status: Ongoing **Project Timeline: Q2 '18 – Q2 '21**

Key partners / stakeholders: CG Power Systems Ireland Ltd

Overview: Upgrading an existing transformer to a larger size model to accommodate increased loads can be challenging. In situations where the space isn't available, except at significant cost, innovative approaches that leverage new and improved technologies and materials may be needed. It is anticipated that customers will want to be able to use electrified heat and charge their EVs at home, at the forecourt, at the office and many other public places. This project supports the delivery of one of ESB Networks' core objectives, which is to provide necessary infrastructure to support this fundamental shift in energy usage.

Modern MV/LV unit-substation housing design accommodates either a 440kVA or 630kVA transformer. These transformers fit the available transformer footprint and match the ability of the existing substation housing to vent enough heat, allowing it to operate at full load. Electrification of heat and transport may result in the largest currently available MV/LV transformer (630kVA capacity) becoming inadequate for both existing and proposed installations.

The proposed solution involves innovatively developing a 1,000kVA compact transformer which retrofits into the existing footprint of the 440kVA or 630kVA transformer it is replacing, and whose heat output is no greater than that which can be handled by the existing substation housing. The new 1,000kVA transformer will need to decrease its heat output and operate at higher temperatures if it is to be retrofitted successfully into the pre-existing housing. The use of ester cooling fluid means that transformer cooling fins could be eliminated or reduced for new installations, providing the needed space saving with the heat dissipation capabilities of the existing housing proving satisfactory for the new transformer type.

The project aims to confirm, or otherwise, that the new larger transformer can operate in the existing housing without presenting operational or safety difficulties.

Milestone: A prototype transformer was specified and produced in Q2, 2020, with type testing taking place in a specialist transformer testing facility in Hungary. Test records show that the transformer passed testing. However, following dismantling of the unit post-testing (standard practice after prototype testing), it was observed that the windings had moved, albeit within specified tolerances. ESB Networks' Subject Matter Experts are reviewing these findings to input into formulating the next steps in the project. It is likely that the prototype transformer will be installed at a heavily loaded pilot location for further on-site assessment in 2021.

4.5.2 Smarter HV and MV Customer Connections (refs: 51, 209)

Status: Ongoing **Project Timeline: Q1 '17 – Q1 '21**

Key partners / stakeholders: CRU, ISEA, Meitheal na Gaoithe, IWEA, IrBEA, DRAI, IESA

Overview: Our planning and security standards must support economically efficient investments, given the many changes affecting the energy market at present, such as large-scale deployment of non-network technologies including Demand-Side Response (DSR) and energy storage. A fundamental review of distribution network planning, operation and design is needed so that new, innovative approaches can be incorporated. The aim is to ensure that Ireland's energy policy objectives can continue to be met economically and sustainably whilst maintaining or enhancing security-of-supply.

Phase 1 of the project is complete and consisted of a comprehensive stakeholder engagement and consultation process, research, analysis and modelling in relation to the review of ESB Networks' planning standards and amendments to customer connection processes.

Phase 2 brings the changes proposed by Phase 1 into Business-As-Usual. The changes resulted in a revision and publication of new Distribution System Security and Planning Standards which was approved by CRU on 23rd September 2020 and published on the ESB Networks' website publications section. The three documents revised and approved were:

- Distribution System Security and Planning Standards
- Non-Wires Alternatives to Network Development Guide
- Non-Firm Access Connections for Distribution Connected Distributed Generators Guide

The project has now moved into its implementation phase, ensuring that load indices and aspects of the revised standards can be embedded into BAU.

4.5.3 Introduction of Sidewalk Transformer (ref: 41)

Status: Ongoing **Project timeline: Q3 '17 – Q4 '21**

Overview: The electrification of heat and transport will lead to increased demand loads and potential congestion on LV networks with the proliferation of low-carbon technologies (LCT).

Transformer thermal capacity limits can be effectively overcome with conventional network reinforcement, e.g. upgrading cables and upgrading or installing additional transformers. This often proves to be an economic long-term solution; however, practical issues (such as finding a suitable site for a new secondary substation) can limit our ability to deliver this solution in, for example, existing housing estates.

Miniature secondary substations, known as sidewalk transformers, are a potential solution to such spatial restrictions, allowing transformers to be located on narrow streets in densely populated city areas. For example, this technology is already in use in Tokyo, Japan. ESB Networks is developing an Irish trial of these units to increase capacity for our residential customers in situations where the use of LCT is anticipated.

A prototype transformer has been specified and layout drawings are in development, and a final prototype unit is expected to be supplied by mid-2021, with type testing and validation to be conducted thereafter. While an examination of the quantity of these transformer types has yet to complete, it is anticipated that the number will be small; of the order of 10-20 units.

4.5.4 Big Data Analytics for Wind Farm Connections (ref: 82)

Status: On Hold **Project Timeline: Q4 '18 – Q4 '21**

Overview: Currently, wind farm connections are deterministically assessed on the basis that they will never cause breaches of our Distribution Planning and Security of Supply Standards. In order to assess the impact of wind farms on the network, a set of 'worst case' conditions are assumed under which the system is modelled. These assumptions are maximum system demand, maximum generation and connection point voltage at its maximum.

Our current planning approach assumes that these worst-case conditions occur simultaneously. Using big data analytics and probabilistic analysis, it may be possible to more accurately evaluate and understand the probability of these worst-case conditions occurring. Understanding and quantifying these risks will allow us to understand the current risk we have on our network and quantify the financial and risk implications of new methods of connecting customers to the network.

While this project has not progressed in 2020, there are early stage investigations on the potential for data analytic approaches in network planning, and this initiative may be superseded or merged into a new project proposal in 2021.

4.5.5 Introduction of MV/LV Tap Changing Transformers (ref: 22)

Status: Ongoing **Project Timeline: Q3 '17 – Q3 '21**

Overview: The LV network is designed so that voltage drop of no more than 5% of nominal voltage (230V) occurs. However, the increased loading on the system, due to the electrification of heat and transport, challenges our design assumptions and this increased loading could result in some LV networks exceeding this 5% limit.

With a tap changing transformer, the allocation of upstream voltage drop for 38kV and MV infrastructure can effectively be reallocated downstream to the LV network by using a tap changer to regulate the voltage at the LV busbar to 244V. This means that a larger voltage drop can then be used in the design of the LV network.

A prototype transformer was produced in Q2, 2020 and type testing was arranged with a specialist transformer testing facility in Hungary. The transformer was dismantled after these tests and it was observed that the windings had moved beyond permitted tolerances. It is proposed to obtain and review the detailed transformer test results to effect repairs to the prototype transformer and, if needed, to redesign before resubmitting the unit for testing.

4.5.6 WinterPeak – Intelligent Secondary Substation Monitoring (ref: 34)

Status: Complete **Project Timeline: Q1 '17 – Q1 '21**

Overview: The anticipated proliferation of low-carbon technologies (LCT) such as EVs, heat pumps, Photovoltaic (PV) based microgeneration, battery energy storage and renewable microgeneration could result in the LV distribution system moving outside its operational limits. The impact on the customer and network of inverter-sourced power quality issues needs to be fully understood across the full range of electrical parameters such as voltage, current, active and reactive power flow as well as harmonics. The LV network needs to accommodate new LCT while ensuring it does not exceed its design limitations. In order to assess all of these issues, monitoring of the network is necessary, as well as collection of large amounts of data to support an analysis of impacts and capabilities.

The WinterPeak project investigated the design, development, installation and operation of standardised LV monitoring devices that gather electrical data based on defined parameters from the LV distribution system. Producing and analysing the data facilitated the evaluation and integration of new technologies onto the LV network, ultimately supporting the deployment of LCT.

The project successfully specified and installed a number of monitoring devices, collected the data and evaluated device performance. This was done in conjunction with other innovation projects, for which the suite of collected data proved invaluable. The project was completed during 2020 and a comprehensive close-out report was published to the ESB Networks' website here: WinterPeak Innovation Project Close-Out Report

4.5.7 Wildlife OHL Contact Prevention (ref: 77)

Status: Ongoing **Project Timeline: Q1 '19 – Q4 '21**

Key partners / stakeholders: ESB Networks Overhead Lines

Overview: The project aims to identify and trial novel measures to prevent wildlife from coming into contact with live conductors and OHL network equipment in general. It is intended to use technology to allow technicians to report bird strikes and other issues caused by wildlife, and the use of mobile device technology can allow workable solutions to be shared. The benefit to the customer will be an improved service (reduced Customer Minutes Lost) through a reduction in wildlife-caused interruptions to supply, while the primary benefit will be to wildlife, who will be deterred from harming themselves.

Project outputs will feed into line design, incorporating any measures at the outset, informing upgrades and alterations to account for local conditions. Another project benefit relates to how existing standard materials can be cost-effectively modified to incorporate risk mitigation during manufacturing.

The project reports positive results from a particular design of 'diverter' which has been trialled on overhead lines in ESB Networks' Northern Region to deter contact between birds and overhead lines. Collaboration with Lancaster University has yielded a better understanding of how birds visually detect obstacles and which colours and shapes work best to highlight them.

4.5.8 Wind Farm Reactive Power Optimisation (ref: 83)

Status: Ongoing **Project Timeline: Q1 '18 – Q1 '21**

Key partners / stakeholders: UCD, Enterprise Ireland

Overview: ESB Networks has collaborated with UCD and Enterprise Ireland to develop a device which modulates the reactive power produced by a wind farm to minimise losses on a designated circuit of the distribution network. This can be immediately adjacent to the wind farm in question or a designated circuit further upstream.

The trial of the device demonstrated that the use of the system will bring benefits to the operation of the distribution system; however, the current regulatory regime does not incentivise this behaviour. The changes may also have operational ramifications which would need to be taken into consideration. They are currently being considered and will form part of the review of the DLAF methodology.

4.5.9 Renewable Heatmaps (ref: 105)

Status: Complete **Project Timeline: Q4 '19 TO Q2, 2020**

Overview: ESB Networks is committed to more openly and transparently sharing data that may be useful to customers and stakeholders. Such data may provide insight into decisions relating to the network and better inform customers before submitting connection applications. This project reflects that ambition by providing an indication of available capacity for new demand and generation customers.

The project succeeded in its aim of providing an interactive map showing the available network capacity in terms of how much demand or generation could be added into a substation without significant reinforcement. As promised to stakeholders in our response paper to our consultation feedback in February 2020, the demand and generation heatmaps were published in May 2020 on ESB Networks' website here: ESB Networks Capacity Heatmaps

This project was completed in November 2020 and a close-out report was published on ESB Networks' website here: Heatmaps Project Innovation Close-Out Report

4.5.10 Introduction of Alternatives to Creosote Wood Poles (ref: 24)

Status: Ongoing **Project Timeline: Q3 '16 – Q4 '22**

Overview: ESB Networks has installed over 2.2 million poles on the LV and MV networks, which have traditionally been creosoted wooden poles. However, the Department of Communications, Climate Action and Environment (DCCAE) banned the use of 'A oil' poles in 2000 and has granted derogation for the continued use of 'B oil' and 'C oil' creosote wood poles up to May 2021. Therefore, there is a requirement for ESB Networks to find an alternative for creosote wood poles.

The first part of this incremental innovation project has been examining different materials such as fibreglass composite poles, steel, concrete, laminate and hybrid poles. The second part of this project sought to investigate alternative treatment types that could protect wooden poles once the use 'B oil' and 'C oil' creosote allowance expires. The project has found that direct alternative treatments to creosote are not available.

Instead, the project has focused on alternative pole types and has installed several fibreglass poles on an overhead line in the northwest of the country. These remain under trial and are routinely inspected. The project aims to afford these pole types the longest trial duration in order to better assess their potential as a permanent replacement to wood poles. The project also notes that fibreglass poles are twice the cost of creosote-treated wood poles.

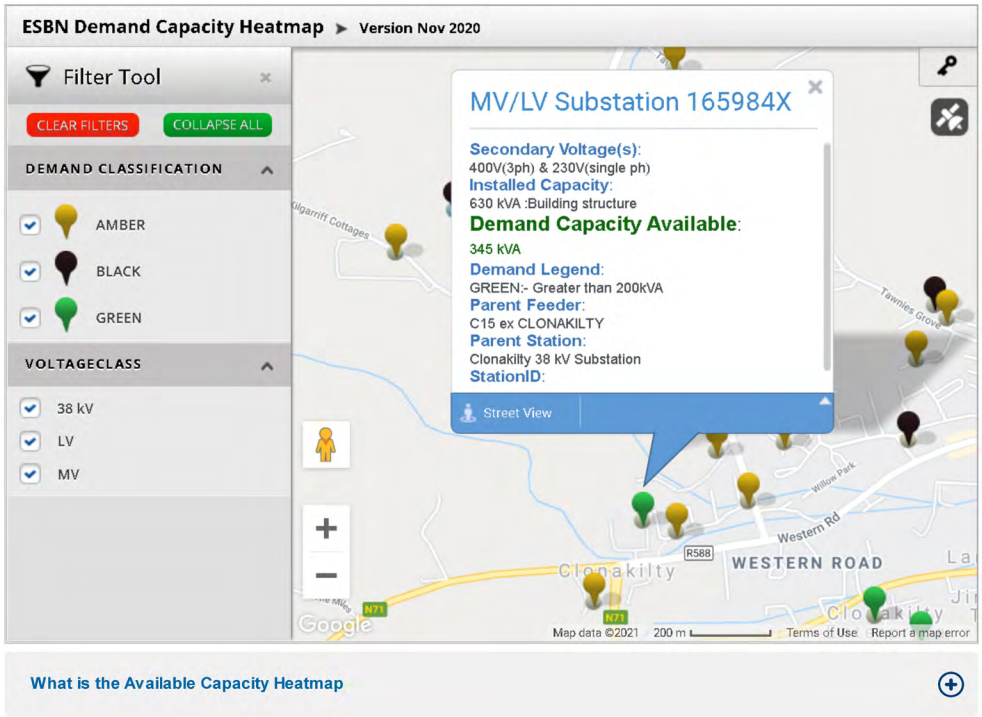


Figure 4.2: Demand Heatmap Layout Showing Voltage and Marker Filter Options

4.5.11 Vegetation Survey System (Tesselo) (ref: 133)

Status: Ongoing **Project Timeline: Q4 '20 TO Q2, 2022**

Overview: ESB Networks have used Lidar to assess the distance between trees and overhead lines, but a more sophisticated approach has been developed by a Portuguese start-up company called Tesselo, which uses satellite imagery in conjunction with Lidar data to produce significantly better results.

Tesselo's innovative technology and systems, which use artificial intelligence (AI) technology and satellite imagery to enable more efficient vegetation management, were brought to the attention of ESB Networks as part of the 2020 Free Electrons programme in which ESB Networks sources innovation through start-up companies (see Section 1.5). A contract has recently been signed with Tesselo to work on a proof of concept trial for vegetation management on the overhead electricity network to improve its continuity performance.

Approved Pipeline Projects

4.5.12 Transformer Loss Load Factor Calculation (ref: 107)

Overview: As part of the 'Data Analytics to Temperature Correct Loads' project, it was observed that data had been collected which would allow the calculation of Loss Load Factors (LLFs) for transformers. The LLF is defined as average power losses over a period of time to the losses at the time of peak demand, and gives an indication of the energy lost in transformer operation. This project was formed to provide a visualisation of a sample set of the data to include:

- total power loss per transformer for the selected period;
- average load factor (LFav) / average Loss Load Factor (LLFav) / Transformer Utilisation Factor (TUF) / TLLF; and
- coefficients for converting average LFs to LLFs.

Once trialled, the resultant dashboard/calculations can then be scaled up to include all transformers in the country that are instrumented.

Benefit: It will then be possible to form a picture of each transformer type's LLF according to their rating and voltage levels and to then identify whether different load mixtures had significantly different loading patterns. 38kV/MV transformers may have high LFs, high TUFs and hence high Transformer LLFs. 110kV/MV transformers will have low TUFs as they are less loaded etc. Transformers can then be categorised to aid specification of Loss Capitalisation rates at tender stage.

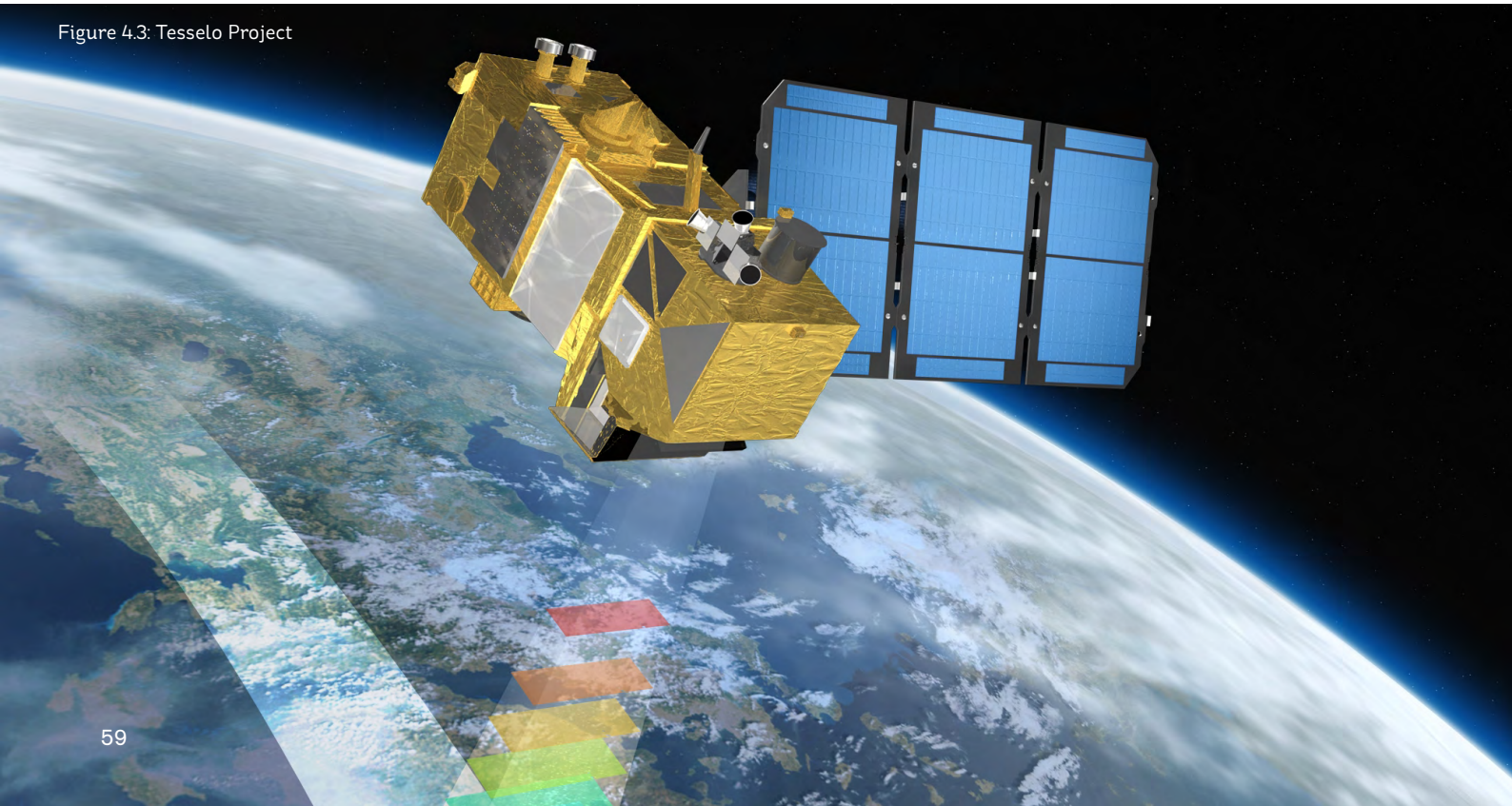


Figure 4.3: Tesselo Project

4.6 NETWORK RESILIENCE ROADMAP

Efficient, Secure, Reliable Electricity: This roadmap focuses on the evaluation of innovations to provide an efficient, resilient and reliable future network that can support a low-carbon future.

The following outlines the portfolio of projects undertaken by ESB Networks under the Network Resilience RoadMap.

4.6.1 Development of High Voltage Stations Health Index (ref: 69)

Status: Ongoing **Project Timeline: Q1 '18 – Q4 '21**

Overview: The identification and tracking of hundreds of thousands of the component pieces of the distribution system is a challenging task that also has many potential benefits. The use of new technology products in conjunction with new processes has the potential to deliver improvements for the management of ESB Networks' many and varied assets. The technologies include databases, back-end systems and visualisation tools, as well as smart field devices equipped with software apps that facilitate the quick and easy capture of asset information. The project aims to improve asset management processes by employing technology to capture information to the benefit of the personnel involved in capturing and analysing it.

This project has developed the first phase of a functioning Health Index for all HV substations and their components. The project will involve reviewing current end-to-end maintenance activities and mapping current business processes to develop new systems that allow the capture and updating of network assets information. The project aims to produce a specification document for tender enquiry purposes relating to the procurement of systems and support services. A plan is currently being developed to widen the application of this project to other asset categories.

The HV substations Health Index project has been trialling the use of new apps developed for smart mobile devices that allow the accurate and up-to-date asset health information to be recorded and stored. The project reports that over 850,000 individual pieces of data were processed, having been collected during routine substation inspections.

The introduction of the proposed asset Health Index into the business is at an advanced stage, albeit that the project is not due to complete until end 2021. During delivery, the project identified that an asset Health Index methodology was in use in other DSOs and DNOs called 'Common Network Asset Indices Methodology' (CNAIM). By performing due diligence, it was felt that the asset health matrix could be introduced into the BAU and this was brought about by transitioning the asset health indices analytics software platform into the business.

Though project progress has been impacted by COVID-19 restrictions, significant progress has been made in developing and rolling out an Asset Performance Management System (APMS) along with accompanying support services and systems.

4.6.2 Nodal Controller for Reactive Power (ref: 3)

Status: Ongoing **Project Timeline: Q1 '16 – Q4 '21**

Overview: To facilitate the transfer of reactive power to the transmission system, ESB Networks has developed a sophisticated control system called a Nodal Controller.

The Nodal Controller is a new concept and seeks, for larger DSO-connected wind farms, to use centralised and automated intelligence, allowing as much reactive power support as possible to be delivered to the TSO-DSO interface, respecting voltage and thermal capabilities of the distribution network. DSO-connected wind farms can be used to provide valuable reactive power support to the transmission network, and in some cases obviating, reducing or deferring investment in transmission infrastructure such as STATCOMs and capacitor banks.

To test this concept, a pilot of this technology was carried out at the Cauteen wind cluster in Co. Tipperary, on Topology 2 wind farms. The project team suggests that this solution should be considered for other wind farm types. Controller and communications equipment have been installed and trialled. The control algorithm has been developed and deployed. Installation checks are complete, and the equipment has been powered up and been trialled on the cluster. Testing of the controller completed in 2020 and some adjustments were made to the algorithm as a result. A three-month trial of the controller in full operation began in Q4, 2020.

4.6.3 Leveraging Fibre Infrastructure for Smart Networks Management (ref: 9)

Status: On Hold **Project Timeline: Q1 '15 – Q4 '21**

Key partners / stakeholders: SIRO

Overview: SIRO, a joint venture between Vodafone and ESB, has initiated a program to deploy fibre to the building (FTTB) services to over 300 urban locations in Ireland. The rollout of this service involves the deployment of fibre-optic cables which pass close to primary and secondary substations. ESB Networks has reserved a single-fibre pair on all SIRO cabling for operational use. The fibre will run alongside existing ESB Networks cable ducts and channels. The objective of this project is to identify the best method of installing the additional, usually short lengths of ducting to attain a viable fibre route between SIRO Point of Isolation (POI) and primary/secondary substations.

ESB Networks intends on delivering communication services over operational fibre to provide a backup for data communications and to potentially afford control of secondary substations. This project will also trial different types of use cases over different technologies. As the 'New Core and Aggregation IP Network' project progresses, backup communications are being facilitated over existing wired and wireless networks. This project is to be reviewed as to its fit with the long-term strategy and overall infrastructure plan in Q1, 2021.

4.6.4 Inspection of Overhead Lines Using Drones and Image Processing Analytics (ref: 19)

Status: Ongoing **Project Timeline: Q3 '16 – Q4 '21**

Key partners / stakeholders: University of Limerick, the TSO

Overview: Currently, line inspections on ESB Networks' overhead transmission lines are carried out manually. To carry out these inspections, the lines need to be switched out before inspectors are deployed to carry out visual inspections on all structures and equipment associated with the line by climbing its structures. Disadvantages associated with this approach include: limited range of visibility for inspections; dependence on accessible locations on the structures; and the requirement for outages to carry out the inspections.

This project aims to trial new drone technologies and associated smart analysis techniques as an innovative alternative to the traditional line inspection. A specification will be drafted to procure and engage a specialist service provider to inspect all transmission lines using drones. As well as optical inspections, it is proposed to seek Corona, LIDAR, radiometric, thermal and infrared capabilities. A tender for drone-carried LIDAR services solutions was conducted and awarded during 2020. Further specifications are needed for optical-capable drones.

4.6.5 Data Analytics to Temperature Correct Loads (ref: 38)

Status: Ongoing **Project Timeline: Q1 '17 – Q2 '22**

Key partners / stakeholders: Met Éireann

Overview: This project uses data analytics techniques to enable temperature correction of network loads. This is important to provide network planners with the most accurate load information on which to base their planning studies.

The relationship between load and temperature for each circuit is different, as the response of load to temperature on each circuit depends on the proportion of temperature sensitive load (% Domestic, % Commercial, % Industrial). A correlation between temperature and load for each MV feeder can be created using SCADA load data and Met Éireann temperature data. Load, temperature and weather conditions for each MV circuit can be used to set appropriate temperature correction factors. This will result in a baseline temperature corresponding to realistic worst-case conditions, allowing all loads to be temperature-corrected to this reference temperature. Special Load Reading (SLR) reports can then be corrected to these levels, and the accumulation of such loads would then form the input data to planners.

Research into similar projects has shown that the expertise needed to conduct this complex analysis is available, and the project aims to procure this expertise in 2021.

4.6.6 Storm Resilience for Overhead Networks (ref: 39)

Status: Ongoing **Project Timeline: Q4 '17 – Q1 '21**

Overview: Overhead line assets are vulnerable during extremely high wind-speed events, particularly where there are large trees growing within falling distance of the electricity network. ESB Networks carries out cyclical planned maintenance and timber clearing programmes to maintain the performance of the network and to ensure public safety.

The concept of 'hardening' the overhead network has been implemented in North America, where targeted actions increase the resilience of overhead networks in storm conditions. This project will trial several 'hardening' initiatives on an overhead MV line. The project scope includes:

- Performing destructive testing on an overhead line;
- Establishment of a larger than standard vegetation exclusion zone on a three-phase backbone line; and
- Trialling of smart reinforcement techniques for vulnerable areas of the network.

Testing was carried out at EPRI's facility in New York in the autumn of 2019. Some significant learnings began to emerge about failure mechanisms from tree strikes. Test results led to a focus on the strength and failure mechanism of cross-arms and the consequential damage they inflicted on conductors during failures. It was felt that using fibreglass composite material in the construction of cross-arms could relieve some of the damage. Furthermore, the failure mode analysis seemed to suggest that new methods of stringing conductors need to be carefully considered if lines are to be designed in such a way as to protect the pole from damage.

Further testing was indicated as a result of the 2019 testing round. The project is to seek budgetary provision and agree next steps.

4.6.7 Smart Network - New Core and Aggregation IP Network (ref: 49)

Status: Ongoing **Project Timeline: Q3 '16 – Q1 '22**

Overview: ESB Networks' telecommunications networks consists of multiple hardware platforms using many manufacturers, and is the main means of providing communications and control connectivity for system-critical services on the electricity network. In order to accommodate the introduction of a smart grid equipped with smart devices, the range of critical and non-critical services that will require connectivity on the electricity network is predicted to grow significantly, with the bandwidth requirements per service also increasing.

ESB Networks is investing in the installation of a scalable new fibre-optics-based core and aggregation network, spanning ten core sites (HV stations) and four aggregation sites. This new core and aggregation IP network will be a fundamental building block in fulfilling the existing and future communications requirements of the electricity network, and will act as a key enabler of smart network operations.

While project activities have been affected by COVID-19 restrictions, live services for the TSO have been migrated to the new network, with disturbance recorder data initially being made available from a small number of pilot locations.

4.6.8 Weather Forecasting and Network Damage Prediction (ref: 54)

Status: Ongoing **Project Timeline: Q4 '17 – Q4 '22**

Overview: ESB Networks often receives positive feedback from customers in relation to storms and storm damage repair. Nevertheless, customers expect best efforts to manage the impact of an increasing number and severity of storms.

Forecasting damage and required response through storm damage prediction is a new and innovative way of meeting expectations. It will also contribute to ESB Networks' ability to reinstate safe conditions in the system following storms. This project looks to introduce a system incorporating:

- A localised multi-day ahead weather forecast with a set of ESB Networks-customised and specified weather metrics (wind, lightning, rain, snow etc.). This system will supplement the existing Met Éireann system – on a national and regional basis – for forecasting general weather impacts.
- This localised weather forecast will then be used to create an outage and damage prediction model by using previous weather-related network outage events and local continuity data in conjunction with the look ahead forecast.
- The system will be used alongside existing operational technologies to forecast damage and outage numbers to relevant stakeholders and feed into the ESB Networks response to major weather events.

A proof of concept trial has begun in which a daily forecast of weather is emailed to relevant ESB Networks personnel. The email contains a first-cut model using localised forecasts and asset damage data to predict vulnerable parts of the network during weather events. The daily emails will be reviewed in Q2, 2021, when it is anticipated that sufficient real-life events will be available to cross-check with the daily predictions.

4.6.9 Development of Dynamic Line Ratings (ref: 56)

Status: Ongoing **Project Timeline: Q1 '17 – Q4 '22**

Key partners / stakeholders: The TSO

Overview: A meteorologically-driven increase in cooling effect on overhead lines would allow for an increase in transmission and distribution line ratings. It is anticipated that this could be of benefit on lines that are placed on exposed landscape, such as those supplying many wind farms.

This project aims to develop a model that accounts for ambient meteorological parameter changes such as temperature, wind speed and wind direction, allowing increased line ratings that lead to a greater operational flexibility. It would look to build on learnings from other jurisdictions and look to identify the appropriate innovation solution to the Irish system and environment.

In addition to the benefit of avoiding line upgrade costs, the following benefits are also possible:

- Potentially speedier uprating – planning and environmental issues are avoided
- Safety hazards avoided – no need to mobilise personnel to site to upgrade the line
- Avoided outages – any consequential inconvenience or costs are avoided by not requiring a line outage to increase its capacity.

The project is to create a set of specifications, identifying line physical and electrical limits, outlining a basic functionality, and setting out both how LIDAR technology can be used and how communications with remote assets can be reliably established.

4.6.10 SOGNO – Smart Monitoring for Increased Resilience (ref: 52)

Status: Complete **Project Timeline: Q3 '17 – Q2 '20**

Key partners / stakeholders: EU Horizon 2020 partners

Overview: An increase in renewable energy penetration on the distribution system is a challenge that drives the need for greater network visibility and performance monitoring. This EU Horizon 2020 project set out to address this challenge by trialling combinations of data analysis and visualisation tools, advanced sensors, an advanced power measurement unit and 5G-based ICT to provide greater visibility and control of both MV and LV power networks using end-to-end automation in a virtual environment.

SOGNO also trialled hardware solutions aimed at increasing the resilience of existing network systems and thereby reducing Customer Minutes Lost (CMLs).

The SOGNO project is now complete, and several papers and conference articles have been produced by project participants and are available from the SOGNO EU web portal. The project successfully assessed Fault Location Isolation and Service Restoration (FLISR) devices by installing them on the network at several remote locations in Ireland. It was found that automated control could be used to quickly isolate faults and restore service to less affected customers.

The collaboration that took place between the partners is highlighted in Section 2.4 of this document.

4.6.11 Net-Flex – Market Support for Network Challenges (ref: 97)

Status: Ongoing **Project Timeline: Q3 '19 – Q1 '22**

Key partners / stakeholders: Market participants / service providers

Overview: The Network Flexibility (Net-Flex) Project is part of a suite of transformational innovation projects that ensure ESB Networks is primed and ready for the delivery of PR5 (2021-2025), and able to meet our obligations to support the Irish Government's Climate Action Plan. The project follows on from the Smarter HV and MV Customer Connections Project (see above) that set the groundwork for Non-Wires Alternatives to conventional network upgrades.

As customers' sources of energy shift from carbon-intensive petrol, diesel and home-heating oil to the low-carbon electricity network, it is anticipated that significant investment in the HV and MV network will be needed to manage expected overloading at certain substation nodes. Conventionally, network upgrades are capital intensive efforts, where substation expansion and new overhead lines are needed. This project aims to investigate the possibility of managing and reducing customer peak demand loads in order to defer or mitigate the need for expensive network upgrade works. Any deferral of network expenditure is beneficial to the customer, since savings equivalent to the deferred cost of capital are realised.

The cost of any services provided must be reflective of the savings possible from the deferral of capital investment at the location of the services provision. The project will need to identify a formula or basis for the calculation of the value of services provided, having regard to the 'Reasonableness Text' identified by the Smarter HV and MV Customer Connections project. The project assembled a team of ESB Networks personnel who meet regularly to establish the project's scope and location selection criteria, and to discuss the challenges for flexibility in the Irish context.

4.6.12 Leveraging Enhanced LV Monitoring to Optimise Targeted Network Reinforcement (refs: 153, 171, 174)

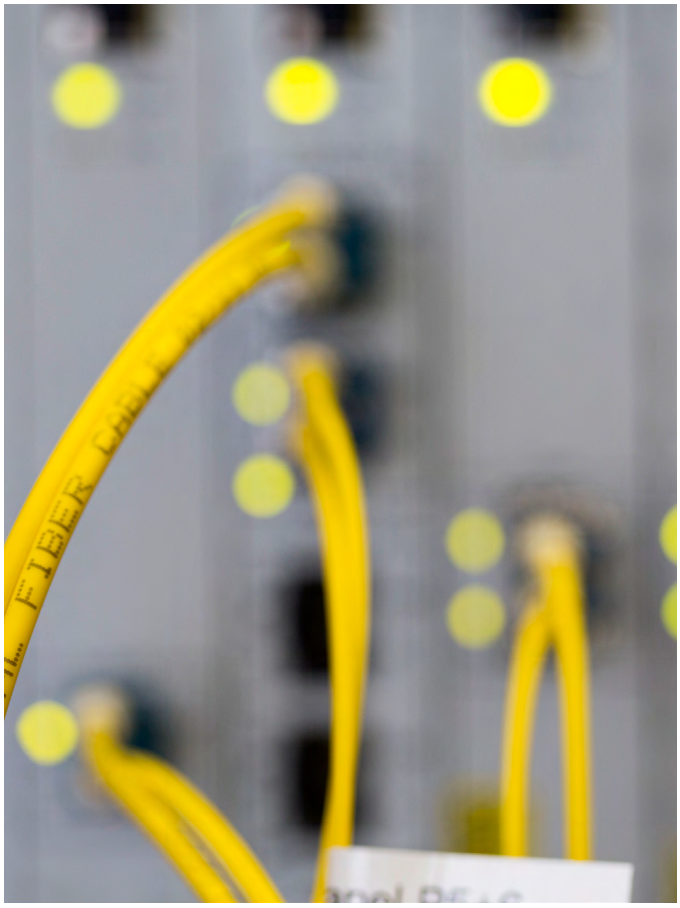
Status: Ongoing **Project Timeline: Q3 '20 – Q1 '22**

Key partners / stakeholders: Market participants / service providers

Overview: ESB Networks must ensure LV network readiness for increased uptake of low-carbon technology to support decarbonisation and enhance customer continuity. Smart solutions to provide additional capability to the distribution network must be considered as options, as well as conventional reinforcement to provide this capability.

Based on forecasts of areas of the LV network that may require additional capability, the project will focus on the targeted deployment of enhanced monitoring equipment on MV/LV substations. This will validate forecasts and ensure that additional capability is added to the distribution system in a cost-effective and timely manner.

Average demands of customers on substations in different socio-economic areas are being used to provide more accurate forecasts of MV/LV substation load, taking into account the propensity of customers to buy EVs and heat pumps.



5 TRANSITION TO BUSINESS OF PROJECTS AND LEARNINGS

ESB Networks' innovation projects deliver quantifiable benefits by successfully embedding the new knowledge, processes, solutions and technologies into our BAU practices to improve the ways in which we work and serve our customers. ESB Networks continues to reap the benefits of projects previously closed as they are embedded in the organisation.

5.1 TRANSITION TO BAU

A culture of innovation is fostered across every level of ESB Networks' business. We have clear innovation objectives and a centralised innovation function that identifies and trials innovation projects before transitioning to Business-As-Usual (BAU). A dedicated Innovation Portfolio and Transition Team was established in mid-2019 to focus on improving the transition process and enhance how we disseminate learnings.

The establishment of the Innovation Steering Group in 2019 has enhanced our governance and Innovation Strategy Framework. The internal and external ISG members bring a wide range of experience, expertise and knowledge to the decision-making process. This ensures that the most appropriate innovation projects which also give the greatest benefits to our customers will make their way through the innovation process and transition into the business. We have found that one of the keys to a successful transition to BAU is to engage the business owner early and ensure engagement and buy-in throughout the project lifecycle.

The Innovation Portfolio and Transition Team use a systematic methodology and implementation process (see Figure 5.1 below) to ensure that a consistent approach to project transition and dissemination is maintained.

On completion of an innovation project and following approval from the Innovation Steering Group to transition the project to the business, the project delivery team compiles a handover document for the business owner. Projects at this point may reveal further innovation opportunities which, once they have passed the appropriate approvals, may be then followed through within the scope of an existing project, or as a new project.

A workshop with the delivery team and Innovation Portfolio and Transition Team is held where a draft transition plan is developed using a standard checklist (see Table 5.1) as a guide. Subsequent workshops are then held with the Innovation Delivery Team, the Business Owner and the Innovation Portfolio and Transition Team to finalise the transition plan and allocate roles, responsibilities and timelines to actions.

Figure 5.1: Transition Methodology and Implementation Process

Checklist Items	Checklist Sub-Items
Scope of Transition	• Scope/Objectives/Measure of Success
Ownership and Stakeholders	• Business/Solution Owner • Business/Solution User • Key Stakeholders
BAU CBA/Benefit Assessment	• Cost Benefit Analysis for BAU • Benefit Assessment for BAU
Business/Systems Transition	• IT Systems • Policies/Standards/Legal Docs • Processes
Resource Transition	• Training • Internal Dissemination
Asset Transition/Procurement	• Tender Requirement: - Specification - Evaluation
External Dissemination	Publications (Consultations/Papers/Reports), Webinars, Workshops, Presentations, Videos , Bilateral Meetings with Stakeholders etc.

Table 5.1: Transition to BAU Checklist

Once the transition plan has been delivered and the innovation project has been embedded into the business, the outputs and benefits are monitored and tracked by the business owner. This enables ESB Networks to demonstrate true integration of the innovation projects' outputs to BAU and the realisation of the expected benefits.

A dissemination plan is developed for all projects, whether they transition to BAU or not, and whether the trials or research outcomes/findings were successful or not. The purpose of the dissemination plan is to ensure all learnings from our innovation activities are disseminated internally in ESB Networks and externally to the wider industry. The detail of these dissemination activities is covered in Section 2.5.

Throughout 2020, the Innovation and Portfolio Transition Team continued to engage with other organisations and jurisdictions to investigate best practice and potential improvements for transitioning innovation project portfolio outcomes to BAU. This has enabled shared learnings in relation to the innovation process, governance, project reporting, transitioning projects to BAU, assessing benefits, measuring success and the dissemination of learnings.

5.2 PROJECT LEARNINGS AND BENEFITS AND TRANSITIONING TO BAU

One of the key priorities of our strategy is ongoing communication of project results and insights with stakeholders who are impacted by, interested in, or have influence on our innovation activities.

In 2020, our engagements were varied and ranged from soliciting feedback and suggestions, to sharing updates on project progress and learnings via a range of online industry events, ESB Networks' website, and research groups in Ireland and abroad. As outlined in Section 2, ongoing collaborations include working with international research and development organisations such as EPRI, EU-funded working groups such as EU Horizon 2020, and numerous academic institutions, as well as participating in a variety of industry conferences and events.

Another key priority is to realise the benefits of innovation to our customers by disseminating and transitioning successful projects into BAU. A number of projects that delivered benefits and learnings in 2020 and which are transitioning into BAU are summarised in the following table.

RoadMap	Innovation Project	Benefits and Learnings	Dissemination and Transition to BAU
Future Customer	Planning Future LV Networks for Electrified Heat and Transport (ref: 10) **Close-Out Report**	Designing LV Networks for the electrification of heat and transport. Develop new standards for the LV Network which will facilitate increased Low-Carbon Technology for electrification of heat and transport. Develop new study and planning tools, for use by ESB Networks Engineering Officers (EOs) to assess new connection applications in line with new ADMD standard. To also assess voltage and thermal issues that may arise from a small scale generation connection (12kW – 200kW) and to determine what network upgrades are required, if any, to facilitate the customer's application.	New LV standards and planning tools have been developed and implemented into the business. These include an increase to After Diversity Maximum Demand (ADMD) from 2.5 to 5.5 to accommodate new power flows from the electrification of heat and transport; new training module for new ADMD planning tools developed and successfully delivered to all EOs; voltage rise calculator tool developed and incorporated into the new planning tools from small scale generation connections; and training programme in place. The project close-out report has been published on ESB Networks' website and the new standards published publicly and approved by the CRU.
	Servo Modeller (ref: 23) **Progress Report**	New IT techniques for Grid Model and Data Management to improve existing processes and enhance the way we utilise our network capacity. Learnings on Smart Grid architecture and how to implement new cloud solutions in utility applications. A central repository for all Network Asset data and related time series data for data management and reporting. This will enable other use cases such as special load readings and innovation projects for data analytics. Servo planner reduces data gathering and validation times, allowing planners to evaluate more load and generation connection applications annually.	SERVO Modeller module has been successfully set up in ESB Networks' MS Azure Cloud infrastructure, thus enabling use cases for the data to be rolled out to the business. Servo planner application, a web-based interface has transitioned into BAU. It is a web-based interface to the Supervisory Control and Data Acquisition (SCADA) and large customer metering that Network Planners use to assess network loading for studies relating to new connections. The SERVO Project Progress Report was published on ESB Networks' website in July 2020. Workshops, training and internal webinars have disseminated the project learnings and uses to the business. Project awarded the EPRI Interoperability Leadership award in 2019.
	Dingle Electrification Project – LV Mapping (ref: 59) **Dingle Electrification Project Website**	Evaluation of the tools, data requirements and processes that will be required to develop accurate, detailed LV network models by accurate detailed mapping. This will enable the development of detailed electrical models of the LV network that will facilitate the connection of Distributed Energy Resources (DERs). Facilitates our country's transition to a low-carbon energy system, while providing secure supplies of "green" and affordable energy to customers' homes and businesses.	Dingle LV Mapping has provided an accurate representation of the entire LV Network on the Dingle peninsula and recording of each LV asset in ESB Networks' databases. The new processes, systems and tools used to undertake the LV mapping across the Dingle peninsula have been disseminated and transitioned into the business to support wider-scale LV mapping of the network. New training modules, contract arrangements and implementation of data security processes have been developed to enable contractors to interact with ESB Networks' systems to support efficient mapping of the LV Network.

RoadMap	Innovation Project	Benefits and Learnings	Dissemination and Transition to BAU
Future Customer	RESERVE Horizon 2020 Project (ref: 36) **Close-Out Report**	Understanding of new voltage control solutions implemented in real-world scenarios utilising multiple types of Distributed Energy Resource (DER) technologies. Learnings on the impact of rapidly emerging Distributed Energy Resources (DERs) on distribution networks and the innovative solutions to mitigate this. The integration of diverse DER technologies sourced from multiple OEMs into a single standardised communications and monitoring platform as well as working with an aggregator.	The project delivered and validated in the field all elements required for the delivery of system services by customer-sited DERs. Project is completed with close-out report and learnings disseminated throughout the business and stakeholders in collaboration with the RESERVE Project partners. Workshops and dissemination events were held internally and externally throughout the project such as the RESERVE Project open day conference in 2019 and an internal webinar in November 2020 that formed part of our internal innovation community webinar series. Learnings and systems knowledge developed as part of the project have been transitioned into relevant innovation projects such as the Dingle Electrification Project.
Climate Action	Renewable Heatmaps Project (ref: 105) **Close-Out Report**	Support 2030 targets of connecting 70% renewable generation. The interactive maps support both demand and customers' connections by providing better information, insight and data transparency on the available network capacity. The maps give clarity in relation to how much demand or generation could be added to a substation without significant reinforcement.	The interactive Demand and Generation Heatmaps went live on ESB Networks' Website in May 2020. In July 2020, ESB Networks hosted a live webinar for all stakeholders on the key features of the Heatmaps and the upcoming Enduring Connections Process 2 (ECP2). The project has successfully transitioned into BAU within Distribution Planning. The generation information will be updated quarterly, and the demand information, annually. New improved features are being developed based on feedback received. The Q4 2020 release provides an update on generation information based on the most up-to-date special load readings and contractual commitments along with an improved layout. Additional information will also be provided with the planned publication of available capacity at 3-phase LV substations throughout the country.
	Smarter HV and MV Customer Connections (ref: 51) **Progress Report**	Supporting increased integration of renewable energy, the project evaluated existing and new innovative approaches to distribution network development, including the connection of new demand and renewable generation and the use of flexibility as alternatives to conventional distribution network reinforcement. Such non-wires alternatives should facilitate the lowering of connection charges and costs, and the shortening of connection times. These innovative approaches to network planning should enable Ireland's energy policy objectives in a more cost-effective manner while ensuring that the security of supply is equal to, or where appropriate even greater than, what is delivered today.	Publication of the new Distribution System Security and Planning and Security of Supply Standards approved by the CRU in September 2020. Two public consultations and ongoing collaborative stakeholder engagement have enabled the development of new standards to meet the changing needs of our customers in a lower-carbon future. Some changes are already in BAU, while others will require an implementation phase / trial before fully implementing into BAU. Please see case study in Section 5.3 for further details.

RoadMap	Innovation Project	Benefits and Learnings	Dissemination and Transition to BAU
Climate Action	Intelligent Secondary Substation Monitoring Project (WinterPeak) (ref: 34) **Close-Out Report**	The project supports electrification of heat and transport by using innovative monitoring systems to enhance the visibility of our LV network. The project trialled a number of different monitoring devices to provide a better understanding of the types of devices that can be used for long-term monitoring of the LV network. Informing future LV visibility strategy by developing a functional specification and related procedures.	A functional specification for an MV/LV monitoring device, associated installation and commissioning procedures (while equipment remains live) and system infrastructure requirements are available for use by the business for LV visibility. This project was completed in 2020 and the project close-out report was published on our website. The project learnings have been disseminated and transitioned into the relevant business areas and innovation projects such as the Dingle Electrification and LV Readiness Projects.
Network Resilience	SOGNO H2020 Project (ref: 52) **Close-Out Report**	The SOGNO H2020 project was completed in July with all EU reports submitted in conjunction with the 12 European partners (see Section 2.6). The project identified potential improvements for our existing equipment and systems. These, along with the learnings and benefits of FLISR, SE and PQ, have been transitioned into the business through workshops and dissemination events. With the services of SOGNO only developed to TRL6, it is recommended that ESB Networks uses our existing SCADA system for any future implementation of these services.	The learnings from this project were disseminated to our stakeholders via a close-out report published on our website, a SOGNO video published and uploaded to our website and the SOGNO EU portal, and a webinar held as part of the Autumn Innovation Webinar Series held in October 2020. The SOGNO partners disseminated project documentation and papers through the SOGNO EU website.
	Replacing Existing Unit Substation Design with Smaller Footprint for Magnefix (ref: 80)	The project supports the electrification of heat and transport by enabling the quick and easy replacement of Magnefix unit substations. This type of historic substations had limited space available and required an innovative approach to address upgrades. Provides a range of sizes of unit substations that enables Magnefix unit substations to be replaced without the need for additional land procurement.	The new range of reduced size MV substations have been transitioned into BAU and are now coded items for standard use on ESB Networks system for use by designers. The project details and outcomes have been disseminated to designers and construction supervisors, as well as providing input to training information at ESB Networks National Training Centre.
	Smart Network – National Radio Access Network Project (ref: 58) **Close-Out Report**	In order to deliver a smart grid network, the development of a reliable cyber-secure national wide area radio access network, independent of the public mobile operators, will enable ESB Networks to meet the demand for the control, protection and management of utility assets. This project involved the development of a dedicated wireless network for the reliable transport of data for future smart grid applications.	Successful spectrum was approved and acquired from ComReg on the 400 MHz Band. Technical capabilities of Long-Term Evolution (LTE) technology were assessed, as well as the interface and deployment capabilities with network equipment for smart grid communications. The project has fully transitioned into BAU with a project team developing the network requirements, specifications and implementation for device communication over the network.

Table 5.2: Innovation Projects Dissemination and Transition

5.3 TRANSITION TO BAU CASE STUDY: SMARTER HV AND MV CUSTOMER CONNECTIONS PROJECT

Under this innovation project, the methods used by ESB Networks to determine how to connect our customers to the distribution system, namely The Distribution System Security and Planning Standards, were fundamentally reviewed in collaboration and consultation with stakeholders to establish how the standards needed to evolve to meet the changing needs of our customers in a lower-carbon future.

To ensure best practice, ESB Networks carried out a comprehensive review and critique of existing planning standards and new innovative approaches to distribution network development, both here in Ireland and internationally.

A key deliverable from the innovation project was the development of new standards, and their implementation into BAU. The new standards were approved by the CRU in September 2020 and are published on our website, and the changes have been briefed out to all Planners. Some changes are already in BAU, while others will require an implementation phase / trial before fully implementing into BAU.

Among the changes to the Standards are increased transparency through the inclusion of more detailed distribution network planning criteria and information, such as security of supply standards, asset loading levels, voltage regulation standards and network development policies.

Other changes include:

- The inclusion of the introduction of Non-Firm Access (NFA) connection arrangements for Distribution Connected Distributed Generators (DG) which will facilitate increased DER on the network supporting Ireland's 2030 targets. This will be part of BAU under the upcoming ECP 2.1. For more information, see Non-Firm Access Connections for Distribution Connected Distributed Generators Guide.
- The inclusion of the introduction of Non-Wires Alternatives (NWA) or 'Flexibility' services to maximise the use of existing network assets, reducing the levels of network reinforcement required wherever possible, while also facilitating the lowering of connection charges and costs, and the shortening of connection times. A trial to test NWA is currently underway with a project called "Net-Flex" (see Section 4.6). Results from this trial will contribute to the future development of NWA for BAU. For more information, see Non-Wires Alternatives to Network Development Guide.
- The inclusion of the technical criteria applied to the assessment of Energy Storage facilities (e.g. Battery Facilities) when such sites are used to provide System Services. This has moved to BAU.
- The inclusion of an interim capacity provision for the expected future growth in microgeneration connections which is strongly supported under the Climate Action Plan 2019. This interim measure was subject to further collaboration and consultation with stakeholders in Q4 of 2020.

Another key deliverable from the project which has transitioned to BAU was the development of a Load Indices (LI) Approach and this was used in the Price Review (PR) 5 submissions to the CRU. This approach allows heavily-utilised HV Stations to be identified, which can be used as an indicator for prioritising work programmes and investment plans. This demonstrates how ESB Networks leverages its existing assets efficiently, providing better value for money for customers. This approach was developed in consultation with stakeholders and approved by the regulatory authority.

These changes and innovative approaches to network planning will ensure that the networks designed today and into the future will facilitate increased DER on our network and flexible NWA solutions for distribution network development, while catering for the changing needs of our customers. This should enable Ireland's energy policy objectives to be reached in a more cost-effective manner, while ensuring that the security of supply is equal to, or where appropriate even greater than, what is delivered today.

6 WORK WITH US ON THE INNOVATION JOURNEY

We are very clear in ESB Networks that the challenge of enabling the transition to a low-carbon Ireland cannot be delivered without extensive and collaborative innovation. ESB Networks is committed to leading the transition and knows we must continue to innovate further and faster to increase the volume of renewable generation connected: to increase the speed with which new generation is connected; to support the timely implementation of the National Climate Action Plan and the European Clean Energy Package; to facilitate the wholesale electrification of transport and heat; to improve network resilience; to manage intermittency; to support energy communities, microgeneration and active customers; and to move the dial on the many fronts required to make an increasingly low-carbon grid a reality.

We must build on our history of innovation, maintain an agile mindset and ensure the processes we have in place and the solutions we implement are capable of responding to a rapidly changing world. This report has summarised how ESB Networks is collaboratively implementing new ideas, innovative concepts and technologies that will provide enduring benefits for our customers. We have shared our approach to innovation including our overall framework, strategy, governance, processes, dissemination, feedback and progress.

Join us on the journey, this transition to the network of the future, by sharing with us your ideas, challenge our approach and continue to hold us to account. We want to hear your views on how ESB Networks delivers innovation, and whether we are focusing on the right innovation projects.

Please send your comments and feedback to **innovationfeedback@esbnetworks.ie**