NETWORKS

INNOVATION IN ESB NETWORKS

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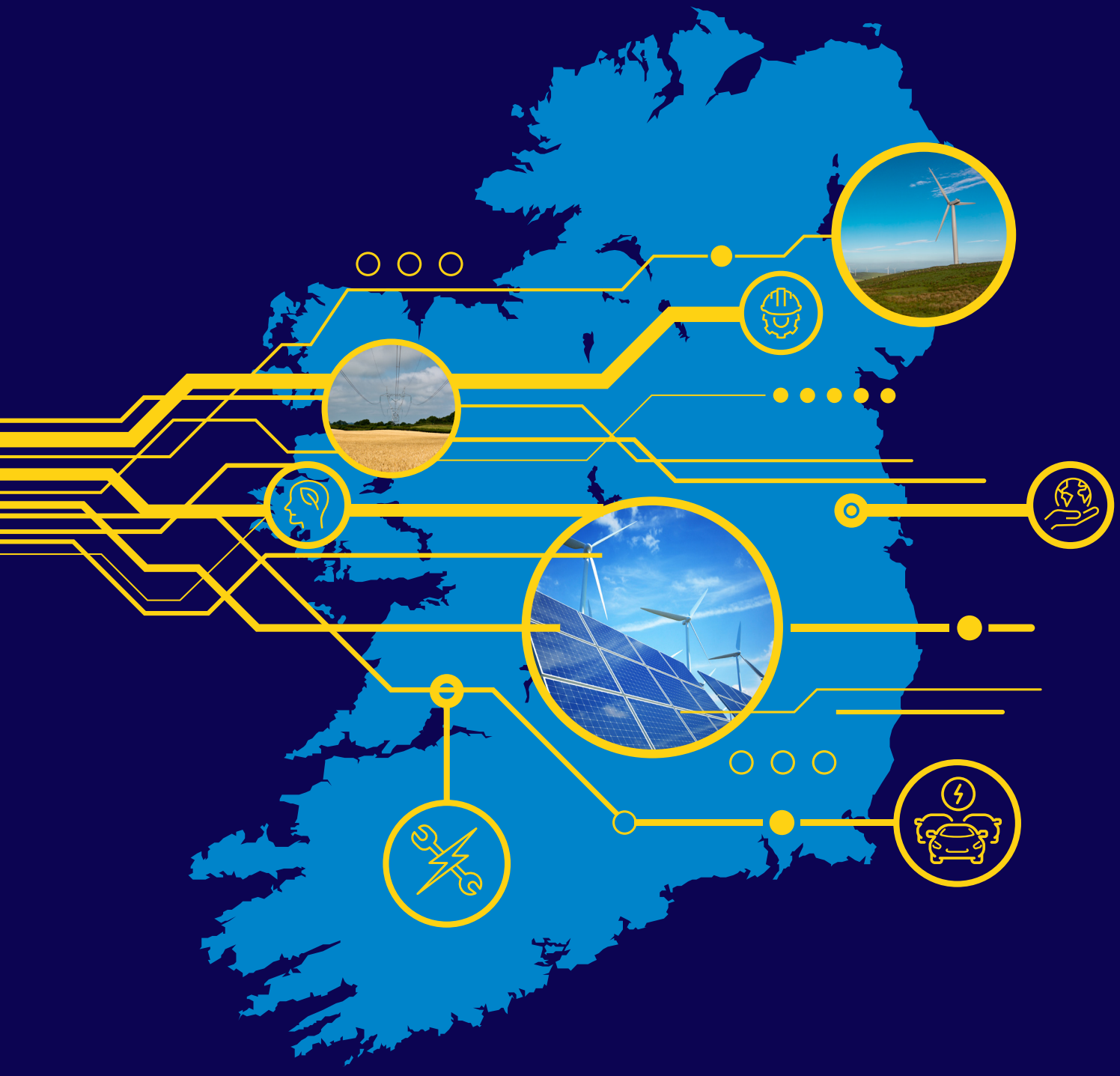

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FOREWORD

Building on a history of Innovation

ESB Networks is committed to playing its part in leading Ireland's transition to a low carbon future powered by clean electricity. The challenge of an Ireland powered by secure, affordable and zero carbon electricity will take far more than the technologies, techniques and business models we use today. At ESB Networks, we understand the importance of working cooperatively with many stakeholders from EirGrid, customers, and generators to service and technology providers, research institutions, SEAI and CRU to develop, test and implement innovative solutions. The challenge of enabling a low carbon Ireland powered by clean electricity builds on our history of innovation, bringing light, heat and power, safely and reliably, to every Irish home, business and community since 1927.

A strong foundation

To us, the purpose of innovation is to develop and implement new ideas with enduring benefits for our customers. Consistent application of this principle has been the foundation for one of the most progressive electricity networks in the world. This network has enabled Ireland to become a world leader in industry and technology, and a location of choice for foreign direct investment. Over the past ten years, together with EirGrid, we have innovated to connect and sustain a system with over 4,000 MW of renewable generation producing over 30% of Ireland's electricity during 2018. Our network developments have played a central role in the emergence of a new industry, supporting 540 MW of hi-tech datacentre load. These developments have been facilitated by the implementation of a world-class IT platform, enabling an active distribution management system. We have done this while introducing new technology and techniques to improve network resilience as we experience, respond to, and learn from the increasing frequency of adverse and extreme weather events.

Through 2018

Throughout 2018, we have actively contributed and shared the value of our innovation programme in a range of industry and stakeholder forums, both nationally and internationally. Listening to and learning from the priorities of customers, stakeholders and other distribution system operators has helped us to identify and validate our innovation activities and find opportunities to collaborate. In 2018, our flagship Dingle project provided ESB Networks with an excellent opportunity to collaborate with local communities as we explore the impact and capabilities of new low carbon and adjacent technologies and how customers and communities interact with new energy systems. In Dingle we are testing and trialling solutions which will help us to develop the decarbonised, decentralised and digitised electricity system of the future.

Innovation in **ESB Networks**

Innovation Strategy

This report provides a summary of our innovation activities – innovation projects and ideas organised into eight Innovation Strategy Roadmaps covering the areas of Connecting Renewables; Customer Engagement; Electrification of Heat and Transport; Asset Optimisation; Flexibility on our Networks; Operational Excellence; Network Resilience and Working with the TSO. It describes how ESB Networks are looking to collaboratively implement new ideas and innovative concepts and technologies that will provide enduring benefits for our customers as we support the transition to a lower carbon economy.

The Challenge for 2019

We are very clear that the challenge of enabling a low carbon Ireland powered by clean electricity cannot be delivered without extensive and collaborative innovation. Innovation 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 Clean Energy Package; to facilitate the wholesale electrification of transport and heat; to improve network resilience; to reduce network costs; 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.

ESB Networks' challenge for 2019 is to innovate further and innovate faster. We look forward to working collaboratively with our many stakeholders to rise to this challenge. We welcome your comments and feedback on the activities highlighted in this document.

Paddy Hayes

Managing Director,
ESB Networks

August 2019

INTRODUCTION

Our Innovation Vision and Values

Our vision is that ESB Networks are innovating towards a sustainable low carbon energy future for our customers and Ireland. Our vision and values serve as the foundation of our innovation strategy, informing every new idea and the development of every project:

Leadership: We are committed to playing a leading role in providing innovative solutions for Ireland's energy future.

Collaboration: We believe collaboration with all stakeholders is essential to delivering the innovations needed to deliver a low carbon energy system.

Customer Value: We understand that innovation must have a commercial focus and provide value for our customers.

Social Benefit: We believe innovations must deliver enduring benefits for Irish society.

Empowerment: We understand that ensuring Ireland's future energy needs are met requires empowering customer participation in electricity generation and storage.

Our Mission

Our mission is to play a leading role in Ireland's transition to a low carbon economy, and to provide secure, sustainable, reliable electricity in an affordable manner for all customers.

In support of Ireland's commitment to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, ESB Networks' Innovation Strategy has been devised to facilitate Ireland achieving its climate change targets which will require us to reduce CO2 emissions by 40% (relative to 2005) by 2030.

The Role of Innovation in ESB Networks

Our definition of Innovation is to implement new ideas for the enduring benefit of our customers and business.

Consistent application of this principle has been the foundation for one of the most progressive electricity networks in the world—a network that has enabled Ireland to become a world leader in industry and technology, and a location of choice for foreign direct investment. Our innovation activities operate across the three broad horizons of innovation: Incremental, Breakthrough and Radical. Innovation is not limited to our "dedicated innovation teams", rather is encouraged across the organization as we seek to challenge the status quo to find more innovation solutions across the range of activities in our business.

INNOVATION STRATEGY & SCOPE

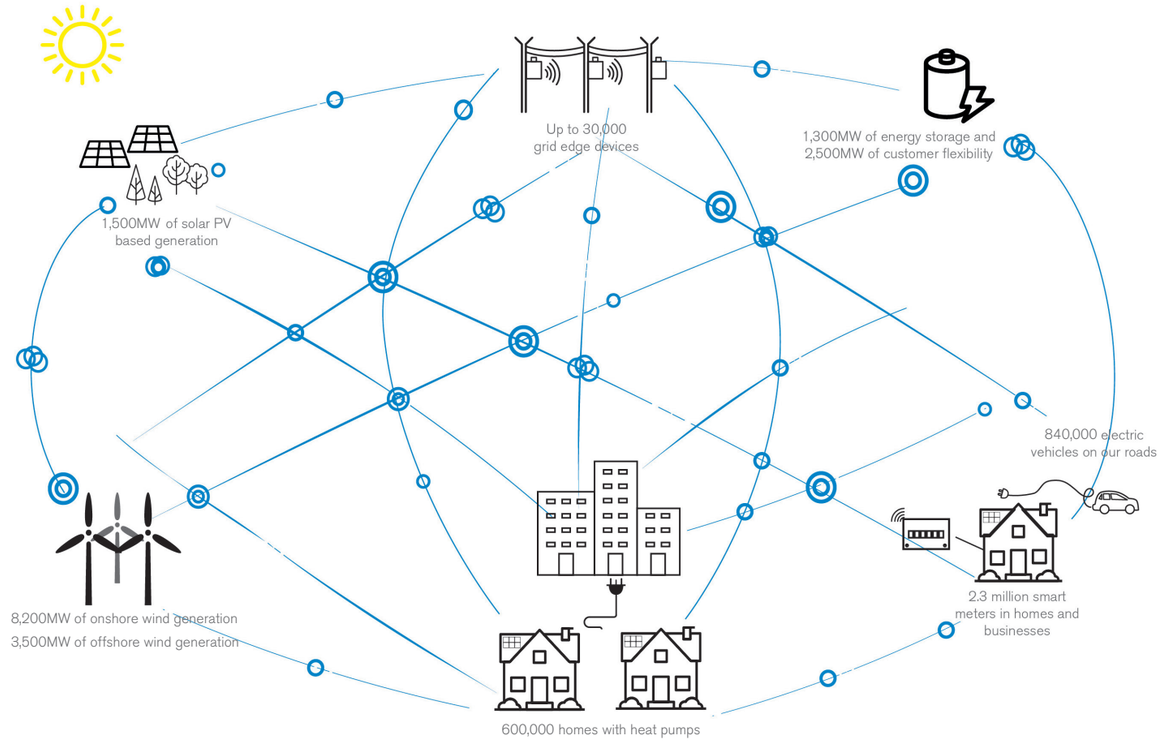
Innovation in **ESB Networks**

ESB Networks Innovation Strategy and Framework

The changing energy environment presents challenges but also offers great opportunities for innovation. The adoption of new materials and technologies, large-scale digital applications and big data analytics will create greater efficiencies, while electrifying the heat and transport sectors will offer a number of opportunities for our customers.

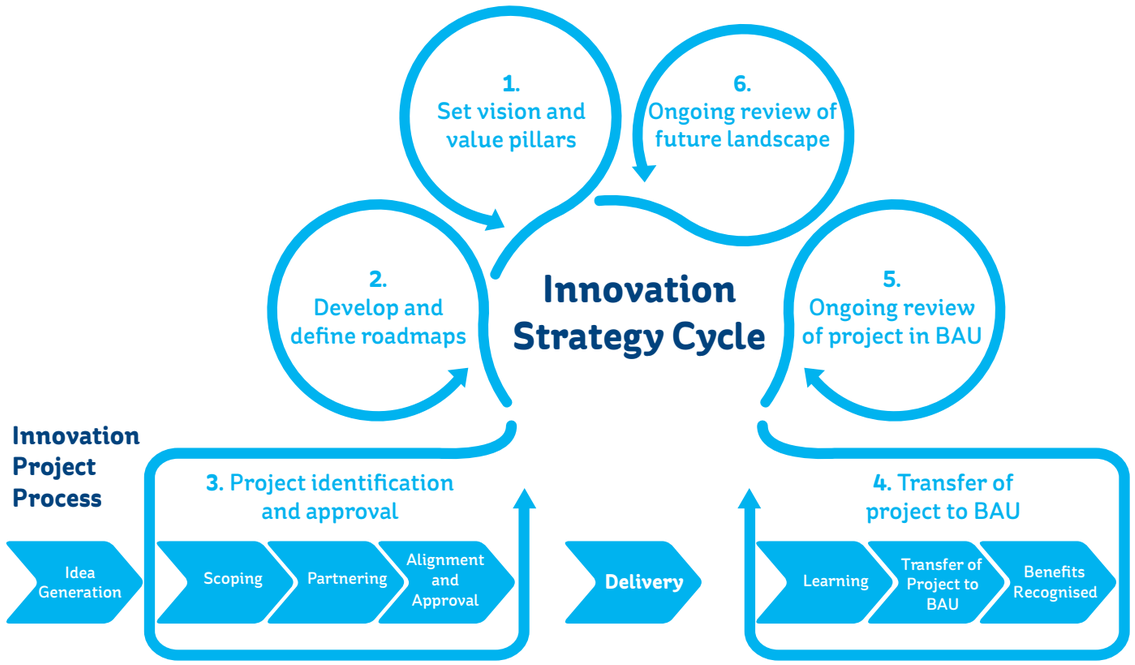
The identification of innovative opportunities for our customers and stakeholders is a key part of ESB Networks' Innovation Strategy. This requires us to consider the disruptive trends and identify how we see the energy landscape developing—in the next decade and beyond. We anticipate radical changes 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.

BY 2030, THE NETWORK WILL SUPPORT:



In order to realise our vision of delivering a sustainable, low carbon energy network that will serve Ireland's future energy needs, we have developed an Innovation Strategy Framework to manage every stage of the development and implementation of strategic initiatives, from setting the vision to establishing business as usual (BAU).

In developing the framework we reviewed best practice from other jurisdictions, worked with external consultants, and engaged in workshops with representative groups from across ESB Networks 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 untested innovation projects or trials and ensures an appropriate level of oversight.



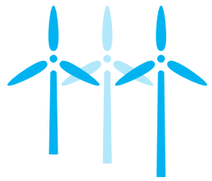
ESB Networks Innovation Strategy Framework

Innovation in **ESB Networks**

Eight Roadmaps: A Progression Plan to 2030 and Beyond

Our Innovation Strategy Framework is applied to a balanced portfolio of projects covering eight roadmaps that broadly cover our ambition to deliver new and improved services.

Connecting Renewables; Customer Engagement; Electrification of Heat and Transport; Asset Optimisation; Flexibility on our Networks; Operational Excellence; Network Resilience and Working with the Transmission System Operator (TSO).



Connecting Renewables

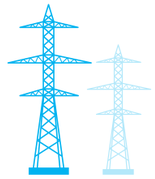
Flexibility on our Networks

Customer Engagement

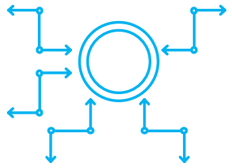
Operational Excellence

Electrification of Heat & Transport

Network Resilience



Asset Optimisation



Working with the TSO

Innovation in **ESB Networks**

INNOVATION PROCESS

Innovation in **ESB Networks**

From Identification to Delivery and Dissemination

To effectively implement our Innovation Strategy, we have developed an end-to-end process for the management of innovation initiatives across our business areas. An overview of our innovation process is presented here.

Our eight Innovation Roadmaps broadly define the scope of work and the areas where we have identified opportunities to deliver new and improved services.

Our strategic framework and ongoing efforts in collaboration and planning allows us to identify a number of potential projects. Active engagement with stakeholders and continuous monitoring 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.

Area	Process to Identify Innovative Ideas and Initiatives	Delivery of Innovation Projects	Dissemination of learnings from Innovation Projects
Process	Scoping, planning and opportunity identification across eight Innovation Roadmaps to achieve a balanced portfolio of projects Impact Assessment across scorecard metrics Risk assessment and mitigation planning Validation through active engagement channels	Ongoing project assessment process to monitor project status, evolution and outcomes Risk assessment and mitigation planning as appropriate Active engagement with partners and wider stakeholder Progressive project evaluation to determine project continuation, cancellation or merge with others as appropriate	Identify delivered benefits across the scorecard metrics Disseminate learnings into BAU operations and/or decision making Disseminate knowledge and learnings to the wider industry Identify opportunities to extend an innovation project to achieve additional benefits
Reporting	Project Proposal Investment Appraisal	Quarterly Update	Close-Out Report Industry papers and conferences
Governance	Governance is provided through our Innovation Governance Board (IGB). The IGB owns the Innovation Strategy and operates to the terms of reference approved by the Managing Director of ESB Networks. Includes a review every three years and reviews as necessary changing drivers that may affect specific Roadmaps. Each of the eight roadmaps have a designated sponsor who oversees the delivery of initiatives in specific Innovation Roadmaps.		

Risk Assessment and Mitigation

Risk assessment and mitigation is 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 IGB, which includes members of the senior management team as well as key operational staff.

The governance of our Innovation Strategy includes oversight of the project process and the delivery of roadmaps in accordance with our vision and values. In addition to a comprehensive review every three years to assess potential changes affecting specific roadmaps, standardised processes have been devised to evaluate areas including proposals, investments, and close-out reports.

While the membership and structure of the IGB changed as a result of an operational effectiveness review in 2018, its aim remains to ensure the collaborative implementation of new ideas that will provide enduring benefits for our customers.

Assessing the benefits of innovation on network users and consumers

We have developed standard Investment Appraisal templates, which are used for each innovation opportunity identified. Included with each appraisal is a set of scorecard metrics, which are 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 Retail Market Services; Environment; and Engagements and Social Obligation. Each innovation opportunity is assessed as either Significant, Moderate, Minor or Non-Applicable.

The results of recent impact assessments in the section titled Innovation Project Portfolio.

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 Retail 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
Engagements and Social Obligation	Customer service, public policy, ESB Networks' role in leading transition to lower carbon economy

Assessing Innovation Beyond Business-As-Usual (BAU)

The innovation framework that ESB Networks has put in place requires those proposing innovation projects to reflect on whether their idea is over and above BAU. The framework works off the definition that innovation is "the implementation of new ideas with enduring benefits". This includes any changes to our existing techniques and processes that results in net benefits to customers.

The project proposer/sponsor assess their innovation idea using standard templates, i.e. Project Proposal, Investment Appraisal templates, and as such are required to consider the following:

1. what are the benefits potentially associated with the project,
2. what options or alternatives exist,
3. what are others in industry doing about the same issue, and
4. what are the risks associated with not pursuing it.

Reflecting on these questions and going through this assessment process ensures that ESB Networks continue to implement new ideas as per our innovation definition and that the threshold for consideration is more than simply BAU.

Strategic Validation Through Collaboration with Stakeholders and Third Parties

As we transition to a low carbon future, we have an important role in understanding the variety of commercial and technical challenges facing the energy industry. These challenges will require us to collaboratively implement new ideas to provide enduring benefits for our customers. Our Innovation Strategy will evolve to reflect the rapidly changing energy landscape. Ongoing stakeholder engagement to consider consumer and industry foresight, as well as third party collaboration to share knowledge, identify opportunities and validate our innovation plans are a feature of implementing our Innovation Strategy.

In addition to our customers, key partners include the CRU, national and EU government departments, local communities, EirGrid, academia and industry. In 2018, collaborations with national industry bodies included discussions on a range of innovation topics as well as engagements with customers and their representatives. These included the Irish Wind Energy Association (IWEA), the Irish Solar Energy Association (ISEA), Demand Response Aggregators of Ireland (DRAI), the Irish Farmers Association (IFA), Irish Wind Farmers Association (IWFA), the Irish Bio Energy Association (IrBEA), demand response and energy storage stakeholder groups, and the Distribution Code Review Panel (DCRP).

Validation Case Study: Distribution Planning and Security of Supply Standards Review

The objective of this review of distribution network planning and security of supply standards will ensure that the system will enable Ireland's energy policy objectives cost effectively whilst ensuring that the security is equal to, or where appropriate even greater than what is delivered today. It is acknowledged however that delivering the most cost effective operation and design of a future distribution network, and thus the development of these standards by ESB Networks, cannot be done in isolation. To support this activity, a number of engagement activities have been instigated. Crucially we have collaborated with industry on the terms of reference, project plan and associated stakeholder plan for the project, giving advance warning of engagement in 2019 including formal consultation on draft standards. This was achieved by workshops and meetings held with Meitheal na Gaoithe IWFA, IWEA, DRAI, solar energy groups including representatives from ISEA, bio-energy groups (including representatives from IrBEA).

Continuing support of the consultation process was achieved by regular updates here held in 2018 via DCRP which has a range of industry stakeholders.

INNOVATION PROJECT PORTFOLIO

Innovation in **ESB Networks**

Our Innovation Strategy was launched in late 2017 which presented the eight roadmaps. At the beginning of 2018 we had 57 active projects or trials. Over 2018, 16 projects were completed and the others continued to progress.

A list of the 2018 projects, including those that were completed, are outlined below. By the end of 2018, over 20 ideas were identified for further consideration and possible progression into our roadmaps.

This reflects the fluid and dynamic nature of innovation in this rapidly evolving sector.

As part of our investment appraisal process, we have developed an impact assessment framework of the innovation projects against a set of scorecard metrics discussed previously. The summarised result of this impact assessment is presented in the table below.

Roadmap	Project	Safety	Network Reliability & Resilience	Facilitating Growth & New Connections	Customer and Retail Market Services	Environment	Engagements and Social Obligation
Connecting Renewables	Distrihost - Mapping Network Capacity						
	Distribution Planning and Security Standards Review						
	Big Data Analytics for Wind farm Connections						
	Solar PV Trials						
	Wind farm Reactive Power Optimisation						
Customer Engagement	Customer Experience Programme						
	Customer Communications Channels						
	New Connections Enhanced Service and Online Portal						
Electrification of Heat and Transport	LV Planning Standards Review						
	Introduction of Sidewalk Transformer						
	Future LV Design Handbook						
	Introduction of MV/LV Tap Changing Transformer						
	Heat Pump Cluster Impact Assessment						
	Winter Peak - Intelligent Secondary Substation Monitoring						
	Introduction of 1MVA Unit Substation Transformer						

Legend: Not Applicable | Minor | Moderate | Major

Roadmap	Project	Safety	Network Reliability & Resilience	Facilitating Growth & New Connections	Customer and Retail Market Services	Environment	Engagements and Social Obligation
Asset Optimisation	Introduction of Fibre Glass Stay Blocks						
	Leveraging Fibre Infrastructure for Smart Network Management						
	Development of Dynamic Line Ratings						
	Introduction of Alternatives to Creosote Wood Poles						
	Inspection of Overhead Lines Using Drones And Image Processing Analytics						
	Data Analytics to Temperature Correct Loads						
	Development of HV Stations Health Index						
	Amorphous Core Transformer						
	LoRa & Sigfox Trials						
	SCADA Digital Polling Radio						
Flexibility on our Networks	RE-SERVE –Customer Flexibility						
	Superhomes 2.0 – Flexible ASHP Customers						
	RealValue - Balancing Heat and Electricity Demand						
	Dingle Project						
	StoreNet - Customer Side Energy Storage						
	Positive CityExChange (+CityxChange)						

Legend: Not Applicable | Minor | Moderate | Major

Roadmap	Project	Safety	Network Reliability & Resilience	Facilitating Growth & New Connections	Customer and Retail Market Services	Environment	Engagements and Social Obligation
Operational Excellence	Smart Networks - SCADA Future Ready System						
	Staff Digitisation Programmes						
	Staff Mobile Applications						
Network Resilience	Storm Resilience for Overhead Networks						
	LV Auto-Reclose on Intermittent Faults						
	Smart Network - New Core and Aggregation IP Network						
	SUCCESS Cyber Security in Future Networks						
	Improved Continuity for 20 kV Sensitive Earth Faults						
	Smart Network - National Radio Access Network Project						
	SOGNO - Smart Monitoring for Increased Resilience						
	Data Analytics For Meter Fraud Detection						
	Open Visibility Trial						
	Weather Forecasting and Network Damage Prediction						
Working with the TSO	Wind Farm VAR Blackbox - Nodal Controller for Reactive Power						
	New RoCof Settings for Distributed Generators						
	Facilitation of Fast DS3 System Services						
	Implementation of Congestion Management And Capacity Allocation Platform via OMS						

A brief overview of each of our current innovation projects follows, for further information or feedback on any of these projects, please contact innovationfeedback@esbnetworks.ie

Legend: Not Applicable | Minor | Moderate | Major

Connecting Renewables

To date large-scale onshore windfarms have provided the main source of renewable generation. In recent years we have also seen new Distributed Energy Resources (DER) apply for and connect to our network. These new technologies include solar photovoltaic (PV), Combined Heat and Power (CHP) and biomass. These technologies are now developing market momentum.

We aim to examine the impact of increased connection of DER and renewables on our future electricity system, and establish how our planning standards and policies need to evolve to support their connection.

The following outlines the portfolio of projects undertaken by ESB Networks under the Connecting Renewables roadmap.

DistriHost: Mapping Connection Capacity

Status: Ongoing

Key partners / stakeholders: ERPI

Overview: As we connect more DER such as large-scale renewables, microgeneration and energy storage onto our distribution network we need to ensure this is done in the most cost-effective way while maintaining a safe, secure and stable system. This can only be done by first determining what capacity is available on our network to connect DER.

The DistriHost project is an EPRI collaboration to develop a set of tools that will evaluate the capacity on our network to accommodate DER without adversely impacting power quality or reliability under current network configurations and without required infrastructure upgrades.

The aim of the project is to equip our network planners with tools to quickly visualise and understand the impact of DER across our distribution network. This will be done by using EPRI's hosting capacity method to analyse large numbers of MV feeders.

The tools developed should enable areas where there is capacity available to connect renewables onto the distribution system to be easily identified. This should aid network planners to quickly evaluate the Least Cost Technically Acceptable (LCTA) connection method to connect DER to the electricity system.

Distribution Planning and Security Standards Review

Status: Ongoing

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

Overview: The most fundamental issue regarding the future evolution of our planning and security standards is whether it prescribes economically efficient investments, given the many changes affecting the energy market at present. These changes include the large-scale deployment of non-network technologies such as Demand Side Response (DSR) and energy storage and the changing role of the customer. This gives rise to the need for a fundamental review of the baseline philosophy of distribution network planning, operation and design to ensure that Ireland's energy policy objectives can continue to be met economically and sustainably whilst ensuring that the security is equal to or where appropriate even greater that what is delivered today.

The review will consist of two distinct phases. Phase 1 is a comprehensive research, analysis and modelling engagement and consultation process.

Phase 2 will take forward the recommendations settled upon in Phase 1 and begin the process of bringing these changes into business as usual. This will take the form of codification of these changes in our Distribution System Security and Planning document and if necessary, in our other codes and approved regulations.

Big Data Analytics for Wind farm Connections

Status: Ongoing

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 windfarms 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. The learnings of this project should also feed into the Distribution Planning and Security of Supply Standards Review project.

Solar Photovoltaic Trials

Status: Complete

Key partners / stakeholders: Tipperary County Council, Tipperary Energy Agency, Nenagh Leisure Centre

Overview: It is anticipated that solar PV based generation will become a major part of Ireland's energy system with a significant portion connected directly to the distribution network. By 2030, it is predicted that ESB Networks will have connected over 1,500 MW of solar PV based generation. This project took advantage of newly installed solar PV generation at the ESB Networks National Training Centre in Portlaoise. The plan is to integrate the PV system into the DER Management System (DERMS) developed within the EU Horizon 2020 RESERVE project and merge into the Dingle project scope. This will allow the presentation of solar PV performance data in a standardised format with other DER devices deployed by ESB Networks.

Wind farm Reactive Power Optimisation

Status: Ongoing

Key partners / stakeholders: UCD, Enterprise Ireland

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

Key outputs from the project will be insights into the benefits this device may bring to the overall energy system that could be used to inform what regulatory changes might be required to achieve these benefits. The changes may have operational ramifications that need to be understood before any regulatory changes are considered.

Customer Engagement

ESB Networks has over 3,000 staff and more than 2,000 work directly with customers every day, including those in the call centre, Network Technicians (NTs) and Engineering Officers (EO's). As consumers come to expect and migrate to digital services, ESB Networks must ensure it remains responsive to the needs of our customers.

A number of customer engagement channels were assessed and added in 2018 to keep up with consumer demand and communications trends. While social media has proven to be a valuable means of considering customer foresight, ESB Networks' managed platforms are a priority for innovative development.

In 2018 explorations into SMS, interactive voice and web chat began as a means to diversify our customer engagement offering and ensure accessibility for all customers.

The following outlines the portfolio of projects undertaken by ESB Networks under the Customer Engagement roadmap.

Customer Experience Programme

Status: Ongoing

Key partners / stakeholders: MCCP

Overview: ESB Networks has over 3,000 staff and over 2,000 work directly with customers every day, either in the call centre responding to customer queries or Network Technicians (NTs) and Engineering Officers (EO's) who meet customers across the country in their daily work.

This project will develop an innovative customer engagement programme for all customer-facing ESB Networks staff. This will involve market research, customer focus groups, briefings, training events, standards, checks and a focus on embedding a customer culture across ESB Networks. Considerable research was carried out in 2018 by MCCP external research agency to understand customer perceptions and investigate areas for improvement.

In Q4 2018 we undertook research with our field staff to find out customer pain points, recommendations on how we can enhance the customer journey and what innovations we can bring about to improve the customer experience. A social media listening report was conducted for 2018 to understand the general public's perception of our reputation and service delivery performance and understand the causes of negative comments and issues customers face.

Customer Communications Channels

Status: Ongoing

Overview: While our customer care centre in Cork is a valuable resource for engaging with customers (in 2016 having been awarded the CCA Excellence Award for Contact Centre of the Year and in 2018 having received accreditation for the 11th year running), our customers require a more diverse and innovative mix in communication channels which will meet their future needs and will lead to improved customer satisfaction levels.

There are a number of projects in motion already which will enhance current communication channels as well as new platforms to reflect the new digital applications that our customers use:

- Powercheck
- Social Media - Twitter, YouTube, Facebook and Instagram
- SMS communications - Fully automated system for outages which is more efficient than the traditional postcard notification.
- Web chat - Having a web chat presence will allow customers to ask questions while on the website and will also deflect calls into the call centre
- Interactive Voice Response (IVR) - A new IVR system was completed in 2018 offering additional functionality and resilience and giving a better customer experience.
- Vulnerable customers - Vulnerable customers are given priority queuing in the IVR system and additional notice of planned outages and overnight unplanned outages.

Innovation in **ESB Networks**

New Connections Enhanced Service and Online Portal

Status: In progress

Key partners / stakeholders: Red C Research (internal), Ipsos MRBI

Overview: This project originated from a review of the New Connections process that was carried out in 2017 driven by findings from our Red C research highlighting customers concerns with the process. In addition, the upturn in the economy in the past few years has resulted in an increase in demand for New Connections from both domestic and commercial customers.

A further review was carried out with representatives of all those involved in getting a customer connected, reviewing reports, customer research, assessing how other Distribution System Operators (DSOs) provide this service and examining the information available to the public through our leaflets, documents and website.

Another key enhancement to the process is the development of an online new innovative connections portal project to deliver the following:

- New online Customer Connection Application forms and update existing online forms
- Registration (using Microsoft Azure B2C) to facilitate secure upload of customer files like drawings, photos etc.
- Tracking facility for Domestic and Commercial customers whose demand exceeds 100 kVA

Electrification of Heat & Transport

As our customers choose technologies including air source heat pumps (ASHPs), storage heating, private electric vehicles (EVs), electric buses, freight and trains in ever higher numbers, greater demands will be placed on the network.

ESB Networks must innovate in network planning and operation, to meet these new demands, without compromising our customers' comfort, security or quality of supply, and at an economic cost reflecting our customers' needs and values.

The following outlines the portfolio of projects undertaken by ESB Networks under the Electrification of Heat and Transport roadmap.

LV Planning Standards Review

Status: Completed

Overview: Our existing planning strategies employ evidence based, validated assumptions regarding customers' use at different times of day, treating most domestic customers as a homogenous group. Emerging low carbon technologies and DER such as EVs, ASHPs, energy storage and domestic PV generation will increasingly challenge these assumptions, as will changes in how customers choose to manage their demand, for their ownuse purposes (e.g. storing locally generated electricity) or coordinated with others (e.g. managed by aggregators, peer-to-peer trading).

The LV Planning Standards Review comprehensively reviewed and critiqued existing LV planning approaches. This is informing effective development of our LV design solutions so that we can effectively meet the demands of these new uses of the distribution system.

This project involved robust statistical analysis to derive new metrics, values and design tools. The analysis leveraged the results of past trial and projects including the National Smart Meter Customer Behavioural Trial and ESB Networks EV impact assessments.

Introduction of Sidewalk Transformer

Status: Ongoing

Overview: The electrification of heat and transport will lead to increased demand loads and potentially congestion on LV networks as the networks were not originally designed with these low carbon technologies in mind.

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

Miniature secondary substations, known as sidewalk transformers, are a solution to such spatial restrictions 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 use this technology to increase capacity for electrification in our LV networks for housing schemes.

Future Low Voltage Design Handbook

Status: Ongoing

Overview: The emergence and uptake patterns of new low carbon technologies and DER such as EVs, ASHPS and micro-generation including PV, and demand response will drive significant changes in how we plan and operate the LV network. The Future LV Design Handbook project will deliver consistent design approaches for new and existing LV networks supporting the economic integration of customers low carbon technology.

The LV design solutions being pursued through this project can be broadly segregated into new design solutions and retro fit solutions. They represent sensible and cost-effective proactive and reactive measures that can be deployed reasonably quickly in response to low carbon technology uptake patterns.

They include for example:

- Revised guidelines for the installation of new infrastructure
- New guidance for the retrofit of existing infrastructure integrating new technology such as: Sidewalk transformers, MV/LV tap changing transformers and energy storage

Introduction of Medium/Low Voltage Tap Changing Transformer

Status: Ongoing

Overview: ESB Networks' investment planning standards provide for defined voltage drop on the MV and LV systems. 10% of this is allocated upstream of the LV bus bar and the balance is allowed for on the LV network.

As LV load increases due to installation of ASHPs and EVs, the voltage drops on the LV network will increase. Ensuring that this does not impact customers' quality of supply would normally require substantial conventional reinforcement. ESB Networks is investigating innovative alternatives which may provide more economic solutions. One approach is to regulate the sending LV voltage using MV/LV on load tap changing transformers. These would allow for larger voltage drops and greater voltage variation on the LV network without compromising customers received voltage.

Pilots in Ireland will allow us to evaluate the operational implications of their use on the Irish system which has its own technical characteristics compared to other jurisdictions, identify and design for the practical issues regarding their installation on the Irish system, and determine how best to integrate them with our existing network technologies and with Irish customers' usage patterns.

Heat Pump Cluster Impact Assessment

Status: Ongoing

Overview: The uptake of ASHPs in domestic dwellings will represent significant load growth, driving the development and update of our LV planning standards and designs. These changes must be evidence-based, and as such, in this project we are monitoring a number of new build locations with clustered ASHP installations. The data gathered will be analysed to develop robust models informing revised planning standards and designs. Building on our current research work around MV/LV transformer monitoring, ESB Networks will install transformer monitoring devices in both unit substations and pole mounted transformers feeding estates with ASHP installations.

Winter Peak – Intelligent Secondary Substation Monitoring

Status: Ongoing

Overview: The anticipated increase in new LV technologies such as EV chargers, ASHPs and PV based microgeneration, battery storage and renewable microgeneration could cause electrical effects or impacts on the LV distribution system. These network impacts are not fully understood yet by ESB Networks. They could cause power quality problems by affecting a range of electrical parameters such as voltage, phase angle, current, active and reactive power as well as harmonics. The LV network needs to facilitate needs to accommodate the new lower carbon technologies while ensuring it does not exceed its technical design capabilities.

This project is about the design, development, installation and operation of a standardised MV/LV monitoring device that is able to gather electrical parameter data on the LV distribution system. Analysing that data will assist ESB Networks in integrating new technologies onto the network ensuring that the network does not become an obstacle to deployment of DER.

Innovation in **ESB Networks**

Introduction of 1MVA Unit Substation Transformer

Status: Ongoing

Key partners / stakeholders: CG Power Systems Ireland Ltd

Overview: This project is trialling small compact transformers which can be retrofitted into smaller spaces to provide extra capacity for the electrification of heat and transport. A modern unit substation design has been made to accommodate either a 440 kVA or 630 kVA transformer. It has two limitations - the available footprint for the transformer and the ability of the unit substation housing to vent excess transformer heat to allow operation at full load.

This project is looking at developing a 1MVA compact transformer solution whose heat output is no greater than those transformers used in existing unit substations that could be retrofitted into the available footprint of an older unit substation design.

If successful this would allow existing unit substations in over-developed locations to be uprated to 1MVA and for new 1MVA unit substations in new housing estates to be installed using the existing unit substation design.

Asset Optimisation

It is essential for ESB Networks to assess the advances in materials and technologies relating to network assets, and to understand how they can be deployed to optimise existing network assets.

The following outlines the portfolio of projects undertaken by ESB Networks under the Asset Optimisation roadmap.

Data Analytics to Temperature Correct Loads

Status: Ongoing

Key partners / stakeholders: SCADA, Met Éireann

Overview: This project is using data analytic 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 would be required based on SCADA load data and temperature data from Met Eireann. Load, temperature and weather conditions for each MV circuit can be used to set an appropriate temperature correction factor for each. This will result in a baseline temperature corresponding to realistic worst-case conditions would then be set and all loads 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.

Leveraging Fibre Infrastructure for Smart Networks Management

Status: Ongoing

Key partners / stakeholders: SIRO

Overview: SIRO intend to deploy fibre to the building (FTTB) services to over 300 urban locations in Ireland. The roll out of this service involves the deployment of fibre optic cables which pass close to primary and secondary substations. ESB Networks has reserved a single pair on all SIRO fibre for operational use.

The fibre will run alongside existing ESB Networks equipment. The objective of this project is to identify the best method of deploying ducting to attain a viable fibre route between SIRO Point of Isolation (POI) and primary/ secondary substations.

ESB Networks intend on delivering communication services over operational fibre to backhaul information and potentially control secondary substations. This project will also trial different types of use cases over different technologies.

Development of Dynamic Line Ratings

Status: Appraisal Stage

Key partners / stakeholders: EirGrid

Overview: A meteorological driven increase in cooling effect on overhead lines would allow for an increase in transmission and distribution line ratings. This project is about the development of a model that accounts for ambient meteorological parameters changes such as temperature, wind speed and wind direction allowing increased line rating that leads to a greater operational flexibility. This project would look to build on learnings from other jurisdictions and look to identity the appropriate innovation solution to the Irish system and environment.

Innovation in **ESB Networks**

Introduction of Alternatives to Creosote Wood Poles

Status: Ongoing

Overview: ESB Networks has installed over 2.2 million poles across the LV and MV networks. These poles have traditionally been creosote 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 will examine materials application using Fibre Glass Composite Poles, Steel Poles, Concrete Poles, Laminate Poles and Hybrid Poles. The second part of this project aims to investigate alternative treatment types that could protect wooden poles once the use 'B oil' and 'C oil' creosote allowance expires.

Inspection of Overhead Lines Using Drones and Image Processing Analytics

Status: Ongoing

Key partners / stakeholders: University of Limerick, EirGrid

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 and then the inspectors are deployed to carry out visual inspections on all structures and equipment associated with the line by climbing the structures. Some drawbacks associated with this traditional means of inspection are: limited range of visibility for inspections; dependant on accessible locations on the structures; outages are required to carry out the inspections. This project aims to explore the application of new drone technology and associated analysis as an innovative alternative to the traditional line inspection approach.

A specification will be produced to engage a service provider to inspect all transmission lines using drones. The service provider will have at their disposal Corona, UV, Radiometric Thermal and Infrared cameras and the survey work will also include:

- Recording galvanising thicknesses on steel structures – to indicate whether the tower needs to be painted
- Tower Footing Resistance measurements – to indicate whether extra Potential Control rings etc. are required
- Soil Resistivity measurements – to indicate whether extra Potential Control rings etc. are required.

Introduction of Fibreglass Stay Blocks

Status: Completed

Overview: Wind stay wires supports are used in ESB Networks to support poles where the foundations are weak and where end poles/angle poles are used. The wind stay wires supports are used on LV/MV/38 kV and 110 kV overhead lines that are built with wooden poles.

The stay wires are attached to the top portion of the poles and the stay wires in turn are anchored into the ground using treated wood that are assembled to make up stay blocks. The stay block depths can vary from between 1.2 and 3m depending on the pole size they are fixed to. The stay blocks can be a single sleeper arrangement or made up of a number of sleepers fixed together in order to make up the bearing surface that is required to support the pole/ poles and conductors/equipment.

This project was about sourcing and trialling fibre glass as innovative substitute for existing wood material stays for end and angle overhead line poles. The trial was to consider learnings in regards to material science characteristics, handling and installation as well as life time cost given the realities of wood rotting in the Irish climate.

Development of High Voltage Stations Health Index

Status: Ongoing

Overview: This project will develop the first phase of a functioning Health Index for all HV Substations. A project is currently being developed to widen the application of this project to other asset categories. The project will involve reviewing current end to end maintenance activities and mapping current business processes to allow a specification document to be produced for tender enquiry purposes.

ESB Networks is looking for a solution that facilitates the collation of asset related data via mobile device deployment in the field, capturing executed maintenance activities via mobile devices with associated work order management. The solution also should update the Asset Health database with said activities, generate reports and performance review dashboards as well as analyse gathered data to allow Health Index computation. The project will also involve the piloting of a current vendor offering to demonstrate 'proof of concept', thus enabling the above specification/tender enquiry process.

Amorphous Core Transformer

Status: Completed

Overview: Amorphous Metal Distribution Transformers (AMDT) proposes a lower electrical loss design solution compared to traditional transformers. They are designed with a unique alloy whose structure of metal atoms occurs in a random pattern and is used in lieu of conventional Regular Grain Oriented (RGO) silicon steel. AMDT cores possess a different grain structure with much lower resistance to magnetization cycles, which leads to reduced core losses. This innovation project is about evaluating the suitability of AMDT transformers on the Irish system and in particular evaluating whether the reduced core losses of this unique material offers sufficient benefits when deployed on the Irish network.

LoRa & SigFox Trial

LoRa Status: Ongoing

SigFox Status: Completed

Key partners / stakeholders: Networks Telecoms, Dingle Project, Net Feasa, Actility, Trinity College

Overview: Innovative telecommunications technologies are being developed which create opportunities for industry (including Utilities) and individuals in society to benefit from increased communications. Such technologies include LoRa, Sigfox and NB IoT. These low power technologies are designed to provide low cost solutions for telecommunications which can be deployed in large volumes nationwide. There is a wide range of uses for these technologies in ESB Networks as a whole.

LoRa: The objective of the LoRa trial was to verify its functionality and evaluate its coverage. LoRa can either be provided through a 3rd party network (where there's coverage) or it can be deployed by ESB Networks in locations of interest. ESB Networks Telecoms are working with the Dingle Project to conduct trials in the region. The Dingle project has an agreement with a third-party network provider (Net Feasa) to provide trial services. ESB Networks Telecoms have engaged with Trinity College and industry players to plan the trial.

SigFox: The SigFox trial verified the functionality of this technology and evaluated its coverage in Ireland. VT Networks operate the Sigfox network in Ireland.

Innovation in **ESB Networks**

SCADA Digital Polling Radio

Status: Completed

Key partners / stakeholders: Magdalene

Overview: This is a radio-based communications system used to provide communications circuits for Supervisory Control and Data Acquisition (SCADA) traffic between approximately 550 HV substations and the Distribution Control Centre (DCC) in Leopardstown. As part of the project ESB Networks' has implemented the following:

- Rollout of Digital Polling Radio system for SCADA communications to provide nationwide resilient and secure UHF radio communications connecting 564 HV Stations via 80 radio base stations (which are co-located on Networks Telecoms Wide Area Network) with DCC.
- Implement cyber security standard AES 256, which is a NIST approved encryption standard for all wireless 'over air' communications traffic.
- Commission Network Management System (NMS) to provide remote monitoring and management from ESB Networks, Telecom Operations Centre (TOC) of the full suite of deployed infrastructure.
- Remote monitoring and management will enable faster fault resolution, reduce requirements for site visits by engineers and will provide advance notice of any system deteriorations.

Flexibility on Our Networks Project Portfolio

Traditionally, large fossil fuel based generation provided flexibility on our systems. New flexibility technologies such as energy storage, vehicle to grid (V2G), web based domestic control systems, Smart Meters, advanced information sensing, advanced data analytics and new supplier business models are now emerging to take the place plant of large fossil fuel generators and decarbonize flexibility.

The aim of the Flexibility on Our Networks roadmap is to understand the impacts and the possibilities provided by the use of flexibility in the overall electrical energy system and also develop systems and processes that cost effectively enable the provision of flexibility from within the distribution network.

The following outlines the portfolio of projects undertaken by ESB Networks under the Flexibility on our Networks roadmap.

RE-SERVE – Customer Flexibility

Status: Ongoing

Key partners / stakeholders: UCD, EU Horizon 2020 RESERVE, 10 consortium partners

Overview: The requirement to significantly decarbonise the Irish economy presents specific challenges to electricity networks in relation to the cost-effective facilitation of small-scale renewable generation and the provision of infrastructure to enable the electrification of heat and transport. Such challenges are emphasised by the predictions for mass adoption of EVs, ASHPs, solar PV generation and battery storage systems at both a global and national level.

ESB Networks are engaged in the EU H2020 funded RESERVE project with 10 other consortium partners developing a solution to the challenge of accommodating up to 100% renewable generation on electricity networks. As the sole Distribution System Operator (DSO) in the consortium ESB Networks are focused on voltage control techniques which utilise inverter-based technologies to provide voltage support to the distribution network.

We are currently testing the performance of such techniques in the field through the deployment of specifically developed field trials incorporating a solar PV generation array, domestic battery systems, V2G charging system and an ASHP installation. We have integrated the control and monitoring of these field devices into a single scalable control platform which acts as the first DER Management System (DERMS) deployed on the Irish network.

StoreNet – Customer Side Energy Storage

Status: Ongoing

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

Overview: StoreNet is a project formed by a consortium including IERC, ESB Networks, Solo Energy and Electric Ireland to validate the performance of domestic behind-the-meter energy storage on the distribution network. The aim of this project is to smooth generation and consumption peaks to increase the energy carrying capability of our network and reduces network losses.

Superhomes 2.0 – Flexible ASHP Customers

Status: Ongoing

Key partners / stakeholders: International Energy Research Centre (IERC), Tipperary Energy Agency (TEA), Limerick Institute of Technology, Electric Ireland

Overview: The retrofitting of buildings is projected to contribute 42% of Ireland's target (13,430 GWh) within Ireland's 2020 Energy Strategy. The Superhomes 1.0 concept was developed to demonstrate how the Near Zero Energy Building (NZEB) standard can be achieved in residential retrofit situations. The Superhomes 2.0 project, builds on the success of its predecessor, and is aimed at optimising further the operation of ASHPs while still maintaining homeowner comfort.

Innovation in **ESB Networks**

ESB Networks are engaged in the IERC co-ordinated Superhomes 2.0 project with four other consortium partners in order to develop an understanding of the impact of ASHPs in newly retrofitted residential dwellings on the distribution network and the associated electrical demand in general.

We have installed interval meters at 20 diverse premises located throughout the country in order to accurately record the premises' energy usage. In addition we have obtained the ASHP usage data for the specific dwelling from consortium partners in order to understand the relationship between ASHP operation and overall domestic consumption.

SERVO – Medium Voltage Pilot with Demand Side Units (DSU)

Status: Ongoing

Key partners / stakeholders: CRU, Waterford Institute of Technology

Overview: Each Demand Side Unit (DSU) acts as an aggregator for a portfolio of Individual Demand Sites (IDS), which are ESB Networks customers and they operate and bid into the market as negative loads. It has been observed that activation of an IDS can lead to congestion issues on the distribution network and it has been decided to effectively deselect sites where congestion occurs. This requires ESB Networks renewable planning team to go through an exercise annually to determine what sites are deemed to be deselected for the summer months. In this project, ESB Networks is investigating the SERVO platform to provide a service allowing DSR aggregators the maximum capability to dispatch DSR without compromising network performance and integrity.

RealValue – Balancing Heat and Electricity Demand

Status: Completed

Key partners / stakeholders: EU Horizon 2020 project, Glen Dimplex, EirGrid, Intel, SSE, UCD and Oxford University

Overview: This EU Horizon 2020 project, in collaboration with Glen Dimplex, EirGrid, Intel, SSE, UCD and Oxford University, seeks to investigate how electricity usage for small scale storage of heat in the residential sector, optimised by controlled aggregation could bring technical and economic benefits to the energy system overall. There will be three physical demonstration locations where the Smart Electric Thermal Storage (SETS) shall be installed into 1,250 homes in Germany, Ireland and Latvia. The trial will be validated by large scale, techno-economic modelling.

In the Irish trial, the SERVO platform to will be used to manage the impact of these SETS devices on the local distribution network. The project will also evaluate the capability of this technology to enable renewable energy integration and provide demand side management as a service to reduce the peak load.

Dingle Project

Status: Ongoing

Key partners / stakeholders: DCU, UCC, MaREI

Overview: By 2030, in order to meet Ireland's challenging targets for emissions reduction and renewable generation, much of our transport and heat needs to be electrified. To enable this transition the electricity system will need to become more resilient and have the additional capacity to cater for this increase in electrical load. This increase in capacity and resilience needs to be done economically in order to accommodate the requirements of our customers and society.

In an effort to fully comprehend and frame the realities of this new era in energy, ESB Networks is developing the Dingle testbed. This flagship project is the largest innovation program ESB Networks will have undertaken to date. The focus of the project will be on developing knowledge and understanding of how networks and customers of today and the future can flexibly participate in the energy system for overall societal benefit. We have identified four foundational areas that we need to implement as part of the testbed to realise our ambitions:

- Overlay of smart devices and systems to the existing distribution network infrastructure enabling Vision, Control, Optimisation and Flexibility of the LV/MV system.
- Development of a platform for control of devices and applications.
- A resilient, and extensive IoT platform.
- Active energy citizens who embrace new technology and services in the energy sector.

Delivering this project will allow ESB Networks to understand that challenges and benefits associated with highly flexible electricity systems underpinned by IoT infrastructure, smart devices and systems and a platform that enables management of devices and applications which in turn empowers customers to transition to the active energy citizen persona. This knowledge will ensure we will be well positioned to deliver the services required by our customers in 2030.

Positive CityExChange (+CityxChange)

Status: Ongoing

Key partners / stakeholders: EU Horizon 2020 and a consortium of 32 partners, including Limerick City and County Councils from cities in 11 countries, including Norway, Romania, Czech Republic, Spain, Bulgaria and Estonia

Overview: This five year project is led by Limerick City and County Council along with the city of Trondheim in Norway and working with five other follower cities, Alba Iulia (Romania), Pisek (Czech Republic), Sestao (Spain), Smolyan (Bulgaria) and Voru (Estonia), the project will develop through citizen engagement a series of demonstration projects on how to become smart positive energy cities.

In Limerick a new "community grid" will be trialled with the use of intelligent meters, innovative new energy sources (including hydrokinetic energy), electrical energy storage, digital tools and citizen participation to create a Distributed Positive Energy Block and District (DPEB) in Limerick city centre. The focus of ESB Networks activities will be to support the integration of the DPEB in the distribution network and provide the regulatory and technical advice and guidance to enable concepts such as peer-to-peer energy trading and the Energy Community Utility (ECU) to be trialled.

Innovation in **ESB Networks**

Operational Excellence

Delivering a future-ready network service and ensuring operational excellence requires a deep understanding of where, how, when customers use the network, why faults occur, and having the ability to deploy solutions quickly. Central to these efforts is the empowering employees with the technology necessary to gather, manage and analyse network data.

The following outlines the portfolio of projects undertaken by ESB Networks under the Operational Excellence roadmap.

SCADA for Future Ready System

Status: Ongoing

Overview: Supervisory Control and Data Acquisition (SCADA) is a business critical 24x7 Operational Technology system which allows ESB Networks to control and monitor the distribution power network. The SCADA system IT enables ESB Networks to operate the distribution network in a manner which is consistent with safety, security, continuity, quality and environmental standards.

The Future Ready project will involve installing new hardware and software to cater for the future expansion in the distribution network, future changes to the way the electricity system will be used and the increase in distribution automation devices, Internet of Things (IoT) and smart networks.

This project will provide a SCADA platform where ESB Operations can continue to safely monitor and control the distribution network. It increase visibility and control and facilitate future distribution automation and IoT devices enabling ESB Networks to maintain continuity of supply during normal and storm conditions. In addition to this the upgraded system will be designed to have enhanced cyber security features ensuring ESB Networks is compliant with the EU Network Information and System Security (NIS) Directive.

Staff Digitisation Programmes

Status: Ongoing

Overview: ESB Networks has approximately 1950 field staff. The business prioritised facilitating 'connecting' our workers and providing new and innovative means to access our systems.

From 2015 to 2018, 550 Apple iPads and 1,100 Apple iPhones were deployed. The devices have been deployed and managed with the safety of our staff and the general public as the foremost concern. They have allowed staff to spend more time at an asset without the need to return to depots for paper instruction or designs.

Deliverables include the launch of new cloud-based document management sites like OneSource (using Microsoft SharePoint) for all safety documentation and the newly redesigned drawings and diagrams repository called Design Hub.

Other new initiatives associated with the deployment of new devices include electronic issuing of work packs, the use of portable thermal cameras and the V.ALRT Safety initiative for lone workers.

Staff Mobile Applications

Status: Ongoing

Overview: The nature of the work in ESB Networks requires a large number of its staff to be "field" based, i.e. working away from the office. The majority of field staff are Network Technicians (NT's) who are carrying out work on different sites and in different locations throughout the day. Traditionally these staff have been unconnected to the internal IT system.

One of the key areas that the Operational Excellence Roadmap concentrates on is the provision of mobile applications for staff working remotely. We have created an ESB Networks app store where staff can download apps that will help them to do their jobs. The following are some of the current and planned mobile applications. Existing apps that are already available on the app store include MyJSSP, MyDepots, MySiteFinder, MyCustomers, MyPatrols, MyForms, MyQualifications, MyDWA, and MySafetyPins. The design and development of an enterprise mobile solution, MyTime is currently underway to replace the paper timesheet process used by field staff.

Innovation in **ESB Networks**

Innovation in **ESB Networks**

Network Resilience

As extreme weather events and cybersecurity threats become more frequent, and our economy electrifies, ESB Networks will need to build network resilience to mitigate disruption, ensure the security of supply.

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

Storm Resilience for Overhead Networks

Status: Scoping

Overview: Overhead line assets 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 cyclic 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 increases the resilience of overhead networks to storm conditions. This project will trial a number of 'Hardening' initiatives on an MV outlet and its continuity performance will be tracked. The Project scope includes:

- Selection of a line on the Western Seaboard with a history of timber and storm related outages.
- Establishment of a larger than standard vegetation exclusion zone on the three-phase backbone line.
- Trialling of smart reinforcement techniques for vulnerable areas of the network.

LV Auto-Reclose on Intermittent Faults

Status: Completed

Overview: Faults on the LV overhead network in urban areas generally result in a fuse blowing to isolate the faulted network. Most of the faults on the rural overhead LV network are caused by clashing or falling timber and are transient in nature as the timber clashes and generally falls clear a short time later. Similar to overhead lines, intermittent faults can occur on underground cables caused by penetrating rainwater that evaporates at time of fault or aluminium and copper pitting in incorrect made cable joints.

Trials have been conducted in the Dublin to improve LV overhead network performance. Trials of a number of new technologies have been carried out which would operate in place of traditional circuit fuse. Two pieces of unique equipment, the REZAP Modular and BIDOYNG, were effective at reducing the number of outages and have been selected for more extensive use.

Smart Network - New Core & Aggregation IP Network

Status: Ongoing

Overview: The ESB Networks' telecommunications networks consists of multiple platforms over various mediums and is the main means of providing connectivity for system critical services for the electricity network. The range of critical services that will require connectivity on the telecommunications 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.

SUCCESS Cyber Security in Future Networks

Status: Completed

Key partners / stakeholders: EU Horizon 2020 partners

Overview: This EU Horizon 2020 project aims were to design, develop and validate, on small scale field trials an adaptable security framework, which is able to significantly reduce the risks of cyber threats and attacks when metering systems are deployed as part of grid applications. The SUCCESS project developed three use cases which incorporated security, resilience, survivability and privacy.

The Irish trial site (ESB Networks in Leopardstown) performed the use case emulating the mass attack on EV chargers. The Romanian trial site simulated an attack on smart meter developed in SUCCESS in a PV installation. The Italian trial site simulated a cyber attack on demand response service and cyber-attack on a DSO electrical storage system. The RWTH Aachen laboratory in Germany hosted all of the innovative components developed in SUCCESS. The SUCCESS project considered both electricity networks and the communications networks and IT capabilities that support them as both networks are equally important in the safe and reliable delivery of electricity to our customers.

Improved Continuity for 20 kV Sensitive Earth Faults

Status: Completed

Overview: Sensitive Earth Fault (SEF) are difficult to detect as they have very low fault current values. During SEF operation, the protection device does not attempt to automatically reclose the circuit breaker to test if the fault conditions are still present. This means that every time the SEF conditions are present the customers connected to that circuit will be disconnected until the fault site is visited to ensure that there are no public safety concerns at the fault location.

This project's aim was to trial new innovative new approaches to SEF to improve the continuity of electrical supply to customers. It did this by reducing the range over which SEF operates while maintaining high levels of fault detections. This project trial found that the changes had a positive impact on reducing customer minutes lost by increasing by 5% the chance of preventing a fault going from temporary to permanent and demonstrating a small reduction in occurrences where stations fully trip out. It reduced the call outs to sites to restore permanent faults.

Smart Network - National Radio Access Network Project

Status: Ongoing

Key partners / stakeholders: Huawei, Nokia

Overview: The existing telecoms infrastructure on ESB Networks' Telecom's network is designed to support connectivity to primary substations from 38 kV to 400 kV. Connectivity beyond the substations is currently supported by public radio networks such as Vodafone GPRS links.

The development of a reliable cyber-secure national wide area radio access network, independent of the public mobile operators, is needed to meet the demand for machine-to-machine data communication for the control, protection and management of utility assets. This National Radio Access Network project will involve the development of a dedicated wireless network for the reliable transport of data for future smart grid applications. This network will enable the replacement of many of the current systems dependent on public mobile networks such as, distribution automation, fault passage indicators and energy meters, and will also provide new systems with their communication needs. The network will also enable large scale connection to individual devices for asset management purposes. To that end Networks Telecoms are trialling long-term evolution (LTE) technology with vendors Huawei and Nokia and preparing to secure the necessary spectrum and frequency license over which the data transport will take part.

Innovation in **ESB Networks**

SOGNO – Smart Monitoring for Increased Resilience

Status: Ongoing

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 will 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 aims to trial solutions that may increase resilience of existing systems and reduce customer minutes lost (CML).

Data Analytics for Meter Fraud Detection

Status: Completed

Overview: ESB Networks are working to identify meters that have been tampered or interfered with. Such interference poses significant dangers to those tampering with the meters, to ESB Networks staff, to members of the public and to the emergency services. The majority of suspect interference cases are reported by ESB Networks staff or contractors following readings or call outs to premises.

With the use of data analytics ESB Networks is pursuing a new avenue in identifying metering anomalies. ESB Networks is developing a tool that is able to identify suspicious readings. It developed an algorithm that is able to rank a pool of different meter readings based on statistical probability. ESB Networks revised the initial algorithm to a more complex version that is fine-tuned over time as more data is collected and analysed. The expected roll out of smart meters should lead to an increase in data volume and allow further fine tuning of the algorithm. The intent is to have a machine learning algorithm that fine-tunes itself with years of historic and more granular data which will be enabled by the roll out of smart meters.

Open Visibility Trial

Status: Ongoing

Overview: To manage in real time overloads and voltage excursions on the network, ESB Networks uses SCADA technology to monitor conditions at various points on the network. This provides both visibility and control to the ESB Networks controller to intervene remotely, or direct a local intervention in response to a change in monitored state of an asset.

Currently SCADA visibility and control does not extend to the LV Network. It is likely that facilitation of increased customer participation in DSR will require some form of visibility of the LV network, with control interventions in some circumstances.

This project intends to demonstrate how visibility could be provided at the LV side of an MV/LV pole mounted transformer by trialling an LV monitoring device. A home automation device shall be installed downstream. This visibility device shall then be tested to communicate with the home automation device for DSR.

Innovation in **ESB Networks**

Weather Forecasting and Network Damage Prediction

Status: Ongoing

Overview: Climate change is predicted to lead to more frequent extreme weather events. To help increase ESB Networks network resilience and adapt to climate change, this project looks to introduce a system that achieves the following objectives.

- 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 Eireann system (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 events and local continuity data in conjunction with the look ahead forecast.
- The system will be used alongside the existing Operational Technologies to forecast damage and outage numbers to relevant stakeholders and feed into the ESB Networks response to major weather events.

Working with the TSO

As Ireland works meet its renewable energy targets, distributed generation assets will increasingly play a role in contributing to the national power supply. In order to ensure the security and sustainability of the system, EirGrid launched the DS3 Programme. As the DSO, ESB Networks is working with the TSO to deliver the DS3 through a number of programmes designed to deliver innovative technologies, processes and standards to ensure that non-synchronous generation from renewables such as wind, deliver maximum benefit and minimal disruption to the network and our customers.

The following outlines the portfolio of projects undertaken by ESB Networks under the Working with the TSO roadmap.

Wind Farm VAr Blackbox - Nodal Controller for Reactive Power

Status: Ongoing

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 windfarms, to use centralised and automated intelligence, to allow as much reactive power support as possible to be delivered to the TSO-DSO interface whilst at the same time, respecting voltage and thermal capabilities of the distribution network. The 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. The pilot was carried out on Topology B wind farms to deliver transmission support functionality at the TSO-DSO interface whilst ensuring that all distribution voltages and current limitations were maintained and protected. It has now been proposed that this solution be considered for other types of wind farms e.g. Topology C.

New ROCOF Settings for Distributed Generators

Status: Completed

Overview: The increase in the proportion of renewables based non-synchronous generation connecting to the electricity system has the impact of reducing system inertia. This means that for a given disturbance on the power system, the frequency will vary more and at a faster rate than previously.

This has a particular relevance for distribution connected generation since ESB Networks, like most DSOs, has traditionally used Rate of Change of Frequency (ROCOF), as a means to detect the occurrence of local islanding, for which the generator needs to disconnect. To cater for these variations in frequency, in a renewables dominated grid, a new threshold of 1 Hz/s for ROCOF has been mandated.

This project involves the implementation of settings changes to protection on generators across the distribution network, so that generators will stay connected to support the grid during system wide frequency events and are still able to detect local islanding events. This programme is a necessary enabler to ensure that we increase system frequency stability, maximise the benefits from renewable generation and deliver on Ireland's 2020 Renewable Energy targets.

Facilitation of Fast DS3 System Services

Status: Completed

Key partners / stakeholders: TSO, CRU

Overview: The TSO, EirGrid, through the DS3 programme has 14 system services including 3 fast-acting services (Fast Frequency Response, Fast Post Fault Active Power Recovery and Dynamic Reactive Response) to ensure frequency and voltage stability on the transmission system.

These system services or flexibility products are typically provided by existing generation and demand customers who are connected to the distribution network. The provision of these services by DSO connected customers in a way that does not impact negatively on other connected customers is essential. It is crucial to understand and quantify these impacts on providing these services will have on the distribution network.

To do this, ESB Networks has used models, validated by trial results where possible, of these customers when providing these services. The learning will be used as an input to the existing planning approaches and the Distribution Planning and Security Standards Review where appropriate.

Implementation of Congestion Management and Capacity Allocation Platform via OMS

Status: Scoping

Overview: DSUs are aggregated market players, and they comprise a portfolio of IDSs, which are usually connected to the distribution system. In 2015, it became apparent that the activation of these IDS, as part of the market activity, had the potential to cause local congestion issues on the distribution network. As a result, the DSOs issues Instruction Sets to confirm whether DSUs are suitable to participate in the market or whether they would exacerbate the situation based on their location.

ESB Networks conducts manual planning studies annually to identify restricted IDS (Red Sites) that are not able to participate in the market as they could exacerbate existing congestion. ESB Networks is evaluating new capability to enable near-time instruction sets to be issued to market players. ESB Networks and NIE Networks are looking to incorporate this new innovative functionality into a trial module of OMS called DER Management System (DERMS).

This result could be a step change in network observability such that every part of the HV and MV network will be visible in effectively real-time and enable us to predict network congestions to a much greater degree of granularity.

COLLABORATION, ENGAGEMENT AND DISSEMINATION

Innovation in **ESB Networks**

Collaboration and Engagement

ESB Networks collaborates with a wide range of stakeholders in our innovation activities. These include academic institutions, government entities and organisations, Irish suppliers and generators as well as new energy actors such as DSUs.

Collaborations and Engagement with Academia and Research Organisations

ESB Networks has extensive engagements with academia and research across all areas of innovation. To fully appreciate the values and choices of our customers today and into the future, we have been working with UCD and UCC MaREI conducting socio-demographic projection models and customer engagement campaigns within the Dingle Project. To understand the digital services and platforms of the future energy system, we have been working with TU Dublin and WIT. To understand the future tools and services that we could use to enhance reliability on our networks, we are working with UL on Autonomous Drone Technologies. To understand the capabilities, services and roles of customer sited DER, we are working with UCD's Energy Institute in the Integrated Energy Laboratory within the EU Horizon 2020 RESERVE project. And to fully appreciate the role of the community and future energy needs of islands, we are working with NUIG within the Renewable Energy for self-sustAinable island CommuniTies (REACT) EU Horizon 2020 project. Other academic institutions that ESB Networks collaborates with include:

- International Energy Research Centre (IERC)
- ETIP SNET (European Technology and Innovation Platform – Smart Network for Energy Transition) WG1 Reliable, economic and efficient smart grid system
- EU Commission Working Group on "Grid System of the Future"
- Polito - Politechnico di Torino - Polytechnic University of Turin, Italy
- Universitatea Politehnica Din Bucuresti - Technical University of Bucharest, Romania (UPB)
- Rheinisch - Westfaelische Technische Hochschule Aachen - German Research University (RWTH)
- University of Bologna
- Vrije Universiteit Brussels
- University of Oxford
- Technical Research Centre of Finland Ltd (VTT)
- DIW - German Institute for Economic Research
- Trinity College Dublin
- Istituto Superiore Mario Boella
- Teeside University, UK
- Uppsala University, Sweden
- Austrian Institute of Technology
- Institute Mihajlo, Serbia

Collaborations with Irish and International Organisations

ESB Networks also undertakes significant external collaboration with Irish suppliers, generators and other external international parties/companies. The majority of our projects feature some industry involvement and various levels of collaboration. Illustrative examples of collaboration with Irish suppliers and generators in 2018 include:

- ESB Networks held regular meetings in 2018 with a number of industry groups to garner insights and feedback on a range of activities including IWEA, IWFA, DRAI, solar energy groups including representatives from ISEA, bio energy groups (including representatives from IrBEA).
- ESB Networks has collaborated with SSE (Retail) on the RealValue EU Horizon 2020 funded project and have also worked with SSE (Generation) on the Wind Farm Reactive Power Optimisation project.
- ESB Networks is collaborating with M-Power, Irish ESCO, on the +CityxChange project.
- ESB Networks is collaborating with Solo Energy, Irish ESCO, and Tipperary Energy Agency on the Dingle project.
- ESB Networks has given a number of innovation updates and engagement presentations to Irish industry representatives via the Distribution Code Review Panel (DCRP). Representatives of the following bodies were present at these sessions:
    - Embedded generators (solar)
    - Synchronous generators
    - Embedded generators (wind)
    - Major customers
    - PES (Public Electricity Suppliers) / Independent Suppliers
- Other EU working groups and committees ESB Networks have representatives on include: the Electricity Association of Ireland (EAI); the UK's Electricity Network Association (ENA); the International Council on Large Electric Systems (CIGRE); and Eurelectric (Union of the Electricity Industry in Europe).
- Utility-to-utility specific sessions were also held with other European utilities such as EDF and Iberdrola to share learnings and knowledge from our innovation activities.

Another one of ESB Networks' collaborative partners has been the Electric Power Research Institute (EPRI).

Our advisory role on EPRI's steering committee helps to inform its research and development programs and identify critical and emerging electricity industry issues. This level of thought leadership has ensured we adopt industry's best practices and solutions to deliver the most suitable solutions for our customers at the most optimal time.

In 2018 ESB Networks selected a number of project sets to collaborate on with ERPI. These include projects pertaining to energy storage and distributed generation, end use energy efficiency and DSR, DER integration, and distribution operations and protection.

Innovation in **ESB Networks**

Dissemination of Learnings Case Study: SUCCESS - Cyber Security in Future Networks

This EU Horizon 2020 project aimed to design, develop and validate on small scale field trials an adaptable security framework which is able to significantly reduce the risks of cyber threats and attacks when metering systems are deployed as part of grid applications. The safe and secure deployment of such metering is critical to enabling products and tariffs to be offered to customers enabled by these meters. Learnings from this project have fed into initiatives such as penetrative testing / cyber security risk assessments that are now planned for the telecoms networks. ESB Networks held an international seminar in Dublin in November 2018 showcasing the results from the project which was attended by national and international stakeholders in the power systems sector.

Disseminating of Knowledge and Learnings

We engage with key stakeholders who were either impacted by our innovation activities or who may have had an influence on our activities. The purpose is varied, ranging from seeking feedback to inform 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 engagements include:

- Project driven engagement such as with the Dingle Project; the Distribution Planning and Security of Supply Standards Review project; LV Planning Standards Review; and the Wind Farm VAr Blackbox project.
- Industry engagement which include us hosting and participating in a range of industry events. This was critical to effective consultation on the energy future and to the sharing of ideas and insights. By working with policy makers, the Liaison Group, working groups and expert panels, we can provide insights and leadership to the sector.
- Publication of information on our website such as details of our Innovation Strategy, the Dingle Project, the terms of reference and project plan associated with the Distribution Planning and Security of Supply Standards Review project, report on our preparations for electric vehicles on the distribution system.
- Participation in a number of public dissemination events where ESB Networks shared plans, outputs and findings of the Innovation Strategy and projects as appropriate for example the National Ploughing Championships and the SEAI Energy Show.

Innovation in **ESB Networks**

Engagement Case Study: Dingle Project

ESB Networks Dingle Project provides us with a trial location to assess new low carbon technologies and smart grid technology, consider associated consumer behaviour and uptake and understand the impact the distribution system. A number of engagement events have been held in Dingle in order to understand the requirements of the local community and share the objectives of our project particularly in encouraging active energy citizens.

We have appointed a number of ambassadors within the community through our Dingle Project Ambassadors Selection Process. This will help ESB Networks learn about consumer behavior towards new energy technology and encourages the broader communities interest in the project. We have supported the development of the Dingle Community Engagement Group (Dingle Board/North West Kerry Development (NWKD)/Marine and Renewable Energy Ireland (MaRIE)). We have also appointed a Strategic Community Engagement Resource. Finally, we have been collaborating with UCD, UCC MAREI, Dingle Community Energy Group, Northwest Kerry Development Board, SEAI, Tipperary Energy Agency and Solo Energy to deliver on these goals. We have also held a Project Launch, Ambassador Launch Event, Dingle Food Festival, Project Information Sessions.

BENEFITS, LEARNINGS, IMPACT & OPPORTUNITIES

Innovation in **ESB Networks**

Assessment of Benefits against Costs

ESB Networks conducts quantitative analysis and cost benefit analysis (CBA) for our innovation initiatives where possible however the nature of the innovation activity is that in some cases it is difficult to quantify in the traditional sense, as per conventional projects. In such situations ESB Networks considers qualitative assessments to provide the justification and analysis to support innovation projects.

To BAU and Beyond: Learnings and Outcomes from 2018

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

In 2018 our engagements were varied and ranged from soliciting feedback and suggestions, to sharing updates on project progress, to disseminating learnings via a range of industry events and research groups in Ireland and abroad. As this update has outlined, ongoing collaborations include working with international research and development organisations such as the EPRI, EU-funded working groups such as EU Horizon 2020, numerous academic institutions, as well as participating in a variety of industry conferences and events.

A number of projects that delivered benefits and learnings in 2018 and are transitioning into BAU are summarised in the table overleaf.

BAU Case Study: Improved Continuity for 20 kV Sensitive Earth Faults

This projects aim was to trial innovative approaches to Sensitive Earth Fault (SEF) to improve the continuity of supply to customers. It was successfully trialled in two locations Julianstown, Co Meath and Caherciveen Co. Kerry. The successful SEF review has now transitioned to BAU and is expected to bring the following benefits:

- 5% decrease in the probability of a fault going from temporary to permanent for 20 kV feeders.
- Increased continuity of customer supply.
- Reduced call outs to sites to restore permanent faults

Innovation Roadmap	Innovation Project Name	High Level Benefit	Specific Learnings and Outcomes
Connecting Renewables	DistriHost	Supporting more renewables and Distributed Energy Resources (DER) for a low carbon future	Developing innovative automated planning tools to simplify network connection studies and reduced time to issue connection offers
Customer Engagement	New Connections Enhanced Service Project	Better customer service using digital platforms to make connecting to the grid simpler	Technology options to deliver easier customer connections process
Electrification of Heat and Transport	Winter Peak Superhomes 2.0	Supporting electrification by using innovative monitoring and control to facilitate eheat and EV equipment	Informing future LV visibility strategy by developing a functional specification for an MV/LV monitoring device
	LV Planning Standards Reviews	New housing developments designed for future eheat and EVs	Changed LV standards to accommodate new power flows from eheat/EVs
Asset Optimisation	SCADA Digital Polling Radio SigFOX Demonstration Trial	Enabling a Smart Grid to create a future ready network and facilitate future electricity market models	Secure Reliable Cost Effective Smart Grid Communications
	Amorphous Core Transformers	Implementing innovative asset solutions to ensure we minimise losses.	Reducing distribution network losses AMDT currently not lowest cost technically acceptable solution for Ireland
Flexibility on our Network	Servo Flex - Increased Capacity for Demand Sites	Enabling a Smart Grid to create a future ready network and facilitate future electricity market models	Learnings on Smart Grid architecture and how to implement new cloud solutions in utility applications

Innovation Roadmap	Innovation Project Name	High Level Benefit	Specific Learnings and Outcomes
Network Resilience	SUCCESS Cyber Security	Enabling a Smart Grid to create a future ready network and facilitate future electricity market models	Learnings on cyber security threats when designing telecoms solutions for Smart Grid architecture
	LV Auto-Reclosing on Intermittent Faults	Improving safety and reliability of the network by reducing interruptions and durations through innovative	Potential improved continuity performance for certain types of equipment and faults
	Improved Continuity for 20 kV Earth Faults	Automation, monitoring and control techniques	
	Data Analytics Meter Fraud Detection	Developing innovative solutions to ensure improve safety for staff, emergency services and the public	Using machine learning algorithms to identify meter anomalies and tampering and reduce distribution network losses and improve safety
Working with the TSO	Wind farm VAr Blackbox	Supporting more renewables and DER for a low carbon future	Allowing wind generation to provide system support services to maintain system stability
	Rate of Change of Frequency (ROCOF)		New protection settings required to ensure the system remains stable during grid-wide frequency events and high wind dispatch scenarios while providing adequate islanding protection
	Facilitation of Fast Frequency DS3 Services		Devices providing the Fast Frequency Response (FFR) DS3 service (e.g. battery storage) should be treated in connection studies as disturbing loads

NEXT STEPS

Innovation in **ESB Networks**

Next steps

ESB Networks is committed to leading the transition to Ireland's low carbon energy system. We recognise that there are commercial and technical challenges facing the energy industry, but associated with this transition there are major opportunities. This is evidenced by our Innovation Strategy and the implementation that we have highlighted for our innovation activities in 2018. This report has summarised ESB Networks' innovation activities since the launch of our Innovation Strategy.

ESB Networks' ongoing challenge for 2019 is to continue to innovate further and faster. While our innovation activities delivered numerous successes in 2018, more must be achieved to deliver on Ireland's 2030 Climate Action Plan for 2030.

This requires building on our history of innovation, maintaining an agile mindset and ensuring the processes we have in place and the technologies we implement are capable of responding to a rapidly changing world.

- Hybrid RES grid connection trial
- Non-firm generation connection trial
- Distributed control of microgeneration for LV networks with large quantities of microgeneration
- Non-wires distribution network reinforcement trial
- Data analytics to inform electrification of heat and transport uptake
- Exploration of ASHP for Ireland's residential heating needs
- LV monitoring of key substations
- LV network modelling with smart meter data for future LV design
- Impact of inverter based load and generation on power quality and harmonics
- Assessment of LV infrastructure needs for upgrade to 1000V
- Installation of Arc Suppression Coils (ASC) for new RES connections
- Preliminary assessment of substation flooding risks using new OPW data
- MV arc suppression and faulted phase earthing hybrid protection
- Network operations in LV networks with large penetrations of domestic flexibility

Innovation in **ESB Networks**

One of the key priorities of our strategy is ongoing collaboration and communication of project results and insights with stakeholders.

As part of this ongoing collaboration and communication, we are interested to seek your views on our innovation processes activites and priorities to date as summarised in this update. In particular we are interested in feedback on our proposed new projects listed above.

We welcome any feedback you may have via innovationfeedback@esbnetworks.ie

Innovation in **ESB Networks**