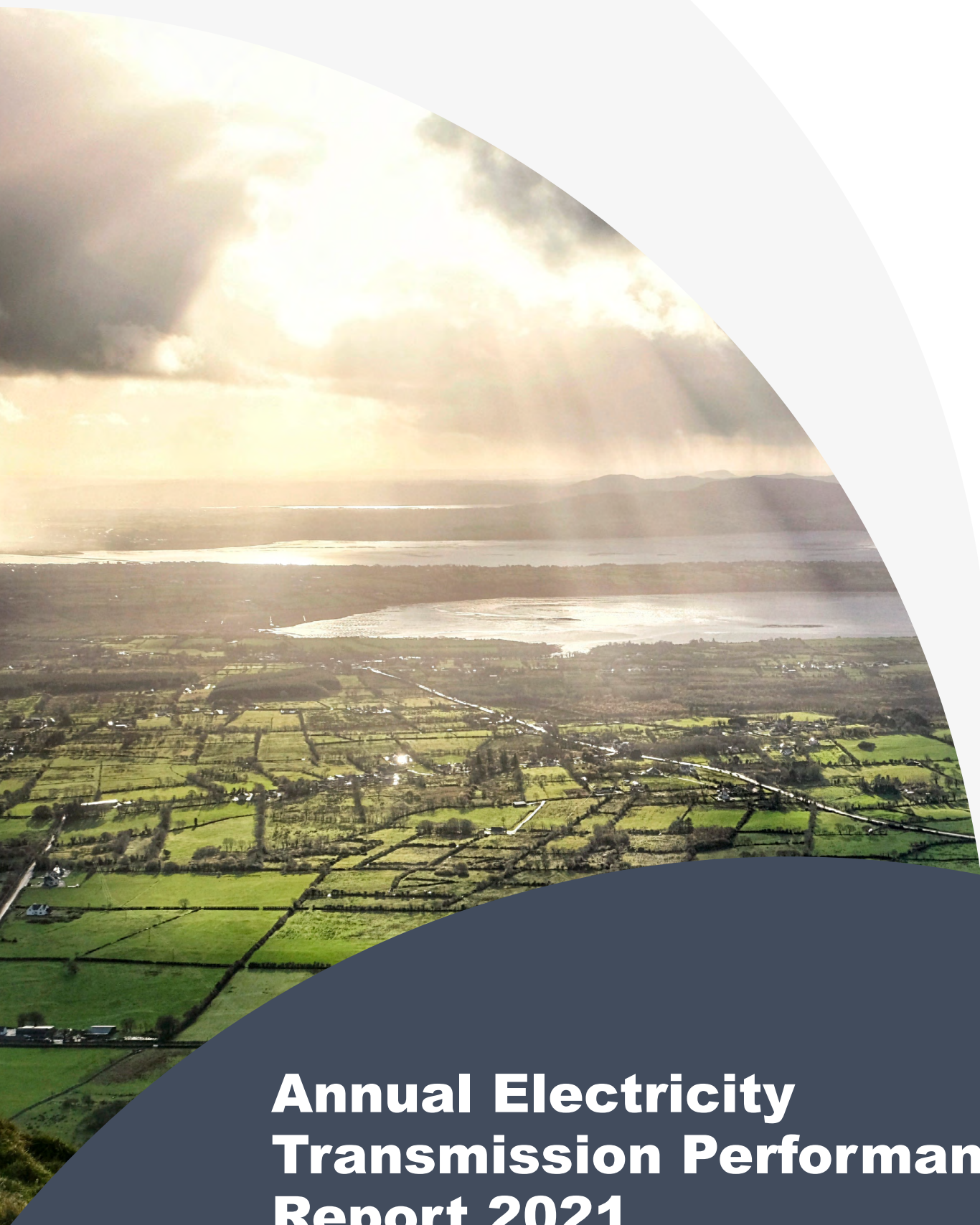




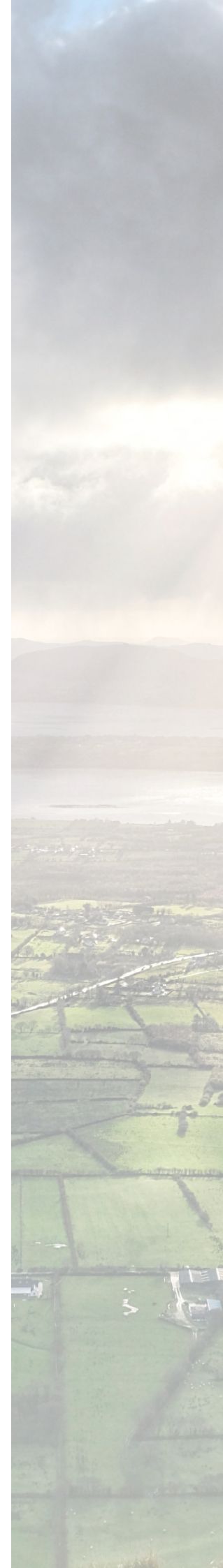
NETWORKS



Annual Electricity Transmission Performance Report 2021

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Welcome

Welcome to the fifth annual EirGrid and ESB Networks' Electricity Transmission Performance Report. This report seeks to provide customers, industry and stakeholders with clear and accessible reporting on our operation, development and maintenance of the transmission system.

2021 was the first year of Price Review Five (PR5). The PR5 Determination¹ contains the Commission for Regulation of Utilities (CRU) decision on EirGrid and ESB Networks revenues for 2021 to 2025. The PR5 Determination aligns with the objectives and ambition set out by the CRU in relation to grid delivery, decarbonisation and local security of supply and is underpinned by cost efficiency and a regulatory framework which supports the delivery of value to customers. EirGrid and ESB Networks are fully committed to the successful delivery of PR5.

In 2021, the Irish Government adopted a new and more ambitious climate action target for the electricity sector. The Climate Action Plan (CAP) 2021² includes an updated national target of delivering up to 80% of our electricity generation from renewable sources by 2030. EirGrid and ESB Networks strongly support this vision for Ireland's future.

During 2021, EirGrid conducted a comprehensive consultation, engaging with stakeholders using both traditional and innovative methods focussing on a number of potential approaches to achieving our renewable ambition. This consultation process concluded with the publication of EirGrid's Shaping Our Electricity Future Roadmap³ in November 2021.

Renewable generation accounted for 34.9%⁴ of all electricity consumed in Ireland in 2021. This was a reduction compared with the 42.1%⁵ achieved in 2020, due in part to the record low wind levels experienced in 2021. In early 2021, EirGrid successfully completed a trial of 70% System Non-Synchronous Penetration (SNSP)⁶ on the system with over 250 hours of operation above 65% SNSP. 70% SNSP then became enduring operating policy. The 75% SNSP trial commenced thereafter in 2021.

The COVID-19 pandemic remained a challenge to operations, development and project delivery during 2021 as some site works and landowner engagements were delayed.

In 2021, there was increased concern regarding the security of supply. Unplanned outages at two major generation facilities; the decreasing reliability of older generating plant exacerbated by reduced maintenance during the pandemic; and several plants retired from operation. At the same time, planned generation capacity did not materialise as expected and there was reduced wind output at critical times throughout the year. All these factors combined to provide some challenges for ensuring security of supply. In September 2021, the Department of the Environment, Climate and Communications (DECC) and the CRU put a programme in place with the aim of securing adequate supply to meet demand. EirGrid worked in support of these measures in 2021 and continues to do so.

We hope that you find this document of use and we look forward to working together with you to further develop our plans. We welcome all feedback with regard to the information set out in this booklet and any additional information you might wish to see included in future versions.

Please contact us at: esbnetworks@esb.ie / info@eirgrid.com

EirGrid in its role as Transmission System Operator (TSO) is responsible for operating and ensuring the maintenance and development of a safe, secure and reliable electricity transmission system - now and in the future. To achieve this, EirGrid continues to develop, manage and operate the electricity transmission grid.

ESB is the Transmission Asset Owner (TAO) and its business unit ESB Networks carries out the licensed TAO functions. ESB Networks is therefore responsible for building works and carrying out the physical maintenance as identified by EirGrid. We work closely together to ensure that all steps in the development and construction of grid infrastructure are carried out as efficiently and cost effectively as possible.

1 Price Review 5 - https://www.cru.ie/document_group/price-review-5-electricity-networks/

2 Climate Action Plan 2021 - <https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/>

3 [Shaping our Electricity Future \(eirgridgroup.com\)](https://www.eirgridgroup.com) was published in 2021 on the basis of the original CAP RES-E target of 70%. Work is ongoing to update SOEF to take account of the revised CAP RES-E target of 80%.

4 Per EirGrid System and Renewable Reports - [Fuel Mix 2021](#)

5 Per EirGrid System and Renewable Reports - [Fuel Mix 2020](#)

6 Comprising mainly of wind and solar generation – see [here](#) for technical definition

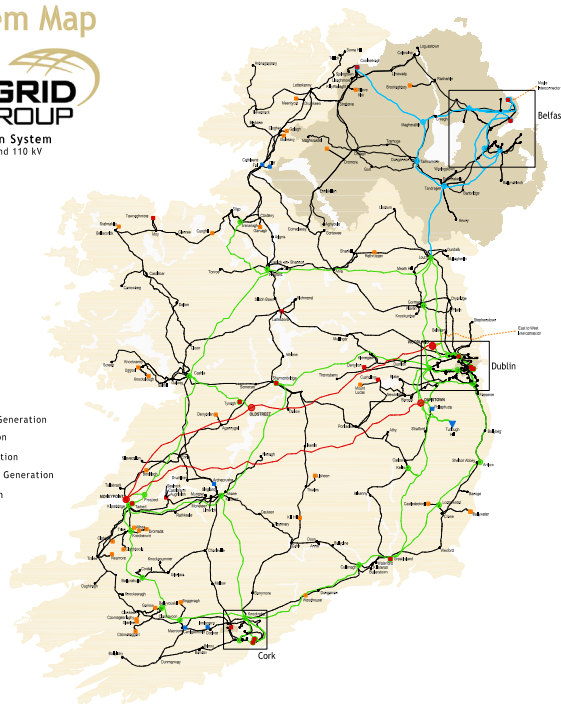
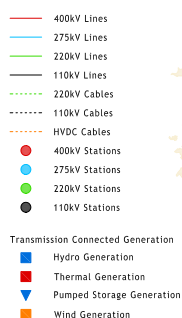


What is the Electricity Transmission System?

Transmission System Map



Transmission System
400, 275, 220 and 110 kV
January 2020



Electricity transmission encompasses the operation, planning and development of the high-voltage network in Ireland, predominately assets that operate at 110 kV, 220 kV or 400 kV, ensuring that supply and demand is balanced on a minute-by-minute basis⁷.

EirGrid is the Transmission System Operator (TSO), and ESB is the Transmission Asset Owner (TAO) and its ring-fenced business unit ESB Networks carries out the licensed TAO functions. The transmission system moves power around the country. It brings power directly to industry and businesses that use large amounts of electricity and also powers the distribution network. The transmission system supplies the electricity used every day in our homes, businesses, schools, hospitals and farms. For further information on the TSO's and TAO's activities in the delivery of the network, please see the 2021 Annual Investment Planning and Delivery report published on the EirGrid and ESB Networks websites. Working closely together, we develop and build energy infrastructure when it is needed. Through our operation and maintenance of the transmission system, we ensure a safe, secure and reliable supply of electricity.

How we work together is governed by the TSO and TAO licences granted by the CRU and by an [Infrastructure Agreement](#) which is a contract on how to develop, maintain and operate the transmission system. Efficient operation of TSO/TAO working arrangements is essential and we can report satisfactory operation of these arrangements during 2021.

An Infrastructure Delivery Charter with joint committee structures underpinning the mutual working arrangements between the TSO and TAO is in operation. This charter commits both companies to renewed levels of engagement and partnership to meet the evolving needs of the electricity customer and society into the future.

The operation of a Joint Programme Management Office (JPMO) and other agreed processes are important aspects of TSO/TAO co-operation. EirGrid and ESB Networks continued to effectively operate, review and develop these arrangements throughout 2021. Updated Terms of Reference and operating arrangements were agreed for the Joint Programme Management Office (JPMO) during 2021. A working group has also been established for TSO and TAO to jointly plan the delivery of the full pipeline of projects out to 2030.

This year also saw the introduction of a PR5 Joint TSO/TAO Incentive for EirGrid and ESB Networks. Details of the operation of this new incentive are provided in the *How we Performed against transmission delivery incentives* section of this report.

⁷ Please note that the Northern Ireland Transmission Network is included for illustration purposes only. It is not covered by this report

How we plan, deliver and use the network

EirGrid's approach to grid development uses a six-step process which explains why and how we develop the grid. More importantly, it also explains how the general public and stakeholders can influence the decisions we make. All our projects go through this process. The Joint EirGrid and ESB Network's Investment Planning and Delivery Report which accompanies this report highlights the work carried out and project progress in 2021.

2021 was the second year of EirGrid's [Strategy 2020-25](#), the aim of which is to *Transform the Power System for Future Generations*. Central to Strategy 2020-25 is EirGrid's six-step approach for grid development which sets out how the general public and stakeholders can influence the decisions that EirGrid makes on grid development projects. EirGrid's focus has been to increase its value position to consumers and stakeholders while improving efficiencies in grid development.

During 2021, EirGrid and ESB Networks continued to partner with some of the biggest companies in the world, to foster jobs and prosperity across the country. We have worked together to develop and build the transmission infrastructure and systems needed to supply power to a number of large energy users, such as new data centres. We continued to upgrade and strengthen the transmission grid where necessary.

Step 1

How do we identify the future needs of the electricity grid?

Step 2

What technologies can meet these needs?

Step 3

What's the best option and what area may be affected?

Step 4

Where exactly should we build?

Step 5

The planning process

Step 6

Construction, energisation and benefit sharing

Summary of 2021

The first year of PR5 saw significant progress made by the TSO and TAO in terms of project development and delivery. Notable trends in 2021 include the continued strong progression of pipeline projects to capital approval and the strong completion of signed project agreements between the two organisations.

Fifty projects achieved capital approval in 2021. This volume of newly approved projects is in line with the number achieved in 2020, sustaining a significant increase on previous years. The new projects include 19 system security projects, 12 new customer connection projects, 10 new system reinforcement /ATR projects, 3 asset refurbishment driven projects, one new technology project, one-line conflict requiring a circuit diversion and 4 physical station security projects.

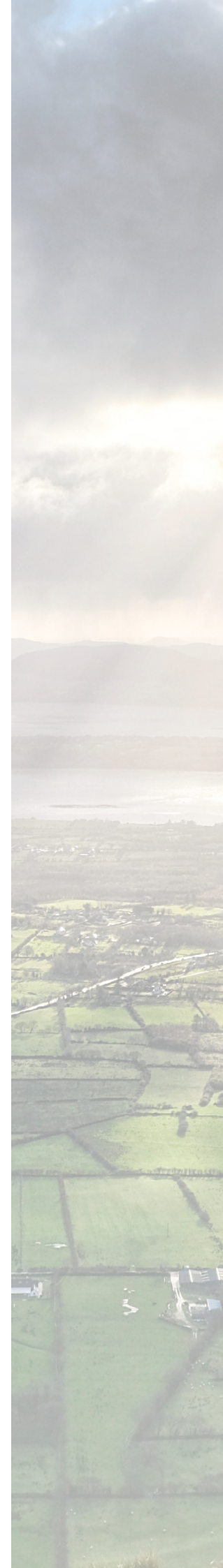
During 2021, four new Battery Energy Storage System (BESS) projects totalling 229 MW Maximum Export Capacity (MEC) and two new reactors to assist with voltage control were completed. Projects contributing to the resolution of local and national security of supply were advanced. These key metrics are indicators of the volume of projects progressing through the six-step process towards energisation and completion over the remainder of PR5, ultimately contributing towards the delivery of our security of supply, 2030 climate change decarbonisation and customer connection targets.

2021 was not without its challenges. The COVID-19 impact on the delivery programme in 2021 was less significant than that which occurred in calendar year 2020, however COVID-19 driven project delays were encountered in 2021 over and above what might normally be expected in a standard calendar year. In addition to COVID-19 related outage impacts, complexity of scope, legal and procurement delays provided additional challenges to delivering the PR5 programme for 2021.

Twenty-two projects were energised and/or completed in 2021:

- Energisation of four new BESS projects totalling 229 MW MEC. These projects will provide system services that allow the electricity system to carry a greater proportion of renewably generated power.
- Connection of one demand customer connection totalling 40 MVA MIC.
- Completion of two Associated Transmission Reinforcement (ATR) projects, alleviating constraints and strengthening the transmission network in the south east and the midlands areas. One of the ATR projects facilitated the connection of 116 MW of Firm Access Quantity (FAQ) to the transmission system.
- Installation of a new 400 kV transformer in Moneypoint to maintain security of supply and reduce constraints in the region.
- Energisation of two new 50 MVA reactors in the south west providing voltage support to the transmission network and customers in the region.
- Completion of four station system reinforcement projects, 3 in the south, and one in Donegal, increasing security of supply in the north west region.
- Completion of a 220 kV circuit refurbishment in the south west.
- Completion of a circuit fibre wrapping project in the west of the country.
- Diversion of two overhead circuit sections to facilitate third party customer construction requests,
 - One associated with the N4 extension in Co. Sligo
 - One to facilitate the construction of a housing development in Co. Cork
- Completion of three transformer replacement and station work projects for the DSO.
- Completion of one generator customer transformer replacement project due to its end of life status.

Further details are set out in our 2021 Annual Investment Planning and Delivery Report.



Key Performance Summary Matrix

Table 1

Metric	Section of Report	2021 Target/ Basis for incentive	2021 Performance	2021 Incentive outturn ⁸	2020 Performance ⁹	2019 Performance ¹⁰
TSO Strategic Objectives Incentive	<i>"How EirGrid performed against strategic incentives"</i> Page 19	Target: 4 incentive metrics with a total incentive available of €0.5m	34%	€0.17m	Target: 5 incentive metrics with a total incentive available of €1.675m. Performance: 41% success Incentive: €0.68m	Target: 5 incentive metrics with a total incentive available of €1.675m. Performance: 60% success Incentive: €1.009m
TSO Transmission System Performance System Frequency (SF)	<i>"How EirGrid manage system performance"</i> Page 20	€0.1m p.a. for each step if exceeds 98%, 99% and 99.5%	SF was operated within the target operating limits of 49.9 Hz and 50.1 Hz for 98.63% of the time, with 33% of the available incentive being awarded as a result.	€0.10m	Target: 94% Performance: 99.67% Incentive: €0.231m	Target: 94% Performance: 99.66% Incentive: €0.238m
TSO Transmission System Minutes Lost (SML)	<i>"How EirGrid manage system performance"</i> Page 20	0.75-2.5	0.054 System Minutes Lost on the transmission system, with 100% of the available incentive being awarded as a result.	€0.30m	Target: 1.5 – 3 Performance: 0.0645 Incentive: €0.231m	Target: 1.5 – 3 Performance: 0.176 Incentive: €0.238m
TSO's Stakeholder Engagement	<i>"Engaging with stakeholders"</i> Page 38	Max score: 10	A score of 6.74 out of 10 was concluded by the NSEE Panel, resulting in 41.4% of the available incentive being awarded.	€0.207m	Target: Stakeholder Engagement Performance: Score of 7.3 (out of 10) Incentive: €0.238m	Target: Stakeholder Engagement Performance: Score of 7.5 (out of 10) Incentive: €0.254m
TSO Investment Planning and Delivery Balanced Score Card ¹¹	<i>"How we performed against transmission delivery incentives"</i> Page 11	Target: 6 incentive metrics with a total incentive available of €0.9m	24%	€0.215m	Target: 5 Incentive Metrics [total incentive available 2% TSO Opex] Performance & Incentive: 'Strong' €1.13m	Target: 5 Incentive Metrics [total incentive available 2% TSO Opex] Performance & Incentive: 'Acceptable' €0.10m
TSO Delivering New Connections ECP	<i>"How we manage new connections"</i> Page 32	Issue connection offers to all applicants in the 2021 Batch as per CRU/20/060 ¹² by the batch deadline of 31 December 2021	EirGrid issued 26 transmission connection offers under ECP-2.1 throughout 2021. Of these 81% (21) issued thirty days in advance of the batch deadline, 12% (3) issued fifteen days early with the remaining 8% (2) issuing by the deadline. This resulted in 86% of the available incentive being awarded.	€0.43m	Target: Issue connection offers to all applicants in the '2018 Batch' as per (CER/18/058) by the target date of 31 May 2020. Full incentive achieved: €0.629	N/A

8 A penalty is indicated in brackets.

9 2020 [APR](#) and [IPD](#)

10 2019 [APR](#) and [IPD](#)

11 Calculation of the Investment Planning and Delivery Balanced Score Card differs in PR4 (2020 & 2019) and PR5 (2021)

12 [CRU/20/060](#)

Metric	Section of Report	2021 Target/ Basis for incentive	2021 Performance	2021 Incentive outturn	2020 Performance	2019 Performance
TSO Renewable Dispatch Down Incentive	<i>"How EirGrid manage system performance"</i> Page 20	5% ¹³	7.3% of Renewables were dispatched down in 2021 in Ireland, resulting in 20% of the maximum penalty being levied.	(€0.06m)	N/A ¹⁴	N/A
TSO SNSP Incentive	<i>"How EirGrid manage system performance"</i> Page 20	75% SNSP	The system was operated with a 75% SNSP limit for 70% of the calendar year 2021. The CRU levied the full penalty applicable to this incentive as a result.	(€0.30m)	N/A	N/A
TSO Imperfections and Constraints Incentive	<i>"How we manage constraint costs"</i> Page 27	Target: 4 incentive metrics with a total incentive available of €1.5m	9%	€0.14m	N/A	N/A
TSO RES-E Incentive	<i>"How EirGrid manage system performance"</i> Page 20	43% ¹⁵	34.9% RES-E ¹⁶	€0m	N/A	N/A
TSO Local Security of Supply Incentive	<i>"How we performed against transmission delivery incentives"</i> Page 11	Target: 5 incentive metrics with a total incentive available of €1.5m ¹⁷	N/A	(€0.27m)	N/A	N/A
TAO/TSO Joint Incentive	<i>"How we performed against transmission delivery incentives"</i> Page 11	Target: 4 incentive metrics with a total incentive available of €1.5m for TAO and €0.2m for TSO	100%	TSO: €0.20m TAO: €1.5m	N/A	N/A
DSO/TSO Joint Incentive ¹⁸	<i>"How we performed against transmission delivery incentives"</i> Page 11	TSO Target: 3 incentive metrics with a total incentive available of €0.2m for TSO	46%	TSO: €0.091m	N/A	N/A
TAO Completion of the Scheduled Transmission Maintenance Work Programme	<i>"How we ensure network resilience"</i> Page 23	100%	93%	N/A	Target: 100% Performance: 89%	Target: 100% Performance: 81%

13 As per [CRU/20/154](#), an upside payment of €0.054m is applied if the TSO meets the target of 5.0% and an additional €0.054m for every 0.1% below 5.0% up to a maximum of €0.6m. A downside penalty of €0.014m is applied if the TSO meets the limit of 7.0% and an additional €0.014m for every 0.1% above 7.0% up to a maximum of €0.3m

14 N/A is noted in the table when the metric/incentive is not applicable to the given year.

15 Achievement of RES-E target is binary. If annual target % achieved, the incentive reward will depend on the CRU's assessment of (i) quality of plan, (ii) quality of implementation; and (iii) effectiveness of plan. If annual target % not achieved, no incentive awarded, regardless of plan.

16 Per EirGrid's submission to CRU in April 2022, it was provisionally estimated that a RES-E level of 35.1% was achieved in Ireland in 2021. The EirGrid Fuel Mix published in June 2022 confirms RES-E for 2021 was 34.9%.

17 75% allocated annually, 25% allocated at the end of PR5

18 See DSO Annual Performance Report for DSO outturn performance for 2021.

Metric	Section of Report	2021 Target/ Basis for incentive	2021 Performance	2021 Incentive outturn	2020 Performance	2019 Performance
TAO Capital Expenditure	<i>"Network Development Costs"</i> Page 43	CRU Capex Monitoring Process	€182m	N/A	Target: CRU Capex Monitoring Process Performance: €144m	Target: CRU Capex Monitoring Process Performance: €154m
TAO Operational Expenditure	<i>"Network Development Costs"</i> Page 43	CRU Opex Monitoring Process	€69m	N/A	Target: CRU Opex Monitoring Process Performance: €66m	Target: CRU Opex Monitoring Process Performance: €63m
TAO Project Delivery Incentive	<i>"How we performed against transmission delivery incentives"</i> Page 11	€3.5m	€3.5m 4 Balanced Scorecard Incentive Metrics	€3.5m Full incentive payment	€2.66m Full incentive payment	€2.44m Full incentive payment:
TAO Management of planned outages	<i>"How we performed against transmission delivery incentives"</i> Page 11	Complete planned work in less than 10,707 outage days	All planned works completed in 9,950 actual outage days, meeting target	€1m Full incentive payment	Target: 10,785 scheduled outage days Performance: 9,842 outage days Incentive: €0.49m	Target: 8,240 scheduled outage days Performance: 7,590 outage days Incentive: €0.49m

Development of the Celtic Interconnector

EirGrid, along with our French counterpart Réseau de Transport d'Électricité (RTÉ) are continuing the development of the Celtic Interconnector project, a planned subsea High Voltage Direct Current (HVDC) electricity link between Ireland and France.

The Celtic Interconnector will deliver a wide-ranging package of benefits to consumers and businesses in both Ireland and France. It will apply downward pressure on the cost of electricity, enhance Ireland's security of electricity supply, and facilitate our national transition to a low-carbon economy.

The interconnector power cables will reach landfall in Ireland at Claycastle Beach, near Youghal in East Cork. From there an underground cable will run inland and continue north of Midleton to the converter station. This will be built at Ballyadam, on part of an IDA-owned site, to the east of Carrigtwohill. The final connection will be by underground cable from Ballyadam to a substation on the national grid at Knockraha.

In November 2020, EirGrid published the best performing project option in the Consultant Development Options report. This was the culmination of a thorough public consultation process. Following this, additional details of the Irish onshore cable route were published in 2021 with a number of public and community information webinars taking place at this time.

The Celtic Community Forum was established in summer 2021. The forum is made up of local community representatives. It provides for dialogue between stakeholders with interests in the project and the project team and represents local communities in the design and implementation of the Community Benefit Fund. Two Celtic Community Forum meetings were held in 2021.

In 2021, a planning application for the onshore infrastructure and a foreshore licence application were submitted to An Bord Pleanála and to the Department of Housing, Local Government and Heritage respectively. In May 2022, An Bord Pleanála published its decision to approve the onshore infrastructure, subject to a number of conditions. The Department of Housing, Local Government and Heritage issued its notice of determination with respect to the foreshore licence application in August 2022.

We would like to thank our stakeholders who have contributed to the process to date. EirGrid will continue to engage with all stakeholders as the project develops.

For up to date information please see our website that is updated regularly [here](#).

Project Benefits



Competition

Apply downward pressure on the cost of electricity to consumers in Ireland and France



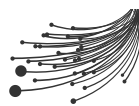
Sustainability

Help facilitate Ireland's transition to a low carbon energy future



Security of Supply

Enhanced security of supply for Irish electricity consumers



Fibre Optics

Provide a direct telecommunications link between Ireland and France (and continental Europe)

Key Facts



575km

length of the interconnection
(500km subsea)



2

project promoters
(working in partnership)



700 MW

capacity
(450,000 homes)

How we performed against transmission delivery incentives

EirGrid and ESB Networks are incentivised against targets set by the CRU for the delivery of the transmission network as detailed in [CRU/20/154](#). These incentive arrangements apply from 2021 to 2025.

TAO Incentives

Project Delivery Incentive Performance

[CRU19150](#) defined a balanced scorecard of incentive measures that applied to TAO investment and project delivery activities during PR4. These incentive arrangements were carried over into PR5 (2021-25) per [CRU20154](#). Both the performance targets and the incentives related to those targets have been increased for PR5 in order to meet the challenges of the Government's Climate Action Plan. The TAO Project Delivery incentive includes both qualitative and quantitative measures, and performance is independently assessed each year by external auditors. The audit report is submitted to CRU to assist in determining the final incentive outturn award. In 2021, CRU awarded the full incentive payment to TAO.

TAO Project Delivery Incentive Performance

TAO Project Delivery Balanced Scorecard	2019	2020	2021
Incentive Award	Full	Full	Full
Incentive value ¹⁹	€2.44m	€2.66m	€3.5m

Table 2

The four performance measures included in the TAO Project Delivery balanced scorecard are:

1. Project Implementation Plans (PIPs)

A PIP is the committed programme of work agreed between TSO and TAO for a new project. The PIP is the baseline schedule against which the work is planned, and progress is monitored. The target list of projects is agreed annually between TSO and TAO. The TAO's performance is measured by the actual percentage of the target PIPs issued during the calendar year.

2. Customer Project Energisation/ Connection

The TAO performance is measured by the actual percentage of the target Customer Projects energised/ connected in the calendar year. This includes customer energisation works scheduled in the annual transmission outage programme.

3. Transmission Capex Spend

The TAO performance is measured by the actual percentage of the Budgeted Annual CAPEX spend delivered in calendar year.

4. Project Delivery Process Improvement

This component is qualitatively audited by independent external auditors and examines the TAO's performance on the quality and rigour of its processes for identifying and implementing efficiencies and improving processes in project delivery.

The Project Delivery Incentive performance for 2021 against the above measures is outlined below:

Item	TAO Project Delivery Measure	2021 Plan ²⁰	2021 Actual
1	Project Implementation Plans	52	51
2	Customer Project Energisations	16	16
3	Transmission Capex Spend	€199m	€197m
4	Process Improvement	-	See Below

Table 3

¹⁹ A penalty would be indicated in brackets. There are no penalties in this period.

²⁰ Plan adjusted for items outside the TAO control.

A process improvement implemented by the TAO during 2021 is described below:

Engineer Procure and Construct (EPC) Framework Contract for HV Substations

The 2030 targets in the national Climate Action Plan requires that large volumes of renewable generation capacity get connected to the transmission system. As a result, large-scale delivery of additional electrical infrastructure on the transmission system will be required to facilitate these connections and to support the electrification and decarbonisation of heat and transport. To meet this challenge, TAO identified that not only volume of resources, but also more expedited allocation of resources was required to meet these large-scale infrastructure projects. In order to meet these needs, Engineer Procure and Construct (EPC) or “turnkey” project arrangements were deployed in the development of HV GIS Substations.

TAO conducted an EPC pilot project in Castlebaggot through direct procurement to build the largest 220kV Station in Ireland. This €100m project was completed in 2021. A further EPC project was procured and implemented in Kellystown to deliver a connection to a major new load. This project is well advanced and will be completed in 2022. Having demonstrated the value of EPC as a delivery option, TAO undertook in 2021 to procure a long-term EPC framework contract with an approved list of suppliers to meet on-going delivery needs. A framework contract was signed in 2021 with six contractors, which can be extended up to eight years. Approximately 15 HV substation projects in PR5 are suitable for EPC delivery. This process improvement is delivering significant business benefits in terms of additional resources but also providing considerable time saving in project delivery by reducing the lead-time involved in procurement for future projects and project life-cycle cost savings. TAO and TSO’s internal delivery processes have been updated to provide for EPC delivery and this new delivery methodology is now embedded and will provide enduring business benefits to the transmission electricity customer.

The TAO Project Delivery Incentive performance, including all of the above measures, was verified by external independent audit and following review CRU determined an overall assessment of “Strong” performance outcome for 2021.

Outage Management Incentive Performance

The incentive for TAO’s management of outages has also been retained and continues for the PR5 period 2021-25. The value of the Outage Management incentive has increased. The performance threshold for an incentive award has also increased. The incentive available to the TAO for Outage Management in PR5 is €1m per annum. The Outage Management Incentive performance report for 2021 was submitted to and reviewed by CRU. TAO delivered on all its targets relating to these outages and was granted the full incentive award of €1m for 2021.

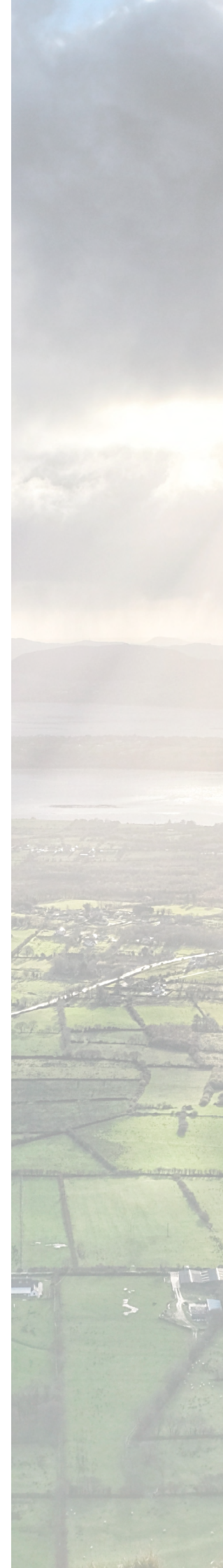
Outage targets are designed to improve the availability of the network by reducing outage durations and providing greater certainty to all affected parties on expected start and finish dates. In 2021 there were a total of 10,707 scheduled transmission outage days. The incentive requirement is to complete all planned works within the scheduled days target. The total actual outage days in 2021 was 9,950 outage days at year end. The 2021 planned works were delivered within the incentive outage days target.

TAO Incentive Performance 2019-2021

TAO Incentives	2019	2020	2021
Outage Management Performance ²¹	€0.49m	€0.49m	€1m

Table 4

²¹ A penalty would be indicated as a bracket. There are no penalties in this period.



TSO and TAO Joint Incentive

CRU20154 introduced a new joint TSO/TAO incentive under PR5. The TSO/TAO joint incentive focusses on network project delivery, with an aim of promoting efficiencies through enhanced collaboration.

The TSO/TAO joint incentive is based on a balanced scorecard containing four separate measures as outlined below. Annual performance is assessed by independent external auditors against this balanced scorecard which includes both quantitative and qualitative measures:

1. Deployment of New Technology

This incentive is to ensure that the TSO and TAO actively deploy new technology on the grid and operate effective processes to enable the trialling and piloting of emerging technologies.

2. Project Initiation to CPP Agreed

This incentive rewards timely project development, measuring from the time that TSO notifies TAO of a new project to the time that the Committed Project Parameters (CPP) (i.e. outline project scope) is agreed.

3. Joint Process Improvement

This incentive examines the TSO and TAOs performance on the quality and rigour of application of joint processes, as well as joint efforts identifying and implementing efficiencies in project and programme delivery.

4. Asset and Programme Data Exchange

This incentive examines the TSO and TAOs performance on the exchange of information with respect to delivery of transmission network capital investment under the PR5 programme.

[CRU202226](#) contains direction and guidance to TSO and TAO on the 2021 Balanced Scorecard joint incentives key performance indicators, targets, and the assessment process.

Joint TSO/TAO performance was assessed by independent external auditors against the 2021 balanced scorecard. The audit report was submitted to CRU to assist in determining the final incentive outturn award. For 2021, CRU awarded the full incentive payment to TSO and TAO as outlined in the table below:

TSO and TAO Joint Incentive Balanced Scorecard	2021 Incentive Award	2021 Incentive Value
TSO Incentive Award	Full	€0.2m
TAO Incentive Award	Full	€1.5

Table 5

The joint incentive measures delivered by TSO and TAO in 2021 and assessed during audit are detailed below:

1. Deployment of New Technology 2021

Three specified new technology projects were completed in 2021. Two of the projects were to facilitate the connection of large volumes of wind generation. Overvoltage issues affecting system stability were developing in areas of the south west, where significant amounts of new underground cable networks had been built. Reactors are a technology which compensate for the presence of underground cables and stabilise the voltage. Two large 220 kV Reactors were installed and commissioned in 2021, one in North Kerry and the other in West Cork. The third new technology project completed in 2021 was a 400 kV uprate innovation project. Following successful modelling and laboratory tests, a trial installation utilising composite crossarm structures was constructed on site in 2021 as a proof of concept. Further information on TSO and TAO collaboration on new technology is contained in the Innovation section of this report.

2. Project Initiation to CPP Agreed

Developing and agreeing the technical scope of new transmission infrastructure projects to meet system and customer needs is a complex process involving onsite assessment, outage planning and consultation with multiple agencies. Many unknowns exist at this early stage of a project, as customer projects can be refused or delayed by planning, environmental or other permissions. Approximately half of projects can be relied upon to proceed to an agreed project scope within a 98-day target window. During 2021, TSO and TAO met or exceeded this target timeline for 22 new projects. The average time to scope agreement for these projects was 65 days, which is an acceleration of infrastructure delivery timelines. Enhanced collaboration and process improvements are on-going between TSO, TAO and stakeholders to mitigate and accelerate these processes to ensure as many projects as possible benefit from accelerated early-stage project development.

3. Joint Process Improvement

In 2021 a Joint Working Group was established to accelerate project development timelines to the Capital Approval (CA) and Project Agreement (PA) stage. A fortnightly joint TSO/TAO workshop was established with the aim of reducing the time from CPP issue to achieving Project Agreement. This involved improving clarity on deliverables of both the TSO and TAO, and embedded new processes for enduring business benefits. The Joint Working Group identified 41 improvements of which 36 were fully implemented in 2021. Some of the major items implemented include batching of similar projects, a joint approach to agreeing outage requirements and clarity on boundary issues and responsibilities where assets are being built contestably. The joint process improvement work has been assessed by independent external auditors.

4. Asset and Programme Data Exchange

This incentive is intended to optimise TSO/TAO collaboration arrangements for information exchange and to support the delivery of transmission network investment under PR5. The 2021 incentive target required TSO and TAO to document the full inventory of Asset and Programme Data Exchange taking place between the two organisations, including:

- i. An overview of TSO/TAO Asset and Programme Data Exchange
- ii. A basis on which to assess TAO/TSO information exchange in respect of transmission capital project delivery in PR5
- iii. A baseline tool for identifying future improvement opportunities for enhanced collaboration and information sharing going forward.

A full Asset and Programme Data Exchange Inventory has been completed which identifies over 50 significant data sharing channels in operation between TSO and TAO. The focus now is to enhance and develop exchange of 'upstream pipeline' information to allow both organisations to collaborate sooner in the project life-cycle and make more effective and timely resource plans.

In respect of Asset Data exchange in 2021, TAO arranged training for 26 TSO engineers on accessing the most up to date asset information on the TAO 'Design Hub' system.

In respect of Programme Data Exchange in 2021, TSO provided a view of the 2022 Transmission Outage Programme to TAO two months earlier than in previous years. This assisted in optimising the 2022 outage and resource plans.

TSO and DSO Joint Incentive Performance

The Joint System Operator Programme (JSOP) was established to facilitate collaboration between EirGrid in its role as TSO and ESB Networks in its role as Distribution System Operator (DSO) in jointly addressing system and customer needs. The System Operators submitted a joint proposal for the 2021 period to the CRU in January 2021.

The CRU published an information paper on the 2021 incentives in March 2022, [CRU202226](#). This information paper contains direction and guidance on the 2021 balanced scorecards targets and the performance assessment process. For this joint incentive, a separate balanced scorecard applies for each of the System Operators. The aspects included in the TSO's balanced scorecard are outlined in the below table.

2021 Balanced Scorecard Aspects - TSO

Dispatch Down & Curtailment

- An incentive/penalty will be applied if the TSO are successful/unsuccessful in demonstrating benefits in collaborative actions with the DSO in 2021 resulting in reduced dispatch down/ and or curtailment compared to 2020 levels after allowing for the impact of COVID-19 e.g. on overall system demand.

Security of Supply/Constraints

- The level of collaboration with the DSO in bringing the first HV/MV flexible product to market will be important here, including presentation of the value to the TSO of collaboration with the DSO and any insights gained through collaboration. The TSO should document the collaborative steps taken to improve the outcome for market participants. Insufficient collaboration would be indicated by inconsistencies between existing system services products and the new flexibility product or a lack of clarity about whether potential providers can 'stack' the new flexibility product with other services.

Whole of System Approach

- The quality of the outputs including the Project Initiation Document (PID), the vision/ principles of the operating model and the flexible network management agreement will be important for assessment here. All project documents should clearly demonstrate the benefits of a whole system approach.

Table 6

The CRU's information paper outlines each aspect of the balanced scorecard will be assessed against the following: quality of the plan and defined actions (20%); quality of implementation of the plan (40%); and effectiveness of the plan and demonstrable impacts (40%).

In 2021, both EirGrid and ESB Networks regularly met on topics such as dispatch-down, "whole of system" challenges and security of supply. Key milestones included quarterly touchpoints on operational policy reviews, workshops on known and locational scarcities and a joint TSO/DSO workshop on plans to modify the Grid and Distribution Code.

The programme allowed for effective and efficient co-ordination between the system operators. Representatives from each organisation formed a Management Liaison Board to govern the consistent delivery of the new JSOP.

In accordance with the direction in [CRU202226](#), the CRU has confirmed an outturn TSO incentive award for 2021 of €0.091m against a total possible incentive allowance of €0.2m for 2021. The CRU assessed this incentive under the three criteria outlined in the balanced scorecard, however given that this is the first year of PR5 the inclusion of a fourth "Overall Project Co-ordination", criteria was considered by the CRU also. Further information regarding the award EirGrid received in respect of TSO/DSO joint incentive can be found in section 3.4 *TSO Allowed Revenue for 2023* of [CRU202290](#).

TSO Transmission Delivery Incentive Performance

As required by CRU, EirGrid has developed a Balanced Scorecard Framework in order to facilitate an annual assessment on the quality and rigour of its end-to-end processes for investment planning and delivery. [CRU/20/154](#) (December 2020) contains direction and guidance to the TSO on incentives and reporting arrangements for PR5. Section 7.8 of the decision paper relates specifically to the TSO's Investment Planning & Delivery (IPD). The CRU's information paper on PR5 2021 Incentives [CRU/202206](#) (March 2022) provides additional guidance to the TSO on the 2021 IPD incentive framework and includes a new timeliness metric as set out in the following table -

PR5 Balanced Scorecard Framework 2021						
Area	Metric no. / type	%	Steps of the 6-step process	Strong Full assurance: €0.9m	Acceptable Satisfactory assurance: €0.2m	Below Acceptable Limited/ Unsatisfactory assurance: -€0.5m
Investment Planning (40%)	Metric 1 Qualitative	10%	Step 1	Audit Full Assurance	Audit Satisfactory Assurance	Audit Limited/ Unsatisfactory Assurance
	Metric 2 Qualitative	10%	Step 2			
	Metric 3 Qualitative	20%	Step 3			
Delivery (40%)	Metric 4 Quantitative	20%	Step 4-5	Greater than or equal to 75%	75-60%	Less than 60%
	Metric 5 Quantitative	20%	Step 6			
Timeliness (20%)	Metric 6 Quantitative & Qualitative	20%	-	Strong (ahead of plan)	Acceptable (in line with plan)	Below Acceptable (behind on plan)

Table 7

The incentive payment is determined by the CRU informed by an independent audit, and performance is graded as “strong”, “acceptable”, or “below acceptable”. An independent audit was carried out on the balanced scorecard for 2021 and the findings of the audit were submitted to the CRU for their consideration. The incentive payment range is outlined in the table above. Per [CRU202226](#), the CRU thereafter considers performance on a holistic basis when setting the final score, the balanced scorecard is assessed by CRU against the following: quality of the plan and defined actions (20%); quality of implementation of the plan (40%); and effectiveness of the plan and demonstrable impacts (40%).

For 2021, EirGrid's performance on the aspects outlined in the balanced scorecard above can be summarised as follows -

- Metrics 1-3: In 2021, EirGrid targeted the approval of 39 gateway 1-3 needs assessments and capital approvals. Of the agreed incentive metrics 32 of 39 (82%) were approved within the calendar year, representing a strong performance for the investment planning metric.
- Metric 4: EirGrid targeted and issued 29 CPPs to the TAO in calendar year 2021 resulting in a strong performance.
- Metric 5: The TOP21 outturn performance at the end of 2021 was 78%²², representing a strong performance.
- Metric 6: EirGrid completed an assessment of the 2021 key project milestones in the Network Delivery Portfolio (NDP) at the end of 2021. This assessment compared the PR5 2021 outturn for the 2021 calendar year against the PR5 programme submission to the CRU in December 2019. The independent audit assessment of EirGrid's outturn performance in 2021 found an acceptable performance with 72% of the 2021 project milestones in line or ahead of the PR5 plan.

²² Includes an ex post adjustment for issues outside of the TSO and TAO's control

For 2021, the CRU confirmed an outturn incentive award be applied for the IPD incentive for 2021 of €0.215m. The outturn awarded is an “Acceptable” performance as per CRU’s grading scale noted above. Further information regarding the award EirGrid received in respect of Investment Planning and Delivery can be found in section 3.4 *TSO Allowed Revenue for 2023* of [CRU202290](#).

As noted in the Electricity Performance Report for 2020, the investment planning and delivery audit for 2020 was not completed prior to the finalisation of the 2020 report. The CRU provided for an assumed ‘Acceptable’ outcome of €100k in their TSO revenue decision finalised in 2021. The 2020 audit has since been completed and was submitted to the CRU for consideration. The actual outturn incentive award for the 2020 Investment Planning and Delivery incentive was €1.13m representing a “Strong” performance on the part of the TSO for this incentive²³.

TSO Security of Supply Incentive Performance

The CRU highlighted the importance of resolving the local security of supply issues within its PR5 Strategic Objectives. The CRU considered that given the significant forecasted growth in demand in the Greater Dublin Region, constraints in the Dublin Region represent a security of supply risk. Via [CRU/20/154](#), CRU’s decision on the PR5 regulatory framework, incentives and reporting, the CRU introduced the Local Security of Supply incentive the aim of which is for EirGrid to demonstrate progress in addressing and managing key transmission network security of supply / constraint areas during PR5. For 2021, this incentive is based on a balanced scorecard containing five key aspects as outlined in the below table.

2021 Balanced Scorecard Aspects

Strategic

1. Provide detailed briefing to CRU around landbank servicing and costs in Q1 2021.
2. Studies detailing optimal locations for new generation capacity

Demand

1. Legal Review of utilising additional generation capacity at Data Centres in Q1 2021.
2. Survey of Data Centres to understand additional generation capacity available in Q2 2021.

Generation

1. The TSO to support the SEM Committee for the 2024/25 capacity year throughout 2021.

Infrastructure

1. CP1021 East Meath North Dublin will progress to GW2.
2. CP966 Kildare Meath will progress to GW3.
3. CP0823 Turlough Hill and CP1100 Finglas Northwall will progress to GW3.

Operational

1. The TSO to develop protocol relating to Flexible Demand for Data Centres in Q2 2021.

Table 8

As per [CRU/20/154](#), 25% of this incentive reward will be withheld until the end of the PR5 period. Therefore 75% of the incentive reward/penalty will be applied annually and the remaining 25% of each years’ reward/penalty will be at stake at the end of price review period and will be subject to resolving the Dublin Security of Supply issue.

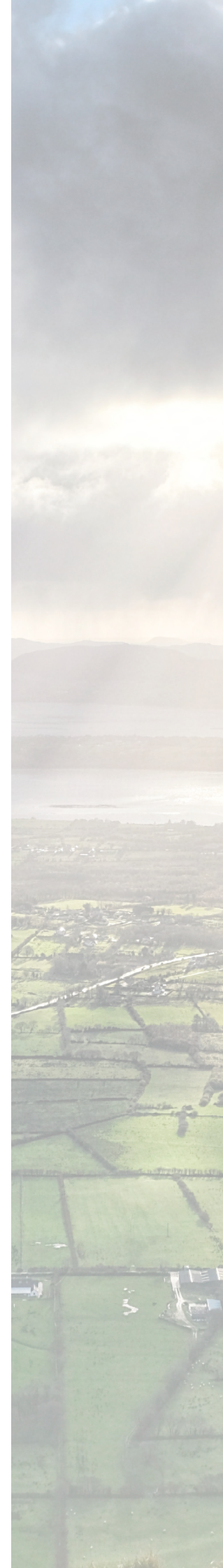
The CRU’s information paper on the 2021 incentives in March 2022, [CRU202226](#), outlines each aspect of 2021 which needs to be delivered in order to be rewarded under this the incentive, with failure to deliver resulting in the full downside allocation being applied. Each aspect of the balanced scorecard is assessed against the following: quality of the plan and defined actions (25%); quality of implementation of the plan (25%); and effectiveness of the plan and demonstrable impacts (50%).

²³ The investment planning and delivery 2020 incentive outturn is included for completeness and as advised in the 2020 Electricity Performance Report.

EirGrid's performance on the aspects outlined in the balanced scored above is set out below -

- Strategic aspect - both targets set out were achieved, however the briefing on landbank services and costs took place 23 days after the set timeframe of Q1 2021.
- Demand aspect - both aspects were achieved within the stated timeframes.
- Generation aspect - EirGrid supported the operation of the T-3 capacity auction for 2024/25 throughout 2021.
- Infrastructure aspect - EirGrid progressed approvals for three of the four projects as stated above during 2021, with the fourth stated project achieving GW3 in Q1 2022.
- Operational aspect - EirGrid reported on the protocol for flexible demand for data centres to CRU on 31 March 2021.

The CRU has confirmed an outturn penalty be applied for the above incentive for 2021 of €0.27m. Information regarding the penalty received by EirGrid in respect of the Local Security of Supply incentive can be found in section 3.4 *TSO Allowed Revenue for 2023* of [CRU202290](#).



How EirGrid performed against Strategic Incentives

We are in a time of unprecedented change to the electricity system as we move to a low carbon future. EirGrid is at the forefront of guaranteeing that this change is brought about in a timely and cost-effective manner while realising a broad range of benefits for end users and market participants.

We do this by maintaining a safe, secure and reliable transmission system while integrating an ever-increasing number of renewables. This is supported by our development of a wide variety of innovative projects and the roll out of new system services.

The CRU PR5 Regulatory Framework Reporting and Incentives Decision Paper ([CRU/20/154](#)) invited the TSO to propose key performance indicators for its strategic incentive, regarding the following three areas:

- Facilitating a Secure Low Carbon Future;
- Increasing Efficiency and Protecting Consumers; and
- Anticipation of Future Investments.

EirGrid built on the CRU's three proposed incentive indicator headings above and proposed a number of initiatives for 2021. The Strategic Incentives balanced scorecard containing four key aspects against which the TSO's performance over 2021 as per the CRU's March 2022 information paper is outlined in the below table.

2021 Balanced Scorecard Aspects

Shaping our Electricity Future

1. Commence consultation on Shaping Our Electricity Future by end of Q1 2021
2. Develop final roadmap
3. Publish Shaping our Electricity Future by end of Q3 2021

Innovation

1. Produce Innovation and Research Strategy and publish by end of Q4 2021

Asset Management Accreditation

1. Achievement of ISO 55001 accreditation by end of Q4 2021

Data Strategy

1. Data Strategy developed with 3 years roadmap of initiatives to delivery
2. Delivery of roadmap
3. Funding proposal submitted

Table 9

The four aspects of this incentive were equally weighted. During 2021, EirGrid's performance against the balanced scorecard for each aspect is summarised below -

- Shaping our Electricity Future (SOEF) - EirGrid completed all three elements of the SOEF aspect during 2021, albeit that the timelines specified at the start of 2021 were not fully adhered to. A 14-week consultation on SOEF commenced in March 2021, with the final SOEF roadmap published in November 2021.
- Innovation - EirGrid published the Innovation and Research Strategy in December 2021.
- Asset Management Accreditation – EirGrid has successfully achieved accreditation for ISO 55001. Stage 1 of the audit for this accreditation was achieved within the specified timeframe. However, Stage 2 was completed in early 2022 due to third party service provider constraints.
- Data Strategy - the Data Strategy was developed in 2021 and the delivery commenced during 2021. A funding proposal was not identified as being required in 2021, therefore no proposal was submitted to CRU.

The CRU's March 2022 information paper states that each aspect of the balanced scorecard will be assessed against the following: quality of the plan and defined actions (20%); quality of implementation of the plan (40%); and effectiveness of the plan and demonstrable impacts (40%).

In accordance with [CRU202226](#), the CRU confirmed an outturn incentive award be applied for the above incentive for 2021 of €0.17m against a total possible incentive allowance of €0.5m for 2021. Further information regarding EirGrid's reward against the Strategic Objectives incentive can be found in section 3.4 *TSO Allowed Revenue for 2023* of [CRU202290](#).

How EirGrid manage system performance

In a highly competitive global marketplace, continuity of supply is crucial to attracting inward investment and ensuring economic growth, especially in the technology sector. A changing generation portfolio with increased penetration of variable renewable generation makes it more difficult to maintain current high levels of security of supply.

As an island with limited interconnection, Ireland is leading the way in resolving the complex technical challenges that the integration of high levels of renewable generation presents. Examples of this include the Celtic and Greenlink interconnectors.

Two of the primary metrics by which a transmission system's performance is measured are System Frequency and System Minutes Lost. These measures are a recognised, robust way of measuring the reliability and quality of supply delivered by an electricity transmission system. Given their importance, EirGrid is incentivised to maintain certain levels for each of these.

System Frequency

Frequency must be maintained at the standard level in order to support the stability of the system. If the frequency is not maintained within defined limits, the system will collapse leading to wide-scale power outages. For the Irish transmission grid, the standard for frequency is 50 Hz. This means that at this level load and generation are perfectly balanced. If the system becomes significantly unbalanced, transmission equipment can be damaged. Household devices are also designed to only handle a certain range of frequencies and can be damaged if this range is not maintained. Ensuring control of the system frequency is critical and challenging as EirGrid seeks to further increase the level of renewable generation connected to the grid. EirGrid continues

to be incentivised to maintain system frequency within prescribed limits. In 2021 the system frequency was operated within the target operating limits of 49.9 Hz and 50.1 Hz for 98.63% of the time. In 2021, EirGrid achieved a partial incentive award of €0.100m for this incentive.

System Minutes Lost

System Minutes Lost (SML) is an internationally recognised measure of transmission system performance. It measures the severity of each system disturbance relative to the size of the system. By measuring SML EirGrid's performance can be compared against other TSOs. EirGrid is incentivised to ensure SML remain low. EirGrid has maintained downward pressure on SML through diligent frequency management, developments in generator performance incentivisation and monitoring, and through the transmission system protection upgrade programme. As per [CRU/20/154](#), the SML annual target is 0.75-2.5 for the PR5 period.

In 2021, there were 0.054 System Minutes lost on the transmission system. In 2021, there were several instances where we were required to manage interruptions to the network and maintain its resilience, ensuring that a constant, safe and secure supply of electricity was available at all times. There were no under-frequency load shedding (UFLS) disturbances in 2021 which resulted in shedding of normal tariff load customers. In 2021, EirGrid achieved its full incentive amount of €0.300m in this regard.

For further information see the All Island Transmission System Performance Report 2021

98.63%
EirGrid maintained system frequency in line with target

0.053690
In 2021, there were 0.053690 System Minutes Lost (SML) on the transmission system, significantly below the target level of between 0.75-2.5

Renewable Dispatch Down

For the PR5 period, the CRU has introduced a new annual incentive focussed on the total dispatch down percentage. Dispatch-down of renewable energy refers to the amount of renewable energy that is available but cannot be used by the system. The dispatch down percentage is based on the average renewable dispatch down for the aggregate of both constraints and curtailment (as currently measured) over the 12 months of the calendar year. The target for 2021 is outlined in the below table. In 2021, 7.3% of renewables were dispatched down. As a result, in accordance with the CRU's direction, EirGrid received a penalty of €56,000 for 2021.

RES-E Target	2021
PR5 Upside Target	5%
PR5 Downside Target	7%
TSO 2021 Achieved	7.3%

Table 10

System Non-Synchronous Penetration

In line with major European Union (EU) commitments on climate action, the Government of Ireland has recently released the Climate Action Plan 2021 which aims to achieve, amongst others, a target of having up to 80% of all electricity generated from renewable energy sources (RES) by 2030. As TSOs, EirGrid and SONI have significant obligations to undertake studies and implement relevant policies to help realise their respective government's renewable energy targets and objectives.

EirGrid has a responsibility to enable increased levels of renewable energy generation on the power system while making sure that the system is operated safely and securely. In 2010, our analysis identified 50% as the then maximum allowable level of renewable generation on the power system, referred to as the SNSP limit. As part of the PR5 Regulatory Framework, the CRU introduced a new annual incentive focussed on increasing SNSP operating policy levels. A target of 75% SNSP was set for 2021.

In March 2021, EirGrid successfully completed a trial of 70% SNSP on the system with over 250 hours of system operation above 65% SNSP. 70% SNSP then became enduring operating policy. The 75% SNSP trial commenced thereafter. During 2021, extensive studies were carried out to ensure that the all-island power system could be operated in a secure and reliable manner when increasing SNSP to 75%, to investigate different aspects of power system security and stability by performing various steady-state and dynamics power system studies and modelling of a number of different power system phenomena.

The system was operated with a 75% SNSP limit for 70% of the 2021 calendar year, while the 75% SNSP trial was ongoing. However, the 75% SNSP trial did not conclude until March 2022. There is no balanced scorecard related to the SNSP incentive. In accordance with the direction in [CRU/20/154](#), the CRU has applied the full penalty of €0.3m for 2021.

Renewable Energy Source – Electricity

The Renewable Energy Source - Electricity (RES-E) is a binary incentive. The total award is subject to meeting the 43% RES-E target for 2021. If the annual target % is achieved, the incentive rewarded is subject to assessment of performance against the quality of the plan (20%), quality of implementation (40%) and the effectiveness of the plan (40%).

2021 was an exceptionally low wind year. In spite of much progress being made on EirGrid's part re the deliverables initially proposed in EirGrid's RES-E plan, the 43% RES-E target was not achieved. Per EirGrid's analysis²⁴, a RES-E level of 34.9% was achieved in Ireland in 2021²⁵.

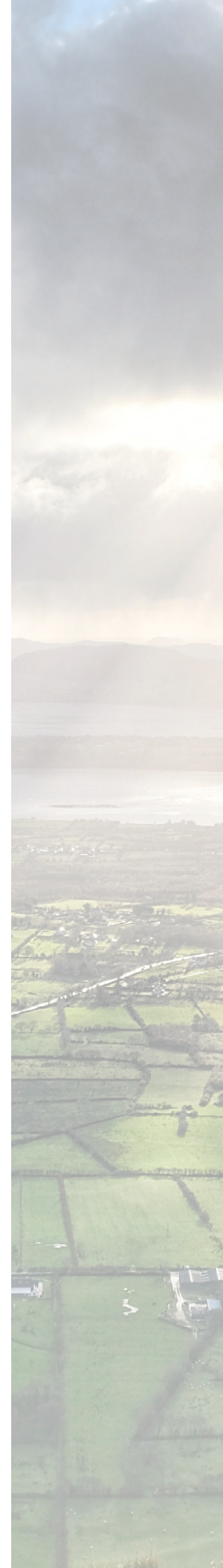
For 2021, EirGrid took the following actions that contributed to the RES-E level achieved:

- During 2021, the Negative Reserve held on conventional generation in Ireland was reduced to zero after a successful trial period, with an associated reduction in curtailment of wind generation of approximately 10%.
- In March 2021, the 70% SNSP trial concluded. 70% SNSP then became enduring operational policy.
- During Q1 2021, detailed system studies on 75% SNSP were carried out, the 75% SNSP trial plan was approved for control centre deployment and the trial commenced. Analysis of this trial showed that SNSP levels above 70% were successfully achieved with no system wide issues related to the high SNSP. The 75% SNSP trial concluded and operational policy was updated in Q1 2022 for this increase in SNSP level.
- The 1 Hz/s RoCoF trial continued during 2021 and allowed EirGrid to operate the power system more flexibly and reduced curtailment of renewable generation. Analysis of the trial period has flagged that under certain system conditions, issues arise with the frequency / RoCoF response of the Northern Ireland power system stabilisers for Tie-Line contingencies. Highlighting issues such as this is an important part of the learnings from system trials.

In accordance with the detail in [CRU202226](#), the CRU has confirmed that no incentive award will be applied for the above for 2021.

²⁴ Per EirGrid System and Renewable Reports - [Fuel Mix 2021](#)

²⁵ In April 20222, it was provisionally estimated that a RES-E level of 35.1% was achieved in Ireland in 2021.



How we ensure network resilience

EirGrid designs and plans the transmission network in accordance with the Transmission System Security and Planning Standards (TSSPS) and operates it in accordance with the Operating Security Standards while ESB Networks constructs and maintains the transmission network on the ground. As the transmission network is vital to the supply of electricity for all customers and end users, these standards are critical to ensuring that the transmission network is designed in a way which guarantees this in a safe, secure and robust manner. The operation of the grid once in place is supported and underpinned by robust policies and procedures both in our control centres and on the ground.

On-going transmission system maintenance is crucial to ensuring the resilience of the network. The Asset Maintenance Policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice. The most up to date guide to Transmission Equipment Maintenance can be found on the EirGrid website [here](#).

The transmission network contains a large amount of overhead lines, cables and substations distributed across the country and at customer's installations. Transmission maintenance work requires a wide range and high volume of complex maintenance tasks to be undertaken annually. EirGrid and ESB Networks agree an annual maintenance programme based on the applicable Transmission Maintenance policies and standards. ESB Networks delivers the transmission maintenance programme utilising teams of highly skilled technicians and specialists distributed nationally. The maintenance expenditure in 2021 was €18m (including both planned and fault maintenance). ESB Networks delivers transmission maintenance efficiently and to a high standard contributing to the health, performance, life and resilience of the transmission system. There is some flexibility in scheduling maintenance within the year, or from year to year.

EirGrid and ESB Networks report and manage the programme actively and dynamically, based on criticality, on an on-going basis. The ability to deliver the full maintenance work programme is affected by the availability of outages; interdependencies with capital project works; weather and other unplanned maintenance or faults arising; additional work or materials requirements identified following inspection; and a wide range of other issues.

In 2021, the delivery of the critical maintenance programme continued to be impacted by disruption to the outage programme as a result of COVID-19 restrictions, low capacity margins and forced outages. While the performance in delivering all maintenance works where an outage was scheduled was positive, a significant amount of maintenance works were deferred (i.e. not "scheduled") due to site closures during lockdown and the on-going disruption that public health restrictions caused to the 2021 outage programme.

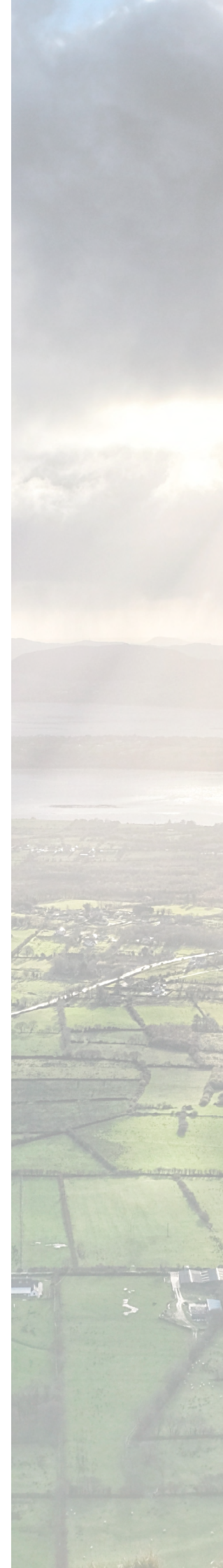
Challenges remain in the delivery of the annual outage programme and security of supply continues to be a key focus for EirGrid. The ability to provide an increased number of outages is not expected to improve in future years as capacity margins remain tight, and the provision of outages has therefore been identified as a key risk to delivering on our strategy of transforming the power system.

In 2021, 93% of the scheduled transmission maintenance programme was completed by TAO. The performance in completing the scheduled transmission maintenance programme improved again in 2021. The percentage completion of scheduled transmission maintenance works in the period 2019 to 2021 is shown in the table below:

Transmission Maintenance			
	2019	2020	2021
Completion %	81%	89%	93%

Table 11

Co-ordinated outage planning is another core requirement to ensuring network reliance on a day-to-day and week-to-week basis. The ability of the system to meet demand, even where generation or system assets are unavailable, is carefully monitored and planned for. The All-Island Generation Outage Plan ensures co-ordination of planned outages when power stations will not be available due to maintenance or other reasons. The plan takes into account security of supply in Ireland, as well as economic operation of the power system, and the maintenance/resource needs of generators.



The All-Island Generation Outage Plan is published in September each year. During the year, the plan for that year is updated on a monthly basis, or as necessary. Details regarding the 2021 All-Island Generation Outage Plan can be found on the EirGrid website [here](#). Generators can send outage requests to EirGrid using the Generator Outage request form on EirGrid's website [here](#).

Transmission Outages involve planned times when lines, cables and substations will be maintained and not in service. It also involves times when plant testing, connection of new plant and decommissioning of old plant is carried out. The annual Transmission Outage Programme (TOP) includes all outages of transmission infrastructure which are planned to occur in the year.

The outturn delivery percentage of planned outage-related capital works and energisations is reported with reference to the annual TOP. In 2021 the TOP delivery percentage was 78%²⁶.

Delivery of the 2021 TOP was subject to a number of influencing factors including:

- Outage complexity, particularly for existing brown field station projects, accommodating changes and difficulty in achieving large volumes/durations of outages regionally;
- Delays on the part of customers;
- Difficulties in gaining access to land;
- Changes in the project scope;
- Availability and scarcity of specialised resources;
- Increasing difficulty in achieving compliance with environmental conditions;
- Issues with the quality of early proposed designs on contestable builds;
- Weather delays associated with weather alerts, storms and unfavourable weather conditions.

COVID-19 related restrictions were introduced on public health grounds in 2020 and these continued into 2021. The COVID-19 impact on the TOP in 2021 was less significant than that which occurred in calendar year 2020, however COVID-19 driven delays were encountered in 2021 over and above what might normally be expected in a standard calendar year.

The CRU introduced new Short Notice Outage Adjustment Mechanism (SNOAM) provisions, providing for the reduction of the duration of planned outages at short notice. In March 2020, the CRU published an information paper [CRU/20/038](#) containing further details of this mechanism. The TSO and TAO are now applying this new mechanism as part of the Outage Management process and will provide information on the operation of the SNOAM mechanism in future Electricity Performance reports. In 2021, the SNOAM provisions were employed in relation to 2 outages.

Further Information on the Transmission Outage Programme can be found [here](#).

Network resilience in an ever-changing system

One of the biggest challenges is maintaining network resilience in an increasingly diverse and complex power system with ever increasing levels of renewable generation.

EirGrid's DS3 programme and SOEF Roadmap²⁷ seek to address this issue. In April 2021, the power system moved to permanent system operation policy at 70% SNSP. This meant we could securely operate the power system with up to 70% of the electricity at a single point in time coming from newer forms of variable, renewable generation. In April 2021, we started a trial with a SNSP limit of 75%. The 75% trial continued into 2022 and was successfully completed by the end of March 2022 when a limit of 75% SNSP became operational policy. With the SOEF programme we are aiming toward 95% SNSP by 2030.

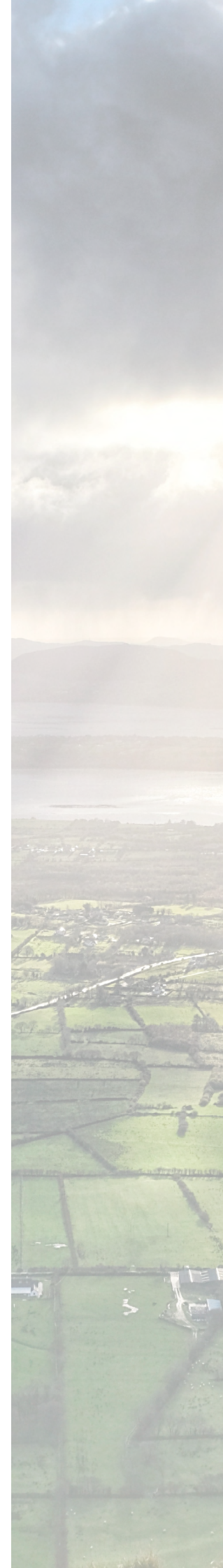
It is also important to optimise delivery of maintenance on the transmission system in order to enhance its resilience. In 2021, critical maintenance plans were again incorporated earlier in the transmission outage planning process giving higher priority to critical maintenance considerations in developing the outage plans and schedules.

Network resilience in action

In 2021, there were several instances where we were required to manage interruptions to the network and maintain its resilience, ensuring that a constant, safe and secure supply of electricity was always available.

²⁶ Includes an ex post adjustment for issues outside of the TSO and TAO's control

²⁷ <https://www.eirgridgroup.com/the-grid/shaping-our-electricity-f/>



There was one adverse weather event which caused a fault on the transmission system (and thus, supply interruption) in 2021:

Between 17:26 hours on Tuesday 07 December 2021 and 01:04 hours on Wednesday 08 December 2021, there were a total of 20 single-phase-to-ground faults and one two-phase fault. The faults were caused by wind during Storm Barra. All faults were zone 1 clearances and fault clearance times were between 52 ms and 86 ms. An interruption to end-users occurred, resulting in 0.000023 system minutes lost.

Three other loss of load events occurred in 2021 for other reasons :

In April, the Charleville-Glenlara 110 kV line tripped for a single phase to ground fault (SE). The cause of the fault is unknown, and no weather warning was in place at the time of the disturbance. The impedance and earth protection operated to clear the fault in 75 ms. An interruption to end-users occurred, resulting in 0.017640 system minutes lost.

In August, the T141 and T143 transformers tripped in Binbane 110 kV station and T141 in Ardnagappary 110 kV station in response to a fault on the Letterkenny-Tievebrack 110 kV line. An interruption to end-users occurred, resulting in 0.005090 system minutes lost.

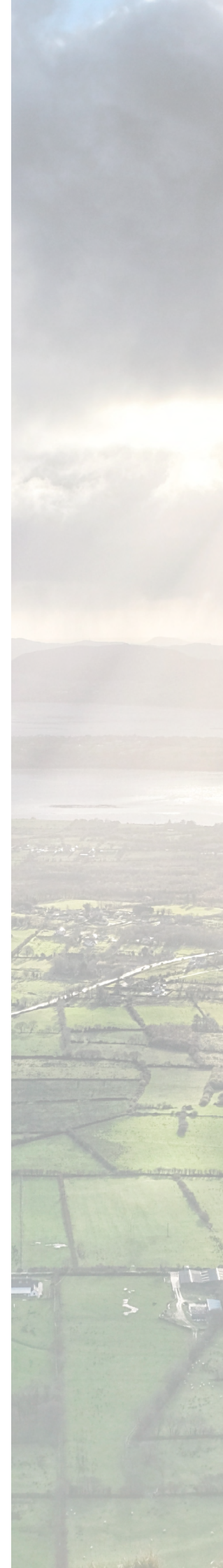
In November, the T143 transformer tripped in Binbane 110 kV station and T141 in Ardnagappary 110 kV station in response to a fault on the Letterkenny-Tievebrack 110 kV line. An interruption to end-users occurred, resulting in 0.030937 system minutes lost.

Power System Emergency Communications Plan

A new Power System Emergency Communications (PSECP) plan was introduced in 2021. Its purpose is:

1. to enable consistent and coordinated stakeholder communications during a power system emergency.
2. to provide for structured information sharing and feedback between EirGrid's operations and communications teams and key stakeholders.
3. to coordinate communication
 - between DECC, CRU, EirGrid, ESB Networks, GNI and:
 - to customers, industry groups, the media and the public.
4. to alleviate concerns and provide reassurance to external parties that the system is currently being managed and restored to its pre-incident state in accordance with agreed and well-practiced procedures and guidelines.
5. to issue messaging to the public in an efficient and timely manner, based on prepared messaging.

The PSECP was trialled on 01 October 2021. The trial was attended by all relevant stakeholders. Participants included senior management and communication representatives from ESB Networks, Gas Networks Ireland, the CRU, DECC and EirGrid. The main objectives of the exercise were successfully achieved.



How we manage Network Constraints

EirGrid implements system operational constraints, in conjunction with SONI the TSO of Northern Ireland, in order to maintain acceptable levels of system stability and voltage levels to enable efficient operation of the system. More information can be found in the [Operational Constraints Update](#) published in December 2021, which covers all the operational constraints in place at the end of 2021.

A review is carried out on all operational constraints annually. A review of operational constraints is carried out if there have been significant network changes made to a particular area of the transmission system, connection of significant generation in an area of the transmission system, or closure of significant generation in an area of the transmission system. The TSO publishes Operational Constraints Updates weekly. EirGrid can confirm that all reports for 2021 were published in a timely manner and are publicly available [here](#).

In terms of short-term management of network constraints, this is carried out in the control centre through the use of a specialist software tool. Using this specialist software tool means short term constraints are identified and information is provided to EirGrid staff which allows them to take the most cost-effective action. The most effective measure of performance in managing constraints is action taken to reduce constraint costs. This is discussed further in the next chapter.

Information on 2021 Curtailment Volumes

Curtailment refers to the dispatch-down of wind/solar for system-wide reasons (where the reduction of any or all wind/solar generators would alleviate the problem). There are different types of system security limits that necessitate curtailment:

1. System stability requirements (synchronous inertia, dynamic and transient stability)
2. Operating reserve requirements, including negative reserve
3. Voltage control requirements
4. SNSP limit

In 2021, 752,376 MWh or 7.3% of the Total Available Wind Energy (10,326,296 MWh) in Ireland was dispatched down. Of that 38.73% was related to curtailment volumes which amounted to 291,412 MWh. This compares to 674,701 MWh in 2020. The Annual Renewable Constraints and Curtailment Report capturing this information in detail can be found [here](#)

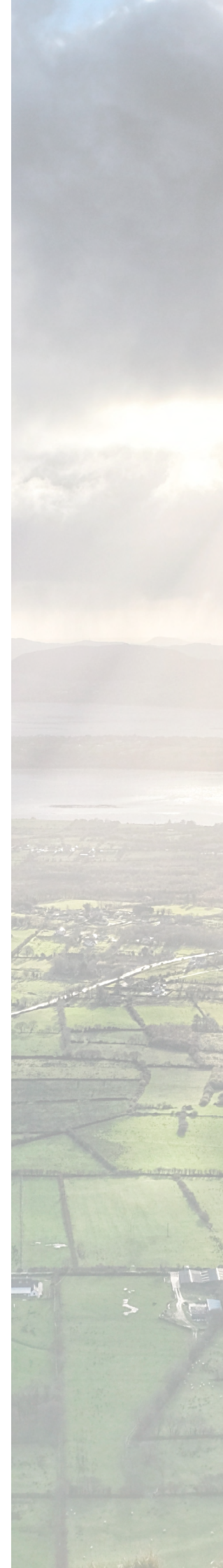
Curtailment levels are affected by several factors which vary year to year. In 2021, the capacity factor²⁸ of wind farms was 24% which was lower than the levels experienced in the previous three years (27%, 26% and 29% in 2018, 2019 and 2020 respectively). In 2021, demand levels recovered to higher than pre-Covid-19 pandemic levels.

During 2021, there were two Operational Policy changes that had a direct impact in helping to reduce the dispatch down of renewable generation:

- Increasing the SNSP Limit from 70% to 75% from 15 April 2021
- Reducing to 0MW the requirement for minimum negative ramping reserve held on conventional generation in Ireland.

In recent years significant capital works have been undertaken to upgrade the transmission system to allow more wind generation to be exported from wind farms on the system particularly in the North West and South West regions of Ireland. These areas have previously experienced the greatest level of restrictions for the export of wind. Every year a range of planned transmission outages are undertaken which at times will increase constraints. Increasingly complex operational switching has been performed in 2021 to maximise renewable output wherever possible across the transmission system. The total wind capacity installed in Ireland at the end of 2021 was 4,332 MW, a minimal increase on the 4,300 MW installed by the end of 2020.

²⁸ The capacity factor is the amount of energy produced (MW output) relative to the theoretical maximum that could have been produced if the wind generation operated at full capacity. Therefore, it represents the average output of the wind generation.



How we manage constraint costs

Sometimes we will have to dispatch or call in some power generators differently from the market schedule, in order to ensure security of supply to end users and market participants. This is because of the technical realities of operating a dynamic and fast-changing power system, such as preventing overloads or maintaining enough generation reserve. Where power stations are run differently from the market schedule, it is termed “constraint”. Generators are kept financially neutral with the original market schedule and the cost associated with doing this is the constraint cost.

Constraint costs are the most significant part of dispatch balancing costs. Dispatch means the sending of instructions from the EirGrid control centre to power generators, demand side units, interconnectors or pumped storage plant about their times, fuel, manner of operation or output. Dispatch balancing costs are a suite of payments that relate to how generators are instructed.

In addition to constraint costs, dispatch balancing costs also include uninstructed imbalance payments and generator testing charges. Constraint costs are an inherent feature of the Single Electricity Market (SEM) design. These costs are levied on suppliers through the Imperfections Charge. EirGrid, working with SONI, the TSO in Northern Ireland, is responsible for forecasting and managing dispatch balancing costs. They form part of the imperfections charge which is paid for by market participants.

As part of PR5, the CRU has introduced a new incentive for Imperfections and Constraints. The aim of the new incentive is to promote EirGrid to mitigate and reduce the costs of constraints on the system. The incentive involves EirGrid identifying areas that are related to imperfections costs and putting in place actions to reduce costs.

The Imperfection and Constraints incentive for 2021 is based on a balanced scorecard containing four key measures as outlined in the below table.

2021 Balanced Scorecard Aspects
<p>Transmission Constraint Group (TCG) review and roadmap</p> <ol style="list-style-type: none"> 1. Constraints Report detailing all active / removed constraints and associated system services. 2. Multi-Year plan for imperfections reductions. 3. Develop quantitative methodology for estimating imperfection cost forecasts and subsequent cost reductions. This methodology will be used in future submissions by the TSO to quantify impact of proposed actions and to measure the success of proposed actions. 4. Report on future transmission reinforcements / TCG removals identifying where imperfections reduction was a substantive determinant.
<p>Reserve Policy Review Following commissioning of batteries at Gate 4/ 4B</p> <ol style="list-style-type: none"> 1. Report on the Review of Reserve Policy reflecting Battery Storage Capacity. This should be completed by the end of 2021 to be included in the incentive assessment for 2021. The TSO should also demonstrate progress regarding implementation.
<p>Imperfections Reporting</p> <ol style="list-style-type: none"> 1. Four published Quarterly Imperfections Cost Reports in 2021 with clear evidence of the imperfection reductions actions, progress on plan and the future improvements that the TSO will make to remove or reduce the cost of each constraint in the next period. 2. Report to CRU on the specific plan for each constraint (as set out in CRU decision). 3. Improved accessibility to the latest report on the TSO’s website.
<p>RoCoF Policy Change to 1Hz/s</p> <ol style="list-style-type: none"> 1. Report on RoCoF trial & policy changes.

Table 12

The CRU published an information paper on the 2021 incentives in March 2022, [CRU202226](#). This information paper contains direction and guidance on the 2021 Balanced Scorecards targets and the performance assessment process. The information paper outlines each aspect of the balanced scorecard will be assessed against the following: quality of the plan and defined actions (20%); quality of implementation of the plan (40%); and effectiveness of the plan and demonstrable impacts (40%).



During 2021, EirGrid's performance on the balanced scorecard under each aspect is noted below -

- Regarding the TCG aspect of the balanced scorecard, EirGrid achieved three out of four targets set. Conclusion of the quantitative methodology remains outstanding. A draft methodology was shared with the CRU in early 2022. It was agreed that further CRU/EirGrid engagement was required prior to finalisation. However, CRU/EirGrid engagement in this regard has not yet concluded.
- As required under the second aspect, a report on the review of reserve policy was issued to the CRU as part of the incentive assessment in April 2022. Since this was a new requirement confirmed via a CRU decision published in March 2022, EirGrid understands that per EirGrid/CRU discussions, submission of the requisite report post publication of the applicable CRU decision would suffice in relation to this aspect.
- Throughout 2021, EirGrid published quarterly imperfections cost reports on a new landing page on the SEMO website in an effort to enhance accessibility of the reports for stakeholders.
- Regarding the other reports requested by CRU as part of this balanced scorecard, the RoCof trial and policy changes report was submitted to CRU as part of the Annual Regulatory Reporting Pack for 2021.

In accordance with the direction in [CRU202226](#), the CRU has confirmed an outturn incentive award be applied for this incentive for 2021 of €0.14m against a total possible incentive allowance of €1.5m. EirGrid receipt of further information from the CRU in relation to the basis for the CRU's decision regarding the outturn is pending. Future iterations of the APR will be updated to include this information on receipt from the CRU. Please see Section 3.4 of [CRU2022090](#) for further detail re the basis for the CRU's decision in this regard.

2020/21 Main constraint changes and TSO Initiatives for cost savings

The table below shows some of the main constraints that were introduced/changed over 2020/21 which impacted imperfections costs. It also identifies the TSO initiatives, that lowered costs for 2020-21 and continually beyond. These TSO initiatives gave rise to imperfections cost savings of approximately €22.44m in 2021.

While many initiatives have reduced costs, tight generation margins in 2020/21 meant that some operational constraints were introduced which increased constraint costs. For example, during certain weeks, some generators were made "Must Run". A "Must Run" is a constraint that requires certain generators to be run in order to keep the transmission system within desired technical limits, to maintain system security.

For a full list of changes to constraints and the full set of constraints that are currently applicable, please see operational constraints report located [here](#).

Action	No.	Description
TSO initiatives to reduce costs	1	In January 2021, the requirement to hold Negative Reserve on thermal generation in Ireland was reduced to zero after a successful trial period.
	2	In April 2021, SNSP increased from 65% to 70% (following completion of successful trial)
	3	In April 2021, reduction in minimum required Dynamic Primary Operating Reserve (as a result of Increased Batteries / DSUs): reduced to 110 MW/75 MW and reduced further to 87 MW/75 MW in May 2021
	4	In May 2021, increase in non-regulating reserve assumed to be available from batteries
"Must run" for System Security	5	From January 2021 onwards, a "Must-Run" constraint, for system security reasons has been active. This was applied at various times to C30, DB1, MP1, MP2, MP3, TB3 and K1
	6	In June 2021, a "Must Not Run" constrained was applied on AT2 and AT4 to minimise risk for margins across winter 2021/22.

Table 13: Transmission constraint group updates in 2020/2021

How we minimise the financial Impact of Transmission Losses on Consumers

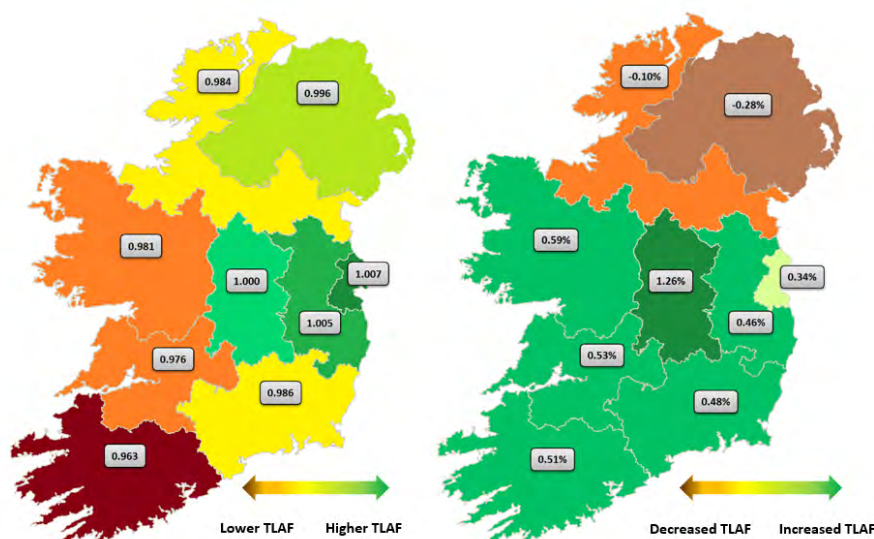
When electricity is transported through electricity networks, there are inherent losses, which means that not all of the power generated reaches end users. This occurs on both the transmission and distribution networks, although higher voltages generally reduce losses.

To ensure that the all-island wholesale market is settled correctly, transmission losses are allocated to generators in Ireland and Northern Ireland (including generators connected to the distribution system), using Transmission Loss Adjustment Factors (TLAFs). TLAFs are only applied to generators so the costs of transmission losses are not directly charged to end consumers.

The TLAFs for the island of Ireland are calculated annually by EirGrid, jointly with SONI in Northern Ireland, and approved jointly by the CRU in Ireland and the Utility Regulator (UR) in Northern Ireland. They effectively discount the value of the generation being produced by individual generators.

The further power has to flow through the system from where it is generated to where it is needed, the greater the potential losses. As a result, TLAFs are location specific. The regional TLAFs for 2021 are shown on the map with green indicating a higher and therefore financially better TLAF. The second map indicates the change in regional TLAFs from 2020. These changes are influenced by yearly dispatch, demand and topology changes.

Such signals provide a commercial incentive for generators to make informed investment decisions concerning their use of the transmission system.



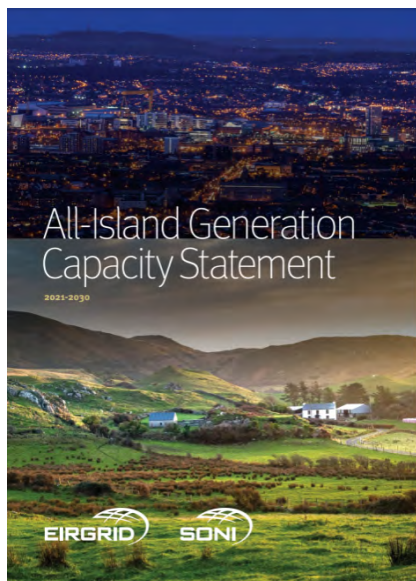
2021 Regional TLAFs % Change from 2020 to 2021: Regional TLAFs

TLAFs are designed to provide locational signals to facilitate a more efficient real time dispatch. They are calculated using a forecast annual dispatch based on the latest assumptions for the tariff year ahead (forecast demand, fuel prices, generator outages, etc.). Historically, the all-island TLAF average typically sits in the 0.98 to 0.99 band, however the average TLAFs of individual participants have ranged from, but are not limited to, 0.95 to 1.03 (a range of approx. 8%).

Given this possibility for improving real time dispatch efficiency, even if the TLAFs conservatively achieved just a 1% reduction in lost energy, it would have accounted for a saving in the all-island wholesale energy required of approx. 390GWh in 2021. Using the average Imbalance Settlement Price for 2021 of €92.53/MWh²⁹ this would equate to a reduction in all-island costs of around €36m. Further information on TLAFs can be found on EirGrid's website located [here](#).

29 [Annual Market Operator Performance Report 2021 \(sem-o.com\)](#)

How EirGrid supports market operation



In its role as TSO, EirGrid provides critical support in the operation of the Single Electricity Market.

The market arrangements are designed to integrate the all-island electricity market with European electricity markets, making optimal use of cross border interconnectors, enhancing security of supply, delivering increased competition and further enabling the integration of renewables onto the system.

New market arrangements for the All-Island Single Electricity Market came into operation on 01 October 2018 under the Integrated-Single Electricity Market project. A number of Capacity Market auctions have been successfully held which are central to generation adequacy. New types of capacity such as batteries and flexible generators have entered the market as a result.

The second North South Interconnector remains critical for security of supply in both jurisdictions. While the capacity auctions ensure provision of adequacy in the near to medium term, the second North South Interconnector remains essential to ensuring long term security of supply across the island. EirGrid and SONI are working towards the delivery of the second North South Interconnector as soon as possible. Together with the SEM, this will enable all consumers on the island of Ireland to realise the ambition of maximising the considerable benefits of an all-island electricity system and market.

Despite a short-term reduction in demand at the beginning of the measures to mitigate the spread of COVID-19, demand in Ireland is increasing and long-term demand is forecast to increase significantly, due to the expected expansion of many large energy users.

One of our key responsibilities is providing accurate system demand forecasts. This is a crucial aspect of ensuring generation adequacy and maintaining security of supply. Using a complex modelling system which predicts electricity demand based on changes in economic parameters, and with the support of bodies such as the ESRI (Economic and Social Research Institute), we ensure that market participants can make informed decisions due to the accuracy of our demand forecasts.

Further details on our work in demand forecasting in 2021 can be found in the [Generation Capacity Statement 2021-2030](#)

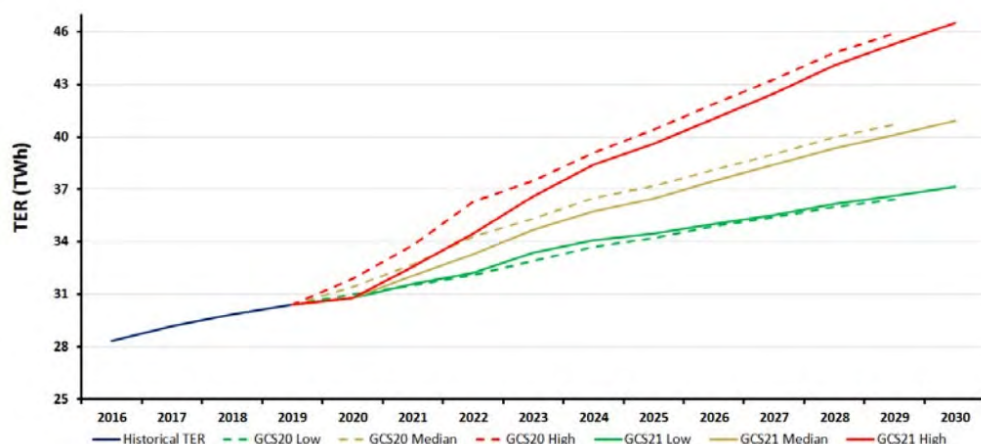


Figure 1: Total Electricity Requirement Forecast for Ireland 2021-2030

In Ireland, the growth in energy demand for the next ten years varies between 28% in the median demand scenarios, to 43% in the high scenarios as shown in the above graph. The median forecast is generally aligned with EirGrid's Tomorrow Energy Scenarios Centralised Energy which predicts an overall Energy Requirement for Ireland of approximately 41TWh by 2030.

The long-term demand forecast in Ireland continues to be heavily influenced by the expected growth of large energy users, primarily data centres. EirGrid's analysis shows that demand from data centres could account for 23% of all demand in Ireland by 2030 in our Median demand scenario. Furthermore, by 2030 there will be some new additional load from the heat and transport sectors as they move towards electrification.

Capacity Auctions

EirGrid, working with SONI, also has a critical role in the operation of the Capacity Market, securing generation capacity to meet the further demand needs of the all-island network. This is achieved through Capacity Auctions.

T-4 auctions take place every year. In January 2021, the TSOs ran a T-4 Capacity Auction for the 2024/2025 Capacity Year (October 2024 to the end of September 2025). The auction secured a total of 6,138 megawatts (MW) of Capacity. The auction clearing price was €47,820 per MW per year.

Of the 130 units that qualified to take part in the auction, 105 units submitted offers in to auction. All 105 were successful. A total of €582 million of capacity payments will be paid during the period October 2024 to September 2025. Between the T-4 and T-3 auctions which took place in 2021, a total of 1,899MW of new capacity was successful across the two auctions. Although 70MW has since been terminated.

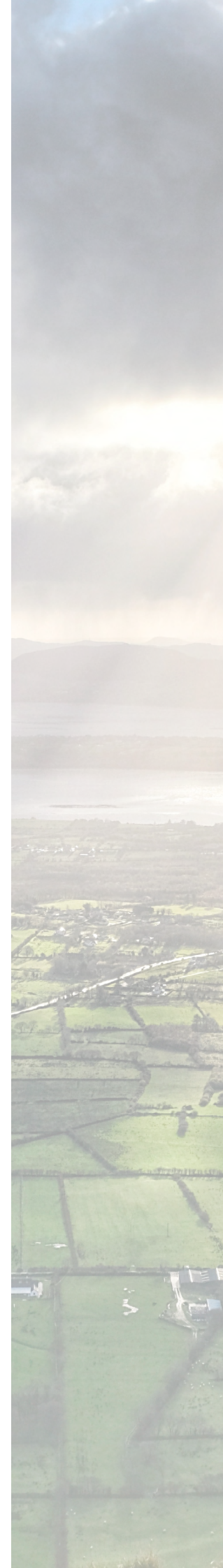
The capacity required from the auction took into account peak demand, security of supply, as well as the reliability and performance of generators, and a range of demand forecasts and interconnection. The final results are available to view in the [Capacity Market Auction Results report](#).

EirGrid has also published the following documents on the SEMO website:

[2024/25 T-4 Final Capacity Auction Results Report](#)

[2022/23 T-1 Final Capacity Auction Results Report](#)

In the event that not all the Awarded Capacity achieves successful completion in the designated timeframes, the SEM Committee may direct the system operators to hold supplementary T-1, T-2 or T-3 auctions in order to procure the additional volume necessary to ensure security of supply. In October 2021, the TSOs ran a T-1 Capacity Auction for the 2022/2023 Capacity Year (October 2022 to the end of September 2023). The auction secured a total of 1,120.5 MW and the auction clearing price was €46,150 per MW per year.



How we manage new connections

EirGrid issues connection offers to large scale generators, interconnectors and demand customers, who seek connection to the transmission system in line with connection policy and directions as issued by CRU from time to time. This section summarises the offers issued in 2021.

Connecting Generators and Interconnectors

Large generators, typically with a capacity of more than 40 MW, connect to the transmission system. Offers are issued to generators seeking connection in line with the regulatory framework set down by the CRU. EirGrid also provide connection offers to the DSO so that generators connecting to the distribution network can export power onto the transmission system. Generator types include thermal plants using fossil fuels, hydro, Combined Heat & Power (CHP) plants, wind and other newer generation types such as solar power or commercial energy storage facilities. EirGrid operates the connection process for new generators in close co-operation with ESB Networks, as DSO and in line with regulatory policy.

The total renewable generation provided to the grid at the end of 2021 was 11,545 GWh which supported 34.9% of the total demand

When a connection offer is executed this means that the applicant has signed a connection agreement but has not yet energised. When an offer is issued it means that the TSO, or DSO, has issued a connection offer to an applicant. This does not mean the offer has at the time been accepted by the applicant. A connection offer which is accepted in one year is also unlikely to impact on connected generation capacity in the same year given the lead times associated with construction.

In addition to issuing connection offers for new generation and demand capacity, EirGrid facilitates existing contracted customers in modifying existing connection agreements. A list of the currently contracted and connected customer to the Transmission system is located on EirGrid website [here](#).

Offers Executed - New and Modifications - Total in 2021	No.	MW
New Transmission Generator Connection Offers Executed	8	550.5
New Transmission Interconnector Connection Offer Executed	1	700
Modifications to pre-existing Transmission Generator connection agreements executed	20	(33.9)
Modifications to pre-existing Interconnector Connection agreements executed ³⁰	1	4
Total	30	1,220.6
Offers Issued – New and Modifications – Total in 2021 Offer issued New and overall Total in 2020	No.	MW
New Transmission Generator Connection Offers Issued	31	2083
New Transmission Interconnector Connection Offer Issued	1	700
Modifications to pre-existing Transmission Generator connection agreements issued	24	(95.4)
Modifications to pre-existing Interconnector Connection agreements issued	1	4
Total	57	2,691.6

³⁰ Incremental MW subject of the modification detailed only i.e. 4 MW

In addition, we facilitate the connection of Interconnectors between the transmission system in Ireland and the transmission systems in other countries. Offers are issued to companies seeking to construct an interconnector in line with the rules set down by the CRU. The Celtic Interconnector connection offer was issued and executed in 2021. A minor modification to the Greenlink Interconnector connection agreement was issued and executed in 2021.

Connecting Demand Customers

A demand customer is a large commercial or industrial user of power. They can apply to connect to either the transmission or the distribution system. In general, customers who require a power supply of over 20MVA connect directly to the transmission system. At the end of 2021 there were 24 demand customer sites connected directly to the transmission system. A total of four transmission demand connection agreements were executed in 2021.

	No.	MVA
Demand Connection Offers Executed	4	406
Demand Connection Offers Issued (includes modifications to contracts)	23	42.5

When a connection agreement is executed for a new connection, it typically takes a number of years before it is connected to the transmission system. This period includes project development, time taken to obtain consents and to construct the connection. In 2021, no new demand customers connected to the transmission system.

Demand Side Units

Demand Side Units (DSUs) do not receive connection offers. A Demand Side Unit or DSU is a single demand site or group of demand sites that can reduce their electricity consumption when instructed by the National Control Centre. These are registered in the market and are offered system services contracts. In 2021, no new DSU's were contracted, so the total number of at the end of 2021 remained 29 with a total capacity of 563MW, as previously reported for 2020.

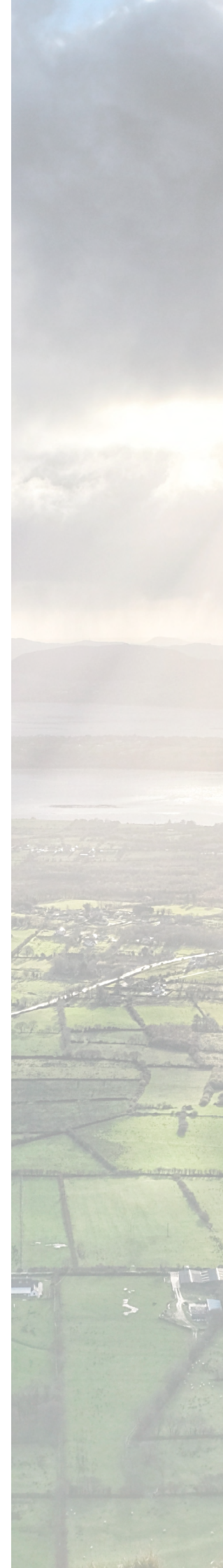
Efficiency Improvements in the Processing of Connection Offers and Modifications

In 2021, EirGrid processed the ECP-2.1 batch. EirGrid introduced early engagement meetings with the customers which improved efficiency and enhanced engagement with customers. EirGrid also introduced Grid Connection Assessments for Capacity Market applicants. This involved the provision of information to customers in relation to their connection methods and connection charges in advance of the auction and allowed EirGrid to build on these to prepare the Connection Offers in a timely manner post Auction. This is a process that EirGrid will be applying in 2022 in relation to Offshore Wind Applications.

Contestable Construction

Contestable construction is the arrangement whereby customers build their own connection assets required to connect to the transmission system, this has been in place for several years. This mechanism provides flexibility to customers to manage and control their costs, their programme and their risk. The ownership of the contestably constructed transmission assets transfers to ESB Networks on completion. EirGrid takes over operational control of the new assets. TSO and TAO work closely together to manage the design review, construction monitoring, due diligence, commissioning and takeover processes associated with contestable construction to ensure the connected assets are fit for purpose.

TSO and TAO work closely together with customers regarding the design review, construction monitoring, due diligence, commissioning and takeover processes associated with contestable design and construction necessary to ensure the connected assets are fit for purpose. TSO and TAO have multidisciplinary teams and processes in place to support and facilitate the increasing levels of contestably constructed connections. During 2021, more than 500 design packages regarding approximately 20 contestable connection projects were reviewed as part of the design review and due diligence processes. Both the TSO and TAO actively manage the turnaround times to assist developers in meeting their project development timelines.



Connection Policy Developments 2021

Enduring Connection Policy

The process for issuing generation offers was consulted on in 2017 resulting in the Enduring Connection Policy (ECP) which led to a significant increase in the number of new generation capacity offers issuing in 2019 and 2020.

ECP-2, which was published in June 2020 prioritises large renewable energy projects in the first instance, in line with the CRU strategic priority of delivering sustainable low-carbon solutions with well-regulated networks. Applications for ECP-2.1 opened in September 2020 and offers to all applicants under ECP-2.1 were issued by 31 December 2021, resulting in an incentive payment of €0.43m.

The application window for ECP-2.2 opened on schedule in September 2021 and offer processing is currently underway.

Data Centre Grid Connections

In November 2021, following public consultation, the CRU published the Direction to the System Operators (SOs) related to Data Centre grid connection processing, [CRU/21/124](#). The purpose of this was to direct the SOs to implement a set of additional assessment criteria by which the SOs must process data centres applications.

The additional assessment criteria to be satisfied are whether a data centre is located in a constrained or unconstrained region of the grid, the ability of the data centre applicant to bring onsite dispatchable generation (and/or storage) equivalent to or greater than their demand in order to support security of supply, and the ability of the data centre applicant to provide flexibility in their demand by reducing consumption when requested. The assessment criteria apply to all connection applications received for the connection of data centres at any location in Ireland.

Security of Supply

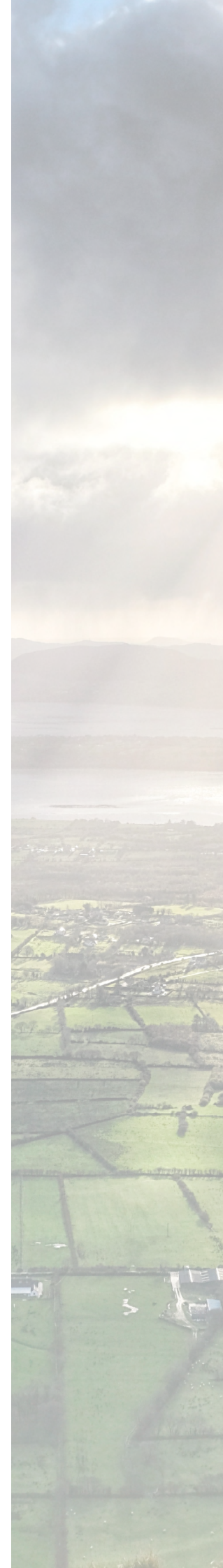
In 2021, there was increased concern regarding the security of supply. Unplanned outages at two major generation facilities; the decreasing reliability of older generating plant exacerbated by reduced maintenance during the pandemic; and several plants retired from operation. At the same time, planned generation capacity did not materialise as expected and there was reduced wind output at critical times throughout the year. This required resorting to some older, less reliable plant and imports which are not always available if the UK is experiencing the same climatic conditions. Taken together, all these factors combined to provide some challenges for ensuring security of supply. In conjunction with the DECC and the CRU (which has the legal responsibility for ensuring security of supply), a programme was put in place with the aim of securing adequate supply to meet demand, as per the CRU Information Paper Security of Electricity Supply – Programme of Actions [CRU21115](#). In 2021, EirGrid worked in support of these measures and is continuing to do so.

Offshore Grid Connections

In 2021, the DECC's [Policy Statement on the Framework for Ireland's Offshore Electricity System](#) designated EirGrid as the TSO and TAO for Ireland's offshore transmission grid. DECC's statement also outlined the policy for three phases of offshore generation projects to be developed in alignment with three offshore support auctions. The CRU is co-ordinating with DECC and EirGrid on the interlinked processes for consent, auctions and grid connection for offshore generation.

In October 2021, the CRU published the first consultation regarding the generation policy that will apply to the first phase of offshore generation projects, the Offshore Grid Connection Assessment – Phase 1 Projects Proposed Decision, [CRU/21/112](#). EirGrid's [Offshore Phase 1 Projects Grid Connection Assessment Report](#) was published alongside the CRU's proposed decision. The CRU proposed that, in the next stage of the process for Phase 1 connection applications, EirGrid would issue a Grid Connection Assessment (GCA) to each eligible Phase 1 applicant. This GCA will detail the method and cost of connecting a Phase 1 project to the transmission system at its onshore connection point. The criteria of this GCA were the subject of the CRU's consultation.

EirGrid continues to work closely with the CRU and industry to develop these vital projects as quickly as possible.



Innovation

EirGrid and ESB Networks have innovation programmes through which we research, develop and use innovative solutions which help us manage the ever-changing power system. We innovate to bring value to all users of the power system.

Both innovation and research are essential in getting us to where we need to be, enabling solutions to realise sustainable energy benefits. Throughout 2021, EirGrid, together with the Northern Ireland TSO, SONI, have strategically innovated to deliver key projects, such as Shaping Our Electricity Future, as well as delivering several smaller individual projects that enhance the way we operate.

EirGrid and SONI have also refreshed our Innovation and Research Strategy³¹ in the last year to outline the necessary support structures, frameworks, and people we need to enhance our innovation and research capability on an all-island basis. The strategy complements recent publications from EirGrid and SONI on the Shaping Our Electricity Future Roadmap to 2030, by focusing our collective research and innovative strategies to deliver on Ireland's and Northern Ireland's respective ambitions to 2030, while enabling and supporting the innovation and research in our ecosystem to deliver on longer term net zero carbon commitments.

EirGrid's collaboration with our partners has been fundamental in delivering on our current innovation programmes. Enhancing these strong relationships, as well as building new ones will be vital as we strive to innovate further with our strategic programmes of work.

Whilst our ambition to net zero carbon is decades away, it is vital we begin our journey of discovery now. We need to understand the options and solutions which will work best for the Island of Ireland, to ensure we are on the right path to deliver on a cleaner energy future.

For more information please refer to EirGrid's 2021 Annual Innovation Report³².

Collaboration on Innovation between TSO and TAO plays an important role in meeting the system resilience and capacity challenges within the climate action plan for the electricity transmission network. The required levels of system security and investment requires new ways of thinking, innovation and collaboration between TSO and TAO focused on several key enabling systems, processes, and technologies to:

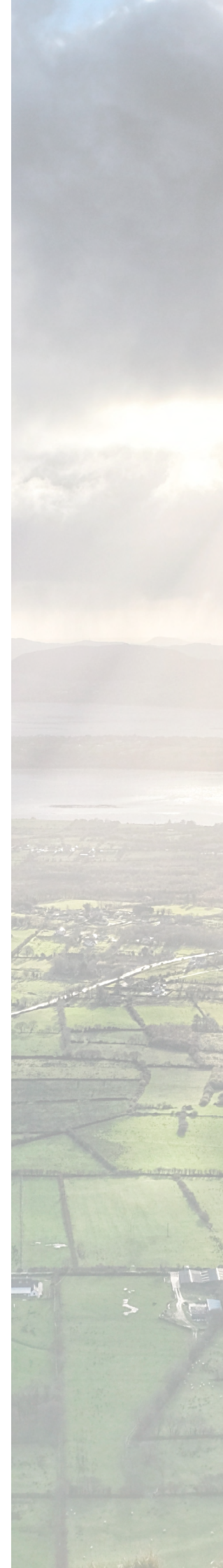
- i. Safely maximise and optimise the load carrying capability of existing network
- ii. Optimise Operations and Maintenance processes and policies
- iii. Identify 'non-wires' solutions to defer traditional reinforcement projects and expenditures
- iv. Upgrade networks utilising innovative assessment and investment approaches and strategies
- v. Interconnect with other transmission systems
- vi. Develop interoperability with the Distribution system
- vii. Develop infrastructure to connect largescale offshore wind generation.

A joint TSO and TAO innovation working group continued to operate during 2021 and a framework agreement on Innovation was developed setting out how both companies will work together to proactively progress viable technology options needed to jointly develop the Transmission system of the future. The working group have developed a multiyear plan to focus on the priority solutions and innovations.

The Joint Working Group meet monthly and maintain a register or 'Toolbox' of new technologies. Progress on deployment of new technologies is measured using an agreed assessment of the Technology Readiness Level (TRL). Key milestones for each technology are planned and monitored. The CRU has linked progress on certain innovation initiatives to the joint annual incentive available to both companies as outlined in the *How we performed against transmission delivery incentives* section.

³¹ [Innovation & Research Strategy](#)

³² [2021 Annual Innovation Report](#)



2021 Highlights

Qualification Trial Process (QTP)

The QTP is the mechanism through which EirGrid, working with SONI in Northern Ireland, manages the transition to a wider portfolio of system service providers. The aim is to identify operational complexities that may be associated with new technologies or the delivery of new System Services. In doing so, EirGrid and SONI can develop a deep understanding of these complexities and suggest solutions on how to best integrate these technologies at scale on the power system on the island of Ireland and Europe.

In 2021 we concluded the 2019/2020 trials focussing on Solar, Residential Services, and enhanced communication protocols for new and existing technology.

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

Each of the trials has demonstrated valuable learnings to EirGrid and SONI. Firstly, the solar trial has shown solar photovoltaic technology can deliver fast-acting reserves (FFR, POR, SOR and TOR1).

On the residential trials, two participants were successful: Energia and SMS (previously Solo Energy). Both participants implemented a different methodology and range of technologies as part of the trial demonstration of System Services capability. Each trial successfully demonstrated a subset of DS3³³ system services is possible from the technologies in domestic properties.

Finally, on the telecommunications trials, two trials took place focussing on alternative forms of communication protocols. Both trial participants brought forward new solution designs that have helped the TSO's look at the possibilities of telecommunications. The learnings and outcomes have identified several operational complexities for the integration of alternative telecommunications protocols.

Detailed information on the trials for 2021 can be found [here](#) .

75% System Non-Synchronous Penetration (SNSP) Study and Trial

There was previously an operational system constraint within EirGrid's operational policy that limited the operation of the all-island power system to up to 70% SNSP. One of the DS3 Programme targets was to relax this operational system constraint to 75% SNSP in order to enable more renewable energy to be transferred through the power system. As aforementioned, during 2021 extensive studies were carried out to ensure that the all-island power system could be operated in a secure and reliable manner when increasing SNSP to 75%. The 75% SNSP trial was ongoing throughout most of 2021.

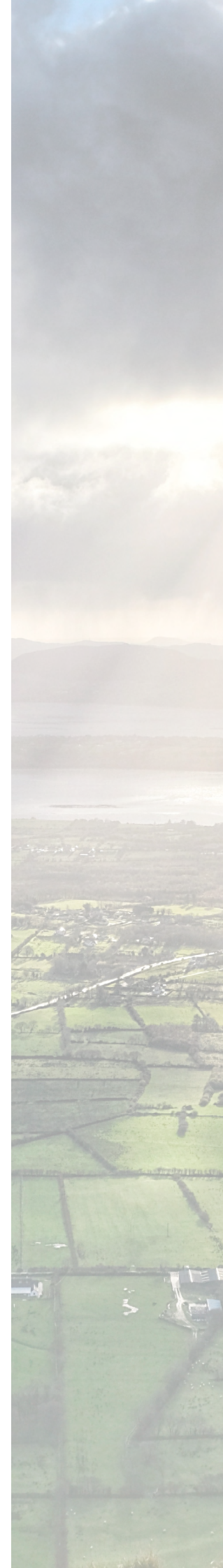
Increasing SNSP is part of the DS3 Programme and will facilitate higher levels of non-synchronous renewable generation on the system. This is just one step in the pathway towards 95% SNSP by 2030, which is required to fulfil government RES-E targets.

Horizon 2020: EU-SysFlex

The EU-SysFlex Project is an EU Horizon 2020³⁴ funded project addressing system operation and flexibility solutions for integrating 50% renewables in Europe by 2030. The project, led by EirGrid and SONI, has several dimensions being delivered by 34 cross sectoral consortium partners including TSOs, DSOs, technology providers, research, and academic institutes as well as consultancy sector across 15 European countries.

³³ [EirGrid, DS3 Programme](#)

³⁴ [European Commission, Horizon 2020](#)



In summary, the project scope consists of:

- Characterising the technical scarcities in the EU power system for ambitious RES-E scenarios aligned with EU and national renewable targets;
- Identification of mitigations options to address the identified scarcities as well as financial and economic analysis of the simulated results to assess the value of the system services required; and
- Market enhancements required to incentivise investment in the identified system services.

For more information please see the EU-SysFlex Website³⁵.

The rationale for participating in EU-SysFlex is to enhance our collaboration with other sectoral participants in addressing system wide challenges as well as sharing knowledge to enhance our understanding and ability to solve future challenges. From a technical perspective, participation has funded the technical analysis and studies associated with future operations aspect of Shaping Our Electricity Future Roadmap.

The four year ground breaking project, co-ordinated by EirGrid and SONI, has identified the needs of the future power system by charactering the technical scarcities of the future power system with a high share of renewables across three synchronous areas of Ireland and Northern Ireland, Continental Europe and the Nordics. Through financial and economic analysis of the simulated results, the project team have identified associated financial gaps and market enhancements required to incentivise investment in system services. From an Ireland and Northern Ireland perspective, this work has directly fed into Shaping Our Electricity Future Roadmap and our plans to meet our renewable ambition of 70% renewables and 95% SNSP.

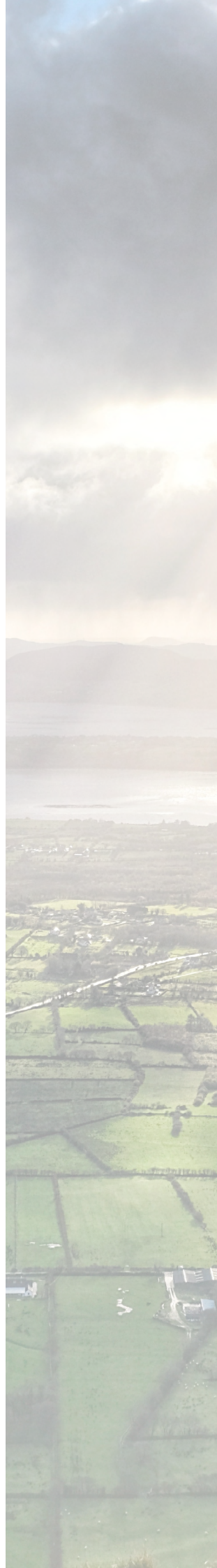
Collaboration

Collaboration with other industry experts is imperative in delivering on our innovative ambition. The collaborative approach enhances our relationships with our partners and strengthens EirGrid's breadth of knowledge and capability.

EirGrid is always open for new opportunities to collaborate further with our established partners, and forge new relationships with partners we do not currently operate with. During 2021, EirGrid collaborated with several groups, such as the Electric Power Research Institute, Friends of the Earth, and local community groups. Further information on how this enhanced EirGrid's operations is available in the annual innovation report³⁶.

³⁵ [EU-SysFlex](#)

³⁶ [2021 Annual Innovation Report](#)



Engaging with Stakeholders

EirGrid Stakeholder Engagement

EirGrid's commitment to meaningful stakeholder engagement is embedded across the company and forms part of our core company strategy. The commitment to understanding the needs of stakeholders is critical to informing all EirGrid activity.

EirGrid's six-step grid development process was designed with a particular focus on engaging with the public and landowners on grid projects - more often and earlier in the decision-making process.

EirGrid's [Strategy 2020-25](#), was informed by extensive engagement with key stakeholders. Achieving the scale of transformation in our strategy requires a significant increase in the scope and frequency of our stakeholder engagement, this journey began in 2020.

The COVID-19 pandemic created an unprecedented and challenging backdrop to our stakeholder engagement throughout 2021. In the face of on-going public health restrictions, much of our engagement remained on-line, and, cognisant of this, EirGrid endeavoured to be innovative to ensure that our stakeholders could benefit from impactful engagement on key and critical issues.

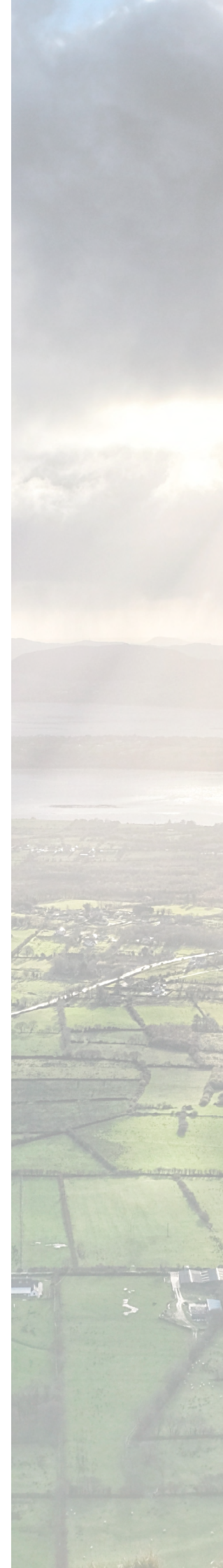
Our commitment to 'Engage for better outcomes for all' has been complemented by the publication of [our new Public Engagement Strategy](#), in February 2021. This strategy recognises the need to continually evolve our engagement with external stakeholders to support the delivery of infrastructure across Ireland and on our path to achieving climate action targets.

EirGrid has a deeply interconnected role in leading the changes necessary for a clean electricity system. We are creating stronger links with Government, local Government, NGOs, the business community and local community and voluntary groups, while also needing to build new alliances with business, industry, education and research bodies. Amongst other benefits, these alliances allow us to develop common practices with key partners. This is important for rolling out coordinated approaches to engaging with local communities.

A new multi-year partnership was launched in 2021, Our Energy Future, with the Renewables Grid Initiative (RGI) and Friends of the Earth. This partnership will support diverse and open dialogues on the challenges and opportunities associated with Ireland's energy transformation from development of grid infrastructure, to the need for a decarbonised, secure and affordable electricity, with a much higher share of community participation. At project level, we renewed relationships with local Chambers of Commerce and Public Participation Networks (PPNs). Additionally, we worked closely throughout the year with Irish Rural Link, Development Perspectives, and the National Youth Council of Ireland in delivering bespoke engagement experiences with and for stakeholders.

A new permanent consultation portal, consult.eirgrid.ie, was launched by EirGrid in 2021. This new site provides seamless integration with our digital suite and exceptional user experience for stakeholders. A highlight for 2021 was the launch of EirGrid's largest ever public consultation. The Shaping Our Electricity Future consultation ran for fourteen weeks from March. EirGrid held a series of workshops, meetings and forums across the country to inform people and gather feedback that directly influenced the final roadmap. This work culminated in the launch in November of the "[Shaping Our Electricity Future](#)" roadmap, a blueprint for radically transforming the country's electricity grid.

Building on our efforts in 2020, EirGrid published its Stakeholder Engagement Report for 2021. This report provides information on all areas of EirGrid's stakeholder engagement during 2021, including an overview of how we are working to improve our engagement and the learnings we have identified. The report can be found on the Stakeholder Engagement section of EirGrid's website [here](#).



The Networks Stakeholder Engagement (NSEE) Panel

In 2018, the CRU introduced the Networks Stakeholder Engagement Evaluation (NSEE) Panel in accordance with PR4 Decision on Reporting and Incentives [CER/18/087](#), CRU have retained this process for the PR5 period, [CRU/20/154](#). The panel is composed of representatives from industry, academia and wider stakeholders and is tasked with assessing the quality, implementation and effectiveness of the network operators, EirGrid and ESB Networks, on their respective stakeholder engagement strategies on an annual basis.

EirGrid was awarded a score of 6.74 out of a possible 10 by the panel for its activities in 2021, which resulted in an incentive payment of €0.207m, as confirmed in Section 3.4 of [CRU2022090](#). At time of writing, the NSEE Panel's close out report has yet to be published by the CRU.

ESB Networks Stakeholder Engagement

ESB Networks has proudly worked with customers, communities and stakeholders across Ireland for over 90 years. We value the trust that has developed with all of our customers and as the use of the transmission network continues to evolve, we understand the importance of keeping our customers at the centre of everything we do.

ESB Networks Stakeholder Engagement

We define our stakeholders are the individuals, groups, communities or organisations that affect, or could be affected by, our activities, products or services and associated performance. Given our central role in the electricity industry connecting over 2.4 million homes, farms, communities, and businesses around the country to a clean electric future, we have a very broad range of stakeholders. Only through an open and ongoing two-way dialogue with our stakeholders, will we ensure that we are able to meet both the needs of our customers today and prepare the network to meet the needs of our customers in the future. as we strive for net zero by 2040.

Considerable changes are taking place within the energy sector at an unprecedented scale, and to this end we are fully aware that who we engage with and how is constantly changing. Each year we publish a 'Stakeholder Engagement Strategy & Plan' providing stakeholders with pathways to engage as well as setting our engagement priorities for the year ahead. Listening and acting on stakeholder feedback is an essential part of the continuous cycle of improvement in our engagement process. We have significantly ramped up the level of stakeholder consultations, which provide valuable insights and opportunities for improvement. Effective stakeholder engagement is essential for the successful management of our business. As a strategic priority, it is led by the Managing Director and the senior leadership team and is seen as a vital activity at every level of the organisation. An internal Stakeholder Engagement Steering Group made up of stakeholder leads from across the business meets regularly to discuss planned engagement activities, review stakeholder feedback and agree proposed improvements and adjustments based on recommendations. This group which is led by the Stakeholder Engagement Team and chaired by the Managing Director provides overall direction to the stakeholder engagement strategy for ESB Networks. Stakeholder engagement forms a core element of our business processes and remains embedded in our business culture and is seen as the role and responsibility of every employee within the organisation.

Over the past year we have increased our engagement activities more than ever before, recognising the importance of stakeholders' contributions to the successful delivery of our initiatives. We have delivered strong outcomes for our customers and stakeholders, including, delivering against our targeted roll-out strategies and large-scale programmes for the future and driving ongoing collaboration with EirGrid to ensure we have the necessary relationships in place to ensure a reliable and future proofed network.



How we monitor expenditure against PR5 allowances

Every five years the CRU determines the revenue price control for EirGrid and ESB Networks as TSO and TAO for the following five year period. The price control sets out the amount of revenues the companies are allowed to recover through tariffs. The allowances are designed to ensure that we, both EirGrid and ESB Networks, have adequate revenues to carry out our activities as TSO and TAO respectively while delivering value for all of our stakeholders. In the interest of delivering value to our customers more efficiently, the current Price Review (PR5) places more emphasis on the results of the network companies' work, while building in agility to adapt to the changing needs of the system.

Within the price control periods there is an opportunity each year for the companies to submit adjustments in advance of tariffs being set. This is to make sure that the most up to date information is used. The CRU publishes updated information on the approved revenues on an annual basis.

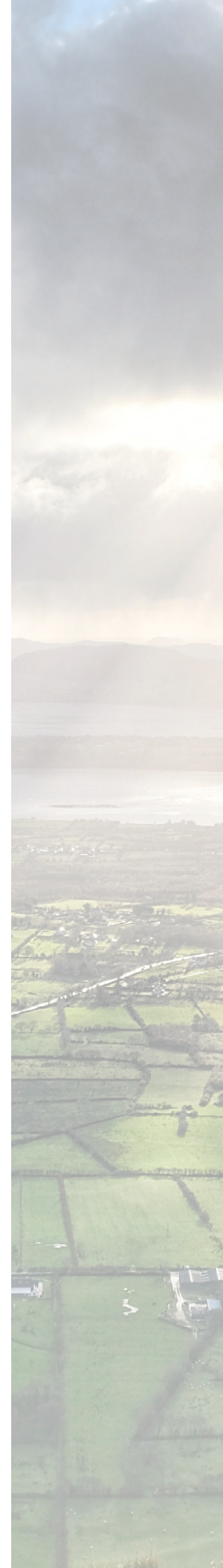
After each year EirGrid and ESB Networks carry out a review of what was actually required to carry out our functions. Updates would include any changes to costs outside of our direct control, updates for inflation rates and incentive payments. We also look back on the previous year and compare the amount the CRU approved to be recovered against the amount that was actually recovered through the tariffs in that year. Any under or over recovery of monies against those approved by the CRU is fed into future tariffs. This is done using the k factor mechanism.

The k factor captures the difference between what was actually required by the TSO and TAO to carry out their responsibilities and what was recovered through the tariffs. This figure is then included as a line item in the following year's tariffs. If there was an over-recovery, meaning that the amount recovered was more than required, this figure is taken off the next year's revenue allowance. Likewise, if there is an under-recovery this figure is added to the next year's revenue allowance. Please see below tables setting out the TAO and TSO's k factors for 2021, which are included in the 2023 revenue allowance.

The Agile Investment Framework (AIF) is one of the main components of the delivery phase of PR5. The AIF comprises of mechanisms to allow access to additional revenues in response to the changing needs of the electricity system. The mechanisms relevant to the TSO and TAO include -

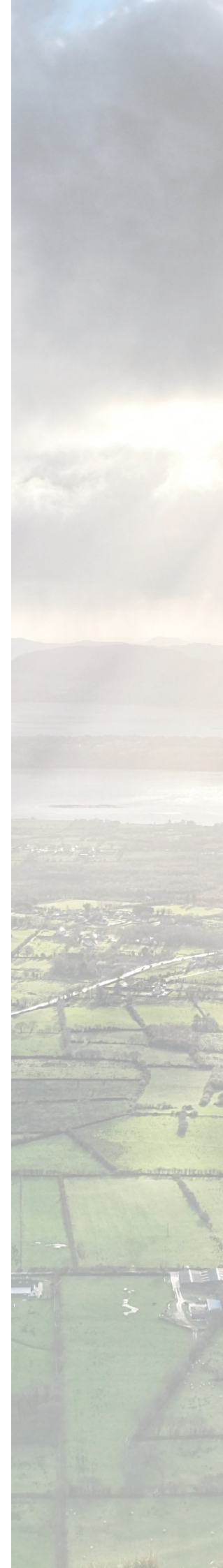
- Uncertainty Mechanism - requests for additional revenue arising from newly identified system requirements
- Capex Adjustment Mechanism – retained from PR4 and allows the TSO and TAO to request adjustments to the overall infrastructure development capital allowance
- Innovation and Research and Development Mechanism and
- The TSO Monitoring Committee.

Work is ongoing regarding the establishment of the TSO Monitoring Committee. The TSO and TAO have not utilised the above mechanisms to date but have sought additional monies as part of the 2023 revenue process on the basis of pre-existing revenue provision arrangements.



TAO 2021 allowed outturn and resulting k-factor

€ millions	Allowance for 2021 (ex-ante)	Outturn Allowance (ex- post)	2021 Adjustments
Pass Through Costs			
CRU Regulatory levy	1.12	1.11	-0.01
Local Authority Rates	28.20	30.80	2.60
Uncertain Costs: Non-Capitalised			
Additional Use of System (AUoS)	-	-1.67	-1.67
Incentives	-	6.00	6.00
Inflation Correction	-	3.12	3.12
Uncertain Costs: Capitalised			
Depreciation	-	-0.46	-0.46
Return	-	-0.81	-0.81
Total k-Factor adjustment (before interest) in 2019 prices			8.77
Total k-Factor (after interest) in 2019 prices			8.67



TSO 2021 allowed outturn and resulting k-factor

2021 prices € millions	CRU Tariff Decision for 2021 revenues	CRU approved updated actual costs of 2021
External Costs		
Inter TSO compensation (€m)	2.240	2.374
CRU levy (€m)	1.180	1.127
CORES0 subscription (€m)	0.714	0.672
Interconnector services (€m)	1.270	2.430
DUoS costs (€m)	2.841	3.159
Ancillary services (€m)	2.820	2.375
DS3 System Services	134.750	119.474
EWIC TUoS Entitlement	3.770	3.770
Dublin Security of Supply	28.400	20.543
TAO payment (€m)	300.440	300.440
Rolling Retention	0.000	0.66
Allowed TSO Operating Revenue		
Internal Costs	46.950	61.467
Depreciation (€m)	8.410	22.819
Return on Stage 1 working capital (€m)	0.960	1.491
Return on other working capital (€m)	5.200	6.864
Return on fixed assets in the RAB (€m)	3.330	3.133
Approved adjustments		
PR4 Adjustment	0.000	-1.545
Strategic Projects Side-RAB (2019 Adjustment)	0.590	0.826
Adjustments GoO	0.250	0.255
Adjustments Constraints bank fee	0.000	0.209
DS3 System Services Implementation - Depr & Rtn	18.280	0.000
I-SEM Implementation Project - Depr & Rtn	1.320	0.000
I-SEM 2018 Adjustment - OpEx	5.020	0.000
Abandoned Projects / Unrecovered Stage 1 Costs	0.000	0.000
IIDM	0.070	0.071
SoS Costs - Expedited Return to Service Costs	0.000	0.299
TSO Market System Release Capital	0.000	0.105
Incentives		
2021 Incentive allowance	0.000	2.413
K-factor Y-2	-31.440	-31.029
Total (2021 Prices)		
Total (2021 Prices)	537.365	524.405
Total CRU approved updated actual costs of 2021 (2021 prices)	(a) 524.405	
TUoS collected in 2021 (2021 prices)	(b) 565.204	
Total k-factor adjustment in 2021 prices	(b)-(a) = € 40.799	

The current Price Review (PR5) will run from 2021 to 2025. The CRU Decision for 2021 Transmission Revenues, which features a breakdown of, and explanation for, the revenue requirements can be found [here](#).

Network Development Costs

As part of the revenue price control for PR5 the CRU sets a revenue envelope to cover the development of the national transmission grid. This is referred to as network capex under which EirGrid and ESB Networks carry out their capital works programme over a five-year period. This envelope can be adjusted, if necessary, during the five years to allow for the changing needs of grid development. The costs associated with development of the national transmission grid are recovered over a 50 year period consistent with the expected network asset life.

Funding arrangements for the construction of the national transmission grid (network capital works) are the responsibility of ESB Networks. Costs incurred by EirGrid as part of the development of network capital works are ultimately recovered by EirGrid from ESB Networks.

The total TSO and TAO network capex allowance for the PR5 period was determined by CRU in the PR5 Final Determination, [CRU/20/152](#), as €1,048 million (2020 Prices), of which €264M was allocated to 2021. Further information on the PR5 final determination can be found [here](#).

The CRU does not approve individual projects. The CRU monitors our actual spend against the overall envelope, with the monies identified by the CRU being provided via the regulated Use of System Tariffs on an annual basis.

The PR5 programme evolved in 2021 as projects were completed, progressed, added, rescheduled or removed. At the end of 2021, the total regulatory spend for 2021 was €145M, €119M lower than the PR5 2021 allowance of €264M.

The variance is associated with an underspend across 16 projects, a number of which have experienced challenges due to a combination of complexity of scope, legal delays, difficulty in granting outages and procurement issues. In addition, it should be noted the West Dublin New 220 /110 kV Station project will be delivered under budget, due to a number of positive factors, which also contributed to the 2021 underspend.

On an annual basis we jointly submit detailed reports to the CRU on our network expenditure as required under the PR5 reporting arrangements. Expenditure in relation to the network is covered in more detail in our Investment Planning and Delivery Report.

The annual investment by ESB Networks in new or refurbished Transmission assets is known as Capital Expenditure and is shown in the following table:

	PR4		PR5
	2019 €m	2020 €m	2021 €m
TAO Capital Expenditure (Nominal)			
Gross Capital Expenditure	154	144	182
Customer Payments	(26)	(11)	(37)
Total Regulatory Spend	128	133	145

This capital investment less the annual depreciation of the asset gives the net value of the Transmission assets also known as the Regulated Asset Base (RAB) shown in the table below:

	PR4		PR5
	2019 €m	2020 €m	2021 €m
TAO Regulated Asset Base (RAB) (Nominal)			
Closing Net Book Value	2,503	2,556	2,663

Day to day expenditure not related to building assets are referred to as Operating Expenditure or Opex. The TAO Opex is shown in the table below:

	PR4		PR5
	2019 €m	2020 €m	2021 €m
TAO Operating Expenditure (Nominal)			
Transmission Operations	2	3	3
Planned & Fault Maintenance	22	19	18
Asset Management	1	1	1
Non-Controllable Costs	26	31	33
Controllable Costs	12	12	14
Total	63	66	69

How we ensure safety

EirGrid Safety Statement

EirGrid is committed to achieving and maintaining the highest standards of Health, Safety and Welfare for all of its staff and for any other persons who may be affected by our activities, and to the protection of the Environment.

EirGrid operates a Health, Safety & Environmental (HS&E) Management System based on the requirements of the International Occupational Health & Safety Standard: ISO45001:2018. Our HS&E Management System enables us to consider various risks associated with our activities, to staff and others who may be affected by these activities, and those to the environment; and to place these risks in the context of any relevant legal or other requirements, thereby ensuring that preventative & control measures are adequate and meet best practice standards.



The EirGrid Health and Safety policy was reviewed and recertified for ISO45001 (Health & Safety) in August 2021. This policy demonstrates EirGrid's commitment to ensuring compliance with statutory requirements which are associated with its business.

There were no Health and Safety Authority (HSA) reportable accidents in 2021.

2021 Health and Safety Initiatives

Development of the EirGrid Group HS&E Management System has continued and the developments of note in particular relate to the management of the pandemic:

- COVID-19 Hub page on the internal intranet created for all staff communication relating to EirGrid COVID controls and well-being supports.
- Return to Office page set up on internal intranet for staff communication on Return to Office protocols.
- Ergonomic assessments for all staff working remotely.
- Financial supports for staff working from home in relation to furniture and equipment to ensure a safe and comfortable environment.

EirGrid Response to the COVID-19 Pandemic

At EirGrid, the safety and well-being of the people who work for us is a priority. In 2021, we continued to protect our people and to ensure the continued operation of critical systems while monitoring the developing situation as a notable risk.

As operators of essential services, we had a responsibility to keep the power system operating to the highest standard. Running the electricity system required critical staff to work in the Dublin Control Centre. These critical operations then needed to be supported by back-office operations and critical IT services. Finally, we had to ensure that all other staff could continue to work remotely. We implemented additional measures to ensure that critical people who needed to be at our workplaces could do so in as safe a manner as possible. We also needed to ensure that the all-island wholesale electricity market continued to run effectively. Finally, it was vital that critical infrastructure construction continued. We achieved all these goals, enabled by solid processes, stable IT systems and thanks to the goodwill and flexibility of our people.

Electric and Magnetic Fields

Electric and Magnetic Fields (EMFs) are produced when electric current flows. EMFs are created from electrical appliances and power lines which produce extremely low frequency in the electromagnetic spectrum. Following research, measurement and monitoring the consensus from health and regulatory authorities is EMFs do not present a health risk. However, some people have genuine concerns about the electric and magnetic fields (EMFs) found near electricity lines and cables. Information on the EirGrid website explains the facts about EMF, based on current information from health and scientific agencies.

ESB Networks Safety

The health and safety of our staff, contractors as well as the communities and customers we serve, continues to be a core strategic priority and area of focus. The ESB Safety Strategy sets out our strategic intent and commitment to how we keep our network safe, and how we raise awareness about the importance of health, safety and wellbeing among our staff and contractors, as well as the dangers of coming into contact with or close proximity to our electricity networks and equipment for the general public. We continued to make improvements across the key areas of compliance, engagement & communications, safety culture transformation, road safety and public safety, while all the time ensuring the provision of essential services against the challenges posed by the COVID-19 pandemic.

External Validation of Safety Management System

In keeping with our aim to continuously improve and develop our capability and performance levels in Safety, Health and Wellbeing, ESB Networks successfully retained its certification to the international ISO 45001 Occupational Health and Safety Management System standard. The National Standards Authority of Ireland (NSAI) recognised the continued effort and commitment that is required to continuously drive safety improvements. In 2021, ESB Networks aligned our ISO 45001 surveillance audit with our Public Safety audit to help streamline and bring efficiencies to external auditing of ESB Networks safety management systems. This was recognised as a significant safety improvement by the auditing body and was a further validation of ESB Networks efforts and commitment to drive safety performance improvements.

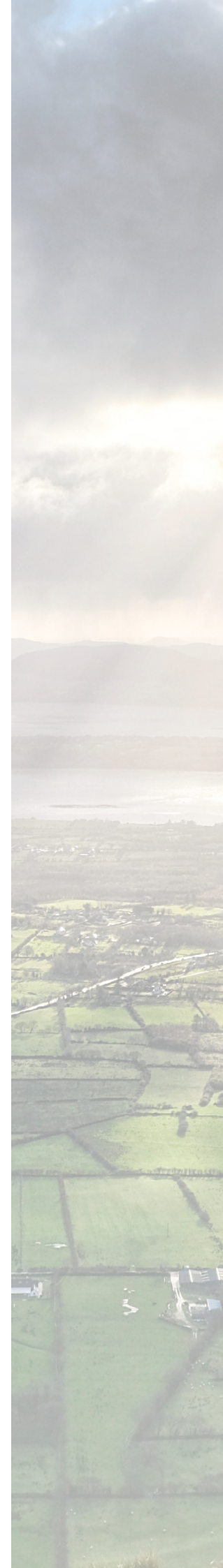
Critical Safety Processes

ESB Networks continued to implement critical public safety interventions by serving 'stop work notices' where we became aware of unsafe construction work near electricity networks. A Mobile App for 'stop work notices' is used to allow staff to easily log these positive safety interventions and to indicate if the Health and Safety Authority (H.S.A.) should be notified if appropriate.

The 'dial before you dig' service provided maps of the overhead and electricity networks to construction companies to support compliance with H.S.A. Codes of Practice in relation to electricity.

Communications & Engagement

During 2021, storms resulted in significant interruptions to the electricity supply and damage to the overhead electricity networks. During these times of emergency response, the safety and wellbeing of our staff and customers was a primary concern with daily morning safety briefings for front line staff, and a text alert system pushing key safety information out to field staff. Tailored briefings were provided for all contact service agents. ESB Networks TV and radio public safety media campaign, social media, and search advertising delivered critical public safety messages.

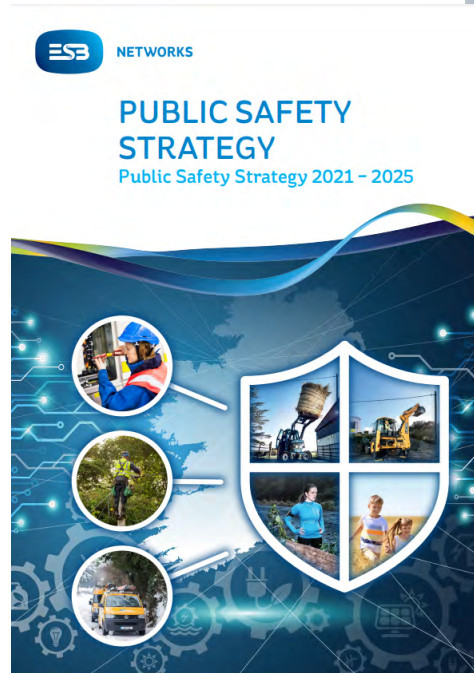


Stakeholder Education and Awareness

In 2021 ESB Networks launched its revised Public Safety Strategy 2021-2025, which is anchored in the core purpose of our business and continues to be a core strategic priority and area of focus.

ESB Networks 'Safe Family Farms' partnership with the Irish Farmers Journal continued into its seventh year, with further additions to the library of general farm safety videos as well as the regular safety pages and full-page public safety advertorials to raise awareness of electrical safety on farms. ESB Networks staff delivered safety talks to the Teagasc colleges and to University College Dublin Agriculture school as part of the 'Champions for Change' initiative, in association with the H.S.A. and FBD Insurance.

Our partnership with CIF resulted in a strong focus on electricity for Construction Safety Week with electricity recognised and promoted as one of the five key construction risks via the webinar – "The Power of Safety – It's in Your Hands". This was supported by our partners in the ESB Networks-led 'Joint Utility Safety Forum'.



How we manage our environmental footprint

EirGrid Group has a target to cut our organisation's energy consumption in half by 2030.

In 2021, energy use in our offices fell by 1.9% compared to 2020. We continued to co-chair the 'Low Carbon Economy' leaders group as part of our commitment to Business in the Community. This initiative sees participants committing to reduce their carbon emissions by 50% by 2030. In 2021, we also continued our financial support for the Friends of the Earth, as they prepared to launch their 'Our Energy Future' campaign. This project seeks to facilitate inclusive discussions and reflections with communities, civil society organisations, local groups, and other stakeholders, with regards to the decarbonisation of the Irish energy system.

We recognise that we have a responsibility to demonstrate sound environmental management and promote sustainability. We have in place a programme to manage our environmental impacts responsibly through setting strategic objectives annually and will endeavour to implement best practice when practicable. We set strategic objectives annually to support the 'Preservation' area of our corporate social responsibility strategy. Our Preservation Pledge is: "We respect the environment: We strive for best practice in environmental protection when developing the grid. We enable the grid to carry ever-growing amounts of renewable electricity. We carefully manage our own environmental impacts".

Our commitment is to conduct our activities in an environmentally responsible manner to protect the environment from harm, degradation, prevent pollution and continually improve the management systems performance.

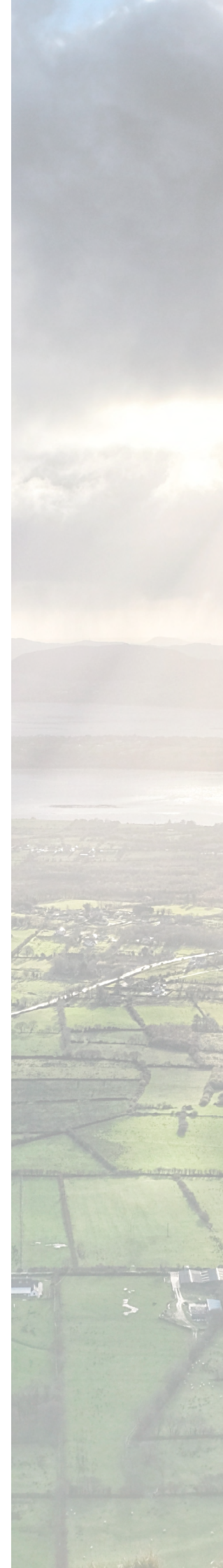
We also continue to find ways to reduce our own energy use. In 2021, this included the Oval Air Handling Unit variable speed drives being updated for Fan Cooling Units and LED lighting installations being completed on 80% of the floors in the Oval, with the remainder planned for future projects in 2022. The identification and installation of this class leading, critical core piece of machinery delivers on EirGrid's goal to reduce our own emissions and our foundation standard to embrace change and innovation to make a real difference.

The sources of energy usage for EirGrid sites are electricity and natural gas. In 2021 EirGrid consumed 3,160 MWh of energy in our six office locations. This energy use can be broken down as follows:

- 2,446 MWh of electricity
- 714 MWh of fossil fuels.

In the context of climate change and the need to de-carbonise the electricity supply, EirGrid is playing a key role in connecting high levels of renewable energy and in developing the electricity grid to connect renewable sources, in line with EU and Government targets. EirGrid is developing the Transmission System with due regard for the environment through sound environmental practices and full compliance with its environmental obligations.

Finally, in 2021 EirGrid continues to bear the Business Working Responsibly Mark. This is the leading standard for CSR and Sustainability Certification in Ireland.



How we manage our environmental impact when planning the network

Respect for the environment is a key part of the development and operation of the transmission system. Electricity transmission infrastructure (overhead lines, underground cables, substations) interacts with many environmental factors including biodiversity, landscape and cultural heritage.

In accordance with European and National law, we undertake Strategic Environmental Assessments (SEA) and Appropriate Assessment (AA) of our grid implementation plans every five years. Our current SEA and AA covers the period 2017-2022. They integrate [Ireland's Grid Development Strategy](#), the approved [Transmission Development Plan \(TDP\)](#) and the [Grid Implementation Plan 2017-2022](#) which includes policies and objectives that guide sustainable grid development.

EirGrid is finalising the analysis of SEA monitoring to determine if targets for each Strategic Environmental Objective in the 2017-2022 SEA were met. EirGrid's SEA monitoring report on the 2017-2022 plan will conclude with a series of recommendations which will shape and influence EirGrid's forthcoming Grid Implementation Plan (2023-2028), which this Strategic framework will feed into.

In parallel with each TDP and associated consultation, an annual Environmental Appraisal Report (EAR) for each TDP is published. This ensures any new projects in subsequent TDPs are consistent with the strategic environmental objectives of the SEA.

Aspects of our approach to the SEA were considered best practice in peer-reviewed research instigated by the Environmental Protection Agency. We are continuing to monitor and report on the environmental impact of Grid Implementation Plan 2017-2022 throughout its cycle. The results of monitoring will help us reduce the environmental impact of future plans in consultation with stakeholders including the Environmental Protection Agency.

Individual projects are all subject to environmental assessment outside of the SEA process. Some projects fall under a class of development requiring an Environmental Impact Assessment (EIA). In these situations, we submit an Environmental Impact Statement to the relevant planning authority. A full Environmental Impact Assessment was included as part of the Planning application submitted to An Bord Pleanála for the Celtic Interconnector. EirGrid submits a non-statutory Planning & Environmental Considerations Report, where an EIA is not required.

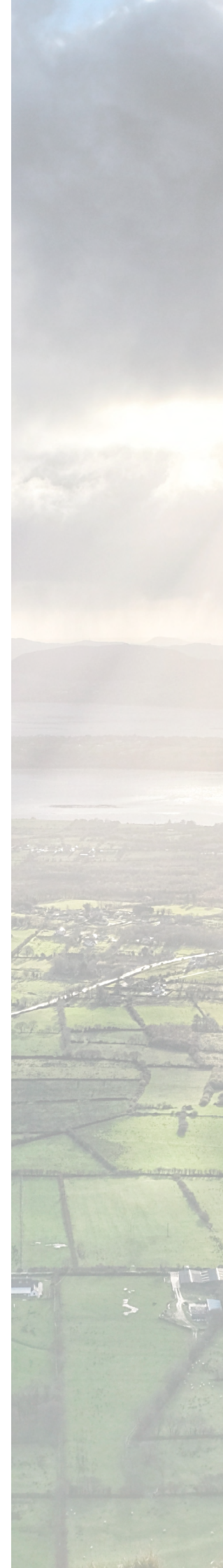
EirGrid has obligations as a public authority under the European Communities (Birds and Natural Habitats) Regulations 2011 and carries out screening for appropriate assessment of all projects. Further information on EirGrid's approach to the environment can be found on our website: www.eirgridgroup.ie.

Minimising our Impact on the Environment During Construction and Maintenance

At ESB Networks we are committed to operating our business so that we can be proud of our environmental and sustainability performance. We recognise that our activities have environmental impacts and that we have a responsibility to manage these impacts in a manner that prevents pollution and provides a high level of protection for the natural environment. ESB Networks' Policy Statement on the Environment is available [here](#)

Environmental Management System

ESB Networks utilises an Environmental Management System (EMS) which has been externally certified to the ISO 14001 Standard since 2010. The EMS provides a framework which allows ESB Networks to systematically identify, assess, prioritise and manage the environmental risks associated with its business operations. The scope of the EMS is such that it covers all of ESB Networks' activities, services and processes associated with managing the electricity network on behalf of the Electricity Supply Board. ESB Networks' EMS retained its external certification to the ISO: 14001 Standard, following two independent external Surveillance Audits in 2021.



Managing the Environment During Construction

ESB Networks continue to make improvements within the challenging environment of project planning and consenting while maintaining a focus on timely and cost-effective delivery of projects in the best interest of the environment and the customer.

At planning stage, multi-disciplinary technical teams work to develop projects and site-appropriate construction methodologies in order to deliver connections to customers while protecting sensitive habitats. Detailed construction packs, capturing all of the requirements of planning consents, are provided to our external contractors who are increasingly important to project delivery. Project support through document review processes (e.g., inputs to Construction Environment Management Plans, Traffic Management Plans, Waste Management Plans, etc.) is key to ensuring delivery on planning permission condition requirements.

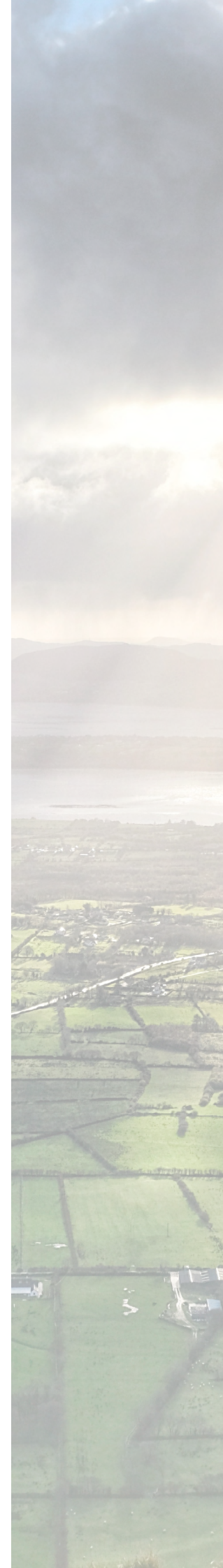
Specialists such as Project Ecologists, Ecological Clerks of Works, Project Archaeologists, etc. are tasked with overseeing construction works to ensure that the utmost care is taken in regard to the environment and the planning permission requirements.

In 2021 ESB Networks provided the Waste Enforcement Regional Lead Authorities (WERLA) with information on ESB Networks' Construction Projects that had the potential to generate Construction and Demolition Wastes. WERLA ensure the proper management of construction and demolition waste nationally.

Enduring Environmental monitoring

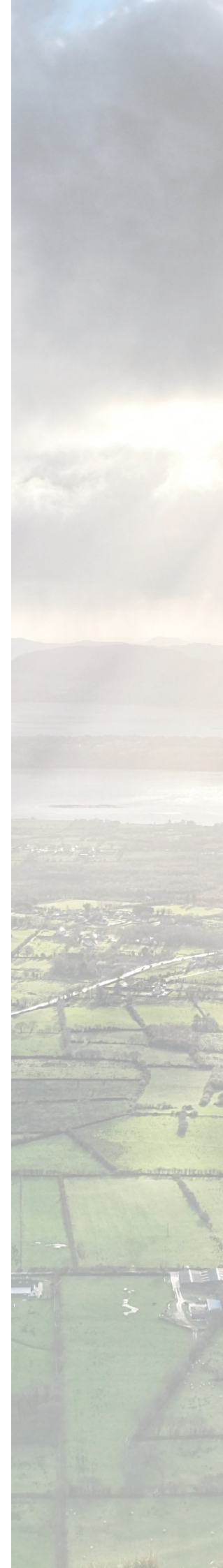
In 2021, ESB Networks had one Local Authority notifiable leak of 1,594 litres related to the Transmission fluid-filled cables Network. You will find detail of cable leaks on our website.

In 2021, approximately 103.56kgs of sulphur hexafluoride (SF6) was emitted due to equipment faults on transmission switchgear. SF6 is used in most of ESB Networks' high-voltage switchgear on the Transmission network. It is used because of its very high electrical insulating properties which facilitate efficient and safe operation of the switchgear. Emissions rates for SF6 gas are reported to the Environmental Protection Agency (EPA) on an annual basis in line with Regulation (EC) No 166/2006. There has been a trend of consistent leakage reduction, as we replace and repair our older switchgear.

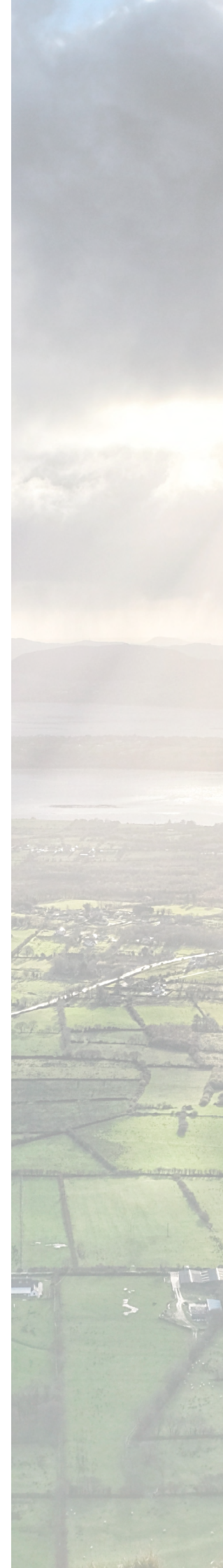


Acronyms

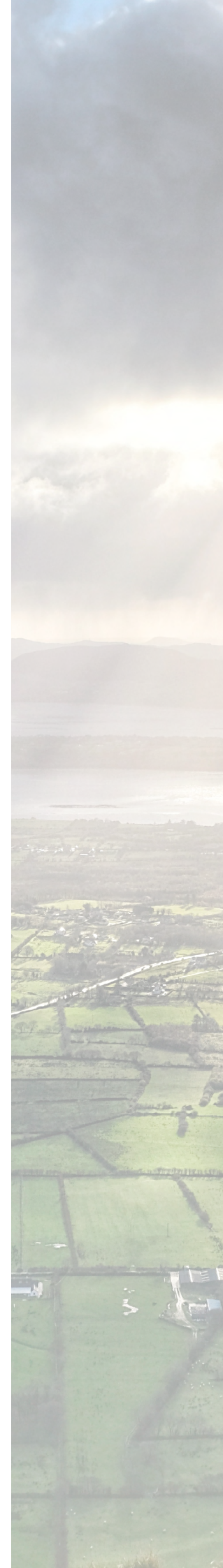
- AA – Appropriate Assessment
- AIF – Agile Investment Framework
- APR – Annual Performance Report
- ATR - Associated Transmission Reinforcement
- BESS – Battery Energy Storage System
- CA – Capital Approval
- CAP - Climate Action Plan
- CAP21 – Climate Action Plan 2021
- CEF - Connecting Europe Facility
- CHP - Combined Heat & Power
- CIF - Construction Industry Federation
- CPP – Committed Project Parameters
- CRU - Commission for Regulation of Utilities
- DECC - Department of Environment Climate and Communications
- DPMS - Digital Performance Monitoring System
- DS3 - Delivering a Secure Sustainable Power System
- DSM - Demand Side Management
- DSO - Distribution System Operator
- DSUs - Demand Side Units
- DUoS - Distribution Use of System
- EAR – Environmental Appraisal Report
- ECP - Enduring Connection Policy
- EIA - Environmental Impact Assessment
- EMFs - Electric and Magnetic Fields
- EMS - Environmental Management System
- EPA - Environmental Protection Agency
- EPC – Engineer Procure and Construct
- ESRI - Economic and Social Research Institute
- FAQ – Firm Access Quantity



- EU – European Union
- GCA – Grid Connection Assessment
- HSA - Health and Safety Authority
- HS&E - Health, Safety & Environmental
- HVDC - High Voltage Direct Current
- IPD – Investment Planning and Delivery
- I-SEM - Integrated Single Electricity Market
- JPMO - Joint Programme Management Office
- JSOP – Joint System Operator Programme
- MEC – Maximum Export Capacity
- MIC - Maximum Import Capacity
- MW – Megawatts
- MVA – Megavolt Ampere
- NDP – Network Delivery Portfolio
- NSAI - National Standards Authority Ireland
- NSEE - Network Stakeholder Engagement Evaluation
- OHSAS - Occupational Health and Safety Assessment Series
- PA - Project Agreement
- PCI - Project of Common Interest
- PID – Project Initiation Document
- PIP - Project Implementation Plan
- PR4 - Price Review Four
- PR5 - Price Review Five
- PSECP – Power System Emergency Communications
- PV - Solar Photovoltaic
- QTP- Qualifier Trial Process
- RAB - Regulatory Asset Base
- RA's – Regulatory Authorities
- RES-E - Renewable energy sources for electricity
- RGI - Renewables Grid Initiative
- RoCof - Rate of Change of Frequency



- RTE - Réseau de Transport d'Électricité
- SEA - Strategic Environmental Assessment
- SEM - Integrated Single Electricity Market
- SEMO – Single Electricity Market Operator
- SF - System Frequency
- SF6 - Sulphur Hexafluoride
- SML - System Minutes Lost
- SNSP - System Non-Synchronous Penetration
- SO's – System Operators
- SONI - System Operator Northern Ireland
- SOEF – Shaping our Electricity Future
- TAO - Transmission Asset Owner
- TCG – Transmission Constraint Group
- TES - Tomorrow's Energy Scenarios
- TII - Transport Infrastructure Ireland
- TLAFs - Transmission Loss Adjustment Factors
- TOL - Technical Operating Limit
- TOP - Transmission Outage Programme
- TRL – Technical Readiness Level
- TSO - Transmission System Operator
- TSSPS – Transmission System Security and Planning Standards
- TUoS - Transmission Use of System
- UFLS - Under-Frequency Load Shedding
- UR - Utility Regulator
- WERLA – Waste Enforcement Regional Lead Authorities





How to Contact Us

We welcome all feedback in regard to the information set out in this booklet and any additional information you might wish to see included in future versions.

Please contact the below:



Please contact our Customer Relations Team at:

info@eirgrid.com



Please contact us at:
esbnetworks@esb.ie