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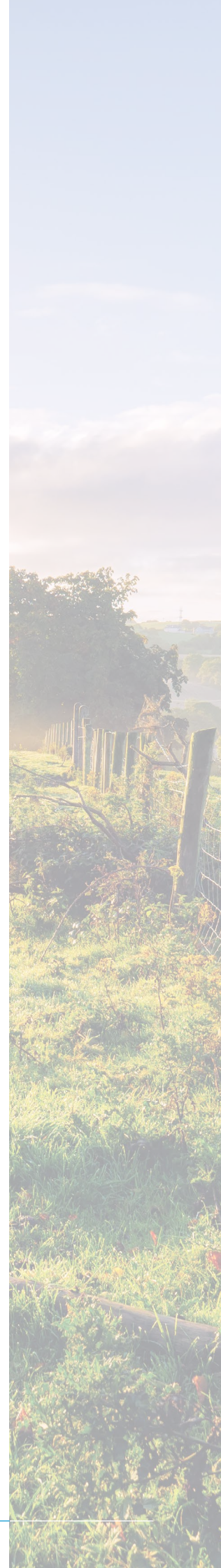
Electricity Transmission Performance Report 2018

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Welcome

Welcome to the second annual EirGrid and ESB Networks' Electricity Transmission Performance Report. This report will evolve over the coming years as we work together to provide customers, industry and stakeholders with clear and accessible reporting of our operation, development and maintenance of the transmission system.

The past year, 2018, has been one of exciting and significant change, including the launch of the new electricity market in September 2018; the announcement that EirGrid Group are able to handle up to 65% variable renewable energy on the electricity grid securely at any given time; alongside a continued focus on safety, reliability and doing the right thing for our customers, stakeholders and consumers.

It was a challenging year in terms of dealing with adverse weather events, connecting an ever increasing number of large energy users to the grid, and ensuring that we are able to handle a continued increase in renewable energy onto the transmission system.

We are pleased to report good progress in our introduction of innovative measures, our development of the transmission grid and connecting new customers, plus our work in delivering a reliable network to meet these challenges, as well as our performance against incentive targets.

This booklet shows some examples of how we have performed during the year. We hope that you find this document of use and we look forward to working together with you to further develop our plans.

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 see how you can get in touch below.



The current. The future.

Please contact our Customer Relations Team at:
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How to use this document

This booklet will take you through our main activities during calendar year 2018, including:

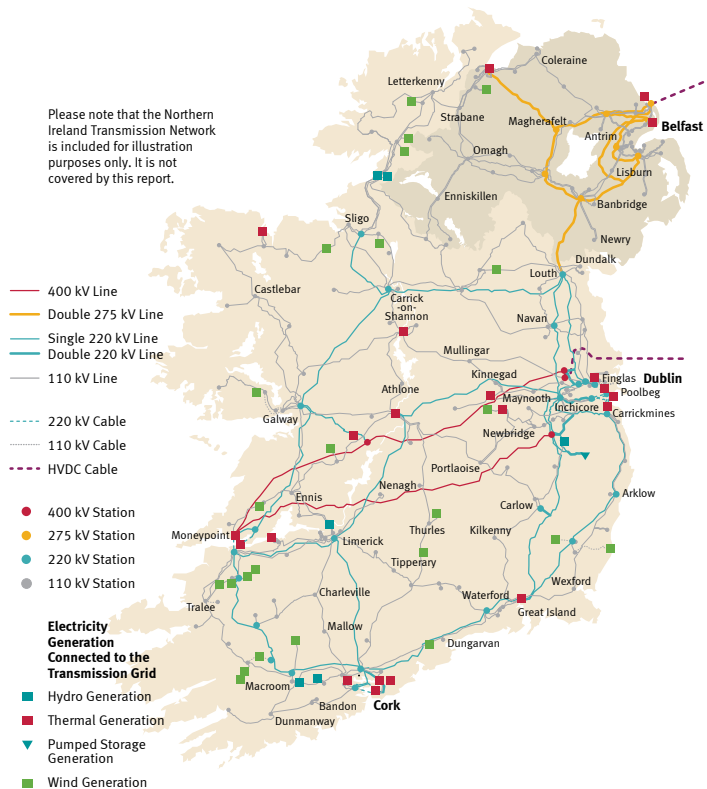
- developing the grid;
- facilitating new connections;
- innovation;
- safety and environment;
- ensuring high levels of transmission system performance;
- making sure the electricity supply is resilient even in extreme weather events;
- tools for managing constraints;
- curtailment volumes and costs;
- how we plan outages to ensure robust security of supply and carry out critical maintenance works; and
- supporting the implementation of the new electricity market.

We also provide links to other documents and data sources where further information can be found.

This booklet is aimed at anyone with an interest in the electricity transmission system, including customers, stakeholders or end consumers. In this document we extensively refer to our customers. A typical transmission connected customer could be a power station, an electricity supplier, or large data centre.

This booklet should be read in conjunction with its companion document the 'Investment Planning and Delivery Report 2018'.

What is the Electricity Transmission System?



161
Electricity
Substations

c. 7,350
Over 7,350 km
of circuits

c. 7,000
7,000 km of
overhead lines
(Transmission
Voltage)

c. 350
Over 350km
of underground
cable

The data shown above represents the position at the end of 2018

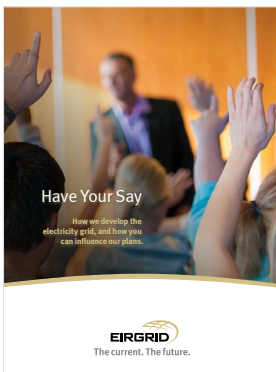
Electricity transmission encompasses the operation, planning and development of the high-voltage network in Ireland predominately assets that operate at 110 kV, 220 kV or 400 kV, ensuring that supply and demand is balanced on a minute-by-minute basis.

EirGrid is the Transmission System Operator (TSO), and ESB is the Transmission Asset Owner (TAO) and its business unit ESB Networks carries out the licensed TAO functions. EirGrid and ESB Networks work closely to develop, maintain, manage and operate the transmission grid. For further information on the TSO's and TAO's activities in the delivery of the network please see the Annual Investment Planning and Delivery report published on the EirGrid and ESB website. The transmission system is used to move power around the country. It brings power to large data centres, industry and other businesses that use large amounts of electricity, and also powers the distribution network. This supplies the electricity used every day in your homes, businesses, schools, hospitals and farms.

Working closely together we develop and build energy infrastructure when it is needed, and 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 TSO and TAO licences granted by the Commission for Regulation of Utilities (CRU) and by an [Infrastructure Agreement](#) which is a contract between EirGrid and ESB on how to develop and maintain the transmission grid. Efficient operation of the TSO/TAO working arrangements is essential and we can report satisfactory operation of these arrangements during 2018. 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 2018.

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. For further information on this please see the 2018 Investment Planning Report published on the EirGrid and ESB website. Since October 2017 all our projects go through the improved process. The joint EirGrid and ESB Networks Investment Planning and Delivery Report which will accompany this report highlights the work carried out and project progress in 2018.

We acknowledge the challenges faced when building transmission infrastructure and we work closely with landowners and communities to manage these challenges. Further details on the six-step process are available in EirGrid’s “[Have Your Say](#)” publication.

Steady Evolution
Renewable electricity generation maintains a steady pace of growth. This is due to steady improvements in the economy, and in the technologies which generate electricity. New household technologies help to make electricity consumers more energy aware. This increases energy efficiency in homes and businesses. Over time, electricity consumers gradually begin to make greater use of electric vehicles and heat pumps. This means that, over time, electricity powers a larger proportion of transportation and heating.
Onshore wind generation increases to approximately 5,200 MW by 2030
New 700 MW interconnector to Europe is in place by 2025
Ireland's 2030 emissions targets are met

Low Carbon Living
The economy enjoys high economic growth. This encourages the creation and rollout of new technologies for low carbon electricity generation. There is strong public demand to reduce greenhouse gas emissions. In addition to high carbon prices and incentives for renewables, this creates a high level of renewable generation on the grid. This clean energy then combines with improvements to broadband and transport to drive growth in large data centres.
Coal generation is repowered to Gas and Peat generation is repowered to biomass by 2025
The total demand for electricity increases by 53% by 2030 compared to today
Data Centre connections reach 1950 MVA in 2030 - most of these are based in Dublin

Slow Change
The economy experiences very slow growth. Investment in new renewable generation is only in established, low risk technologies. Due to poor economic growth, new technologies that could increase the use of renewable generation at household and large scale levels are not adopted. Overall there is little change in the way electricity is generated when compared to today. Domestic consumers and commercial users are also avoiding risk and uncertainty. The only source of new growth is the connection of new data centres but the level of investment slows down significantly after 2025.
Fossil fuel generation capacity remains over 5,000 MW by 2030
The total demand for electricity increases by 22% by 2030 compared to today
Ireland's 2030 emissions targets are missed

Consumer Action
A strong economy leads to high levels of consumer spending ability. The public want to reduce greenhouse gas emissions. Electricity consumers enthusiastically limit their energy use and generate their own energy. This results in a large number of community led energy projects and a rapid adoption of electric vehicles and heat pumps in the home.
There are almost 560,000 electric vehicles on the road by 2030
17% of residential houses are heated through heat pumps by 2030
Household batteries and Solar PV help to increase self-consumption of electricity

In addressing the needs of the transmission system:

- We consider all practical technology options; and
- We optimise the existing grid to minimise the need for new infrastructure

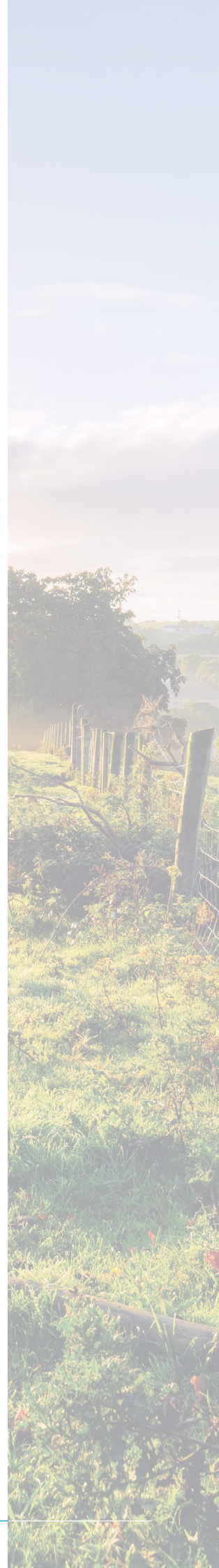
During 2018 EirGrid and ESB Networks continued to upgrade and strengthen the transmission grid where necessary. A total of 40 projects were completed in 2018 including several new and upgraded transmission stations and circuits, further details are set out in our ‘Investment Planning and Delivery Report 2018’.

As noted last year we continue to partner with some of the biggest companies in the world throughout the year, to foster jobs and prosperity across the country. In particular, 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. As more large energy users such as data centres are built, it will continue to be a challenge to meet increased demand in the coming years. This will significantly change how the network is used and we will continue to seek to improve the capabilities of the system to ensure that a safe, secure supply of electricity is maintained. Our Investment Planning and Delivery Report highlights the work undertaken in 2018.

Highlights:

A selection of 2018 highlights include:

- The Snugborough 110 kV station was energised in August, facilitating the connection of a 22 MVA data centre (MIC).
- A new 220 kV bay was energised in Finglas 220 kV station in September. This will facilitate the connection of Belcamp 220 kV station in 2019.
- Construction works for a new 220 kV substation at Castlebagot (the West Dublin project) progressed in 2018, with an energisation programme scheduled during 2019.
- A number of stations facilitating the connection of renewable generation were completed including: the Slievecallan 110 kV connection energised in August, the Knockacummer 110 kV connection energised in October and energisation of Knockalough 110 kV station in November.
- In excess of over 350 MW of windfarm connection projects, across both the transmission and distribution system were energised in 2018
- Activation of the Kelwin Power Hybrid Wind Farm in Kerry connecting into Kilpaddoge 110 kV station was complete in July. This involved the connection of a 37 MW wind farm, 2.6 MW battery storage technology and 2 MW in diesel generation. This is the first project of its kind connected to the Irish transmission network.
- The Kilpaddoge - Knockanure 220 kV line uprate was completed in July.
- 4 major 110 kV line uprates completed in 2018, namely Cauteen-Tipperary, Raffeen-Trabeg, Bellacorrick-Castlebar and Carrick-on-Shannon-Arigna-Corderry. This progress represented a positive development in 2018.
- The Ardnacrusa 110 kV substation replacement project was also completed in 2018. The substation was commissioned in 1929 when the Ardnacrusa Hydro-Electric Power Station was built as a starting point for the rural electrification scheme by the Irish Free State. This upgrade of the substation has made possible the continued supply of renewable energy from the power Ardnacrusa Power station and the further integration of new renewable energy sources into the network.
- The Great Island 110 kV station refurbishment project was also completed.
- Major station refurbishment works continued at a number of stations across the country, including Moneypoint 400 kV station, Kilpaddoge 400 kV station, Aghada 220/110 kV, Finglas 220/110 kV, Carrickmines 220/110 kV and Castlebar 110 kV.



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.

This potential project has been identified by the EU as a Project of Common Interest (PCI), meaning it is viewed as a critical piece of work in furthering the integration of the European energy market. If progressed, this would mean that electricity can be exported to and imported from mainland Europe.

This will drive down electricity prices for end users and would offer increased options for market participants in terms of where to buy and sell electricity. An additional interconnector would also increase security of supply; it is proposed that the interconnector would transport 700 MW of electricity, the equivalent of supplying power to around 450,000 homes.

In September 2018 EirGrid and RTÉ submitted a Joint Investment Request to the national regulatory authorities, CRU in Ireland and CRE (Commission de régulation de l'énergie) in France, seeking a cross border cost allocation decision in respect of the investment costs of the proposed interconnector including a decision on their inclusion in each country's tariffs under the Trans-European Network Energy Regulations (TEN-E). This is a key step in the projects development. A positive decision would enable EirGrid and RTE to continue to advance the project including the ability to submit a grant application for European Commission funding to support the ongoing development and construction of the project in 2019.

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.

New Incentives arrangements

Incentives are an important part of the regulatory framework and we welcomed the opportunity to input into this process. In 2018 the CRU published a Decision Paper (CER/18/087) setting out a set of twenty decisions for improving reporting and incentive arrangements covering the totality of the activities undertaken by TSO/TAO and DSO/DAO. The new incentive arrangements apply from 2018 to 2020.

TAO Incentives and performance in 2018

Amongst other outputs, under the new incentive arrangements, an incentive “scorecard framework” with TAO performance metrics was developed. These include both qualitative and quantitative targets. The performance against the scorecard will be assessed each year by independent auditors and the audit results will assist the CRU in determining the incentive outturn.

The potential incentive performance payment available under the “Scorecard framework” system to the TAO is €2.407m for 2018. However, as the scorecard detail was yet to be finalised by the 2019 Revenue Submission, the TAO has not received any incentive payment/penalty for this incentive for 2018. The CRU approved cost of the audit was included in the TAO revenue allowance for 2020. The approved outturn will be included in the 2020 revenue determination.

In addition there is also a separate incentive available to the TAO of €493,000 for its management of planned outages. In 2018 the full incentive award was achieved for this.

Outage targets are designed to improve the availability of network by reducing outage durations and providing greater certainty to all parties affected by outages regarding expected commencement and conclusion dates. In 2018 there were a total of 5,410 scheduled transmission outage days, with a total actual outage days reached of 5,201 by years end. ESB Networks delivered on all of its targets relating to these outages, and therefore were granted the full related incentive by the CRU.

TSO Transmission Delivery Incentive 2018

As per CER/18/087, from 2018 onwards a new network delivery incentive has been put in place for the TSO. Under this framework “Balanced Scorecard” is to be agreed between the TSO and the CRU which will put in place performance measures for the incentive. Engagement is ongoing between both parties on the “Scorecard”. Once the scorecard is agreed and put in place, the TSO’s 2018 performance will be assessed. Both 2018 and 2019 performance will be reported on as part of the 2019 Electricity Transmission Performance Report. The CRU approved cost of the audit was included in the TSO revenue allowance for 2020.



How we performed against Strategic Incentives

We are in a time of unprecedented change on 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 recognised this in its Price Review 4 (PR4) Decision (CER/15/296) through the provision of a €5m allowance for strategic incentives. This €5m allowance is split from 2017 to 2020.

In 2018 CRU invited the TSO to provide its proposed performance indicators for 2018 by 30 June 2018 under two broad headings:

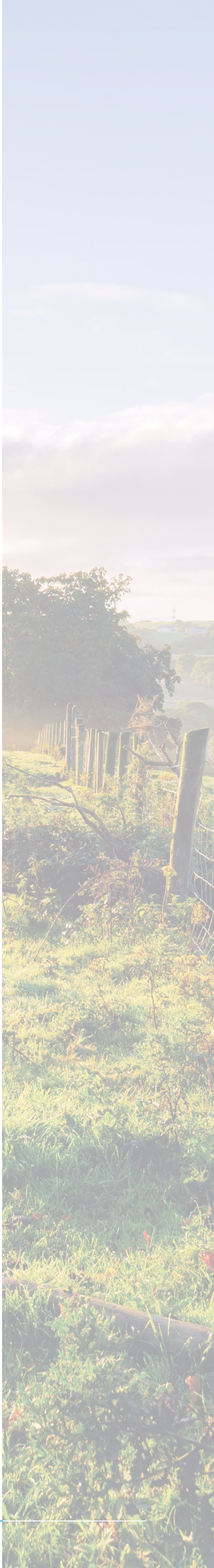
- “delivering the energy transition”*; and
- “managing the impact and costs of the energy transition”*.

The proposals included 13 performance indicators split into the above headings were submitted to CRU. On 30 November 2018 the CRU provided feedback on the proposals, and CRU determined €0.4m of the indicators should apply in 2018. Ultimately EirGrid achieved an incentive of €0.25m against the target of €0.4m which represents 63% success against the targets. EirGrid’s performance against each of its 2018 targets is set out below.

Target	Incentive Value (€m)	Achieved	Incentive Received (€m)
Rate of Change of Frequency (RoCoF) – Phase 1 & 2 studies and testing.	0.100	No	0
Firm Frequency Response (FFR) Procured in 2018	0.150	Yes	0.150
Volume Capped procurement opened to industry	0.150	Partial	0.100

In terms of the partially achieved targets, the Volume Capped procurement, this target contained three steps necessary to finalise the procurement process. The TSO achieved two of the three steps within 2018, with the final step being finalised. As a result under the framework EirGrid achieved a partial incentive against this target amounting to €100,000 of a possible €150,000.

In regard to the RoCoF incentive target, the target set was for completion of conventional generation studies and testing for 51 units by year end 2018. By the end of 2018 approx. 70% of the total MW capacity (provided by 28 of the units) had been completed. The remaining 30% related to generation units belonging to one party who have experienced a range of issues, including technical issues, which have prevented the certification of RoCoF compliance. However it was noted that the RoCoF programme is a multiple year programme and in practical terms work on a number of the units had been completed in the 2017 calendar year not 2018 which is the intended focus period of the incentive. As a result it was agreed with the CRU that the incentive should not be measured on the basis as initially set out and a zero aware was received.



How we manage system performance

Maintaining transmission system performance to high standards involves significant work. It ensures that the transmission system is operated in a safe and secure manner, maintaining electricity supply for customers and market participants.

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. Operational policies and procedures are reviewed on a continuous basis.

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 2018 EirGrid achieved its full incentive amount of 0.33min in this regard.

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. In 2018 EirGrid achieved its full incentive amount of 0.33 in this regard.

In 2018, there were 0.411 System Minutes lost on the transmission system. In 2018, there were a number of 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 2018 which resulted in shedding or normal tariff load customers. The short term active response (STAR) interruptible load scheme was discontinued in April 2018. Detail of the STAR scheme can be found in the 2017 Electricity Transmission performance report located [here](#). EirGrid continues to be incentive to minimise SML. In 2018 EirGrid achieved its full incentive amount in this regard.

For further information see the [All Island Transmission System Performance Report 2018](#)

99.65%
EirGrid maintained system frequency in line with targets 99.65% of the time

0.411
In 2018, there were 0.411 System Minutes Lost (SML) on the transmission system, significantly below the target level of 'less than 1.5 SML

How we ensure network resilience

EirGrid designs and plans the network in accordance with the transmission system security and planning standards while ESB Networks constructs, maintains and operates the 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 network is designed in a way which guarantees this in a safe, secure and robust manner. The operation of the network once in place is supported and underpinned by robust policies and procedures both in our control centres and on the ground.

Ongoing transmission system maintenance is crucial to ensuring the resilience of the network. Transmission maintenance is undertaken in accordance with the Transmission Asset Maintenance Policy. The 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](#).

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. The 2018 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 includes all outages of transmission infrastructure which are planned to occur in the year. The 2018 Transmission Outage Programme can be found in the library section of the EirGrid website by searching for 'transmission outage programme 2018'. In 2017 EirGrid developed a dashboard which monitors the percentage of the Transmission Outage Programme delivered in terms of capital projects. The 2017 percentage was 80%, and the 2018 percentage was 83%. 100% delivery was not achieved in 2018 for a large variety of reasons, summary of some key causes of delays below:

- Updated outage requirements for projects as they develop
- Land access issues/delays
- Weather delays
- Additional works being identified on site
- Difficulty granting additional transmission outages



How we manage performance

Network resilience in an ever changing system

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

EirGrid's pioneering Delivering a Secure Sustainable Power System (DS3) programme seeks to address this issue. In April 2018, the power system moved to permanent system operation at 65% System Non-Synchronous Penetration (SNSP) following the successful completion of a five month trial, during which the system was operated for 160 hours between 60% and 65% SNSP. This means we can securely operate the power system with up to 65% of the energy coming from newer forms of variable, renewable generation. The continued increase in SNSP levels is a clear demonstration of the excellent collaborative work across the entire energy industry in Ireland and further demonstrates our continued drive to integrate more renewable generation on to the power system

Network Reliance in Action

In 2018 there were a number of 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.

We are pleased to report that during these events, the protection equipment on the network, our processes and procedures ensured that the faults were resolved, with minimal impact to customers.

There was one adverse weather event which caused faults on the transmission system in 2018; however there were no power supply interruptions on the transmission system;

- Storm Eleanor had a level orange weather warning in place for the West, North West and South West. There were 10 faults caused by wind and lightning, all of which were cleared in a matter of milliseconds.

In July, we were faced with a rare event, a damaged electricity pylon. The protection equipment on the line operated as intended, to safeguard anyone in the vicinity and ensured that power stopped flowing through the circuit. ESB Networks deployed an emergency restoration system which enabled the line to be returned to service within 10 days. A permanent replacement structure was installed on site in 2018.

We are working to improve this restoration system so that it could be deployed, if required, to restore lines that are damaged in areas.



Emergency restoration system

How we manage Network Constraints

EirGrid implements system operational constraints, in conjunction with SONI the TSO of NI, 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 Dec 2018, which covers all the operational constraints in place at the end of 2018. The TSO publishes updates to the Operational Constraints monthly and as required if any changes are made. EirGrid provides important information to market participants. EirGrid can report that all reports for 2018 were published in a timely manner and are available on EirGrid's website.

A review is carried out on all operational constraints annually. A review of operational constraints is also 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.

Ensuring efficient operation of the system is critical to maintaining a safe, secure and robust supply of electricity for end users and market participants. Scheduling operational constraints well in advance also ensures that they are accounted for in the market schedule, reducing the imperfections charge for market participants.

In terms of short term management of network constraints, this is carried out in the control centre through the use of a software tool. Using specialist 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 on actions taken to reduce constraint costs. This is discussed further on the next page.

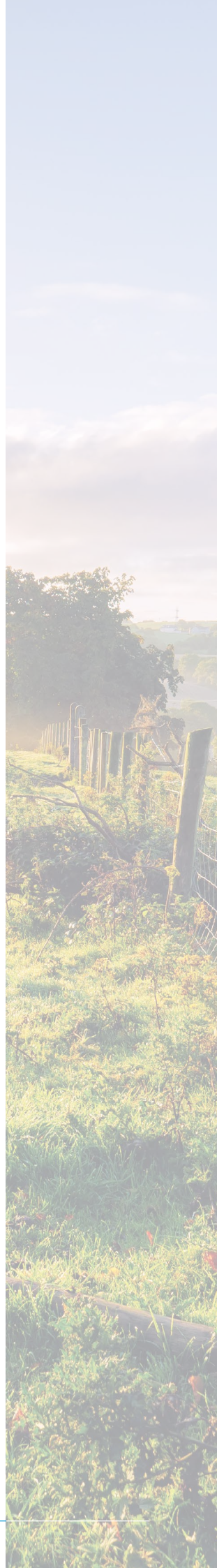
Information on 2018 Curtailment Volumes

Curtailment refers to the dispatch-down of wind for system-wide reasons. 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. System Non-Synchronous Penetration (SNSP) limit

In 2018 5.0% of the Total Available wind energy (9,184,961 MW) in Ireland was dispatched down. Of that 66.2% related to curtailment volumes which amount to 302,571 MW. This compares to 198,291 MW in 2017.

Curtailment levels are affected by a number of factors which vary year to year. The amount of wind installed on the system will have a significant impact on curtailment. In 2018, in excess of over 350 MW was added to the wind installed capacity in Ireland. This is higher than the average annual wind connection level of about 322 MW over the previous 5 years.



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.

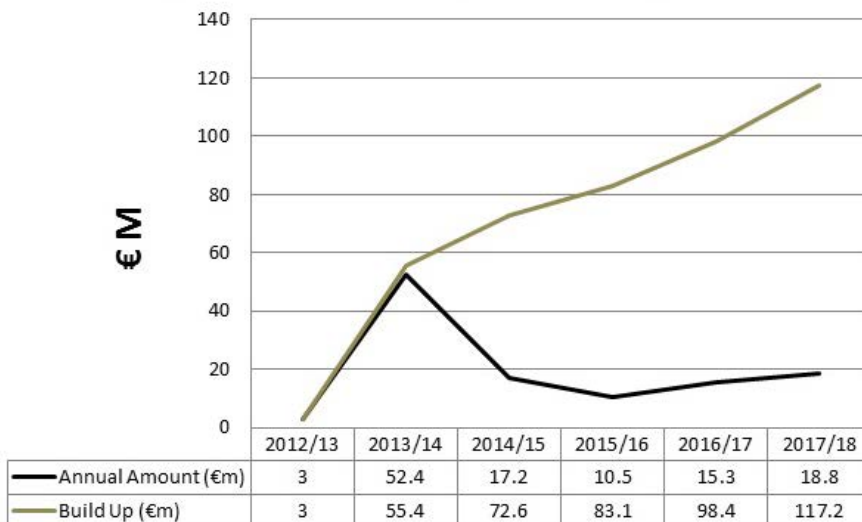
Constraint costs are the most significant part of dispatch balancing costs. Dispatch means the sending of instructions from the EirGrid control centre to power generators, demand side units, interconnectors or pumped storage plant about their times, fuel, manner of operation or output. Dispatch balancing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

We are incentivised to reduce the imperfections costs. The incentive mechanism takes account of the current industry structure and the degree of control which the TSO has on the cost drivers. The incentive period runs from October to September each year, with the most recent recorded figures being for the 2017-2018 period. In advance of each year the TSOs submit a forecast of the costs for that period. Following the end of the period this forecast is adjusted to ensure the protection of both the TSOs and customers from potential windfall gains or losses, by removing some of the risk for events outside of the TSOs’ control such as unforeseen long-term outage of generators or transmission plant or changes in fuel prices, exchange rates, or market rules. The actual outturn costs are then assessed against this adjusted baseline

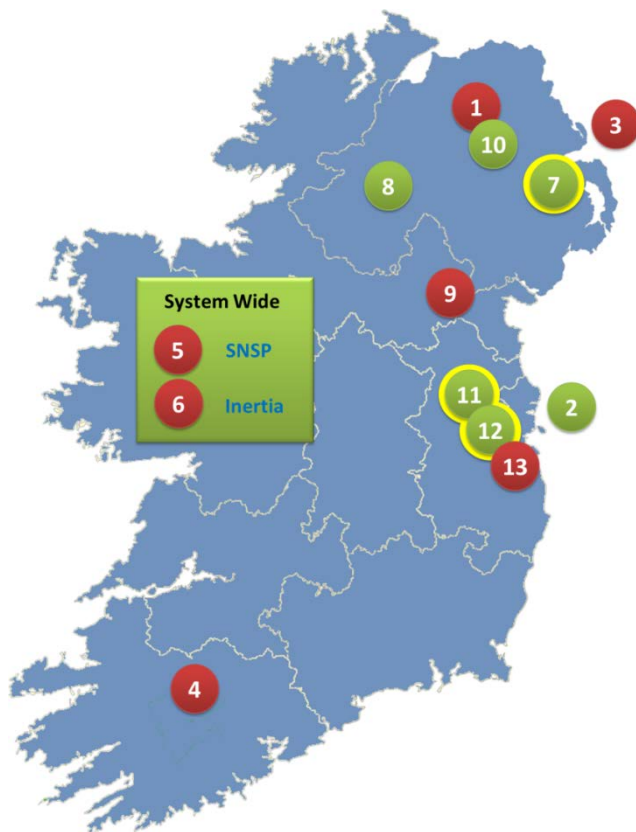
In total the ex post adjusted baseline for constraint costs in 2017-2018 was determined to be €203.1m, compared to actual outturn imperfections costs of €184.3m. We therefore ensured €18.8m in savings for market participants. The full 2017-2018 Imperfections Incentive Report can be found here. Since the incentive was introduced in 2012, our actions have led to €117.7m in savings for market participants. The year on year build-up of savings, as well as the annual savings figures, since the incentive was started can be seen in the graph below.

Imperfections Savings for Participants



2017-18 Main constraint changes and TSO Initiatives

The map below shows some main constraints that were introduced/changed over 2017/18 which influenced imperfections costs; red indicates a change that increased costs, green indicates a change that reduced costs. Some of the green constraints (highlighted in yellow) are TSO initiatives, which are operational improvements that lowered costs for 2017-18 and continually beyond. For a full list of changes to constraints on a monthly basis, and the full set of constraints that are currently applicable, please see operational constraints report referenced on page



Transmission constraint group introduced in 2018

As these constraint changes occurred after the Imperfections Forecast was determined, they formed the basis for the Imperfections Incentive process, which resulted in €18.8m in savings for market participants for the 2017-18 year, due to the TSO initiatives.

- 1 RoCoF Settings on NI Windfarms at start of Tariff Year
 - 2 Full exports allowed on EWIC for all levels of wind at start of Tariff Year
 - 3 Firm Export Limit of 80MW on Moyle from Nov-17
 - 4 South Generation demand constraint amendment from Mar-18
 - 5 SNSP Trial to 65% from Nov-17
 - 6 Inertia increased by 3000 MWs from Nov-17
 - 7 Removal of a demand based Kilroot constraint from Jan-18
 - 8 Omagh - Gort circuit came into service Feb-18
 - 9 10 Day Tie-Line outage Apr-18
 - 10 Removal of 0.4Hz RoCoF settings on NI Windfarms from Apr-18
 - 11 Dublin North/South constraints removed from May-18
 - 12 PBA or PBB open cycle contribution to voltage control from May-18
 - 13 Increased unit commitment for Dublin demand from May-18
- Initiative
- Initiative
- Initiative

2017-18 TSO initiatives to reduce constraint costs

The level of savings to constraint costs over the last few years represents significant effort on behalf of the TSOs to reduce costs where possible. As highlighted above, the primary operational initiatives introduced by the TSOs which helped to decrease constraint costs across the island in 2017-18 are as follows:

1. Dublin Generation Rules and Poolbeg A and Poolbeg B:

In ROI there was a requirement for having both a unit in South Dublin and a unit in North Dublin on for load flow and voltage control. A reassessment in 2018 showed this was no longer required. Additionally some other constraints in the Dublin region were amended to facilitate this adjustment.

2. Kilroot Generation Rules:

In NI it is required that at least one Kilroot unit is on load when system demand in Northern Ireland exceeds 1400 MW, and two units when system demand in Northern Ireland exceeds 1550 MW. In 2018 a reassessment showed that these rules were no longer required.

These changes allowed for more flexible management of the all island transmission system, reducing constraint costs for end users across the island.



How we minimise the Financial Impact of Transmission Losses on Consumers

When electricity is transported through networks, there are losses, which mean that not all of the power generated reaches customers and end users. This can occur either in transmission or 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.

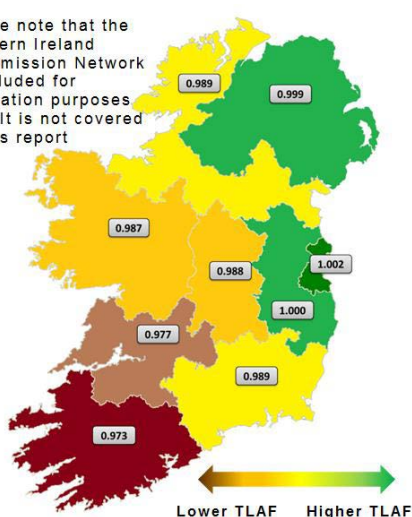
The TLAFs for the island of Ireland are calculated annually by EirGrid, jointly with SONI in Northern Ireland, and approved jointly by the CRU in Ireland and the Utility Regulator (UR) in Northern Ireland. They effectively discount the value of the generation being produced by individual generators.

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 2018 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 2017. These changes are influenced by yearly dispatch, demand and topology changes.

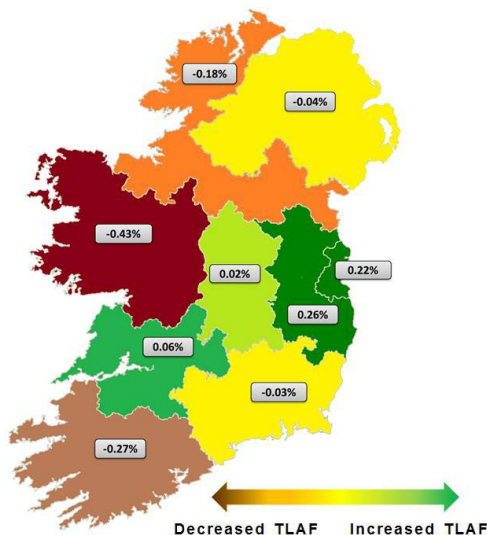
Such signals provide a commercial incentive for generators to make informed investment decisions concerning their use of the transmission system.

Further information on the TLAFs and their calculation can be found in the TLAF Methodology Explanatory Paper

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

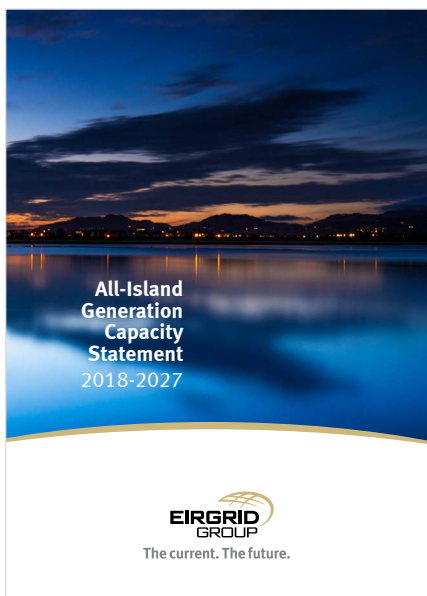


2018 Regional TLAFs



% Change from 2017 to 2018: Regional TLAFs

How we support market operation



In its role as TSO EirGrid provides critical support in the operation of the Single Electricity Market. The new Integrated Single Electricity Market (I-SEM) arrangements, went live on the 30 of September 2018.

The move from the SEM to the Integrated SEM (I-SEM) involved a significantly re-designed Ex-ante Market, a new Balancing Market, a new Capacity Market and new financial instruments in the form of Financial Transmission Rights (FTRs). The Regulatory Authorities, the Commission for the Regulation of Utilities in Ireland and the Utility Regulator in Northern Ireland, were responsible for designing the new market while EirGrid plc and SONI Ltd, in their respective capacities as licenced TSOs and Market Operators, were responsible for its implementation.

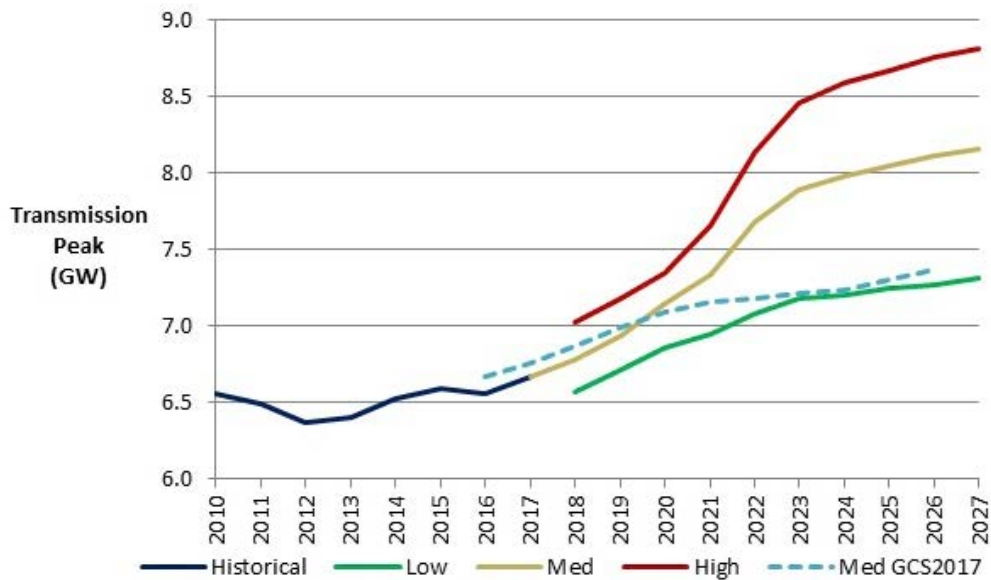
The new market arrangements are designed to integrate the all-island electricity market with European electricity markets, making optimal use of cross-border interconnectors, enhancing security of supply, delivering increased competition and further enabling the integration of renewables onto the system.

Throughout 2018 EirGrid continued working towards delivery of the new I-SEM arrangements, along with SONI, SEMO, and the Regulatory Authorities. In particular this included supporting and participation in an extensive market trial over a c.nine month period, trialling processes and software with participants, vendors and service providers. This culminated in the successful transition to the new integrated single market arrangements on the 30 September.

I-SEM Go Live represents a significant achievement that provides a more integrated market with the rest of Europe, leading to increased competition which should benefit end users through driving down prices.

One of our key responsibilities is providing accurate 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 2018 can be found in the [Generation Capacity Statement 2018-2027](#).

This task has become more critical in the new Capacity Market. The aim of the market auction is to secure just enough generation to keep the system within standard. Below is a graph showing the forecast demand under different demand scenarios.



Transmission Demand Forecast – For Capacity Auction Purposes

The demand forecast developed here is to be used to ascertain the capacity requirement, towards which the capacity auction is geared. The first capacity auction (2018/2019 T-1) occurred on schedule on Friday the 15 of December 2017. The second auction (2019/2020 T-1) occurred on schedule on the 13 of December 2018. The auction ran successfully, with 100 capacity market units taking part of which 95 were successful representing a total of 8,266 MW of de-rated capacity.

Throughout 2018 the TSO, along with the market operator, worked to deliver the new I-SEM project. We achieved this goal on the 30 of September 2018. A more integrated market will lead to increased competition which should benefit end users by driving down prices.



How we manage new connections

EirGrid issues connection offers to large scale generators, interconnectors and demand customers, who seek connections 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 2018.

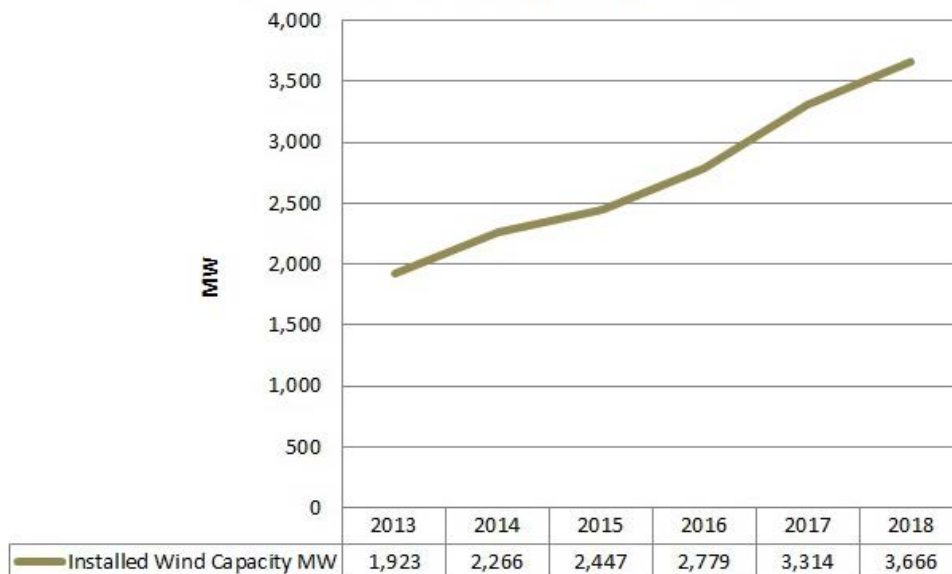
Connecting Generators and Interconnectors

Large generators, typically with a capacity of more than 40 megawatts (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 Distribution System Operator (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 storage devices.

EirGrid operates the connection process for new generators in close co-operation with ESB Networks, as DSO and in line with regulatory decisions.

In 2018, EirGrid and ESB Networks as DSO facilitated the connection of over 350 MW of windfarm projects which is made up of 183 MW of transmission and 171 MW on the distribution systems. A graph charting the increase of installed wind capacity can be seen below.

Installed Wind Capacity Ireland



By the end of 2018 the connection of these new windfarms resulted in the overall generation provided from renewable energy sources reaching 36.1% of total demand. Other sources of renewable energy include biomass, hydro, solar PV and renewable waste. In the coming years, further new wind and solar farms are due to connect at transmission and distribution level in order to meet our 40% RES-E target in 2020. Key stats for Generator Connection Offers in 2018:

	No.	MW
New Transmission Generator Connection Offer Agreements Executed	12	626.00
Total Generator Connection Offer Agreements Executed	24	688.93
New Transmission Generator Connection Offers Issued	14	14
Total Generator Connection Offers Issued	29	755.88

When an offer agreement is executed this means that the party has signed a connection agreement but have 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 participant. List of contracted and connected for Transmission is located on EirGrid website [here](#).

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. No connection offers were issued or agreement executed with interconnectors in 2018; however we do expect to progress two connection offers for interconnectors in 2019.

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 2018 there were twenty customer sites connected directly to the transmission system. A total of one transmission demand connection agreement was executed in 2018. This was to facilitate an increase in total energy requirement of an existing connected customer. Key stats for Demand Transmission Connection Offers in 2018:

	No.	MIC (MVA)
Demand Connection Offer Agreements Executed	1	142.00
Demand Connection Offers Issued	1	142.00

Demand Side Units

Demand Side Units (DSUs) do not receive connection offers or agreement. These are registered in the market and are offered system services contracts. In 2018 a total of one new DSU was contracted, adding 33 MW of capacity to the network. This brought the total number of DSUs at the end of 2018 to 22 with a total capacity of 395 MW. The table below shows the change from 2017 to 2018, this will be updated annually in future reports.

	2017	2018
DSU Total Capacity (MW) - Ireland	362	395
Total No. of Operational DSU's - Ireland	19	22

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. Innovation is one of our core values and we innovate to bring value to all users of the power system.

One of our main aims is to create flexibility in the system to adapt to the changes in the electricity industry. We are a small island with ambitious targets for renewable generation and increased energy user participation. This creates the opportunity to do things differently and deliver solutions that have real benefits for our customers and the wider community.

The Innovation Programme involves the integration of new technologies and services which work well with each other and improve the way we operate the transmission system. The programme will help facilitate a low-carbon energy future, while helping us operate and maintain a safe, secure and efficient power system. The Programme focuses on the following areas; more detailed projects of the programme, stemming from the focus areas, for 2018 can be seen on the next page under 2018 Highlights.

Innovation Focus Areas

Evolving User Facilitation

As the power system becomes increasingly dynamic we must ensure we are positioned to both facilitate new types of users and manage their impact on the system. We focus on new user types that support energy efficiency and sustainability such as active demand, PV and Storage. By ensuring we are equipped to manage such users we are positioned to utilise them in managing intermittent generation and network congestion.

Reduced Community & Environmental Impact

The TSO is mindful of the impact of transmission infrastructure development on the environment and we are keen to seek out innovative ways to adapt how we approach the deployment of infrastructure so we can minimise the impact on the local environment. By seeking out innovative ways to adapt existing infrastructure to meet our system needs we can minimise the impact on the local environment.

Enhanced Grid Utilisation

This area focuses on how we can identify and test devices which can be added to the network to enable the efficient use of existing infrastructure. Such technologies work by redirecting power flow from heavily loaded circuits to circuits that are less loaded. This functionality provides EirGrid with greater ability to manage system congestion and has the potential to suppress the short term need for infrastructure build, reduce constraint costs and facilitating connection to the grid.

Control Centre Evolution

How we operate and manage the system will become more complex as we move towards an increasingly diverse and dynamic energy mix with new technologies on the system. It is essential that we are innovative in our development and use of sophisticated control system tools that ensure the efficient and effective operation and management of the grid and fully exploit the benefit of our innovations.



2018 Highlights

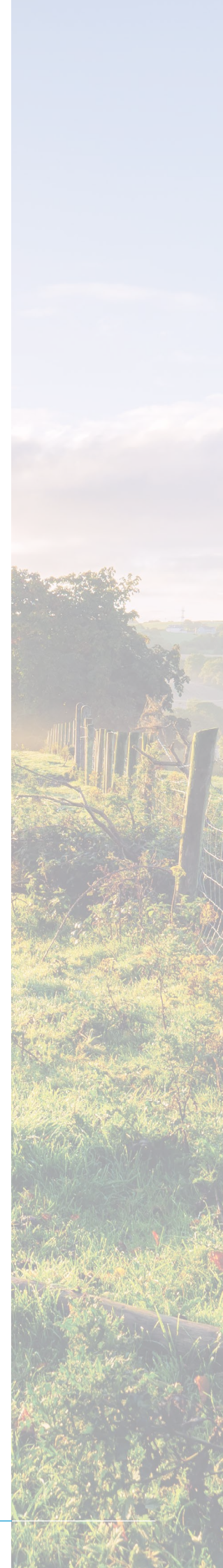
In 2018 there were several successful tests of the **Power Off and Save** pilot project. The objective of the pilot was to investigate if a test group of up to 1,500 residential consumers could significantly reduce their consumption on request to allow for the management of the grid at peak times. This could enable residential consumer participation in forthcoming System Services processes which will give greater control to electricity consumers over their usage and in turn help to drive down prices through increased competition for System Services.

A report on the progress of this programme between October 2017 and July 2018 can be read [here](#). In addition to turning off appliances manually or through an app on their smart phone, many customers opted in to enable Electric Ireland turn off their appliances, smart plugs, immersions and electric vehicles, directly with no advance notice. The focus of the trial was on the willingness of consumers to provide DSM to the grid and to understand customer behaviour. It was clear from the project that there is a great appetite from customers to partake in this initiative. In terms of percentage of reduction, we observed a 17% demand reduction for the evening peak and 15% reduction from the morning peak at the times of a Demand Response Event reduced their consumption by over 560 kWh in total. This is the equivalent to switching off over 14,000 light bulbs or the carbon emissions of a flight from Dublin to London. While the level of electrical loads in homes, available to switch, is low at present, the move to electrification of heat and transport and increased connectivity provides a huge potential for residential customers to be a key part of the energy system of the future. More information on Power Off and Save can be found on the EirGrid website [here](#).

In November 2018 EirGrid was the recipient of an **SEAI Sustainable Energy Award** in the Renewable Energy Project category. The Award was in recognition of EirGrid's DS3 Programme which was put in place in collaboration with other stakeholders including ESB Networks, to meet the challenges of operating the electricity system in a secure manner while also enabling an increase in the levels of renewable generation possible on the power system at any given time. More information on SEAI Energy awards 2018 can be found [here](#).

As noted in our 2017 report EirGrid and ESB Networks worked with Smart Wires to finish a trial of a new technology called Smart Valve in 2017. This technology changes the amount of power transmitted on a circuit in real time. The technology is a light and modular technology that can be installed on towers, at substations or even on modular trailers making it rapidly deployable and re-deployable. A technology like the SmartValve provides EirGrid with the capability to respond quickly to new challenges. The cumulative effect of the benefits outlined above delivers long-term value for the TUoS customer.

In 2018, EirGrid capitally approved a project on the Lanesboro- Richmond corridor for the installation of this innovative power flow technology to re-distribute and avoid overloads on the network allowing connected generators to export their full capacity leading to lower production (energy) costs in the market and reduced constraints payments to generators with firm access.



EirGrid Group was also nominated for an **Irish Times Innovation Award** in November 2018. The award nomination recognised that EirGrid has responded to the Decarbonisation and Sustainability challenge by developing a novel and efficient trial process for renewable energy suppliers to qualify to supply services to the grid. The qualification trials process ran for six months in 2017 and focused on three key areas;

1. The provision of reserve capacity which is available instantly should renewable or other sources drop out,
2. The provision of what is known as ramping power which can be called up in a matter of hours, and
3. Services which address the reactive power issue.

The process has seen a number of new technologies demonstrate their ability to provide services and contribute to the security of the system, deliver consumer value for money, and facilitate the reduction in carbon emissions and further deployment of renewable technologies. For more information please see **Innovation awards: Contenders tackle the challenges of parking, housing and power article**.

EU-Sysflex, EirGrid as the coordinator of Sysflex continues to lead the project involving 34 organisations from 15 countries. In December 2018 the project published three significant technical reports.

1. State of the Art Literature Review of System Scarcities at High Levels of Renewable Generation
2. EU SysFlex Scenarios and Network Sensitivities
3. D.3 Models for Simulating Technical Scarcities

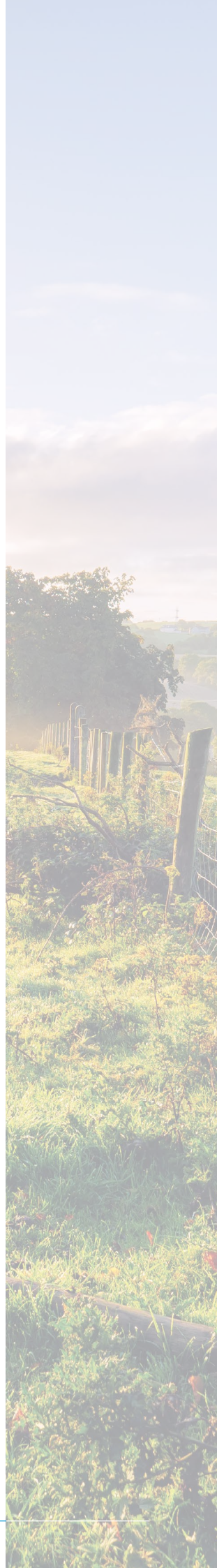
These reports and further detail on Sysflex project can be found on our website located **here**.

One of our innovations is to adapt existing infrastructure to increase capacity without having to add new lines or cables. This is called **Voltage Upgrading**, and we are currently testing a potential increase from 110 kV to 220 kV and from 220 kV to 400 kV.

ESB Networks and EirGrid are presently implementing a trial project on the de-energised Donard test site to develop construction and maintenance methods on “400 kV Composite Cross-arms” an essential element of this innovation.

Further to the completion of designs for new 220 kV **composite poles** in 2017, in 2018 the type testing of the composite poles was successfully completed. The result achieved in the type testing of the composite poles provides confidence that this concept has practical potential for further evaluation.

Composite poles are made from an advanced composite material that combines fiberglass and polyurethane resin. The technology is considered an innovative alternative solution to traditional steel lattice and wood pole structures and the technology has been successfully adopted in other transmission and distribution systems. Composite poles have embedded UV protection which means there is no scheduled maintenance requirements like preservative treatments or repainting, resulting in significant operational savings in their minimum 80 years’ service life.



EirGrid is currently investigating the potential application of the composite pole technology for converting (voltage uprating) existing 110 kV circuits to 220 kV circuits. The benefits of this approach include the potential to increase the power flow through an existing corridor up to four times while minimising visual impact by replacing existing 110 kV wood polesets with a similar structure form in the same locations.

ESB Networks and EirGrid are considering a trial for application of 220 kV composite poles for a 220 kV line refurbishment project on an existing circuit.

ESB Networks are independently implementing composite pole trials on 10 kV, 20 kV and 38 kV systems. Learnings from these trials will assist in trialling at 220 kV. ESB Networks are considering the improvement of the '110 kV braced poleset' for 110 kV application to improve collective understanding of the composite pole for transmission applications.

Before we deploy these poles on a largescale project they must be trialled in the field. During 2019, we are assessing the network to identify the optimal location on the network to trial composite poles. It is envisaged we will physically construct the poles at the chosen location to give the necessary assurances that this new technology is suitable for large scale deployment in 2020.

In 2018 ESB Networks successfully completed testing on the Nodal Controller trial at the Cauteen windfarm cluster. A number of workshops were held between ESB Networks and EirGrid in order to coordinate the handover of the project to EirGrid in order for EirGrid to commence testing. Upon completion of successful testing by EirGrid, the intent remains for a joint report to be made to CRU on the trial outcome and suggest next steps for wider roll out of the project.



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.

As mentioned previously, 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.

In 2018 we published 'Tomorrow's Energy Scenarios (TES) 2017 Locations report', which analyses assumptions about where various demand and generation technologies may connect in the future.

The stakeholder engagement strategy for the TES 2017 locations involved three stages of engagement scheduled around the publication a consultation report and a final report. For further information on this please see our Stakeholder and engagement report located [here](#).

In 2016, we launched a mobile information centre, which we continued to bring to towns and villages across Ireland in 2018. This allows liaison officers to meet with communities and stakeholders. We also participated in a number of events that allowed us to discuss our work with rural, landowner and farming communities. These events included, national ploughing championships, the Annual Customer Conference and we continue to bring the mobile information centre to towns and villages across Ireland.



Our commitment to openness and transparency has been complemented by significant work in bringing forward communications material which is accessible to all. We have introduced a Plain English policy in all of our public facing documents to further this commitment.

EirGrid has also been progressive in ensuring that there is active engagement with industry to ensure that there is maximum alignment between the TSO and market participants.

Building on our efforts in 2017, EirGrid published (in 2019) its Stakeholder Engagement Report 2018. This report provided information on all areas of EirGrid's stakeholder engagement including continued engagement with local communities in proximity to network developments. The report can be found on EirGrid's website [here](#).

Under the new incentive arrangements implemented by the CRU in 2018 EirGrid's performance in terms of Stakeholder Engagement is assessed on an annual basis by the independent Network Stakeholder Engagement Evaluation (NSEE) Panel established by the CRU. EirGrid was pleased to achieve a panel score of 7.14 out of a possible 10 for its performance in 2018. EirGrid welcomes the panel's feedback and notes the recommendations of the panel and will take these matters into consideration as we continue to develop and enhance our Stakeholder Engagement. The CRU Panels Report is available [here](#).

ESB Networks Stakeholder Engagement

ESB Networks has proudly worked with customers, communities and stakeholders across Ireland for the past 90 years.

As the energy sector changes and evolves going forward while transitioning into a low carbon future, ESB Networks will ensure that the Irish electricity customer will remain at the center of everything they do. Throughout 2018 ESB Networks maintained regular interaction with Landowners, Landowner Representative Organisations and EirGrid regarding land access issues and arrangements. In particular, in April 2018 ESB Networks organised a conference for ESB Networks and EirGrid staff focusing on the Planning and Environmental aspects of project delivery.

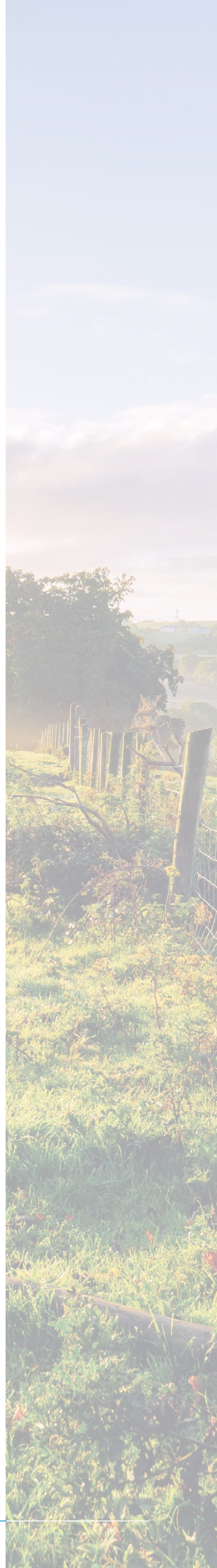
Care for safety, the environment and our heritage is foremost in our minds and actions in the work that we do. Throughout 2018 ESB Networks continued regular interaction with the public, landowners and relevant organisations on these important issues.

During 2018, ESB Networks created a new dedicated organisational role "TAO-TSO Interface Manager". The role supports agreed processes between ESB Networks and EirGrid to allow both parties to discharge their license duties for the benefit of transmission stakeholders.

In preparation for Price Review 5, ESB Networks engaged in joint forecasting workshops with EirGrid, developing joint proposals to deliver effective whole-system solutions.

In the area of network code development, both the TAO and the TSO have worked together with the CRU on the European Network Codes (EUNC). This also involved stakeholder engagement in the form of All Island EUNC Forums.

Through strong engagement between ESB Networks and EirGrid on an ongoing basis, we ensure that the needs of all customers and stakeholders are taken into consideration in the planning, management, operation and future development of the transmission network in Ireland.



How we monitor expenditure against PR4 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.

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 2018, which will be included in the 2020 revenue allowance.

TAO 2018 allowed outturns and resulting k-factor

2014 Prices € millions	PR4 allowance for 2018 (ex-ante)	CRU outturn allowance for 2018 (ex-post)	Adjustments (ex-post minus ex-ante)
Pass Through Costs			
Local Authority Rates	28.30	24.55	-3.75
CRU Regulatory Levy	1.20	1.08	-0.12
Incentives*			
2018 Incentive allowance	2.25	2.69	0.44
Inflation correction:			
Difference in forecast and actual inflation for 2018	0	-2.12	-2.12
Uncertain Costs – Non Capitalised			
AUoS	-0.50	-0.27	0.23
Uncertain Costs - Capitalised			
Depreciation	0	-0.24	-0.24
Return	0	-0.56	-0.56
Total k-factor adjustment (pre-interest) in 2014 prices		-€6.11	

TSO 2018 allowed outturns and resulting k-factor

2018 prices € millions	CRU Tariff Decision for 2018 revenues	CRU approved updated actual costs of 2018
External Costs		
CRU Regulatory Levy	1.24	1.09
DUoS Costs	2.86	2.60
Interconnector Services	0.66	0.82
Inter TSO Compensation	1.28	1.69
CORES0	0.23	0.37
Ongoing Service Charge	0	0
Ancillary Services	5.16	3.01
DS3 System Services	85.05	80.63
RoCoF Implementation	1.5	0.59
TAO Charge	232.43	232.2
EWIC Charge	21.77	21.37
Allowed TSO Operating Revenue		
Allowed TSO Internal Opex costs	47.99	47.55
Depreciation	8.47	8.39
Stage 1 Side RAB - Working Capital	3.28	1.71
Working Capital (Other)	4.70	4.57
Return on RAB - CapEx non-network	1.36	1.24
Approved adjustments		
Guarantees of Origins	0.33	0.33
Constraints arrangement fee	0.09	0.089
PR3 Adjustment	-0.70	-0.69
Strategic project France-Ireland Interconnector	0.29	0.32
I-SEM opex		
I-SEM operating revenues	4.44	4.44
Incentives*		
2018 Incentive allowance	0	1.79
2016 Over recovery	-5.96	-5.96
TOTAL (2018 prices)	416.47	408.19
TOTAL (2014 prices)	405.22 (a)	
Total CRU approved updated actual costs of 2018 (2014 prices)	(a) 405.22	
TUoS collected from TSO in 2018 (2014 prices)	(b) 435.44	
Total k-factor adjustment in 2014 prices	(b)-(a) = -€30.22m	

Our current Price Review (PR4) runs from 2016 to 2020. The CRU Decision for 2018 Transmission Revenues, which features a breakdown of, and explanation for, the revenue requirements can be found [here](#). Details on the approved costs for 2018 taking into account this lookback review are published by the CRU as part of the 2019 Transmission Revenues [here](#).

Network Development Costs

As part of the revenue price control the CRU sets a revenue envelope specifically associated with 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, 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 development of this 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 CRU does not approve individual projects. The CRU monitors our actual spend against the overall envelope, with the monies identified by the regulator being provided via the regulated Use of System Tariffs on an annual basis. In 2018 the combined TSO and TAO actual spend on network capex was €182.5m bringing the spend during PR4, 2016 to 2018 inclusive, to €492.5m. The approved revenue envelope for PR4 totals €985m. It is important to note that a review of performance of network expenditure is carried out as part of each five year Price Control review against the overall envelope.

On an annual basis we jointly submit detailed reports to the CRU on our network expenditure as required under the PR4 reporting arrangements. Expenditure in relation to the network is covered in more detail in our Investment Planning and Delivery Report.



How we ensure safety

EirGrid Safety Statement

In line with its strategy, vision and values, safety is never compromised during any activities undertaken by EirGrid or on its behalf. To achieve this EirGrid has implemented and maintains an Occupational Health and Safety management system externally certified to BS OHSAS 18001 *Occupational Health and Safety Management Systems - Requirements*.



With active support of the executive team and senior management ongoing dialogue with staff, consultants, contractors and other relevant parties, EirGrid maintains the highest standards of occupational health and safety.

There were no has HSA reportable accidents in 2018.

Electric and Magnetic Fields (EMFs)

Electric and Magnetic Fields are produced when electric current flows. EMFs are created from electrical appliances and power lines which produce extremely low frequency in the electro-magnetic 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 Statement

Safety is fundamental to everything we do in ESB Networks and we are committed to protecting the safety, health and wellbeing of our employees, contractors, customers, members of the public and others who may be affected by our work activities. Throughout 2018, ESB Networks continued to make significant progress in building our capability and performance levels in Safety, Health and wellbeing with independent assurance coming from successful ISO 18,001 accreditation and independent validation of our compliance with our public safety obligations.

Networks Work Programme

Our public safety work programmes including the cyclical hazard maintenance of overhead & underground networks and timber cutting have an important and positive impact on public safety. The delivery of these programmes is monitored and reviewed regularly to ensure delivery within agreed cycles. The Public Safety team monitor and analyse public safety electricity incidents and respond with new information initiatives and campaign, based on risk. The monthly safety briefing is used to communicate safety incidents to staff and continually reinforces the priority of public safety.

We continued to implement critical public safety interventions by serving 'stop work notices' where we become aware of unsafe construction work near electricity networks. Where we are notified of low or fallen electricity wires we carried out remote disconnection of the electricity network to safeguard the public. 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.

Stakeholder Education and Awareness

In 2018 ESB Networks delivered safety talks to Teagasc colleges as part of the FBD 'Champions for Change' initiative, in association with the H.S.A.

2018 was the fourth year of ESB Networks' 'Safe Family Farms' partnership with the Irish Farmers Journal. New online farm safety videos were added to complement regular editorial safety pages and full-page public safety advertisements to raise awareness of electrical safety on farms. We also participated in the Tullamore Show where we engaged with large numbers of the public in relation to electricity safety.

The high winds associated with storm Ali in late September caused significant interruptions to electricity customers and meant that we were not in a position to attend at the National Ploughing Championships. ESB Networks continued to participate in the Construction Safety Partnership Advisory Committee, including the development of a joint initiative with Gas Networks Ireland as part of CIF's Construction Safety Week in October. As part of Construction Safety week, we implemented initiatives to provide safety information to the construction industry, including thousands of CIF members, and others in the construction and related industries.

ESB Networks launched the new 'Emergency Services' video at the Chief Fire Officers national conference worked with the Fire Services, nationally and locally, to develop a new training video in relation to the risks when responding to electricity related incidents.



How we manage our environmental footprint

The Irish Government has set a target of an energy efficiency improvement of 33% by 2020 across the public sector, under the National Energy Efficient Action Plan 2014 and SI 426/2014: 'Energy Efficiency Regulations'. These regulations and targets apply to EirGrid and ESB Networks. We are committed to playing a leading role in enabling Ireland's transition to a low carbon future.

In 2018 EirGrid consumed 3,680 MWh of energy in our Dublin offices and business continuity centre. The latter is an off-site location with a fully functional backup of the national control centre. This energy use can be broken down as follows:

- 2,949 MWh of electricity, and
- 731 MWh of fossil fuels.

Year-on-year, we have achieved an energy reduction of 3% for our Dublin sites. We continue to find ways to reduce our energy use. In 2018, this included installing LED lights in stairways, communications rooms and the datacentre. We also incorporated new, more energy efficient computer room air conditioning units. Thanks to all our energy saving initiatives, we are on target to achieve the 2020 public-sector target.

In 2018, ESB Networks made significant efforts to ensure effective management of our environmental responsibilities. This includes the following;

- ESB Networks Fleet & Equipment undertook a fleet utilisation exercise, which has identified up to 100 light diesel vans which are suitable for replacement with a zero emissions fully electric alternative.
- During 2018 ESB Networks began the process of removing all single use plastics from all catering services in Republic of Ireland.
- ESB Networks operates an Environmental Management System (EMS) which is externally certified to ISO 14001 Standard. The EMS provides a framework for the operational control of risk, performance management and continuous improvement and is independently audited against the ISO14001 standard each year. We retained this certification in 2018
- ESB Networks is committed to becoming a leading company in the area of sustainability. The effective management of waste is seen as a key environmental management objective in supporting this strategy. In 2018 ESB Networks diverted 98% of its waste/retired materials from landfill.

Enduring Environmental monitoring

During 2018, there was one repair to a fluid filled cable (FFC), caused by third party damage. There were no other FFC leaks on the transmission system in 2018.

Sulphur hexafluoride (SF6) is used in most high-voltage switch gear on the Transmission network. It is used because of its very high electrical insulating properties and allows the switch gear to work efficiently and safely. We continue to work to minimise SF6 leaks on transmission switchgear. The national SF6 emission figure is submitted by ESB Networks to the Environmental Protection Agency (EPA) annually.



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 natural habitats, wildlife- especially birds, landscape and cultural heritage.

In accordance with European and national law we undertake Strategic Environmental Assessments (SEA) of our grid implementation plans every five years. Our current plan and SEA covers the period 2017-2022. The plan integrates [Ireland's Grid Development Strategy](#), the approved [Transmission Development Plan](#) and the Grid Implementation Plan 2017-2022 which includes policies and objectives that guide sustainable grid development. EirGrid adopted the Grid Implementation Plan 2017-2022 and associated Strategic Environmental Assessment (SEA) documents in 2019.

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. No projects requiring an EIA were submitted in 2018.

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.

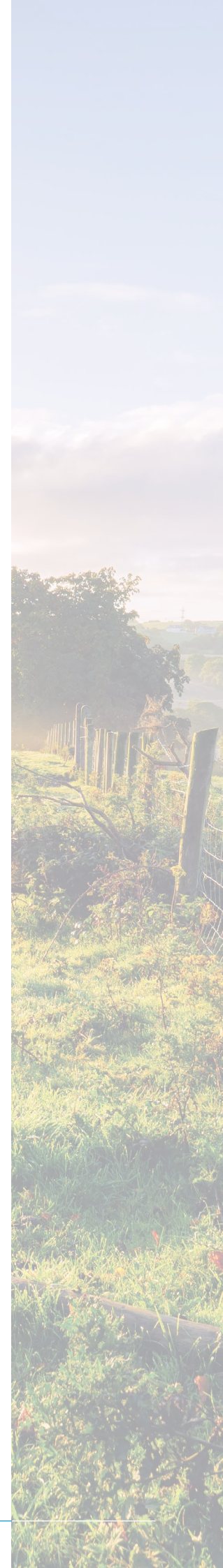
Managing the environment during construction

ESB Networks has continued to prioritise environmental protection in the delivery of new construction projects.

Key to this has been the approach to managing projects as they move from the planning/consenting process into the construction and post construction stages.

- Significant emphasis and resources have been put in place to ensure that environmental protection measures (incorporated either by way of planning conditions, particulars of design or as committed environmental mitigation measures) are reflected in both final design and management of on-site activity.
- Early identification of planning and environmental commitments ensures delivery programmes accurately reflect all the steps that need to be put in place before on-site activity commences. Construction Environmental Management Plans (CEMPs) are critically important in this respect – providing a structure for how our contractors will ensure that a project is delivered within approved environmental commitments and relevant national legislation, such as the Waste Acts.
- CEMPs are provided in advance of construction activity to key authorities – principally Planning Authorities, for approval. On-site activities can then be audited to ensure compliance and to provide support to on-site teams where needed.

These Plans ensure that environmental commitments associated with construction activity are met while minimising project delays once works start. All activities are managed in the context of ESB Networks company-wide Environmental Management System (EMS).



For all new projects, the complexity of the planning and consenting system is increasing, posing challenges for timely and cost-effective delivery of projects. It is the nature of transmission construction projects that they traverse a wide range of physical environments and the company has responded to these combined challenges by developing bespoke project solutions that can create a safe working environment within each particular setting. Through construction activity audits and post-construction reviews we are gaining a better understanding of how effective environmental measures are, allowing for continued improvements in our approach and an improved understanding of implications for project programmes.

Throughout 2018, ESB Networks continued to deliver large-scale construction projects in environmentally sensitive areas – both within, and close to, areas designated under European law as areas of ecological importance, including boglands and watercourses. The required environmental management techniques for such areas are extensive and require significant consideration at a pre-development stage. Details provided in support of particular planning applications have included specifying how particularly sensitive sites are accessed – whether by;

- helicopter,
- using wide-tracked vehicles,
- temporary access-roads developed using bog-matting,
- or by-foot;

detailing what surface water management techniques will be implemented to protect water courses; and specifying how foundations will be initially excavated and subsequently reinstated to ensure full recovery of bog habitats.

Ecological surveys immediately prior to and during construction are routinely undertaken to ensure minimum disturbance to protected species occurs. Post construction assessment provides a final evaluation of site recovery, identifying further action if required. The implementation of monitoring programmes has been critical and these have often required consultation and agreement between ESB Networks and external agencies such as the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Inland Fisheries Ireland and Local Authorities, before, during and after construction stages. Significant progress has also been made in improving on-site support whereby experts such as Project Ecologists and Archaeologists, provide practical ‘real-time’ advice and support ESB Networks contractors and staff attending site works and promoting best practice with toolbox talks on a wide range of issues from invasive species to managing in-stream works. Throughout 2018 construction projects were delivered in such challenging environments with successful outcomes – both for the System Operators and the customer. This has assisted in the delivery of ambitious infrastructure programmes, and also provided positive contexts for future construction projects.



Acronyms

- (CORESO) Coordination of electricity system operators
- (CHP) Combined Heat & Power
- (CRE) Commission de régulation de l'énergie
- (CRU) Commission for Regulation of Utilities
- (CEMP) Construction Environmental Management Plans
- (CIF) Construction Industry Federation
- (DS3) Delivering a Secure Sustainable Power System
- (DSUs) Demand Side Units
- (DAO) Distribution Asset Owner
- (DSO) Distribution System Operator
- (DUoS) Distribution Use of System
- (EWIC) East West Interconnector
- (ESRI) Economic and Social Research Institute
- (EMFs) Electric and magnetic fields
- (EIA) Environmental Impact Assessment
- (EMS) Environmental Management System
- (EPA) Environmental Protection Agency
- (EUNC) European Network Codes
- (FTRs) Financial Transmission Rights
- (FFR) Firm Frequency Response
- (FFC) Fluid Filled Cable
- (HSA) Health and Safety Authority
- (HVDC) High Voltage Direct Current
- (IDA) Industrial Development Agency
- (I-SEM) Integrated Single Electricity Market
- (JPMO) Joint Programme Management Office
- (MIC) Maximum Import Capacity
- (MW) Megawatts
- (NPWS) National Parks and Wildlife Service
- (NSAI) National Standards Authority Ireland
- (NSEE) Network Stakeholder Engagement Evaluation
- (OHSAS) Occupational Health and Safety Assessment Series
- (PR3) Price Review
- (PR4) Price Review



- (PA) Project Agreement
- (PIP) Project Implementation Plans
- (PCI) Project of Common Interest
- (RABB) Regulatory asset Base
- (RoCof) Rate of Change of Frequency
- (RES-E) Renewable energy sources for electricity
- (RTE) Réseau de Transport d'Électricité
- (RCUC) Reserve constrained unit commitment
- (DS3) Secure Sustainable Power System
- (STAR) Short Term Active Response
- (I-SEM) Single Electricity Market
- (SPS) Special Protection Schemes
- (SEA) Strategic Environmental Assessments
- (SF6) Sulphur Hexafluoride
- (SML) System Minutes Lost
- (SNSP) System Non-Synchronous Penetration
- (SONI) System Operator Northern Ireland
- (TES) Tomorrow's Energy Scenarios
- (TEN-E) Trans-European Network Energy
- (TAO) Transmission Asset Owner
- (TCG) Transmission constraint group
- (TLAFs) Transmission Loss Adjustment Factors
- (TSO) Transmission System Operator
- (TUoS) Transmission Use of System
- (UFLS) Under-Frequency Load Shedding
- (UR) Utility Regulator
- (VAR) Volt-Ampere reactive





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:



The current. The future.

Please contact our Customer Relations Team at:

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NETWORKS

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