Short Circuit Issues in Dublin

Update for Industry and Developers

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1 Introduction

Renewable energy is fundamental in unlocking greater energy independence and security, as well as economic growth and the development of a stronger society. And as the transmission system operator for Ireland, EirGrid has been tasked with making Ireland’s grid renewable-ready in line with the Government’s Climate Action targets.

In order to meet these targets, we’re currently progressing the most ambitious programme of work ever taken on the transmission system in Ireland. This includes reinforcements, upgrades and new infrastructure across the whole of the country.

We are already in the process of connecting significant volumes of offshore and onshore wind, solar and conventional generation while also reinforcing the power system.

By 2030, we anticipate over 350 projects to reinforce the system and connect industry, will have been completed, representing an investment of over €3bn.

We are experiencing a period of rapid growth for both the country and the economy, which has been accelerated by the Government’s 2025 Programme, ‘Securing Ireland's Future’. This outlines the Government's plans for economic growth and reform over the next five years and identifies key priorities for investment including offshore wind development, the rollout of new electricity interconnectors and also ensuring the grid can support the transition to renewable energy while maintaining energy security.

With this work in progress, Ireland’s planned generation portfolio has grown significantly. That’s why EirGrid is continuing to work closely with key stakeholders such as the Government and industry bodies, to understand how best to complement this substantial growth in generation with the development of a resilient onshore transmission system, powered by renewables.

1.1 Secure and resilient operation of the electricity system

On the Issues

Under certain operating scenarios in Dublin, high-short circuit levels can create challenges in the operation of the transmission system. The worst time for high short-circuit levels is when demand is very high, such as during winter evenings, and when renewable generation is very low at the same time. For example, when wind is low, more conventional generation needs to be online, and this type of generation has a greater impact on short-circuit levels because of its electrical characteristics. The technical phenomenon of potential high short circuit levels has an impact on allowable dispatches and topology of the transmission network, and this has resulted in an imposed limit on how much generation can be accommodated in Dublin for the Capacity Remuneration Mechanism (CRM).

This communication seeks to update the industry and potential developers on the issue and provide a brief explanation of why high short circuit levels arise, the measures EirGrid is taking to manage the challenges, and outline the identified solutions and their timelines.

1.2 About short circuit levels

A short-circuit is a type of fault that can occur on the power system or in any electrical device. In power systems, we use three-phase electricity. Normally, these phases which carry the high-voltage electricity are kept isolated from the (electrical) earth, and from each other. The earth (which is sometimes referred to as 'ground') has a voltage of zero. If the phases somehow become connected to earth, or connected together, that is called a short-circuit. This can happen for reasons such as lightning strikes, other adverse weather conditions, vegetation close to power lines and equipment failure. In underground cable networks, excavations can inadvertently break into cables, causing a short-circuit.

When a short-circuit happens on the power system, a very large electrical current will flow because the electricity sees a low resistance path and wants to follow it. This current can be so large that if it is allowed to flow for more than a few cycles, it can permanently damage equipment, in some cases destructively. The safety implications of this are clear, but the knock-on impact on system and market operation could also be very significant with cost implications. The power system is protected against damage through the use of relays that monitor electricity flows and respond if they detect unusually large currents flowing. The relays send signals to circuit breakers to open (at both ends of a power line for example), which stops the fault current flowing. Circuit breakers are designed to interrupt short-circuit currents up to a particular value. In Ireland, the current Grid Code standard is 50 kA at 400 kV, 40 kA at 220 kV, and 31.5/25 kA at 110 kV depending on the location. The power system must be operated to ensure that if a fault does happen, a circuit breaker will not experience a short-circuit current greater than it is designed to interrupt. Some older equipment on the power system have lower short-circuit ratings, and thus there has been an ongoing programme of work over many years to replace/uprate out-of-date equipment.

The main sources of short-circuit currents are conventional generators, synchronous condensers, and induction machines. But renewable sources and inverter-based resources also produce short-circuit currents, and generator transformers also change the impedance of the network, exacerbating the issue. The many new connections across the country in recent years have seen short-circuit levels increase everywhere. Dublin (and to a lesser extent Cork) is where the issue has now manifested due to the rapid development experienced there, which necessitates the running of a lot of conventional generation at times to manage powerflows and other constraints. This comes against a backdrop where renewable sources are almost always connected and contributing to the short-circuit level, even when their power output is low.

1.3 Key Findings and Challenges

A recent study conducted by EirGrid assessed how short circuit levels would evolve over time. Three Winter Peak scenarios were analysed, namely years 2024, 2028 and 2030. Winter Peak scenarios are when we typically see short circuit levels at their highest. For Winter Peak 2024, most of the short-circuit levels are less than 30 kA and well within standards and equipment ratings. The initial studies identified Poolbeg, Maynooth, Inchicore, and Carrickmines substations as places where short-circuit levels could exceed the planning limit of 90% of equipment rating if no mitigations were applied. When sectionalising and rearranging how the three Poolbeg generators feed onto the system, the analysis indicates that the short-circuit levels drop and short-circuit levels do not exceed the planning limit of 90% of equipment rating in the Winter 2024 scenario.

Operationally, in the real time system, the National Control Centre (NCC) may encounter short circuit issues beyond what the planning studies have highlighted. This can happen for several reasons. There could be several outages on the system that restrict sectionalising options or the earthing arrangements on transformers can exacerbate single phase fault levels in certain situations.

For Winter Peak 2028, the situation worsens as this scenario includes additional contracted generation and transmission network topology changes in Dublin. The additional conventional generation are the seven units that have been qualified for 2028 via the Capacity Remuneration Mechanism (CRM) T-4 Auction process. In the Winter 2028 scenario, several substations in Dublin exceed the planning limit of 90% of equipment rating, particularly around Corduff, Finglas, and Mooretown, even when sectionalising is applied as a mitigation. It should be understood that this operational situation would typically happen during Winter Peak if the wind generation is low and as such, is a relatively infrequent operating situation. During these situations, there are very few options open to the National Control Centre to resolve the problem. Apart from sectionalising[1], the only other option is to de-commit generators, and start up units elsewhere on the system, far away from the problem area. This may not be possible if generation margins are tight or if the transmission network cannot support resulting power flow changes. For Winter Peak 2030, the situation worsens slightly again with further transmission network topology changes in Dublin and with offshore wind generation along the east coast assumed to be energised.

EirGrid and the wider industry is thus facing multiple challenges, including:

- **Network Constraints**: The existing transmission infrastructure is being upgraded to remove transmission bottlenecks and allow new generation capacity to connect without causing short-circuit standard to be breached.
- **Operational Risks**: High fault current levels increase the risk of circuit breaker failures and grid instability.
- **Regulatory Pressures**: Compliance with Grid Code requirements places restrictions on new generation connections and operational flexibility.
- **Market and Investment Uncertainty**: Constraints on new generator connections create challenges for market participants and investors.

1.4 Impact on Generator Connections

The high short circuit level problems in Dublin are such that no new generation can be accommodated on the 220 kV system in the Greater Dublin area beyond what has been contracted. Adding more generation in this area will potentially lead to stranded generations units/assets that cannot be used as the transmission system cannot accommodate all the generation as breaches of the short-circuit standards cannot be allowed. This is for reasons of safety and the risk to personnel working on the system, as well as the risk posed to overall system stability if circuit breakers failed to clear a fault. To add more generation at present on the 220kV system in the Greater Dublin area would therefore not contribute to security of supply or help with generation margins during Winter. The above has resulted in an imposed limit on how much generation can be accommodated in Dublin for the Capacity Remuneration Mechanism (CRM) to manage a technical phenomenon in a market mechanism.

The long-term solution is to extend the existing 400 kV network towards the centre of Dublin, vastly increasing network capacity and opportunities for new generation to connect. The limitation in the CRM may have to remain until these reinforcements have been implemented, unless generation units in Dublin can qualify for the auction using connection methods involving the 400 kV voltage level.

[1] Sectionalising refers to splitting the network in order to remove paths for short-circuit current to flow.

2 Proposed Solutions

There are several solution options available to mitigate the high short-circuit level issues and manage the overall ability of the transmission system in the greater Dublin region to meet the ever-increasing demand from various sources and operating scenarios. The solutions have different timeframes of delivery, and this will also affect the choice of solution depending on the nature of the issue, there is no one solution but a combination is required.

In the short to medium term (2025 to 2028), operational strategies are the only option as we await the planned reinforcements specified in the Network Delivery Portfolio (NDP) to be energised. From an operational perspective, the National Control Centre (NCC) has few mitigation strategies available to it. Sectionalising the network where possible is the main option available to the NCC. Note that flexible demand solutions may exacerbate the short-circuit issue as demand customers start up local generators to reduce their apparent demand.

As mentioned above, EirGrid is progressing network upgrades to resolve potential breaches of the short-circuit standards outlined in the Transmission System Security and Planning Standards (TSSPS) and ensure that all equipment is rated sufficiently for high short-circuit levels. There are also various upgrade projects in train in accordance with asset condition or life-cycle asset-management policies. These planned replacements have been specified in the Network Delivery Portfolio (NDP) for a number of years, as a subset of infrastructure projects which are already included in the NDP and have associated programmes for delivery. Some of the (already planned) network reinforcements include switchgear replacement as part of station refurbishments at Poolbeg/Pigeonhouse, Carrickmines and Inchicore 220 kV stations, all of which are expected to energise in the next few years.

To address the high short-circuit levels in Dublin in the long term, new generation must connect at the 400 kV voltage level. Dublin does not currently have any circuits at this voltage level, but there are several 400 kV projects contained in the NDP which will provide a much-needed base to accommodate opportunities for new demand and generation in combination with solving operational constraints that affect transfer capacity, network reliability, and solving market power issues. If larger conventional generators are looking for connections in Dublin to enter into the T-4 CRM Capacity Auctions, EirGrid will very likely specify 400 kV connection methods and as the 400 kV network has not yet expanded, it may mean that those generators will have difficulty qualifying due to the associated delivery times with 400 kV infrastructure.

From a CRM viewpoint, prospective larger conventional machines could connect at the 400 kV voltage level once those projects have been delivered. It would not be prudent to allow more conventional generation connect on the 220 kV system in Dublin beyond what has been contracted, unless it was allotted to replace an existing unit. There may be scope for connection of very small-scale batteries or other inverter-based resources in Dublin that will not drive short-circuit levels up significantly, but this would need to be studied.

2.1 Recommendations for Generator Developers

Generator developers must carefully evaluate their connection strategies to avoid short-circuit limitations that could delay or restrict project viability. Considerations include:

- **Site Selection**: Connecting at 400 kV stations minimises short-circuit contributions and provides greater operational flexibility.
- **Early Engagement with EirGrid**: Developers should consult with EirGrid during project planning to assess feasibility and potential network constraints.

EirGrid will carefully assess all potential new connections. With the ongoing rise in short-circuit levels, earth grid design must strictly adhere to standards. In some cases, Eirgrid may specify specific technical requirements related to the short-circuit issue, such as installing fault limiting reactors to meet regulatory and network requirements.

3 Conclusion

The short-circuit issue in Dublin presents a growing challenge for grid stability and generator integration. The operational solutions are limited and only provide temporary relief. Long-term investments in infrastructure and technical advancements are necessary to facilitate new connections. Stakeholders, including prospective generator developers, must construct their plant in line with EirGrid's specifications to ensure a resilient and secure transmission network in Dublin. With careful planning and investment, the risks associated with high short-circuit levels can be managed, allowing for a more efficient and sustainable expansion of Ireland's electricity grid.