Network Analysis

Celtic Interconnector Feasibility Study

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EIRGRID

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Executive Summary

This analysis was requested as part of the investigations into the feasibility of building an interconnector between Ireland and France, known as the Celtic Interconnector. The purpose of this analysis is to assess the potential impact of the Celtic Interconnector on the transmission system when it is connected at different connection points and to do a relative comparison of these impacts.

Due to the significant capacity of the interconnector at 700 megawatts (MW), it must connect to an existing substation on either the 220 kV or 400 kV network. Based on their geographic location along the south coast of Ireland and their connectivity within the transmission system, the two strongest potential connection points for the Celtic Interconnector are the substations at Knockraha in County Cork and Great Island in County Wexford.

The analysis undertaken clearly indicates that the transmission system can accommodate the potential power flows from the Celtic Interconnector significantly better with the connection point at Knockraha rather than a connection point at Great Island. Connection at Great Island would likely require significant levels of upgrading of existing transmission system infrastructure and/or new infrastructure in comparison with the Knockraha option.

1. Introduction

EirGrid is undertaking investigations into the feasibility of constructing a high voltage direct current (HVDC) interconnector between Ireland and France, known as the Celtic interconnector. If the project proceeds, it would connect a substation in France with a substation in Ireland, using a subsea cable.

The analysis detailed in this report was requested as part of these feasibility investigations. The purpose of this high level technical analysis is to assess the potential impact of the Celtic Interconnector on the transmission system when it is connected at different connection points and to do a relative comparison of these impacts.

This analysis will form one part of the decision making process used to identify a connection point onto the existing transmission network for the Celtic Interconnector.

2. Identification of Feasible Connection Points

Due to the significant capacity of the interconnector (700 MW) it must connect to an existing substation on either the 220 kV or 400 kV network. Due to the geographic location of France in relation to Ireland, a connection point in the south or south east of Ireland is the most suitable.

The substations at Knockraha in County Cork and Great Island in County Wexford have been identified as the two strongest potential connections points for the Celtic Interconnector. These have been identified based on their location along the south coast of Ireland and their connectivity within the transmission system. These connection points are illustrated in Figure 1 which comprises a map of the transmission network.

Knockraha 220 kV substation is located to the north east of Cork city. It is well connected to the rest of the 220 kV network via six 220 kV circuits and to the 110 kV network via six 110 kV circuits. It is close to a major hub of conventional generation totalling approximately 1,400 MW of generating capacity. It is also close to an area of high wind generation in the south west which will total approximately 1,900 MW once all contracted wind generation has connected.

Great Island 220 kV substation is located in County Wexford. It is connected to the rest of the 220 kV network via three 220 kV circuits and to the 110 kV network via four 110 kV circuits. There is a 470 MW combined cycle gas turbine (CCGT) generator connected to the substation.

Connection of the Celtic Interconnector at other well connected 220kV or 400kV substations that are more northerly, e.g. the existing Tarbert, Moneypoint, Killonan, Dunstown or Carrickmines substations, would significantly increase the length and therefore the cost of the interconnector and would make the interconnector not economically viable.

Figure 1 - Map of Irish transmission network showing potential connection points for Celtic Interconnector

3. Analysis Methodology and Assumptions

Methodology

Power flow studies have been carried out to determine the potential network issues arising on the transmission system by the introduction of the Celtic Interconnector at each of the two connection points. From the network issues identified, a high level assessment of the potential level of transmission network reinforcement required to mitigate these issues has been undertaken for each connection point.

It should be noted that a detailed analysis of the resultant potential transmission network reinforcement requirements has not been undertaken as part of this analysis. The results of the analysis therefore are an indication of the potential level of transmission network reinforcement required for each potential connection point based on our expert judgement and experience of planning the transmission system.

This analysis is a high level analysis and does not provide a final network solution. Transmission network reinforcements may have multiple drivers and each potential network reinforcement must undergo a detailed technical and economic assessment to determine if there is a substantive need for the reinforcement. These potential reinforcements would then be subject to detailed economic, environmental and social impact assessment along with public and stakeholder engagement to determine what exactly the final reinforcements should be.

Assumptions

There are two existing HVDC interconnectors connected to the Irish transmission system, namely:

- East West Interconnector (EWIC) – a 500 MW HVDC interconnector between Woodland in County Meath and Wales;
- Moyle Interconnector – a 500 MW HVDC interconnector between Ballylumford in County Antrim and Scotland.

Figure 2 shows the locations of these two existing interconnectors. Both of the existing interconnectors connect the transmission network in Ireland to the transmission network in Great Britain. The Celtic Interconnector by contrast, will connect the Irish transmission network to the transmission network in France.

In order to carry out the analysis, it was necessary to make some assumptions regarding the most appropriate generation dispatch scenarios to be considered. The analysis is based on the generation dispatch scenarios which are considered most likely to appropriately test the transmission network. The scenario which is most likely to justify additional transmission reinforcements is a scenario with simultaneous interconnector import on the two existing interconnectors from Great Britain and on the Celtic Interconnector from France, in conjunction with high wind generation in the South West.

The analysis undertaken assumes that all currently planned network reinforcements are complete, some of which will affect the flow of power between the south of Ireland and the Dublin area. These network reinforcements are included in the network models used for this analysis. The most relevant network reinforcements are listed in Appendix A.

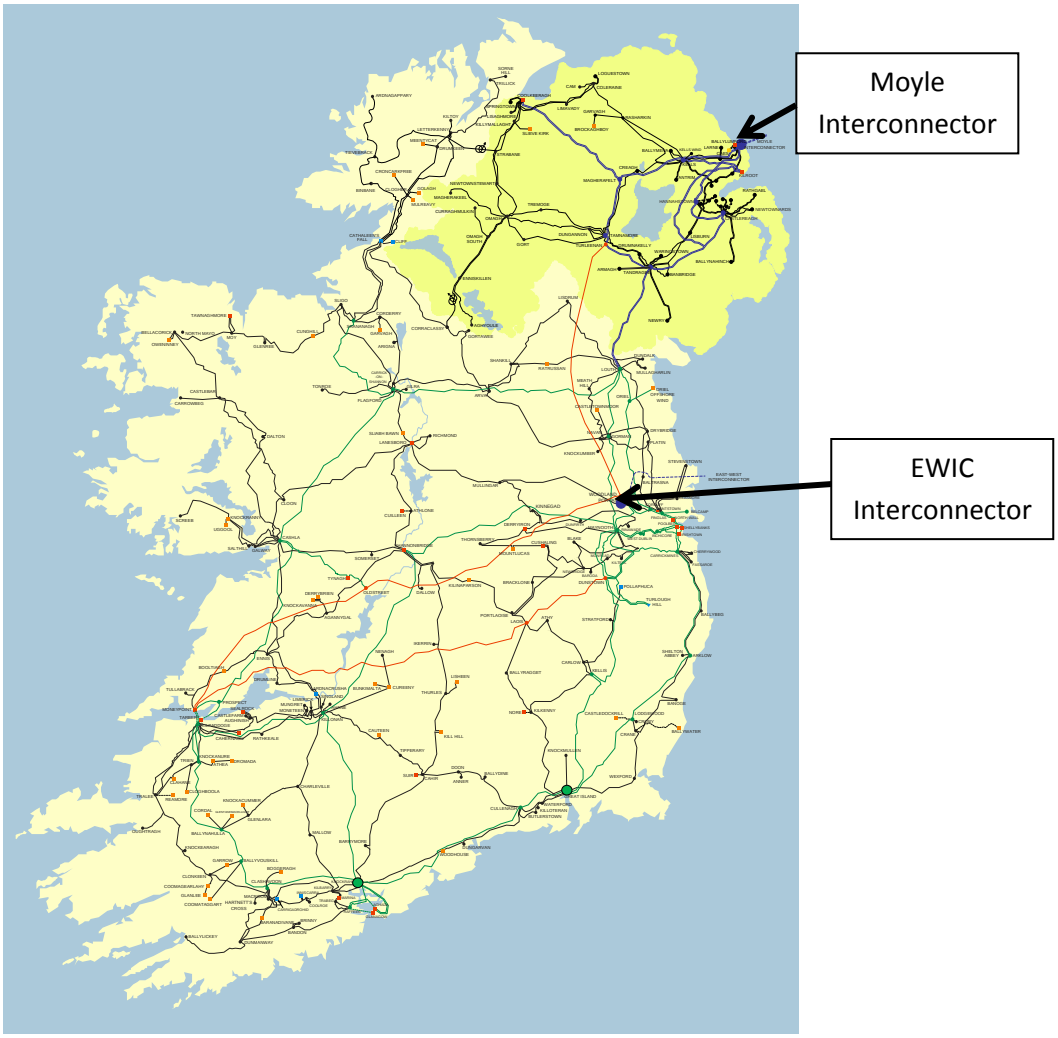

Figure 2 - Map of Irish transmission network showing locations of existing HVDC interconnectors

4. Analysis Results: Connection at Knockraha

A high level assessment of the wider network implications has been undertaken based on the connection of the Celtic Interconnector at Knockraha. A number of network issues were identified in respect of this connection. The network problems were mainly caused by very high power flows from the Knockraha area towards the high load centre of Dublin during imports from France on the Celtic Interconnector coincident with high wind generation levels on the system. The high power flows were seen both along the 220 kV network in the south west from Knockraha to Moneypoint, and also, to a lesser extent, along the network in the south east between Cullenagh and Great Island. The map in Figure 3 highlights in pink the areas of the network that were identified to be outside network standards following the connection of the Celtic Interconnector at Knockraha. A breach of these network standards may require a reinforcement of the transmission network.

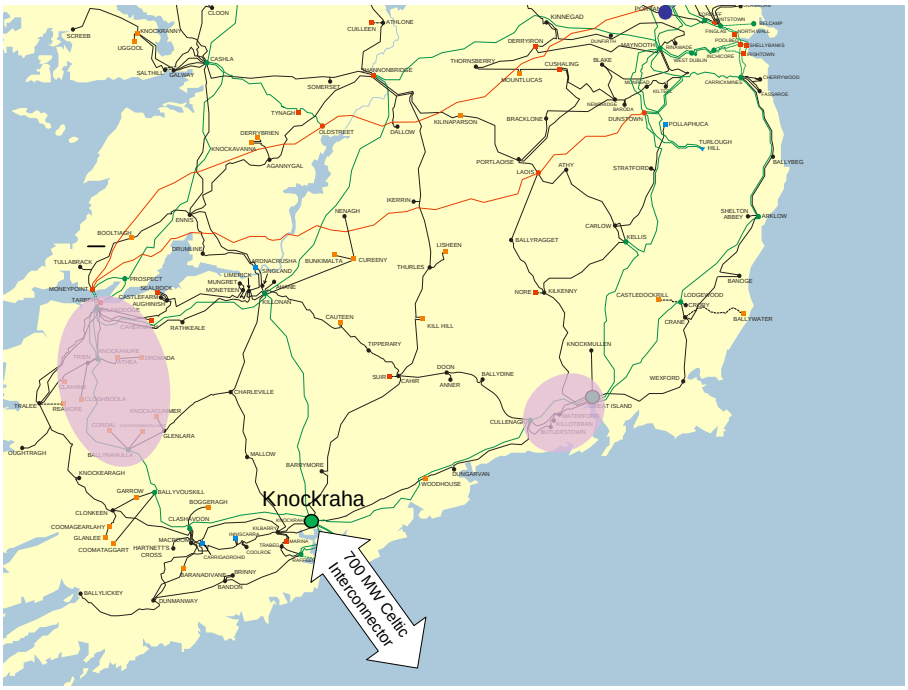

Figure 3 - Areas of the network with network violations for connection at Knockraha

With regard to the pink area in Figure 3 that is in the south west, a number of circuit overloads were identified as well as a low voltage / voltage collapse issue. These issues are all caused by large power flows from the Knockraha area towards Moneypoint along the 220 kV network in the south west region during high import scenarios on the Celtic Interconnector coincident with high wind generation levels on the system.

With regard to the pink area in Figure 3 that is in the south east, a number of circuits were identified as being overloaded due to large amounts of power flowing from the Knockraha area towards the Dublin area along the south east coast.

At this point in time, it is considered that a small amount of new 110 kV circuit construction in the south east region, along with a moderate level of uprating of existing circuits, would resolve the network issues that were identified. Some operational measures may also be required e.g. sectionalising of certain substations (wind generation collector substations in the south west) under certain generation conditions.

5. Analysis Results: Connection at Great Island

A high level assessment of the wider network implications has been undertaken based on the connection of the Celtic Interconnector at Great Island. A number of network issues were identified due to this connection. The network problems were mainly caused by high power flows from Great Island towards the load centre of Dublin during high imports from France on the Celtic Interconnector coincident with high wind generation levels on the system. The high

power flows were mainly identified on circuits in the south east, mid east and east regions of the country which connect Great Island to the Dublin area. High power flows were also seen along the south west 220 kV network, particularly between Knockanure and Kilpaddoge 220 kV stations in County Kerry. The map in Figure 4 highlights in pink the areas of the network that are identified as being outside network standards following the connection of the Celtic Interconnector at Great Island.

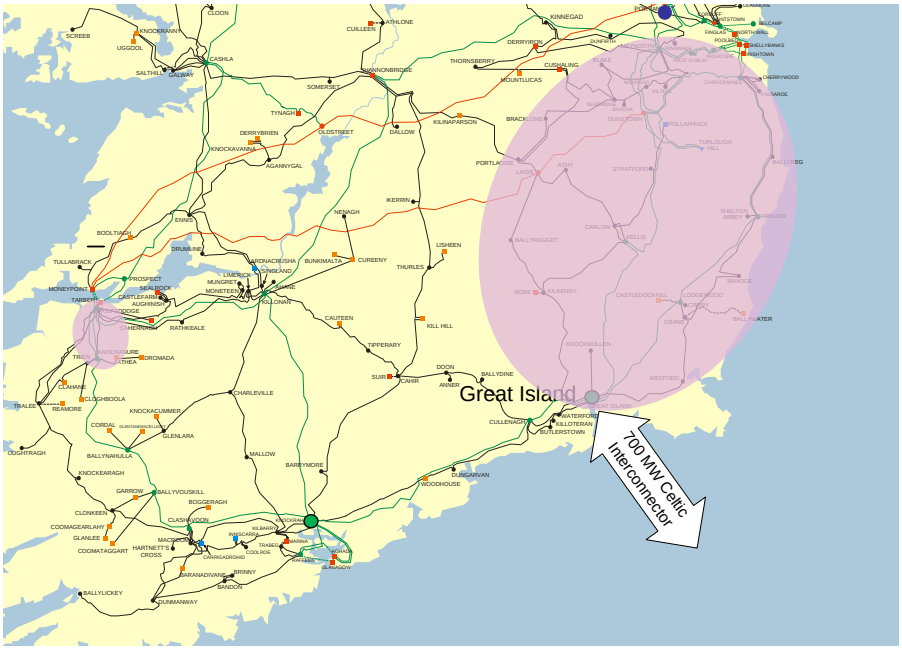

Figure 4 - Areas of the network with network violations for connection at Great Island

With regard to the pink area in Figure 4 that is in the south east, a large number of circuit overloads were identified as a result of high power flows from Great Island towards the Dublin area during high import on the Celtic interconnector coincident with high wind generation levels on the system.

With regard to the pink area in Figure 4 that is in the south west, a smaller number of circuit overloads were identified between Knockanure and Kilpaddoge, due to high power flows along the south west 220 kV network caused by imports on the Celtic Interconnector.

To resolve the identified issues, at this point in time it is considered that a new Extra High Voltage (EHV) circuit, as well as a large amount of circuit uprates would be required, particularly in the south east, mid east and east region, to resolve the network issues identified. Some operational measures may also be required e.g. sectionalising of certain substations (wind generation collector substations in the south west) under certain generation conditions.

6. Comparison of Connection Points

The foregoing analysis gives an indication of the potential difference in scale of the transmission reinforcements that may be required for each of the connection points based on information available at time of writing. The analysis shows that the connection of the Celtic Interconnector at Knockraha is technically superior to a connection at Great Island.

7. Conclusion

Based on their connectivity in the transmission system and their geographic location along the south coast of Ireland, the two strongest potential connection points for the Celtic Interconnector are the substations at Knockraha in County Cork and Great Island in County Wexford.

Technical studies were carried out to determine the network implications of connecting the Celtic Interconnector at each of these connection points. Given the early stage of this project, the comparison is necessarily a high level assessment.

The analysis undertaken concludes that the transmission system can accommodate the potential power flows from the Celtic Interconnector significantly better with the connection point at Knockraha rather than a connection point at Great Island. Connection at Great Island would likely require a significant level of upgrading of existing transmission system infrastructure and / or the construction of new infrastructure in comparison to the Knockraha option.

Appendix A

All currently planned network reinforcements are assumed to be complete and have been included in the network models for this analysis. This includes the following:

- North South Interconnection between Woodland 400 kV substation in County Meath and Turleenan 400 kV substation in County Tyrone;
- A strengthening of the network between Woodland 400 kV substation in County Meath and Dunstown 400 kV substation in County Kildare. This reinforcement is currently being optimised;
- Installation of three series capacitors on each of Moneypoint-Coolnabacky, Dunstown-Coolnabacky and Oldstreet-Woodland 400 kV circuits;
- A 400 kV marine cable across the Shannon estuary connecting Moneypoint 400 kV substation in County Clare and Kilpaddoge 400 kV substation in County Kerry;
- An uprate of the Great Island-Wexford 110 kV circuit;
- An uprate of the Great Island-Kilkenny 110 kV circuit;
- An upgrade of the Wexford 110 kV substation.