Additional Electricity Interconnection between Northern Ireland and Republic of Ireland

Introduction

Following the completion of a range of technical, economic and stakeholder studies, NIE and ESBNG were directed by the Regulators to proceed with additional studies, route investigations and other actions needed to prepare for and lodge planning applications for an additional electricity interconnector.

At this current stage of the project a key question to be addressed is as follows:

To what standard should the interconnector be constructed? This refers to both its voltage rating and whether it should be single or double circuit.

The construction standard chosen for the line will impact on the Total Transfer Capacity which may eventually be achieved across the interconnector and also impact on the project cost. If interconnector capacity restrictions impose limits to the economic dispatch of generation on the island, constraint costs will be incurred in the new all-island market arrangements.

Terminology

Circuit capacity is the capacity which can physically be carried on the interconnector circuit and is set by the lowest rated equipment in the interconnector circuit.

Total Transfer Capacity is the capacity which can be transferred across the total interconnection by the two systems. This depends on the ability of both systems to carry power to and from the interconnector and the circuit capacity of the interconnector.

The Total Transfer Capacity is the sum of two separate elements:

Total Transfer Capacity = Transmission Reliability Margin + Net Transfer Capacity

The Transmission Reliability Margin is reserved by the system operators. It is predominately used following the loss of a generation unit for rescue flows to ensure the safe operation of the combined systems. The Net Transfer Capacity is the quantity of transfer capacity that is available to the market.

Background

At present, the Total Transfer Capacity is restricting market trading due to the existing interconnection. The key network outage is the possible loss of the existing 275kV double circuit interconnector. Such an event would cause the systems to separate and, for large power transfers, would provide an unacceptable shock to one or both systems. Hence, the North – South Total Transfer Capacity is restricted, at present, to between 400 MW and 500 MW depending on system demand.

When both the additional interconnector and the proposed Dublin – North East 400kV circuit are completed, both systems will be capable, for certain generation dispatches, of supporting power transfers of the order of 1000 MW with only limited additional reinforcements[1]. The exact performance of both systems will depend on generation dispatch and on the location of future generation and load within both systems.

Options

There are two options to be considered as follows:

(1) The first option is to build an interconnector that has a circuit capacity of around 750MW[2] but which will essentially be non-expandable. (A further interconnector route would be required.)

(2) The second option is to build an interconnector that has initially a circuit capacity of around 900MW and which could be easily expanded in the future to around 1500MW. The expansion work involves adding incremental equipment from the end of the overhead line to the stations and within the stations at both ends.

Choice of Option

The decision as to which option should be chosen relies upon strategic, compatibility, achievability and cost factors. Dealing with these in turn:

(1) Strategic issues

When technical studies into interconnection commenced, a Total Transfer Capacity of 600-700MW was identified as a target. Since then, Total Transfer Capacity has been increased N→S to 500MW and TSOs are examining whether up to 600MW could be allowed for limited time windows. Market opening and active trading are demanding increased levels of network flexibility. Therefore, the demand for Total Transfer Capacity already approaches the 600-700MW level. If a new interconnector is to be constructed and is expected to deliver market requirements for over 40 years, it would seem inappropriate to deliver as a potential maximum only the market requirements at the time of commissioning.

A number of external factors may drive demand for interconnector capacity in ways that cannot be fully anticipated. These external factors include market forces,

[1] The level of reinforcement is likely to include increases in transformer capacity and additional voltage support.
[2] The figures 750MW, 900MW and 1500MW are approximations of line capacity. Actual capacity will depend on final line design and the prevailing ambient temperature. These figures represent typical design sizes relevant to the construction options considered.

implications of emission requirements, variations in fuel prices and generator unit sizes.

Aside from these, several specific scenarios can be envisioned which require higher transfers:

- If increased generator capacity (> 200MW) locates in Northern Ireland, a 700MW Total Transfer Capacity would limit access of the Northern Ireland generation portfolio to customers in the Republic of Ireland and be a transmission constraint in the all-island market.

- Renewables incentives mean high wind power scenarios are likely. The increased flexibility provided by higher transfer capacity will help facilitate the management of wind variability associated with high levels of wind generation.

- Separately, additional reserve will be required to manage the uncertainty of wind generation output. Higher transfer capacity is necessary to optimise the dispatch of generation and operating reserve on the island. Sharing the provision of this reserve between north and south will further increase the requirement for Transmission Reliability Margin.

- Interconnection between Northern Ireland and the Republic of Ireland could be used for transit flows of power from Scotland to England if interconnection between Ireland and Great Britain is built.

These examples indicate scenarios where a 700MW Total Transfer Capacity would restrict both the all island market and the integration of renewables. Therefore, it is now believed that the circuit should have the potential (when internal reinforcements are carried out) to deliver a Total Transfer Capacity in excess of the 700MW originally envisaged.

(2) Compatibility with Existing Network - Construction and Capability

The transmission network in Northern Ireland, although operated at 275kV, is constructed to a 400kV standard. This includes the existing Tandragee Louth interconnector. Although operated at 275kV the Northern Ireland system could be uprated in the future to 400kV to provide for load increase and flow flexibility. The RoI network is being extended at 400kV to the North East. It would therefore be compatible to construct the new interconnector at 400kV (see Figure 1). A 275kV construction, even if double circuit, would be less compatible with the existing and future network systems in NI and RoI.

The proposed interconnector needs to be compatible with the expected performance of both systems. As discussed earlier, when both the additional interconnector and the proposed Dublin – North East 400kV circuit are completed, both systems will be capable of supporting power transfers of approx 1000 MW with only limited additional reinforcements. Therefore, a 750MW interconnector will continue to restrict power transfers between the two systems. The 900 MW interconnector option gives a good match with expected internal network performance. The flexibility to expand to 1500 MW matches the increases in network performance that are likely to occur over a 40 year project life.

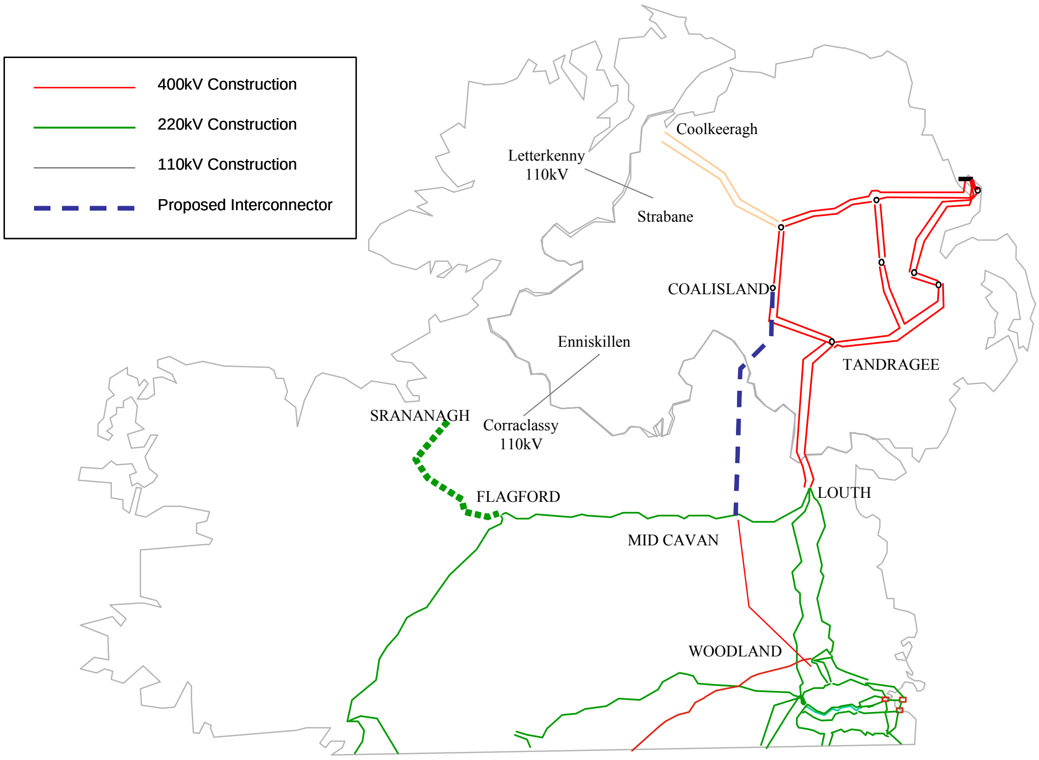

Figure 1: Network Schematic showing Proposed Interconnector

It is also important, in the long term, that the new interconnector has similar circuit capacity to the existing double circuit interconnector. The existing and proposed interconnectors will operate in parallel to connect the two systems. The loss of either interconnector will leave the remaining interconnector to link the systems. This solves the system separation issue, but limits the power transfer to the capability of the remaining circuit. Therefore, strategically, the optimum rating for the new circuit is to equal the rating of the existing interconnector, otherwise the new interconnector will be the limiting factor for Total Transfer Capacity. The existing interconnector has a circuit capacity of the order of 1500MW. Therefore the new interconnector circuit should also be capable of being expanded to around 1500MW.

(3) Achievability

There are a variety of sub-options relating to project delivery, but the main decision is whether to construct the new interconnector as a single circuit 275kV line or a single circuit 400kV line. It is expected that implementation of any new transmission line will be difficult. Both projects are considered achievable.

The 275kV single circuit provides approx. 750MW Total Transfer Capacity. When more transfer capacity is required, another 275kV single circuit is needed. Given the limited availability of route corridors, this additional circuit will have a significant additional environmental impact and achievablility is questionable.

Two 275kV circuits have a much higher environmental impact than a single 400kV circuit.

(4) Cost Comparison

The single circuit 275 kV, 750MW option costs about €140m. To increase the project to around 1500MW circuit capacity, later, would require a further interconnector route at an additional cost of approx. €120m[3]. This would result in a total cost of €260m and two routes to provide a capacity of 1500MW.

The single circuit 400kV option would be built initially with a circuit capacity of 900MW for a cost of €180m. It could be easily upgraded later to 1500MW circuit capacity at an additional cost of €30m, a total cost of €210m.

Other options were considered, such as a 275kV double circuit which would provide 750MW initially. The initial cost for this was about the same as for the 400kV single circuit option without the initial benefit of an extra 150MW capacity. A 275kV double circuit is considered to be more difficult to deliver because of the greater height of the towers.

Schematic diagrams of the interconnector designs used in this cost comparison are shown in the Appendix.

All costs have been based upon best information available in a desk-top pricing study. Final costs will not be available until detailed construction standards and equipment layouts are agreed between the parties and a tendering process has been undertaken.

It should be noted that these costs are for interconnector works only and do not include internal system reinforcements. However, internal system reinforcements are common between the options and are therefore not a differentiating factor.

Summary

A summary of the considerations pertaining to the two main options is provided in Table 1.

	Initial Interconnector capacity			1500 MW interconnector capacity Flexibility for a variable future		
275kV single circuit	€140 M	750 MW could restrict market		€260 M	Needs 2nd circuit Highest environmental impact – final phase	Most expensive – final phase Long lead time to convert to 1500MW
400kV single circuit	€180 M	900 MW		€210 M	Least environmental impact – final phase Least expensive – final phase	Relatively easy and quick to convert to 1500MW

Table 1: Summary of Comparison of Interconnector Construction Alternatives

[3] €120 million is probably a conservative cost estimate for a further 275kV single circuit. The cost is based on similar line length assumptions for the first 275kV single circuit and is used here as an indicative cost.

Conclusion

Total Transfer Capacity significantly above 700MW is likely to be required over the life-time of the project. Aside from the interconnectors, it is expected that both networks will become capable of approximately 1000MW power transfer for certain generation dispatches and with limited additional reinforcement.

A 750MW interconnector would mean that the Total Transfer Capacity will be restricted by the new circuit. For an interconnector project with a forty year life, it would seem inappropriate to build an interconnector with a capacity as low as 750MW and face the development challenge of yet another interconnector route within the foreseeable future.

The 900MW interconnector better matches the expected system performance and can easily be converted to 1500MW circuit capacity with little additional environmental impact. This option, therefore, represents the most achievable, compatible project which is easily extensible to match longer term requirements. A 900MW capacity 400kV interconnector is estimated to cost €180m and can be extended to 1500MW for a further €30m.

The existing interconnection has a Total Transfer Capability of up to 450MW. The 750MW interconnector provides the flexibility for an increase to 750MW, an increase of 300MW at a cost of €140 million. The 900 MW interconnector provides the flexibility to increase the Total Transfer Capability to 900MW, an increase of 450MW at a cost of €180 million. Therefore, the 900MW interconnector provides better value for money.

Recommendation

The 400kV single circuit option is recommended as the overall least cost option to provide strategic flexibility to deal with known or projected developments on the island. NIAER and CER are requested to approve proceeding with implementing the 400kV single circuit interconnector option, which will deliver 900MW capacity in the initial phase at an estimated cost of €180 million and has the potential to be expanded to a capacity of 1500 MW at a cost of a further €30 million at a later date.

Appendix – Circuit Configurations used in Cost Comparison

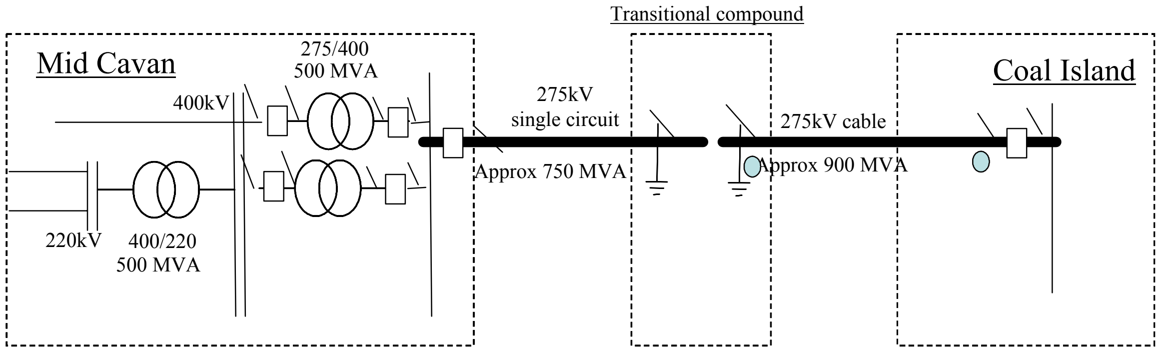

Figure A.1: Initial Phase of 275kV single circuit

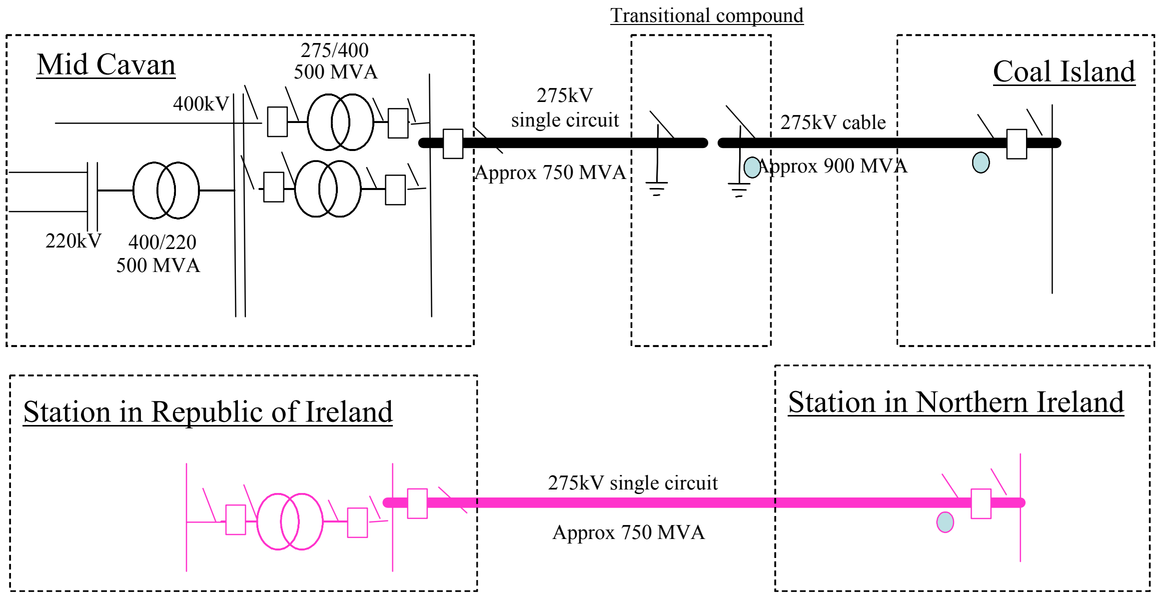

Figure A.2: Second Phase of Interconnector - approx 1500 MW - for cost comparison purposes only

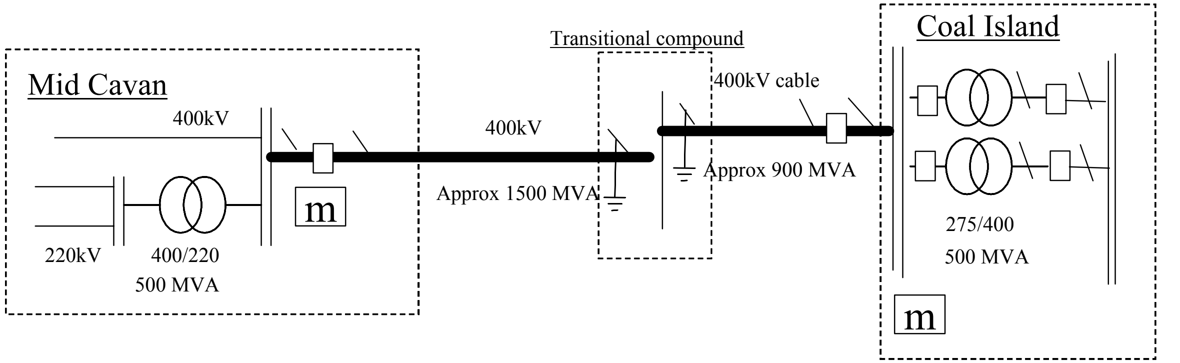

Figure A.3: initial phase of 400kV single circuit – approx 900 MW – used for cost comparison

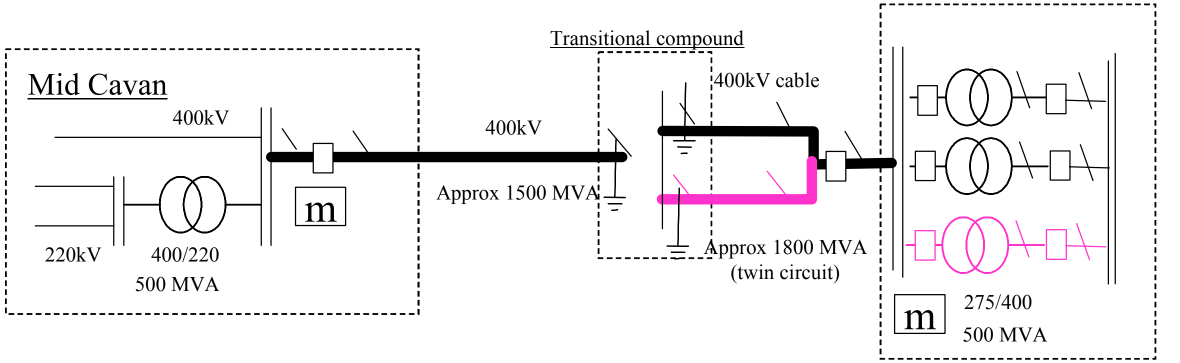

Figure A.4: Final Phase 400kV single circuit – increase to 1500 MW