INTERCONNECTION BETWEEN IRELAND AND ENGLAND / WALES

TECHNICAL INVESTIGATION INTO CONNECTION OF EAST WEST INTERCONNECTOR TO IRISH TRANSMISSION SYSTEM

EIRGRID

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EXPLANATORY NOTE FOR PUBLISHED DOCUMENT

The attached report presents a summary of the technical investigation concerning the connection of a 500 MW interconnector to the Irish transmission system. This is the basis for the selection of the connection point for the East West Interconnector to the Irish transmission system. Because the report was originally intended as an internal document, this cover note is included to provide a number of clarifications for the published version of the document.

Evaluation

A 500 MW interconnector will introduce very significant power flows on the Irish transmission system which could potentially trigger significant associated reinforcements. In selecting a point of connection to the Irish transmission system, EirGrid has identified the connection point with the lowest overall impact (i.e. for both the project and the associated reinforcements) in terms of environmental impact, feasibility, cost and delivery timescale.

Cost Estimates for Associated Reinforcements

Costs provided in this report for the identified reinforcements are estimates based on standard costs and are used for comparative purposes only.

Assumptions and Base Case Reinforcements

The assumptions made in this report (for example, load growth to 2013/4, Cork CCGTs and Gate 2 wind) mean that some reinforcement of the transmission system will be required independent of the interconnector. A set of reinforcements were identified and included in the studies to ensure an adequate transmission network as a basis for the interconnector evaluation. The assumptions made are not listed here because they may not represent the projects that will actually be implemented. However they are deemed to be adequate for the purposes of the analysis.

Disclaimer

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Executive Summary

The Minister for Communications, Marine and Natural Resources has asked the Commission for Energy Regulation to arrange a competition for the construction of a proposed east west interconnector.

One of the key decisions required at an early stage is to select a preferred connection point. This report details the implications of a 500 MW interconnector at each of five connection points in Ireland investigated for an east west interconnector. Different interconnector locations drive the need for different reinforcements.

EirGrid has a number of approved system reinforcements that are scheduled to be implemented on the network in the next few years. Additionally other as yet unplanned reinforcements which do not relate to an east west interconnector are required due to network developments. The network performance identified in this report is based on the assumption that these reinforcements will be implemented.

The table below summarises the estimated cost of reinforcements associated with each of the five connection points studied. The costs outlined are the estimated cost of reinforcements above the cost of reinforcements already planned or unrelated to an east west interconnector. The table also shows the length of circuit which need to be built or reconductored due to an east west interconnector at each connection point and the number of new transformers associated with an interconnector.

	Associated Reinforcement (€ million est.)	New 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Arklow 1[1]	175	60	16	15	120	105	1
Arklow 2	165	65	16	15	100	50	0
Cullenagh	132	0	0	15	0	180	1
Dunstown[2]	94	0	0	15	45	0	1
Inchicore	164	0	0	15	190	50	1
Woodland[3]	94	0	0	15	32	0	2

Estimated cost and summary of circuit and transformer reinforcements associated with a 500 MW interconnector at five locations in the network.

In addition to the above all connection points studied require a significant amount of voltage support in the Dublin area.

The criteria for selecting the connection point are achievability within the timeframe, overall cost to the consumer including reinforcements and environmental impact.

Due to the amount of reinforcements identified and their estimated cost Arklow, Cullenagh and Inchicore are not recommended connection points.

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[1] Two studies were undertaken for Arklow. The second study assumed an Arklow Dunstown 220 kV circuit would be feasible.

[2] Including the impact of future generation at Louth.

[3] Including the impact of future generation at Louth.

Dunstown and Woodland are both connected to the 400kV network and are strong connection points.

Comparing the Dunstown and Woodland connection points, the reinforcement requirements have been evaluated for two cases. The first case is with new generation at Louth and the second case is without further generation at Louth. For the first case, Woodland and Dunstown have the same level of reinforcement requirements. For the second case Dunstown is evaluated as requiring €30 million less associated reinforcement than Woodland.

However, there are a number of other factors that must be considered. These include a consideration of the difference in associated reinforcements in the second case, the feasibility and timeliness aspects for the alternate connection points and the overall cost including the interconnector.

The difference in the associated reinforcements for the second case is the need associated with a Woodland connection to reinforce the Dublin cable network. The Dublin cable network will be quite highly stressed by 2014 with high circuit loadings and high fault levels. It is likely that this Dublin reinforcement will be required in any case. This is borne out by the case inclusive of the generation at Louth which shows the need for the Dublin reinforcement for the Dunstown interconnector also.

Feasibility and timeliness. Both locations are quite far inland and the achievability (planning permission) and cost considerations in securing a circuit route from the landing point to the respective stations are considerations in the final selection. A route has been identified from Woodland station to the coast that is 45km in length and which is deemed to be feasible. Dunstown is even further inland and is 65km from the coast. In addition the route from Dunstown to the coast would transverse the environmentally sensitive Wicklow Mountains . Thus the combination of the sensitive location that a Dunstown connection would traverse and the additional distance compared to a Woodland connection has significant achievability and timeliness implications.

Overall Cost. On the Irish side, the cost of the Dunstown connection is impacted by the incremental cost of installing the additional 20km of DC circuit from the station to the coast which is estimated as €30 million. On the British side, there are a limited number of connection points in North Wales to which the east west interconnector is likely to connect. Woodland is the best location on the Irish network for all viable connection points on the Welsh side and is significantly less expensive for some. For example, if Deeside becomes the connection point on the Welsh side, the extra length of submarine cable needed from Dunstown would make the project €40 million more expensive compared to Woodland.

In summary, Woodland is the superior connection point. Woodland is significantly better in some aspects and as good in others when compared with the alternatives. Woodland is the preferred and recommended connection point for an east west interconnector.

1 Introduction

The Minister for Communications, Marine and Natural Resources has asked the Commission for Energy Regulation to arrange a competition for the construction of a proposed east west interconnector.

One of the key decisions required at an early stage is to select a preferred connection point. This report details the implications of a 500 MW interconnector at each of five locations thoroughly investigated, namely Arklow in Co. Wicklow, Cullenagh west of Waterford City in Co. Waterford, Dunstown south of Naas in Co. Kildare, Inchicore in Dublin city and Woodland north west of Dublin in Co. Meath.

The study presents an overview of the level of reinforcement needed for a 500 MW interconnector at each of the five locations. It provides estimates of costs and lead times for the associated deep reinforcements for each interconnector location. This report identifies the preferred connection point of the interconnector. The preferred connection point will require confirmation following a detailed feasibility study of the circuit route to the connection point.

1.1 Context of Report Findings

The objective of the study is to understand the deep reinforcement requirements on the Irish transmission network associated with locating a 500 MW interconnector at Arklow, Cullenagh, Dunstown, Inchicore or Woodland.

It is expected that these findings will form one part of the supporting information that will inform the decisions that will be made concerning the proposed east west interconnector. The other pieces of information that are expected to inform the choice of interconnector location are likely to include an understanding of the network implications on the England / Wales transmission network and the relative costs and difficulties of the alternative undersea routes, cable landing points, converter sites and onshore routing.

The findings from this study will be sufficient to form an assessment on the relative impacts of a 500 MW interconnector on the Irish transmission network. The impact of any 500 MW interconnector on the Irish network is significant. There are further studies which will also need to be undertaken including dynamic studies and other system integration issues arising from the large size of the proposed interconnector relative to system size. These system issues are not expected to impact on the selection of the connection point and will be addressed as part of the east west interconnector project.

Studies were performed before reinforcements for Gate 2 wind generation and two additional CCGTs in the Cork area were finalised. Network reinforcements which approximate those expected for Gate 2 wind generation and additional CCGTs in Cork were included in these east west interconnector studies.

Following discussions with the CER the impact of possible future generation at Louth was also examined.

1.2 Report Contents

Section two of this report contains a review of the assumptions underpinning this report and an overview of the study method used.

Section three of this report outlines the assumptions behind associating reinforcements with the interconnector.

Sections four to eight outline the deep reinforcements that have been identified as being associated with a 500 MW interconnector based at the locations investigated.

Section nine outlines the impact of generation at Louth on reinforcement requirements for a 500MW interconnector.

Section ten summarises the associated reinforcements for each connection point and provides preliminary cost estimates of the reinforcements.

Section eleven outlines lead times for the associated reinforcements and also for assumed reinforcements which are significant to the interconnector project.

Section twelve outlines some other technical issues that need to be considered before the east west interconnector is implemented.

Section thirteen provides a conclusion of the findings of this report.

Appendix A outlines the network reinforcements that are currently planned but not yet implemented. The realisation of these projects underpins all the findings in this report.

Appendix B contains a list of generators assumed available for dispatch in the studies.

1.3 Support from European Commission

These studies are co-financed by the European Commission as part of the Trans-European Networks (TEN-E) initiative.

2 Assumptions and Study Method

The primary objective of the study is

- To identify the preferred location in the Republic of Ireland for an interconnector to Britain.
- To identify the reinforcements that would be required so that the Republic of Ireland transmission network will be able to support the full import and export capacity of the proposed interconnector at these potential connection points.
- To provide estimates of the costs and lead times for the identified deep reinforcements.

It is possible that future work may highlight issues which lead to the consideration of variations in the connections as studied.

2.1 Network Connection Points

This study investigates five locations in the Republic of Ireland transmission network as possible points of connection for a proposed east west 500 MW HVDC interconnector: Arklow 220 kV, Cullenagh 220 kV, Inchicore 220 kV, Dunstown 400 kV (connected at the 220 kV busbar), and Woodland 400 kV station (connected at the 220 kV busbar or the 400 kV busbar). Independent studies were performed for each connection point.

A high level view of the Republic of Ireland transmission network initially identified ten potential connection points which could merit study. These east west HVDC interconnector connection points were

- Woodland
- Louth
- Gorman
- Dublin city
- Carrickmines
- Dunstown
- Arklow
- Cullenagh
- Great Island
- Knockraha

Previous studies undertaken in 2005 examined an interconnector at Woodland and Cullenagh.

Time and resource limitations meant ten connection points could not be studied. Knowledge of the network and geography of Ireland was used to determine which locations merited further study.

Woodland was studied in 2005 and performed very well in terms of minimum requirements for reinforcements associated with an east west interconnector. It is a very strong location in the network and is near to Dublin load and generation. A circuit route to the coast is known to be feasible. Woodland merited study.

Louth is geographically very far north and would require a significantly longer circuit route than other connection points. This coupled with the fact that is in not considered as strong a connection point as others identified meant Louth was not selected for study.

Gorman was considered a variation on the Woodland option and was not selected for study.

An interconnector point in Dublin city would be close to the load and generation in the area. Geographically it would also be very close to the coast; however congestion in the harbour may make a circuit route infeasible. Large scale reinforcements in the area may be difficult to implement due to conflicting demands for land in the area. The strong network in the area merited a connection point in Dublin to be studied. Inchicore station was chosen as the connection point to study.

Carrickmines was considered a variation on the Dublin city option and was not selected for study.

Dunstown is geographically quite far inland and a circuit route from the coast to Dunstown may be difficult. However being connected to the 400kV network Dunstown is a relatively strong point of the network and merited study.

From a geographic point of view Arklow may be a desirable location for an interconnector as the length of the undersea cable to Britain would be short. As a 220kV double circuit part of the network it is also reasonably electrically strong. In addition Arklow could potentially be connected to either south or north Wales. This geographic and network advantage meant that Arklow merited study.

A connection point in the southern part of the Republic of Ireland network would be favoured if the British side of the interconnector was in south Wales. Initial indications are that south Wales could not facilitate an interconnection before 2016 at the earliest. This reduces the relative merits of studying a connection point at Great Island, Cullenagh and Knockraha than might otherwise be the case.

Cullenagh was studied in 2005 and a large number of reinforcements were identified for an interconnector. Reinforcements required for Gate 2 wind and additional generation in the Cork area, which were not known about in the 2005 studies, could reduce the number of reinforcements required for this connection point. Geographically it is very close to the coast. The assumed network changes meant that Cullenagh merited study.

Great Island was considered a variation on the Cullenagh option and was not selected for study.

Knockraha would require a very long under sea cable route. A large amount of reinforcement would be required for importing power to Ireland with the projected generation profile in the area. Knockraha was not selected for study.

2.2 Assumptions for the Study

As with any study a number of assumptions are required in order to perform the investigation. A brief discussion of these assumptions is provided below.

2.2.1 Study Year – 2013/14

The study year was chosen as peak demand summer 2013 and winter 2013/14. This year was considered appropriate as it was sufficiently far into the future to give a realistic view of the issues, while not being so far in the future as to give rise to undue uncertainty surrounding future reinforcement requirements.

In studying 2013/14 the forecast load growth will drive the need for some network reinforcements unrelated to the additional interconnection. The network studies will separately identify those from the deep reinforcements which are linked with the interconnector.

2.2.2 Interconnector Modelling Assumptions

The final configuration and electrical characteristics of the proposed HVDC interconnector are not known at this time.

In the absence of more detailed information the following assumptions are made

- Each interconnector is modelled as a single unit connected at Arklow 220 kV busbar, Cullenagh 220 kV busbar, Inchicore 220 kV busbar, Dunstown 220 kV busbar, Woodland 400 kV busbar and Woodland 220 kV busbar respectively.
- The interconnector is capable of 500 MW power flow in either direction.
- The interconnector is studied at unity power factor.

Typically HVDC links have significant reactive power requirements and it is usual for reactive support to be located at the connection point to supply this reactive power. The assumption of unity power factor was made in these studies so as to understand the implications of power transfer to and from the interconnector as distinct from issues driven by the reactive power requirements. A separate study will be required at a later date in order to investigate the impact of the specific reactive power arrangements and assumptions.

2.2.3 Approved Reinforcements

EirGrid has a number of approved system reinforcements that are scheduled to be implemented on the transmission system in the next few years. The network performance identified in this report is based on the assumption that the approved projects will be implemented.

A list of all the network reinforcements that are assumed and that form the basis for this report are contained in Appendix A.

2.2.4 Interaction with Northern Ireland

The scenarios that are examined in this study include power transfers to and from Northern Ireland. The study does not consider the impact of contingencies in Northern Ireland or compliance with transmission planning standards in Northern Ireland.

The study assumes the proposed second north south interconnector from Co. Tyrone in Northern Ireland to Co. Cavan and associated 400 kV line from Co. Cavan to Woodland in the Republic of Ireland is built.

2.2.5 Generation Assumptions

This study is performed with all presently committed generation as identified in the Transmission Forecast Statement 2006-2012 with two additional CCGTs in the Cork area of 430 MW and 450 MW.

2.2.5.1 Installed Wind Generation

The total quantity of wind generation in the studies is 2532 MW. This consists of 1230 MW connected and committed wind generation and 1322 MW of generation applications in Gate 2. Note that connected and committed wind generation is around 50% of the total wind generation.

A list of wind generation assumed in the studies is contained in Appendix B. A number of small non wind generators are being processed as part of the Gate 2 wind generation group. These are included in the wind dispatch studies.

2.2.5.2 Interaction with other applications for connection

The study is carried out assuming two additional CCGT machines in the Cork area of 430 MW and 450 MW both of which have signed connection agreements as of June 2007. The output from these two CCGTs is needed to meet system demand.

When the main body of studies was complete an application for additional generation in the Louth area was received. A selection of high level studies was undertaken looking at the impact of this generation on the reinforcements required for a 500MW interconnector. Section nine of this report discusses the impact of generation at Louth further.

The study is carried out in isolation from all other potential non wind applications for connection to the system.

2.2.6 Costs

The costing of reinforcements identified during these studies is based on costs in 2006-2010 Transmission Price Control Review, which uses 2005 prices. These have been uplifted to 2007 terms[4]. The costs are indicative and should only be used for internal planning purposes.

2.3 Study Method and Scenarios

The objective of the study is, for an otherwise intact network, to identify violations of the transmission system standards associated with the connection of a 500 MW HVDC interconnector arising as a result of a single contingency (N-1) or an overlapping generator outage and single contingency (N-G-1). Transmission reinforcements which would reduce or eliminate the violations are identified.

The study is intended to reflect the wide range of operating conditions that can be expected on the transmission system and so for each connection point the range of scenarios shown in Figure 2.3.1 will be analysed.

[4] An uplift of 6.5% was applied to the 2005 costs based on 4% inflation in 2006 and a presumed inflation of 2.5% in 2007.

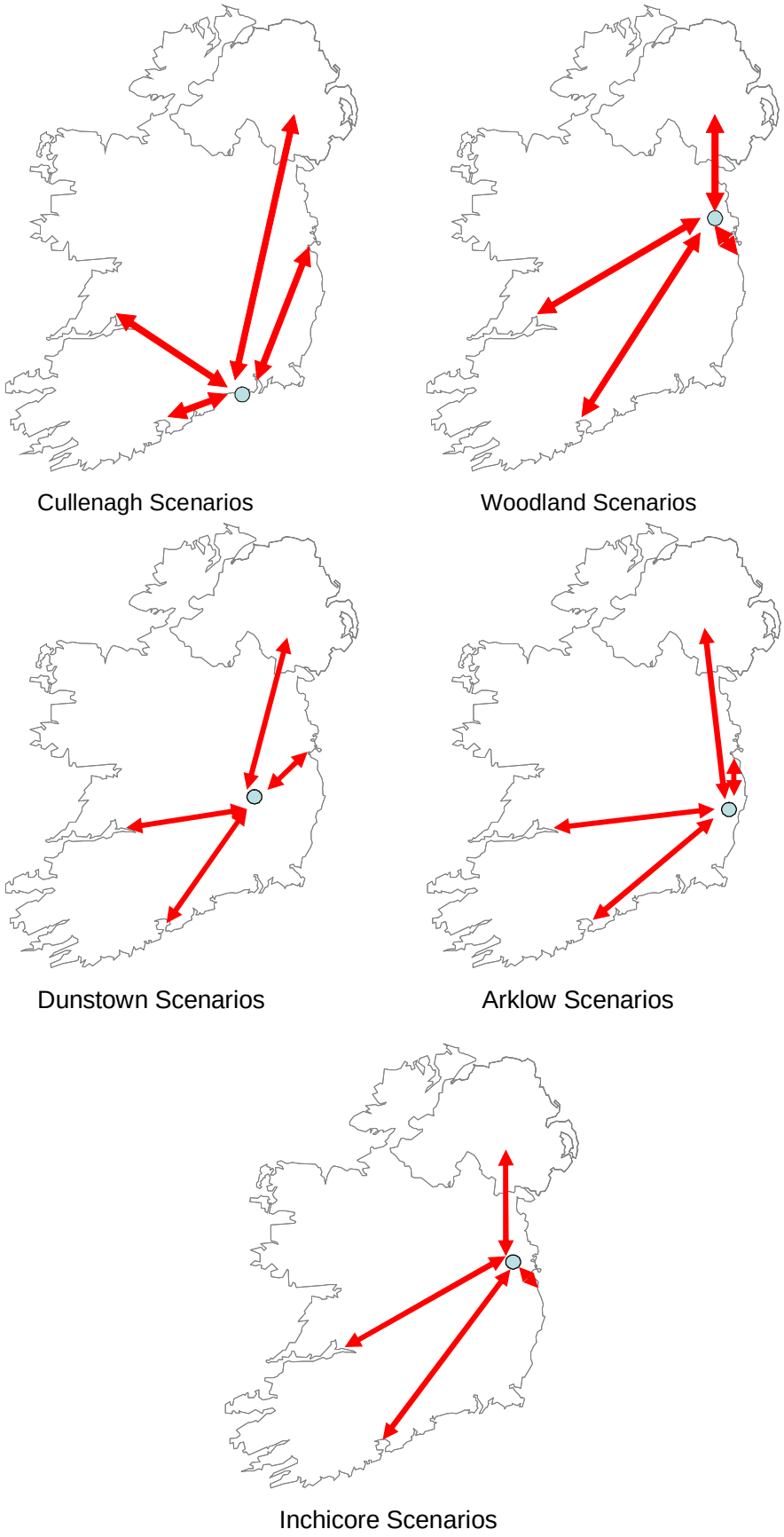

Figure 2.3.1: Illustration of interconnector trade being balanced by generation redispatch in various different parts of the country for five interconnector locations.

These studies evaluate the impact of interconnector trade being balanced by generation redispatch in various different parts of the country. This represents the concept that imports from the interconnector would need to be capable of substituting for a variety of generation from different parts of the network. The studies also ensure that generation in different parts of the network have access and will be able to export power on the proposed interconnector.

In summary a wide range of scenarios will be used in identifying the associated deep reinforcement requirements in Ireland. The study examines combinations of the following:

- Maximum levels of east west power transfer; import (500 MW to Ireland) and export (500 MW to England / Wales).
- Range of north south power transfers; 500 MW to Republic of Ireland, no trade, 500 MW to Northern Ireland.
- Range of load levels and seasons; winter peak and summer peak.
- Three levels of wind generation; 0%, 50% and 100%.
- Range of generation dispatches on the network to counterbalance interconnector trade; to or from the south, Dublin area, the west, or Northern Ireland.

This study methodology is similar to that undertaken for other connection applications received by EirGrid. For example when importing power to Ireland the interconnector could replace generation outages located in Dublin, the south, west or Northern Ireland. By undertaking a comprehensive search potential problems are identified. A decision must then be made as to whether these problems require reinforcements or could be cleared by other means, e.g. generation redispatch.

3 Reinforcement Classification

The deep reinforcements assumed and required to connect a 500 MW interconnector in the Republic of Ireland network can be subdivided into three categories:

- Reinforcement projects which have capital approval.
- Reinforcements assumed in the study to solve base case network problems. These are predominantly reinforcements for natural load growth, Gate 2 wind generation and two additional CCGTs in the Cork area.
- Reinforcements identified in the study that are exclusively associated with the 500 MW interconnector.

These reinforcement categories are discussed below.

3.1 Existing Capital Approvals

EirGrid has a number of planned system reinforcements that are scheduled to be implemented on the transmission system in the next few years. These are required regardless of a 500 MW interconnector. If some of these projects are not successfully implemented it is likely to have a material impact on the findings of this study.

These reinforcements are listed in Appendix A.1.

3.2 Reinforcements to Solve Base Case Issues

The network was investigated without east west interconnector trades. A number of reinforcements were identified that will probably be required independently of the interconnector.

Several reinforcements are assumed in the study that were included to remedy problems caused either by the forecast increase in system demand, the connection of two CCGTs in the Cork area, or by the increase in installed wind generation to 2532 MW (including 1322 MW of Gate 2 wind).

There is a need for reactive compensation in the Dublin area associated with the connection of Gate 2 wind. However the quantity of this reactive compensation has not been identified at this time. The interconnector studies assumed sufficient reactive power in the form of large SVCs were installed to meet all the system needs which included requirements for the Gate 2 wind and for the interconnector. A number of studies were performed that estimated the quantity of reactive compensation that is driven by an interconnector.

These reinforcements are listed in Appendix A.2.

3.3 Reinforcements Associated with 500 MW Interconnector

Transmission reinforcements are considered to be associated with an east west interconnector if the problems that are intended to be solved are caused by or are exacerbated by power flow on the interconnector.

The respective reinforcements for each connection point studied are outlined in sections four to eight of this report. A summary of the reinforcements is provided in section ten.

4 Reinforcements for 500 MW Interconnector at Arklow 220 kV

Arklow substation is located near the coast in the south east of Ireland, in Arklow in Co. Wicklow. It will be connected to the transmission system by one single circuit 220 kV line to Great Island through Lodgewood 220 kV and by one double circuit of 220 kV construction to Carrickmines. The other circuit is presently operated at 110 kV.

Two separate studies were undertaken at Arklow 220 kV. The second study, referred to as option two, assumed an Arklow Dunstown 220 kV circuit would be feasible.

4.1 Associated Reinforcements – Option One

Reinforcements identified for an interconnector at Arklow 220 kV include commissioning around 75 km of additional overhead circuits, and reconductoring 225 km of overhead circuits. This includes re commissioning a 110 kV circuit to 220 kV. An additional cable in the Dublin area was also identified, as well as an additional 220/110 kV transformer and significant reactive support.

The total estimated cost of reinforcements associated with an east west interconnector at Arklow 220kV for option one is €175 million.

The reinforcements are detailed below.

Arklow 125 MVA 220/110 kV transformer

There is a 125 MVA transformer and a 63 MVA transformer in Arklow at present. The connection of a 500 MW interconnector means that the 63 MVA transformer is no longer sufficient and needs to be replaced with a second 125 MVA transformer.

- Uprate transformer at Arklow from 63 MVA to 125 MVA

Cost Estimate - €5 million

Additional 220 kV Cable in the Dublin area

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. The introduction of an interconnector at Arklow and the requirement to facilitate trades to Northern Ireland, West Ireland, or the Cork area will change the flows on the Dublin cable network. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

Re-commission 110 kV side of Arklow Carrickmines circuit and reconductoring both sides to Redwood

The 220 kV line to Carrickmines is a double-circuit line with one circuit in use at 220 kV and one at 110 kV. The loss of Arklow Carrickmines 220 kV overloads the 110 kV parallel circuits. Connection of the interconnector at Arklow requires re-commissioning of the 110 kV line at 220 kV and reconductoring the two 220 kV circuits to Redwood.

- Reclaim Arklow Ballybeg Charlesland Carrickmines 110 kV circuit for 220 kV operation, Redwood
- Reconductor Arklow Carrickmines 220 circuit with Redwood[5]

Cost Estimate - €41 million

Note that an alternative means of providing supply to Ballybeg and Charlesland will be needed. This is included in the cost above.

220 kV line reconductorings

With very low dispatch in Dublin (380 MW) and wind generation dispatched at 100% the interconnector exports could be limited during N-1 contingency. As a result the following 220 kV developments are associated with the connection of the interconnector at Arklow

- Reconductor Inchicore Maynooth 220 kV circuit 2 with Redwood

Cost Estimate - €2 million

For the east west interconnector studies it is assumed that the existing Killonan Shannonbridge 220 kV line loops into a new station near Nenagh, named West Midland for the purposes of this report. When power is exported to Britain via an interconnector at Arklow the West Midland Killonan 220 kV circuit needs to be reconductored.

- Reconductor Killonan West Midland 220 kV from 467/357 to 518/431[6]

Cost Estimate - €11 million

Additional 110 kV lines and 110 kV line reconductorings

The 220 kV network and the 110 kV network are closely integrated from South Leinster to North Munster. Changes in flow on the 220 kV network due to a 500 MW interconnector at Arklow, wind generation, and two additional CCGTs in the Cork area will be accompanied by changes in generation pattern and flows on the 110 kV network. The following 110 kV network changes are associated with the connection of the interconnector at Arklow:

- Add Tarbert "New Trien" 110 kV circuit 2
- Reconductor Arklow Banoge 110 kV from 126 / 107 to 164 / 137
- Reconductor Banoge Crane 110 kV from 126/107 to 223 /187
- Reconductor Crane Wexford 110 kV from 103/72 to 164/137

[5] Redwood is a type of conductor for over head line

[6] Note that circuits are described by stating their winter and summer rating, for example a circuit described as being 518/431 has a winter rating of 518 MVA and a summer rating of 431 MVA.

- Reconductor Great Island Wexford 110 kV from 126/107 to 164/137

Cost Estimate - €38 million

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Arklow alter the voltage profile of the network. Around 100 Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation was required in the Dublin area. This was modelled as two 500 Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support was also required to facilitate large imports at Arklow 220 kV. Studies indicated that for an interconnector at Arklow 220 kV around 320 Mvar of the 1000 Mvar can be attributed to the interconnector.

- Add SVC at Maynooth 220 (A) set to 500
- Add SVC at Maynooth 220 (B) set to 500

Cost estimate for 320 Mvar SVCs – €40 million.

4.2 Associated Reinforcements – Option Two

A second set of studies were undertaken for an interconnector at Arklow 220 kV, with an additional Arklow Dunstown 220 kV circuit assumed. Reinforcements identified for this scenario include commissioning around 80 km of additional overhead circuits, and reconductoring 150 km of overhead circuits. An additional cable in the Dublin area was also identified, as well as significant reactive support.

The total estimated cost of reinforcements associated with an east-west interconnector at Arklow 220 kV option two, which assumes an Arklow Dunstown 220 kV circuit, is €165 million.

The reinforcements are detailed below.

New Arklow Dunstown 220 kV circuit

Option 2 assumes a new 220 kV circuit between Arklow 220 kV station and Dunstown 220 kV station. This circuit is assumed to be 65km long.

- Add Arklow Dunstown 220 kV circuit

Cost Estimate - €46 million

Additional 220 kV Cable in the Dublin area

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. The introduction of an interconnector at Arklow and the requirement to facilitate trades to Northern Ireland, West Ireland, or the Cork area will change the flows on the Dublin cable network. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

220 kV Line Reconductorings

The loss of the proposed 220 kV circuit from Arklow to Dunstown overloads the Arklow to Carrickmines circuits when importing power to Ireland via the interconnector. Connection of the interconnector at Arklow would require reconductoring the Arklow Carrickmines 220 kV circuit with Redwood to cover for N-1 contingency situation.

Note that reclaiming the 110 kV circuit which supplies Ballybeg and Charlesland to 220 kV is not necessary for option two.

For the east west interconnector studies it is assumed that the existing Killonan Shannonbridge 220 kV line loops into a new station near Nenagh, named West Midland for the purposes of this report. When power is exported to Britain via an interconnector at Arklow the West Midland Killonan 220 kV circuit needs to be reconductored.

- Reconductor Arklow Carrickmines 220 kV with Redwood
- Reconductor Killonan West Midland 220 kV from 467/357 to 518/431

Cost Estimate - €17 million

Additional 110 kV line and 110 kV line reconductorings

The 220 kV network and the 110 kV network are closely integrated from South Leinster to North Munster. Changes in flow on the 220 kV network due to a 500 MW interconnector at Arklow, wind generation, and two additional CCGTs in the Cork area will be accompanied by changes in generation pattern and flows on the 110 kV network. The following 110 kV network changes are associated with the connection of the interconnector at Arklow:

- Add Tarbert "New Trien" 110 kV circuit 2
- Reconductor Arklow Banoge 110 kV from 126 / 107 to 164 / 137
- Reconductor Banoge Crane 110 kV from 126 / 107 to 223 /187

Cost Estimate - €25 million

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Arklow alter the voltage profile of the network. Around 100 Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation was required in the Dublin area. This was modelled as two 500 Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support was also required to facilitate large imports at Arklow 220 kV. Studies indicated that for an interconnector at Arklow 220 kV around 230 Mvar of the 1000 Mvar can be attributed to the interconnector.

- Add SVC at Maynooth 220 (A) set to 500
- Add SVC at Maynooth 220 (B) set to 500

Cost estimate for 230 Mvar SVCs – €40 million.

Table 4.1 summarises the estimated cost of reinforcements associated with an east west interconnector at Arklow and illustrates the differences between option one and option two. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at Arklow for both option one and two.

	Associated Reinforcement (€ million est.)	**new 220kV (km)**	**new 110kV (km)**	**220kV cable (km)**	**Reconductor**		**Transformers (units)**
					220kV line (km)	**110kV line (km)**	
Arklow option 1	175	60	16	15	120	105	1
Arklow option 2	165	65	16	15	100	50	0

Table 4.1: Estimated cost and summary of circuit and transformer reinforcements associated with an interconnector at Arklow, option one and two.

5 Reinforcements for 500 MW Interconnector at Cullenagh 220 kV

Cullenagh substation is located in the south east of Ireland, in county Waterford. It is connected to the transmission system by two 220 kV single circuit overhead lines to Great Island and Knockraha. There is also a connection to the 110 kV network through one 220/110 kV transformer.

Reinforcements identified for an interconnector at Cullenagh 220 kV include reconductoring around 180 km of overhead circuits. An additional cable in the Dublin area was also identified, as well as an additional 220/110 kV transformer and significant reactive support.

The total estimated cost of reinforcements associated with an east west interconnector at Cullenagh 220 kV is €132 million.

The reinforcements are detailed below.

Additional Cullenagh 250MVA 220/110 kV transformer

There is a single 250 MVA transformer in Cullenagh at present. The connection of a 500 MW interconnector means that this is no longer sufficient and that additional transformer capacity is required.

- Add second 250MVA 220/110 kV transformer at Cullenagh

Cost Estimate - €5 million

Additional 220 kV Cable in the Dublin area

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. The introduction of an interconnector at Cullenagh and the requirement to facilitate trades from Northern Ireland to an interconnector at Cullenagh will change the flows on the Dublin cable network. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

110 kV line reconductoring and uprating

The 220 kV network and the 110 kV network are closely integrated. Changes in flow on the 220 kV network, due to a 500 MW interconnector at Cullenagh will be accompanied by changes in flow on the 110 kV network. The loss of certain 220 kV circuits will tend to overload one or more parallel 110 kV circuits. As a result the following 110 kV developments in the south-east are associated with the connection of the interconnector at Cullenagh.

- Reconductor Ballydine Cullenagh 110 from 126/107 to 223/187
- Reconductor Ballydine Doon 110 from 126/107 to 164/137
- Reconductor Banoge Crane 110 from 126/107 to 164/137
- Reconductor Butlerstown Cullenagh 110 from 126/107 to 223/187

- Reconductor Cahir Doon 110 from 126/107 to 164/137
- Reconductor Crane Wexford 110 from 103/72 to 164/137
- Reconductor Cullenagh Waterford 110 cct 1 from 126/107 to 223/187
- Uprate Great Island Waterford 110 cct 1 and 2 from 128/120 to 223/187
- Reconductor Great Island Wexford 110 from 126/107 to 164/137

Cost Estimate - €50 million

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Cullenagh alter the voltage profile of the network. Around 100Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation was required in the Dublin area. This was modelled as two 500Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support was also required to facilitate large imports at Cullenagh 220 kV. Due to time restraints no studies were undertaken to determine how much of the 1000 Mvar can be attributed to an interconnector at Cullenagh. For costing purposes it is assumed to be similar to the other connection points.

- Add SVC at Maynooth 220 (A) set to 500
- Add SVC at Maynooth 220 (B) set to 500

The estimated cost for the amount of Mvar attributable to the interconnector of these SVCs is €40 million.

Table 5.1 summarises the estimated cost of reinforcements associated with an east west interconnector at Cullenagh. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at Cullenagh.

	Associated Reinforcement (€ million est.)	new 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Cullenagh	132	0	0	15	0	180	1

Table 5.1: Estimated cost and summary of circuit and transformer reinforcements associated with an interconnector at Cullenagh.

6 Reinforcements for 500 MW Interconnector at Dunstown 220 kV

Dunstown substation is located south east of Dublin, in county Kildare. It is connected to the transmission system by a 400 kV single circuit overhead line from the Moneypoint generating station situated on the Clare coast in the west of Ireland. Connection is made to the 220 kV network through a 400/220 kV transformer. Five 220 kV circuits are connected to Dunstown. These comprise two circuits to Maynooth and one each to Kellis, Carrickmines and Turlough Hill.

Reinforcements identified for an interconnector at Dunstown 220 kV include reconductoring 45 km of overhead circuits. An additional 400/220 kV transformer at Dunstown was also identified, as well as significant reactive support.

The total estimated cost of reinforcements associated with an east west interconnector at Dunstown 400 kV connected on the 220 kV side is €62 million.

The reinforcements are detailed below.

Additional Dunstown 500MVA 400/220 kV transformer

There is a single 500 MVA transformer in Dunstown at present. The connection of a 500 MW interconnector means that this is no longer sufficient and that additional transformer capacity is required.

- Add second 500MVA 400/220 KV transformer at Dunstown

Cost Estimate - €6 million

220 kV Line Reconductoring

For the east west interconnector studies it is assumed that the existing Killonan Shannonbridge 220 kV line loops into a new station near Nenagh, named West Midland for the purposes of this report. When power is exported to Britain via an interconnector at Dunstown the West Midland Killonan 220 kV circuit needs to be reconductored.

- Reconductor Killonan West Midland 220 from 467/357 to 518/431

Cost Estimate - €11 million

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Dunstown alter the voltage profile of the network. Around 100Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation was required in the Dublin area. This was modelled as two 500Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support was also required to facilitate large imports at Dunstown 220 kV. Studies indicated that for an interconnector at Dunstown 220 kV around 230 Mvar of the 1000 Mvar can be attributed to the interconnector.

- Add SVC at Maynooth 220 (A) set to 500
- Add SVC at Maynooth 220 (B) set to 500

Cost estimate for 230 Mvar SVCs – €40 million.

Table 6.1 summarises the estimated cost of reinforcements associated with an east west interconnector at Dunstown. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at Dunstown.

	Associated Reinforcement (€ million est.)	new 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Dunstown	62[7]	0	0	0	45	0	1

Table 6.1: Estimated cost and summary of circuit and transformer reinforcements associated with an interconnector at Dunstown.

[7] This is not the final estimated associated cost for an east west interconnector at Dunstown. Future generation at Louth increases the cost. Refer to section nine of this report for further details.

7 Reinforcements for 500 MW Interconnector at Inchicore 220 kV

Inchicore substation is located in Dublin city. It is connected to the transmission system by three 220 kV cables and two 220 kV single circuit overhead lines. These comprise two circuits to Maynooth and Poolbeg and one to Irishtown. There is also a connection to the 110 kV network through three 220/110 kV transformers.

Reinforcements identified for an interconnector at Inchicore 220 kV include reconductoring 240 km of overhead circuits. An additional cable in the Dublin area was also identified, as well as an additional 400/220 kV transformer and significant reactive support.

The total estimated cost of reinforcements associated with an east west interconnector at Inchicore 220 kV is €164 million.

The reinforcements are detailed below.

Additional Dunstown 500MVA 400/220 kV transformer

The following network change is associated with the connection of the interconnector at Inchicore.

- Add second 500MVA 400/220 kV transformer at Dunstown

Cost Estimate - €6 million

Additional 220 kV Cable in the Dublin area

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. The introduction of an interconnector at Inchicore and the requirement to facilitate trades to Northern Ireland, West Ireland, or the Cork area will change the flows on the Dublin cable network. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

220 kV Line Reconductorings

The parallel Inchicore Maynooth 220 kV circuits are heavily loaded following the connection of the interconnector at Inchicore. The loss of one of these circuits overloads the remaining circuit. Connection of the interconnector at Inchicore would require reconductoring the two 220 kV circuits with Redwood to cover for N-1 contingency situation.

- Reconductor Inchicore Maynooth 220 kV circuit 1 and 2 with Redwood

Cost Estimate - €4 million

500 MW interconnector exporting power to Britain from wind generation with very low dispatch in Dublin (380 MW) could be limited during N-1 contingency. As a result the

following 220 kV developments are associated with the connection of the interconnector at Inchicore

- Reconductor Killonan West Midland 220 kV from 467/357 to 518/431
- Reconductor Maynooth Shannonbridge 220 kV from 370/286 to 518/431

Cost Estimate - €65 million

110 kV Line Reconductoring

The 220 kV network and the 110 kV network are closely integrated from South-Leinster to North-Munster. Changes in flow on the 220 kV network, due to importing 500 MW from Britain via the interconnector, wind generation, and very low generation in Cork area will be accompanied by changes in flows on the 110 kV network. The following 110 kV reconductoring is associated with the connection of the interconnector at Inchicore.

- Reconductor Crane Wexford 110 from 103/72 to 164/137

Cost Estimate - €5 million

500 MW interconnector exports from wind generation could be limited during N-1 contingency when there is very low dispatch in Dublin (380 MW). As a result the following 110 kV developments are associated with the connection of the interconnector at Inchicore.

- Reconductor Crane Banoge 110 kV from 126/107 to 164/137

Cost Estimate - €6 million.

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Inchicore alter the voltage profile of the network. Around 100Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation was required in the Dublin area. This was modelled as two 500Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support was also required to facilitate large imports at Inchicore. Studies indicated that for an interconnector at Inchicore around 320 Mvar of the 1000 Mvar can be attributed to the interconnector.

- Add SVC at Maynooth 220 (A) set to 500
- Add SVC at Maynooth 220 (B) set to 500

The estimated cost for 320Mvar of these SVCs is €40 million.

Table 7.1 summarises the estimated cost of reinforcements associated with an east west interconnector at Inchicore. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an

interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at Inchicore

	Associated Reinforcement (€ million est.)	new 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Inchicore	164	0	0	15	190	50	1

Table 7.1: Estimated cost and summary of circuit and transformer reinforcements associated with an interconnector at Inchicore.

8 Reinforcements for 500 MW Interconnector at Woodland 400kV and 220 kV

Woodland substation is located north west of Dublin in Co. Meath. It is connected to the transmission system by one 400 kV single circuit overhead line to Oldstreet and a proposed second 400 kV single circuit to Co. Cavan. Connection is made to the 220 kV network through a 400/220 kV transformer. Four 220 kV circuits are connected to Woodland. These comprise two circuits to Finglas and one each to Louth and Maynooth.

Two separate studies were undertaken at Woodland. The first study had the interconnector connected to the 220 kV station and the second had the interconnector connected to the 400kV station.

The associated reinforcements required for an interconnector at Woodland are identical, regardless of the voltage level the interconnector is connected to.

Reinforcements identified for an interconnector at Woodland include reconductoring 10 km of overhead circuits. An additional cable in the Dublin area was also identified, as well as two additional 400/220 kV transformers and significant reactive support.

The total estimated cost of reinforcements associated with an east west interconnector at Woodland is €91 million.

The reinforcements are detailed below.

Additional Woodland 500MVA 400/220 kV transformer

There is a single 500MVA transformer in Woodland at present. The connection of a 500MW interconnector means that this is no longer sufficient under N-1 conditions and that additional transformer capacity is required.

- Add second 500MVA 400/220 KV transformer at Woodland

Cost Estimate - €6 million

Additional Dunstown 500MVA 400/220 kV transformer

There is a single 500 MVA transformer in Dunstown at present. The connection of a 500 MW interconnector at Woodland changes the flows on the 400kV network. Under N-1 conditions a single transformer at Dunstown is overloaded for various generation dispatches.

- Add second 500MVA 400/220 kV transformer at Dunstown

Cost Estimate - €6 million

Additional 220 kV Cable in the Dublin area

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. The introduction of an interconnector at Woodland 220 kV and the requirement to facilitate trades to and from Northern Ireland and trades to and from generation in the Dublin or Cork area will change the flows on the Dublin cable network. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

220 kV Line Reconductorings

With very low generation dispatch in the Dublin area the Corduff Finglas 220 kV circuit overloads if the parallel circuit trips when 500MW of power is exported to Britain via Woodland 220 kV.

- Reconductor Corduff Finglas 220 circuits 1 and 2 to Redwood

Cost Estimate - €1 million

Reactive Compensation

Changes in generation dispatch due to a 500 MW interconnector at Woodland alter the voltage profile of the network. Around 100Mvar of additional capacitive support is required at various parts of the network. The location of this support should be optimised in future studies.

Cost estimate for 100 Mvar capacitive support – €5 million.

With the connection of Gate 2 wind generation a large amount of reactive compensation is required in the Dublin area. This is modelled as two 500Mvar SVCs at Maynooth 220 kV busbars A and B. Part of this reactive support is also required to facilitate large imports at Woodland 220 kV. Studies indicated that for an interconnector at Woodland 220 kV around 290 Mvar of the 1000Mvar can be attributed to the interconnector.

Cost estimate for 290 Mvar SVCs – €40 million.

Table 8.1 summarises the estimated cost of reinforcements associated with an east west interconnector at Woodland. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at Woodland

	Associated Reinforcement (€ million est.)	new 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Woodland	91[8]	0	0	15	10	0	2

Table 8.1: Estimated cost and summary of circuit and transformer reinforcements associated with an interconnector at Woodland.

[8] This is not the final estimated associated cost for an east west interconnector at Woodland. Future generation at Louth increases the cost. Refer to section nine of this report for further details.

9 Impact of Generation at Louth 220

When the main body of studies were complete an application for additional generation in the Louth area was received. Following discussions with the CER the impact of this future generation was examined.

A limited number of studies were performed to assess the impact of the Louth 445 MW generator on the requirement for associated system reinforcements in order to provide a view on whether it might change the preferred location for the interconnector. Studies were performed for the Woodland and Dunstown interconnector connection points respectively. These locations were selected for these studies because they are the strongest connection points in the studies thus far and because they are geographically either side of the Dublin transmission network.

While these indicative studies are neither intended nor expected to provide a replacement for the comprehensive studies in the generator connection application process, the findings are significant and the studies give an indication of the impact of the generator at Louth.

The studies identified a number of additional reinforcements required with 445 MW of generation at Louth. These reinforcements fall into three categories; additional reinforcements in both scenarios, additional reinforcements for Woodland interconnector and additional reinforcements for Dunstown interconnector.

The reinforcements are detailed below.

Additional Reinforcement in both Scenarios

These studies indicated a number of 110 kV circuit issues in the Louth area. Reinforcement is required in these areas regardless of the location of the east west interconnector.

These additional reinforcements being common do not impact on the choice of location of the east west interconnector.

Additional Reinforcement for Dunstown Interconnector

These studies indicate that the combination of a Louth generator with a Dunstown interconnector may trigger the requirement for a Dublin cable reinforcement.

The Dublin cable network forms an integral part of the transmission system and at present this network is heavily loaded. With an interconnector located south of Dublin and 500 MW being exported to Britain from high merit order plant, including future generation at Louth, the flow through the Dublin network is increased. This combined with the need to support different generation dispatches in Dublin means that a new 220 kV cable is required in the Dublin area for an interconnector at Dunstown.

- Add 220 kV cable in Dublin area

Cost Estimate - €32 million

Additional Reinforcement for Woodland Interconnector

These studies indicate that the combination of a Louth generator with a Woodland interconnector may trigger the requirement to uprate the Maynooth Woodland 220 kV circuit.

There are a number of parallel paths for north south power transfer on the transmission network. These include the Maynooth Woodland 220 kV circuit, the 400 kV circuits to Moneypoint and the Dublin 220 kV network. Contingencies on the parallel paths overload the Maynooth Woodland 220 kV circuit for some generation scenarios. This portion of the network was previously identified in the 2005 studies as requiring reinforcement associated with a Woodland interconnector.

- Reconductor Maynooth Woodland 220 kV with Redwood

Cost Estimate - €3 million

The impact of a 445 MW generator at Louth on the two interconnector connection points is as follows.

For Dunstown the estimated cost of reinforcements increases by €32 million due to a Dublin cable to €94 million.

For Woodland the estimated cost of reinforcements increases by €3 million due to reconductoring a 220 kV circuit to €94 million.

Table 9.1 summarises the estimated cost of reinforcements associated with an east west interconnector connected at Dunstown or Woodland, with a generator assumed at Louth. The table also shows the length of circuits which need to be built or reconductored and the number of new transformers associated with an interconnector. Note that a large amount of reactive support is also required in the Dublin area for an east west interconnector at either connection point.

	Associated Reinforcement (€ million est.)	**new 220kV (km)**	**new 110kV (km)**	**220kV cable (km)**	**Reconductor**		**Transformers (units)**
					220kV line (km)	**110kV line (km)**	
Dunstown with gen at Louth	94	0	0	15	45	0	1
Woodland with gen at Louth	94	0	0	15	32	0	2

Table 9.1: Estimated cost and summary of associated circuit and transformer reinforcements for an interconnector at Dunstown or Woodland, with a generator assumed at Louth.

10 Summary of Reinforcements

Table 10.1 summarises the estimated cost of reinforcements associated with each of the five connection points studied. The table also shows the length of circuits which need to be built or reconductored due to an east west interconnector at each connection point and the number of new transformers associated with an interconnector. The studies found a large amount of reactive support is required in the Dublin area for each of the five connection points.

	Associated Reinforcement (€ million est.)	New 220kV (km)	new 110kV (km)	220kV cable (km)	Reconductor		Transformers (units)
					220kV line (km)	110kV line (km)	
Arklow 1[9]	175	60	16	15	120	105	1
Arklow 2	165	65	16	15	100	50	0
Cullenagh	132	0	0	15	0	180	1
Dunstown[10]	94	0	0	15	45	0	1
Inchicore	164	0	0	15	190	50	1
Woodland[11]	94	0	0	15	32	0	2

Table 10.1: Estimated cost and summary of circuit and transformer reinforcements associated with a 500 MW interconnector at five locations in the network.

Table 10.2 details the associated network reinforcements identified with each of five connection points studied for an east west interconnector. The estimated cost is also noted.

Tables 10.1 and 10.2 show the costs of reinforcements for an interconnector is between €94 million for an interconnector at Dunstown or Woodland to €175 million for an interconnector at Arklow.

Comparing the Dunstown and Woodland connection points, the reinforcement requirements were evaluated for two cases. The first case is with new generation at Louth and the second case is without further generation at Louth. For the first case, Woodland and Dunstown have the same level of reinforcement requirements. For the second case Dunstown is evaluated as requiring €30 million less associated reinforcement than Woodland. The results in this table are presented for the case with new generation at Louth.

A rationale and recommendation on the preferred connection point is provided in Section thirteen.

Appendix A outlines all other reinforcements assumed in the network.

[9] Two studies were undertaken for Arklow. The second study assumed an Arklow Dunstown 220 kV circuit would be feasible.

[10] including generation at Louth.

[11] including generation at Louth.

	Arklow 220	Arklow 220 with Dun Ark 220	Cullenagh 220	Dunstown 220	Inchicore 220	Woodland 220 or 400
220kV underground cables						
Add cable in Dublin	√	√	√		√	√
Total km 220 cables added: -	15	15	15	0	15	15
Total cost of 220kV cables, millions	€ 32	€ 32	€ 32	€ 0	€ 32	€ 32
220kV overhead lines						
Reclaim Arklow Carrickmines 110kV circuit for 220kV operation, Redwood	√					
Add Arklow Dunstown 220 cct at 518/431		√				
Total km 220 circuits added: -	60	65	0	0	0	0
Total cost of 220kV lines	€ 35	€ 46	€ 0	€ 0	€ 0	€ 0
Reconductor Arklow Carrickmines 220 circuit with Redwood	√	√				
Reconductor Corduff Finglas 220 cct 1 & 2 with Redwood						√
Reconductor Killonan - West Midland 220 from 467/357 to 518/431	√	√		√	√	
Reconductor Inchicore Maynooth 220 cct 2 from 518/431 to Redwood. Side A	√				√	
Reconductor Inchicore - Maynooth 220 cct 1 from 518/431 to Redwood. Side B					√	
Reconductor Maynooth Shannonbridge 220 from 370/286 to 518/431					√	
Total km 220 circuits Reconductored: -	120	100	0	45	190	10
Total cost of 220kV reconductoring, millions	€ 19	€ 17	€ 0	€ 11	€ 69	€ 1
110kV overhead lines						
Add Tarbert New Trien 110 cct 2 at 223/187	√	√				
Total km 110 circuits added: -	16	16	0	0	0	0
Total cost of 110kV lines, millions	6	6	0	0	0	0
Reconductor Arklow Banoge 110 from 126 / 107 to 164 / 137	√	√				
Reconductor Ballydine Cullenagh 110 from 126/107 to 223/187			√			
Reconductor Ballydine Doon from 126/107 to 164/137			√			
Reconductor Banoge Crane 110 from 126/107 to 164/137			√		√	
Reconductor Banoge Crane 110 from 126/107 to 223/187	√	√				
Reconductor Butlerstown Cullenagh 110 from 126/107 to 223/187			√			
Reconductor Cahir Doon 110 from 126/107 to 164/137			√			
Reconductor Crane Wexford 110 from 103/72 to 164/137	√		√		√	
Reconductor Cullenagh Waterford 110 cct 1 from 126/107 to 223/187			√			
Uprate Great Island Waterford 110 cct 1 from 128/120 to 223/187			√			
Uprate Great Island Waterford 110 cct 2 from 128/120 to 223/187			√			
Reconductor Great Island Wexford 110 from 126/107 to 164/137	√		√			
Total km 110 circuits Reconductored: -	105	50	180	0	50	0
Total cost of 110kV reconductoring, millions	€ 33	€ 19	€ 50	€ 0	€ 12	€ 0
Transformers						
400/220kV transformers						
Add second 400/220 Woodland transformer						√
Add second 400/220 Dunstown transformer				√	√	√
220/110kV transformers						
Add second 220/110 Cullenagh transformer			√			
Uprate Arklow 220/110 transformer from 63 MVA to 125 MVA	√					
Total (units): -	1	0	1	1	1	2
Total cost of Transformers, millions	€ 5	€ 0	€ 5	€ 6	€ 6	€ 13
Capacitors						
Dublin SVC - total required for Gate 2 wind and interconnector approx 1000 Mvar possibly split over two locations. Studies assumed 500 Mvar at both sides of Maynooth 220 Studies indicate 200 - 320 Mvar of reactive support (probably SVC) in Dublin associated with interconnector Note that land costs could be high in Dublin	√	√	√	√	√	√
Additional Capacitive Support within network - approx 100 MVAr	√	√	√	√	√	√
Total Cost of Capacitors, millions	€ 45	€ 45	€ 45	€ 45	€ 45	€ 45

Total Cost of reinforcements, in Euros	**€ 175**	**€ 164**	**€ 132**	**€ 62**	**€ 164**	**€ 91**

Impact of Generation at Louth

Add Dublin 220kV cable	Not studied	Not studied	Not studied	√	Not studied	
Uprate Maynooth Woodland 220 cct to Redwood	Not studied	Not studied	Not studied		Not studied	√
Total cost of 220kV cables, millions				€ 32		€ 3

Total Cost of reinforcements, in Euros including impact of generation at Louth				**€ 94**		**€ 94**

Table 10.2: Network reinforcements identified during studies for a 500MW east west interconnector to be connected to the network at five locations. The impact of a generator at Louth is also shown.

11 Lead Times

Lead times for reinforcements outlined in sections four to eight of this report can be estimated using typical lead times for various types of projects. Table 11.1 outlines indicative standard lead times for projects.

Reinforcement	Lead Time (est.)
New underground cable	4 years
New 220 kV line	5 – 7 years
New 110 kV line	3 – 5 years
Reconductor 220 kV line	2 – 5 years
Reconductor 110 kV line	2 – 3 years
Reactive compensation	2 years
220 / 110 kV transformer	2 – 3 years

Table 11.1: Indicative standard lead times for projects

11.1 Associated Reinforcements

For all connection points studied there is a requirement for some reinforcement of the Dublin cable network. It is likely that the lead time for a Dublin cable project will be approximately 4 years.

For all connection points studied there is a requirement for significant reactive support in the Dublin area, probably SVCs. It is likely that the lead time for a Dublin SVC project will be approximately 4 years. This is longer than the estimated lead time for a typical reactive support project due to the amount of reactive support.

The lead time for transformers is estimated to be 2-3 years. Additional transformers are required for an interconnector at all connection points, except Arklow option two which assumes an additional Arklow Dunstown 220 kV circuit.

The lead time for any individual line reconductoring would be significantly shorter than to build a new line. Arklow, Cullenagh and Inchicore interconnector points require some 110 kV circuits to be reconductored. Some of the individual line upratings are estimated to take 2 – 3 years. While a detailed programme has not been worked out for the combined programme of line reconductoring, it is estimated that a programme could be implemented in approximately 3 years for an interconnector at Arklow or Inchicore. The lead time for these upratings would not be the longest lead time for these two interconnector points.

Cullenagh requires a significant volume of 110 kV line reconductorings. Given the large number there is likely to be issues in co-ordinating circuit outages so that these projects can be implemented. Therefore it will not be possible to implement these projects concurrently and an overall programme for these projects will take considerably longer than the lead times for other reinforcements required for an interconnector at Cullenagh. It is estimated that a programme of 110 kV line reconductorings could be implemented in approx 6 years.

All interconnector points except for Cullenagh require some 220 kV circuits to be reconductored. The individual line reconductorings are estimated to take 2-5 years. Reconductoring to Redwood introduces a new concept to the network. Investigations into how to undertake these reconductoring should not be delayed.

While a detailed programme has not been worked out for the combined programme of 220 kV line upratings, it is estimated that a programme of 220 kV line upratings could be implemented in approximately 4 years for an interconnector at Dunstown or Woodland.

Arklow and Inchicore require a significant volume of 220 kV line reconductorings. Given the large number there are likely to be issues in co-ordinating circuit outages so that these projects can be implemented. Therefore it would not be possible to implement these projects concurrently and an overall programme for these projects may take longer than the lead times for other reinforcements required for an interconnector at Inchicore. If the lead time is greater than 6 years the reconductorings would be the longest lead time project for an interconnector at Arklow.

Both Arklow options require an additional Tarbert New Trien 110 kV circuit. The lead time for this 110 kV circuit depends on a favourable passage through the planning processes and is expected to take approximately 5 years.

Arklow, option one, requires the Arklow Ballybeg Charlesland Carrickmines 110 kV circuit to be reclaimed to operate at 220kV. This is expected to take approximately six years.

Arklow, option two, requires an additional Arklow Dunstown 220 circuit. The lead time for this 220 kV circuit depends on a favourable passage through the planning processes and is expected to take approximately seven years. Note that a route feasibility study of this circuit will need to take into account the unique geographic features of the area, namely the Wicklow Mountains.

In conclusion subject to resource constraints the longest lead time project for associated reinforcements is determined by different reinforcements at each location.

If the total lead time for reconductoring the 110 kV and 220 kV circuits identified for an interconnector at Arklow is less than six years then reclaiming the Arklow Ballybeg Charlesland Carrickmines 110 kV circuit to 220kV operation is estimated to be the longest lead time project for Arklow option 1.

If the total lead time for reconductoring the 110 kV and 220 kV circuits identified for an interconnector at Arklow is less than seven years then constructing an Arklow Dunstown 220 kV circuit is estimated to be the longest lead time project for Arklow option 2.

The longest lead time project for an interconnector at Cullenagh would be the reconductoring of the 110 kV circuits. It is estimated these would have a lead time of six years.

The longest lead time project for an interconnector at Dunstown would be SVCs and an additional cable in Dublin. These are both estimated to have a lead time of four years.

The longest lead time project for an interconnector at Inchicore could be reconductoring 220 kV circuits. It is estimated these would have a lead time of at least five years.

The longest lead time project for an interconnector at Woodland would be SVCs and an additional cable in Dublin. These are both estimated to have a lead time of four years.

Table 11.1.1 illustrates the estimated lead times for each type of reinforcement associated with each of the five connection points studied. An overall programme for the reinforcements required at each interconnector point has not been developed. This overall programme may indicate an overall lead time greater than the longest lead time project if projects can not be undertaken concurrently.

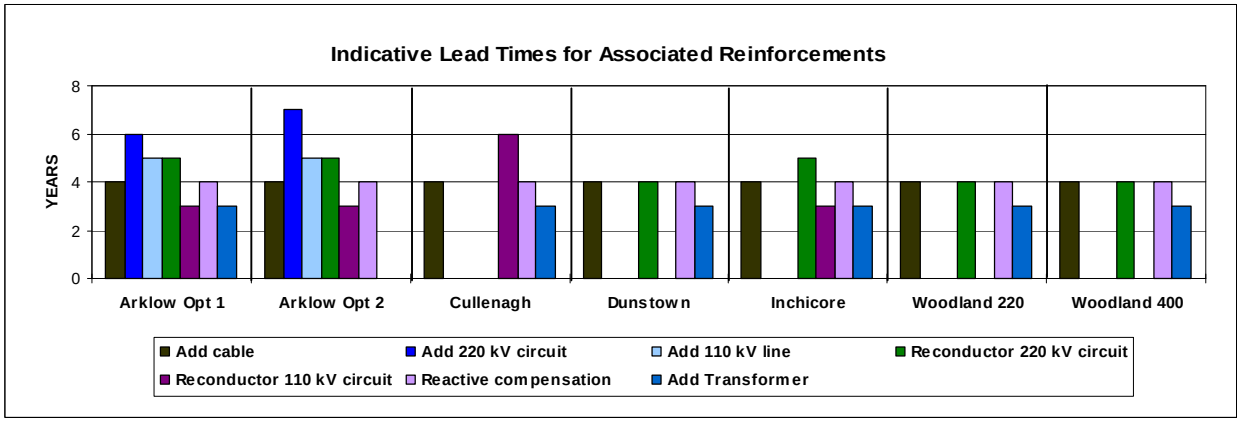

Table 11.1.1: Estimated lead times for each type of reinforcement associated with five connection points.

11.2 Significant Assumed Reinforcements

Significant quantities of reinforcements have been assumed to be completed before the connection of an east west interconnector, as listed in Appendix A and discussed in section three of this report.

If some of these projects are not successfully implemented, for whatever reason, it may have a material impact on the results of this study. The most significant of these projects for a 500 MW east west interconnector are

- Commissioning of Co. Cavan 400/220 kV station
- Add Co. Cavan - Co. Tyrone 400 kV circuit
- Add Co. Cavan Woodland 400 kV circuit
- Add Tarbert 400/220kV station
- Add Moneypoint Tarbert 400 kV cable
- Add West Midland 400/220 kV station

Approved projects

- Other assumed reinforcements

EXPLANATORY NOTE FOR PUBLISHED DOCUMENT

The assumptions made in this report (for example, load growth to 2013/4, Cork CCGTs and Gate 2 wind) mean that some reinforcement of the transmission system will be required independent of the interconnector. A set of reinforcements were identified and included in the studies to ensure an adequate transmission network as a basis for the interconnector evaluation. The assumptions made are not listed here because they may not represent the projects that will actually be implemented. However they are deemed to be adequate for the purposes of the analysis.

The Woodland - Co. Cavan - Co. Tyrone 400 kV project is due for completion in December 2012. The resulting 400 kV circuit creates an important route for power transfers to Northern Ireland. Sensitivity studies were undertaken without the Woodland

Co. Cavan 400 kV circuit present. This study shows that the intact network is capable of power transfers from the interconnector to Northern Ireland without the Woodland Co. Cavan 400 kV circuit. However it is important to state that the Woodland Co. Cavan 400 kV circuit is required to ensure that the system is adequate during maintenance conditions, with or without an east west interconnector.

The Moneypoint Tarbert project is due for completion in December 2009. This project increases the use of the 400 kV network for power flows across the network, especially with power flowing to and from the west coast.

The West Midland 400/220 kV station project is due for completion in December 2011. This project increases the use of the 400 kV network for power flows across the network, especially with power flowing to and from the Cork area.

12 Other Issues to be Considered

This section discusses other issues to be considered prior to implementation of an interconnection.

12.1 Reactive Power Studies

In this study, the interconnector is modelled at unity power factor. This is a simplifying assumption in order to understand the issues associated with power transfer to and from the point of connection as opposed to issues related to the reactive power requirements of the interconnector.

When the reactive power requirements of the proposed interconnector and its associated filters are known, a further study will be required to implement the detailed planning of the connection of the interconnector. It is possible that further system reinforcements and costs will be identified, driven by the reactive performance of the interconnector, that are in addition to the reinforcements identified elsewhere in this report.

12.2 Dynamic Stability Studies

Dynamic stability studies are a vital part of the evaluation of any proposed interconnector and are used to identify whether there are any stability problems associated with the interconnection and to identify solutions for these potential problems.

Typically any dynamic stability issues that may arise are likely, though not guaranteed, to be addressable by adjusting the control and protection settings of the HVDC link and other equipment.

Extensive system dynamic studies will be required in conjunction with the detail design of the interconnector and in the detailed planning of the connection of the interconnector.

12.3 Assessment of impact of interconnection on system operation

Given the large size of any proposed east-west interconnector with respect to the system (a 500 MW interconnector means the system can see a variation in power at the point of connection of 1000 MW), its impact on system operation is going to be very significant. An assessment will be required on the impact of an east – west interconnector on the continued safe operation of the system.

It is not likely that this consideration will impact on the choice of connection point.

12.4 Fine Tuning Connection (when Connection Point Chosen)

When the connection point is chosen, further studies will be required to fine tune and optimise the connection method.

For example, a study would address the question of the relative merits of Great Island 220 kV station instead of Cullenagh 220 kV station. Or in the case of Woodland, whether the optimum connection would be to the 400 kV or 220 kV busbar. Further variables arise at the other locations.

For Woodland the studies have been performed to compare the impact on the transmission system of the interconnector being connected at the 400 kV or 220 kV station. The information from this comparison will be used at a later date in conjunction with other information to decide on the connection voltage at Woodland.

At any connection point there would also be an investigation required into the location of the converter station. The converter station could be at the coast with an AC line to the connection point or the converter station could be at the connection point with a DC line between the connection point and the coast. A decision on these matters would depend on a large number of factors; technical, strategic, environmental and cost.

12.5 Fault Levels

The interconnector itself will not significantly increase fault levels. However the associated deep reinforcements that accompany the interconnector will tend to increase fault levels and may cause limits to be exceeded in some locations. This may lead to a consequential need to upgrade equipment in some transmission stations. This will be addressed at the implementation stage.

A particular issue has been identified with the fault levels in Dublin. A solution to the high levels in Dublin has not yet been developed. This could affect the choice of reinforcements.

It should also be noted that conventional HVDC has a requirement for a minimum short circuit level for normal operation. The minimal short circuit level at the proposed point of connection shall be evaluated for a number of possible network configurations to assess the suitability of the location for the connection of a 500MW interconnector.

13 Conclusion

This report has outlined reinforcements that are associated with a 500 MW interconnector placed at five possible locations within the Republic of Ireland network. Different interconnector locations drive the need for different reinforcements.

EirGrid has a number of approved system reinforcements that are scheduled to be implemented on the transmission system in the next few years. Additionally other as yet unplanned reinforcements which do not relate to an east west interconnector are required. These are required to remedy problems caused by the forecast increase in system demand, the connection of new CCGTs in the Cork area and the connection of wind generation up to Gate 2. The network performance identified in this report is based on the assumption that the approved projects and the listed, or equivalent, additional reinforcements will be implemented. It is recommended that there is no delay in progressing these projects.

All connection points studied require a significant amount of voltage support in the Dublin area. The use of reconductoring to Redwood is also identified as a requirement. These are new concepts for EirGrid and further investigation should be undertaken on how to deliver these requirements.

The criteria for selecting the connection point are achievability within the timeframe, overall cost to the consumer including reinforcements and environmental impact.

The report identifies that the interconnector connection points of Arklow, Cullenagh and Inchicore would require significant associated reinforcements. The cost of reinforcements for an interconnector at Arklow, Cullenagh or Inchicore is between €132 million and €175 million. This is significantly greater than the other two interconnector connection points studied. Furthermore the deliverability of significant volumes of reconductoring and additional circuits for these three connection points mean Arklow, Cullenagh and Inchicore are not recommended connection points.

Dunstown and Woodland are both connected to the 400kV network and are strong connection points. Comparing the Dunstown and Woodland connection points, the reinforcement requirements have been evaluated for two cases. The first case is with new generation at Louth and the second case is without further generation at Louth. For the first case, Woodland and Dunstown have the same level of reinforcement requirements. For the second case Dunstown is evaluated as requiring €30 million less associated reinforcement than Woodland.

However, there are a number of other factors that must be considered. These include a consideration of the difference in associated reinforcements in the second case, the feasibility and timeliness aspects for the alternate connection points and the overall cost including the interconnector.

The difference in the associated reinforcements for the second case is the need associated with a Woodland connection to reinforce the Dublin cable network. The Dublin cable network will be quite highly stressed by 2014 with high circuit loadings and high fault levels. It is likely that this Dublin reinforcement will be required in any case. This is borne out by the case inclusive of the generation at Louth which shows the need for the Dublin reinforcement for the Dunstown interconnector also.

Feasibility and timeliness. Both locations are quite far inland and the achievability (planning permission) and cost considerations in securing a DC circuit from the landing point to the respective stations are considerations in the final selection. A route has been identified from Woodland station to the coast that is 45km in length and which is deemed to be feasible. Dunstown is even further inland and is 65km from the coast. In addition the route from Dunstown to the coast would transverse the environmentally sensitive Wicklow Mountains . Thus the combination of the sensitive location that a Dunstown connection would traverse and the additional distance compared to a Woodland connection has significant achievability and timeliness implications.

Overall Cost. On the Irish side, the cost of the Dunstown connection is impacted by the incremental cost of installing the additional 20km of DC circuit from the station to the coast which is estimated as €30 million. On the British side, there are a limited number of connection points in North Wales to which the east west interconnector is likely to connect. Woodland is the best location on the Irish network for all viable connection points on the Welsh side and is significantly less expensive for some. For example, if Deeside becomes the connection point on the Welsh side, the extra length of submarine cable needed from Dunstown would make the project €40 million more expensive compared to Woodland.

In summary, Woodland is the superior connection point. Woodland is significantly better in some aspects and as good in others when compared with the alternatives. Woodland is the preferred and recommended connection point for an east west interconnector.

Appendix A – Assumed Reinforcements

The studies assumed a number of reinforcements were completed prior to the interconnection. These reinforcements are split into two groups.

The first group contains projects that already have approval to proceed. These projects are listed in Section A.1.

The second group are potential reinforcements that are not approved, which had to be assumed for the purposes of these studies. These are listed in Section A.2.

Note that circuits are described by stating their winter and summer rating, for example a circuit described as being 518/431 has a winter rating of 518 MVA and a summer rating of 431 MVA.

A.1 Approved Projects

EirGrid has a material number of planned system reinforcements that are scheduled to be implemented on the transmission system in the next few years. It is assumed that all these transmission reinforcements will be implemented.

If some of these projects are not successfully implemented, for whatever reason, it may have a material impact on the results of this study.

The network developments that have capital approval and which form the basis of the findings of this report are as follows:-

400 kV

- Add Co. Cavan 400/220 kV station
- Add Co. Cavan – Co. Tyrone 400 kV circuit
- Add Co. Cavan – Woodland 400 kV circuit
- Add Tarbert 400/220 kV station
- Add Moneypoint Tarbert 400 kV cable
- Add West Midland 400 kV/220 kV station

220 kV

- Add Aghada Raffeen 220 kV circuit
- Add Castlebar Tonroe 220 kV circuit operated at 110 kV
- Add Poolbeg Reactor
- Flagford Srananagh 220 kV project
- Lodgewood 220 kV project
- Ballycadden 110 kV project
- Reconductor Killonan West Midland 220 kV line

110 kV

- Add Arva Shankill 110 kV circuit 2
- Add Athea 110 kV station and Athea Trien 110 kV station
- Add Athlone Shannonbridge 110 kV circuit 2
- Add Athy 110 kV station between Carlow and Portlaoise
- Add Ballyadam 110 kV station between Midleton and Whitegate

- Add Ballycummin 110 kV station between Limerick and Rathkeale
- Add Baltrasna 110 kV station between Corduff and Drybridge
- Add Banoge 110 kV station between Arklow and Crane
- Add Baroda 110 kV station between Newbridge and Monread
- Add Bunbeg 110 kV station and Bunbeg Tievebrack circuit
- Add Camus 110 station and Camus Galway 110 circuit
- Add Charlesland 110 kV station between Ballybeg and Carrickmines
- Add Clahane 110 kV station between Trien and Tralee
- Add Clashavoon Dunmanway 110 kV circuit
- Add Coomacheo 110 kV station and Clonkeen Coomacheo circuit
- Add Cushaling Thornsberry 110 kV circuit
- Add Gorman Meath Hill 110 kV circuit
- Add Gorman Navan 110 kV circuit 3
- Add Harnett's Cross 110 kV station and Hartnett's Cross Macroom 110 kV circuit
- Add Kilmurry 110 kV station between Great Island and Kilkenny
- Add Lanesboro Richmond 110 kV circuit 2
- Add Nenagh 110 station and Killonan Nenagh 110 kV circuit
- Add Stevenstown 110 station between Finglas and Glasmore
- Add Tarbert Tralee 110 kV circuit 2
- Add Tievebrack 110 kV station between Binbane and Letterkenny
- Loop Cashla into Galway Dalton 110 kV circuit
- Loop Kilteel into Maynooth Monread 110 kV circuit
- Loop Newbridge into Cushaling Blake T 110 kV circuit
- Reconductor Ardnacrusha Killonan 110 kV from 126/107 to 223/187
- Reconductor Ardnacrusha Limerick 110 kV from 126/107 to 223/187
- Reconductor Clashavoon Clonkeen 110 kV to 223/187
- Reconductor Clonkeen Knockearagh 110 kV to 223/187
- Reconductor Kilbarry Marina 110 kV circuits 1 and 2
- Uprate Maynooth Kilteel 110 kV circuit
- Uprate Corduff Mullingar 110 kV circuit
- Reconductor Corduff Platin 110 kV circuit

Transformers

- Additional Cashla 220/110 kV 175MVA transformer
- Additional Finglas 220/110 kV 250 MVA transformer

Voltage Support

- Add ±10Mvar statcom at Glanlee 110 kV station
- Add 13Mvar capacitor at Derrybrien 110 kV station
- Add 15Mvar capacitor at Thurles 110 kV station, bringing total to 30Mvar
- Add 30Mvar capacitor at Kilkenny 110 kV station
- Add 30Mvar capacitor at Kilteel 110 kV station
- Add 30Mvar capacitor at Lisdrum 110 kV station
- Add 30Mvar capacitor at Navan 110 kV station
- Add 30Mvar capacitor at Louth 110 kV station
- Add 45Mvar capacitor at Shankill 110 kV station

Note that the capacitors at Navan, Louth and Shankill are presently considered to be required until the Woodland - Co. Cavan - Co. Tyrone interconnector is commissioned in December 2012. These studies assume the capacitors are connected after 2012.

A.2 Reinforcements Assumed Prior to East West Interconnection

<u>EXPLANATORY NOTE FOR PUBLISHED DOCUMENT</u>
The assumptions made in this report (for example, load growth to 2013/4, Cork CCGTs and Gate 2 wind) mean that some reinforcement of the transmission system will be required independent of the interconnector. A set of reinforcements were identified and included in the studies to ensure an adequate transmission network as a basis for the interconnector evaluation. The assumptions made are not listed here because they may not represent the projects that will actually be implemented. However they are deemed to be adequate for the purposes of the analysis.

Appendix B – Connected Generation

B.1 Conventional Generation

Table B.1.1 shows the conventional generation assumed available for dispatch for the east west interconnector studies, the location and capacity of each unit. The generation is listed in the groups used during the studies for power transfer, as outlined in section 2.3 of this report.

CORK AREA			
bus	unit name	unit	MW
10471	Aghada 1	1	270
10472	Aghada 11	11	90
10473	Aghada 12	12	90
10474	Aghada 14	14	90
10475	Aghada Peaking	1	51
39672	Marina	2	30
39675	Marina	GT	90
30671	Lee Inniscarra 1	1	15
30671	Lee Inniscarra 2	2	4
16873	Lee Carrigadrohid	3	8
9891	Aghada new CCGT	1	438
	Whitegate new CCGT	1	452
	Total Generation in Cork area		**1628**
WEST			
bus	unit name	unit	MW
10271	Ardnacrusha 1	1	22
10272	Ardnacrusha 2	2	22
10273	Ardnacrusha 3	3	22
10274	Ardnacrusha 4	4	23
39471	Moneypoint 1	1	301.5
39472	Moneypoint 2	2	301.5
39473	Moneypoint 3	3	301.5
50573	Seal Rock	3	77.3
50574	Seal Rock	4	77.3
51471	Tarbert 1	1	57
51472	Tarbert 2	2	57
51473	Tarbert 3	3	256
51474	Tarbert 4	4	256
51771	Tynagh CT	CT	256
51772	Tynagh ST	ST	132
	Total Generation in West		**2162.1**
DUBLIN AREA			
bus	unit name	unit	MW
29671	Huntstown ST	ST	120
29672	Huntstown CT	CT	230
29673	Huntstown 2	2	400
31271	Dublin Bay Power Irishtown	1	409.9
42404	North Wall CC	1	15
42404	North Wall CC	2	15
42404	North Wall CC	3	15
42474	North Wall CC	4	118
42475	North Wall	5	109

DUBLIN AREA			
bus	unit name	unit	MW
44671	Poolbeg 1	1	115
44672	Poolbeg 2	2	115
44673	Poolbeg 3	3	255
50274	Poolbeg 14	14	150
50275	Poolbeg 15	15	150
50276	Poolbeg 16	16	170
	Total Generation in Dublin Area		**2386.9**
No defined area			
bus	unit name	unit	MW
17073	Erne Cathaleen's Fall 3	3	22.5
17074	Erne Cathaleen's Fall 4	4	22.5
17671	Erne Cliff 1	1	10
17672	Erne Cliff 2	2	10
19471	Edenderry Power Cushaling	1	130
22671	Derryiron 1	1	51
22672	Derryiron 2	2	51
27204	Leixlip	5	4
27471	Great Island 1	1	57
27472	Great Island 2	2	57
27473	Great Island 3	3	116
35074	Lanesboro - Lough Ree Power	4	100
44471	Liffey 1	1	15
44471	Liffey 2	2	15
44471	Liffey 4	4	4
49474	Shannonbridge - West Offaly Power	4	150
52071	Turlough Hill 1	1	73
52072	Turlough Hill 2	2	73
52073	Turlough Hill 3	3	73
52074	Turlough Hill 4	4	73
52476	Tawnaghmore Peaking	1	51
	Total other RoI Generation		**1103**

Table B.1.1: Conventional generation assumed available for dispatch for the east west interconnector studies

When studies were undertaken to investigate the impact of possible future generation at Louth a 445MW unit was placed at Louth, bus 3522.

B.2 Wind Generation

Table B.2.1 shows the location and MW output of the connected and committed wind farms assumed for the east west interconnector studies. The total output of the generation in Table B.2.1 is 1230MW.

PSSE Bus	110 kV Node	Wind Farm Name	MEC (MW)
1071	Agannygal	Derrybrien (1)	59.5
1021	Ardnacrusha	Curraghgraigue (1)	2.55
1021	Ardnacrusha	Knockastanna (1)	7.5
1021	Ardnacrusha	Mienvee (1)	0.66
1061	Arigna	Corrie Mountain (1)	4.8
1061	Arigna	Kilronan (1)	5
1061	Arigna	Spion Kop (1)	1.2
1121	Arklow	Arklow Banks (1)	25.2
1131	Athea	Athea (1)	51
1331	Ballycadden	Ballycadden (1)	14.45
1331	Ballycadden	Knocknalour (1)	5
1281	Ballylickey	Kealkil (Curraglass) (1)	8.5
1281	Ballylickey	Glanta Commons (1)	19.55
1441	Bandon	Kilvinane (1)	4.5
1401	Bellacorick	Bellacorick (1)	6.45
1341	Binbane	Corkermore (1)	15
1341	Binbane	Killin Hill (1)	6
1341	Binbane	Killybegs (1)	2.55
1341	Binbane	Loughderryduff (1)	7.65
1341	Binbane	Meenachullalan (1)	11.9
1341	Binbane	Burtonport Harbour (1)	0.66
1251	Booltiagh	Booltiagh (1)	19.45
1481	Butlerstown	Beallough (1)	1.7
1901	Carlow	Cronelea (1)	4.999
1901	Carlow	Cronelea Upper (1)	2.55
1661	Castlebar	Cuillalea (1)	3.4
1661	Castlebar	Burren [Mayo] (1)	2.1
1661	Castlebar	Raheen Barr (1)	18.7
1701	Cathleen Falls	Anarget (1)	1.98
1701	Cathleen Falls	Anarget (2)	1.1
1701	Cathleen Falls	Meenadreen (1)	3.4
1771	Coomacheo	Coomacheo (1)	41.225
1971	Coomagearlaghy	Coomagearlahy (1)	42.5
1631	Corderry	Black Banks (1)	3.4
1631	Corderry	Geevagh (1)	4.95
1631	Corderry	Altagowlan (1)	7.6
1631	Corderry	Black Banks (2)	6.8
1631	Corderry	Caranne Hill (1)	3.4
1631	Corderry	Moneenatieve (1)	3.96
1841	Crane	Ballywater (1)	31.5
1841	Crane	Greenoge (1)	4.99
1931	Cunghill	Kingsmountain (1)	23.75
2241	Dallow	Carrig (1)	2.55
2241	Dallow	Skehanagh (1)	4.25
2321	Drumkeen	Meentycat (2)	14

PSSE Bus	110 kV Node	Wind Farm Name	MEC (MW)
2321	Drumkeen	Meentycat (1)	70.96
2181	Drybridge	Dunmore (1)	1.7
2101	Dundalk	Dundalk IT (1)	0.5
2101	Dundalk	Mullananalt (1)	7.5
2221	Dunmanway	Lahanaght Hill (1)	4.25
2221	Dunmanway	Curabwee (1)	4.62
2221	Dunmanway	Coomatallin (1)	5.95
2221	Dunmanway	Milane Hill (1)	5.94
2781	Galway	Inis Mean (1)	0.675
2781	Galway	Inverin (Knock South) (1)	3.3
2731	Glanlee	Glanlee (1)	29.8
2881	Glenlara	Dromdeveen (1)	10.5
2881	Glenlara	Taurbeg (1)	25.3
2801	Golagh	Golagh (1)	15
3101	Ikerrin	Ballinlough (1)	2.55
3101	Ikerrin	Ballinveny (1)	2.55
3301	Knockeragh	Gneeves (1)	9.35
3581	Letterkenny	Lurganboy (1)	5.1
3581	Letterkenny	Cronalaght (1)	4.98
3581	Letterkenny	Culliagh (1)	11.88
3581	Letterkenny	Cark (1)	15
3581	Letterkenny	Meenanilta (1)	2.55
3581	Letterkenny	Meenanilta (2)	2.45
3881	Macroom	Carriganimma (1)	15
4021	Mallow	Carrigcannon (1)	20
3821	Meath Hill	Gartnaneane I & II	15
3941	Moneypoint	Moneypoint (1)	21.9
4041	Moy	Lackan (1)	6
1651	Pallas	Pallas (1)	37.8
4681	Rathkeale	Glenshesk (1)	5
4681	Rathkeale	Killacullen (1)	2.5
4681	Rathkeale	Rathcahill (1)	5
4781	Ratrussan	Mountain Lodge (1)	24.8
4781	Ratrussan	Ratrussan (1)	70
4961	Shankill	Corneen (1)	3
4961	Shankill	Mountain Lodge (2)	3
5001	Somerset	Sonnagh Old (1)	7.65
4991	Sorne Hill	Glackmore Hill (1)	0.6
4991	Sorne Hill	Sorne Hill (1)	31.5
5341	Tonroe	Largan Hill (1)	5.94
5281	Tralee	Mount Eagle (2)	1.7
5281	Tralee	Beenageeha (1)	3.96
5281	Tralee	Lee Strand Co-Operative (1)	15
5281	Tralee	Mount Eagle (1)	5.1
5281	Tralee	Muingnaminnane (1)	15.3
5281	Tralee	Tursillagh (1)	15.18
5281	Tralee	Tursillagh (2)	6.8
5261	Trien	Beale (2)	2.55
5261	Trien	Knockawarriga (1)	22.5
5261	Trien	Tournafulla (2)	17.1

PSSE Bus	110 kV Node	Wind Farm Name	MEC (MW)
5261	Trien	Beale (1)	1.65
5261	Trien	Tournafulla (1)	7.6
5361	Trillick	Drumlough Hill (2)	10.2
5361	Trillick	Crockahenny (1)	5
5361	Trillick	Drumlough Hill (1)	4.8
5361	Trillick	Beam Hill (1)	14
5221	Tullabrack	Moanmore (1)	12.6
5501	Wexford	Carnsore (1)	11.9
5501	Wexford	Richfield (1)	20.25
5501	Wexford	Richfield (2)	6.75

Table B.2.1: Location of connected and committed wind farms and their output as used in east west interconnector studies.

Table B.2.2 shows the Gate 2 wind farms assumed for the east west interconnector studies. A number of small non wind generators are being processed as part of the Gate 2 wind generation group. These are included in the wind dispatch studies. The total output of the generation in Table B.2.2 is 1322MW.

Windfarm Name	Unit	MW
Curraghgraigue (2)	1	2.55
Moanvaun (1)	2	3
Keelderry (1)	1	29.75
Leabeg (1)	1	4.25
Bantry Bay Seafoods (1)	1	2
Derryvacoreen (1)	2	17
Glanta Commons (2)	3	8.4
Kilcar (1)	1	2.55
Silver Hill	2	3.2
Boggeragh (1)	1	57
Caranne Hill (2)	1	1.6
Garvagh (1)	2	31.525
Moneenatieve (2)	3	0.29
Seltanaveeny (1)	4	5.4
Tullynahaw (1)	5	26.7
Tullynamoyle (1)	6	9
Cuillalea (2)	1	1.7
Lenanavea (1)	2	3.4
Lenanavea (2)	3	2.55
Lenanavea (3)	4	3.4
Raheen Barr (2)	5	8.5
Croaghnameal (1)	1	4.25
Meenadreen (2)	2	82
Meenadreen South (1)	3	3.6
Ballywater (2)	1	10.5
Castledockrill (3)	2	3.3
Castledockrill (4)	3	16.1
Greenoge (1)	4	2.6
Ballyduff (1)	5	4
Ballynancoran (1)	6	4
Castledockrill (1)	7	20
Castledockrill (2)	8	2

Windfarm Name	Unit	MW
Gibbeet Hill (1)	9	14.8
Kennystown (1)	10	3.6
Roosky (1)	1	3.6
Cronelea Upper (2)	1	1.7
Cronelea (2)	2	4.5
Gortahile (1)	3	21
Kingsmountain (2)	1	11.05
Kingsmountain (3)	2	4.25
Coomagearlahy (2)	1	20.5
Coomagearlahy (3)	2	18
Dunmore (2)	1	3
Coomatallin (2)	1	3.05
Reenascreena (1)	2	4.5
Mace Upper (1)	1	2.55
Booltiagh (2)	1	3
Booltiagh (3)	2	9
Loughaun North (2)	3	24
Cloonlusk (1)	1	4.25
Coolegrean (1)	1	18.5
Foiladaun (1)	2	13.8
Glentanemacelligot (1)	3	18
Dromdeveen (2)	4	16.5
Knockacummer (1)	5	87
Blakefield (1)	1	0.85
Templederry (1)	2	3.9
Ballymartin (1)	1	6
WEDcross (1)	1	4
WEDcross (2)	2	0.5
Barna (1)	3	5.95
Carrigans (1)	4	1.7
Foilgreana (1)	5	6
Killavoy (1)	6	18
Scartaglen (1)	7	14
Cordal (1)	8	35.85
Skrine (1)	1	4.999
Meenanilta (3)	1	3.4
Lisheen (1)	1	55
Crocane (1)	1	1.7
Knocknagappagh (1)	2	1.7
Bailie Food CHP	1	5
Burren [Cork] (1)	1	9
Caherdowney (1)	2	10
Cummeennabuddoge (1)	3	5
Curragh (1)	4	18
Crowinstown (1)	1	4.999
Esk (1)	1	6
Pluckanes (1)	2	0.85
Reisk (1)	1	3.9
Knockaneden (1)	1	9
Carrons (1)	1	2.55
Carrons (2)	2	2.55
Grouse Lodge (1)	3	15

Windfarm Name	Unit	MW
Slievereagh (1)	4	3
Edenmore (1)	1	2.55
Mountain Lodge (3)	1	5.82
Bunnyconnellan (1)	1	28
Carrowleagh (1)	2	27.25
Ounagh Hill (1)	3	6.9
Flughland (1)	1	9.2
Glackmore Hill (2)	2	1.4
Glackmore Hill (3)	3	0.3
Meenkeeragh (1)	4	4.2
Sorne Hill (2)	5	6.5
Sorne Hill Single Turbine (3)	6	2.3
Three Trees (1)	7	4.25
Brandon Hydro-Power Scheme (1)	1	0.85
Cahercullenagh Upper	2	4.25
Cloghanaleskirt (1)	3	10
Dromadda Beg (1)	4	2.55
Kerry LFG (1)	5	1
Knockagoum (1)	6	14
Maghanknockane (1)	7	12
Mount Eagle (3)	8	1.7
Muingnate (1)	9	10.2
Muingnate (2)	10	0.85
Falleennafinnoga (1)	1	4
Glenough (1)	2	33
Holyford (1)	3	9
Tooreen (1)	4	4
Cappagh White (1)	1	16.1
Garracummer (1)	2	22
Rahora (1)	1	4.25
Athea (2)	1	17
Beale Hill (3)	2	1.7
Caherlevoy (1)	3	3.6
Dromada (1)	4	46
Glenduff (1)	5	6
Knocknacaheragh (1)	6	4
Tooradoo (1)	7	5
Cloghboola (1)	8	46

Table B.2.2: Gate 2 wind farms as used in east west interconnector studies.