Policy Advisory

Energy Policy and Economic Opportunity
The Potential for Large Scale Electricity Exports

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THE IRISH ACADEMY OF ENGINEERING

The Irish Academy of Engineering

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The members of the Standing Committee and Sub-Group participated in extensive discussions in the course of a series of meetings and submitted comments on a series of drafts of the report. Its content conveys the general tone and direction of the discussion, but its recommendations do not necessarily reflect a common position reached by all members of the Standing Committee and Sub-Group, nor do they necessarily represent the views of the organisations to which the members belong.

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1. FOREWORD

This policy advisory examines issues around the opportunity to export electricity to GB. This opportunity has arisen because of the difficulty the UK has in meeting its EU renewable energy targets; the commissioning of the East West Interconnector in 2012 between Ireland and GB; the opportunity to offload onshore wind in the Irish system which would otherwise have been curtailed off; and a surplus of conventional generation in Ireland. The question is whether there is a potential economic case for exporting electricity which will not impose burdens on the Irish electricity consumer or taxpayer.

Exporting power to the UK or attracting energy intensive industries to Ireland is a desirable goal and will require competitive energy prices. This is a particular challenge given the current excessive generation capacity on the system and the plans for adding further large quantities of wind power generation plus the associated transmission infrastructure at a time of static demand.

This paper is intended to highlight the main issues that should be examined and assessed in the forthcoming report which has been commissioned by the government.

2. INTRODUCTION

In the past twelve months a serious discussion has developed in Ireland on the merits of exporting large quantities of electricity, particularly renewable electricity to Great Britain (GB). The proposal has been discussed at Ministerial level and the Academy understands that a report has been commissioned on the prospects for such exports.

The expected commissioning of the East West Interconnector (EWIC) in 2012 is perceived to support the proposal although the scale of exports under discussion would probably require a very large increase in the capacity of currently planned interconnection to Great Britain. It is important in the Academy's view to carefully consider all aspects of this proposal. These are not only technical and economic issues but very much social and environmental as well. The Academy is pleased to note the Government's intention to commission an independent report into the proposal in order to inform national policymaking. This is very much in line with the Academy's often repeated advice of basing policy on independent evidence-based research, particularly in these difficult economic times.

This policy advisory sets out some of the principles and criteria that might be applied in policy formation in this area and seeks to identify the risks and constraints which may be relevant. This advisory focusses on the medium term possibility (approximately up to 2020) of large scale exports to the UK. It does not address the longer term issue of developing infrastructure for energy exports to Europe in the period 2020 to 2035. It is possible that with substantial EU and private investment coupled with on-going decarbonisation policies such exports may become attractive in the long term. Such proposals will merit a separate analysis at the appropriate time.

In its report of February[1] 2011 the Academy stressed the overriding importance of competitiveness in the Irish Economy as the country struggles to escape the financial constraints under which it currently labours. There have been substantial improvements in competitiveness generally in the economy over the past eighteen months and these are contributing significantly to enhancing the critically important flow of foreign direct investment (FDI) into the country. Energy prices, and particularly electricity prices, play an important role in maintaining this competitiveness.

The Academy believes that competitiveness considerations must be at the heart of energy policy for the foreseeable future and this view is reflected in the advice suggested in this report.

[1] Energy Policy and Economic Recovery 2010-2015 - http://www.iae.ie/site_media/pressroom/documents/2011/Apr/06/IAE_Energy_Report_Web2_05.04.2011.pdf

3.0 PRINCIPLES AND CRITERIA

Significantly increased exports to GB will involve large increases in power generation in Ireland coupled with equally large increases in transmission capacity in order to transport the power to the GB market. This may be met either by:

- **increased utilisation of existing capacity (both generation and transmission)**
  or
- **Investment in new capacity**

Better utilisation of existing capacity is likely to reduce costs generally. In the case of generation this may mainly accrue initially to existing generators but a properly functioning electricity market should result in at least some of the savings benefitting Irish consumers.

In the case of transmission there is likely to be scope for an increased return on already sunk costs. It will be for the regulator to ensure that these savings are shared appropriately with the Irish consumer.

The economic analysis becomes much more complex when new investment has to be considered. It is essential that neither costs nor risks associated with this investment for exports fall on the Irish consumer. Indeed it is essential that in addition to the non-imposition of costs, Irish consumers see some return from such exports if only to compensate for the environmental impact.

Some form of "community gain" will therefore be essential. Depending on the scale of the proposal and its impact on the national environment this "gain" may need to be expanded beyond the "community" and might take the form of a royalty payable to government.

There may be many arguments put forward by promoters of export schemes outside of the strict adherence to the foregoing. These should be resisted. There is an infamous example from recent Irish economic history where a large quantity of the country's resources in the form of natural gas from the Kinsale Head gas field was provided below the market price to NET[2] for processing into fertiliser. This was subsequently sold on the world market losing Irish taxpayers tens of millions of pounds in the process. Such ill-considered economic policy making must be resolutely resisted.

ADVISORY PRINCIPLE 1:
Increased exports of electricity to Great Britain must not, under any circumstances, result in increased costs for the Irish electricity consumer or taxpayer. Indeed there must be a demonstrable and proportional benefit for Irish citizens arising from the proposal.

At a time when capital for investment in Ireland is so scarce, it is critically important to minimise such investment in public infrastructure such as transmission. Given that the Irish Government implicitly stands behind such investment by state owned companies such as ESB and EirGrid it must be realised that such investment competes directly with Government investments in, for example, Irish health and education.

While it is helpful (and probably essential) to involve the private sector in such investments, the terms of such financial arrangements are extremely important. Public Private Partnership (PPP) arrangements may still leave much of the risk of the investment with Government in which case international lenders will view the project as reducing the government's already limited ability to borrow.

There has been a view in the past that once "off-balance-sheet" arrangements could be struck which met the criteria required under international accounting practice rules then lenders would ignore such schemes in assessing Government creditworthiness. It is likely that this was always just wishful thinking but in today's financial world there is no escaping the perceived limits to the sovereign borrowing

[2] Nítrigin Éireann Teoranta

capability of the Irish Government. Investment in infrastructure for electricity exports must not impact negatively on the borrowing capacity of the Irish sovereign state.

ADVISORY PRINCIPLE 2:
It is critically important for the country's recovery that capital expenditure on such areas as transmission required for increased exports be minimised.
The involvement of private capital will almost certainly be required but the terms of the provision of such finance must not place any risk or burden on Irish taxpayers or electricity consumers

One of the criteria to be considered in assessing the gain from such export proposals is the likely provision of employment from the ensuing economic activity. While accepting the principle, the Academy is of the opinion that this benefit is likely to be small in the medium term. It is imperative therefore that this aspect be thoroughly analysed and a dispassionate view developed as to whether employment benefits are likely to be both significant and realised.

The construction of very large amounts of wind generation in Ireland may prompt the location of facilities for the manufacture of such equipment in Ireland. Such "offset" programmes can be attractive in certain circumstances. It is important however to take a very dispassionate look at such suggestions. Even with the promise of large scale investment for export the Irish market remains small in the context of locating manufacturing facilities in the country.

Recent experience has favoured the relocation of such facilities to developing economies such as China. The resulting closure of plants in Europe coupled with the loss of employment has proved quite traumatic. The bankruptcies in the solar energy sector in both Europe and the United states are a salutary reminder of just how quickly the energy industry changes and how poor policymakers are when it comes to "picking winners"

The Academy is aware that facilitation of new emerging technologies, possibly in the marine sector, may lead to significant employment increases. The arguments in support of such investment must be based on industrial development policy rather than energy policy. In strictly energy policy terms Ireland does not need this capacity in the short to medium term. Investment targeted at such proposals may merit consideration from the long term employment creation point of view.

ADVISORY PRINCIPLE 3:
In the case of proven technologies such as conventional generation and transmission as well as onshore wind, the Academy is not optimistic in relation to likely long term employment benefits and suggests that these undergo a rigorous and dispassionate assessment.

All of the foregoing points to a need for a compelling investment case supported by rigorous techno-economic analysis.

The Academy is pleased to note that a good start has been made with the commissioning of an independent expert report by Government.

4.0 SUPPLY AND DEMAND

In order to rapidly increase exports to GB it is important to consider the supply-demand balance in both countries and to observe, at least at a superficial level, whether the economic basis for such increased trade exists. At the superficial level it is fair to say that some potential appears to exist. The following high level analysis examines both the Irish and UK electricity markets.

4.1 Ireland

The contraction in Ireland's economy since 2007 has been such that GDP in 2011, at constant prices, was no higher than in 2005. Not surprisingly electricity demand in 2011 was almost identical to that in 2005. With the exception of the experience during World War 2, this contraction of demand over a six-year period has been unprecedented.

The extent of the collapse in growth expectations is shown in fig 1

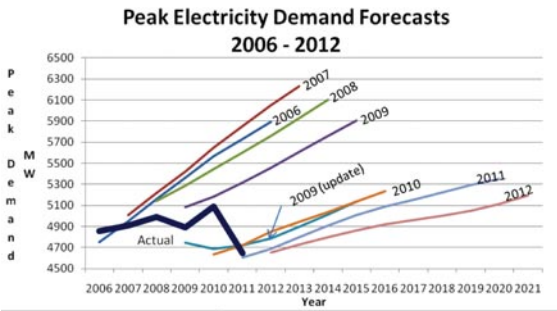


Fig 1 Peak Electricity Demand Forecasts[3] from EirGrid Generation Adequacy reports

Only when one carefully examines this chart can one see the gradual (much too gradual) realisation of the calamity that hit the Irish Economy in 2007. It can fairly be said that it has taken far too long for policymakers and planners to get to grips with the type and depth of the economic contraction which Ireland is enduring. Early predictions of recovery by the ESRI were far too optimistic but there were plenty of well-regarded authorities, including the Academy, who disagreed at the time with these early overly-optimistic economic projections showing a rapid recovery in the Irish economy. Getting peak power demand forecasts right is important because investment decisions are directly dependent on them. It is extremely important to avoid basing large investment decisions on estimates with a very high level of underlying error. It is often better in such circumstances to take short term low cost actions that buy time until more certainty emerges and more robust decisions can be made. A willingness to "bet the farm" on a particular projection is rarely viewed with hindsight as a sensible strategy.

The projected peak demand of 5181 MW for the year 2010 (based on the 2009 forecast) is now not likely to be realised until 2020 with resulting consequences for capital investment. The timing of investment decisions by state-owned monopolies is critically important to Irish competitiveness. If the decision is too late the economy will suffer from the lack of needed infrastructure. If it is too early then the cost of underutilised assets will be carried by the consumer for possibly several years.

This begs the obvious question: how reliable can the current forecasts be considered? The Academy is more reassured about the current estimates, based as they are on more realistic economic growth projections, however it is very important that the underlying error range is recognised and that investment decisions are only adopted if they are "robust" against changing demand growth.

As a result of reduced demand and:

- **the very considerable expenditure on generation assets, both conventional and renewable, in the past decade**
- **the expenditure being incurred on the development of the East West interconnector (EWIC)**

Ireland's electricity supply capability is now very substantially greater than the demand. In EirGrid's GCS 2012/2021[4], using the median growth scenario, the analysis concludes that, on an All Island basis, total generation availability will exceed demand by over 2000 MW in 2013 falling to 1700 MW by 2020.

[3] Transmission Peak, Medium Demand Forecast, Republic of Ireland only. Based on published Generation Adequacy Reports 2006 - 2012
[4] Generation Capacity Statement (EirGrid). Previously "Generation Adequacy report"

This conclusion is based on the planning assumption that approximately 700 MW of new thermal generation will be added to the system by 2015. Given the existing Irish overcapacity and the financial difficulties being faced by electricity utilities across Europe, it appears likely that not all of this additional capacity will be developed and possibly that none of it will materialise. But even if the latter assumption is correct there will still be a capacity surplus of almost 1000 MW throughout the period to 2020.

GCS4 2012-2021[5] also assumes that the East-West Interconnector (EWIC) from Ireland to the UK and the Moyle interconnector (North of Ireland -Scotland) will contribute 890 MW of imports from Britain at peak demand periods in Ireland. This assumption is also built into National Grids' Seven Year Statement[6] (for Great Britain). Thus even if the East/ West and Moyle interconnector's were to make no contribution to meeting demand at peak periods the existing generation capacity would be sufficient to meet projected demand through to 2021.

4.2 UK

Given the circumstances outlined in 4.1 above, could generation in Ireland make a contribution to meeting demand in GB? Could Ireland sensibly dispose of its generation surplus in its neighbour's electricity market?

This is particularly relevant given:

- **The planned closure of 11,950 MW of existing coal and oil fired plant in GB, which will not meet the requirements of the EU's Large Combustion Plant Directive in 2017**
- **The recent decision by E.ON and RWE to withdraw from their plans to develop new nuclear plants at Wylfa and Oldbury**
- **The somewhat slower than anticipated construction of gas-fired CCGT plant currently in GB.**

National Grid (UK), in its 2011 National Electricity Transmission Statement (NETS) Seven Year Statement indicates that, in the base case:

- **Overall grid connected Average Cold Spell Peak Demand is not projected to change from 2010/11 level of 58 GW in the period through 2017/18. This reflects the economic slowdown in the UK**
- **Existing thermal and hydro generation capacity is projected to fall from 79 GW in 2010/11 to 66 GW in 2017/18, due to the planned retirement of non-compliant coal and oil fired generating capacity and of the remaining Magnox nuclear units**
- **That there was 3150 MW of CCGT plant under construction in May 2011.**

Thus National Grid indicated that existing plant continuing in operation plus plant under construction is likely to total at least 69 GW in 2017/18. On this somewhat crude basis there does not appear to be an immediate opportunity to place Ireland's surplus of conventional dispatchable generation in the UK market.

ADVISORY PRINCIPLE 4:

It is unlikely that a significant market exists in the UK in the medium term for conventional Irish thermal generation. Further interconnection should not be constructed to service such a possible need unless it is demonstrably justified by detailed economic analysis.
It is essential that reliable demand forecasts are available for infrastructure planning. At a time of considerable economic volatility, it may well be prudent to make small investments to "buy time" until more confidence can be placed in projections of economic and demand growth.

[5] http://www.eirgrid.com/media/All-Island%20GCS%202012-2021.pdf
[6] National Grid UK http://www.nationalgrid.com/NR/rdonlyres/A693C979-18C8-4A56-A6F2-F1FA601B6031/46996/NETSSYS2011.pdf

5.0 POTENTIAL FOR TRADE

Based on the foregoing section 4.2 it would appear that the potential to export electricity from thermal plants in Ireland to GB would be dependent on major and sustained plant failure in GB.

It is true that an integrated electricity market is expected to be in place by mid-decade permitting easy exchange of electricity with the UK under a common set of trading rules still to be developed. With the freedom to trade, the opportunity for Irish generators would depend on whether the marginal cost of Irish electricity delivered to the UK could compete with the marginal cost of production in the UK.

However:

- **Most Irish thermal generation is fuelled by natural gas from Scotland and therefore Irish generators incur extra transportation costs.**
- **Irish electricity exports would incur the extra transportation costs associated with new interconnectors.**
- **Irish gas fired power plants are typically smaller in scale and therefore more expensive to construct and operate than their counterparts in the UK.**

On a more positive note however:

- **NETS 'Users' based forecasts envisage demand increasing from 58.1 GW in 2010/11 to 63.6 the GW in 2017/18**
- **Over 25 GW of the existing coal and nuclear AGR plant on the system will be over 40 years old by 2017/18 and some will be over 50 years in commission. National Grid in its report made no assumptions as to plant forced outage rates in these circumstances**
- **The availability of Corrib gas in Ireland would eliminate the unfavourable transport cost differential currently suffered by Irish generators importing gas from Scotland for a limited period**

The requirement for further generation in the UK will also be relieved by the construction of new large interconnectors from England to Scotland, the Western HVDC Link has already been approved and the Eastern Link awaits approval. On balance therefore the Academy is of the view that it is unlikely that Irish thermal generators will find large export possibilities to the UK over the next decade. Certainly no basis exists for the construction of further large scale interconnection to facilitate such exports. This view would change in the event of significant development of new Irish gas reserves, either offshore or on shore. Proposals exist for both such developments and these should be evaluated based on the merits of the respective economic and technical arguments. The facilitation of such an electricity export trade to the UK will be critically dependent on a common set of trading rules which are being developed in order to comply with European Single Market Directives. These trading rules are not expected to be in place until 2016.

> ADVISORY PRINCIPLE 5:
> Unless significant quantities of gas reserves are found and developed in Ireland, it is unlikely that gas fired generation, based in Ireland, and using gas imported from Scotland will find a large scale and economically attractive market in England.

While the principles underlying the new market arrangements have been established by the EU it is likely that the needs of the UK market may predominate in the fleshing out of details given its relative size. The Academy nevertheless supports the development of a common set of trading rules and urges that this be done as quickly as possible. The Academy advises that extreme care will be necessary in the drafting of trading rules on Irish interconnectors as, uniquely as far as the Academy is aware, these were funded by one side only, rather than being jointly funded by the connected utilities, as is the norm. Thus the unquestioning adoption of EU rules may not appropriately recognise the investment made by the Irish electricity industry and its customers. A particular problem may arise, for example, in the event of excess wind generation in Scotland when electricity could be wheeled through the Moyle, N/S and E/W interconnectors from Scotland to Wales, without appropriate compensation to Irish investment which funded the interconnectors. This could also limit the ability of Irish generators or utilities to trade over these interconnectors

> ADVISORY PRINCIPLE 6:
> The Academy believes that the full value of existing or planned interconnectors cannot be realised until a common set of trading rules is in place for electricity exports, which in Ireland's case should be 2016 at the latest. The Academy is however concerned that, as a result of the relative size of the UK market, the new rules may disadvantage Irish operators.

6.0 RENEWABLES

The discussion so far has centred on the general concept of exporting large scale electricity to the UK. There is a particular case to be made for renewables where non-market forces intervene and targets set by the EU become important.

It is argued that as Ireland has one of the 'best wind regimes in the world[7] this resource should be developed, not alone to meet Ireland's renewable energy obligations, but to export renewables powered generation to GB (and possibly further afield in the next decade).

This advisory focusses on the medium term possibility (up to 2020) of large scale exports to GB. It does not address the longer term issue of developing infrastructure for energy exports to Europe in the period 2020 to 2035. It is possible that with substantial EU and private investment coupled with on-going decarbonisation policies such exports may become attractive in the long term. The short term EU emission allowance price of less than €7/tonne of CO2 does not, however, augur well for such exports.

Under the EU's 2020 targets the UK is required to increase the proportion of renewable energy in its gross final energy consumption from 2.9% in 2009 to 15% in 2020.

Given the unquestionable difficulties the UK would face in achieving a fivefold increase in renewable energy output in a decade the development of wind exports appears feasible and possibly economically desirable. However to date no serious techno-economic analysis assessing the potential has been published.

The UK provides incentives for renewable generation; Renewable Obligation Certificates (ROCs). Large scale onshore wind projects attract one ROC per MWh, currently worth approximately €50. The Academy understands that UK authorities are considering an extension of the scheme for electricity generated outside of its national jurisdiction, particularly in Ireland.

Assuming that:

- **UK renewables subsidies might be provided for electricity generated in Ireland but delivered in the UK.**
- **An appropriate market would be in existence in the next few years to facilitate this.**

There are a number of important issues to be considered in developing appropriate policy. These include transmission constraints, community gain issues, permitting possibilities and competition from other regions (mainly Scotland).

Finally one should not underestimate the capacity of UK policymakers (or indeed any policymakers) to abandon targets such as the renewables penetration target when difficult economic conditions arise and consumers complain of the cost[8]. Raising UK energy costs at a time of falling incomes is politically very unattractive to the Westminster Government. There is some evidence of this "consumer backlash" beginning in the UK at present.

The UK will miss its 2020 renewable target by a large margin, but will substantially exceed the target of reducing CO_2 emissions by 20% by 2020. There must be a strong possibility that the UK Government will seek a treaty renegotiation which prioritises emission reduction over renewable development (a policy which the Academy generally supports)

[7] "The Saudi Arabia of Renewables!"
[8] http://www.ft.com/intl/cms/s/0/45afd57a-9abf-11e1-9c98-00144feabdc0.html#axzz1urjkUMH6

There must also be a strong possibility that UK support for very expensive offshore wind and/ocean energy projects will be substantially reduced, because of the cost of these projects to electricity customers.

Such "political risk" must be seriously assessed by Irish policymakers when planning long term infrastructure.
The Academy is aware that a number of companies are at present developing proposals for very large scale wind exports from Ireland to GB. The promoters of these projects have an impressive track record developing wind farm businesses in Ireland and overseas.

The scale of the wind farm developments now proposed in the Midlands exceeds anything undertaken in Ireland or GB to date and would require the development of clusters of wind farms with a total up to 500-750 wind turbines, with tower heights and rotor diameters in excess of 100m and an aggregate installed capacity of up to 2000 MW. The stated intention of the promoters is that these wind farms would be directly connected to National Grid's Transmission network in GB via HVDC cable links and would not be connected to EirGrid's transmission network.

In the Academy's view the scale and onshore location of the wind developments proposed for the Midland's means they have the potential to be competitive with offshore wind farms in GB and potentially even with onshore wind generation in Scotland and could thus be attractive to the UK authorities. These proposed developments may benefit from payments for 'Carbon Free Generation' proposed in the Westminster Government's recently announced Electricity Bill.

There is however a number of issues that needs to be addressed in considering proposals of this nature including:

What benefit would be provided to local and regional communities.

Developments of the scale proposed are multi-billion euro projects and in terms of the financial resources required equal or indeed exceed that required for 1000 MW nuclear stations.

The development of long onshore HVDC cable links while technically feasible does introduce a much higher risk of faults, because of the considerable number of cable joints required. This is less of a problem with subsea cables because much longer lengths of cable can be carried in a ship than can be transported by road.

The Academy welcomes the development of cost effective proposals which do not adversely affect Irish electricity prices or competitiveness and also agrees that a concentration of wind farms in a small number of areas is more desirable, on visual amenity and electrical transmission grounds, than having them scattered all over the countryside.

The Academy recommends that formal policies balancing the interests of developers and investors with those of the wider community be developed as a matter of urgency in order to offer more certainty to potential developers

6.1 Transmission for export

Ireland

Large scale exports of electricity from Ireland to the UK cannot be contemplated without a major investment in transmission. This will include both onshore and offshore investment.

See Appendix 1 for a detailed commentary on transmission issues in Ireland and the UK

In the short term only onshore Irish wind generation can credibly provide the sort of large scale generation foreseen in the current discussions between the two Governments. Such generation will require large scale grid investment in Ireland. It is conceivable that such a "parallel grid" for "exports only" could be constructed if the scale of the individual projects was sufficiently large. In such a case private investment would be expected to fund such infrastructure.

It is also possible that underutilised Irish transmission assets could be used once an enhanced return could be generated for the benefit of Irish consumers who funded the transmission in the first place.

Two principles suggest themselves:

- **Use of Irish owned transmission infrastructure for electricity exports must convey a benefit to Irish consumers**
- **Large scale wind production should be concentrated in clusters with easy and economic access to transmission.**

Offshore

There is considerable EU interest in offshore grids at present. A number of proposals exist for a so-called "super-grid" in the North Sea with extensions to the Irish Sea and possibly the Atlantic coastline.

The Academy generally supports these initiatives but recognises the extraordinary high costs which will almost certainly have to be borne by a combination of private investment and EU funding.

It is not realistic in the current economic circumstances to envisage significant funding support for such ventures from the Irish State.

It is the opinion of the Academy that, given the large scale of the necessary investment, such expensive grid infrastructure will be constructed on a gradual or incremental basis rather than a "build-it-and-they-will-come" philosophy.

The Academy has previously raised the relative cost of interconnection as provided by Irish authorities and their EU counterparts. Some approximate comparisons are shown below. Part of the unit cost discrepancy is undoubtedly down to scale issues. The Academy suggests that these cost differentials merit further investigation in order to ensure that Ireland is obtaining the best value for money in its transmission investments.

HVDC LINKS COST COMPARISONS[9]

	East-West (EWIC) Ireland- Wales	Western HVDC Link Scotland- Wales
Circuit Lengths	**km**	**km**
Onshore	75	44
Offshore	185	370
Total	260	414
Estimated Capital Cost	**€m**	**€m**
	550	1350
Capacity	**MW**	**MW**
	500	2200
Unit Cost	**€/kW**	**€/kW**
	1100	615
Technical Characteristics		
Operating Voltage kV plus/minus	200	600
Transmission Losses including convertor station losses	6%	3%

It should be noted that:

- **Although the Western HVDC link from Scotland to Wales is almost 60% longer than the East/West Interconnector (EWIC) from Ireland to Wales, its projected capital cost/MW is almost half the of EWIC**

[9] Source(s)) http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2012/energy/power-transmission/EPT201202029.htm
http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/CriticalInvestments/InvestmentIncentives/Documents1/TII_Aug11_WHVDC_FINAL.pdf

- **The system losses on the Western HVDC link are also projected to be half of those of the EWIC, due to the employment of much higher voltages and different converter station technology.**

It is likely that both the overall scale of the Western HVDC link as well as technology advances significantly contributes to its lower unit transfer costs. This may present a major barrier to cost effective interconnections for Ireland given the relative lack of scale involved.

On the other hand rapid technology improvements may mitigate this disadvantage. This is an important issue and should be carefully investigated prior to the construction of any future Irish interconnectors. It is essential that any new infrastructure provides the optimum value to the Irish electricity consumer and that any apparent excess cost over neighbouring interconnectors is fully understood and factored into the overall economic analysis.

The Academy has, on several occasions in the past, recommended the carrying out of detailed post – implementation audits on large electricity infrastructure projects. The Commission for Energy Regulation should mandate and publish such an audit, including the benefits being derived by electricity customers, for the EWIC before any decisions are taken on future interconnections.

ADVISORY PRINCIPLE 7:
The Commission for Energy Regulation should mandate and publish an independent report on the cost of interconnection between Ireland and the UK

6.2 Permitting

The Academy has commented on a number of occasions on the dysfunctional nature of Irish planning and permitting legislation. The length of time involved and the uncertainty of outcome associated with the Irish planning process contrast unfavourably with the processes in other EU countries. The UK, in particular, with its 200 year history of industrialisation, provides a rigorous but clearer path to permitting infrastructure.
In the case of transmission the average length of time to complete a transmission line project is 7 years of which the construction period is approximately 18 to 24 months. Repeated arguments at the permitting stage often hinge around the safety of overhead lines and the alternative of underground cables. Outcomes are that some projects never get built and others are modified and rerouted at increased cost. These additional costs are paid for by electricity customers and have an impact on national competitiveness.

Recent modifications to the legislation do little to tackle the underlying issue of process uncertainty and the Academy again suggests that the Government set out to establish a more reasonable balance between development objectives and community interests with a strong focus on delivering early certainty to potential developers.

The example of the Shell fiasco in Co. Mayo is still plain for all to see and, based on recent offshore licensing rounds, clearly discourages major companies from investing in the Irish energy sector. This excessive permitting risk will drive up the cost of investment and thus reduce the financial returns available to be shared with Irish community interests.

6.3 Community Gain

The establishment of electricity infrastructure was, at one time in Ireland, viewed benignly by communities given that the benefits accrued directly to the electricity consumer under a regime of monopoly state owned management of the industry. With the arrival of private investment in the industry this changed as groups questioned why facilities which had a major impact on their local environment delivered profits to private shareholders seemingly at the expense of communities which did not share in the value created by the investment.

This is not an isolated issue and has been a topic of debate in many countries where policymakers have struggled to establish an appropriate balance between essential investments provided by "for-profit" institutions and the resulting impact on local communities. The Academy, in its earlier reports, has called for a fundamental reappraisal of the balance between public and private interests and

a review of planning regulation in Ireland based on this. There is a strong perception that electricity infrastructure investment can only proceed if some benefit accrues to the affected communities. Such a benefit is broadly referred to as "Community Gain". Planning authorities in Ireland have sought to implement policies promoting "Community Gain" but on a very "ad-hoc" basis. Such policies are almost certain to discourage investors, not because of the concept, but rather because of the arbitrary way in which they are applied in Ireland.

Community gain can take many different forms, for example:

- **A community fund provided by the developer for use by the community.**
- **The provision of specific community infrastructure by the developer.**
- **Provision for an investment stake in the venture by the community at little or no cost.**

The nuclear industry in France for example, for many decades, has employed such schemes including the provision of subsidised electricity to communities affected by the siting of nuclear power[10] plants.

The provision of employment in an area of otherwise high unemployment may often be sufficient to persuade a local community of the value of a specific investment.

There are many such schemes and none are perfect. Defining the geographical area of benefit for a community, for example, can be problematic. How "local is local" can become a major point of contention.

Transmission infrastructure provides an example of just how difficult this exercise can be since there may be little if any immediate benefit to communities impacted along the route of the line. It is doubtful if any transmission could be constructed in Ireland if arrangements had not been made long ago to compensate landowners along the route for the construction of the towers on their land despite the considerable legal powers available to ESB and EirGrid to impose such infrastructure on the community.

Even if transmission remains a publicly owned asset in Ireland, its construction to facilitate private generation is certain to lead to difficulties with affected communities. It is interesting to consider the development of wind power in the United Kingdom for example.

While wind farms are broadly acceptable in Scotland, this is not the case in England and parts of Wales. England's population density is such that it has become virtually impossible to obtain permission to construct wind farms in the jurisdiction. Rural dwellers have refused to accept what they perceive to be the "industrialisation of the landscape"[11,12,13], they have successfully lobbied for policies at local planning level to exclude such developments and in general enjoy widespread support for this policy in their local areas.

In the context of the possible construction of large scale privately owned wind generation facilities in Ireland aimed at exporting electricity to the UK in order to facilitate that country's compliance with renewable energy penetration targets, the issue of the "industrialisation of the Irish landscape" is certain to be raised, particularly if it is perceived to result from a policy of refusing to locate such industrial infrastructure in England. It is essential that Irish policymakers recognise and make provision for this issue from the outset.

While some straight-forward community gain approaches may be successful for the siting of wind generation facilities, enormous social problems will arise from the necessary transmission development for the

ADVISORY PRINCIPLE 8:
Policy makers must address the Community Gain issue from the outset and formulate policies for national application which appropriately balance the interests of affected communities with those of potential private investors.

Large scale wind production should be concentrated in clusters with easy and economic access to transmission.

[10] One of the few recorded pro-nuclear street demonstrations took place in France following the cancellation of plans to construct a nuclear plant and with it, the associated community gain.
[11] http://stoplitlingtonwindfarm.com/Portals/0/Images/SLWF%20Newsletter%201%201211.pdf
[12] http://shamwag.com/2012/04/21/launch-of-national-opposition-to-windfarms-and-charter/
[13] http://its-in-the-wind.blogspot.com/

scale of infrastructure envisaged. Compensation for this impact may have to take the form of a royalty, much as might be applied in the extractive industries. It is important that such issues be resolved early in the policy making process and that appropriate certainty is provided to potential investors.

Clearly, minimising the extent of such infrastructure will assist in alleviating the problem. This reinforces the argument for clustering wind generation facilities adjacent to existing transmission capacity, a policy long advocated by the Academy.

6.4 Scottish Competition

As well as looking west for its renewable electricity, GB (in particular the major load centre in the South East of England) can look north to Scotland. The major constraint on Scottish renewables exports has been the lack of export transmission capacity to England. The Western HVDC subsea circuit will greatly relieve this constraint in the near future providing transmission capacity at a significantly lower cost to that provided by EWIC. The Eastern HVDC circuit, included in Scottish Power's planning but awaiting approval, promises a further large increase in transmission capacity at relatively low cost.

An important input into the cost of wind power is the wind regime at the generation location. An examination of the European Wind Atlas indicates that Scotland has as much right to be called the "Saudi Arabia" of wind power as Ireland has. Indeed it is noticeable that the high energy wind regime shown for most of the territory of Scotland exists only on a narrow coastal band in the West of Ireland. A Scot might well claim that while Ireland has a good wind regime, Scotland has a great one. Based on published wind atlas data it would be difficult to contradict this assertion.

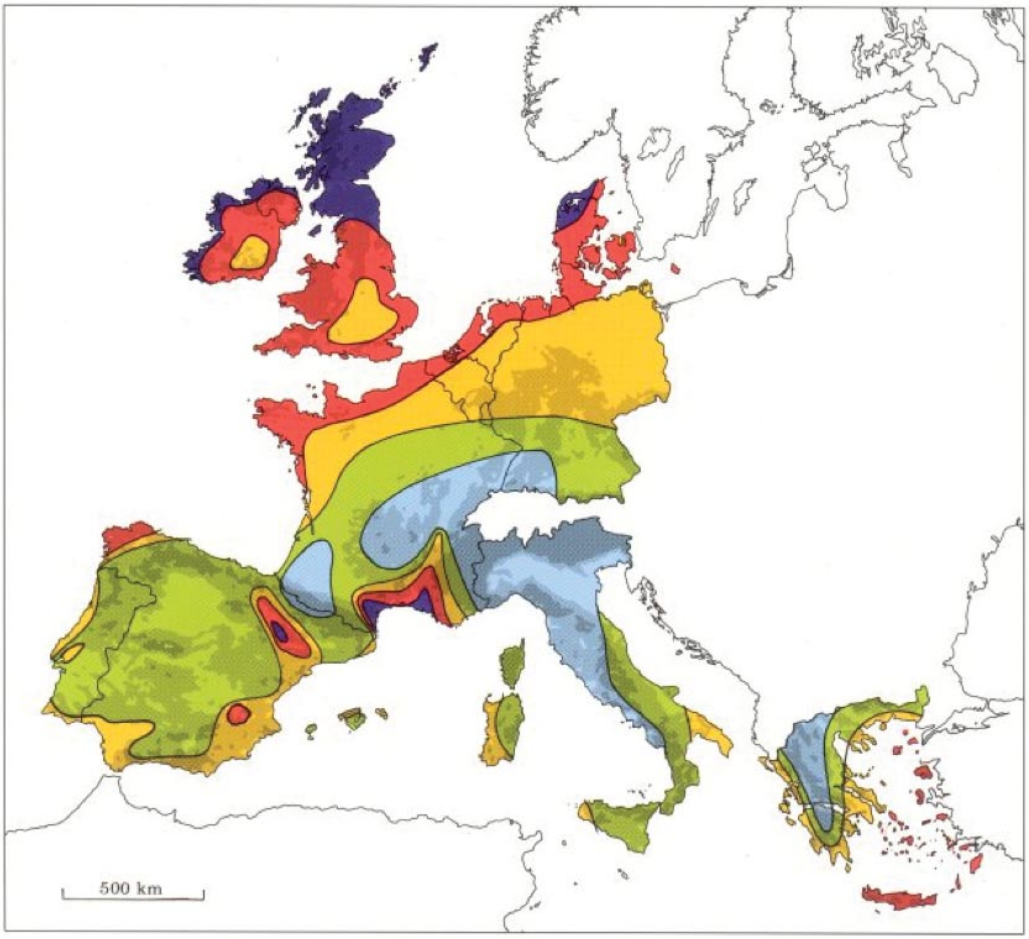
This high wind intensity band in the West of Ireland is extremely poorly served by existing transmission infrastructure. While the west of Scotland is similarly poorly served this is not true of the central area and the East coast. In addition the transmission capacity through the Highlands will be very considerably increased by the decision of the Scottish Executive to approve the replacement of an existing double circuit 132kV line, from Inverness to the central belt, by a 400 kV double circuit line, of much greater capacity.

Indeed the real barrier to wind power development in Scotland, to date, has been the constraints on the effective capacity of the transmission links to England. There are at present two double circuit 400kV lines linking Scotland and England. However the capacity of these links is greatly constrained by the fact that there is an 80km. gap in the East Coast 400kV lines between the Stella West and Norton 400kV substations in north-east England, due to the refusal of the planning authorities to grant consent for the construction of a double circuit 400kV line through that area.

The effect of this is to limit electricity transmission from Scotland to England to the transfer capacity of the underlying 275kV system along the East Coast. The considerable transfer capacity of the West Coast 400kV double circuit line cannot be fully utilised because of the possibility of a double circuit fault (single tower collapse for example) on those lines.

The same considerations apply in the case of the existing North South interconnector in Ireland, where the risk of a double circuit fault on the double circuit 275kV line from Louth to Tandrageee severely limits transfer capacity, hence the need to construct a 400kV North South interconnector, to remove the capacity constraint.

Taking into account therefore comparisons in the basic wind regime, the cost of connectivity and the problems of permitting, it is likely that on balance Scotland may be more favourably positioned to export wind power to England and Wales. Other factors may mitigate Ireland's disadvantage but the Academy advises caution in any assumption that Irish wind power exports will be automatically competitive with those available from UK sources.



Wind resources[1] at 50 metres above ground level for five different topographic conditions

	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

ADVISORY PRINCIPLE 9:

Irish electricity exports to the UK will face competition from Scottish sources, particularly as the transmission connections from England to Scotland are reinforced.

The construction of new transmission infrastructure in Ireland to facilitate exports should only be undertaken once the competitive dynamics have been understood and found to be favourable.

APPENDIX 1 – SOME SELECTED TRANSMISSION ISSUES

The existing grid infrastructure in European countries was not developed with wind power development in mind. Indeed the major population and electricity demand centres are very often located remote from the more suitable areas for wind power development. This issue is of increasing significance as the difficulties in gaining acceptance and planning approval or consents for wind farm developments are very often dwarfed by the difficulties in gaining acceptance of the necessary supporting electricity infrastructure, to transmit the power to market.

This problem becomes particularly acute when the overhead line design requires the use of lattice steel towers throughout, as is the case for 400kV, 275kV and 220 kV lines and double circuit 110kV lines.

Ireland has an extensive electricity transmission infrastructure but much of that infrastructure is of single circuit 110kV or 220 kV construction with limited transmission capacity in the context of the GB market. Indeed the only power lines in Ireland with capacities comparable to the extensive 400 and 275 kV grid in GB are the 400 kV lines from Moneypoint to the Dublin area, hence the decision to link the East -West interconnector to Woodland 400 kV sub-station.

The following table shows the typical rating of these lines as built, expressed in MVA11 as is the norm. The power carrying capacity of these lines, in MW, is typically over 90% of their individual MVA ratings. EirGrid has undertaken a programme of replacing conductors with higher rated designs and in some cases rebuilding existing 110kV lines and this typically allows a 30% to 60% increase in rating, which facilitates wind power development in certain areas, but does not result in circuit capacities capable of facilitating large-scale entry to the export market.

In contrast to the relatively weak grid in Ireland GB has a very extensive high-capacity 400 and 275 kV grid, covering much of GB, which was necessitated by its much higher population density and consequently electricity demand. The GB grid is predominantly of double circuit overhead line construction and, though ageing and in need of very significant reinvestment, provides wind generators, both onshore and offshore GB, with a relatively wide range of options as to where major wind farm developments can be located.

Because of its excellent wind regime the position of Scotland and its links to England are particularly significant. The Scottish executive has set a target of having 100% of Scotland's electricity requirements produced from renewables, predominantly wind, by 2020. This however does not mean that all coal and nuclear generation will cease in Scotland by 2020. Rather the target is that the aggregate renewable electricity output will exceed electricity demand in Scotland by 2020.

The key to achieving this target is Scotland's electricity transmission links to England and the extent which renewable electricity generation in Scotland can be exported to England. Historically Scotland has had a major generation capacity surplus and its ability to export, from conventional and nuclear generation, was limited by its grid connections to England.

Typical Transmission Line Ratings in Ireland

Voltage	Conductor Cross Section	Design Temperature	Rating	
			Summer	Winter
kV	sq mm	oC	MVA	MVA
110	200	80	107	126
220	600	80	431	518
400	2×600	80	1424	1713

[14] Apparent Power measured in Mega Volt Amperes.

These are two 400 kV double circuit lines, running down the east and west coast of Scotland and northern England. Each of these circuits is rated at 2,200 MVA, in summer and should allow exports of in excess of 4000 MW. However there is an 80 km gap in the east coast 400 kV system in north-east England, between the Stella West and Norton sub-stations and National Grid has not been able to gain consent for the construction of the 400 kV double circuit line between the substations.

Thus to date the ability to export electricity from Scotland to England is limited and this has consequently constrained wind power development in Scotland. To overcome these difficulties, Scottish Power Transmission Ltd. (SPTL) the network operator in the South of Scotland and National Grid Company the network operator in England and Wales, proposed the construction of two 2,200 MW HVDC links down the west and east coast. The first HVDC link is to be constructed from Hunterston nuclear power station, in Ayrshire, on the west coast Scotland to Deeside 400 kV substation, where Ireland's E/W interconnector will also terminate. Hunterston and Deeside are both electrically strong points on the grid.

- **Hunterston is connected by two double circuit 400 kV lines.**
- **Deeside is connected to four double circuit 400 kV lines.**

This, coupled with the already strong transmission connection from Scotland to England, allows the development of a 2,200 MW HVDC link, which is very significantly larger than the E/W interconnector, (rated at 500 MW). The routing, timing and capital approval of the Eastern HVDC link have not been finalised but SPTL network plans indicate it as originating in the Firth of Forth and being completed by 2017/18. Based on the above developments the load flow studies in NGC's 2011 Seven-Year Statement indicate power exports from Scotland to England, increasing from 2900 MW in 2011/12 to 6000MW in 2017/18,.

It should be noted that while the above represent projected representative load flows, at system peak, they may not represent peak exports, as with increasing wind power generation in Scotland wind output and exports may well exceed these projections, which are believed to be based on average wind farm outputs.

To further facilitate renewable development in Scotland, on Jan 2010 the Scottish Government gave approval for the construction of a 220 km double circuit 400 kV line from Beauly, near Inverness, to Denny, near Falkirk, close to the Firth of Forth. One circuit of this line is to be operated at 400 kV, to provide a high-capacity link from the Highlands and Moray Firth area to the Central Belt. The other circuit is to operate at 275 kV and is to encourage renewable generation development through the centre of Scotland. This line will complement the already strong transmission network running down the east coast of Scotland, which is provided by two double circuit 275kV lines.

The Beauly-Denny 400kV line is to replace an existing double circuit 132 kV line, running along the same alignment. The planning application was considered to be the most controversial to date in Scotland as the line passes through the Cairngorm National Park and calls to have portion of the line undergrounded were rejected. The planning application was lodged in Sept 2005 and consent was granted in Jan 2010. The project was estimated to cost £331 million in 2004 but recent reports, by the BBC, indicate that the final cost may approach £600m.

The required transmission infrastructure to allow for very large scale wind power development in Scotland has been planned for and is being delivered.

1 Energy Policy and Economic Recovery 2010-2015 http://www.iae.ie/site_media/pressroom/documents/2011/Apr/06/IAE_Energy_Report_Web2_05.04.2011.pdf
2 Nítrigin Éireann Teoranta
3 Transmission Peak, Medium Demand Forecast, Republic of Ireland only. Based on published Generation Adequacy Reports 2006 - 2012
4 Generation Capacity Statement (EirGrid). Previously "Generation Adequacy report"
5 http://www.eirgrid.com/media/All-Island%20GCS%202012-2021.pdf
6 National Grid UK http://www.nationalgrid.com/NR/rdonlyres/A693C979-18C8-4A56-A6F2-F1FA601B6031/46996/NETSSYS2011.pdf
7 "The Saudi Arabia of Renewables!"
8 http://www.ft.com/intl/cms/s/0/45afd57a-9abf-11e1-9c98-00144feabdc0.html#axzz1urjkUMH6
9 Source(s)) http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2012/energy/power-transmission/EPT201202029.htm http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/CriticalInvestments/InvestmentIncentives/Documents1/TII_Aug11_WHVDC_FINAL.pdf
10 One of the few recorded pro-nuclear street demonstrations took place in France following the cancellation of plans to construct a nuclear plant and with it, the associated community gain.
11 http://stoplitlingtonwindfarm.com/Portals/0/Images/SLWF%20Newsletter%201%201211.pdf
12 http://shamwag.com/2012/04/21/launch-of-national-opposition-to-windfarms-and-charter/
13 http://its-in-the-wind.blogspot.com/
14 Apparent Power measured in Mega Volt Amperes.

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