Issues In Accessing Enormous Renewable Resource In Ireland
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ABSTRACT

Ireland has a potential renewable resource that is many multiples of its own total energy demand, which is why the Irish Government is currently in the process of making an agreement with the UK for renewable electricity exports. The resource is primarily wind and wave energy located in the vast marine Exclusive Economic Zone, which is some 6 times the landmass area. And yet it is already proving very difficult to achieve the EU 2020 16% primary energy target, which requires that 40% of electricity should come from renewable sources, mostly wind energy. Failure to meet that target will prevent exports. The main obstacle is grid development, with connection delays that can reach 10 to 15 years for firm access, which then reverses the whole project development process, making it very complex, risky and costly. In addition, the 'REFIT' support price is modestly attractive to investors, when projects must pay huge connection and other administrative costs. Planning permission for projects and their connections is increasingly unpredictable, more difficult, with a reducing number of projects getting consent, and some projects having issues with retrospective changes to or withdrawal of permissions. The paper sets out the issues, and analyses them in terms of timing, cost and risk. It proposes a solution based on the simpler German model of wind development.

Keywords: Renewable energy, Ireland, resource, grid issues, backward development model

1 RENEWABLE ENERGY RESOURCE IN IRELAND

The Republic of Ireland is recognised as having some of the best renewable energy resources in Europe, primarily due to the weather conditions to which it is exposed on the Eastern edge of the Atlantic Ocean. Satellite-based ocean wind mapping shows that, along with Iceland and Greenland, Ireland's Western seaboard is hugely endowed and that the resource is also superior to that in almost all of Africa and Asia (illustrated in Appendix 1).

And as technology for marine energy is developing, such as wave energy converters, but in particular floating wind turbines, that favourable position is only being strengthened, since Ireland has a 200 mile Exclusive Economic Zone (EEZ) of some 410,000 square km, or approx. 6 times its land area of some 70,000 sq km. Ireland's continental shelf area is much larger again (illustrated in Appendix 2).

Electricity demand in Ireland is currently approx. 25 Terawatt-hours (TWhrs) per year, while the Total Primary Energy Requirement (TPER) peaked at around 190 TWhr in 2008 [1]. The technical wind energy resource available to Ireland is estimated at some 2,000 TWhrs on land [2] and a further 7,000 TWhrs from floating wind turbines at sea inside the EEZ [3], which is several times the EU 25's electricity demand in 2004 of some 2,500 TWhrs.

2 ACCESSING IRELAND'S RENEWABLE ENERGY RESOURCE

From a position in which most of its energy and virtually all of its electricity came from renewable sources by the middle of the last century, Ireland's share of total primary energy requirement (TPER) supplied from renewable sources is now very low at around 6%, while the rest comes from fossil fuel sources. Dependency on external energy sources has remained at around 90% since the start of the millennium [1]. Under the EU's Renewables Directive, Ireland has an obligation to reverse these trends, with a view to providing 16% of energy demand from renewable sources by 2020 [4]. That has been translated by the Irish authorities into a transport target of 10%, heating/cooling target of 12% and an electricity target of 40% coming from renewable sources, primarily wind energy [5].

At the same time, discussions between the Irish and UK Governments are leading to an arrangement for the export of electricity generated from renewable sources from Ireland to the British mainland, given Ireland's rich endowment, and the UK's impeding shortfall in energy supplies due to the closure of coal and nuclear power stations, as well as the need to meet UK targets under the Renewables Directive. However, it must be noted that the targets under the Renewables Directive are legally binding, while the provisions relating to exports merely facilitate it. Consequently, Member States' ability to meet the targets must not be compromised by engaging in exports. The European Commission is unlikely to facilitate such exports where Ireland cannot demonstrate its ability to meet its own national targets. There is growing concern about Ireland's ability to meet the binding targets by 2020 (illustrated in Appendix 3).

3 ISSUES IN ACCESSING IRELAND'S RENEWABLE ENERGY RESOURCE

While Ireland has some biomass and solar energy resources, by far the largest renewable energy resource available is in the wind that blows over the island's land and seas, though that may change in future decades with the advent of commercial wave energy converters. Due to the strength of the winds, Ireland's most economical energy source is electricity produced from onshore wind [6], and it is therefore the primary focus of renewable energy policy today. At the same time, the two electrical interconnection links between the island of Ireland and elsewhere use Direct Current (DC) rather than Alternating Current (AC) technology, which means that the combined electrical system of the Republic and Northern Ireland forms a relatively isolated network of modest scale. The primary challenge then is in reliably accommodating vast amounts of electricity generated from variable renewable sources on a relatively small and isolated electricity network with variable demand. Plans are in place in the two jurisdictions to reach an average renewable generation of 40% of all electricity demand on the combined island system by 2020, which in turn implies that at some points in time, the level of wind generation on the total system will reach up to 75% of electricity demand. This is very ambitious, even in world terms, and means that the island's authorities are trying to break new ground in the management of the network without a diminution in the level of reliability (illustrated in Appendix 4).

3.1 Operation of the electricity system

The primary obstacles then relate to operation of the electrical system, and exist at two levels. At the balancing level, there is a need to match supply and demand at all times, and the growing mismatch between variable sources and variable demand poses a growing challenge. The availability of a single 292 Megawatt (MW) pumped storage station at Turlough Hill and a few hundred MW of large hydro stations helps, and the interconnectors at Moyle in Northern Ireland and the East-West Interconnector (EWIC) from Wales to the Dublin area allow some electricity trading to assist system balancing. But in the end, the all-island System Operator, Eirgrid-SONI, is relying on dispatchable generation plant that is almost entirely based on fossil fuels to balance the system, as is normal on electrical networks today.

The second level at which obstacles arise is the dynamic stability of the relatively isolated all-island network. This is the aspect that will be of most interest to outside observers. Ireland is reaching this obstacle long before most other places, due to the degree of isolation and the demanding penetration levels of variable renewable generation. The Republic's System Operator, Eirgrid, presented a very significant report in 2010, known as the 'Facilitation of Renewables Study', which dealt with the various issues of concern as regards the dynamic stability of the all-island system [7]. It examined issues such as voltage and frequency control, inertia, fault response and so on. The analysis suggested the separation of equipment on the system into two distinct categories, namely synchronous and non-synchronous, the latter category being made up primarily of non-synchronous renewable generators and DC interconnectors. The authors considered that the non-synchronous equipment could not provide the requisite inertia in an instantaneous passive manner and therefore could not be relied upon to respond adequately to frequency excursions and faults. The implications are two-fold: that the system has to be considered completely isolated for dynamic stability analysis purposes, since both interconnectors are DC and not AC; and within the island network, a limit would have to be imposed on the instantaneous level of non-synchronous generation and that level would depend on certain aspects of the system being improved, the details of which need not be set out here. The level of System Non-Synchronous Penetration (SNSP) is currently set at 50%, and is due to rise to a maximum of 75% once a defined set of measures have been adopted. In other words, the rather ambitious target of having an average of 40% of all electricity coming from renewable sources by 2020, which in turn means an instantaneous level of some 75% at times, relies very heavily on the implementation of that set of measures. Their implementation is currently being handled through a programme known as DS3 [8].

This is not without some controversy, since both the interconnector and wind turbine manufacturers consider that their systems provide a type of inertia, known as 'proto-inertia', which can assist system stability. Indeed, direct drive wind turbines, such as the Enercon machines, which pass all of their power through an AC-DC-AC power converter, are capable of providing quite extensive system services, and are considered by some transmission system experts known to this author to be even superior to conventional plant in this respect. Ireland will continue to operate under this limiting regime for the moment, but as the limits start to prevent wind development, the industry will inevitably force a review, which should take full account of the extensive capabilities of these new generation and transmission technologies, as well as further new technologies, such a synchronous wind turbines [9].

Both of the above issues have encouraged the System Operator to require quite a high level of fossil plant minimum generation (MinGen) and quite often renewable generators are curtailed to facilitate this MinGen, well before the SNSP limit is reached.

3.2 Access to the electricity system

Another significant limitation has been imposed on renewables development in Ireland by the very long delays incurred by projects in becoming connected to the grid. Up to late 2003, the Irish authorities employed a '70 day' process for grid applications, which projects entered after receipt of planning permission. However, as the quantity of projects increased, and the spare capacity on the transmission system reduced, projects were considered to 'interact' with one another very significantly, causing increasing delays. Additionally, there was a widely held view amongst the authorities that the network could only accommodate some few hundred MW of wind, which resulted in a moratorium on connections being declared by the Republic's regulator, the Commission for Energy Regulation (CER), on 3rd December 2003. After a hiatus of almost one year, a new grid application system for renewables was introduced, known as 'Group Processing', which handled applications from adjacent renewable projects in groups. However, in the meantime, a huge queue of grid applications built up out of concern for the increasing delay, which persists to this day. Many projects started to apply without having already secured planning permission. The CER then began a series of 'Gates' in which a defined part of the Republic's grid application queue was allowed to receive a grid connection offer, while all other projects were made to wait for a subsequent Gate. The processing of these Gates became increasingly complicated, in terms of allocating grid connection costs between projects, estimation of the impact of network limitations on project output (local 'constraints' and national 'curtailment)', timing of the availability of firm access (where projects receive the market price for output lost due to network issues), and most recently updated lists of Associated Transmission Reinforcements (ATRs). The result has been increased delay. Some projects in the current Gate 3 applied for connection to the grid in 2004, and still do not have complete grid connection offers, they might connect in 2015 and get firm access to the network by 2019, or even later.

During this development, it became clear that such lengthy delays for grid access had extended beyond the planning permission time limit, which was initially 5 years, but was extended by the authorities to as much as 10 years. This meant that planning permission could not be a requirement for making a grid application, and indeed for receiving a connection offer, since otherwise the planning would have expired by the time the grid connection was delivered. Therefore, these extensive delays in grid connection now mean that projects must apply for it before they apply for planning permission, which is the opposite of a normal development model; what this author terms a 'backward development model'. A whole new set of rules have had to be defined to cope with projects that have a grid connection but are without planning, permitting the splitting, merging and relocation of grid. This 'backward development model' effectively causes the chance of project success to fall from some 30% to as low as 5%, while considerably raising costs (illustrated in Appendix 5). The authorities need to put a time limit on grid delivery of say 3 years, and then make planning a condition for grid access again, reverting to a 'forward development model'. In the ground-breaking German 1990 law, the 'Einspeizegesetz', this forward model was inherent, in that projects with planning were pretty much guaranteed grid access and price support [10], which is the model that is now required to enable real progress.

3.3 Legal issues as regards grid

Apart from setting binding primary energy targets, the EU's Renewables Directive strengthens the rules within the electricity market in favour of renewable generators. Article 16 sets out extensive operation and access rules, subject only to the reliability and safety of the network.

When dispatching generators, renewables must be given priority, and this rule has been somewhat reluctantly implemented without reference to cost by the Single Electricity Market Committee (SEMC), which is the joint regulatory authority for the electricity market on the whole island of Ireland.

However, the same cannot be said for the 'guaranteed transmission' obligation, because adequate measures are not being taken by the authorities to prevent the inexorable growth in the levels of constraint and curtailment, which are completely undermining the financing of renewable energy generation projects. The authorities argue, despite the very clear wording of the Article, that they need not build energy storage or undertake similarly costly measures to guarantee transmission, relying on the excuse that the obligation is subject to safety and reliability of the grid. Were it correct, this interpretation would render that obligation void, which was clearly not intended by the EU. The correct interpretation is that they must adopt measures to guarantee transmission while maintaining reliability and safety, which of course those very measures would do.

In the Irish Government's 'National Renewable Energy Action Plan' (NREAP), published in July 2010, Ireland opted for priority access to the grid under Article 16 of the Directive. But the opposite has been the case, since fossil fuel plant that applied after renewable energy projects have connected and been given firm access first, even where that firm access allocation was revised as recently as December last (illustrated in Appendix 6). The CER has justified its decisions on the grounds of 'security of supply', but this is not the qualification on priority access provided for in the Directive.

To circumvent these issues, two enormous onshore wind projects are now seeking direct connection to the UK in order to export surplus power under the UK support scheme, while avoiding the local grid constraints. The authorities on the island are of course anxious to incorporate these 'interconnectors' into the local network, arguing overall economic benefits.

3.4 Other obstacles

While grid has become by far the most significant issue, planning and support schemes have not been without issues. The proportion of projects achieving planning in the Republic has increased to quite a high level, despite increasing planning requirements, many of which come from the EU. However, it should be noted that the total number of planning permissions being achieved has peaked, and is now falling due to increased requirements and costs, larger scale of projects, and emerging social acceptance issues. (illustrated in Appendix 7).

The Renewable Energy Feed In Tariff (REFIT) is the support scheme in the Republic of Ireland, managed by the Department of Communications, Energy and Natural Resources (DCENR). It takes the form of a guaranteed floor price for electricity produced from specific renewable energy sources, where the price depends on the technology. It does not cover solar, offshore wind or marine energies. It has a number of weaknesses, the primary one being that it is paid on metered output. Losses of output caused by grid issues lead to an uncertain revenue stream, which directly contradicts the whole point of a guaranteed price scheme. Grid connection costs account for an increasing proportion of project capital cost, reducing the attractiveness of the REFIT. Indeed, charging projects for grid connections, which they must then gift to the network owner (the incumbent ESB) is an economically inefficient way of funding grid connections [11]. A preliminary analysis of the cost benefits of measures dealing with these two issues suggests a lower REFIT price and a consequent reduction in cost to the consumer (illustrated in Appendix 8).

There have also been periods in time when there was no support scheme at all on offer to wind projects, such as between December 2009 and March 2012, while issues of state aid were resolved with the European Commission. The current REFIT 2 scheme for wind will close for applications at the end of 2015 and plant must be built by 2017, placing further doubt over targets.

4 CONCLUSION

While the island of Ireland has a truly enormous renewable energy resource, large enough for exports many times local demand, significant difficulties are currently faced in merely achieving relatively modest binding targets for renewable energy's share of primary energy demand. Grid is central to these difficulties, because the vast bulk of the available renewable energy is to be delivered in the form of electricity, while the local network is relatively isolated. Analysis for the grid authorities, based on somewhat conservative assumptions about wind and DC technology, has led the authorities to impose quite stringent limits on the progress of variable renewable generation, and will in due course bring the renewables sector to a halt, apart from projects that may directly connect elsewhere. Lengthy delays in connecting renewable projects, at enormous cost, as well as rules permitting uncompensated constraint and curtailment, serve to further undermine the development of the sector. There is no possibility of a 100% renewables system under these conditions, and exports simply cannot happen without much more significant progress towards EU targets. Reversion to a forward development model is essential, along with payment of REFIT supports on the available output of renewable energy projects, more economically appropriate rules to fund grid connections, and most importantly, investment in various network assets to allow higher renewable penetrations, with a view to a 100% renewable energy future.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Sustainable Energy Authority of Ireland, *Energy in Ireland 1990-2011* (www.seai.ie)

[2] ESB International, Future Energy Solutions, Energy Research Group, UCD, *Updating the renewable energy resource in Ireland (2004), final report*, for Sustainable Energy Ireland, Nov 2004 (www.seai.ie)

[3] Halligan, B., Hurley, B., Healy, G., O'Rorke, B., *Europe's energy exporter*, not yet published

[4] *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources…,* OJEU L140/16, 5th June 2009

[5] Government of Ireland, *National Renewable Energy Action Plan*, July 2010 (www.dcenr.ie)

[6] Meitheal na Gaoithe, *Embedding sustainability, the business case for small wind*. Feb 2013 (www.mnag.ie)

[7] Bömer, J., Burges, K., Nabe, C. (Ecofys), Pöller, M. (DIgSILENT), *All island TSO facilitation of renewables studies, Final report for work package 3*. 4th June 2010 (www.eirgrid.com)

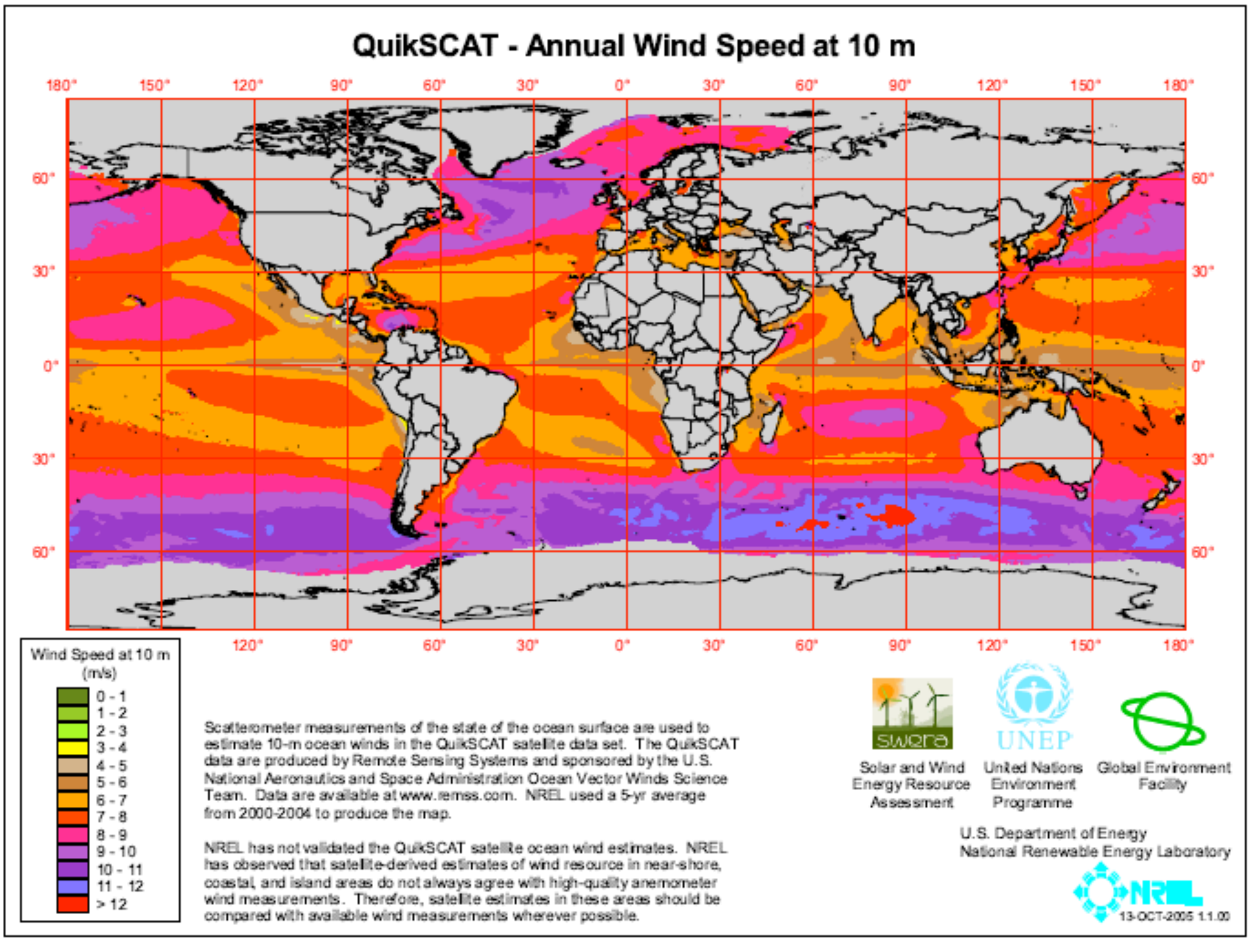
[8] Eirgrid plc, *Delivering a Secure Sustainable Electrical System*. www.eirgrid.com

[9] For example, see Dewind's synchronous version of their wind turbines, www.dewindco.com

[10] Germany, *Electricity In-feed law*, as of 7 Dec 1990, (English translation: http://ierne.ie/Ierne_Wind_Energy_Consulting_Ltd/Reference.html)

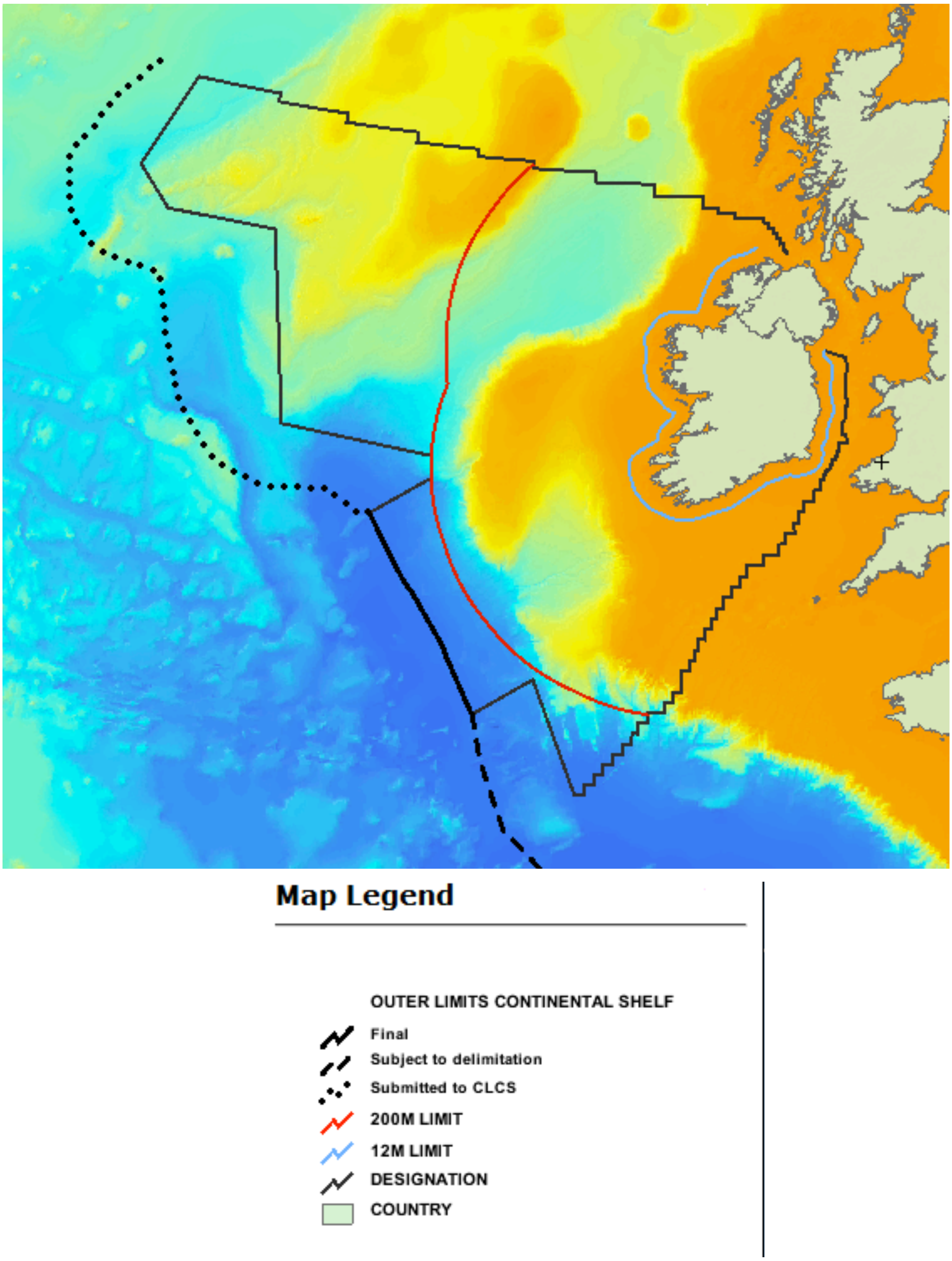
[11] KHSK Economic Consultants, *Efficient Funding of Transmission Network Connection Costs*. for NOW Ireland, Jan 2010, www.nowireland.ie/downloads.html

APPENDIX 1



Global annual wind speeds as measured by QuikSCAT satellite, presented by NREL (based on World monthly offshore wind maps, posted at www.retscreen.net)

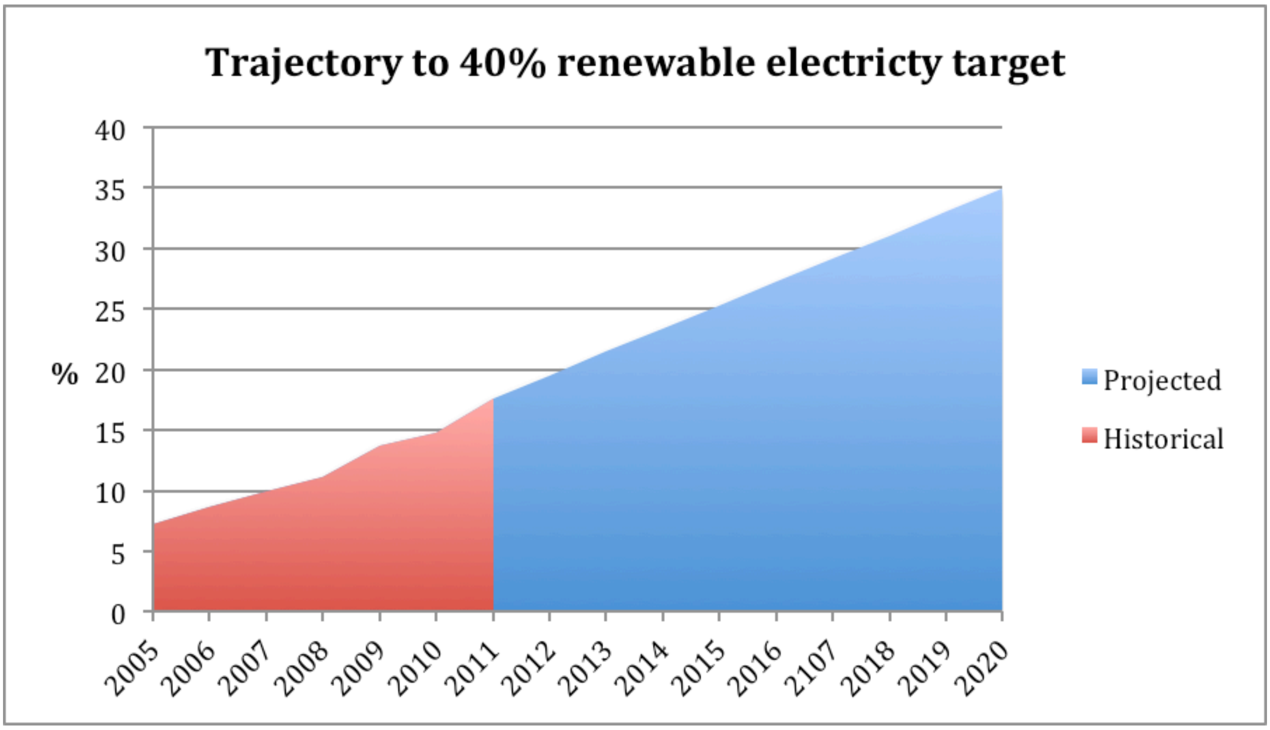
APPENDIX 2



Ireland's Nautical Territorial Boundaries

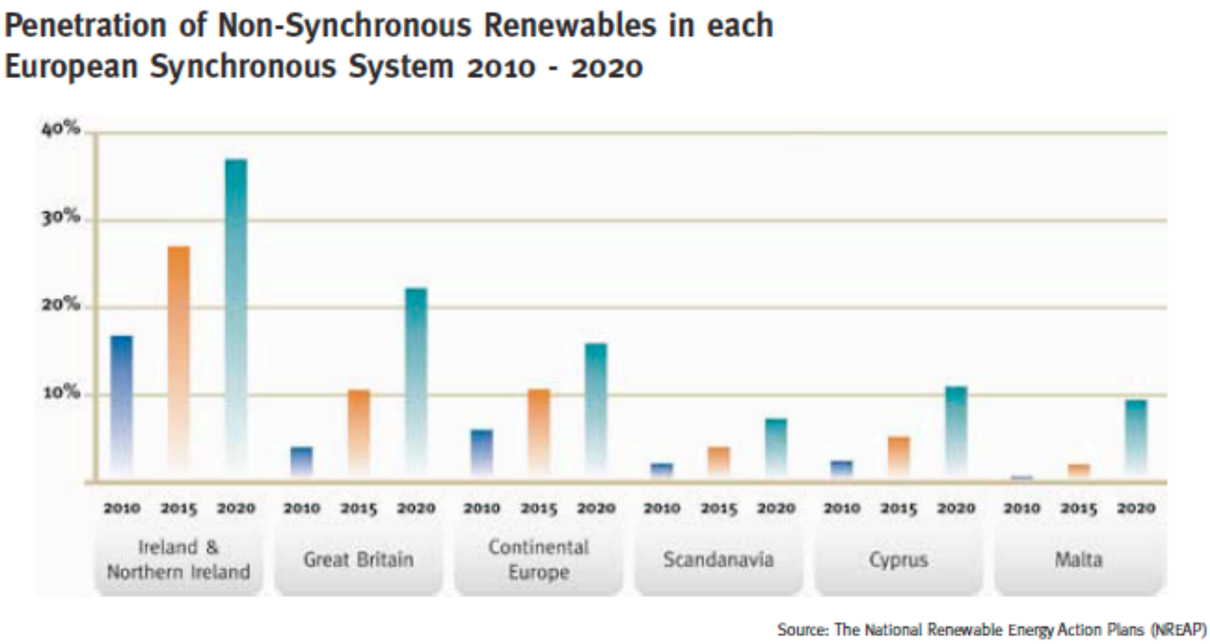
Source: Department of Communications, Energy and Natural Resources (DCENR), Ireland; Petroleum Affairs Division

APPENDIX 3



Projection of progress to Ireland's Renewable elecricity target of 40% by 2020
(historical data source SEAI, *Renewable Energy in Ireland 2011*, 2012)

APPENDIX 4



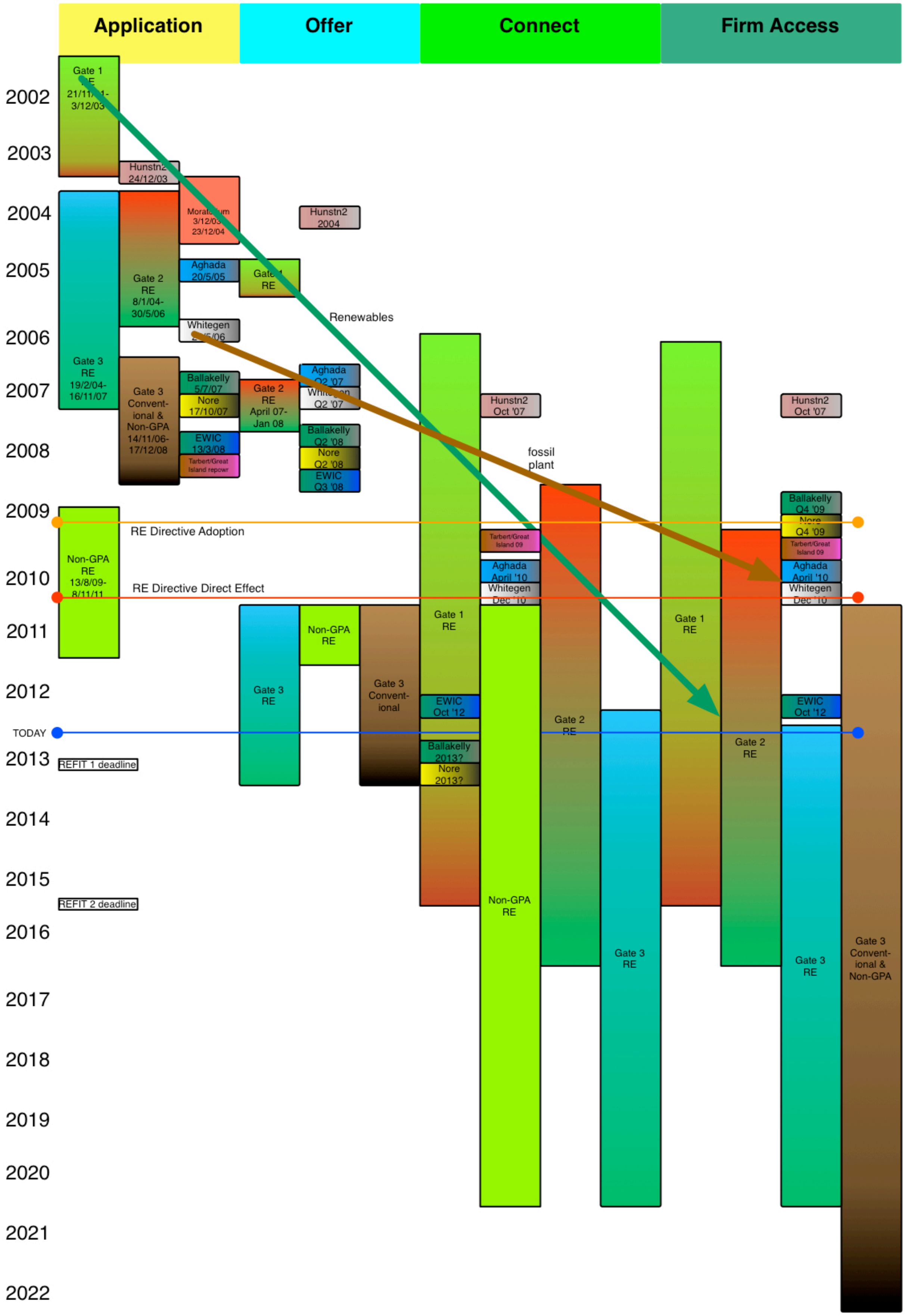
Projected non-syncrhronous penetrations on various electrical systems
(source Eirgrid Group, *Annual renewable report 2012*, www.eirgrid.com)

APPENDIX 5

	Approx. probability	**Approximate timing**	**Rough cost estimate**
Backward development model			
Get into a Gate	50%	3 yrs	€7k + €20-80k
Get grid offer	100%	3-6 yrs	€300k/MW
Get planning	30%	1-5 yrs	€250k+
Get REFIT	50%	1-2 yrs	€0
Get Finance	70%	1-2 yrs	€100-200k
Overall	5%	15-20 yrs	€1 million +
Forward development model			
Get planning	30%	1-5 yrs	€250k+
Get grid offer	100%	0.5 yrs	€7k + €20-80k
Get grid	100%	3 yrs	€50k/MW
Get REFIT	100%	0 yrs	€0
Get finance	90%	1 yr	€100k
Overall	27%	5-8 yrs	€ half million

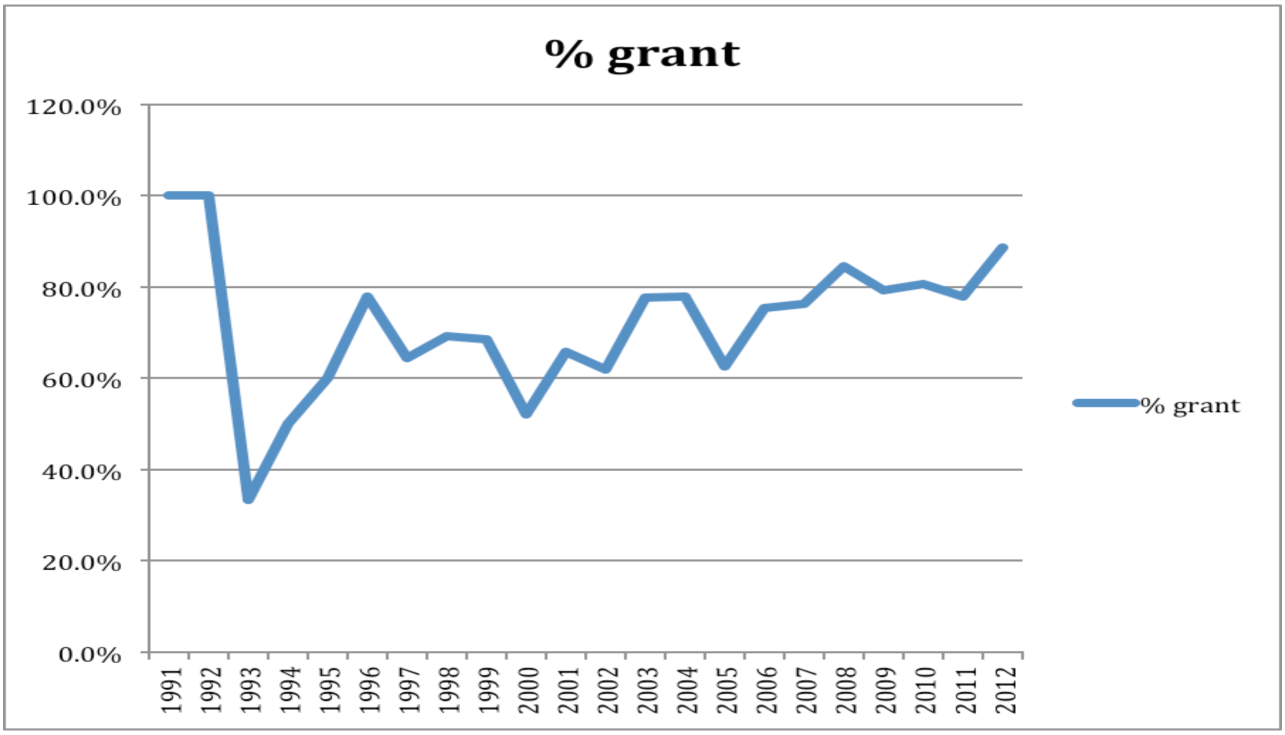
Estimated risk and cost comparison between 'forward' and 'backward' development models for renewables

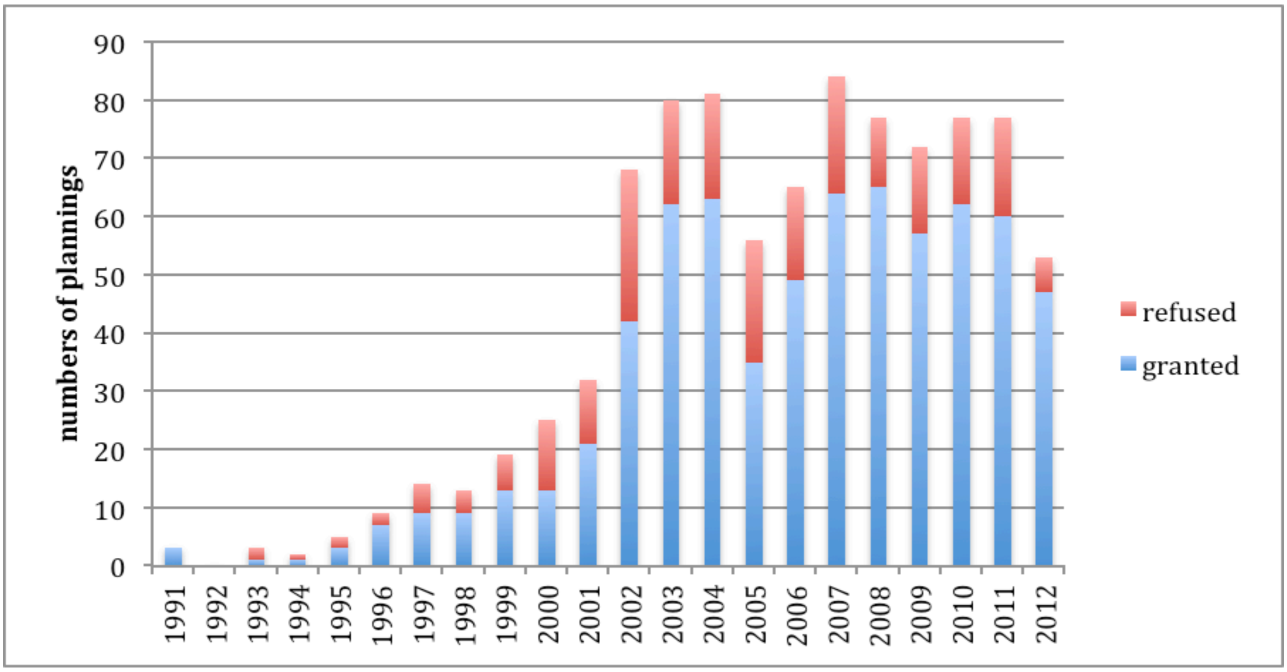
APPENDIX 6



Renewble and fossil plant timelines in Republic of Ireland since 2002

APPENDIX 7





Proportion and total grants/refusals of planning for wind farms (including appeals) 1991 to 2012, Republic of Ireland (data source SEAI)

APPENDIX 8

10MW project; constant 20 year Equity IRR		**Existing model**	**Constraint & Curtailment paid at REFIT**	**Underground Cable Connection paid**	**Both**
REFIT start price (unadjusted)	€c/kWhr	6.808	6.808	6.808	6.808
REFIT start price (adjusted)	€c/kWhr	6.808	6.121	5.794	5.224
CAPEX	€	14,347,826	14,347,826	11,739,130	11,739,130
Annualised interest rate (4 loan payments/yr)	%	6.00%	5.50%	6.00%	5.50%
Gearing	%	80.00%	85.00%	80.00%	85.00%
Unpaid constraint and curtailment	%	6-9%	0	6-9%	0
Average annual paid production	kWhr/yr	26,961,513	29,290,074	26,961,513	29,290,074
20 year Equity IRR (unadjusted)	%	10.61	16.88	19.53	29.63
20 year Equity IRR (adjusted)	%	10.61	10.61	10.61	10.61
PSO cost (incl. 0.5c balancing; SMP at 5.8c)	€/yr	406,580	240,472	133,190	0
Connection cost to consumer (financed by ESB at 4% over 50 years)	€/yr	0	0	121435	121435
Consumer cost (PSO + connection)	€/yr	406580	240472	254625	121435

Estimate of cost benefit of paying for constraint and grid

(based on author's proprietary wind project financial model)