Annex A List of project questionnaires:

- Questionnaires for E 149a and E 149b – Natural Hydro Energy "Project Highway" and Natural Hydro Energy "Project Store"
- Questionnaire for E 150 – MAREX (MAYO ATLANTIC RENEWABLE ENERGY EXPORT)
- Questionnaire for E 151 – Project CAES Larne NI
- Questionnaire for E 152 – Renewable Integration Development Project
- Questionnaire for E 153 – Grid Link
- Questionnaire for E 154 – Ireland – Great Britain Interconnector
- Questionnaire for E 155 – North South 400 kV Interconnection development
- Questionnaire for E 156 – Greenwire Interconnector
- Questionnaire for E 291 – ISLES (Irish Scottish Links on Energy Study)

Natural Hydro Energy

Natural Hydro Energy Ireland

Questionnaire II response (Project Highway)

Interconnection with the UK Market via DC link 1,200MW (this project NHE "Project Highway") to serve Large Scale Hydro Storage (90,000MWhrs) (separate project NHE "Project Store" subject of a separate application)

Please NOTE

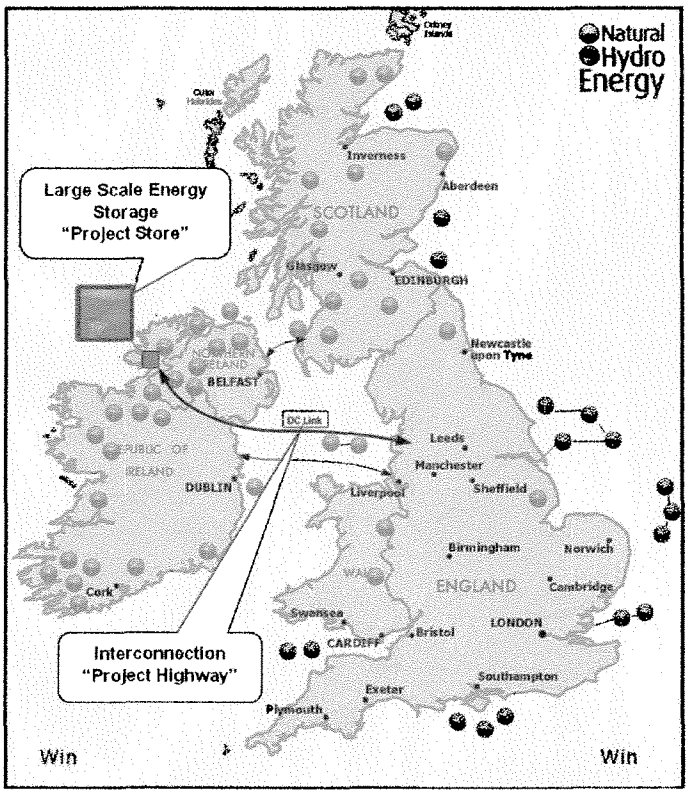
The Natural Hydro Energy overall project consists of two parts:

1. HVDC cable Interconnection between Ireland and the UK, not included in current TYNDPs, is covered by Questionnaire II (NHE Project Highway) and

2. Large scale Hydro Storage facility (NHE Project Store) is covered by Questionnaire III.

This overall project has been in development for three years. It is at an advanced stage of planning.

In this response, for clarity of understanding, Natural Hydro Energy (NHE) gives details of both aspects of this project. NHE responds to the similar questions raised in both questionnaires and the one additional question raised in Questionnaire III as a separate project.



Natural Hydro Energy

Only the DC Transmission link relevant to Questionnaire II need be considered in this response. This is designated NHE "Project Highway"

Ireland's energy resources are large and essential to EU Carbon Free Energy Security.

NOTE EU questions required to be answered in Questionnaires are shown in **BLUE PRINT.**

Responses are in BLACK PRINT

Title of the project: Natural Hydro Energy Project Highway

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: Natural Hydro Energy

☐ TSO ☐ DSO ☒ Other project promoter[1] Other Promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? Northern Seas Electricity Corridor

Natural Hydro Energy

II. Questionnaire for transmission projects not included in TYNDP

1. Reason for non-inclusion of project in TYNDP 2012

☐ No transmission license or no exemption from regulated regime; please explain:

☒ Other, please specify: Change in National Policy and economic imperative to drive energy export from Ireland to other EU countries as a means of meeting EU objectives and driving Ireland's economic recovery

2. General information

a) Name of project

Natural Hydro Energy "Project Highway"

b) Brief description

1,200MW interconnection to UK from Ireland coupling a large hydro energy store to both markets

c) Are any other project promoters involved in the project? (list each)

- Countries: ☒ EU ☐ Non-EU, please specify: United Kingdom
- Name of undertaking: Natural Hydro Energy UK Ireland Strategic Energy Infrastructure
- Contact details: Natural Hydro Energy Ltd.

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  Private company with anticipated participation by large EU utilities
- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  This information will be provided in confidence
- What is the share capital of this undertaking?

[redacted]

e) Project type

☒ New

☐ Upgrade

☐ Extension

☐ Replacement

f) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area): North West Ireland
- End point (area): Midlands UK
- Length (km): approximately 450km
- Route type: ☒ Onshore ☒ Offshore

g) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): 1,200MW
- Voltage (kV): 320 - 400kV
- Current: ☒DC ☐AC
- Line type: ☐ OHL ☒ Underground cable

h) Estimated project cost (capital expenditure in million euros) [redacted]

i) Planned date of commissioning (year) 2017

j) Implementation status

☐Pre-feasibility

☐Feasibility/FEED

☒Final Investment Decision (FID)

☒Permitting

☐Construction

k) Obstacles for the implementation of the investment item

☐Permit granting (please explain):

☐Regulatory treatment (please explain):

☐Financing (please explain):

☒Other (please explain): Market integration planning to be completed. This will provide greater commercial certainty

☐None

Please provide:

A list of all studies carried out so far for the project;

List of all studies carried out so far on project

Wind Studies

10 years wind generation data every 15 minutes was analysed initially from the records of Eirgrid the Transmission System Operator for the Republic of Ireland and after the introduction of the Single Electricity Market (SEM) for the combined grids of Northern Ireland and the Republic from the records of the Single Electricity Market Operator (SEMO). The total generation was divided by the installed wind turbine capacity at the appropriate time to give average wind generation per 15 min period per MW of generation over the entire grids.

The resulting data formed the basis of accurate modelling of expected wind generation. Seasonal variations, differences from year to year and in particular values for typical variations of wind generation output over time were all derived from the basic data. These results were used to model wind generation expected to be available for export and also to power pumping for hydro storage reservoirs.

Hourly wind strength records for several years were analysed from the meteorological observatories of the Irish Meteorological Service Met Eireann. Results from these studies were used to determine local wind patterns and variation between regions

Irish Demand Studies

10 years of 15 minute total national grid demand were also analysed initially from Eirgrid and later from SEMO. The demand data was used in conjunction with the wind generation data to determine, when wind generation would have to be curtailed to comply with grid stability constraints. These studies were carried out to model grid operation including potential curtailment, both with and without the National Hydro Energy Hydro Storage project in operation.

System Marginal Price Analysis

10 years of the half hourly System Marginal Price data for every trading period from Eirgrid and SEMO records was also analysed

Operational Modelling

The wind generation, demand and SMP data were three of the principal inputs used in extensive, stochastic, deterministic, modelling of operation of the Natural Hydro Energy project. A full inventory of conventional plant available for generation, the storage capacity of the hydro storage reservoir and the operational characteristics of the NHE plant permitted accurate modelling of how all components would interact together. The output performance in terms of MWh produced from all categories of plant at appropriate prices determined by standard tariff structures permitted projected financial revenues to be calculated under all possible operational scenarios.

Equipment Pricing

[redacted]

Financial Modelling

[redacted]

Storage Sites Investigation

[redacted]

Dam and Power Station Design

Extensive preliminary civil works and engineering design and costing studies were undertaken for the dam and power station structures by prominent Irish and international consultants Knight Piesold based in Vancouver Canada.

Land Acquisition and Pricing

The necessary land, approximately six square kilometres has been leased for 299 years. Detailed negotiations have been undertaken with both land owners and local communities to ensure agreement from all parties to construction of the project subject to agreed conditions.

Cable Routing

Studies into possible routes for cables linking the NHE Reservoir and power station to the greater Dublin area for interconnection to the Irish national grid and from Ireland to the UK have also been completed and are in detailed discussion with Eirgrid.

Transmission Facilities

Preliminary studies for transmission substations, AC/DC converter stations and cable design and costing have also been completed

Curtailment Studies

The most difficult problem facing Ireland's ability to meet its target of 40% of electricity generation from renewable sources in 2020 is the reduction of satisfactory economic returns to wind farm developers, due to increased curtailment of wind generation to maintain satisfactory grid stability at high levels of wind penetration. This problem has received extensive study, together with the solutions offered by the NHE project

A list of interactions with all concerned transmission system operators (TSO) and/or national regulatory authorities (NRAs): e.g. letter from TSO acknowledging receipt of application for grid connection or landing point, technical and financial proposal from TSO for connection, letter from NRA concerning the applicable legal regime for the project

Discussions and interactions began with Eirgrid Ireland in 2009 and with National Grid UK in 2011. The Storage facilities herein described are of considerable value to both TSOs. The exact nature of its operation acting separately in and between the two systems are a matter of very detailed technical analysis. This is ongoing and can be confirmed by the TSOs.

3. Specific information

a) Which EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

Ireland and UK

b) Which non-EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

None

c) Does the project cross borders directly or does it have a cross-border impact? Yes

Please specify the impact of the project on the grid transfer capability of each concerned border (in MW) 1,200MW

d) What are the main reasons for you to propose this project for consideration as a PCI?

This project very clearly meets all EU objectives for producing Carbon Free, Price Stable, Secure Power. As such, it is a perfect exemplar of integrated transnational thinking and co-operation.

The particular substantive reasons for proposing the Natural Hydro Energy project from Ireland for consideration as a PCI arise from the following factors:

- Energy sources from the periphery of the EU need to be developed to their full potential. Ireland has 6% of all of the renewable resources of the EU with 1% of the population. Ireland can make a very valuable contribution to EU needs and security.

- The availability of extensive, low cost, high wind strength, onshore wind generation sites in Ireland, far in excess of domestic requirements, to assist satisfying EU renewable generation targets is a low cost, low risk, highly secure strategy.

- This project allows for greatly increased penetration of renewable energy in the Irish market above the 40% target level.

- It allows cross border large scale energy trading.

- This, in turn, allows effective competition, with lower projected costs, for increasing renewable generation in all EU Member States, but particularly in the UK and Ireland, to meet 2020 target values.

- There are considerable economic advantages from enhanced energy trading between Ireland, UK and mainland EU.

- NHE provides greatly enhanced security of supply advantages in Ireland and UK arising from large scale hydro storage reservoirs, increased, indigenous, price stable, renewable generation and reduced reliance on imported fossil fuels.

- The project represents considerable technical advances in terms of evolution of a very cost effective design for large scale hydro storage reservoirs.

- Easing integration of intermittent renewable generation by use of large scale hydro storage reservoirs to replace parallel operation of conventional thermal generation to compensate for fluctuation in renewable output.

- Creates <u>essential</u> dispatchability of renewable generation.

- Increasing the arbitrage value of stored, night time, off peak, renewable generation by releasing it during high demand, day time periods.

EU Proposals for Renewable Generation

All EU Member States have agreed target levels of electricity generation from renewable sources by 2020 to reduce emissions of harmful green house gasses and combat climate change. Most member states will need to considerably increase investment in renewable generation, in order to meet these targets. The cost and effectiveness of investments will depend on the category, capacity and strength of the sources of renewable energy available in each Member State.

Trading mechanisms have been evolved to permit States with large amounts of cost effective renewable energy, in excess of their own projected requirements, to export power to countries facing shortages or more costly generation technologies. Hydro electric schemes have traditionally been the largest source of renewable generation worldwide. They currently supply around 19% of electricity generated in the EU. However, throughout Europe, the most economic sites have already been exploited. Limited increases in hydro capacity are planned prior to 2020, but these will fall well short of the overall increase in renewable generation needed to meet the 2020 targets.

Other than hydro, wind generation has become the most successful and cost effective source of renewable generation in recent years. Extensive new large scale wind farms are under construction.

Examination of the TYNDPs for all EU Member States covering the period up to 2020 and beyond, shows that apart from moderate increases in hydro capacity, large amounts of increased wind generation is expected to constitute the main increase in renewable generation.

Economics of Renewable Generation in the EU

Because of the large scale future role envisaged for wind generation, it is important to consider site availability and wind energy levels available across the full range of Member States. Onshore wind is rapidly approaching similar costing per MWh produced to hydroelectric power, on sites with good capacity factors. However, wind generation suffers from an important disadvantage. It, like marine and solar power, is intermittent and can not be dispatched as easily as hydro.

The relative costs of both hydro and wind generation are very dependent on capacity factors. These vary considerably across the EU. Good onshore wind sites have capacity factors in the

range 35% - 40%, with exceptional sites producing over 40% of rated capacity per annum. Hydro capacity factors depend strongly on the available head height on the site. High head Alpine and Nordic sites have capacity factors up to 55%. Medium and lower head run of the river sites lie more in the range 20% - 35%.

The working life spans of both hydro and wind generation are also important in determining cost per MWh produced. Realistic lifetimes of 80 to 100+ years are well established for hydroelectric stations, with major refurbishment intervals of around 40 years. Wind turbines have an expected economic life of 20 – 25 years.

Onshore wind and hydroelectricity are currently much less expensive than other competing forms of renewable generation such as offshore wind, marine or solar energy. However examination of the EU TYNDPs up to 2020 indicate that sites for onshore wind are becoming scarcer in many Member States, after available onshore sites have been developed. Towards 2020, it is expected, there will be greater migration to much more expensive, but more readily available offshore sites.

The UK NREAPS show plans for a very large increase in wind power from 5,430MW in 2010 to 22,450MW in 2020. This includes an increase in onshore wind of 10,850MW. However, a large increase of 10,210MW in offshore wind is also included. This will be associated with a significant increase in renewable generation costs.

Capital costs of offshore wind farms are much more expensive (currently in the range 2.5 to 3 times) than the equivalent cost per MW installed capacity of onshore sites. Erection and foundation costs increase rapidly in deeper water. Grid connection costs increase as turbines are located further offshore. Operation and maintenance costs are also much higher for offshore sites, particularly during adverse weather conditions. These increased costs are not offset by slightly higher offshore capacity factors, generally expected to be in the range 40% - 45%, off suitable coasts.

Cost / MWh produced and site availability will largely determine the increased capacity of EU renewable generation. Wind generation is expected to supply the greatest increase. Countries such as Ireland, with extensive availability of low cost, onshore sites, with high capacity factors, significantly above domestic renewable target requirements will have considerable advantages over areas with lower wind strengths and countries, where limited onshore site availability forces migration towards more extensive, but higher cost offshore locations.

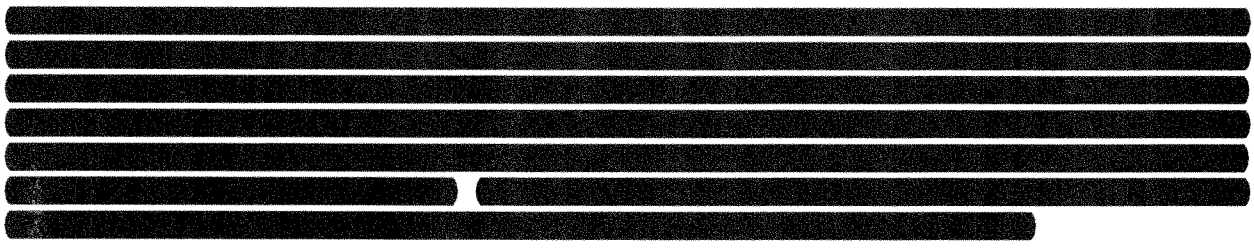
Role of Energy Storage in Increasing Penetration of Renewable Generation

One of the major difficulties experienced with integrating sources of renewable generation in large scale electricity grid structures is intermittency. Wind, solar and marine generation are

all subject to large scale variation in output over quite short time scales, depending on the intensity of the energy input. These sudden fluctuations can threaten security of supply on grids, unless output from conventional generation can be adjusted sufficiently rapidly, to compensate for the output variation from renewable sources.

In order to safely integrate intermittent, fluctuating, renewable generation, grid operators (Transmission and Distribution System Operators [TSOs & DSOs]) must ensure sufficient reserves of conventional generation are operated in parallel to the renewable sources, so that they can be ramped up or down to compensate, within adequate time response limits, for the worst potential variation in renewable output. Different categories of conventional generation exhibit greater or lesser flexibility in response time to load variation.

Conventional hydro generators and pump/turbines in pumped storage schemes have the fastest response time ranging from less than 1 minute to 2 minutes from no load to full load depending on machine size.



Either conventional hydro generation or pumped storage generation can compensate for intermittent renewable energy very effectively. Both have very rapid response times, which permit them to compensate for sudden changes in renewable output. Efficiency losses under part load operation and increased maintenance charges due to load ramping are less than for thermal plant. Hydro energy stored during high wind conditions can be released, when wind strength is low, so that the combined wind and hydro output is smoothed and in effect provides controlled amounts of dispatchable renewable energy.

Curtailment Constraints on Renewable Penetration

At the early stages of integrating intermittent renewable energy to large scale electricity grids, transmission system operators were concerned with the potential of severe excursions in renewable output to cause instability in grids. If for example, a sudden drop in wind output should occur, before sufficient conventional generation can be brought on line to compensate for the reduction, instability could occur, resulting in load shedding or possible black outs.

To avoid these problems, either sufficient fast acting reserve capacity must be available or renewable generation output may have to be curtailed. Curtailment results in undesirable loss

of potential renewable generation. Isolated or lightly interconnected grids are most vulnerable to these conditions. The island grids of Ireland and the UK will be more prone to curtailment than the much more extensive grids in mainland Europe. Stronger interconnection will alleviate this problem, but will not eliminate it.

As the smaller of these two island grids, Ireland offers an interesting insight into the possible effects of curtailment. Renewable energy is allocated priority dispatch status over conventional generation in Ireland to encourage its usage. At the early stages of introducing renewable generation, the Irish TSO was reluctant to permit more than 10% of renewable generation to operate on the grid under any demand conditions.

Increased introduction of fast reacting open cycle gas turbine plant in recent years and greater experience of operating and more accurate forecasting of renewable (primarily wind) generation has permitted this constraint to be extended considerably. Ireland now permits 50% renewable generation on the grid in normal demand conditions, but this has to be reduced to 30%, when demand is lowest.

Ireland has accepted a high target of 40% of electricity generation from renewable sources by 2020. At present, nearly 15% of total generation is supplied by renewable sources. Low levels of curtailment are already necessary on the grid in strong wind conditions, when demand is low, particularly at night time. This is expected to increase considerably as renewable generation approaches the 40% target value. Curtailment will heavily reduce the economic returns from renewable sources, unless a solution to this problem is introduced.

Unique Storage Attributes of Natural Hydro Energy Project Design

[redacted] The UK has 2800MW of pumped storage generation with 14,000MWh storage. France has 7 schemes totalling 184,000MWh. Natural Hydro Energy plans a number of reservoirs in the longer term, any two of which will equal the total French hydro storage capacity.

Most pumped storage schemes have capacity to generate at full load for between 5 to 8 hours. The first NHE project at Kilcar on the North West coast of Co. Donegal, operating under its planned 13 hour daytime generating cycle and 11 hour night pumping regime will be able to generate continuously at full load for 2 weeks, even if there is no wind input. [redacted]

[redacted]

[redacted]

[redacted] Wind curtailment is expected to be much higher at night, when system demand is low. [redacted]

This will improve the economics of off peak wind generation considerably. The increased demand needed for pumping will increase the level at which curtailment would otherwise be required. [redacted]

Interaction of the Interconnection with very large NHE storage capacity will provide a number of important advantages.

- Because much of the hydro generation will be pumped by wind generation, which would otherwise be curtailed, the overall electricity exported to the UK both directly from onshore, high capacity factor wind generation, supplemented by hydro pumped by onshore wind, will contain a very high percentage of renewable energy content. This will involve lower production costs and subsidisation than offshore wind production in the UK.

- The large storage capacity will permit variable wind generation to be supplemented by hydro electricity, ensuring fully controllable / dispatchable power throughout all export periods.

- The value of off peak renewable generation will be increased to high demand day time values

- Much less generation will be wasted due to curtailment

- The interconnector will operate at a high capacity factor and at 100% capacity during export hours

- Much lower interconnector capacity will be needed to export the steady state, average 1500MW of combined wind and hydro generation, than would be needed for the same MWh capacity of volatile wind generation, where interconnector capacity would have to match peak wind generation, while average generation may only be equivalent to 35% of peak.

- Large storage capacity will greatly increase security of supply, in ways which will be described later.

- The greater dispatchability and controllability of NHE generation, reduced difficulty and cost of parallel operational costs for conventional compensating generation, increased day time value achieved from the large capacity hydro storage combined with the low cost of high capacity factor onshore wind sites will all contribute to greater penetration of cost effective, reliable, secure, renewable generation.

Advantages of Unique Design Features of NHE Hydro Storage Reservoir

Many of the advantages of the NHE project are due to the low storage cost per MWh associated with the hydro storage reservoir. [redacted] It is expected that, subject to environmental approval and legal permitting, that the first of these projects will be sited near Kilcar in Co. Donegal in North West Ireland. [redacted]

The project will use sea water as a working medium, instead of fresh water used in nearly all other pumped storage schemes. A sea water based scheme has been operating successfully in Okinawa in Japan for the last 15 years. The ocean will be used as the lower reservoir in the scheme. This greatly reduces construction costs normally associated with artificially created lower reservoirs in conventional pumped storage schemes.

The projects rely on the use of naturally occurring glacial formations created in the last ice age, which in a few rare instances created high valleys suitable for energy storage. Since Ireland has a very low level of seismic activity, a rock fill dam can safely be used to form an upper reservoir for the scheme. This is a less expensive form of construction than traditional concrete dam construction methods.

The dam is expected to be approximately 1.3km in length and will have a possible height of 120m at mid point. It will be constructed at the mouth of a long glacial valley. Having to dam only one end of a long narrow valley provides very large capacity in the upper reservoir in

comparison to many conventional pumped storage schemes, where the reservoir is formed by a curtain dam, which completely encircles the reservoir. The geology of the valley floor is made up of primarily impermeable rock.

Water will be carried from the dam in multiple steel penstocks. The distance from the dam to the power house varies from 1 to 3 km on the sites selected by Natural Hydro Energy. The ground slopes gently over the intervening territory and provides heads ranging from 180 to 230m. The penstocks will be laid close to the surface of the ground in shallow covered trenches to minimise environmental impact. Using penstocks greatly reduces excavation and tunnelling costs for machine hall caverns, water head and tail race, access and cable tunnels frequently associated with conventional pumped storage schemes.

The first Natural Hydro Energy power station will be located in the North West of Ireland and will have 10 x 150MW Francis type pump/turbines totalling 1500MW capacity. It will be located approximately 2.5km from the dam. The head between the dam and the powerhouse will be approximately 230m on this site. The storage capacity of the reservoir with approximately 4 square km surface area will be 90,000MWh.

The power station will be connected to the ocean by a short channel. Rock for construction of the dam will come from excavations for the channel and the power station site, which must be located in a cutting to accommodate water transit from the draught tubes of the pump/turbines to the ocean 25m below minimum tide level. This local source of rock minimizes dam construction costs by eliminating the need to transport rock from outside the site.

This unusual design provides exceptionally large storage capacity of 90,000MWhs. Ireland has the potential for up to 300,000 MWhrs. This compares very favourably to the storage capacity of pumped storage schemes in the following countries.

	MWh
Spain	1,530,000
Switzerland	369,000
France	184,000
Austria	125,000
Portugal	107,000
Lithuania	49,000
Germany	39,000
UK	33,000
Greece	21,000
Poland	11,000
Belgum	8,000
Czech Republic	7,000
Luxemborg	6,000
Slovakia	4,000
Ireland	2,000
Bulgaria	1,000

Eurelectric 2020 Report "Hydro in Europe" Powering Renewables"

The Natural Hydro Energy design provides very large, low cost storage capacity to compensate for intermittent wind generation. Two of these Irish schemes would provide equivalent storage to all 7 of the pumped storage schemes in France, which provide important peak capacity in addition to France's 78% nuclear generation capacity.

This provides the advantage of an exceptional storage cycle length of a minimum of 2 weeks in zero wind conditions, which effectively eliminates intermittency. The Natural Hydro Energy power station can operate indefinitely in only intermittent light to moderate wind conditions. This advantage arises from the unique geographic topography of the long, narrow, sloping, Irish glacial valley sites.

UK Generation Capacity Plans

The UK faces two major challenges to generation capacity up to 2020 and shortly beyond. The existing UK nuclear stations are approaching the end of their economic working life. Most of the first generation Magnox stations have already been closed. All of the remaining 9.3GW Magnox and second generation Avanced Gas Cooled Reactor stations with the exception of Sizewell B are planned to close by 2023.

The remaining 3 oil fired stations and a number of old coal fired stations have chosen to opt out of the requirements for flue gas desulphurization imposed by the EU Large Combustion Plant Directive. A total of 12GW of these stations will have to close by the end of 2015. The continued economic viability of the remaining 20GW of more modern coal fired stations will depend on the costs of new Carbon Capture and Storage technology, which is currently undergoing pilot scheme evaluation.

In addition to the requirements to replace the nuclear and conventional stations facing closure, the UK must greatly increase generation from renewable sources to meet its 2020 target of 30%. This includes NREAP plans to increase onshore wind capacity by 10,850MW and offshore wind by 10,210MW. The migration to more offshore sites as onshore capacity approaches saturation will significantly increase cost of renewable generation.

The closure of the UK nuclear and fossil fuel fired stations together with the large requirement for increased renewable generation will open the UK market to possible imports of cost effective, renewable energy up to 2020. Ireland, with a large surplus of high capacity factor onshore wind farm sites on land with low agricultural and commercial value, well in excess of

its own renewable target requirements, will be in a strong position to compete for this potential market.

Ireland has two further important advantages. Its proximity to the UK reduces the length and hence cost of interconnectors. The advantages of the large scale hydro storage reservoirs proposed by the NHE project will also enhance the attraction of dispatchable, cost effective renewable energy imports from Ireland over interconnectors operating at high load factors during high demand day time trading periods.

Renewable Generation from Ireland Aided by Large Scale Storage

Finally, the main reasons, why the NHE project should be proposed for consideration as a PCI are as follows:

- It exploits extensive availability of economic, high strength, onshore wind resources in Ireland with offshore and wave available long term. This will earn valuable revenue for Ireland and greatly assist the UK meet its renewable generation targets benefiting emissions reduction and suppressing climate change in both countries

- Plentiful land with low agricultural or commercial value remains in Ireland, which offers the strongest wind and wave strengths in Europe. These are ideal conditions to expand cost effective sustainability between two cooperating Member States within the EU.

- The Irish home market for power generation is saturated. The only possible utilization of the valuable Irish renewable site potential is for export.

- Limited interconnection capacity is currently available out of Ireland. Much higher capacity would be required to fully exploit Ireland's valuable renewable assets. The NHE project offers a large increase in capacity, which will operate at very high load factors due to the benefits of high capacity storage smoothing peaky export flows from renewable generation.

- Ireland's population density is low on the west coast, which resulted in appropriate grid capacity, when they were constructed. The strong sites for renewable generation are also on the Atlantic coast. Extensive grid reinforcement is needed from wind and wave rich resource western areas to the east coast for export to the UK or Mainland Europe. The NHE project will make major contributions to grid reinforcement at no cost to the state.

- Due to the economic recession, the Irish state would have difficulty in providing funding for this size of project. NHE proposes to arrange funding from private sources, in a manner that will still provide substantial benefits to Ireland.

- The proximity of the UK to Ireland will require moderate interconnection costs to exploit Irelands valuable renewable resources combined with large scale, low cost storage.

e) How will the project facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

Market Integration

The NHE project will immediately provide a large increase in interconnection capacity between Ireland and UK. In the longer term, it opens potential for further future interconnection between Ireland, France and mainland Europe via the UK.

The UK is facing difficulties with adequate overall future generation capacity, due to closure of both nuclear and fossil fuel fired plant. In addition, it expects to implement a very large expansion in renewable plant to meet its 2020 target. As the renewable construction programme progresses, the UK plans indicate increased development of around 50% of new wind capacity on expensive offshore sites, after its onshore sites are fully exploited. NHE could assist UK solve some of its generation shortfall and or meet its renewable targets economically.

Ireland has the potential to offer a large export capacity of surplus, dispatchable, low cost, onshore wind generation well in excess of Ireland's own foreseeable home market requirements. Ireland's onshore wind sites have some of the highest wind strength conditions in the World. This advantage coupled with low land values can provide wind generation at very competitive prices.

In addition to high quality onshore sites, the long storage cycle, high capacity, low cost, hydro storage potential will complement strong wind sites. The combined output from both sources will be dispatchable. The value of off peak wind generation will be greatly increased by dispatching it during high cost trading periods, when demand is highest. The large economic storage capacity of the Irish storage reservoirs will ensure that both wind and hydro can complement each other indefinitely, even during protracted periods of low wind strength. Losses due to curtailment will be minimised, which will further improve the economics of NHE generation.

Both Irish onshore wind site and hydro storage capacity is far in excess of Irish home market requirements. The only means by which Irelands valuable assets can be exploited is through export. Many Member States will face more expensive solutions to reach their 2020 targets. There has already been controversy in the UK over the cost of offshore wind sites combined

with the additional cost of parallel operation of conventional generation at part load to compensate for wind intermittency. Availability of large amounts of dispatchable, renewable generation from Ireland at attractive prices will further market integration and encourage increased penetration of renewable generation.

Elimination of Isolated Markets

Ireland is no longer strictly speaking an isolated market, since one interconnector to the UK has been in operation for some time and a second is due for commissioning shortly. However, in comparison to the highly interconnected networks of mainland Europe, Ireland's island market is still relatively isolated to a large degree.

The NHE project will greatly reduce this isolation by providing extensive new interconnection capacity. This increased capacity will be essential to exploit Ireland's valuable wind and hydro capacity. By smoothing out peaks and valleys in wind output, the complementary hydro storage will ensure high load factors on interconnectors during export periods. This will minimise interconnection costs.

Competition

One of the primary aims of opening the electricity market is that competition will encourage cost effective prices. The 2020 targets for renewable generation will introduce a new aspect of competition to the open market. Not only will market competition continue between all suppliers, because of the large increases in renewable generation required to meet targets, specialised competition is likely to develop in this sector for the most cost effective renewable sources.

Future increases in fossil fuel prices and renewable technology improvements will continue to improve the competitive position of cost effective, renewable generation, with no fuel costs, in comparison to conventional sources Renewable generation has no fuel costs. Not only are continuously rising fuel prices effecting the electricity market with knock on effects to other industries, concern is increasing in many countries over security of future fuel supplies. This is most acute among countries with limited or no indigenous fossil fuel supplies.

These two important market forces will continue to increase competition between conventional generation and secure, emissions free, price stable renewable energy. Dispatchable, renewable energy will provide an additional bonus. Most Member States will be under pressure to increase renewable generation to meet 2020 targets initially and increasing targets beyond 2020. Competition for cost effective sources is likely to increase. Not only will

generation companies seek competitive renewable sources, these will also be attractive to many industries under pressure to reduce emissions.

Limited availability of high capacity factor, low cost, onshore wind sites in many member states will increase migration of renewable generation towards more expensive offshore sites. This trend will continue to improve the competitive position of onshore sites, with good wind strengths, on land with low agricultural or commercial value.

Ireland has the highest onshore and offshore wind strengths in Europe, plus the strongest wave energy levels. It has abundant sites for high capacity factor, low cost onshore wind generation. There is extensive availability of low value land. The NHE project will avail of all of these competitive advantages to the fullest extent.

The NHE design combined with low seismic activity and unique Irish glacial valley topography, geography and geology offers exceptionally large capacity hydro storage capacity at low cost. NHE hydro storage reservoirs can absorb and store low value, off peak, surplus wind generation to pump hydro into storage and release it later during high demand periods. This is a very important competitive advantage of NHE over conventional onshore generation, without access to storage facilities.

NHE hydro storage will eliminate wastage of curtailed surplus generation in high strength wind conditions above safe grid acceptance levels resulting in further increase in advantages. In low wind conditions, NHE reservoirs can store valuable, high efficiency, low cost, conventional generation, which would otherwise be displaced/unused at night by increased wind penetration.

NHE hydro generation backed up by long term storage will smooth out peaks and valleys in wind generation. This will ensure highly efficient use and low cost design of transmission facilities connecting NHE combined wind and hydro generation to the UK grid. The close proximity of Ireland to the UK market will contribute to low interconnection costs. Low transmission costs will increase NHEs competitive position for exports.

System Flexibility

The NHE project offers a number of important enhancements to flexibility in the Irish grid as well as excellent flexibility in its own internal operations. Conventional hydro turbines and pump/turbines used in hydro storage schemes have the fastest ramping speeds to increase load in emergency situations of any generation category. This makes them ideal for fast reaction to compensate for rapid load changes in intermittent/volatile renewable generation.

The NHE pump/turbines can offer this rapid response flexibility indefinitely, because of the very large capacity of the hydro storage reservoirs and the long pump/generation cycles this storage can support. Most conventional pumped storage schemes have only generation capacity at full load of around 5 to 8 hours. NHE can effectively offer fast response continuously for indefinite periods of time.

In addition to flexible load following services, NHE will offer 1500 MW of the highest reaction speed of spinning reserve to both Irish and UK grids. This is a very valuable asset to both systems to assist recovery from serious fault conditions and protect against catastrophic grid failures and blackouts.

Pumped storage plant has another important inherent spinning reserve advantage over equally fast reacting conventional hydro generators and all other generation categories. It has the ability, under serious grid fault conditions, when operating in pumping mode, to stop pumping and eliminate this demand. It can then change to generation mode and supply the same amount of additional generation. In this way, it effectively doubles the amount of spinning reserve that can be offered to recover from faults.

There is significant concern about inertia on the Irish grid system as penetration of new wind farms increases. Modern direct drive wind turbines are decoupled from the grid through AC/DC converters used for frequency conversion and do not supply any inertia to the grid. As new wind penetration increases, this reduces the effective inertia supplied to the grid by conventional generators, which are displaced by the new wind turbines. Reduction in inertia, decreases the reaction time available for spinning reserve to compensate for serious faults. This increases the risk of load shedding or even catastrophic blackouts.

Finally, the NHE hydro generators will supply large amounts of reactive power to the grids to which it is connected. This is valuable for accurate voltage regulation and improving supply quality.

Impact on energy system-wide generation and transmission costs.

[redacted] This combination produces very low cost renewable energy. Clearly, EU renewable generation costs to meet targets will benefit to the maximum extent from this approach.

The impact on overall generation costs will depend on the ratio of renewable and conventional generation adopted by each Member State, to meet 2020 targets, as well as the technologies used. Hydro and onshore wind are the cost leaders in the renewable sector. Combined Cycle Gas Turbine (CCGT) technology leads the fossil fuel sector. Nuclear costs are much more

difficult to compare, due to the diverse manner in which decommissioning, waste handling costs and depreciation over various claimed economic lifetimes are charged.

Recent improvements in wind turbine technology, resulting in better performance and reduced cost per MW installed, have contributed to lower costs per MWh produced. Increasing European gas prices, after the severe price drop immediately after the start of the economic recession, have increased CCGT price per MWh produced. These two opposing trends have tended to close the gap between renewable and conventional costs.

Future values will naturally be influenced by fuel prices and availability. Renewable costs have no fuel costs and capital costs are expected to fall slowly due to design improvements and cost reduction due to economies of scale from increased production volumes.

The advantages of the NHE storage facilities in smoothing peaks and valleys in transmission capacities have already been explained. The proximity of Ireland and the UK provide a second saving arising from short cable lengths.

f) How will the project facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly and indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

In the longer term, Ireland has both sufficient potential onshore wind site and hydro storage capacity to supply 100% of its foreseeable electricity demand from renewable sources and still have a large surplus for export. More wind and storage capacity is expected be employed in the future to satisfy Irish demands as existing economic conventional generation is retired. The potential surplus of Irish capacity can only be seriously deployed by export via DC undersea cables to the UK and or France and possibly onward to major consumption centres in Europe.

The large hydro storage sites on the west coast of Ireland are adjacent to areas with strongest wind resources. Hence no long transmission links are needed between the contracted NHE wind generation and storage sites. Wind generation on the National Grid that must be curtailed for system security could in theory be absorbed at any connection point between the national grid and the NHE DC link from the hydro storage site to the UK. In practice, the two systems will need to connect at a suitable strong point in the grid, capable of handling the large 1200MW load. This is most likely to be in the greater Dublin area.

All NHE renewable onshore generation will be both directly connected and indirectly connected via the hydro storage reservoirs to the HVDC transmission interconnecting cables linking the natural energy power generation and storage stations to major demand centres in the UK.

The nature of the NHE project makes it more difficult to specify the capacity and type of renewable generation that will be connected. Two sources of primarily onshore wind generation are planned to be used. Purely onshore wind generation totalling 700MW is planned to be contracted exclusively to NHE for export from suppliers.

The second major source of wind is planned to be generation imported from the national grid that would otherwise have to be curtailed. This will be drawn from the full National wind generation pool, which is expected to total around 6400MW for the SEM to meet 2020 targets. This wind will be primarily onshore, but may have some small offshore content. Both wind sources are expected to have 12MW installed capacity per km^2.

The first NHE pumped storage station will be rated at 1500 MW. The associated reservoir is expected to occupy approximately $4km^2$.

These parameters are only for the first NHE project. The application backlog for new wind generation licences in Ireland indicates availability of up to 15,000MW of potential onshore capacity between existing and potential new sites and much more offshore capacity. [redacted] A primary site has been agreed and initial negotiations with land owners are progressing with the next two sites.

g) How will the project contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience

Although the primary aim of the project is for energy export, an agreement has been made with the Irish authorities that priority will be assigned to assisting the Irish grid in times of difficulties. The worst failure condition envisaged for the Irish grid is failure of the largest generating set. This is a 450MW CCGT unit. Hence, the NHE 1500MW can supply far more fast reacting spinning reserve than was ever envisaged for the Irish grid. Under normal operation services on the Irish grid, this spinning reserve can be availed of on the UK grid.

In addition to the valuable spinning reserve capability offered by NHE, the pump turbines will supply 1500MW of additional inertia to whichever grid they are connected. This service is of considerable value due to the reduction in inertia arising from increasing penetration of modern direct drive wind turbines, which provide no inertia.

The increase in wind energy provided by the project reduces dependence on imported fossil fuel on which the UK and Ireland are dependent. This in turn increases security of supply.

Increased wind strengths may increase curtailment. This will be countered by using the excessive wind generation to power pumping for hydro storage. This valuable energy, which would otherwise be wasted can be released for use later, when required.

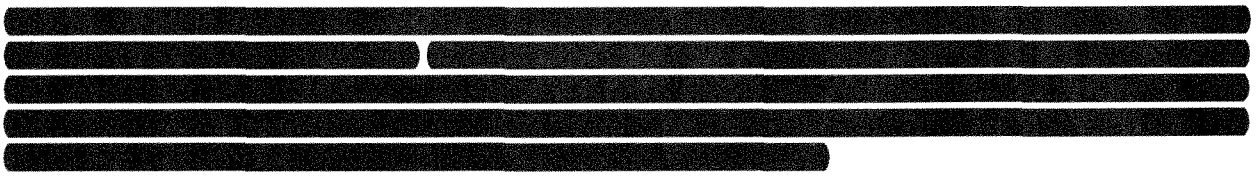
The limit on the project output will be determined by the capacity of the DC transmission cable to the UK. This is designed for continuous operation at 1200MW. Under fault conditions, on one of the two DC cables, standby service can be maintained on the second cable at 600MW. In terms of impact on the UK grid, this is equivalent to the loss of one large generator on the very extensive UK grid.

Ireland has a temperate climate. It is not subject to extreme weather events such as hurricanes, tornadoes or ice storms. It is therefore not anticipated that the NHE project will be subject to extreme weather conditions. The large storage capacity of the hydro storage reservoirs will ensure continuous operation for a minimum period of 2 weeks with no wind generation, under the operational cycle planned for the project. No wind for 2 weeks is an extremely rare occurrence in Ireland.

h) Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

i) Market Integration and Competition

The NHE project will provide 1200MW increased interconnection capacity between Ireland and UK. This is more than the combined existing Moyle and the planned EWIC interconnectors. It will react to a window of opportunity to ease potential UK generation shortfalls from the closure of nuclear and older fossil fuelled stations and may assist UK meet its renewable target. Power will be traded over interconnectors operating very efficiently at high load factors during trading periods. This effective use of interconnector capacity by smoothing out fluctuations in wind generation by supplementary hydro will reduce the cost of interconnection capacity and encourage more trading of renewable energy.



ii) Sustainability

Sustainability will be enhanced by increased integration of high levels of renewable, emissions free generation. Energy wastage due to curtailment will be reduced. High load factors on interconnectors will reduce associated costs and encourage more renewable trading

iii) Security of Supply

NHE will supply 1500MW of very fast response spinning reserve. This pumped storage, spinning reserve will have twice the reserve effects of conventional generation due to its ability to change from pumping to generating mode. NHE will also supply large inertia and extensive reactive power to assist stability and voltage control.

i) Are there any interdependencies and/or complementarities with other projects? If yes, which?

The existing 500MW Moyle undersea interconnector already links the UK and Irish grids. A new East West 500MW interconnector (EWIC) nearing completion by Eirgrid the Irish TSO between Ireland and the UK is to enter service shortly. These were both planned to provide normal interconnection services between the two national grids prior to plans for the 1200MW NHE interconnector. NHE is specifically planned to provide export of new renewable generation to the UK over the Irish requirement needed to meet its 2020 target. This is not expected to interfere with the services planned for the Moyle and EWIC links. On the contrary, it is hoped that spare capacity on these links may be used to export more NHE hydro generation.

The NHE project will have one very important interdependency with all other intermittent renewable generation projects in Ireland. Grid security constraints on the Irish grid have already introduced the need for curtailment of wind generation in strong wind conditions, even though only around 15% of generation is being supplied from renewable sources. Curtailment will have to increase significantly as renewable generation approaches its 40% 2020 target. The reduced income from curtailed wind generation will inevitably reduce the incentives for new wind farm construction. The large hydro storage content of the NHE project will greatly reduce curtailment and support further construction of renewable energy in Ireland.

The questions raised in sections d) to i) of Questionnaire II have been answered above. These are very similar to the questions e) to j) in Questionnaire III listed below, with the exception of g). This is answered separately below.

Conclusion

Integration of Ireland's extensive energy resources (6% of 27 member states) into the union makes complete economic, technical and political sense. This is s project of considerable importance.

Thank you.

Natural Hydro Energy

Natural Hydro Energy Ireland

Questionnaire III response (Project Store only)

Large Scale Hydro Storage (90,000MWhrs) NHE "Project Store" to be interconnected with the UK Market via DC link 1,200MW (NHE "Project Highway" subject of a separate application)

Please NOTE

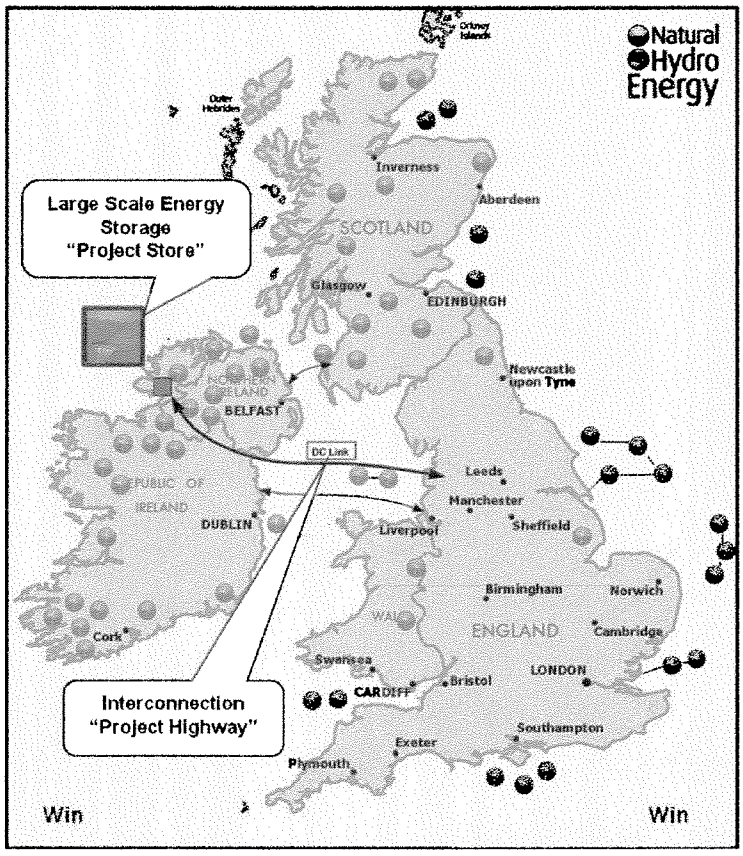
The Natural Hydro Energy overall project consists of two parts:

1. HVDC cable Interconnection between Ireland and the UK, not included in current TYNDPs, is covered by Questionnaire II (NHE "Project Highway") and

2. Large scale Hydro Storage facility (NHE "Project Store") is covered by Questionnaire III.

The overall project has been in development for three years. It is at an advanced stage of planning.

In this response, for clarity of understanding, Natural Hydro Energy (NHE) gives details of both aspects of this project. NHE responds to the similar questions raised in both questionnaires as a separate project.



Natural Hydro Energy

Only the hydro storage reservoir and associated power station relevant to Questionnaire III need be considered in this response. This is designated NHE Project Store. Details of the transmission link are for information purposes only.

Ireland's energy resources are large and essential to EU Carbon Free Energy Security.

NOTE EU questions required to be answered in Questionnaires are shown in **BLUE PRINT.**

Responses are in BLACK PRINT

Title of the project: Natural Hydro Energy Project Store

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: Natural Hydro Energy

☐ TSO ☐ DSO ☒ Other project promoter[1] Other Promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? Northern Seas Electricity Corridor

Natural Hydro Energy

III. Questionnaire for electricity storage projects

1. General information

a) Name of project

Natural Hydro Energy "Project Store"

b) Brief description

90,000MWhrs fast acting Hydro Energy Storage primarily serving the Irish and UK markets

c) Are any other project promoters involved in the project? (list each)

- Countries: ☒ EU ☐ Non-EU, please specify: United Kingdom
- Name of undertaking: Natural Hydro Energy UK Ireland Strategic Energy Infrastructure
- Contact details: Natural Hydro Energy Ltd.

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  Private company with anticipated participation by large EU utilities
- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  This information will be provided in confidence
- What is the share capital of this undertaking?

[redacted]

e) Project type

☒ New
☐ Upgrade
☐ Extension
☐ Replacement

f) Key geographical characteristics ***[please submit map indicating information given below]***

- Location: North West Ireland
- Connection point to transmission network: North West Ireland

g) Key technical characteristics

- Technology (please describe as necessary) Hydro Storage
- Installed generation power (MW) 1,500MW

- Installed generation capacity (GWh) 90 GWhrs.
- (for hydro-pumped storage) Net pumping power (MW) 1500MW
- Response time (seconds) 15 seconds
- Energy rating of storage (minutes) 5,400,000 MW minutes
- Power density of storage (W/kg) Not applicable
- Energy density of storage (Wh/kg) Not applicable
- Round-trip efficiency (charging-discharging) (%) 81%
- Lifetime (years) – for new installations, please specify expected lifetime from start of operation; for upgraded, repowered, retrofitted or extended installations, please specify how this will affect remaining expected lifetime. 40 years before refit in a lifetime of in excess of 80 years.
- Cycles – for battery storage, please specify the expected number of cycles over the lifetime of the battery; for pumped hydro storage, please specify the number of cycles per day (for a given expected lifetime). Normally 1 cycle per day in standard operating mode for in excess of 80 years. Multiple cycles may be used under certain circumstances.
- Voltage at connection point (kV): 320kV DC converted to 400kV AC

h) Estimated project cost (capital expenditure in million euros) [redacted]

i) Planned date of commissioning (year) 2019

j) Implementation status

- ☐ Pre-feasibility
- ☐ Feasibility/FEED
- ☒ Final Investment Decision (FID)
- ☒ Permitting
- ☐ Construction

k) Obstacles for the implementation of the investment item

- ☐ Permit granting (please explain)
- ☐ Regulatory treatment (please explain):
- ☐ Financing (please explain):
- ☒ Other (please explain): Market integration planning to be completed.

  This will provide greater commercial certainty
- ☐ None

2. Specific information

a) Which EU Member States are involved or affected by the project, at which borders?

Ireland and United Kingdom

b) Are any non-EU Member States involved or affected by the project, at which borders?

None

c) Does the project cross borders directly or does it have a cross-border impact? Please specify the installed generation capacity and the average net annual electricity generation capacity over the first 20 years of the project (GWh/year), using appropriate modelling results

13GWh per year Generation capacity over first 20 years 260GWhrs over 20 years

d) What are the main reasons for you to propose this project for consideration as a PCI?

This project very clearly meets all EU objectives for producing Carbon Free, Price Stable, Secure Power. As such, it is a perfect exemplar of integrated transnational thinking and co-operation.

The particular substantive reasons for proposing the Natural Hydro Energy project from Ireland for consideration as a PCI arise from the following factors:

- Energy sources from the periphery of the EU need to be developed to their full potential. Ireland has 6% of all of the renewable resources of the EU with 1% of the population. Ireland can make a very valuable contribution to EU needs and security.

- The availability of extensive, low cost, high wind strength, onshore wind generation sites in Ireland, far in excess of domestic requirements, to assist satisfying EU renewable generation targets is a low cost, low risk, highly secure strategy.

- This project allows for greatly increased penetration of renewable energy in the Irish market above the 40% target level.

- It allows cross border large scale energy trading.

- This, in turn, allows effective competition, with lower projected costs, for increasing renewable generation in all EU Member States, but particularly in the UK and Ireland, to meet 2020 target values.

- There are considerable economic advantages from enhanced energy trading between Ireland, UK and mainland EU.

- NHE provides greatly enhanced security of supply advantages in Ireland and UK arising from large scale hydro storage reservoirs, increased, indigenous, price stable, renewable generation and reduced reliance on imported fossil fuels.

- [redacted]

- Easing integration of intermittent renewable generation by use of large scale hydro storage reservoirs to replace parallel operation of conventional thermal generation to compensate for fluctuation in renewable output.

- Creates essential Dispatchability of renewable generation.

- Increasing the arbitrage value of stored, night time, off peak, renewable generation by releasing it during high demand, day time periods.

EU Proposals for Renewable Generation

All EU Member States have agreed target levels of electricity generation from renewable sources by 2020 to reduce emissions of harmful green house gasses and combat climate change. Most member states will need to considerably increase investment in renewable generation, in order to meet these targets. The cost and effectiveness of investments will depend on the category, capacity and strength of the sources of renewable energy available in each Member State.

Trading mechanisms have been evolved to permit States with large amounts of cost effective renewable energy, in excess of their own projected requirements, to export power to countries facing shortages or more costly generation technologies. Hydro electric schemes have traditionally been the largest source of renewable generation worldwide. They currently supply around 19% of electricity generated in the EU. However, throughout Europe, the most economic sites have already been exploited. Limited increases in hydro capacity are planned prior to 2020, but these will fall well short of the overall increase in renewable generation needed to meet the 2020 targets.

Other than hydro, wind generation has become the most successful and cost effective source of renewable generation in recent years. Extensive new large scale wind farms are under construction.

Examination of the TYNDPs for all EU Member States covering the period up to 2020 and beyond, shows that apart from moderate increases in hydro capacity, large amounts of increased wind generation is expected to constitute the main increase in renewable generation.

Economics of Renewable Generation in the EU

Because of the large scale future role envisaged for wind generation, it is important to consider site availability and wind energy levels available across the full range of Member States. Onshore wind is rapidly approaching similar costing per MWh produced to hydroelectric power, on sites with good capacity factors. However, wind generation suffers from an important disadvantage. It, like marine and solar power, is intermittent and can not be dispatched as easily as hydro.

The relative costs of both hydro and wind generation are very dependent on capacity factors. These vary considerably across the EU. Good onshore wind sites have capacity factors in the range 35% - 40%, with exceptional sites producing over 40% of rated capacity per annum. Hydro capacity factors depend strongly on the available head height on the site. High head Alpine and Nordic sites have capacity factors up to 55%. Medium and lower head run of the river sites lie more in the range 20% - 35%.

The working life spans of both hydro and wind generation are also important in determining cost per MWh produced. Realistic lifetimes of 80 to 100+ years are well established for hydroelectric stations, with major refurbishment intervals of around 40 years. Wind turbines have an expected economic life of 20 – 25 years.

Onshore wind and hydroelectricity are currently much less expensive than other competing forms of renewable generation such as offshore wind, marine or solar energy. However examination of the EU TYNDPs up to 2020 indicate that sites for onshore wind are becoming scarcer in many Member States, after available onshore sites have been developed. Towards 2020, it is expected, there will be greater migration to much more expensive, but more readily available offshore sites.

The UK NREAPS show plans for a very large increase in wind power from 5,430MW in 2010 to 22,450MW in 2020. This includes an increase in onshore wind of 10,850MW. However, a large increase of 10,210MW in offshore wind is also included. This will be associated with a significant increase in renewable generation costs.

Capital costs of offshore wind farms are much more expensive (currently in the range 2.5 to 3 times) than the equivalent cost per MW installed capacity of onshore sites. Erection and foundation costs increase rapidly in deeper water. Grid connection costs increase as turbines are located further offshore. Operation and maintenance costs are also much higher for offshore sites, particularly during adverse weather conditions. These increased costs are not

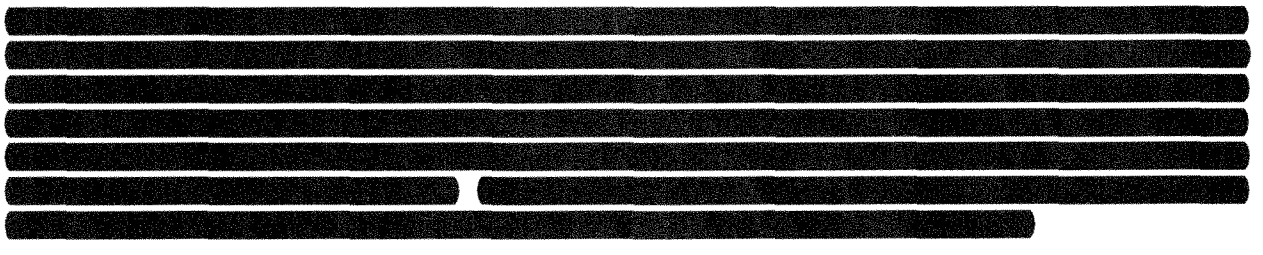
offset by slightly higher offshore capacity factors, generally expected to be in the range 40% - 45%, off suitable coasts.

Cost / MWh produced and site availability will largely determine the increased capacity of EU renewable generation. Wind generation is expected to supply the greatest increase. Countries such as Ireland, with extensive availability of low cost, onshore sites, with high capacity factors, significantly above domestic renewable target requirements will have considerable advantages over areas with lower wind strengths and countries, where limited onshore site availability forces migration towards more extensive, but higher cost offshore locations.

Role of Energy Storage in Increasing Penetration of Renewable Generation

One of the major difficulties experienced with integrating sources of renewable generation in large scale electricity grid structures is intermittency. Wind, solar and marine generation are all subject to large scale variation in output over quite short time scales, depending on the intensity of the energy input. These sudden fluctuations can threaten security of supply on grids, unless output from conventional generation can be adjusted sufficiently rapidly, to compensate for the output variation from renewable sources.

In order to safely integrate intermittent, fluctuating, renewable generation, grid operators (Transmission and Distribution System Operators [TSOs & DSOs]) must ensure sufficient reserves of conventional generation are operated in parallel to the renewable sources, so that they can be ramped up or down to compensate, within adequate time response limits, for the worst potential variation in renewable output. Different categories of conventional generation exhibit greater or lesser flexibility in response time to load variation. Conventional hydro generators and pump/turbines in pumped storage schemes have the fastest response time ranging from less than 1 minute to 2 minutes from no load to full load depending on machine size.



Either conventional hydro generation or pumped storage generation can compensate for intermittent renewable energy very effectively. Both have very rapid response times, which permit them to compensate for sudden changes in renewable output. Efficiency losses under part load operation and increased maintenance charges due to load ramping are less than for thermal plant. Hydro energy stored during high wind conditions can be released, when wind

strength is low, so that the combined wind and hydro output is smoothed and in effect provides controlled amounts of dispatchable renewable energy.

Curtailment Constraints on Renewable Penetration

At the early stages of integrating intermittent renewable energy to large scale electricity grids, transmission system operators were concerned with the potential of severe excursions in renewable output to cause instability in grids. If for example, a sudden drop in wind output should occur, before sufficient conventional generation can be brought on line to compensate for the reduction, instability could occur, resulting in load shedding or possible black outs.

To avoid these problems, either sufficient fast acting reserve capacity must be available or renewable generation output may have to be curtailed. Curtailment results in undesirable loss of potential renewable generation. Isolated or lightly interconnected grids are most vulnerable to these conditions. The island grids of Ireland and the UK will be more prone to curtailment than the much more extensive grids in mainland Europe. Stronger interconnection will alleviate this problem, but will not eliminate it.

As the smaller of these two island grids, Ireland offers an interesting insight into the possible effects of curtailment. Renewable energy is allocated priority dispatch status over conventional generation in Ireland to encourage its usage. At the early stages of introducing renewable generation, the Irish TSO was reluctant to permit more than 10% of renewable generation to operate on the grid under any demand conditions.

Increased introduction of fast reacting open cycle gas turbine plant in recent years and greater experience of operating and more accurate forecasting of renewable (primarily wind) generation has permitted this constraint to be extended considerably. Ireland now permits 50% renewable generation on the grid in normal demand conditions, but this has to be reduced to 30%, when demand is lowest.

Ireland has accepted a high target of 40% of electricity generation from renewable sources by 2020. At present, nearly 15% of total generation is supplied by renewable sources. Low levels of curtailment are already necessary on the grid in strong wind conditions, when demand is low, particularly at night time. This is expected to increase considerably as renewable generation approaches the 40% target value. Curtailment will heavily reduce the economic returns from renewable sources, unless a solution to this problem is introduced.

Natural Hydro Energy

Unique Storage Attributes of Natural Hydro Energy Project Design

[redacted] The UK has 2800MW of pumped storage generation with 14,000MWh storage. France has 7 schemes totalling 184,000MWh. Natural Hydro Energy plans a number of reservoirs in the longer term, any two of which will equal the total French hydro storage capacity.

Most pumped storage schemes have capacity to generate at full load for between 5 to 8 hours. The first NHE project at Kilcar on the North West coast of Co. Donegal, operating under its planned 13 hour daytime generating cycle and 11 hour night pumping regime will be able to generate continuously at full load for 2 weeks, even if there is no wind input. [redacted]

[redacted]

[redacted]

[redacted] Wind curtailment is expected to be much higher at night, when system demand is low. [redacted]

This will improve the economics of off peak wind generation considerably. The increased demand needed for pumping will increase the level at which curtailment would otherwise be required. [redacted]

Interaction of the Interconnection with very large NHE storage capacity will provide a number of important advantages.

- Because much of the hydro generation will be pumped by wind generation, which would otherwise be curtailed, the overall electricity exported to the UK both directly from onshore, high capacity factor wind generation, supplemented by hydro pumped by onshore wind, will contain a very high percentage of renewable energy content. This will involve lower production costs and subsidisation than offshore wind production in the UK.

- The large storage capacity will permit variable wind generation to be supplemented by hydro electricity, ensuring fully controllable / dispatchable power throughout all export periods.

- The value of off peak renewable generation will be increased to high demand day time values

- Much less generation will be wasted due to curtailment

- The interconnector will operate at a high capacity factor and at 100% capacity during export hours

- Much lower interconnector capacity will be needed to export the steady state, average 1500MW of combined wind and hydro generation, than would be needed for the same MWh capacity of volatile wind generation, where interconnector capacity would have to match peak wind generation, while average generation may only be equivalent to 35% of peak.

- Large storage capacity will greatly increase security of supply, in ways which will be described later.

- The greater Dispatchability and controllability of NHE generation, reduced difficulty and cost of parallel operational costs for conventional compensating generation, increased day time value achieved from the large capacity hydro storage combined with the low cost of high capacity factor onshore wind sites will all contribute to greater penetration of cost effective, reliable, secure, renewable generation.

Advantages of Unique Design Features of NHE Hydro Storage Reservoir

Many of the advantages of the NHE project are due to the low storage cost per MWh associated with the hydro storage reservoir. [redacted] It is expected that, subject to environmental approval and legal permitting, that the first of these projects will be sited near Kilcar in Co. Donegal in North West Ireland. The main

The project will use sea water as a working medium, instead of fresh water used in nearly all other pumped storage schemes. A sea water based scheme has been operating successfully in Okinawa in Japan for the last 15 years. The ocean will be used as the lower reservoir in the scheme. This greatly reduces construction costs normally associated with artificially created lower reservoirs in conventional pumped storage schemes.

The projects rely on the use of naturally occurring glacial formations created in the last ice age, which in a few rare instances created high valleys suitable for energy storage. Since Ireland has a very low level of seismic activity, a rock fill dam can safely be used to form an upper reservoir for the scheme. This is a less expensive form of construction than traditional concrete dam construction methods.

The dam is expected to be approximately 1.3km in length and will have a possible height of 120m at mid point. It will be constructed at the mouth of a long glacial valley. Having to dam only one end of a long narrow valley provides very large capacity in the upper reservoir in comparison to many conventional pumped storage schemes, where the reservoir is formed by a curtain dam, which completely encircles the reservoir. The geology of the valley floor is made up of primarily impermeable rock.

Water will be carried from the dam in multiple steel penstocks. The distance from the dam to the power house varies from 1 to 3 km on the sites selected by Natural Hydro Energy. The ground slopes gently over the intervening territory and provides heads ranging from 180 to 230m. The penstocks will be laid close to the surface of the ground in shallow covered trenches to minimise environmental impact. Using penstocks greatly reduces excavation and tunnelling costs for machine hall caverns, water head and tail race, access and cable tunnels frequently associated with conventional pumped storage schemes.

The first Natural Hydro Energy power station will be located in the North West of Ireland and will have 10 x 150MW Francis type pump/turbines totalling 1500MW capacity. It will be located approximately 2.5km from the dam. The head between the dam and the powerhouse will be approximately 230m on this site. The storage capacity of the reservoir with approximately 4 square km surface area will be 90,000MWh.

The power station will be connected to the ocean by a short channel. Rock for construction of the dam will come from excavations for the channel and the power station site, which must be located in a cutting to accommodate water transit from the draught tubes of the pump/turbines to the ocean 25m below minimum tide level. This local source of rock minimizes dam construction costs by eliminating the need to transport rock from outside the site.

This unusual design provides exceptionally large storage capacity of 90,000MWhs. Ireland has the potential for up to 300,000 MWhrs. This compares very favourably to the storage capacity of pumped storage schemes in the following countries.

	MWh
Spain	1,530,000
Switzerland	369,000
France	184,000
Austria	125,000
Portugal	107,000
Lithuania	49,000
Germany	39,000
UK	33,000
Greece	21,000
Poland	11,000
Belgum	8,000
Czech Republic	7,000
Luxemborg	6,000
Slovakia	4,000
Ireland	2,000
Bulgaria	1,000

Eurelectric 2020 Report "Hydro in Europe" Powering Renewables"

The Natural Hydro Energy design provides very large, low cost storage capacity to compensate for intermittent wind generation. Two of these Irish schemes would provide equivalent storage to all 7 of the pumped storage schemes in France, which provide important peak capacity in addition to France's 78% nuclear generation capacity.

[redacted]

This provides the advantage of an exceptional storage cycle length of a minimum of 2 weeks in zero wind conditions, which effectively eliminates intermittency. The Natural Hydro Energy power station can operate indefinitely in only intermittent light to moderate wind conditions. This advantage arises from the unique geographic topography of the long, narrow, sloping, Irish glacial valley sites.

UK Generation Capacity Plans

The UK faces two major challenges to generation capacity up to 2020 and shortly beyond. The existing UK nuclear stations are approaching the end of their economic working life. Most of the first generation Magnox stations have already been closed. All of the remaining 9.3GW

Magnox and second generation Advanced Gas Cooled Reactor stations with the exception of Sizewell B are planned to close by 2023.

The remaining 3 oil fired stations and a number of old coal fired stations have chosen to opt out of the requirements for flue gas desulphurization imposed by the EU Large Combustion Plant Directive. A total of 12GW of these stations will have to close by the end of 2015. The continued economic viability of the remaining 20GW of more modern coal fired stations will depend on the costs of new Carbon Capture and Storage technology, which is currently undergoing pilot scheme evaluation.

In addition to the requirements to replace the nuclear and conventional stations facing closure, the UK must greatly increase generation from renewable sources to meet its 2020 target of 30%. This includes NREAP plans to increase onshore wind capacity by 10,850MW and offshore wind by 10,210MW. The migration to more offshore sites as onshore capacity approaches saturation will significantly increase cost of renewable generation.

The closure of the UK nuclear and fossil fuel fired stations together with the large requirement for increased renewable generation will open the UK market to possible imports of cost effective, renewable energy up to 2020. Ireland, with a large surplus of high capacity factor onshore wind farm sites on land with low agricultural and commercial value, well in excess of its own renewable target requirements, will be in a strong position to compete for this potential market.

Ireland has two further important advantages. Its proximity to the UK reduces the length and hence cost of interconnectors. The advantages of the large scale hydro storage reservoirs proposed by the NHE project will also enhance the attraction of dispatchable, cost effective renewable energy imports from Ireland over interconnectors operating at high load factors during high demand day time trading periods.

Renewable Generation from Ireland Aided by Large Scale Storage

Finally, the main reasons, why the NHE project should be proposed for consideration as a PCI are as follows:

- It exploits extensive availability of economic, high strength, onshore wind resources in Ireland with offshore and wave available long term. This will earn valuable revenue for Ireland and greatly assist the UK meet its renewable generation targets benefiting emissions reduction and suppressing climate change in both countries

- Plentiful land with low agricultural or commercial value remains in Ireland, which offers the strongest wind and wave strengths in Europe. These are ideal conditions to expand cost effective sustainability between two cooperating Member States within the EU.

- The Irish home market for power generation is saturated. The only possible utilization of the valuable Irish renewable site potential is for export.

- Limited interconnection capacity is currently available out of Ireland. Much higher capacity would be required to fully exploit Ireland's valuable renewable assets. The NHE project offers a large increase in capacity, which will operate at very high load factors due to the benefits of high capacity storage smoothing peaky export flows from renewable generation.

- Ireland's population density is low on the west coast, which resulted in appropriate grid capacity, when they were constructed. The strong sites for renewable generation are also on the Atlantic coast. Extensive grid reinforcement is needed from wind and wave rich resource western areas to the east coast for export to the UK or Mainland Europe. The NHE project will make major contributions to grid reinforcement at no cost to the state.

- Due to the economic recession, the Irish state would have difficulty in providing funding for this size of project. NHE proposes to arrange funding from private sources, in a manner that will still provide substantial benefits to Ireland.

- The proximity of the UK to Ireland will require moderate interconnection costs to exploit Irelands valuable renewable resources combined with large scale, low cost storage.

e) How does the project contribute to the integration of the internal energy market, competition and / or eliminate isolated markets?

Market Integration

The NHE project will immediately provide a large increase in interconnection capacity between Ireland and UK. In the longer term, it opens potential for further future interconnection between Ireland, France and mainland Europe via the UK.

The UK is facing difficulties with adequate overall future generation capacity, due to closure of both nuclear and fossil fuel fired plant. In addition, it expects to implement a very large expansion in renewable plant to meet its 2020 target. As the renewable construction programme progresses, the UK plans indicate increased development of around 50% of new wind capacity on expensive offshore sites, after its onshore sites are fully exploited. NHE

could assist UK solve some of its generation shortfall and or meet its renewable targets economically.

Ireland has the potential to offer a large export capacity of surplus, dispatchable, low cost, onshore wind generation well in excess of Ireland's own foreseeable home market requirements. Ireland's onshore wind sites have some of the highest wind strength conditions in the World. This advantage coupled with low land values can provide wind generation at very competitive prices.

In addition to high quality onshore sites, the long storage cycle, high capacity, low cost, hydro storage potential will complement strong wind sites. The combined output from both sources will be dispatchable. The value of off peak wind generation will be greatly increased by dispatching it during high cost trading periods, when demand is highest. The large economic storage capacity of the Irish storage reservoirs will ensure that both wind and hydro can complement each other indefinitely, even during protracted periods of low wind strength. Losses due to curtailment will be minimised, which will further improve the economics of NHE generation.

Both Irish onshore wind site and hydro storage capacity is far in excess of Irish home market requirements. The only means by which Irelands valuable assets can be exploited is through export. Many Member States will face more expensive solutions to reach their 2020 targets. There has already been controversy in the UK over the cost of offshore wind sites combined with the additional cost of parallel operation of conventional generation at part load to compensate for wind intermittency. Availability of large amounts of dispatchable, renewable generation from Ireland at attractive prices will further market integration and encourage increased penetration of renewable generation.

Competition

One of the primary aims of opening the electricity market is that competition will encourage cost effective prices. The 2020 targets for renewable generation will introduce a new aspect of competition to the open market. Not only will market competition continue between all suppliers, because of the large increases in renewable generation required to meet targets, specialised competition is likely to develop in this sector for the most cost effective renewable sources.

Future increases in fossil fuel prices and renewable technology improvements will continue to improve the competitive position of cost effective, renewable generation, with no fuel costs, in comparison to conventional sources Renewable generation has no fuel costs. Not only are continuously rising fuel prices effecting the electricity market with knock on effects to other industries, concern is increasing in many countries over security of future fuel supplies. This is most acute among countries with limited or no indigenous fossil fuel supplies.

These two important market forces will continue to increase competition between conventional generation and secure, emissions free, price stable renewable energy. Dispatchable, renewable energy will provide an additional bonus. Most Member States will be under pressure to increase renewable generation to meet 2020 targets initially and increasing targets beyond 2020. Competition for cost effective sources is likely to increase. Not only will generation companies seek competitive renewable sources, these will also be attractive to many industries under pressure to reduce emissions.

Limited availability of high capacity factor, low cost, onshore wind sites in many member states will increase migration of renewable generation towards more expensive offshore sites. This trend will continue to improve the competitive position of onshore sites, with good wind strengths, on land with low agricultural or commercial value.

Ireland has the highest onshore and offshore wind strengths in Europe, plus the strongest wave energy levels. It has abundant sites for high capacity factor, low cost onshore wind generation. There is extensive availability of low value land. The NHE project will avail of all of these competitive advantages to the fullest extent.

The NHE design combined with low seismic activity and unique Irish glacial valley topography, geography and geology offers exceptionally large capacity hydro storage capacity at low cost. NHE hydro storage reservoirs can absorb and store low value, off peak, surplus wind generation to pump hydro into storage and release it later during high demand periods. This is a very important competitive advantage of NHE over conventional onshore generation, without access to storage facilities.

NHE hydro storage will eliminate wastage of curtailed surplus generation in high strength wind conditions above safe grid acceptance levels resulting in further increase in advantages. In low wind conditions, NHE reservoirs can store valuable, high efficiency, low cost, conventional generation, which would otherwise be displaced/unused at night by increased wind penetration.

NHE hydro generation backed up by long term storage will smooth out peaks and valleys in wind generation. This will ensure highly efficient use and low cost design of transmission facilities connecting NHE combined wind and hydro generation to the UK grid. The close proximity of Ireland to the UK market will contribute to low interconnection costs. Low transmission costs will increase NHEs competitive position for exports.

Elimination of Isolated Markets

Ireland is no longer strictly speaking an isolated market, since one interconnector to the UK has been in operation for some time and a second is due for commissioning shortly. However, in comparison to the highly interconnected networks of mainland Europe, Ireland's island market is still relatively isolated to a large degree.

The NHE project will greatly reduce this isolation by providing extensive new interconnection capacity. This increased capacity will be essential to exploit Ireland's valuable wind and hydro capacity. By smoothing out peaks and valleys in wind output, the complementary hydro storage will ensure high load factors on interconnectors during export periods. This will minimise interconnection costs.

f) How does the project facilitate integration of renewable generation? Please describe, using appropriate modelling results.

In the longer term, Ireland has both sufficient potential onshore wind site and hydro storage capacity to supply 100% of its foreseeable electricity demand from renewable sources and still have a large surplus for export. More wind and storage capacity is expected be employed in the future to satisfy Irish demands as existing economic conventional generation is retired. Despite this increased future usage, the potential surplus of Irish capacity can only be seriously deployed by export via DC undersea cables to the UK and or France and possibly onward to major consumption centres in Europe.

The renewable generation that can be exported from Ireland can be produced economically primarily from highly cost effective onshore wind farms constructed on land with low agricultural or commercial value, which is subject to exceptionally strong wind conditions. This large surplus of cost effective renewable generation can be of considerable assistance, initially to the UK in meeting its 2020 and possible future increased renewable generation targets at lower cost than UK offshore wind projects. It will also be available to assist the UK address generation capacity needs to replace closures of existing nuclear and fossil fuel fired stations.

In addition to having a large surplus of cost effective onshore wind capacity available for export, a large hydro storage scheme is planned to alleviate/eliminate the intermittency effects of wind generation. By merging intermittent, real time wind generation with supplementary dispatchable hydroelectricity, NHE can ensure export of steady state dispatchable generation on its 1200MW DC transmission link in its associated "Highway" project. Planning application procedures are expected to commence shortly on the first site subject to completion of finance availability, which is currently in progress. The site is planned to have power station with 1500MW generation/pumping capacity with 90,000MWh storage capacity.

[redacted]

[redacted] Both these sources are planned to supply real time wind generation for export to the UK on the NHE 1200MW DC "Highway" interconnector during daytime trading periods. If these two sources have insufficient available output to fill the cable capacity, NHE will release sufficient stored hydro to generate the balance needed to fill the cable.

[redacted] In the event of shortage of wind energy, NHE can use imported conventional power for pumping. This can be sourced either from unused, efficient Irish CCGT or coal fired base load plant or from UK imports on the NHE interconnector.

The Republic of Ireland currently has around 3800MW of efficient, economic CCGT and coal fired plant. Total night demand ranges from minimum night time values of 1800MW in Summer to around 2300MW in Winter. Hence, there will always be significant unused conventional capacity available at night. In addition, significant amounts of this capacity will be displaced by wind generation, which is allocated priority status. The amount of conventional plant dispatched at night will depend on wind strength, but considerable unused capacity will available even under low wind conditions. This can compete with night time prices for imports from the UK of conventional generation or possibly curtailed UK wind if some is available.

The effective reduction in curtailed renewable generation that the large NHE storage capacity will provide will reduce the cost of wind generation. This will encourage greater expansion. It will also substitute for and reduce the cost of parallel operation of conventional generation to compensate for renewable intermittency. This will further contribute to reducing renewable generation costs as well as contributing to increased system security.

Hydro generators have the fastest reaction speed of all categories of generators. They can ramp from zero to full load In as little as 15 seconds, which takes the next fastest open cycle gas turbine plants 15 minutes. This can supply large amounts of the highest quality spinning reserve capacity to whichever grid it is connected, which is very valuable in assisting fault

recovery. The 1500MW NHE potential reserve will make an important contribution to system security.

The fast response time of hydro plant is also very useful in rapid load following to compensate for short term minute to minute changes in renewable output. This is becoming more important as volatile renewable capacity increases. Fast load following ability is being awarded premium prices in many utilities experiencing increasing difficulties with effective short term load following ability.

Increased penetration of the latest direct drive wind turbines is causing concern on the Irish grid over reduction in inertia on the grid. The direct drive machines are decoupled from the grid by AC/DC converters used for frequency conversion between the slow rotor/generator rotational speed and the 50HZ electrical output from turbine/generators to the grid. Because no inertia is supplied by these turbines, their increased deployment instead of conventional generation is reducing the overall level of inertia on the grid.

Inertia slows the reduction in generator speed after a fault on the grid causes generation to fall below demand. Balance between generation and demand on a grid maintains stable frequency. Inertia slows down generator speed reduction and fall in frequency under fault conditions and permits more time for spinning reserve to come into operation to relieve the problem. The NHE hydro generators will provide large inertia to help overcome this problem.

In addition to the advantages described above, the NHE project will provide one further important boost to renewable generation. Renewable generation must follow the available wind conditions throughout the full 24 hour daily cycle. Demand for electricity is much lower at night than during the day. Power prices fall heavily at night, when there is plenty of the most efficient, lowest cost plant available to compete for the low demand. The UK Renewable Operation Certificates offer a fixed subsidy per MWh to wind generation on top of the basic system marginal price. Hence, night time wind is less valuable than day time wind.

This is currently under review. However, regardless of the commercial outcome of the review, night wind is inherently less valuable than day wind, particularly during peak demand. Because demand is lower at night, curtailment is more likely to arise for intermittent renewable energy. NHE offers a major advantage of absorbing potentially curtailed wind at night for pumping operations. This pumped hydro capacity can be "time shifted"/"arbitraged" and released during the day to provide generation at much higher day time prices. This will greatly increase the value of wind generation and make renewable generation more attractive as well as much easier to integrate.

The large hydro storage sites on the west coast of Ireland are adjacent to areas with strongest wind resources. Hence no long transmission links are needed between the contracted NHE wind generation and storage sites. Grid imports that would otherwise be curtailed for system security could in theory be absorbed at any connection point between the national grid and the NHE DC link from the hydro storage site to the UK. In practice, the two systems will need to

connect at a suitable strong point in the Irish grid, capable of handling the large 1200MW load. This is most likely to be in the greater Dublin area.

The hydro generation from NHE storage reservoirs can be used to ensure high load factors on both the NHE cables from the storage reservoir site to Dublin and on the onward link to the UK. By eliminating the peaks and valleys normally associated with transmission of volatile renewable generation, NHE will ensure operation of its transmission cables at high load factors close to 100% during trading hours in comparison t around 35%, when carrying volatile, intermittent wind generation alone. This is the final benefit NHE can provide to encourage greater penetration of the most economic form of renewable generation.

The advantages described above are only for the first NHE project. The application backlog for new wind generation licences in Ireland indicates availability of up to 15,000MW of potential onshore capacity between existing and potential new sites and much more offshore capacity. [redacted] A primary site has been agreed and initial negotiations with land owners are progressing with the next two sites.

g) What is the additionality of the project? Please list the installed capacity of each existing storage installation using a technology similar to the one of the project in a radius of 200 km from the project.

[please submit map showing location and size of each existing storage installation

The additionality of the project is primarily as follows:

- It will capitalise on the large surpluses of internationally tradable, low cost, dispatchable, renewable generation that can be made available for export from Ireland by exploitation of the extensive inventory of suitable sites.

- The increase in wind energy provided by the project reduces dependence on imported fossil fuel on which the UK and Ireland are dependent. This in turn increases security of supply.

- The potential wind capacity is further enhanced by 1500MW of hydro generation/pumping with a storage capacity of 90,000MWh and minimum load cycle of 2 weeks and an exceptionally low storage cost of €15/MWh.

- The large, low cost storage capacity will greatly alleviate the difficulties and integration costs of increased wind penetration by providing a dispatchable output of combined real time wind and supplementary hydro generation.

- Hydro storage can time shift low value night time wind generation to meet high value day time demand.

- Increased wind strengths may increase curtailment. This will be countered by using the excessive wind generation to power pumping for hydro storage. This valuable energy, which would otherwise be wasted can be released for use later, when required.

There is no storage installation within 200km of the NHE site. The nearest is the 292MW Turlough Hill scheme which is over 250km distant.

h) How does the project ensure security of supply and a secure and reliable system operation? Please describe, using appropriate modelling results.

Although the primary aim of the project is for energy export, an agreement has been made with the Irish authorities that priority will be assigned to assisting the Irish grid in times of difficulty. The worst failure condition envisaged for the Irish grid is failure of the largest generating set. This is a 450MW CCGT unit. Hence, the NHE 1500MW can supply far more fast reacting spinning reserve than was ever envisaged for the Irish grid. Under normal operation services on the Irish grid, this spinning reserve can be availed of on the UK grid.

Pumped storage plant has another important inherent spinning reserve advantage over equally fast reacting conventional hydro generators and all other generation categories. It has the ability, under serious grid fault conditions, when operating in pumping mode, to stop pumping and eliminate this demand. It can then change to generation mode and supply the same amount of additional generation. In this way, it effectively doubles the amount of spinning reserve that can be offered to recover from faults.

In addition to the valuable spinning reserve capability offered by NHE, the pump turbines will supply 1500MW of additional inertia to whichever grid they are connected. This service is of considerable value due to the reduction in inertia arising from increasing penetration of modern direct drive wind turbines, which provide no inertia.

The hydro generators will supply large amounts of reactive power, which has an important role in ensuring voltage stability on the grid.

i) Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

i) Market Integration and Competition

The NHE project will provide 1200MW increased interconnection capacity between Ireland and UK. This is more than the combined existing Moyle and the planned EWIC interconnectors. It will react to a window of opportunity to ease potential UK generation shortfalls from the closure of nuclear and older fossil fuelled stations and may assist UK meet its renewable target. Power will be traded over interconnectors operating very efficiently at high load factors during trading periods. This effective use of interconnector capacity by smoothing out fluctuations in wind generation by supplementary hydro will reduce the cost of interconnection capacity and encourage more trading of renewable energy.

[redacted]

The principal urgency of expediting the NHE project is to alleviate serious potential curtailment of renewable generation on the Irish grid, to avoid stability problems as wind penetration approached closer to the 2020 target

ii) Sustainability

Sustainability will be enhanced by increased integration of high levels of renewable, emissions free generation. Energy wastage due to curtailment will be reduced. High load factors on interconnectors will reduce associated costs and encourage more renewable trading

iii) Security of Supply

NHE will supply 1500MW of very fast response spinning reserve. This pumped storage, spinning reserve will have twice the reserve effects of conventional generation due to its ability to change from pumping to generating mode. NHE will also supply large inertia and extensive reactive power to assist stability and voltage control.

j) Are there any interdependencies and/or complementarities with other projects? If yes, which?

The existing 500MW Moyle undersea interconnector already links the UK and Irish grids. A new East West 500MW interconnector (EWIC) nearing completion by Eirgrid the Irish TSO between Ireland and the UK is to enter service shortly. These were both planned to provide normal interconnection services between the two national grids prior to plans for the 1200MW NHE interconnector. NHE is specifically planned to provide export of new renewable generation to the UK over the Irish requirement needed to meet its 2020 target. This is not expected to interfere with the services planned for the Moyle and EWIC links. On the contrary, it is hoped that spare capacity on these links may be used to export more NHE hydro generation.

The NHE project will have one very important interdependency with all other intermittent renewable generation projects in Ireland. Grid security constraints on the Irish grid have already introduced the need for curtailment of wind generation in strong wind conditions, even though only around 15% of generation is being supplied from renewable sources. Curtailment will have to increase significantly as renewable generation approaches its 40% 2020 target. The reduced income from curtailed wind generation will inevitably reduce the incentives for new wind farm construction. The large hydro storage content of the NHE project will greatly reduce curtailment and support further construction of renewable energy in Ireland.

Conclusion

Integration of Ireland's extensive energy resources (6% of 27 member states) into the union makes complete economic, technical and political sense. This is a project of considerable importance.

Thank you.

Title of the project: MAREX (electricity)

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: Organic Power Ltd (Company Number Ireland 406133) .....

☐ TSO ☐ DSO ☒ Other project promoter[1]

Contact person: [redacted] .....

E-mail address: [redacted] .....

Telephone number: [redacted] .....

Type of project

☐ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☒ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☒ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary?

NORTHERN SEAS OFFSHORE GRID .....

NOTE: This proposal includes electricity transmission and energy storage and both questionnaires have been completed.

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

II. Questionnaire for transmission projects not included in TYNDP

1. Reason for non-inclusion of project in TYNDP 2012

☒ No transmission license or no exemption from regulated regime; please explain:

As a non-TSO, we are precluded from making interconnection proposals. We were not party to ENTSOE or NSOG deliberations to date on PCIs.....

☐ Other, please specify: .....

2. General information

a) Name of project

MAREX (MAYO ATLANTIC RENEWABLE ENERGY EXPORT) .....

b) Brief description

COMBINED 1900MW WIND GENERATION, WITH 6.1GWHr STORAGE IN MAYO IRELAND, CONNECTED TO UK AT PEMBROKE VIA 1300MW HVDC VSC CABLE.....

c) Are any other project promoters involved in the project? NO (list each)

- Countries: ☐ EU ☐ Non-EU, please specify: .....
- Name of undertaking: .....
- Contact details: .....

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  LIMITED COMPANY (Company Number 406133).....

- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  N/A

- What is the share capital of this undertaking?

  N/A

e) Project type

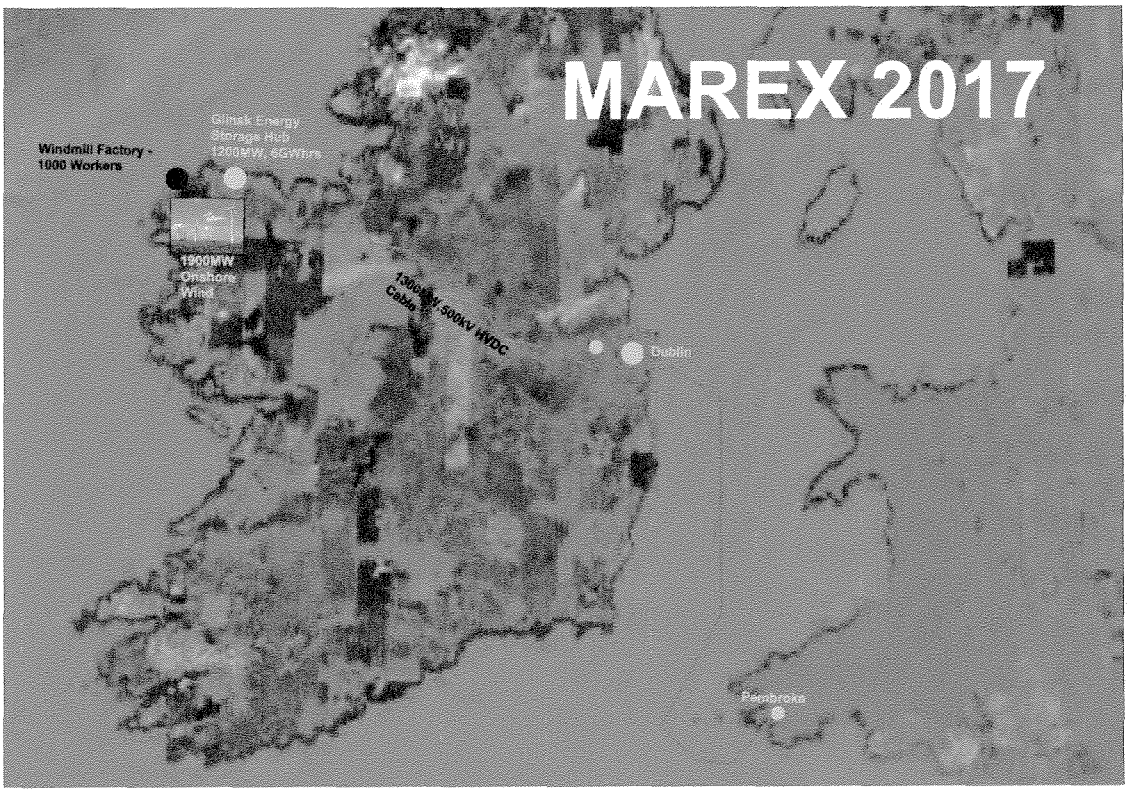
☒New

☐Upgrade

☐Extension

☐Replacement

f) Key physical characteristics ***[new lines]***



- Start point (area) Glinsk, Mayo, Ireland.....
- End point (area)Pembroke, Wales, UK.....
- Length (km) 530 km total. Subsea Atlantic 75, cross country Ireland 222km, Irish Sea 230 approx, 1-3km onshore Pembroke. .....
- Route type: ☒ Onshore ☒ Offshore (Both)

g) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): 1300 DC .....
- Voltage (kV): 500.....
- Current: ☒DC ☐AC
- Line type: ☐ OHL ☒Underground cable

h) Estimated project cost (capital expenditure in million euros) €1,500,000,000.....

i) Planned date of commissioning (year) 2017 provisional pending permits .....

j) Implementation status

☐Pre-feasibility

☒Feasibility/FEED

☐Final Investment Decision (FID)

☒Permitting

☐Construction

k) Obstacles for the implementation of the investment item

☐Permit granting (please explain):.....

☒Regulatory treatment (please explain): Ownership requirement of offshore grid in UK waters by "OFTO" incompatible with single ownership in both Irish and UK jurisdictions

☒Financing (please explain): Finance is dependent on intergovernmental agreement on interisland renewable energy trading between UK and Ireland

☐Other (please explain):.....

☐None

Please provide:

a list of all studies carried out so far for the project;

- Transmission route selection study
- Natura 2000 Assessment Transmission route
- Preliminary Civil and Electrical Design Storage facility
- System modelling
- Baseline environmental studies Storage facility
- Draft EIS for Storage facility

a list of interactions with all concerned transmission system operators (TSO) and/or national regulatory authorities (NRAs): e.g. letter from TSO acknowledging receipt of application for grid connection or landing point, technical and financial proposal from TSO for connection, letter from NRA concerning the applicable legal regime for the project.

See documents included in email IRELAND

1. Commission for Energy Regulation (Ireland)
2. An Bord Pleanala (national Irish Planning Authority)
3. EPA
4. Mayo County Council
5. National parks and Wildlife Service
6. Department of Environment Foreshore Section
7. Department of Communications Energy natural resources
8. EIRGRID

UK

1. UK National Grid plc
2. Department of Energy and Climate Change

3. Specific information

a) *Which EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?*

Republic of Ireland, UK, maritime border in Irish Sea.....

b) *Which non-EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?*

None .....

c) *Does the project cross borders directly or does it have a cross-border impact? Please specify the impact of the project on the grid transfer capability of each concerned border (in MW).*

Crosses Border directly, 1300 .....

d) *What are the main reasons for you to propose this project for consideration as a PCI?*

- Meets criteria laid out in 2011/0300 Proposal for a Regulation of the European Parliament and of the Council on guidelines for a trans-european energy infrastructure and repealing Decision no 1364/2006/EC

- MAREX will increase the grid transfer capacity from Ireland via a new private network to the UK National grid by 1300MW, in excess of 500MW.

- MAREX includes the Glinsk Energy Storage hub, which if operated on a minimum basis of one cycle per day of 5 hours for 180 days per year will store 900GWhrs annually, in excess of 500GWhrs. MAREX includes a 500kV underground and submarine cable, which is in excess of 150kV.

- MAREX includes an electricity storage system directly connected to a 500kV HVDC high voltage transmission line.

- MAREX is designed to allow the flow of electricity from generation and storage located in one Member State for consumption in another.

e) *How will the project facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.*

- MAREX is consistent with both NSOG, and NSI West Electricity. The project will cross the border between Ireland and the UK. MAREX will contribute to the integration of Irish and UK electricity markets, separate from the Irish Grid. It will provide a competitive alternative to REFIT for the development of wind power in Ireland.
- It will assist the UK significantly in meeting its 2020 renewable energy targets, increase security of energy supply, provide complementary competition to offshore wind energy.

- It will affect the UK and Ireland, and deliver 6TWhr annually of 100% renewably sourced electricity to the UK market from Ireland at a lower cost and greater reliability than offshore wind.

f) *How will the project facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly and indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.*

- The plan is economically, socially, and environmentally sustaniable.
- MAREX will transmit 6TWhrs/year of intermittent wind power to the UK major centre of consumption directly or via storage in Ireland.
- MAREX will allow 1.9GW of intermittent wind energy generation in County Mayo, Ireland, to be rendered dispatchable via 6.1GWhrs of power storage in County Mayo, Ireland, and to be transmitted to the power demand centre of the UK National Grid south of the Midlands congestion zone via 530km of 1300MW capacity HVDC transmission cable. This represents a load factor on the transmission system of 68% with curtailment of generation effectively eliminated by the availability of local demand from the storage. In the terms requested this represents 3.58 GW/1000km.
- The system will be interoperable in that it can accept power from the UK for storage, if required, and is a secure system backed up by storage.

g) *How will the project contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.*

- For the area of analysis as defined as "*all member states and third countries, on whose territory the project shall be built, all directly neighbouring Member States and and other Member States affected by the project*", the area of analysis for this individual project is The Republic of Ireland and the United Kingdom.
- The inclusion of storage in MAREX gives the system flexibility to dispatch power when required, provide black start capability of up to 1.2GW and offer reserve capacity of up to 6.1GWhrs.
- If operated as a dispatchable system, 1.2GW can be delivered to coincide with 5 hours of peak demand in the UK, daily on days when wind generation capacity exceeds 22.5% on average for the preceding 19 hours. Wind speeds in Mayo statistically exceed this level 230 days per year.
- The project transmission system is entirely subsea and underground, making it immune from sun storm interference, and ice storm encrustation of aerial structures.

h) *Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?*

- This project will assist the UK in meeting its NREAP 2020 target by providing reliable renewable electricity from another member state into the UK.
- MAREX is urgent because it is commercially predicated on an energising date of 31st March 2017 at the latest, in order to be eligible for the required revenue security represented by the UK ROC support scheme. (While optimal, energising by this date is not essential, as commercial viability is also expected to be underwritten by CFD mechanism which will replace ROCs in the UK after this date.)
- The PCI timeline is appropriate for MAREX, giving sufficient time for the Competent Authority in Ireland to permit the plan, and the UK and Irish governments to establish the required flexibility mechanisms to allow the project to be licensed by the end of 2013, as a joint project under the Renewable Energy Directive.

i) *Are there any interdependencies and/or complementarities with other projects? If yes, which?*

No

III. Questionnaire for electricity storage projects

1. General information

a) Name of project

Glinsk Energy Storage Hub (an element of MAREX Plan)

.....

b) Brief description

6.1 GWhr/cycle, 1.2GW pump turbine capacity Sea water Pumped Hydroelectric Energy Storage. .....

c) Are any other undertakings involved in the project? NO (list each)

- Countries: ☐ EU ☐ Non-EU, please specify: .....
- Name of undertaking: .....
- Contact details: .....

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  LIMITED COMPANY (Company Number 406133).....
- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  N/A
- What is the share capital of this undertaking?

  N/A

e) Project type

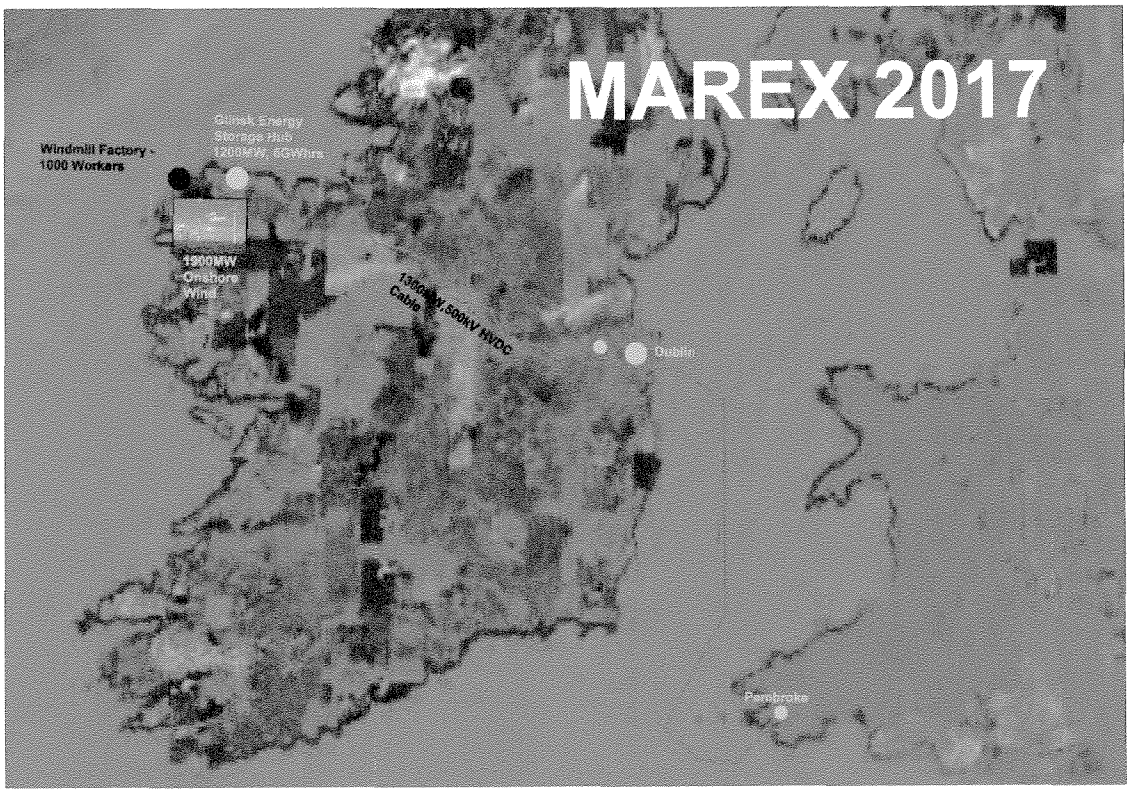
☒New

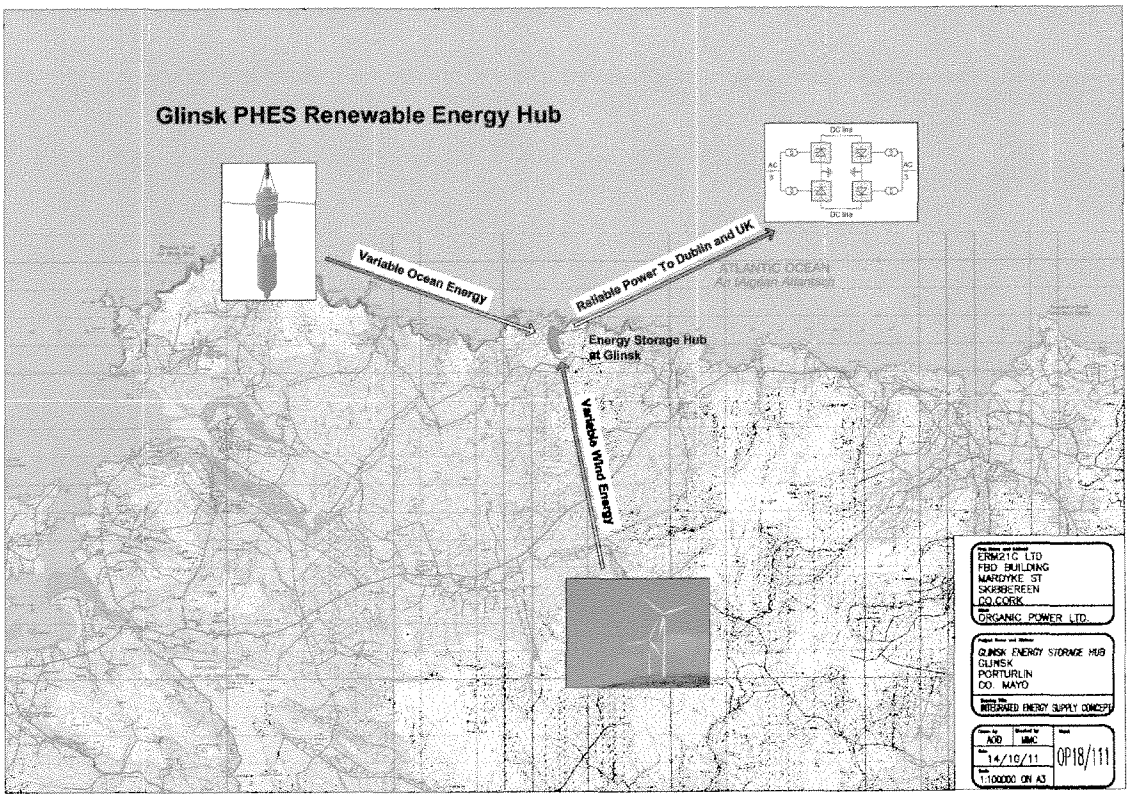
☐Upgrade / Repowering / Retrofitting

☐Extension

f) Key geographical characteristics ***[please submit map indicating information given below]***

- Location: Glinsk County Mayo, Ireland .....
- Connection point to transmission network: Glinsk County Mayo connection to proposed TREX cable (element of MAREX plan).....


MAREX 2017
Windmill Factory -
1000 Workers
Glinsk Energy
Storage Hub
1200MW, 8GWHrs
1300MW
Onshore
Wind
1300MW 500kV HVDC
Cable
Dublin
Pembroke


Glinsk PHES Renewable Energy Hub
Variable Ocean Energy
Reliable Power To Dublin and UK
Energy Storage Hub
at Glinsk
Variable Wind Energy
ATLANTIC OCEAN
ERM21C LTD
FBD BUILDING
MARDYKE ST
SKIBBEREEN
CO.CORK
ORGANIC POWER LTD.
GLINSK ENERGY STORAGE HUB
GLINSK
PORTURLIN
CO. MAYO
INTEGRATED ENERGY SUPPLY CONCEPT
ADD
MMC
14/10/11
OP18/111
1:100000 ON A3

Key technical characteristics Technology

g)

Seawater Pumped-Hydro Plant

The plant is conceived to provide energy storage for wind power and ocean power, transforming these unpredictable energy sources into reliable power available on demand. It will expedite the long awaited potential to develop renewable wind generated electricity in Mayo at a large scale. It will be ready to also accept energy from wave and floating wind turbines and at large scale when this technology comes of age, targeted for 2027. It will link the best wind resource in Europe to the UK market, delivering clean power when it is needed.

The €480,000,000 project (excluding grid) is commercially competitive at a build cost of €400/kW excluding transmission systems. Construction will generate 200 jobs for 3 years and justify the immediate rollout of a dedicated grid connection to the UK by 2017 as part of the MAREX plan.

The use of seawater in the plant dictates that all wet elements be marinised through the use of marine grade steel, concrete, plastics etc. Experience from the operation of the Yanbaru seawater PHES by JPower in Okinawa since 1999 has shown that seawater is perfectly adequate for use in PHES systems[i].

Glinsk, Co. Mayo has been selected for this project because of its almost unique qualities as a high, flat topped, mountain beside the sea, composed of very hard, impermeable, and immensely stable schist rock. The location is not included in an environmentally designated site. The site of the project faces the Atlantic Ocean and the upper reservoir is located on the plateau of Glinsk mountain, the reservoir base will be 288 metres above sea level and 700m from the coastal intake. The Glinsk project (see fig. 2) will use the sea as the lower reservoir. The design concept carried out by erm21c is being advised on by JPower.

A total of 8,900,000m^3 of sea water can be pumped to an average elevation of 292m above sea level to fill the reservoir from empty, providing 6.1GWhr storage per cycle. When released, the water from the reservoir will generate electrical power at 1200MW from the four variable speed 300MW reversible turbines for 5 hours. The scheme will accept energy off peak for 8 up to 19 hours per day depending on the available wind energy. Electrical efficiency for the PHES has been modelled from the design at 75%.

Electric power sourced from wind and later ocean and floating wind power will provide the input power during off peak hours of electricity demand. The facility will accept wind power from planned[ii] 1900MW of wind turbines initially in 2017, during off peak night time hours or when generation exceeds demand and use it to pump seawater to a reservoir on the top of Glinsk Mountain. The stored energy will be exported via HVDC link to the UK for use during peak times. The PHES scheme can deliver power at maximum output for 5 hours per day, approximately corresponding to peak demand in the UK. It is further planned to facilitate the ability of the plant to accept sea water pumped to the reservoir from 800MW of ocean energy pumps, and power from 500MW of potential floating wind turbines for 2027. More info available at www.organicpower.ie.

- Installed generation power (MW) 1200 .....
- Installed generation capacity (GWh) 6.1.....
- (for hydro-pumped storage) Net pumping power (MW) 1200 .....

- Response time (seconds) <6.....
- Energy rating of storage (minutes) N/A.....
- Power density of storage (W/kg) N/A.....
- Energy density of storage (Wh/kg) N/A.....
- Round-trip efficiency (charging-discharging) (%) 75.....
- Lifetime (years) – for new installations, please specify expected lifetime from start of operation; for upgraded, repowered, retrofitted or extended installations, please specify how this will affect remaining expected lifetime.

  50 years
- Cycles – for battery storage, please specify the expected number of cycles over the lifetime of the battery; for pumped hydro storage, please specify the number of cycles per day (for a given expected lifetime).
- N/A
- Voltage at connection point (kV): 500kV (DC).....

h) Estimated project cost (capital expenditure in million euros) €480,000,000 excluding grid and substations .....

i) Planned date of commissioning (year) 2017 .....

j) Implementation status

☐ Pre-feasibility

☐ Feasibility/FEED

☐ Final Investment Decision (FID)

☒ Permitting

☐ Construction

l) Obstacles for the implementation of the investment item

☒ Permit granting (please explain):

- The Glinsk Energy Hub proposal was submitted to the Irish Planning Authority for consideration as Strategic Infrastructure, which is a prerequisite to the authority accepting a planning application. To date, the authority have not made any decision as to whether the project constitutes Strategic Infrastructure, citing that without evidence of the feasibility of a connection to a transmission system, to do so would be premature.
- To demonstrate such a connection, the promoters have consulted with UK National Grid, who have indicated in writing as of 1st June 2012 that such a connection for MAREX is feasible to their system.
- We are still awaiting a response to this from the Irish Planning Authority.

☐ Regulatory treatment (please explain): .....

☐ Financing (please explain):.....

☐ Other (please explain):.....

☐None

2. Specific information

a) *Which EU Member States are involved or affected by the project, at which borders?*

Republic of Ireland, UK, maritime border in Irish Sea (TREX cable, part of MAREX plan) .....

b) *Are any non-EU Member States involved or affected by the project, at which borders?*

No .....

c) *Does the project cross borders directly or does it have a cross-border impact? Please specify the installed generation capacity and the average net annual electricity generation capacity over the first 20 years of the project (GWh/year), using appropriate modelling results.*

Crosses Border directly, Glinsk Energy Storage Hub has1.2GW installed generation capacity, 900GWhrs minimum annual net average electricity generation over first 20 years, TREX cable has 1300 MW transmission capacity.....

d) *What are the main reasons for you to propose this project for consideration as a PCI?*

- Meets criteria laid out in 2011/0300 Proposal for a Regulation of the European Parliament and of the Council on guidelines for a trans-european energy infrastructure and repealing Decision no 1364/2006/EC

- MAREX will increase the grid transfer capacity from Ireland via a new private network to the UK National grid by 1300MW, in excess of 500MW.

- MAREX includes the Glinsk Energy Storage hub, which if operated on a minimum basis of one cycle per day of 5 hours for 180 days per year will store 900GWhrs annually, in excess of 500GWhrs. MAREX includes a 500kV underground and submarine cable, which is in excess of 150kV.

- MAREX includes an electricity storage system directly connected to a 500kV HVDC high voltage transmission line.

- MAREX is designed to allow the flow of electricity from generation and storage located in one Member State for consumption in another.

e) *How does the project contribute to the integration of the internal energy market, competition and / or eliminate isolated markets?*

- MAREX is consistent with both NSOG, and NSI West Electricity. The project will cross the border between Ireland and the UK. MAREX will contribute to the integration of Irish and UK electricity markets, separate from the Irish Grid. It will provide a competitive alternative to REFIT for the development of wind power in Ireland.

- It will assist the UK significantly in meeting its 2020 renewable energy targets, increase security of energy supply, provide complementary competition to offshore wind energy.

- It will affect the UK and Ireland, and can deliver 6TWhr annually of 100% renewably sourced electricity to the UK market from Ireland at a lower cost and greater reliability than offshore wind.

f) *How does the project facilitate integration of renewable generation? Please describe, using appropriate modelling results.*

- The Glinsk Energy Storage Hub will facilitate the integration of 1900MW of wind capacity with a high capacity factor due to its location, into the UK National electric supply, with variability eliminated by the ability of the storage to create demand when the market demand is low. This directly facilitates the integration of energy from renewable generation into the market which would otherwise be curtailed.

g) *What is the additionality of the project? Please list the installed capacity for each existing storage installation using a technology similar to the one of the project in a radius of 200km from the project*

- No existing storage facility within 200km. Additionality is based on the projected wind development of western Ireland, for which no storage capacity exists. Nearest PHES is on East Coast, 260km away, Turlough Hill with 1.75GWhr capacity and 0.292GW installed capacity. This is used to create demand for the current 1500MW of wind installed on the Irish Grid, and is operating at capacity.

h) *How does the project ensure security of supply and a secure and reliable system operation? Please describe, using appropriate modelling results.*

- The inclusion of Glinsk Energy Storage Hub in MAREX gives the system flexibility to dispatch power when required, provide black start capability of up to 1.2GW and offer reserve capacity of up to 6.1GWhrs. This gives security of supply.
- If operated as a dispatchable system, 1.2GW can be delivered to coincide with 5 hours of peak demand in the UK, daily on days when wind generation capacity exceeds 22.5% on average for the preceding 19 hours. Wind speeds in Mayo statistically exceed this level 230 days per year.

i) *Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?*

- Without storage the MAREX plan would not be able to dispatch electricity sourced from variable wind supply, without which access to market at times of consumer demand cannot be guaranteed. The inclusion of the Glinsk Energy Storage Hub in the MAREX plan solves this issue.
- This project will assist the UK in meeting its NREAP 2020 target by providing reliable renewable electricity from another member state into the UK.
- MAREX is urgent because it is commercially predicated on an energising date of 31st March 2017 at the latest, in order to be eligible for the required revenue security represented by the UK ROC support scheme. (While

optimal, energising by this date is not essential, as commercial viability is also expected to be underwritten by CFD mechanism which will replace ROCs in the UK after this date.)

- The PCI timeline is appropriate for MAREX, giving sufficient time for the Competent Authority in Ireland to permit the plan, and the UK and Irish governments to establish the required flexibility mechanisms to allow the project to be licensed by the end of 2013, as a joint project under the Renewable Energy Directive.

j) *Are there any interdependencies and/or complementarities with other projects? If yes, which?*

No

Projects of Common Interest

Project CAES Larne NI (electricity, storage)
PCI NUMBER E151
ADDITIONAL AND UPDATED INFORMATION
8th February 2013

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: **Gaelectric Energy Storage Ltd**.....

☐ TSO ☐ DSO ☒ Other project promoter[1]

Contact person: [redacted].....

E-mail address: [redacted].....

Telephone number: [redacted].....

Type of project

☐ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☒ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? **NSOG**

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[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

III. Questionnaire for electricity storage projects

1. General information

a) Name of project

Project CAES Larne NI

b) Brief description

Compressed Air Energy Storage using caverns/chambers to be created in bedded salt deposits.

Phase 1: Two CAES units each of 134MW generation capacity and 80-100 MW compression, for a total of 268 MW generation capacity and 160-200 MW of compression. Environmental baseline studies are in progress. Planning application is scheduled for Q3 2013. Expected Commercial Operation Date: Unit 1, 2016; Unit 2, 2019-20. This project will require innovation around the business model and also the optimisation of storage caverns and surface plant to facilitate integration and operation of onshore wind in Northern Ireland (UK) and Ireland (IE) to provide necessary storage and ancillary services to the TSO. Phase 1 will use caverns created in the salt deposits by the standard method of solution mining. The project promoter has conducted

- extensive geological and geotechnical work to establish the suitability of the salt deposits to host CAES caverns and provide cavern design
- detailed modelling of the operation of the CAES technology in its interplay with the caverns
- detailed economic, commercial and financial modelling of the project to identify and quantify system benefits and derive a business model for the particular requirements of the TSOs in Northern Ireland and Ireland in the context of the high renewable energy targets.

c) Are any other undertakings involved in the project? The project includes connection to the transmission grid.

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  Gaelectric Energy Storage Ltd is a company registered in Ireland.

  Company registered number: 428818

  Date of incorporation: 26 October 2006

  Registered address: Portview House, Thorncastle Street, Ringsend, Dublin 4, Ireland

  If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  Name of shareholder: Gaelectric Holdings plc holds 100% of Gaelectric Energy Storage Ltd

Activity: Renewable energy and energy storage in UK, Ireland and North America

Class of holding: Ordinary Shares

Amount: €2.00

Nationality: Company registered in Ireland, Registered number 418730

Additional information:

- What is the share capital of this undertaking?

  Class of capital: Ordinary Shares (€1)

  Amount issued: €2.00

  Amount authorised: €100,000.00

e) Project type

☒ New

☐ Upgrade / Repowering / Retrofitting

☐ Extension

f) Key geographical characteristics ***[please submit map indicating information given below]***

- Location: **Larne, Northern Ireland, UK**
- Connection point to transmission network:

  Phase 1, Unit1: In April 2012 the System Operator for Northern Ireland (SONI) requested Northern Ireland Electricity (NIE) to carry out feasibility studies for connection of Unit 1 of the project.

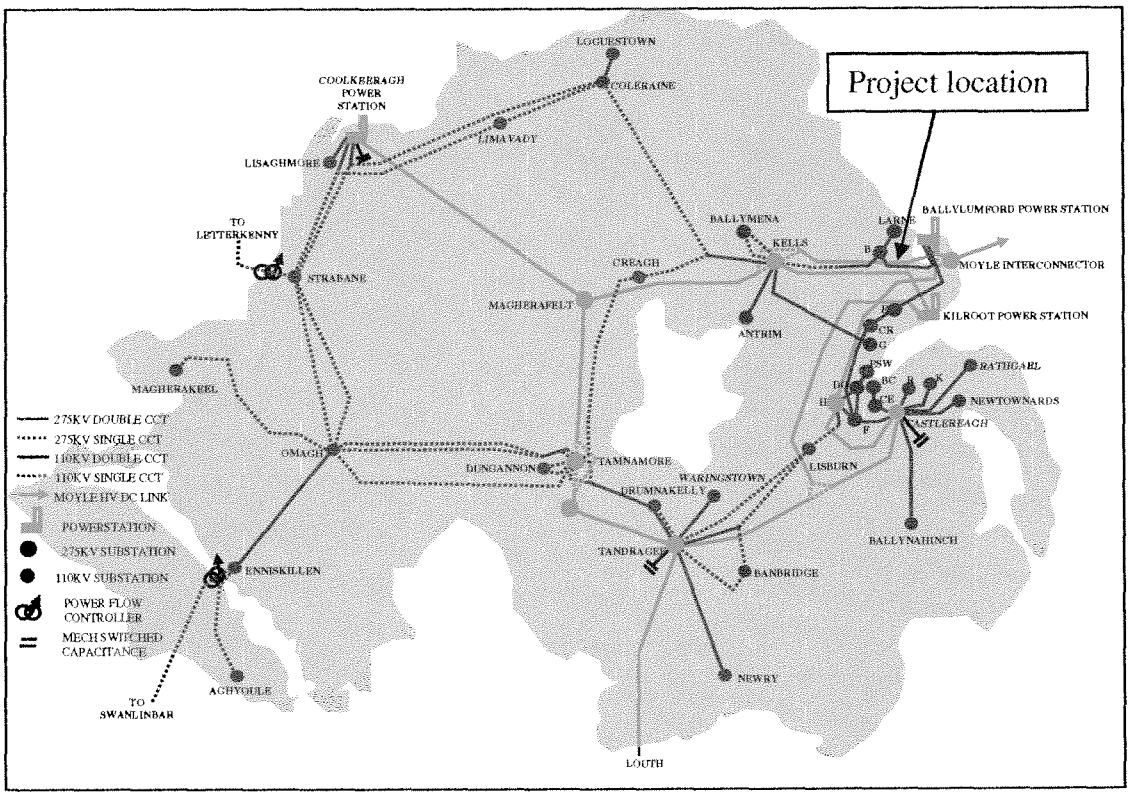

Figure 1: Proposed NIE network in 2015 showing location of the project

g) Key technical characteristics

- Technology (please describe as necessary)

  Compressed Air Energy Storage.

  For Phase 1, CAES Units 1 and 2, we intend to deploy existing CAES technology. The generation train offered is modular and fixed at 134MW. A range of compressors can be provided. The project promoter is considering compressor options in the 80 to 100MW range for each unit.

  In addition the project promoter will assess the viability of partially adiabatic CAES, using heat storage technologies to maximise energy efficiency. This would involve storing some of the heat of compression to contribute to the generation mode, thereby minimising gas consumption during generation. This would require a trade-off between energy efficiency and the provision of inertia as provided by currently offered compression technology which produces low-grade heat with little potential for contributing to generation.

- Installed generation power (MW)

  Phase 1: 268 MW

- Installed generation capacity (GWh)

  Phase 1: 1,047 GWh annually

- Net compression power (MW)

  Phase 1: 160-200 MW

- Response time from de-synch to full load (seconds)
- Energy rating of storage (minutes)
- Power density of storage (W/kg)
- Energy density of storage (Wh/kg)
- Round-trip efficiency (charging-discharging) (%)

  Phase 1: 53.0%.
  Note that round-trip efficiency may not be an appropriate metric for describing efficiency of CAES due to its use of electricity for compression and natural gas combined with compressed air for generation.

  For CAES, a metric termed *energy ratio* is generally used to describe and quantify the electrical energy balances alone. It is represented by the compression energy divided by the generated energy:

$$ER = \frac{E_C}{E_G}$$

  Lifetime (years) – for new installations, please specify expected lifetime from start of operation;

  New installation. Phase 1: 30 years from start of operation.

- Cycles – for battery storage, please specify the expected number of cycles over the lifetime of the battery; for pumped hydro storage, please specify the number of cycles per day (for a given expected lifetime).

  Phase 1:

- Voltage at connection point (kV): **Phase 1:** 110kV

h) Estimated project cost (capital expenditure in million euros)

i) Planned date of commissioning (year)

Phase 1: Unit 1 2016

j) Implementation status

☐ Pre-feasibility

☒ Feasibility/FEED

☐ Final Investment Decision (FID)

☐ Permitting

☐ Construction

k) Obstacles for the implementation of the investment item

☒ Permit granting (please explain):

☒ Regulatory treatment (please explain):

- Existing market structures do not currently consider or address the unique characteristics of CAES.

☒ Financing (please explain):

☐Other (please explain):.....

☐None

2. Specific information

a) Which EU Member States are involved or affected by the project, at which borders?

The project is located in Northern Ireland, UK.

Member States affected by the project are UK and Ireland:

- across the border between Northern Ireland and Ireland and
- between the Island of Ireland and Great Britain.

b) Are any non-EU Member States involved or affected by the project, at which borders? **No**

c) Does the project cross borders directly or does it have a cross-border impact? Please specify the installed generation capacity and the average net annual electricity generation capacity over the first 20 years of the project (GWh/year), using appropriate modelling results.

The project has cross-border impacts as follows:

(i) across the border between Northern Ireland (UK) and Ireland (IE), via

- the existing All-Island Grid
- the Single Electricity Market, the first cross-border electricity market of its kind that operates between EU member states, across Northern Ireland (UK) and Ireland (IE).

and

(ii) between the Island of Ireland and Great Britain, via

- the existing Moyle Interconnector (NI-Scotland)
- the East-West Interconnector (Ireland-Great Britain, recently completed)

Installed generation capacity:

Phase 1 of the project provides storage capacity allowing a net annual electricity generation of more than 1,000 GWh/year

d) What are the main reasons for you to propose this project for consideration as a PCI?

The project meets the PCI qualification criteria:

- the project is necessary for the implementation of the NSOG energy infrastructure priority corridor
- the project displays economic, social and environmental viability

- the project involves Member States UK and IE, by being located on the territory of UK and having a significant cross-border impact in UK and IE
- the project contributes significantly to:
  - market integration, competition and system flexibility
  - sustainability
  - interoperability and secure system operation.

e) How does the project contribute to the integration of the internal energy market, competition and / or eliminate isolated markets?

The energy storage and ancillary services to the grid provided by the project facilitate the integration of the internal energy market, reduce isolation of the SEM and promote competition as follows:

The project provides flexible, fast acting plant thereby achieving increased efficiency in the envisaged power markets

The technical characteristics of CAES all contribute towards driving competition in the market, particularly in provision of Balancing services.

f) How does the project facilitate integration of renewable generation? Please describe, using appropriate modelling results.

The Single Energy Market faces challenges with respect to the level of the inertia on the system, primarily caused by the significant amounts of variable wind energy on the grid system. CAES reduce curtailment. This is done whilst maintaining the system integrity through keeping inertia on the system at all times.

Further to this, the project will provide numerous Ancillary Services. These system services will be increasingly relied upon given the future system issues which will be encountered through increased integration of renewables. By providing these services in a fast, efficient and competitive manner, the project will facilitate integration of renewable energy.

Preliminary modelling carried out by GES has shown that a CAES plant could avoid curtailment in the year 2020 on the island of Ireland. This modelling does not incorporate transmission constraints etc and is at an hourly resolution. Therefore it is likely that the project would allow even more curtailment avoidance in actual operation, especially if it is optimised to provide ancillary services for curtailment avoidance.

g) What is the additionality of the project? Please list the installed capacity for each existing storage installation using a technology similar to the one of the project in a radius of 200km from the project ***[please submit map showing location and size of each existing storage installation]***

There are no existing storage installations using a technology similar to the one of the project, within a radius of 200km from the project.

This project is unique and particularly innovative in several respects:

- It is the most advanced CAES project in Europe. It is the only storage project proposed for PCI designation in the UK

- It is the only PCI candidate storage project in the NSOG region that proposes to address the needs of the System Operators with regard to integration of high levels of wind rather than simply providing a means of storing excess wind energy for export.

h) How does the project ensure security of supply and a secure and reliable system operation? Please describe, using appropriate modelling results.

Introduction

Security of Supply is ensured through the ability to call on flexibility in tight market scenarios, which occurs due to supply/demand imbalance. CAES has shown itself in the Alabama plant which was built in 1991 to have a reliability rating in excess of 97% running, and the technology is proven to an extent that it can provide numerous ancillary services power plants must remain synchronised to the grid to allow a sufficient amount of inertia to be retained on the system. The Project can help to prevent this constraint from being breached while simultaneously allowing more wind to come online.

The plant will ensure security of supply at all times on the grid.

All-Island Generation Capacity Statement 2013-2022

The GCS (EirGrid-SONI 2013) identifies the risk of serious generation deficits in Northern Ireland:

- NI is at risk of generation deficits from 2016 onwards in the event of a prolonged outage of a large generation plant or of the Moyle Interconnector;
- There is uncertainty as to when the current ongoing fault on one cable of the Moyle Interconnector will be repaired;
- In a number of different scenarios, e.g. the loss of a major generator or of the Moyle Interconnector, NI fails to meet the generation adequacy standard post 2015;
- Capacity Margins in NI fall to 200 MW in 2016 with the closure of 510 MW at Ballylumford;
- Capacity Margins in NI go negative in 2021 as Killroot (476 MW) is restricted in compliance with the Industrial Emissions Directive;

i) Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

The realisation of this project is particularly urgent with regard to market integration and competition, sustainability and security of supply because of the challenges faced by the system operators (SONI and EirGrid) in integrating high levels of wind in order to meet the ambitious RES targets for Northern Ireland and

Ireland. These challenges are described in detail in the Facilitation of Renewables Study.

i) Market integration and competition
The introduction of a plant onto the island with the attributes that CAES has can contribute significantly towards achieving market integration through improving the ability of the market to adhere to target model. The firming of renewables is a further requirement of the target model, which can be optimised using fast acting bulk storage, through time shifting.

The characteristics of CAES have the capability of allowing reduced curtailment and therefore increasing the business case for renewable energy sources (in line with Directive 2009/28/EC).

ii) Sustainability: As described integration of high levels of wind is already presenting a serious challenge to the TSOs. These technical issues, described in detail in the Facilitation of Renewables Study, will become increasingly challenging without the introduction of flexible plant such as CAES.

CAES has the attributes to provide system services and act as an integral tool for the TSOs to effectively dispatch plant in the market, whilst supporting renewables, and in so doing, maintaining and fostering a sustainable market place.

The Island of Ireland, and Northern Ireland in particular, is at present heavily reliant on generation fuelled by imported gas. The ability of CAES to provide ancillary services reduces the requirement to ramp thermal plant, thereby enhancing the sustainability of the system.

iii) Security of supply: See all responses above

Security of supply in energy markets is intrinsically linked to the services which the TSO can call upon from generators. In the SEM particularly, these system services are vital to the integrity of the grid and to continue to ensure adequate security of supply.

Additionally, the project will provide services to the grid which maintain system security,crucial to the continued integration of renewables. CAES can increase room for wind on the system. The issues will become more critical in Northern Ireland in 2016 with the decommissioning of 510 MW of conventional generation at Ballylumford.

j) Are there any interdependencies and/or complementarities with other projects? If yes, which?

Complementarities:

Phase 1 of the project facilitates investment in and operation of wind projects on the island of Ireland to participate in the Single Electricity Market between Northern Ireland (UK) and Ireland (IE).

The project enhances market integration and cross-border trading of renewable energy.

[NB: Additional technical information might be requested for storage projects for further evaluation.]

Title of the project (electricity)
Renewable Integration Development Project

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: EirGrid

☒ TSO ☐ DSO ☐ Other project promoter[1]

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Company: Northern Ireland Electricity (NIE)

☐ TSO ☐ DSO ☒ Other project promoter (NIE has the licence obligation to plan the development of the transmission system in Northern Ireland)

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Company: System Operator Northern Ireland (SONI)

☒ TSO ☐ DSO ☐ Other project promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☐ Storage project – please refer to Questionnaire III

---

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:

a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or

b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? North South Electricity Interconnections in Western Europe

[NB: A separate questionnaire has been prepared for smart grid projects as well and has been discussed in the relevant ad hoc working group under the Smart Grid Task Force.]

I. Questionnaire for transmission projects included in Ten-Year Network Development Plan (TYNDP)

1. Information concerning relevant Project of Pan-European relevance (PPER) as identified in TYNDP (i.e. cluster level)

a) Name and number of PPER or PPERs to which the investment item belongs:

TYNDP PPER: 82

b) How is the PPER necessary for the implementation of the priority corridor?

The project combines a number of schemes designed to integrate large amounts of renewable generation into the systems of Ireland and Northern Ireland in order to meet the 2020 renewable energy targets of both the Ireland and Northern Ireland governments.

c) Which EU Member States are involved in the PPER, at which borders?[2]

Ireland and the United Kingdom, at the Ireland – Northern Ireland border

d) Does the PPER cross borders directly or does it have a cross-border impact?

☒ Yes or ☐ No

Please specify, including with regard to impact on grid transfer capability in MW/MVA.

The PPER comprises a number of investments, some wholly within Ireland and some wholly within Northern Ireland. One of the investments designed to integrate wind generation on either side of the border involves a cross border link. The whole PPER increases grid transfer capability by between 2150 and 2650 MW.

e) Are there any interdependencies and/or complementarities with other PPER of the TYNDP? If yes, which?

The design and operation of this PPER is dependent on the prior completion of the North South 400 kV Interconnection Development (TYNDP PPER #81).

[2] Definition in Article 4(1) c of the draft Regulation COM(2011) 658 of 19.10.2011: the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact as set out in point 1 of Annex IV.

General information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please identify, within a given PPER, the investment items contributing significantly to the benefits provided by the PPER. Provide the requested information below for each investment item selected within the PPER proposed as PCI.

a) Name and number of investment item (as in TYNDP):

Renewable Integration Development Project; TYNDP Investment: 82.463.

b) Brief description (as in TYNDP)

Strengthening of the EHV networks (partial uprate and new) into Donegal and north and west of Northern Ireland and enhanced links between the two countries.

The investment which is the subject of this submission is a new cross border circuit.

c) Are any other project promoters involved in the investment item? (list each)
Details of all promoters are provided in the Introductory Information

- Countries: ☒ EU ☐ Non-EU, please specify:
- Name of undertaking:
- Contact details:

d) Type of the investment item

☒New

☐Upgrade

☐Extension

☐Replacement

e) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area) Srananagh 220 kV station in Co. Sligo in Ireland
- End point (area) Turleenan 400/275 kV station in Northern Ireland
- Length (km) 196 km
- Route type: ☒ Onshore ☐ Offshore

f) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): Part 710 MVA and part 431 MVA (minimum capacities)
- Voltage (kV): 275 kV and part 220 kV
- Current: ☐DC ☒AC
- Line type: ☒ OHL ☐ Underground cable

g) Estimated cost of the investment item(capital expenditure in million euros) 273

h) Planned date of commissioning (year) 2020

i) Implementation status

☐Pre-feasibility

☒Feasibility/FEED

☐ Final Investment Decision (FID)

☐ Permitting

☐ Construction

j) Obstacles for the implementation of the investment item

☐ Permit granting (please explain):

☐ Regulatory treatment (please explain):

☐ Financing (please explain):

☐ Other (please explain):

☒ None – It is too early in the life of the project to identify potential obstacles.

2. Specific information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please provide the information requested below for each investment item selected within the PPER proposed as PCI.

a) What are the main reasons for you to propose this investment item for consideration as a PCI?

The project is expected to reach Financial Investment Decision point and enter the public consultation and permitting phase with the two year PCI cycle. It is considered that the PCI status will assist the project in the permitting phase, and prioritise it in investment decision making processes.

b) Which EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

Ireland and United Kingdom, at the Ireland-Northern Ireland border.

c) Which non-EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

None

d) Does the investment item cross borders directly or does it have a cross-border impact? Please specify, in particular with regard to impact on grid transfer capability of this investment item (in MW) compared to the impact of the whole PPER.

The investment crosses the border directly. It increases grid transfer capability by approximately 680 MW.

e) How will this investment item facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

Since November 2007, a wholesale market for electricity has operated on the island of Ireland. The North South 400 kV Interconnection Development is planned to overcome an identified lack of transmission capacity between Ireland and Northern Ireland by providing significant additional capacity between the two parts of the island to enhance market trading.

While the North South 400 kV Interconnector links two strong points of the networks, RIDP links weaker areas. RIDP is therefore dependent on the completion of the North South 400 kV Interconnector Development for reliable operation of the market. While the RIDP project is not designed for market integration, it provides additional cross border capacity, improves system flexibility and may further enhance the operation of the all island market.

f) How will the investment item facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly or indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

The governments of Ireland and Northern Ireland have both set targets of meeting 40% of electricity consumption from renewable sources by 2020. This is expected

to be achieved mainly by significant amount of new wind generation capacity in both jurisdictions. This investment will facilitate the integration of wind generation in Co. Donegal in Ireland and the west of Northern Ireland. The quantity of planned wind generation which this investment is expected to facilitate is approximately 768 MW, which equates to 0.1 GW/1000km^2. The investment will also provide additional capacity in these areas and in the wider network for further connections beyond 2020.

g) How will this investment item contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

The RIDP investment will allow for the secure transfer of power from renewable sources to the main load centres on the east of the island. By facilitating the connections of renewable generation, the investment will contribute to an increase in the amount of installed generation capacity and to reducing the dependency of the market on imported fossil fuels, such as coal and gas. It will improve the stability of the network in the north west of the island, specifically in Donegal in Ireland and in the western part of Northern Ireland, and will share the resources of both member states in these remote areas.

h) Why is this investment item particularly necessary for the implementation of the TYNDP PPER?

There are considerable renewable energy resources available in the north-west of Ireland and in the west and north of Northern Ireland. The TYNDP PPER consists of a number of separate investments designed to integrate renewable generation in this region. This RIDP investment is particularly necessary to integrate wind generation in Donegal in Ireland and in the western part of Northern Ireland.

i) Why is the realisation of this investment item particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

This project is designed to integrate wind generation to help both Ireland and Northern Ireland achieve their 2020 renewable energy targets. It is deemed as crucial for Northern Ireland in particular in meeting its targets, as most of Northern Ireland's renewable resources lie in this area.

3. Please describe the interdependencies and complementarities between the proposed investment items of the TYNDP PPER.

The TYNDP PPER consists of a number of separate investments designed to integrate renewable generation in the north west of Ireland and in Northern Ireland. The RIDP scheme is currently being finalised following extensive period of technical and feasibility studies. The scheme in totality comprises a number of new EHV circuits and 110 kV circuits and EHV and 110 kV circuit uprates to facilitate renewable generation in Donegal and across the west and northern part of Northern Ireland. This investment, from Srananagh to Turleenan, is an integral part of the RIDP scheme, and complements the other elements of the scheme. It provides cross border capacity between Donegal and

Northern Ireland, and is particularly necessary to integrate wind generation in Donegal in Ireland and in the western part of Northern Ireland.

Title of the project (electricity)
Grid Link

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: EirGrid

☒ TSO ☐ DSO ☐ Other project promoter[1]

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☐ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? North South Electricity Interconnections in Western Europe

[NB: A separate questionnaire has been prepared for smart grid projects as well and has been discussed in the relevant ad hoc working group under the Smart Grid Task Force.]

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

I. Questionnaire for transmission projects included in Ten-Year Network Development Plan (TYNDP)

1. Information concerning relevant Project of Pan-European relevance (PPER) as identified in TYNDP (i.e. cluster level)

a) Name and number of PPER or PPERs to which the investment item belongs:

TYNDP PPER: 83

b) How is the PPER necessary for the implementation of the priority corridor?

The project creates significant transfer capacity between the south and the east of Ireland, facilitating renewable generation in the south, reducing market constraints and providing capacity for integration of a new interconnector in the south of the Ireland – a likely region for connection to Great Britain or France.

c) Which EU Member States are involved in the PPER, at which borders?[2]

The project is wholly within Ireland.

d) Does the PPER cross borders directly or does it have a cross-border impact?

☐ Yes or ☒ No

Please specify, including with regard to impact on grid transfer capability in MW/MVA.

The PPER provides between 1500 and 2000 MVA of additional grid transfer capacity. The PPER provides between 700 and 1000 MW of capacity for new interconnections in the south.

e) Are there any interdependencies and/or complementarities with other PPER of the TYNDP? If yes, which?

The PPER provides capacity for integration of a new interconnector in the south of the Ireland – a likely region for connection to Great Britain (TYNDP PPER #106) or France (TYNDP PPER#107)

[2] Definition in Article 4(1) c of the draft Regulation COM(2011) 658 of 19.10.2011: the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact as set out in point 1 of Annex IV.

2. General information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please identify, within a given PPER, the investment items contributing significantly to the benefits provided by the PPER. Provide the requested information below for each investment item selected within the PPER proposed as PCI.

a) Name and number of investment item (as in TYNDP):

Grid Link; TYNDP Investment: 83.469.

b) Brief description (as in TYNDP)

The Grid Link project and the Moneypoint to North Kerry projects are essential to facilitate the connection of RES and thermal generation in the South and South West of Ireland. When completed, Grid Link will also facilitate future interconnection connecting to the grid in the southeast of Ireland.

More information on the Grid Link investment is available on EirGrid's website at http://www.eirgridprojects.com/projects/gridlink/overview/

c) Are any other project promoters involved in the investment item? No (list each)

- Countries: ☐ EU ☐ Non-EU, please specify:
- Name of undertaking:
- Contact details:

d) Type of the investment item

☒ New

☐ Upgrade

☐ Extension

☐ Replacement

e) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area) a new 400 kV substation at Knockraha 220 kV substation
- End point (area) Dunstown 400 kV substation (with a mid-point connection into a new 400 kV substation at Great Island 220 kV substation)
- Length (km) 250 km
- Route type: ☒ Onshore ☐ Offshore

f) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): 1500 MVA
- Voltage (kV): 400 kV
- Current: ☐ DC ☒ AC
- Line type: ☒ OHL ☐ Underground cable

g) Estimated cost of the investment item(capital expenditure in million euros) 500

h) Planned date of commissioning (year) 2020

i) Implementation status

☐ Pre-feasibility

☐ Feasibility/FEED

☐ Final Investment Decision (FID)

☒ Permitting

☐ Construction

j) Obstacles for the implementation of the investment item

☐ Permit granting (please explain):

☐ Regulatory treatment (please explain):

☐ Financing (please explain):

☐ Other (please explain):

☒ None

3. Specific information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please provide the information requested below for each investment item selected within the PPER proposed as PCI.

a) What are the main reasons for you to propose this investment item for consideration as a PCI?

It is considered that the PCI status will assist the project in the permitting phase, In addition, PCI status will allow for access to the Connecting Europe Facility for the construction phase, should it be required.

b) Which EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

Ireland is involved directly. The potential for interconnection to Great Britain or France is facilitated by this investment.

c) Which non-EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

None

d) Does the investment item cross borders directly or does it have a cross-border impact? Please specify, in particular with regard to impact on grid transfer capability of this investment item (in MW) compared to the impact of the whole PPER.

The investment is wholly within the borders of Ireland. It opens up capacity for future interconnections to Great Britain or France of between 700 and 1000 MW.

e) How will this investment item facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

The investment is planned to remove network constraints within the single electricity market on the island of Ireland, which arise because of the connection of renewable and conventional generation in the south of the island. Removal of congestion is estimated to reduce generation costs by 11 € million per annum. In addition, this investment will facilitate interconnection to Great Britain or France which would initially reduce generation production costs by between €40 million to €110 million per annum (depending on which system is interconnected), with higher savings possible in later years.

f) How will the investment item facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly or indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

The government of Ireland set a target of meeting 40% of electricity consumption from renewable sources by 2020. This is expected to be achieved mainly by significant amount of new wind generation capacity much of which will connect in the south west of Ireland. This investment is planned primarily to facilitate the integration of 1283 MW of wind generation in the south of the country. This is

approximately equivalent to 0.054 GW/1000 km^2, based on GW of additional wind installed within county boundaries. Because of the favourable wind conditions on the island of Ireland and offshore there is interest (evidenced by applications for grid connections) in developing renewable generation capacity well in excess of what is required for native demands. The connection of such capacity can only be facilitated if further interconnection is installed to provide access for this generation to the British and continental European markets. In addition it will facilitate future interconnection to Great Britain or France.

g) How will this investment item contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

The project will allow for the secure transfer of power from renewable sources and conventional generation to the main load centres on the east of the island. It will also provide an additional circuit to secure supplies to Cork and Waterford cities and the south of the country in the long-term.

h) Why is this investment item particularly necessary for the implementation of the TYNDP PPER?

The TYNDP PPER consists of a number of investments designed to integrate renewable and conventional generation in the south west of Ireland. This investment is critical in connecting the south with the east of the country where the main load centres are located.

i) Why is the realisation of this investment item particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

Connection offers have been made to 1283 MW of renewable generation in the south. These will contribute to Ireland's 2020 RES target. Access to the network for this generation is contingent on the completion of this project. In addition, because of the favourable wind conditions on the island of Ireland and offshore there is interest (evidenced by applications for grid connections) in developing renewable generation capacity well in excess of what is required for native demands. The connection of such capacity can only be facilitated if further interconnection is installed to provide access for this generation to the British and continental European markets. This investment will facilitate interconnection capacity for renewable generation to Great Britain or France.

4. Please describe the interdependencies and complementarities between the proposed investment items of the TYNDP PPER.

The TYNDP PPER consists of a number of separate investments designed to integrate renewable generation in the south west of Ireland. Grid Link provides a new 400 kV circuit from the south west to the east coast where the main load centres are located. The other complementary projects connect renewable generation from the south west to the western end of the existing 400 kV circuits which connect the west to the east. All the investments

of this PPER are required to ensure adequate capacity to deliver the generation from the south to the east.

Title of the project (electricity)
Ireland – Great Britain Interconnector

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: EirGrid

☒ TSO ☐ DSO ☐ Other project promoter[1]

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☐ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? Northern Seas Offshore Grid

[NB: A separate questionnaire has been prepared for smart grid projects as well and has been discussed in the relevant ad hoc working group under the Smart Grid Task Force.]

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

I. Questionnaire for transmission projects included in Ten-Year Network Development Plan (TYNDP)

1. Information concerning relevant Project of Pan-European relevance (PPER) as identified in TYNDP (i.e. cluster level)

a) Name and number of PPER or PPERs to which the investment item belongs:

TYNDP PPER: 106

b) How is the PPER necessary for the implementation of the priority corridor?

The interconnector increases capacity between the Single Electricity Market in Ireland and the British BETTA market, enhancing market integration and providing capacity for excess renewable generation in Ireland to access the British and continental European markets.

c) Which EU Member States are involved in the PPER, at which borders?[2]

Ireland and the United Kingdom, across the Irish Sea

d) Does the PPER cross borders directly or does it have a cross-border impact?

☒ Yes or ☐ No

Please specify, including with regard to impact on grid transfer capability in MW/MVA.

The TYNDP identified that there was an economic opportunity for greater interconnection of 700-1000 MW between Ireland and Great Britain.

e) Are there any interdependencies and/or complementarities with other PPER of the TYNDP? If yes, which?

The economic benefits deriving from this interconnector project will be directly influenced by the completion of other TYNDP PPERs comprising interconnectors off the island of Ireland, namely the East West Interconnector due to be completed in 2012 (TYNPD PPER 80.461), and the conceptual Ireland-France interconnector (TYNDP PPER #107).

[2] Definition in Article 4(1) c of the draft Regulation COM(2011) 658 of 19.10.2011: the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact as set out in point 1 of Annex IV.

2. General information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please identify, within a given PPER, the investment items contributing significantly to the benefits provided by the PPER. Provide the requested information below for each investment item selected within the PPER proposed as PCI.

a) Name and number of investment item (as in TYNDP):

Ireland – Great Britain Interconnector; TYNDP Investment: 106.A34.

b) Brief description (as in TYNDP)

A new HVDC subsea connector between Ireland and Great Britain.

c) Are any other project promoters involved in the investment item? (list each)

- Countries: ☒ EU ☐ Non-EU, please specify: United Kingdom
- Name of undertaking: Possibly a GB TSO
- Contact details: N/A

d) Type of the investment item

☒ New

☐ Upgrade

☐ Extension

☐ Replacement

e) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area) To be determined
- End point (area) To be determined
- Length (km) To be determined
- Route type: ☐ Onshore ☒ Offshore

  Please note that this project is at the conceptual phase and no connection points or routes have been decided. Therefore no map has been submitted.

f) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): 700-1000 MW
- Voltage (kV): To be determined
- Current: ☒ DC ☐ AC
- Line type: ☐ OHL ☒ Underground cable

g) Estimated cost of the investment item(capital expenditure in million euros) To be determined

h) Planned date of commissioning (year) 2020 or beyond

i) Implementation status

☒ Pre-feasibility

☐ Feasibility/FEED

☐Final Investment Decision (FID)

☐Permitting

☐ Construction

j) Obstacles for the implementation of the investment item

☐ Permit granting (please explain):

☒ Regulatory treatment (please explain): In Ireland the TSO has an obligation to build network where deemed necessary and to explore opportunities for new interconnections, but in Great Britain opportunities are identified on more market based principles, potentially valuing the wider benefits (producer surplus, security) differently. This presents EirGrid with a difficulty in identifying a suitable promoter in GB to progress the project.

☐ Financing (please explain):

☐ Other (please explain):

☐ None

3. Specific information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please provide the information requested below for each investment item selected within the PPER proposed as PCI.

a) What are the main reasons for you to propose this investment item for consideration as a PCI?

The project was identified as having economic potential in the TYNDP 2012 and is conceptual at present. Further studies are required to determine whether investment is justified and which parties will undertake the project. PCI status will make funding of the studies possible under the CEF proposals.

b) Which EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

Ireland and United Kingdom (Great Britain), across the Irish Sea.

c) Which non-EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

None

d) Does the investment item cross borders directly or does it have a cross-border impact? Please specify, in particular with regard to impact on grid transfer capability of this investment item (in MW) compared to the impact of the whole PPER.

The investment crosses the border (the Irish Sea) directly. It would increase grid transfer capability between Ireland and Northern Ireland by the selected size of the interconnector. The TYNDP envisaged an interconnector of capacity 700-1000MW as the appropriate size.

e) How will this investment item facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

At present, the island of Ireland is interconnected to Great Britain by the Moyle interconnector which has a transfer capacity of 450 MW. The East West interconnector which is due to be completed in 2012 will increase the capacity between the two islands to 950 MW. The TYNDP and other studies carried out by EirGrid have identified potential generation cost savings of between 40 and 70 € millions per annum associated with a further interconnector between the two islands.

f) How will the investment item facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly or indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

The governments of Ireland and Northern Ireland have both set targets of meeting 40% of electricity consumption from renewable sources by 2020. This is expected to be achieved mainly by significant amount of new wind generation capacity in both jurisdictions. Because of the favourable wind conditions on the island of

Ireland and offshore there is interest (evidenced by applications for grid connections) in developing renewable generation capacity well in excess of what is required for native demands. The connection of such capacity can only be facilitated if further interconnection is installed to provide access for this generation to the British and continental European markets. This investment will provide interconnection capacity for renewable generation to the British market.

g) How will this investment item contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

The investment will provide significant additional capacity between Ireland and Great Britain which in the long-term may allow for a reduction in the required amount of generation capacity installed in Ireland or Great Britain to maintain security of supplies.

h) Why is this investment item particularly necessary for the implementation of the TYNDP PPER?

This investment is the one and only investment in the PPER.

i) Why is the realisation of this investment item particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

This investment has been shown to have an opportunity to make significant cost savings while facilitating further renewable generation in Ireland. Further studies are urgently required to determine whether there is a robust case for the investment and to establish the details of the project.

4. Please describe the interdependencies and complementarities between the proposed investment items of the TYNDP PPER.

This investment is the one and only investment in the PPER.

Title of the project (electricity)
North South 400 kV Interconnection Development

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: EirGrid

☒ TSO ☐ DSO ☐ Other project promoter[1]

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Company: Northern Ireland Electricity (NIE)

☐ TSO ☐ DSO ☒ Other project promoter (NIE has the licence obligation to plan transmission developments and to construct and maintain the transmission system in Northern Ireland)

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Company: System Operator Northern Ireland (SONI)

☒ TSO ☐ DSO ☐ Other project promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

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[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:

a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or

b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

☐ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? North South Electricity Interconnections in Western Europe

[NB: A separate questionnaire has been prepared for smart grid projects as well and has been discussed in the relevant ad hoc working group under the Smart Grid Task Force.]

I. Questionnaire for transmission projects included in Ten-Year Network Development Plan (TYNDP)

1. Information concerning relevant Project of Pan-European relevance (PPER) as identified in TYNDP (i.e. cluster level)

a) Name and number of PPER or PPERs to which the investment item belongs:

North South 400 kV Interconnection Development; TYNDP PPER: 81

b) How is the PPER necessary for the implementation of the priority corridor?

The project provides the necessary transmission capacity between Ireland and Northern Ireland to enable the proper functioning of the single wholesale electricity market on the island of Ireland.

c) Which EU Member States are involved in the PPER, at which borders?[2]

Ireland and the United Kingdom, at the Ireland-Northern Ireland border.

d) Does the PPER cross borders directly or does it have a cross-border impact?

☒ Yes or ☐ No

Please specify, including with regard to impact on grid transfer capability in MW/MVA.

The PPER will increase grid transfer capacity by 600MVA to approximately 1,000 MVA. The grid transfer capability can be further increased to 1,500 MVA in the future by uprating a number of existing 220 kV lines in Ireland.

Are there any interdependencies and/or complementarities with other PPER of the TYNDP? If yes, which?

The RIDP project, which is part of TYNDP PPER 82, is dependent on the completion of this project.

[2] Definition in Article 4(1) c of the draft Regulation COM(2011) 658 of 19.10.2011: the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact as set out in point 1 of Annex IV.

2. General information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please identify, within a given PPER, the investment items contributing significantly to the benefits provided by the PPER. Provide the requested information below for each investment item selected within the PPER proposed as PCI.

a) Name and number of investment item (as in TYNDP):

North South 400 kV Interconnection Development; TYNDP Investment: 81.462. This is the only investment item in the TYNDP PPER 81.

b) Brief description (as in TYNDP)

A new 140 km single circuit 400 kV 1,500 MVA overhead line from Turleenan 400/275 kV in Northern Ireland to Woodland 400/220 kV in Ireland. This is a new interconnection project between Ireland and Northern Ireland.

More information about this investment project is available on the EirGrid website at http://www.eirgridprojects.com/projects/NorthSouth400kVInterconnectionDevelopment/ and on the NIE website at http://www.nie.co.uk/Network/Major-projects/Tyrone-Cavan-Interconnector

c) Are any other project promoters involved in the investment item? (list each)

- Countries: ☒ EU ☐ Non-EU, please specify:
- Name of undertaking: Details of all promoters are given in the Introductory Information section above
- Contact details: Details of all promoters are given in the Introductory Information section above

d) Type of the investment item

☒New

☐Upgrade

☐Extension

☐Replacement

e) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area) Woodland 400/220 kV station in Ireland
- End point (area) a new 400/275 kV station at Turleenan in Northern Ireland
- Length (km) 140 km
- Route type: ☒ Onshore ☐ Offshore

f) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC): 1500 MVA
- Voltage (kV): 400 kV
- Current: ☐DC ☒AC
- Line type: ☒ OHL ☐ Underground cable

g) Estimated cost of the investment item(capital expenditure in million euros) 280

h) Planned date of commissioning (year) 2017 (updated since project information was provided for the TYNDP)

i) Implementation status

- ☐ Pre-feasibility
- ☐ Feasibility/FEED
- ☐ Final Investment Decision (FID)
- ☒ Permitting
- ☐ Construction

j) Obstacles for the implementation of the investment item

- ☒ Permit granting (please explain): There has been strong opposition from local residents and landowners on both sides of the border to this project.
- ☐ Regulatory treatment (please explain):
- ☐ Financing (please explain):
- ☐ Other (please explain):
- ☐ None

3. Specific information concerning main investment item(s) within TYNDP PPER (i.e. project level)

Please provide the information requested below for each investment item selected within the PPER proposed as PCI.

a) What are the main reasons for you to propose this investment item for consideration as a PCI?

It is considered that the PCI status will assist the project in the permitting phase, In addition, PCI status will allow for access to the Connecting Europe Facility for the construction phase, should it be required.

b) Which EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

Ireland and the United Kingdom, at the Ireland-Northern Ireland border.

c) Which non-EU Member States are involved or affected by the investment item with respect to grid transfer capability, at which borders?

None

d) Does the investment item cross borders directly or does it have a cross-border impact? Please specify, in particular with regard to impact on grid transfer capability of this investment item (in MW) compared to the impact of the whole PPER.

The investment crosses the border directly. It increases grid transfer capability between Ireland and Northern Ireland by 600 MW to approximately 1,000 MW. The grid transfer capability can be further increased to 1,500 MW in the future by uprating a number of existing 220 kV lines in Ireland.

e) How will this investment item facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

In November 2007, a new all island wholesale market for electricity was established on the island of Ireland. At the time, it was identified that lack of transmission capacity between Ireland and Northern Ireland was a constraint on the proper functioning of the new market. It has been estimated that this constraint is costing the consumers an approximate €30 million per annum. This project provides the necessary capacity to remove the constraint and allow the full and uninhibited operation of the market.

f) How will the investment item facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly or indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

The governments of Ireland and Northern Ireland have both set targets of meeting 40% of electricity consumption from renewable sources by 2020. This is expected to be achieved mainly by significant amount of new wind generation capacity in both jurisdictions. The RIDP project is required to facilitate the connection of wind generation in Donegal in Ireland and in the west and north of Northern Ireland,

where the renewable resources are largely located. The additional grid transfer capacity provided by this North South 400 kV interconnection project is essential to allow access to a larger market for the new renewable generation, particularly for Northern Ireland wind generation in times of high wind conditions and low local demand. This project therefore indirectly allows the connection of 600 MW in Northern Ireland, i.e. the equivalent of the additional grid transfer capacity initially provided by the link.

g) How will this investment item contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

The project provides greater transfer capacity between Ireland and Northern Ireland. This allows for the sharing of generation capacity between the two parts of the island in times of shortage in either part. In particular, the All Island Generation Capacity Statement 2011-2021 indicates that Northern Ireland could have insufficient generation capacity in the latter half of this decade without the completion of this project.

Additionally, this project relieves the flows on existing 220 kV circuits between the greater Dublin area and the border and as a result alleviates an emerging security of supply issue in the north east of Ireland.

h) Why is this investment item particularly necessary for the implementation of the TYNDP PPER?

This is the one and only investment in the TYNDP PPER

i) Why is the realisation of this investment item particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

The absence of this investment is hindering the full integration of the wholesale market on the island of Ireland, which is estimated to be costing about €30 million per annum. Additionally, achievement of the 2020 renewable energy targets, particularly for Northern Ireland, relies on the timely completion of this investment. Security of supply issues, emerging later in this decade in the north east of Ireland and in Northern Ireland, will be alleviated by this investment.

4. Please describe the interdependencies and complementarities between the proposed investment items of the TYNDP PPER.

This is the one and only investment in the TYNDP PPER.

Title of the project (electricity)

**** Please send to ENER-B1-PROJECTS@ec.europa.eu and specify the priority corridor in the subject line ****

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Company: **Greenwire Ltd (owned in turn by Element Power and Hudson Clean Energy).** .....

☐ TSO ☐ DSO X☐ Other project promoter[1]

Contact person: [redacted] .....

E-mail address: [redacted] .....

Telephone number: [redacted] .....

Type of project

☐ Transmission project included in TYNDP 2012 – please refer to Questionnaire I

X☐ Transmission project not included in TYNDP 2012 – please refer to Questionnaire II

☐ Storage project – please refer to Questionnaire III

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary? **North Seas Offshore Grid**.....

[NB: A separate questionnaire has been prepared for smart grid projects as well and has been discussed in the relevant ad hoc working group under the Smart Grid Task Force.]

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

II. Questionnaire for transmission projects not included in TYNDP

[NB: Non TYNDP project promoters have been informed via a public request for information about the current process of identifying project proposals. In a second phase, they will have to provide the following more detailed information.]

1. Reason for non-inclusion of project in TYNDP 2012

X☐ No transmission license or no exemption from regulated regime; please explain:

Element Power does not have a transmission licence, and there is no regulatory regime in place to allow for wind directly connected from Ireland to the UK. We are working with both CER and OFGEM to devise an appropriate regime. As an independent generation developer, we have no interaction with the TYNDP process. .....

☐ Other, please specify: .....

2. General information

a) Name of project

Greenwire Interconnector .....

b) Brief description

The Greenwire Generation project consists of around 40 individual onshore wind farms, totalling 3GW, collected together through and underground private network in the midlands of Ireland, connected directly to the UK national grid via 2 x 2.5GW sub-sea cables HVDC cables in Wales. Electricity produced in Ireland will count towards UK 2020 Renewables Targets under the EU Joint Project Mechanism. The Greenwire Interconnector project adds two spurs, one of 1000MW and another of 500MW, using multi-terminal HVDC technology, will connect to the Irish power system, creating a 1.5GW interconnector between the Irish and UK markets for under half the cost of a standalone interconnector of the same rating. The Greenwire Generation and Interconnector projects share the same 2.5GW DC cables and connection points in the UK.

Greenwire accepted a connection agreement for 3GW of generation capacity was accepted on 16th July for connection to the UK transmission system for connection in 2017/2018 of the Greenwire Generation project......

c) Are any other project promoters involved in the project? (list each)

- Countries: ☐ EU X☐ Non-EU, please specify: ...**The Hudson Clean Energy fund is based out of the US**.....
- Contact details: ..... **Shaun Kingsbury, 3 Sheldon Square, Paddington Central, London W2 6HY**

d) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

  n/a.....

- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  n/a.....

- What is the share capital of this undertaking?

  n/a.....

  .....

e) Project type

X☐New

☐Upgrade

☐Extension

☐Replacement

f) Key physical characteristics ***[please submit map indicating existing and new lines]***

- Start point (area) **Co. Offaly, Ireland** .....
- End point (area) **Pembroke and Pentir 400kV substations Wales**.....
- Length (km) **c500km total of both routes**.....
- Route type: X☐ Onshore X☐ Offshore

g) Key technical characteristics

- Transmission capacity (MW for DC/ MVA for AC):5000 .....
- Voltage (kV): **600**.....
- Current: X☐DC ☐AC
- Line type: ☐ OHL **X** ☐ Underground cable

h) Estimated project cost (capital expenditure in million euros) **€8bn for Greenwire generation project, c. €400m for Greenwire Interconnector**.....

i) Planned date of commissioning (year) **2017** .....

j) Implementation status

X☐Pre-feasibility

X☐Feasibility/FEED

X☐Final Investment Decision (FID)

X☐Permitting

☐Construction

k) Obstacles for the implementation of the investment item

☐Permit granting (please explain):.....

X☐Regulatory treatment (please explain):.....

☐Financing (please explain):.....

☐Other (please explain):.....

☐None

Please provide:

- a list of all studies carried out so far for the project;

– a fully detailed budgeting and costing exercise has been completed on the wind farm component, showing that Greenwire can deliver green power to the UK up to 1/3rd cheaper than UK offshore wind

National Grid has completed a detailed network impact study as part of the grid application process, and the resulting design takes into account pre and post fault power flows, reactive power, harmonics and other power system characteristics, specifying upgrades to protection systems, detailed HVDC control system parameters, and outlining a list of system upgrades that will be required to connect 2GW to Pembroke and 1GW to Pentir.

Greenwire has also completed a detailed onshore permitting feasibility for the wind farms, as well as an environmental scoping exercise to determine the necessary ecological surveys. Greenwire has also commissioned consultants to determine cable land and sub-sea routing.

Regulatory consultants have outlined the key changes to the UK and Irish regulatory regime to enable such a project, and indeed both regulators have now commenced projects to consult on and implement a regime that can licence generation projects located in Ireland connected only to the UK, with and without associated interconnector functions.

- a list of interactions with all concerned transmission system operators (TSO) and/or national regulatory authorities (NRAs): e.g. letter from TSO acknowledging receipt of application for grid connection or landing point, technical and financial proposal from TSO for connection, letter from NRA concerning the applicable legal regime for the project.
- **Please find attached .pdf letter confirming acceptance of 1.5GW of interconnector application in Ireland under name Miyazaki, since reassigned to Greenwire Ltd.**
- **Please refer to UK TEC Register to see application for 3GW of capacity assigned to Greenwire Ltd.**

3. Specific information

a) Which EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

UK and Ireland .....

b) Which non-EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

None

c) Does the project cross borders directly or does it have a cross-border impact? Please specify the impact of the project on the grid transfer capability of each concerned border (in MW).

It crosses the UK-Ireland border in the Irish Sea with 5GW of capacity

d) What are the main reasons for you to propose this project for consideration as a PCI?

While the core Greenwire concept is an independent commercial undertaking, the additional interconnection that could be built sharing the cables is potentially of national benefit to consumers in both the UK and Ireland, and is in line with EU policy of creating a single electricity market

e) How will the project facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

Interconnection between UK and Ireland will achieve all of the above at half the cost of a purpose built standalone interconnector. EirGrid's cost benefit work implies that benefits of interconnection accrue even above 1.5GW of additional capacity over and above that installed today.

f) How will the project facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly and indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

The Greenwire generation project will ship 3GW of surplus wind energy from the midlands of Ireland to the densely populated island of Great Britain. The Greenwire interconnector of 1.5GW has the potential to export surplus renewables from Ireland to the UK, although it could also be used for general electricity trading between the UK and Ireland.

g) How will the project contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

Building 1500MW of interconnection in addition to the existing 900MW of interconnection and an installed generation capacity of c6000MW in an Irish system with a peak demand of 4500MW renders the concept of losing load pretty much moot.

h) Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

Ireland is one of the least well interconnected countries in Europe, but has multiple GW surplus of the lowest cost wind generation in Europe.

i) Are there any interdependencies and/or complementarities with other projects? If yes, which?

No .....

[NB: Additional technical information might be requested for transmission projects not included in the TYNDP for further evaluation.]

ISLES (electricity)

Introductory information

Contact details of the project promoter(s) (if several, please fill in for each project promoter)

Scottish Government, Energy Directorate

☐ TSO ☐ DSO ☒ Other project promoter[1]

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Irish Government, Dept. of Communications, Energy & Natural Resources

☐ TSO ☐ DSO ☒ Other project promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Dept. of Enterprise Trade & Investment, Northern Ireland

☐ TSO ☐ DSO ☒ Other project promoter

Contact person: [redacted]

E-mail address: [redacted]

Telephone number: [redacted]

Type of project

☒ Transmission project not included in TYNDP 2012

Priority corridor

For the implementation of which energy infrastructure priority corridor is the project necessary?

North Seas Offshore Grid

[1] Project promoter is defined in Article 2.5 of the draft Regulation COM(2011) 658 of 19.10.2011. 'projectpromoter' means:
a) transmission system operator or distribution system operator or other operator or investor developing a project of common interest; or
b) if there are several transmission system operators, distribution system operators, other operators, investors, or any group thereof, the entity with legal personality under the applicable national law, which has been designated by contractual arrangement between them and which has the capacity to undertake legal obligations and assume financial liability on behalf of the parties to the contractual arrangement.

II. Questionnaire for transmission projects not included in TYNDP

1. Reason for non-inclusion of project in TYNDP 2012

☐ No transmission license or no exemption from regulated regime; please explain:

.....

☒ Other, please specify:

Project remains under development, although extensive pre-feasibility work has been undertaken. Reports are available on system configuration and likely institutional obstacles to the development of the envisaged meshed offshore network are available at www.islesproject.eu.

2. General information

a) Name of project

ISLES (Irish Scottish Links on Energy Study)

b) Brief description

The governments of Scotland, Northern Ireland and Ireland commissioned Irish-Scottish Links on Energy Study (ISLES) on the feasibility of creating an offshore interconnected electricity grid based on renewable resources (wind, wave and tidal) part funded by the INTERREG IVA Programme, with the balance from partner governments. The area of study is to the north and west of Scotland and the island of Ireland, on the periphery of the EU, but home to plentiful potential renewable energy resources.

A detailed resource assessment was performed to identify the marine renewable energy resource (offshore wind, wave, and tidal stream) available within the offshore areas of Ireland, Northern Ireland, and Scotland, defined by their 12 nautical mile territorial boundary. Based on the existing resource assessments, a total of **16GW** of realisable energy are available to be exploited within the ISLES area.

The study concluded that an ISLES cross-jurisdictional offshore integrated network, based on HVDC interconnectors, is economically viable and competitive under certain regulatory frameworks and has the potential to deliver a range of wider economic, environmental and market related benefits, with offshore generation delivered at a capex of c. €1.15 million/MW.

Are any other project promoters involved in the project? (list each)

- Countries: ☒ EU ☒ Non-EU, please specify:

  Scotland, UK, Ireland, Northern Ireland
- Name of undertaking: .....
- Contact details: as in Section 1 of the application

c) Situation of the project promoter(s):

- What is legal status of the project promoter(s)? Please specify (registered undertaking, group of companies, other).

OTHER – the promoters are governments within the development area of the ISLES proposal

- If you are a registered undertaking, please provide the list of all shareholders, information on their main activity and their respective shares in the undertaking.

  Not applicable

- What is the share capital of this undertaking?

  Not applicable

d) Project type

☒New

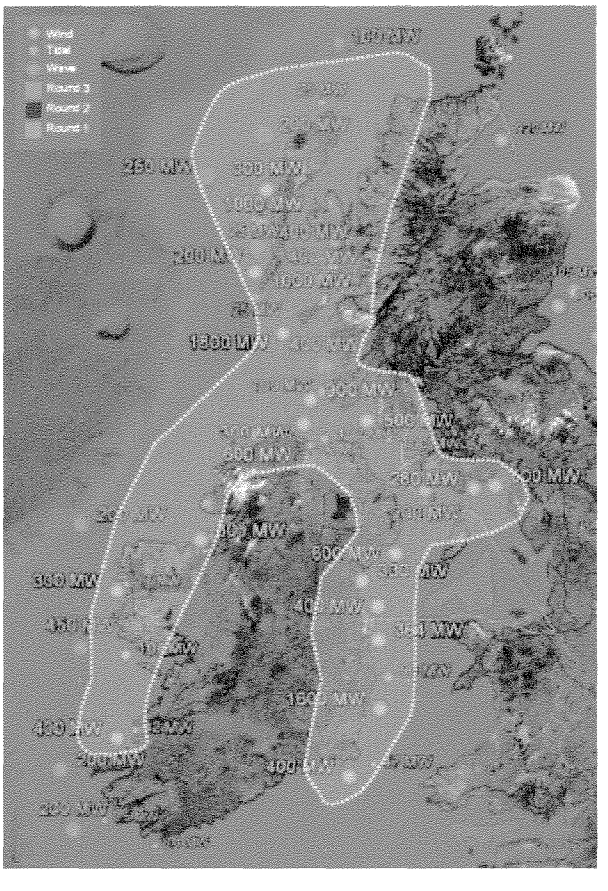
☐Upgrade

☐Extension

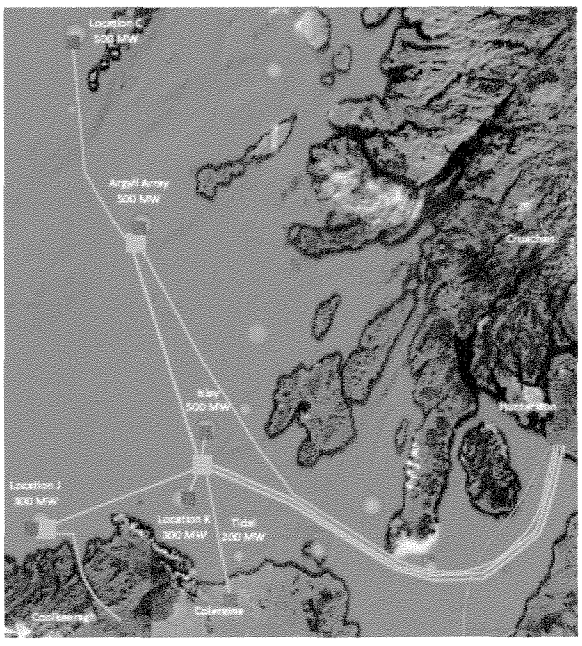
☐Replacement

e) Key physical characteristics

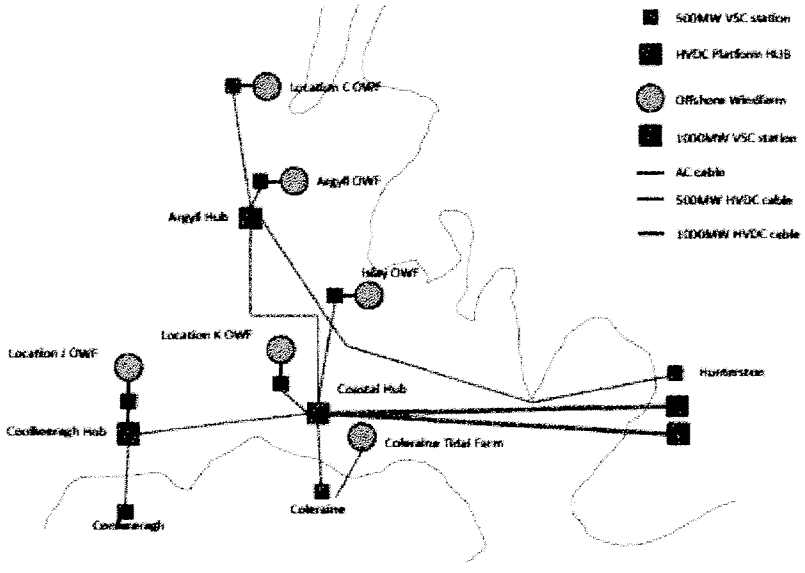
ISLES RESOURCE AREA



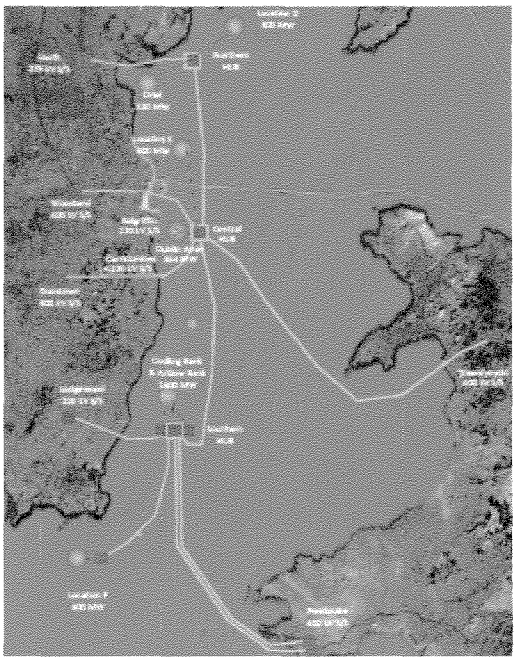
NORTHERN ISLES AREA OVERVIEW MAP



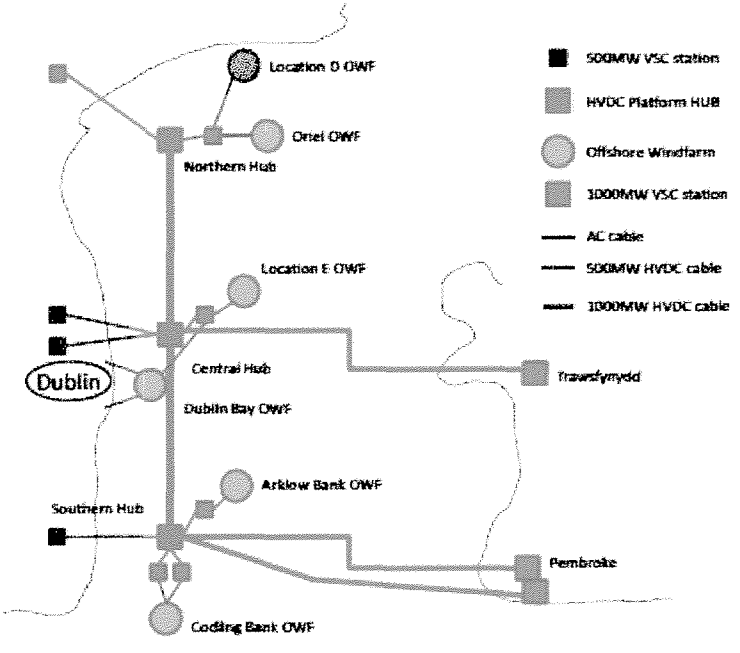
INDICATIVE NORTHERN AREA GRID CONNECTION SCHEMATIC



SOUTHERN ISLES AREA OVERVIEW MAP



INDICATIVE SOUTHERN AREA GRID CONNECTION SCHEMATIC



- Start point (area) Not applicable
- End point (area) Not applicable
- Length (km) 850km in the northern area, connecting 2,300MW of generation
- Route type: ☐ Onshore ☒ Offshore

The most dominant area of development; project has been designed with existing onshore network development plans.

f) Key technical characteristics

The network will be a meshed offshore grid of DC interconnection technologies, with AC links from individual generation sites joining into that network at converter sites built on an incremental, modular basis.

- Transmission capacity (MW for DC/ MVA for AC): 500/1000MW DC
- Voltage (kV):
- Current: ☒DC ☒AC
- Line type: ☒ OHL ☒ ~~Underground cable~~ Undersea cable

g) Estimated project cost (capital expenditure in million euros) €6,300 million

h) Planned date of commissioning (year) 2016 onwards

i) Implementation status

☒Pre-feasibility

☐Feasibility/FEED

☐Final Investment Decision (FID)

☐Permitting

☐Construction

a) Obstacles for the implementation of the investment item

☒Permit granting (please explain):

Extensive work was undertaken to examine the issues relating to permit granting in the ISLES region. Reports on those issues were prepared for both the Northern and Southern sections of the study area. The conclusions were that whilst differing rules and data requirements applied in the respective jurisdictions, there was a high potential for creating a 'one stop' approach to permitting. This would ensure that potential developers will be able to access consistent information on the permitting process. Creating that approach is the subject of a current bid for INTERREG funding.

☒Regulatory treatment (please explain):

Extensive work was undertaken to examine the issues relating to regulatory treatment of an interconnected network in the ISLES region. A report on regulatory issues was prepared for the study area. The conclusions were that it would be important to:

- define the legal and regulatory status of interconnectors,
- align or modify subsidies to drive market behaviours to meet the needs of each jurisdiction;
- establish mechanisms for funding and remunerating strategic network build with incremental development of assets over a period of time
- work with the evolving EU legislation to ensure benefits of network development are fully realised.

Governments in each jurisdiction are currently engaged in developing what is termed the All Islands Approach, which seeks to tackle many of the market issues identified in the above report. It is also one of the objectives of the current INTERREG bid for further funding.

☒Financing (please explain):

The project is considered bankable; the issue of defining ownership models for the ISLES network remains to be resolved. It is likely that the incremental build of the project, and the requirement for anticipatory investment will be such that novel approaches will be required. The current legal separation between interconnectors and transmission assets adds significant complexity, and a final model chosen for ISLES will need to address this issue directly for the project to be owned by one or more entities/developers. Works preparatory to a business plan that can encapsulate this complexity is part of the current bid for INTERREG funding for continuation funding of the project.

☐Other (please explain):.....

☐None

Please provide:

- a list of all studies carried out so far for the project;

All project reports can be accessed at the following website: www.isleproject.eu.

- a list of interactions with all concerned transmission system operators (TSO) and/or national regulatory authorities (NRAs): e.g. letter from TSO acknowledging receipt of application for grid connection or landing point, technical and financial proposal from TSO for connection, letter from NRA concerning the applicable legal regime for the project.

Throughout the development of the ISLES project there was significant interaction with TSOs, NRAs and the partner governments, culminating in a significant conference presentation of the findings in November 2011 at the conclusion of the project contract. While there has been ongoing contact throughout the project all the major stakeholders and decision makers have been sent copies of the final reports and their views sought on the nature and form of the interconnections and development proposed.

3. Specific information

a) Which EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

UK and IE at offshore borders, also Intra-UK (Northern Ireland-mainland UK).

b) Which non-EU Member States are involved or affected by the project with respect to grid transfer capability, at which borders?

Not applicable

c) Does the project cross borders directly or does it have a cross-border impact? Please specify the impact of the project on the grid transfer capability of each concerned border (in MW).

Cross border interconnection IE-UK is enhanced by 2,800 MW, whilst 16GW of renewable generation will be facilitated.

d) What are the main reasons for you to propose this project for consideration as a PCI?

ISLES is firmly grounded in the implementation of EU policy to provide competitive, sustainable and secure energy. The Energy 2020 Strategy adopted by the European Commission in November 2010 provides a solid and ambitious European framework for energy policy:

- 20% renewable energy contribution by 2020
- Free movement of energy across national borders
- Secure, safe and affordable energy through a functioning internal market
- A technological shift to decarbonise energy towards a low carbon future based on long-term strategic planning and development of trans-European energy networks.
- Strong international partnership, as Europe is the world's largest regional market and largest importer; so the common goals of security of supply, competitiveness and sustainability are critical.

ISLES has all of these characteristics and objectives, making it an exemplar EU energy project. Comprehensive studies undertaken to date have considered the planning, environment, regulatory, technical and construction feasibility that is required for all such multi-jurisdiction projects and may in other instances be considered an obstacle to meeting the objectives of current EU energy policy.

ISLES also contributes to the fundamental objectives of the European Commission's new "Connecting Europe Facility" of October 2011, funding further interconnection of Europe across energy, transportation and communications. That ISLES is centred on an area on the periphery of the EU is significant – not only is it an area of outstanding natural resource in terms of the potential renewable energy on offer, but historically such areas have suffered from under-investment in infrastructure.

Obtaining PCI status for ISLES would help to secure future development of a significant portion of EU renewable resources, whilst also firmly connecting previously peripheral areas into the wider integrated EU energy market.

e) How will the project facilitate market integration, elimination of isolated markets, competition and system flexibility? Please specify in particular the impact on energy system-wide generation and transmission costs.

ISLES can facilitate market integration by more effectively linking markets in Ireland and UK together, deepening the market size for renewable energy whilst also alleviating limitations created by technical constraints presently operating against increases in renewable generation on an island market.

Currently, the transmission system on the island of Ireland as a whole is severely limited in ability to accept significant levels of offshore renewable energy; a

situation which can be addressed through the greater use of offshore interconnection between generation sites. The already high background level (has peaked at more than 40%) of intermittent generation on the island of Ireland has begun to impose constraints on the connection and operation of renewable projects as fundamental technical limitations in the Irish grid, plus the small size of the immediately available market, make it more difficult to connect and finance such projects.

The relative remoteness of the generation in the west and north of Scotland also renders individual schemes expensive to connect to grid, particularly if treated on a standalone basis. Several schemes in this area have in the past not proceeded due in part to the costs of connection.

ISLES has the potential to provide an export path for renewable generation, with the predominant flows being South and East into England and Wales, and provide additional interconnection into Ireland and Northern Ireland, potentially reducing electricity prices on the island of Ireland and relieving constraints on the grid.

f) How will the project facilitate sustainability, inter alia through the transmission of renewable generation to major consumption centres and storage sites? Please specify in particular, which capacity of renewable generation will be connected directly and indirectly (in GW/1000 km²). Please specify also the type of renewable generation capacity concerned.

Up to 2.8GW interconnection between the island of Ireland and Scotland/England will be created, supporting up to **16 GW** of renewable generation. The impact of this generation and interconnection will lead to a reduction in the need for up to **100 million tonnes of CO_2** emissions from thermal generation over the project lifetime. The generation will be directly connected into the network and is broken down as follows: **12 GW offshore wind, 2.6 GW wave and 1.4 GW of tidal generation**.

g) How will the project contribute to security of supply and secure and reliable system operation? Please specify the impact of the project on the loss of load expectation for the area of analysis as defined in point 10 of Annex V of the draft Regulation in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience.

Interconnection provides an additional potential in-feed to a system that adds to security, and in addition has the added advantage of deferring/reducing the need to build additional back-up generating plant. For the project to contribute to maintaining an acceptable plant margin the in-feed needs to be provided on a firm basis backed by contracted interconnection capacity and available generation.

As an example, starting with a Loss of Load Probability (LOLP) of 0.0031 and adding 500MW of firm input capacity would reduce the LOLP to 0.0007 with a saving of **€65m** to the All-Island market area. This compares to the capital cost/yr for new gas and coal plant to cover loss periods in the region of €40-74m/yr. The benefit to end users derives from avoiding the added capital cost of new generation, assuming common market mechanisms can be applied in the ISLES area.

h) Why is the realisation of this project particularly urgent with regard to the EU energy policy targets of i) market integration and competition, ii) sustainability and iii) security of supply?

The ISLES proposal delivers in all three areas of EU energy policy:

1. **Market integration** – the GB market and Single Electricity Market in Ireland are already seeking greater integration, and investment here in the proposed offshore grid and interconnection would reduce congestion barriers allowing peripheral areas and renewable production greater access to market, increase renewable penetration within the market place and introduce a greater degree of competition for renewable energy through greater access. In total, interconnection could lead to around **€280m per annum** of combined cost savings in the two electricity markets, of which, around two-thirds (€190m) could be attributed to the utilisation of Southern ISLES assets. Most of this benefit accrues to consumers on the island of Ireland, although the exact amount would depend upon the regulatory model adopted.
2. **Sustainability** - the economic and social sustainability of the proposal is evidenced through **anticipated costs/MWh comparable with current subsidy regimes**, and within current market expectations. Building in a coordinated manner, rather than a series of unconnected developments, is already known to deliver economic benefits to developer and consumer alike. Employment opportunities will also be created in peripheral areas during the construction phase of the project, the central estimate peaking at an estimated **2,100 FTEs**. Environmental sustainability is based upon not only the production of green energy which will **prevent some 100 million tonnes CO_2** of emissions, but also through establishing an offshore network in a manner which is compatible with Habitats & Species legislation protecting the marine environment in which the development will take place.
3. **Security of supply** – security of supply is enhanced through the creation of interconnection both between the two markets and within more peripheral areas of the EU. The proposed meshed grid development creates greater overall availability of the network when compared to traditional radial-type offshore developments, and can enhance both import and export characteristics for wider benefits. The reach of the grid is such that generation from areas with differing prevailing conditions has the added advantage of being able to manage intermittency on a wider system basis. An additional supply issue to consider is that the Irish electricity market having a high dependence gas generation, based upon gas imported from the UK via interconnectors. Greater electricity interconnection will offer alternate routes to satisfying demand other than indigenous thermal generation.

i) Are there any interdependencies and/or complementarities with other projects? If yes, which?

The TYNDP 2010 Deeside-Hunterston HVDC link (TYNDP project 79.452) is one of a number of major TYNDP projects around the following boundaries – 77, 80 and 82 – which this proposal would complement. The export capacity that will be created by the HVDC link – which has the cable on order and is expected to be complete in 2016 – is important to the realisation of export from the northern ISLES area.