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CHAPTER 03
Need and Alternatives

Shannon LNG Limited
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Shannon Technology and Energy Park
Environmental Impact Assessment Report

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3. Project Need, Site Selection and Consideration of Alternatives

3.1 Introduction

This chapter outlines the need for the Power Plant, the Battery Energy Storage System (BESS), and the LNG Terminal that encompass the Proposed Development. It also discusses the siting of the Proposed Development, the main layout options as well as the main alternatives considered in respect of the technologies and processes. Each of these can be found in the following sections:

- Need for the Proposed Development (Section 3.2);
- Alternative locations (Section 3.3);
- Alternative designs (Section 3.4);
- Alternative layouts (Section 3.5); and
- Alternative processes/ technologies (Section 3.6).

3.2 Need for the Proposed Development

This section outlines Ireland's needs for:

1. Diversity and security of natural gas supply;
2. Natural gas to backup intermittent renewable generation; and
3. Additional modern, flexible and efficient gas fired power plant to resolve a predicted generation capacity shortfall.

The Proposed Development addresses Ireland's security of energy supply risks, supports intermittent renewable generation, and resolves a predicted generation capacity shortfall.

3.2.1 The Need for Natural Gas

As electricity from renewable sources increases, a simultaneous increase in electricity demand, and closure of coal, oil and peat-fired electricity generation, means that natural gas is predicted to play an increasingly important role as a backup fuel.

Specifically, natural gas demand from now to 2040 is forecast in the National Energy and Climate Change Plan (NECP) 2021 to 2030 (Department of the Environment, Climate and Communications (DECC), 2020b) (Figure 3-1). The NECP considers Irish energy and climate policies, the levels of demographic and economic growth identified in the Project 2040 process and includes the climate and energy measures set out in the National Development Plan 2018-2027. The NECP was prepared to incorporate all planned policies and measures that were identified up to the end of 2019 and which collectively deliver a 30% reduction by 2030 in greenhouse gas emissions (from 2005 levels), excluding emissions associated with the EU Emissions Trading System (ETS). Specifically, it considers the objective for 70% of Ireland's electricity to come from renewable sources by 2030. Combined with the imminent closure of coal and peat fired generation units, gas fired generation is identified as the principal source of back up available for intermittent renewable regeneration. As can be seen in the NECP forecast (Figure 3-1), natural gas demand is forecast to increase from current demand levels of 4.69 million tonnes of oil equivalent (MTOE) to 6.38 MTOE by 2040.

DECC confirmed the long term need for gas in November 2020 by noting that (DECC, 2020a):

- '*Ireland's demand for electricity is expected to increase in the coming years due to increased electrification in the heat and transport sectors and growth in demand from large energy users such as data centres;*
- *Following the phasing out of peat and coal use for electricity generation, Ireland's security of electricity supply is expected to become much more dependent on natural gas which is likely to be*

the principal source of non-variable generation supporting variable renewable sources such as wind and solar.

- *There will be a significant reduction in indigenous supplies of natural gas due to production at the Kinsale fields having ceased in July 2020, and the planned tapering decline in production from Corrib over the next decade;*
- *Ireland's gas import dependency is predicted to increase from over 50% in 2019 to approximately 80% by the middle of the decade and to over 90% import dependency by 2030;*
- *All of Ireland's natural gas imports are sourced (via the two pipelines) from a single supply point at Moffat in Scotland with no alternative import routes;*
- *There is no natural gas storage in Ireland; and*
- *The UK has left the European Union which will lead, at the end of the withdrawal period[1], to difficulties for Ireland in meeting the requirements of EU law in relation to gas security of supply including potential challenges for future compliance with EU law including the 'N-1' infrastructure standard and the supply standard.'*

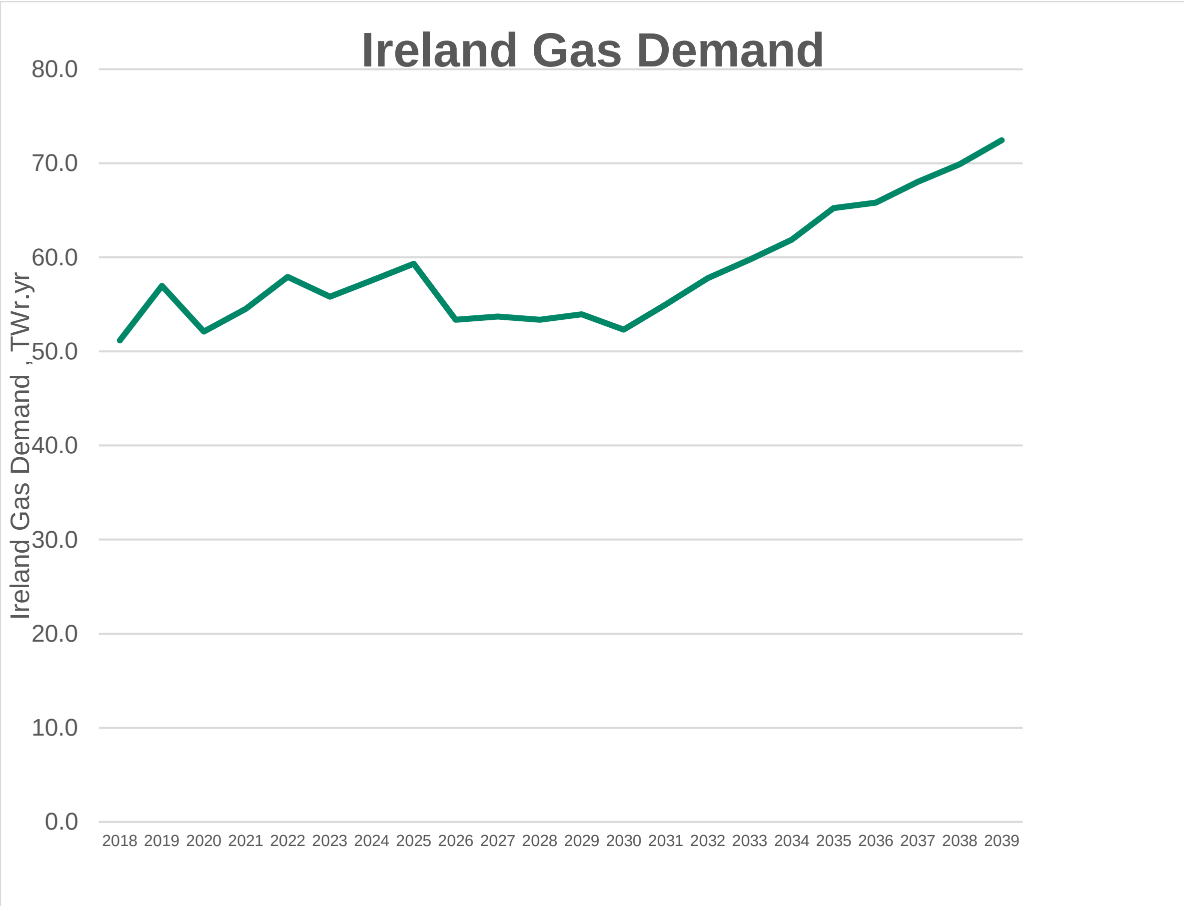


Figure 3-1 Gas Demand in Ireland (to 2040) (DECC, 2020b)

[1] The withdrawal period ended 31st December 2020.

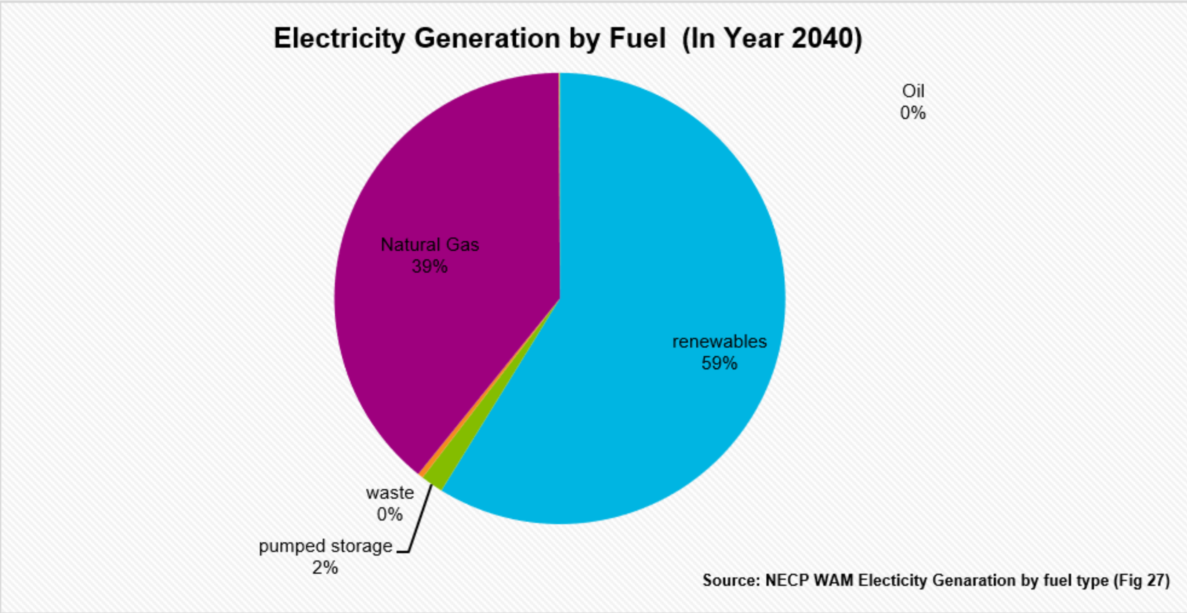


Figure 3-2 Projected Electricity Generation by Fuel in 2040

3.2.2 Shortfall in Power Generation Capacity

The Proposed Development contains a 600 MW gas fired Power Plant. The Power Plant will provide additional and flexible power generation capacity to support intermittent renewable generation and resolve a predicted generation capacity shortfall.

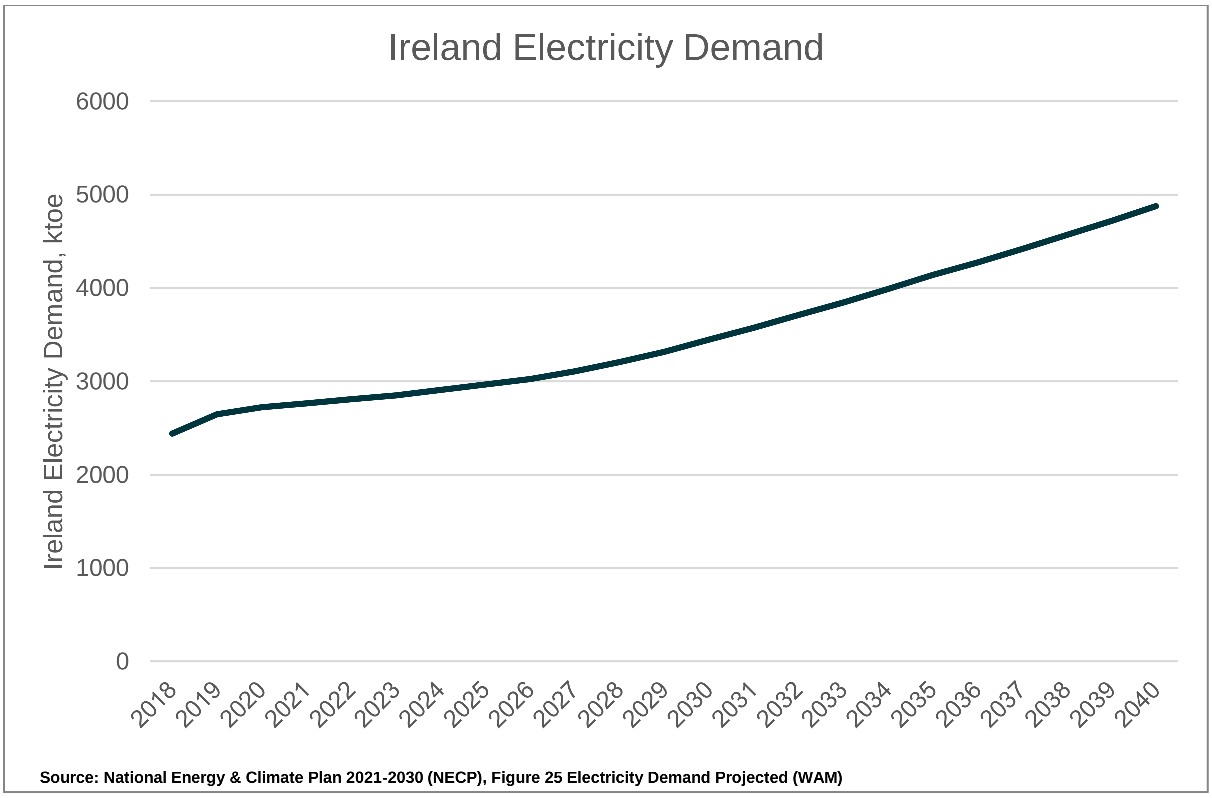


Figure 3-3 Ireland Electricity Demand, National Energy and Climate Plan 2021-2030 (DECC, 2020b)

The NECP (DECC, 2020b) forecasts that for the year 2025, natural gas will provide 52% of electricity in Ireland, with renewables providing 46%, pumped storage 1%, and waste and back up oil providing the remaining 1% of electricity (Figure 3-4). By 2040, the NECP forecast gas generating 40% of electricity in Ireland, with renewables providing 58%. The NECP also forecasts that with increasing intermittent renewable generation, and increasing electrical demand, the amount of electricity produced from gas fired generation will increase by 30% from 2025 to 2040.

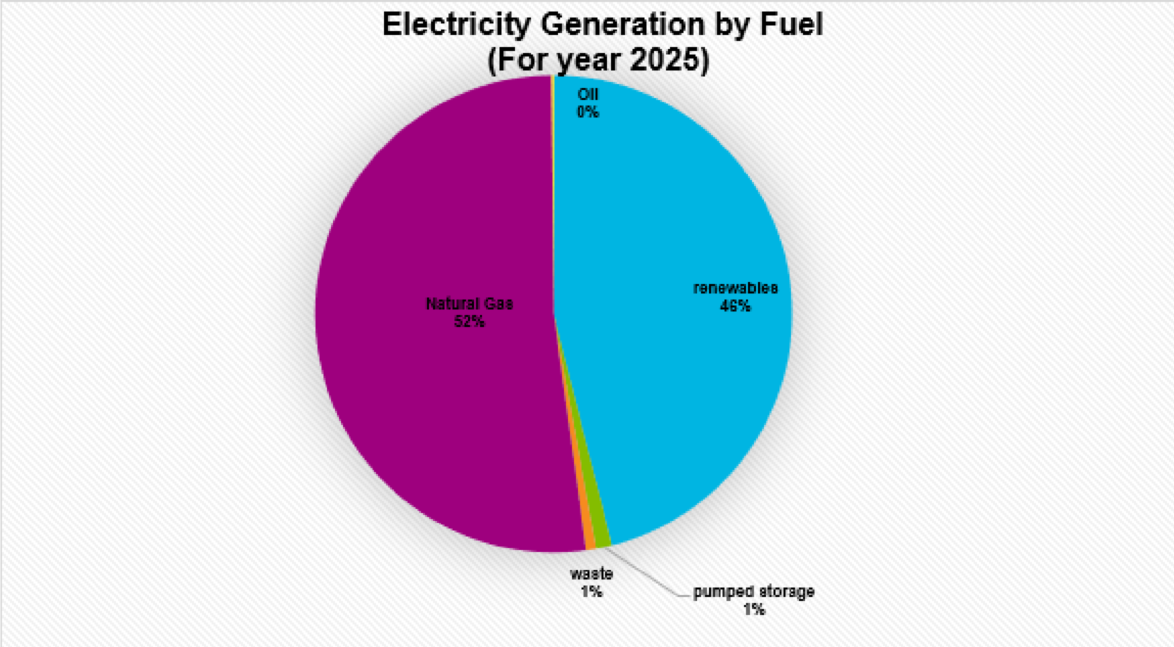


Figure 3-4 Projected electricity generation by fuel for the year 2025 (DECC, 2020b)

Therefore, even with a future significant increase capacity of renewable power being connected to the grid, there is a predicted shortage of conventional power generation. EirGrid has forecast a shortfall in generation capacity of up to 570 MW by 2026 and advised that new additional gas fired conventional power plants are urgently required (EirGrid and Soni, 2020). The 600 MW Power Plant can be delivered within the timeframe to counteract this predicted shortage. In this regard, the Applicant is currently awaiting an imminent grid connection offer having been successful in the Enduring Connection Policy Stage 2 (ECP-2.1) process in 2020.

To encourage new generation capacity onto the grid, the Single Electricity Market Operator (SEMO) holds periodic auctions for new and existing capacity for delivery up to four years in the future (SEM Committee, 2021). The capacity payments achieved by new (and existing) generation via these auctions have been reducing in recent years as the market design moves towards the delivery of system services to support the drive for increased renewables on the system (DS3) (EirGrid, 2021a).

'*The Capacity Remuneration Mechanism (CRM) is designed to ensure that the demand for electricity is always met. The overall aim of the CRM is to ensure security of supply, as well as ensuring that consumers don't pay for more capacity than is needed. The CRM was implemented as part of the revised SEM arrangements which went live on 1st October 2018, and replaced the Capacity Payment Mechanism under the previous arrangements. Capacity providers sell qualified capacity to the market, based on generation capacity required in a future capacity year. This takes place in the form of capacity auctions. Auctions are normally held by the Transmission System Operators between one and four years ahead of delivery.*'

A number of new build gas power station projects which had successfully cleared the auctions in recent years, and were awarded 10 year CRM contracts have withdrawn/ terminated their contracts due to their inability to deliver in the required timeframe (EirGrid and Soni, 2021). This failure to attract new modern, efficient, baseload generation may lead to a sub-optimal future electricity system where aging, inefficient, unreliable peaking power stations, that run on coal and oil, may remain on the system (Nord Pool, 2021).

In the absence of new additional power generation, and with the closure of coal, peat and oil fired power plants, a generation capacity shortfall is forecast by 2026. If realised, this shortfall will mean that that electricity demand exceeds supply, and the system operator(s) will be required to reduce demand on the system (known as load shedding). The Proposed Development can counteract this issue and provide sufficient system capacity to prevent a shortfall from occurring.

Many of the plant that currently run on the margins of the electricity system in times of peak demand are oil and coal fired plant that are increasingly unreliable with multiple faults reported in recent time.

3.2.2.1 System Alerts

System Alerts are issued by the Single Electricity Market Operator (SEMO) during periods when there is an elevated risk of not being able to meet electricity system demand. The number of system alerts warning of potential electricity shortages on the national grid has risen in the last 12 months, with the most recent being on 17th May 2021. In the last year the SEMO has issued six system alerts to warn of capacity shortages on the electricity grid and has warned customers to expect more alerts in the coming months. During System Alerts, dormant coal and oil generators can be instructed to start up to manage the mismatch between supply and demand. Large energy demand users can also be requested to reduce their energy use.

There has been a notable increase in generation outages in recent years. The thermal generation fleet in Ireland (and Northern Ireland) is ageing and many of the existing units were not designed for the current highly variable operation conditions associated with backing Ireland's high penetration of non-dispatchable renewables in the generation mix. The sub-optimal operating conditions relative to the original design are leading to increased reliability, operating, and maintenance issues, as well as the associated costs for operators. The Power Plant is optimised to operate within the current and future SEM system design, being capable of low minimum load and rapid ramping up and down of output thanks to its modular design.

The BESS will also provide fast (<5 sec) response power for system stability services caused by sudden changes in the supply/ demand balance, mainly as a result of intermittent renewable generation. Refer to Chapter 02 – Project Description for more information.

The Commission for Regulation of Utilities (CRU) is extremely cognisant of the urgent need for additional gas fired generation to safeguard electricity security of supply. In August 2021, the CRU published details of specific directions given to both Eirgrid and GNI in order to prevent serious adverse impacts on the electricity system in both the short and medium term (CRU, 2021):

'*The CRU, working closely with System Operators, has recently progressed a number of measures to support both medium term and short-term electricity supply and demand balance, in light of unexpected generator outages and delays in the delivery of new gas-fired generation capacity.*

Some of these measures, such as the proposed decision on a direction on data centre connections, are subject to public consultation while other measures are not. Given the importance of these measures and in the interests of transparency and openness, the CRU is today publishing a number of letters related to recent directions to EirGrid and GNI in support of electricity security of supply.

The CRU will continue to engage with the system operators and the Department of Environment, Climate and Communications and other stakeholders on the transition to a secure, low-carbon future.'

The specific measures included a direction to EirGrid to secure temporary emergency firm generation capacity for Winter 2021/ 22 due an acknowledged 'likely and substantial risk of a security of supply emergency in respect of which is not practicable in the time available to otherwise ensure security of supply'.'

This direction required the consent of Minister Eamonn Ryan. In his letter to the CRU (DECC, 2021a), the Minister stated that:

'*Ensuring a continued secure supply of electricity is vital for the proper functioning of society and the economy. It is also necessary to ensure people and businesses have confidence in switching to electrified solutions such as heat pumps and electric vehicles, which are core elements of the Government's Climate Action Plan.*'

At the end of his letter, the Minister stated that:

'*In parallel with the request pursuant to Regulation 28(10) to provide emergency generation, I acknowledge that the CRU and EirGrid are engaged in a range of measures to mitigate the risks to security of supply.*

In its report, EirGrid noted a number of these measures such as improvements of the performance of existing conventional generators and engagements with the demand side units to improve their performance.

It is important that the CRU also consider why the current electricity market structure and the regulatory measures in place are not delivering the required level of new generation capacity necessary to ensure security of supply in Ireland and thus support the Government's emission reduction targets. It would seem appropriate that the CRU would review and evaluate the performance of the market and the regulatory measures in place and consider if changes to the market and/or additional measures are required.'

GNI wrote to the CRU in June 2021 to highlight that it has received a significant number of connection enquiries from potential new electricity generation plant. GNI highlights that:

'*Despite the high number of enquiries and the successful completion of the T-4 capacity auction by EirGrid, all but one connection offer remains outstanding with developers reluctant to commit to a connection agreement at this time. The on-going delays with developers committing to a gas connection means the proposed timelines for the delivery of these projects can no longer be met and GNI is concerned that the security of supply may be impacted as a result.*'

GNI's proposal, which was approved by the CRU, was that GNI would progress with detailed design for some or all of the 16 identified projects without receiving a contractual commitment from the prospective connecting parties (as is typically required under the GNI Connections Policy) (EirGrid, 2021b).

The Proposed Development, including the CCGT, is significantly advanced relative to other gas fired electricity generators. For example, the 26 km Shannon Pipeline has already been permitted. The level of advanced work undertaken by the Applicant, along with GNI to this juncture, puts the Proposed Development in a very strong position to contribute to meeting the challenges of safeguarding Ireland's electricity supply in the timelines identified by the CRU.

3.2.3 Intermittency of Renewable Generation

Renewable generation is weather dependent, and its output fluctuates considerably. For this reason, conventional power plants are required to fill the fluctuating gap between electricity demand and renewable generation. Natural gas is the only major energy source currently available to back-up renewable generation and thereby maintain a resilient electricity supply to the country while supporting the transition to 70% renewable generation by 2030.

As an example, the wind generation profile on 6th December 2020 provides an insight into the vulnerability of wind power to weather conditions (EirGrid, 2021c). On this day, there was installed wind generation capacity of over 4,000 MW. However, at 2:45 PM wind produced only 1 MW of power with the system requiring over 5000 MW of power at that time. Most the power generation at that moment was delivered by gas fired power generation. The low level of wind generation continued to the next day, 7th December, when Ireland experience a system record peak day electrical demand (see Figure 3-5).

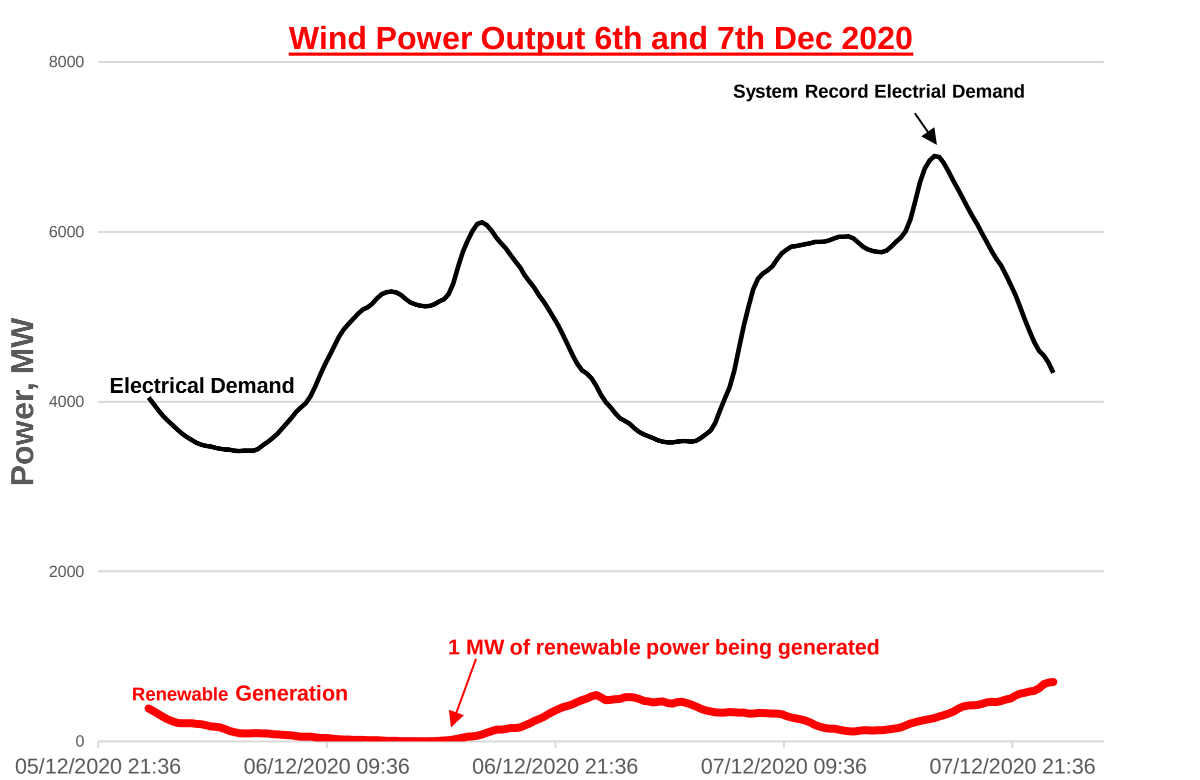


Figure 3-5 Wind Power Output and Electrical Demand on 6th and 7th December 2020

The Irish Academy of Engineering (2021) notes the following:

'*Like other climatic phenomena annual mean wind speeds are subject to significant variations from year to year. The winter of 2010 was characterised by an exceptionally cold spell over Western Europe. Such weather patterns are unusual over Western Europe but when they do occur, they are accompanied by exceptionally low wind speeds and the patterns survive for prolonged periods. During the five week period from mid-November 2010 to the final week in December, wind output, at peak demand period, was less than 10% of installed wind generation capacity. There was a 10 day period in this very cold spell where wind output was close to zero.*

In these conditions it is questionable as to whether a significant infeed could be obtained through interconnectors with GB and France. Scotland, which has much of GB's wind generation capacity, was even more affected by the same climatic conditions and France has a high dependence on electric heating, which was promoted to complement its nuclear programme and thus has high domestic electricity requirements when temperatures are extremely low. The key to understanding the challenges posed by such weather patterns is to acknowledge their extent –not just Ireland or GB, but most of Western Europe.

It has been suggested that storage technologies might be used to manage such multi week periods of low renewable generation and high demand. While such technologies could indeed contribute to solving daily intermittency problems, the cost of implementing such solutions (pumped hydro, or battery storage for example) to provide power over many days makes them entirely unfeasible for the foreseeable future.'

3.2.4 Security of Supply of Gas

Please refer to Chapter 04, Section 4.1.3.7 Security of Supply for a detailed policy discussion.

As the year-on-year production from the Corrib gas field declines, Ireland will increasingly rely on imports of gas via a single supply point from the UK, predicted to provide 90% of gas by 2030. Due to the decline in North Sea production, the UK itself is expected to import up to 75% of its gas supply by 2030 (from Norway, Russia, Qatar and various countries outside Europe). Therefore, the gas supply route to Ireland will be longer than at present with a greater risk of supply disruption (Irish Academy of Engineering, 2018). The impact of losing this single gas supply point from the UK has been assessed by the Commission for Regulation of Utilities (CRU) (2020), as being a '*major*' risk for electricity production in Ireland. An interconnector to France, discussed further in Section 3.2.6, would not provide sufficient capacity for the loss of the UK gas interconnector. Figure 3-6 notes the expected gas demand and supply to Ireland to the year 2040.

Pipeline infrastructure failures and supply disruptions occur and the potential consequences must be planned for. For example in 2017, gas supplies from the Corrib Gas Terminal at Bellanaboy were interrupted for 21 days. Gas supplies can also be vulnerable to mechanical failure, man-made events and cyber-attacks such as ransomware. In May 2021, the US's largest fuel pipeline, Colonial Pipeline, was disabled after a ransomware attack.

The Department of Communications, Climate Action and Environment, with support from the Commission for Regulation of Utilities (CRU) commissioned Gas Networks Ireland (GNI) and EirGrid to complete a Security of Supply review in 2018, called the Long Term Resilience Study 2018 (GNI and EirGrid, 2018). The Long Term Resilience Study concluded with a key recommendation to *'Conduct a detailed cost benefit analysis for a floating LNG terminal. The most economically advantageous option to improve the resilience of Ireland's gas supply is a floating LNG terminal. A floating LNG terminal would provide a direct connection for Ireland to the global LNG market and would allow Ireland to diversify its gas supply'.*

Separately, the International Energy Association (IEA) in their report *'Ireland 2019 Review of Energy Policies of IEA Countries'* recommended that the government of Ireland should: *'Optimise the role of gas in the transition to a low-carbon-energy system, including encouraging, through appropriate regulation and policy, the development of an LNG import facility and seasonal gas storage. A cost benefit analysis should be used when deciding on any public infrastructure investments and developing programmes for gas demand in the heating and transport sectors.'*

A concrete example of the dependence on Moffat has been seen this year when flows at Corrib were curtailed by issues at an offshore well control valve (REMIT Inside Information Platform, 2021), at the same time as GNI were undertaking planned works at the Beattock Compressor Station in Scotland (European Network of Transmission System Operators for Gas, 2021). The Beattock Compressor Station connects directly to the National Grid Transmission Network at Moffat, and feeds the 2 subsea gas interconnectors into Ireland as well as offtakes to Northern Ireland and the Isle of Man. The works at Beattock limited the capability of the Entry Point to approximately 57% of its technical capacity, for approximately 6 weeks. During the period in question, there were no restrictions on downstream gas usage due to the low heating demand associated with the time of year as well as long term outages associated with unplanned maintenance at four large CCGT power stations (Whitegate, Huntstown 1, Tynagh and Dublin Bay) (EirGrid, 2021d). In this period the electricity system relied heavily on coal and oil plant to replace the missing gas generation. If the gas power stations had been available and a sustained period of low wind conditions had prevailed, which would not be unusual in an Irish summer, there would likely have been a need to implement load shedding of the gas power stations, which could also have impacted additional industrial users.

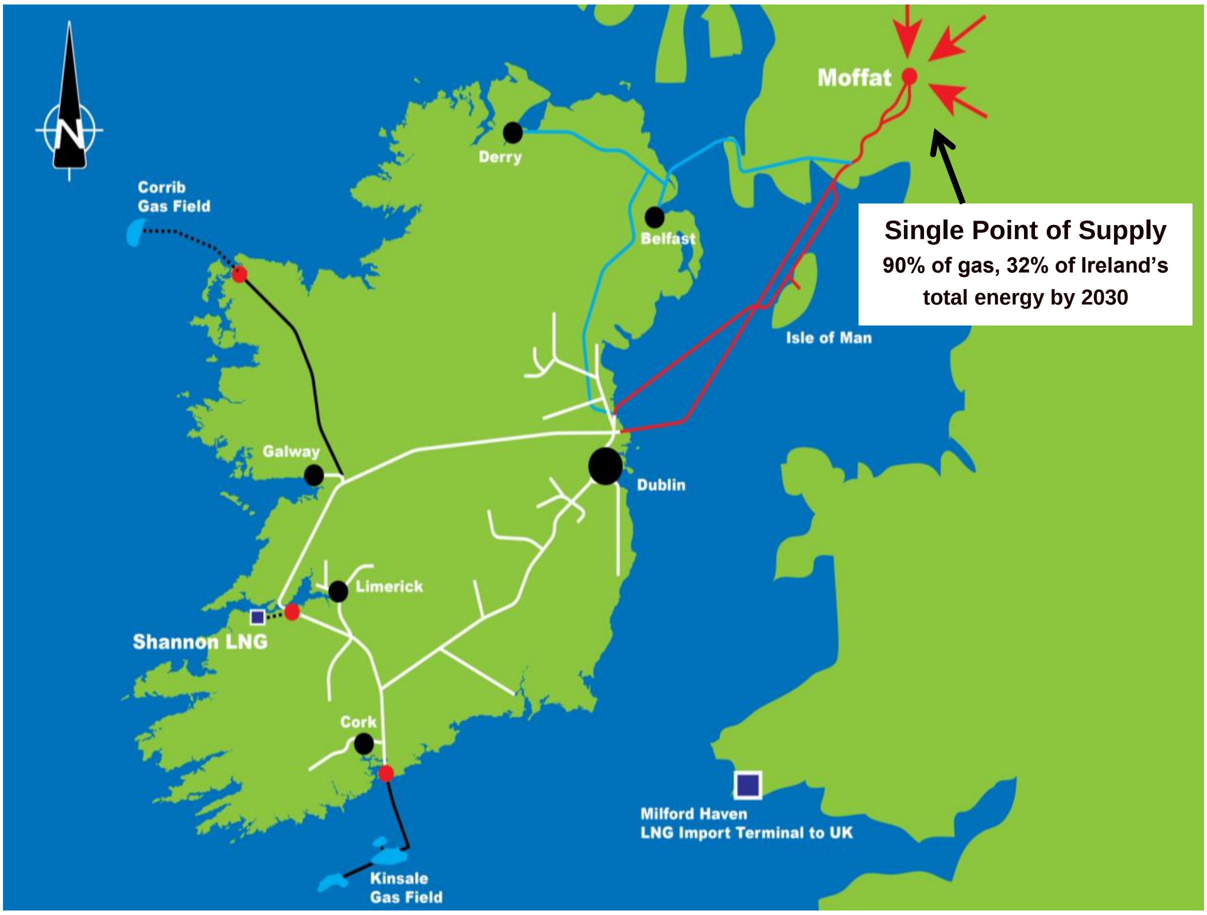
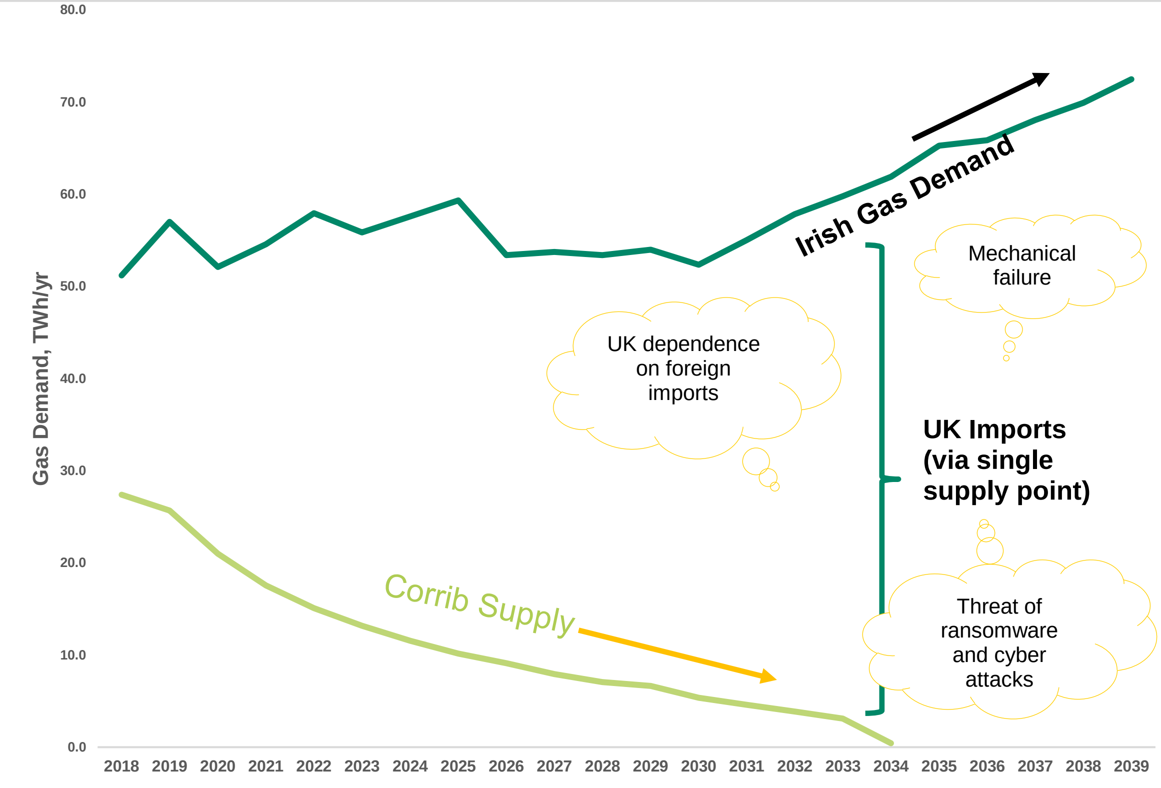


Figure 3-6 Single Point of Gas Supply to Ireland



Source: *The National Energy and Climate Change Plan 2021 to 2030 (NECP), Figure 23 Total Primary energy requirement by fuel (WAM) **F**igure 23 and CRU18105 Copy of Corrib Linkline Element Calculation 2018/19*

Figure 3-7 Irish Gas Demand vs Supply

Another key element of security of supply for Ireland is diversity of supply sources. The UK's domestic reserves are in decline, as are those of the Netherlands, which is the only major domestic producer of natural gas within the EU. Russia supplies approximately 40% of the EU's gas, though the reliability of supply can be subject to political constraints. In Q2 and Q3 2021, despite requirements for additional supplies into Europe in order to fill storage facilities, Gazprom (which has a monopoly on Russian pipeline exports) did not use additional transit capacity via Ukraine to meet the demand.

In the event of a supply deficit in Europe, Ireland would likely be the last country with access to supplies of gas following each country along the supply route. EU Regulation (EU) 2017/1938, the security of gas supply law, provides for a solidarity mechanism between member states. Recital 38 of the Regulation states '*The solidarity mechanism is designed to address extreme situations in which supply to solidarity protected customers as an essential need and a necessary priority is at stake in a Member State. Solidarity ensures cooperation with more vulnerable Member States'.*

As Ireland relies on a single supply route from the UK, which is not governed by the EU Regulation, issues with security of supply may not be easy to resolve. The Proposed Development increases the options available to Ireland to request solidarity from any member states, through either reload of LNG from an EU terminal or diversion of inbound cargoes to Ireland, along with commercial measures to ensure cargoes arrive and maintaining strategic reserves of LNG (in the same way as the National Oil Reserves Agency (NORA) manages fuel stocks (NORA, 2021).

Other European countries, which would have been considered 'energy islands' similar to Ireland, have used the development of LNG terminals to diversify and secure their gas and electricity supply. These developments have been significantly financially supported by the European Commission (see Chapter 2.1.2). The development of the Klaipaèda LNG terminal in Lithuania is a prime example of the way in which an LNG terminal (particularly an FSRU-based terminal) can deliver significant diversity and security of supply to a previously isolated country. Germany is also investigating the potential for LNG as a means to diversify its gas supply (see Appendix A3-1). The positive outcomes achieved by Lithuania, as recognized by the IEA, are pointed to by the same organization in its 2019 review of Ireland: *'The development of LNG import facilities would substantially improve gas supply security in Ireland by providing direct access to the global LNG market.'*

It is clear that there is policy support at national and Commission level in Europe for the benefits that LNG terminals bring to the function of the internal energy market, in terms of security and diversity of supply as well as increased market competition. This is further examined in Section 2.1 of Chapter 04.

3.2.5 Failure to comply with EU regulations

EU Regulation (EU) 2017/1938 is an EU law that requires member states to assess the security of their gas supplies. The assessment is in the form of a simple calculation which removes the technical capacity of the single largest piece of gas infrastructure on a peak day with a view to determining whether the remaining gas infrastructure can meet 100% of peak day gas demand. Ireland currently fails to comply with EU Regulation (EU) 2017/1938. Specifically, according to the CRU (2018):

'*The N-1 calculation removes the technical capacity of the single largest piece of gas infrastructure on a peak day with a view to determining whether the remaining gas infrastructure can meet 100% of peak day gas demand. To pass, the calculation must equate to 100% or more.* ***Ireland failed the Infrastructure Standard meaning that after losing the single largest gas infrastructure the technical capacity of the remaining infrastructure cannot meet demand*** *…*

It can be seen that the result of the N-1 calculation is 85%36 and that Ireland fails to meet the criteria (i.e. if the supply of gas via Moffat is partially disrupted ***Ireland will be unable to deliver sufficient gas from other entry points to meet total demand on a 1 in 20 year peak-day)****.*' **[emphasis added]**

The Minister for the Environment, Climate and Communications has also recently noted (DECC, 2020b):

'*The UK has left the European Union which will lead, at the end of the withdrawal period*[2]*, to difficulties for Ireland in meeting the requirements of EU law in relation to gas security of supply including potential challenges for future compliance with EU law including the 'N-1' infrastructure standard and the supply standard.*'

The Proposed Development provides gas supply diversity and will allow Ireland to comply with the EU Regulation on security of supply, the N-1 Infrastructure standard (CRU, 2018 and Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply).

In the absence of the Proposed Development, Ireland will remain non-compliant with the EU Regulation on security of supply and the N-1 infrastructure standard to 2040 and beyond. The European Commission may launch infringement proceedings for failure to comply with this EU regulation. The LNG Terminal will protect Ireland in the event of a major gas supply disruption from the UK.

3.2.6 Alternatives to the Proposed Development

Alternative natural gas supplies are either insufficient to satisfy demand (pipeline from France and biomethane), technically not mature (hydrogen), or contrary to Irish legislation (offshore exploration). The Proposed Development gives Ireland direct access to global gas markets and therefore greater control over the source of Ireland's gas supplies.

3.2.6.1 Biomethane and Hydrogen

The injection of renewable gas including Biomethane into the gas network has commenced. Together these will make a relatively small contribution to Irish gas supply in the short to medium term and as such they cannot be considered as a significant substitute for imported gas (Irish Academy of Engineering, 2018). For reference, under GNI's Path to Zero, by 2050 the gas network contains 37% renewable gas (biomethane), 13% hydrogen gas, with the remaining natural gas abated by carbon capture and storage.

3.2.6.2 Indigenous Exploration

The Climate Action and Low Carbon Development (Amendment) Bill 2021 (DECC, 2021b) contains a provision to end the issuing of new licences for the exploration and extraction of gas, to help meet the national climate objective to transition to a climate resilient, biodiversity rich, environmentally sustainable, and climate neutral economy by 2050. The DECC is no longer accepting new applications for exploration licences for natural gas or oil, nor will there be any future licensing rounds.

[2] The withdrawal period ended 31st December 2020.

The DECC (2021) notes the number of authorisations has dropped from 55 at end September 2019 to 30 at end December 2020, a decrease of 45%. It is expected that the number of authorisations will decline further as authorisations continue to expire or are relinquished, with no new authorisations for new exploration and extraction replacing them. It is therefore increasingly unlikely that any new gas supply from indigenous production will be brought to market.

3.2.6.3 Alternative Import Routes for Pipeline Gas

A gas pipeline between Ireland and France was assessed by the Department of Communications, Climate Action and Environment, with support from the Commission for Regulation of Utilities (CRU) in the GNI/ EirGrid Long Term Resilience Study 2018.

When considering a pipeline to France, it should be noted that France is dependent upon LNG and inter-connecting pipelines for its domestic gas demand (CRE, the French Energy Regulatory Commission, 2021). Indeed, all countries in Northwest Europe are forecast to see declining indigenous gas production and will need to import gas to meet their long-term supply needs. A significant portion of the imported gas will be sourced from LNG (see Figure 3-5).

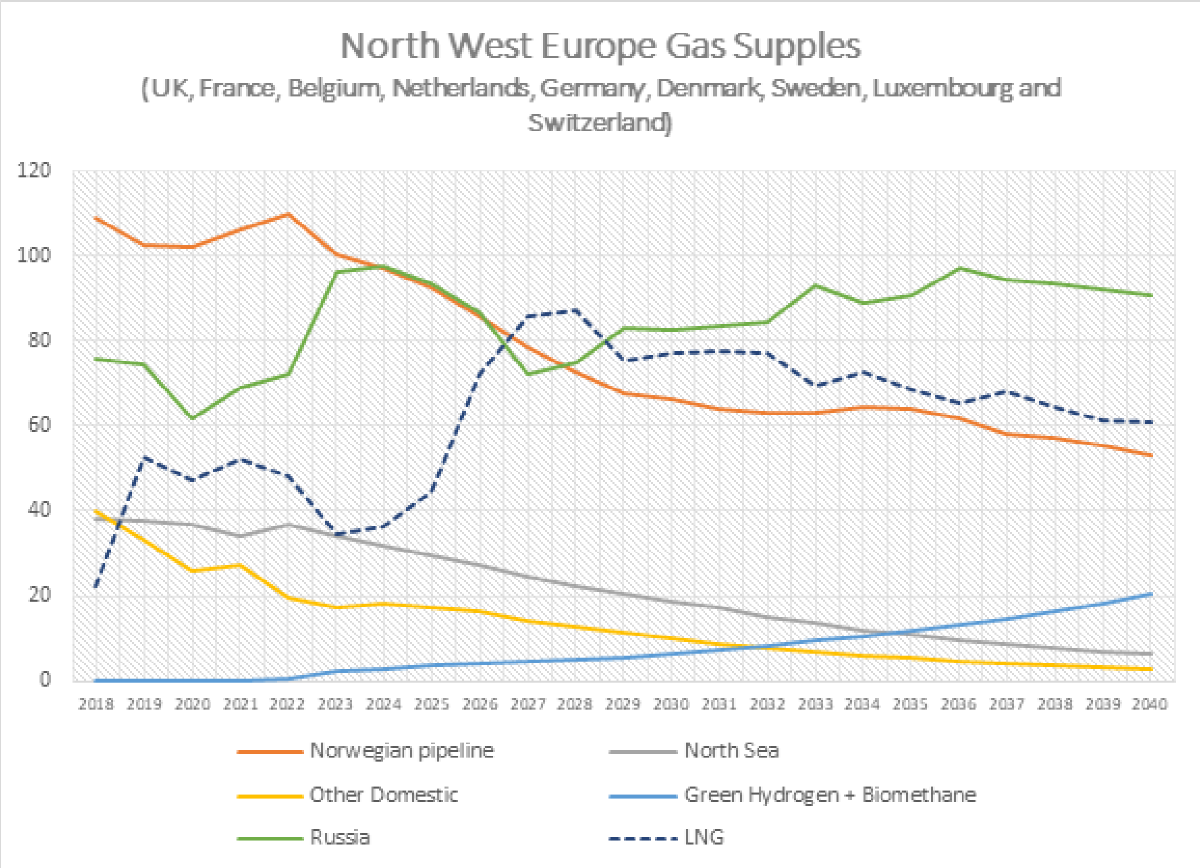


Figure 3-8 North West Europe gas supplies (Platts, n.d.)

The pipeline capacity in the study was estimated at 100 GWh/day. This capacity represents only 39% of Irish peak day gas demand for 2020/ 21, which is forecast at 255 GWh/day. The Proposed Development can supply up to (approximately) 256 GWh/day.

The Long Term Resilience Study notes: *'A gas interconnector to France, while having a positive impact in terms of security of supply and diversification, would have less impact than either of the LNG options. Building a gas interconnector would not on its own result in Ireland meeting the required EU infrastructure standard. This option requires the largest capital investment of the mitigation measures under consideration.'*

By contrast, the Proposed Development, which is a domestic LNG terminal, gives Ireland direct access to global LNG markets and greater control over these factors, thereby enhancing security of supply. Moreover, it is also unclear whether an interconnector from France would satisfy Irish policy regarding the source of supply of natural gas, further reducing its benefits to the Irish people. In contrast to the Proposed Development, the interconnector to France would not support the future integration of hydrogen into the Irish energy system.

3.2.6.4 Natural Gas Storage

There is only one location considered suitable in geological terms for large scale gas storage on the Island of Ireland (Irish Academy of Engineering, 2021). This is at Islandmagee in Co. Antrim. Efforts have been underway for the past decade to licence and finance a large-scale storage project at the site, however this appears unlikely to materialise in their short to medium term. The market dynamics that previously made the development of new storage projects viable no longer exist, namely low wholesale gas prices during the summer months when gas would be injected, followed by high winter prices when stocks would be withdrawn. The facilities associated with the Kinsale Energy gas reservoir have now been decommissioned, but even when in operation the reservoir was not sufficient to satisfy Ireland's total demand requirements under the N-1 infrastructure standard.

3.3 Alternative Locations

3.3.1 Selection of the Preferred Site

3.3.1.1 Site Selection

A site selection process has been carried out (Refer to AECOM's 2021 Site Selection Assessment Report (AECOM, 2021) (Appendix A3-2, Vol. 4). It considered the following key requirements:

- A large landbank zoned for industrial purposes with access to or adjacent to the foreshore;
- Access to deep water greater than 13 m;
- Uniform cross sectional depth navigational channel with minimum width five times the beam of Qmax (260 m);
- A turning circle twice the length of Qmax (690 m);
- 150 m control zone surrounding the LNGC and FSRU;
- Significant wave heights less than 1.5 metres; and
- Peak wave periods less than 9 seconds.

The scope of the study included a review of potential coastal locations across Ireland. In total, sixty-seven locations were identified. The site selection process, which included several phases of screening under specific technical criteria, gradually narrowed this down to five, see below. The selection criteria and headings were derived from policy and from European and international standards.

An important selection criterion was the eligibility of any site to receive a grid connection offer from EriGrid in 2021, to allow power to be generated before the forecast capacity shortfall in 2025. EirGrid has notified the Applicant that the Proposed Development site will receive a grid offer in 2021.

Phase 1

The initial stage of the Phase 1 screening included a planning and practical context that assessed the location, land use character and context, with due regard to relevant specific local planning policies and zoning/ land use designations and surrounding areas. In conjunction with the respective statutory planning policies, the selected criteria for each location specifically assesses land parcel sizes.

From the sixty-seven locations identified during Phase 1, eleven were deemed suitable under the Phase 1 screening criteria. These locations (listed below) were then brought forward to Phase 2 screening:

1. Arklow (Co. Wicklow);
2. Aughinish (Co. Limerick);
3. Ballylongford/ Tarbert (Co. Kerry);
4. Castletownbere (Co. Cork);
5. Dunmore East (Co. Waterford);
6. Greenore (Co. Louth);
7. Killybegs (Co. Donegal);

8. Moneypoint (Co. Clare);
9. Ringaskiddy (Co. Cork);
10. Whiddy Island (Co. Cork); and
11. Whitegate (Co. Cork).

The Phase 1 screening process is summarised in the screening matric provided in Table 3-1 below.

Table 3-1 Phase 1 Screening Matrix

Site Location	> 20 ha Site (Zoned Industrial)	> 40 ha Site (Zoned Industrial)	> 80 ha Site (Zoned Industrial)	Water Depth (> 13 m)
Aranmore Island	x	x	x	x
Ardmore (Rams Head)	x	x	x	✓
Arklow	✓	✓	x	✓
Aughinish	✓	✓	✓	✓
Ballycotton Harbour	x	x	x	x
Ballylongford/ Tarbert	✓	✓	✓	✓
Ballyhack	x	x	x	x
Baltimore	x	x	x	x
Bantry	✓	x	x	x
Belview Port	✓	✓	✓	x
Bere Island	x	x	x	✓
Broadhaven Bay	x	x	x	x
Bunbeg	x	x	x	x
Burtonport	x	x	x	x
Callanafersy	x	x	x	x
Castletownbere	✓	x	x	✓
Cape Clear	x	x	x	✓
Clare Island	x	x	x	✓
Clew Bay	x	x	x	x
Cleggan	x	x	x	x
Clogher head	x	x	x	x
Doolin	x	x	x	✓
Dublin Port	✓	✓	✓	x
Dún Laoghaire	x	x	x	✓
Dunmore East	✓	x	x	✓
Dundalk	x	x	x	x
Drogheda	✓	✓	x	x
Fenit	x	x	x	x
Foynes Island	x	x	x	✓

Site Location	> 20 ha Site (Zoned Industrial)	> 40 ha Site (Zoned Industrial)	> 80 ha Site (Zoned Industrial)	Water Depth (> 13 m)
Foynes Port	✓	✓	✓	x
Galway Port	✓	x	x	x
Greenore	✓	x	x	✓
Inishboffin	x	x	x	✓
Inisheer	x	x	x	✓
Inishmaan	x	x	x	✓
Inishmore	x	x	x	✓
Killala Bay	x	x	x	x
Killary harbour	x	x	x	✓
Kinsale	x	x	x	x
Killybegs	✓	✓	✓	✓
Labasheeda	x	x	x	✓
Lough Swilly	x	x	x	✓
Malahide Inlet	x	x	x	x
Magheraroarty	x	x	x	x
Marino Point	✓	x	x	x
Moneypoint	✓	✓	✓	✓
Mount Trenchard	x	x	x	✓
New Ross	✓	✓	✓	x
Passage East	x	x	x	x
Quigley's Point	x	x	x	✓
Reenard Point	x	x	x	✓
Ringaskiddy	✓	✓	✓	✓
Roonagh Quay	x	x	x	x
Rossaveel	✓	x	x	x
Rosslare Port	✓	x	x	x
Rosses Point	x	x	x	x
Schull	x	x	x	x
Shannakea	x	x	x	✓
Sheep Haven Bay	x	x	x	✓
Sherkin Island	x	x	x	✓
Strandhill	x	x	x	x
Tory Island	x	x	x	✓
Valentia	x	x	x	✓
Whiddy Island	✓	✓	x	✓
Whitegate	✓	✓	✓	✓

Site Location	> 20 ha Site (Zoned Industrial)	> 40 ha Site (Zoned Industrial)	> 80 ha Site (Zoned Industrial)	Water Depth (> 13 m)
Wicklow Town	✓	✓	x	x
Youghal Estuary	x	x	x	✓

Phase 2

Phase 2 of the site selection then assessed the selected eleven locations against the Phase 2 criteria which included specific navigation channel widths, as well as specific turning circle and control zone requirements, resulting in five locations which passed both the Phase 1 and 2 screening criteria (note the cells highlighted in blue in Table 3-2 below):

1. Arklow (Co. Wicklow)
2. Ballylongford/ Tarbert (Co. Kerry);
3. Dunmore East (Co. Waterford);
4. Moneypoint (Co. Clare); and
5. Whiddy Island (Co. Cork).

The final findings of the preferred criteria requirements for the Phase 2 appraisal are summarised in Table 3-2.

Table 3-2 Phase 2 Screening Matrix

Site Location	Navigation Channel	Turning Circle	Control Zone
Arklow	✓	✓	✓
Aughinish	x	x	x
Ballylongford/ Tarbert	✓	✓	✓
Dunmore East	✓	✓	✓
Greenore	x	x	x
Moneypoint	✓	✓	✓
Ringaskiddy	x	x	x
Whiddy Island	✓	✓	✓
Whitegate	x	x	x

Phase 3

Five locations remained after Phase 2 screening.

Moffatt & Nichol (M&N) were commissioned to consider wave conditions at the selected locations for the Phase 3 screening. This final phase of the site selection applied critical criteria for LNG transfer operations set out in SIGTTO guidance '*Site Selection and Design for LNG Ports and Jetties*' including significant wave heights less than 1.5 metres and peak wave periods less than 9 seconds.

The comparison of the five selected locations after Phase 2 screening against Phase 3 criteria led to the identification of Ballylongford/ Tarbert and Moneypoint as the most suitable locations to accommodate and safely operate the LNG Terminal and Power Plant.

The final findings of the preferred criteria requirements for the Phase 3 screening are summarised in Table 3-3.

Table 3-3 Phase 3 Matrix Screening

Site Location	Hs>1.5 m	Tp < 9s	Hs>1.5m or Tp < 9s
Arklow	x	x	x

Site Location	Hs>1.5 m	Tp < 9s	Hs>1.5m or Tp < 9s
Ballylongford/ Tarbert	✓	✓	✓
Dunmore East	x	x	x
Moneypoint	✓	✓	✓
Whiddy Island	x	x	x

An 840 MW coal-fired power plant is currently located at the Moneypoint site, which is owned and operated by the ESB. Under the Climate Action Plan 2019 (DECC, 2019), power generation from coal at Moneypoint will stop no later than 2025.

In April 2021, the ESB announced their 'Green Atlantic' plan for the future use of the Moneypoint site (ESB, 2021). Green Atlantic is a multi-billion euro programme of investment over the next decade which will transition the Moneypoint site from coal-fired electricity generation to renewable generation. Specifically, Green Atlantic proposes the following investments at Moneypoint:

- A *Sustainable System Support* facility to provide a range of electrical services to the electricity grid.
- *Moneypoint Floating Offshore* wind farm of 1,400 MW capacity to be developed off the coast of Counties Clare and Kerry.
- *A wind turbine construction hub:* Moneypoint will become a centre for the construction and assembly of floating wind turbines. This hub will require modifications to the existing jetty at the site.
- Hydrogen production, storage and generation facility at Moneypoint site towards the end of the decade.

ESB confirmed that *'Moneypoint has played a critical role in the country's energy supply for almost 40 years. We are proud that it will continue to have a crucial role in Ireland's energy future with many benefits for the local community and wider society.'*

Additionally, while not considered in the initial screening criteria, access to high-capacity power and gas transmissions systems is a core requirement for the Proposed Development. Both Moneypoint and Ballylongford/ Tarbert enjoy access to high-capacity electricity transmission networks. However, only the Ballylongford/ Tarbert landbank has a consented gas transmission pipeline connecting it with the GNI gas transmission network at Foynes.

Therefore, in light of ESB's Green Atlantic plans, and the lack of a consented interconnecting gas pipeline, the Moneypoint site was ruled out. The site selection assessment concludes that the Ballylongford/ Tarbert location should be deemed the most suitable location to accommodate the Proposed Development. Additional information on the site selection assessment can be found in the 2021 Site Selection Assessment Report (AECOM, 2021) (Appendix A3-2, Vol. 4). The advanced status of the Proposed Development provides an advantage over other power or terminal projects in the context of the planning process.

3.4 Alternative Designs

3.4.1 LNG Terminal Concept

There are three main types of LNG terminals that can be developed (Figures 3-9 to 3-11):

(a) **Onshore Terminals**, where LNG is transferred to onshore storage tanks and regasified as required;

(b) **Floating Terminals**, where LNG storage and regasification is completed on a ship or barge, referred to as a floating storage and regasification unit (FSRU); and

(c) **Hybrid Terminals,** where LNG is stored on a vessel, a floating storage unit (FSU), but the regasification occurs onshore.

Onshore Terminal | Floating Terminals | Hybrid Terminals

Figures 3-9, 3-10 and 3-11 Three main types of LNG Terminals.

3.4.1.1 Onshore Terminal Design

Onshore LNG terminals, of a scale required for the capacity of the Proposed Development, typically have large onshore tanks of a diameter up to 100 m and approximately 50 m tall. Each LNG tank has a capacity of around 200,000 m^3 of LNG. LNG is delivered to the terminal via an LNG carrier (LNGC) unloading into the tanks. Once emptied the LNGC departs. LNG regasification is via onshore vaporisation equipment. Additional tanks can be built to provide more storage capacity.

The LNG storage capacity of onshore terminals is normally larger than floating or hybrid terminals. Because the onshore tanks are large, these terminals have a significant onshore footprint, higher environmental impact and longer construction time than floating terminals.

3.4.1.2 Hybrid FSU Design

Hybrid terminals have LNG storage onboard a ship or barge, called a floating storage unit (FSU). Typically, capacity of the FSU is up to 180,000 m^3. LNG is delivered to the FSU via an LNGC unloading into the FSU's tanks. Once emptied, the LNGC departs. The FSU is permanently moored at the terminal site. LNG is pumped onshore to onshore regasification vaporisation equipment.

As hybrid terminals do not have onshore storage tanks, they have a reduced onshore footprint and environmental impact compared to onshore terminals, but greater than floating terminals, as more onshore development is required than where FSRUs are used. Construction time is less than onshore terminals but more than FSRUs.

3.4.1.3 Proposed FSRU Design

Since 2013, floating terminals have become the preferred type of LNG terminal for development in Europe. Specifically, in Europe there are thirty-seven LNG import terminals operational or being built. Of the thirty-seven, eight have been built since 2013. Of the eight built since 2013, six have been FSRU-based, including the most recent example in Croatia.

Floating terminals, of scale required for the capacity of the Proposed Development, have LNG storage onboard a ship or barge, the FSRU. Typically, capacity is up to 180,000 m^3. LNG is delivered to the FSRU via an LNGC unloading into the FSRU tanks. Once emptied, the LNGC departs. The FSRU is permanently moored at the Proposed Development site. No LNG is pumped onshore. LNG regasification is completed onboard the FSRU via onboard vaporisation equipment, which is permanently operating.

As FSRUs do not have onshore storage tanks or onshore vapourisation, they have a reduced onshore footprint and environmental impact compared to onshore terminals and FSU's. Construction time is less than for onshore terminals and FSUs. Additionally, FSRU terminals are easier to re-purpose to transition to less carbon-intensive fuel sources in the future, such as hydrogen if and when that technology matures.

A summary of the above discussion is presented in Table 3-4 and Table 3-5 below. In conclusion, the Applicant looked at the three types of terminals and the FSRU-based terminal approach was determined to best match the objectives.

Table 3-4 Rank Order for Each Terminal

Rank Order for Each Terminal (1 is the Best)			
	Land Based	FSRU	Hybrid
Environmental	3	1	2
Construction time	3	1	2
Hydrogen transition	3	1	1

Table 3-5 Technical Solutions Considered

Item	Onshore Terminal	FSU	Proposed FSRU Design
Jetty required	Yes	Yes	Yes
Total developed area (Acres)	230 acre	175 acre	110 acre
Storage	800,000 m^3 via 4 x 200,000 m^3 landed tanks	Up to 180,000 m^3 via 1 LNG Carrier acting as a Floating Storage Unit	Up to 180,000 m^3 via FSRU
Delivery Options	LNG Carriers up to Q-max (266,000 m^3)	LNG Carriers up to Q-max (266,000 m^3)	LNG Carriers up to Q-max (266,000 m^3)
Ability to Land LNG	Yes	Yes	No
Construction Time	4 years	2 years	1.5 years

3.5 Alternative Layouts

3.5.1 Power Plant

The site layout for the Proposed Development has been condensed since the previous 2012 CHP Plant EIS and 2007 LNG Terminal EIS (Arup, 2007). The previously consented CHP Plant was located on Knockfinglas Point (Figure 3-12).

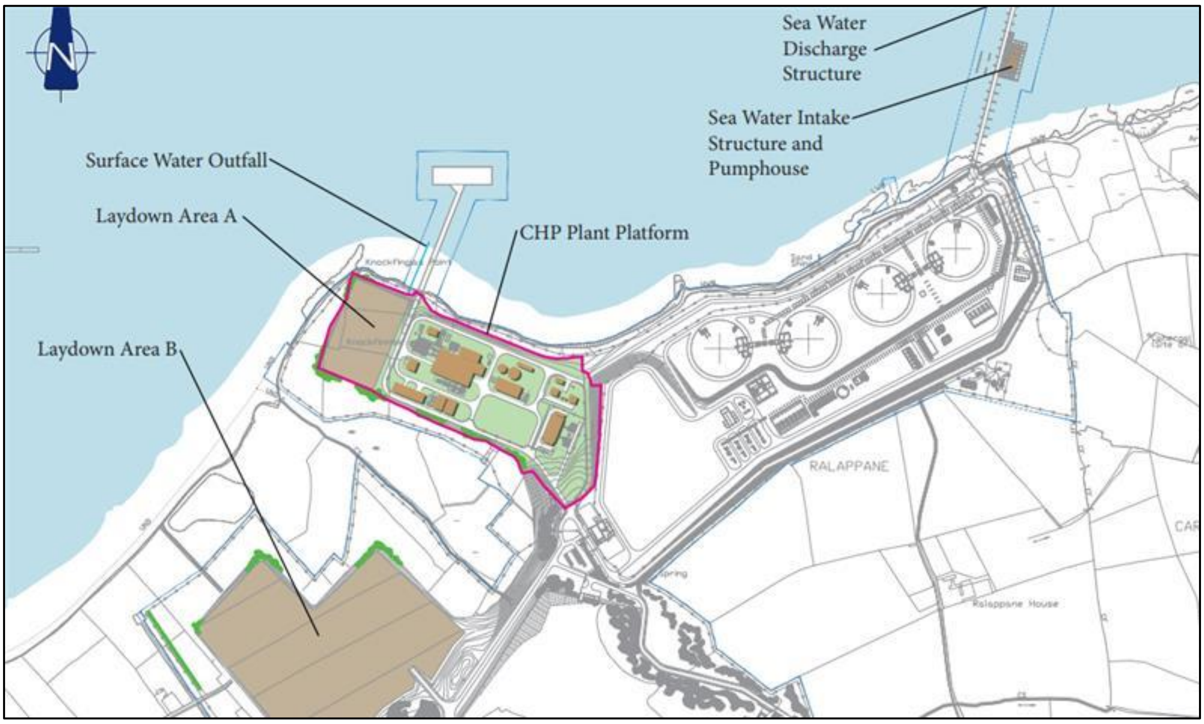


Figure 3-12 Location of Previously Consented CHP Plant

It is now located to the east of Knockfinglas Point. This layout is more efficient and minimises the total site footprint. The Proposed Development site layout and the associated design minimises visual impacts by utilising natural screening and avoiding designated sites (cSAC, SPA, NHAs).

The location of the Power Plant was selected to minimise overall land take and to minimise environmental impact including:

- Reduced impacts on biodiversity by reducing the overall footprint;
- Reduced visual impact;
- Optimised platform level at 18 m OD by balancing cut/ fill requirements;
- Reduced impacts on Cultural Heritage assets; and
- Reduction in carbon sequestration.

3.5.2 LNG Terminal

The jetty is located at point of deep water (22 m) which is ideally suited for marine operations. The deep water at this point, which does not require dredging, is one of the main reasons why the landbank is zoned for marine/ industrial development. Alternative locations and layouts for the jetty would not have satisfied marine navigation risk assessments or would have required significant dredging in environmentally designated sites.

Once the location of the jetty was determined, the onshore receiving facility was located in the eastern part of the Proposed Development site as close as possible to the landfall of the jetty in order to minimise the length of piping through which the gas is transferred from the FSRU. This is considered the optimal location in term of efficient process plant layout, minimising visual impacts by utilising natural screening and avoiding the environmentally designated sites.

The main site platform is at an elevation of 18 m above Ordnance Datum (OD), which will result in less cut and fill (and associated release of stored carbon) compared to lower elevations.

3.6 Alternative Processes/ Technologies

3.6.1 Power Plant

3.6.1.1 Power Plant Technologies

Alternative Power Plant technologies were considered. Technology options considered against the proposed multi-shaft combined cycle configuration included:

- Combined heat and power CHP;
- Open cycle gas turbines;
- Single-shaft; and
- Multi-shaft.

In determining the optimum configuration, specialised studies and extensive consultation were carried out to identify the key functional requirements of the power generation capability to be developed:

1. Be capable of fast response to sudden instructions from the System Operator to support intermittent wind generation.
2. Enable low minimum stable generation to allow the System Operator to keep units on the system at a minimum level to ensure a sufficient level of system inertia is maintained.
3. Be natural gas fuelled to meet with national Climate Change Policies and objectives.
4. Be able to accommodate faster or slower than forecast development of renewables power generation, and consequently be flexible in build out.
5. Support transitioning to deliver Ireland's net zero carbon emission by 2050 ambition.

In summary, the proposed Power Plant is the most efficient, flexible and reliable option with the lowest CO_2 emissions profile of the alternatives considered.

Combined Heat and Power (CHP) Plant

The Applicant considered the option of combined heat and power (CHP). CHP is the recovery of waste heat from the CCGT for the LNG regassification (i.e. Combined Heat and Power).

Waste heat generated by the CHP plant would have been delivered to the LNG terminal and would have been used to regasify the LNG. This CHP plant would have generated power for its own needs, for the needs of the LNG terminal and for sale to the Single Electricity Market (SEM) via the national electricity grid.

Upon detailed review, it was determined that heat supply from the CHP plant to the LNG terminal would be unreliable and insecure. It should be noted the LNG terminal requires heat all the time. Frequent interruptions of the waste heat supply from the CHP plant, with potentially very little or no notice, would be operationally very challenging for the FSRU. Specifically, the Applicant's detailed electricity market modelling has shown that with increasing wind penetration, the Power Plant will be frequently instructed to shut down, and potentially with very little or no notice, by EirGrid during periods of high wind generation. This would result in a sudden loss of the heat supply for the LNG Terminal and would be operationally very challenging for the FSRU to react to.

Furthermore, in November 2020, the CRU approved a decision to eliminate priority of dispatch for new high efficiency CHP plants (SEM, 2020). This means that new CHP plants could be shut down with very little notice by EirGrid without regard to the fact that the CHP plant would be sending waste heat to the LNG terminal. This effectively means that the LNG terminal's heat supply would not be secure or protected.

Pursuing such a terminal design in Ireland, at the Proposed Development site location under current grid rules, would be highly speculative and would dramatically increase the risk of economic and technical failure.

Due to the increased risk of economic and technical failure, and the unreliable and insecure nature of the heat supply, the CHP option was not considered further.

Open Cycle Gas Turbine

An Open cycle gas turbine (OCGT) plant is where a gas turbine generates power and the exhaust gases from the turbine are exhausted to air without heat recovery. An OCGT was proposed and was considered as an alternative design option. These facilities have relatively low capital costs and low thermal efficiencies: about 40%, compared to the Proposed Development with an efficiency of approximately 54%. Given their low efficiencies, electricity produced from OCGTs has a much higher CO_2 emission factor than electricity from CCGTs. Refer to Chapter 15 – Climate Change for a discussion and comparison on this.

With these performance characteristics, OCGT plants only dispatch in the electricity market during periods of peak demand or low wind. Given their low efficiencies and much higher CO_2 emission factors, OCGT were discounted.

Single-Shaft

As part of the Applicant's detailed electricity market modelling, the Applicant considered a larger single-shaft CCGT compared to the proposed multi-shaft unit. The larger single shaft unit was discounted because it was less flexible than the multi-shaft unit.

Specifically, as Ireland transitions to 70% renewables by 2030, the System Operator will require gas thermal units to be flexible. Units that have very low minimum stable generation will be kept running more than units with high minimum stable generations. A single shaft 600 MW would suffer from a minimum stable generation of about 176 MW compared to 41 MW for the multi- shaft unit. Given its high minimum stable generation, a single shaft unit was discounted.

Multi-Shaft

The Applicant has chosen a flexible modular Power Plant, which will comprise up to three blocks of CCGT, each block with a capacity of approximately 200 MW, for a total installed capacity of up to 600 MW. Each CCGT block will comprise two gas turbine generators, two heat recovery steam generators, a steam turbine generator, and an air cooled condenser. This configuration enjoys higher efficiency, lower CO_2 emission factor, greater flexibility, and is more reliable than the alternatives considered above.

Future Grid Requirements

The Power Plant will not operate at 100% capacity all year round. The actual operation of the plant will be determined by many factors such as power demand itself, the amount of renewable generation on the system, its bid price into the market compared to other generators, and the rules of the grid to ensure priority is given to renewable generation. The grid also needs to remain stable and secure with increased levels of renewable generation.

EirGrid has advised the Applicant in pre application consultations, to ensure grid stability with increased renewables, the future grid requires flexible gas fired power plants with high inertia[3], low minimum stable generation and fast response capability. Other stakeholder consultations and information support this advice.

The Applicant commissioned a detailed market analysis (*the Baringa Shannon Wholesale & Ancillary Revenue Report*) to consider these issues and model the future operation of the Power Plant from 2023 to 2050. Other power plant configurations were also modelled. The model assumes the Government's 70% renewable by 2030 target is met. It also considers the detailed requirements of the system operator (EirGrid) to keep the grid stable and secure.

As previously outlined, the design of the Power Plant and the BESS have been chosen for flexibility and efficiency. All future energy scenarios show gas power plant being required in the period to 2050 and beyond.

The operation of the Power Plant in the Single Electricity Market (SEM) is discussed in Chapter 15 (Section 15.4.4). In summary, the SEM takes into account the cost of emissions under the EU ETS, which therefore dictates that the most efficient and least emitting plant will be dispatched first for energy generation and system stability. The efficiency of the Power Plant, combined with its ability to operate

[3] One of the challenges with increased renewable (wind) generation on the system is a potential for an increased rate at which the grid frequency falls. This is known as the rate of change of frequency (RoCoF). Events that result in high RoCoF levels can potentially lead to instability in the power system. All power systems, including the Irish power system, have inertia. Inertia is a resistance to change in motion. The inertia on the power system resists the RoCoF and helps maintain system stability.

at a low minimum generation capacity, means that the Power Plant will be dispatched ahead of a less efficient OCGT power plant. It will provide lower direct emissions and also provide system inertia (and other system services) at a lower output, allowing for higher instantaneous renewable (non-synchronous) generation than would otherwise be the case if the Power Plant was not developed.

As discussed earlier, as the level of renewable generation on the system at any one time increases, thermal power plant has their dispatch quantities decreased by EirGrid to facilitate the output of the renewable power plants. However, a certain number of dispatchable plants must remain on the system to provide the services mentioned above. 'Positioning' is when the grid operator keeps a power plant running so as to be on standby to provide these services to the grid operators in real time. This is a vital process for grid stability; however, with inflexible power plants it can lead to larger than necessary power plants being positioned. This causes increased emissions, increased curtailment of renewables (to make room for the positioned power plant) and increased costs.

The ability of the Power Plant to operate at a 50% blend of hydrogen by design offers the potential for the Power Plant emissions to become even more efficient over the period to 2050, as and when the required policies and supply chains for hydrogen are implemented.

Both the Power Plant and the Terminal are 'future-proofed' and have the ability to transition to hydrogen fuel once the technology and public policy are fully developed, thereby achieving a 'zero emission' facility. The location of the Proposed Development site will provide access to future offshore renewable projects around the world, combined with facilities for the production and landing of hydrogen. This would contribute to the decarbonisation of Ireland's energy system by providing long term hydrogen energy storage (produced onsite or into the national gas transmission network), renewable energy storage (through the BESS) and direct electricity generation at the Power Plant. The modular Power Plant offers flexibility to incorporate alternative fuels, and the modern nature of the LNG Terminal will ensure it can easily be adapted in future.

This capability is acknowledged by the CRU in their contributions to the Oireachtas Committee on Environment and Climate Action on 7th July 2021:

> '*Ms MacEvilly said there was not necessarily a contradiction between building new gas infrastructure and quitting fossil fuels as it was expected that biomethane and green hydrogen would eventually replace natural gas in the supply chain.*
>
> *CRU chairperson, Aoife MacEvilly told the committee: Gas-fired generation will play a pivotal role in underpinning electricity security of supply and the secure electrification of heating and transport.*
>
> *Commissioner Jim Gannon added: It's not beyond the bounds of commercial or technical possibility that gas terminals that will help us supply security and diversity of supply couldn't also be designed to be converted over time to using hydrogen.*'

Refer to New Fortress Energy Inc.'s 'A Step Towards a Zero Carbon Future' policy for further details.

In conclusion, the flexibility of the Power Plant, including the BESS, is ideally aligned with a high renewable market from now to 2050. In particular, the Power Plant offers the market high inertia, very low minimum stable generation, and fast response capability with an ability to transition to hydrogen when the required policies and supply chains are implemented.

3.6.1.2 Cooling Processes

Alternative processes for cooling were considered as CCGT power generation produces waste heat. The methods considered of providing condenser cooling for the Power Plant are listed below. The Air-Cooled option was selected.

- **Indirect Wet Cooling:** In an indirect wet cooling system, cooling water is circulated around a loop circuit with waste heat from the Power Plant being transferred into the water, raising its temperature. This hot water is then directed to a cooling tower where the water is in direct contact with the atmosphere. In the cooling tower a significant proportion of the cooling water evaporates and, as a result, must be replaced with 'make up' water so the water stream can be re-circulated to the proposed Power Plant and used to generate more electricity. For a power plant of the size and cooling system design proposed, large volumes of fresh water will be required for make-up. In addition, the cooling tower will be a large structure with a visible plume of water vapour emanating from it during some atmospheric and plant operating conditions.

- **Direct Wet Cooling:** In a direct wet cooling system, heat from the Electric Generation Facility is transferred into water. This requires large volumes of water to be drawn from a nearby water body. This warm water would be returned directly to the nearby water body at a higher temperature. Typically, the water intake structure and discharge structures in the water body are separated by some distance so that the warm water from the discharge structure does not circulate back to the inlet structure. Direct wet cooling is best suited to locations where there is a large body of cooling water available, such as a lake, river or estuary with strong tidal flows. It offers better condenser performance and cycle efficiency than Direct Air Cooling or Indirect Wet Cooling, and the lower condenser temperatures that can be achieved generally result in higher power Generation Efficiency.

  A seawater cooling system was identified as the preferred direct wet cooling method for the Power Plant. This would include separate water inlet and outlet structures in the Shannon Estuary and associated pumps and piping to convey seawater between the water-cooled condenser, the LNG Terminal, Power Plant and the estuary. However, this would also entail a significant seawater intake structure located within the Lower River Shannon cSAC, hence it has been discounted.

- **Heat Extraction**: This option would have consisted of extracting heat from the atmosphere, which has been proven effective in hot climates. However, this option was discounted in the 2012 EIS (Arup, 2012) as the location of the project does not have the necessary air temperatures during the year to make this process efficient or feasible.
- **Air Cooled Condenser**: Steam exiting the steam turbine would enter the steam condenser and pass through air-cooled fin tubes. The steam would not be in direct contact with the air. The heat is transferred from the steam to the surrounding ambient air resulting in the steam being condensed. This produces a cooler condensed steam, i.e. water condensate which is boiler quality feed water. The key advantage of air cooled steam condensers is that large volumes of cooling water are not required. Another advantage is that the water intake and discharge structures are not required to be built in the estuary, minimising the impact on the cSAC.

3.6.2 LNG Terminal

3.6.2.1 FSRU Regasification Alternative Processes

LNG regasification will take place onboard the FSRU. As described in Chapter 02 – Project Description, the heat required for regasification will be from seawater (‘open loop’) or a combination of seawater and gas-fired heaters (‘combined loop’), depending on the season and the associated seawater temperatures. When the FSRU is regasifying and sending out gas, boil-off gas (BOG) will be recovered and used as a fuel source in the generators on the FSRU, with any excess being recondensed back into a liquid and stored as LNG.

A ‘closed loop’ option for LNG regasification was considered. In ‘closed loop’, 100% of the heat for LNG regasification comes from gas fired heaters and no heat from the seawater is used. This is not proposed due to its low energy efficiency and much higher emissions of greenhouse gases (GHGs).

3.6.3 Other Alternative Processes

3.6.3.1 Wastewater Treatment Discharge

The sanitary wastewater treatment plant, which will be used for both the LNG Terminal and Power Plant, has been designed to discharge to sea via an outfall. The effluent waste stream will be monitored for compliance with the Industrial Emissions (IE) licence limits before being discharged.

The option of discharging the sanitary effluent from the Proposed Development to ground was considered in the context of the EPA (2011) Guidance on the Authorisation of Discharges to Groundwater and EPA (2014) Guidance on the Authorisation of Discharges to Groundwater. The 2014 guidance states that discharges to surface water should always be considered as a first option in the process, if technically and economically feasible. Furthermore, the Proposed Development site is considered unsuitable for indirect or direct wastewater effluent disposal to ground/ groundwater for the following reasons:

- The clay and silt dominated subsoils on the northern area of the Proposed Development site are thin (<1 m in the LNG Terminal and Power Plant area) and characterised by poor drainage and low infiltration properties, with low subsoil permeability (typically <4 x 10-6 m/s in the upper 900 mm of soils (Upper Till) with the lower till being of lower permeability where present). Groundwater vulnerability beneath the Proposed Development site is classified as 'High to Extreme' due to the limited subsoil thickness in areas of the Proposed Development site;
- The underlying sandstone and shale bedrock aquifer of the Proposed Development site is also of low permeability (from 1.05 x 10-5 to 1 x 10-6 m/s) and therefore does not have sufficient ability to 'accept' and move the effluent away from the Proposed Development site;
- Both the subsoil and bedrock have a high water table, with depth to groundwater in February 2020 typically being less than 1 m; and
- The construction of the 18 m OD platform will involve removal of subsoils, extensive blasting and excavation of bedrock and use of excavated material (largely crushed rock) as engineering fill to construct the northern part of the platform. These activities will result in an operational site founded either on fractured rock or granular rock fill, resulting in little effluent attenuation capacity.

These soil and bedrock characteristics would result in inadequate attenuation of pollutants, making the Proposed Development site unsuitable for onsite effluent discharge to ground, resulting in the design decision to use a packaged wastewater treatment plant for treatment of the effluent prior to discharge under licence via the combined surface water discharge.

3.7 References

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