



Gas
Networks
Ireland

Economic Case

April 2024

Private & Confidential

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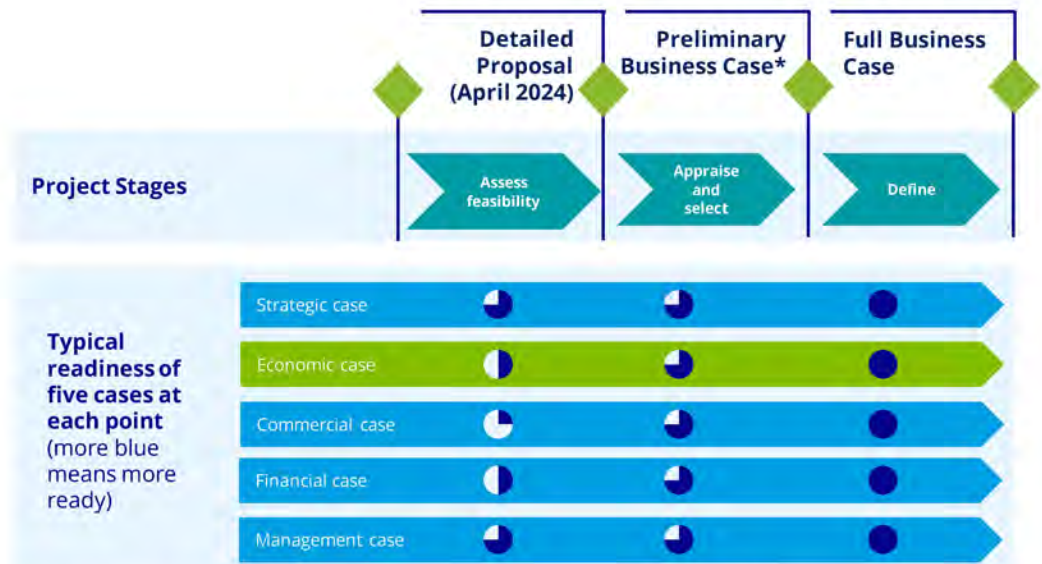
2.1 Introduction



2.1 Introduction

Business Case structure:

- The business case has been prepared in compliance with both the Infrastructure Guidelines: Strategic Assessment and Preliminary Business Case, December 2023¹ and the Infrastructure and Projects Authority's Infrastructure Business Case five-cases model². The business case includes: strategic, economic, commercial, financial and management cases – the five dimensions of the case.
- The Project is currently at the Preliminary Business Case stage, which if approved, will enable the Project to proceed to Final Business Case, where detailed design and procurement activities will determine the final scope, cost and schedule for the project.
- At Preliminary Business Case stage the Economic Case should:-
 - Determine how the project will deliver the economic, social, and environmental objectives, while achieving the most value for money for society;
 - Appraise a wide range of possible options and refine to a shortlist;
 - Provide high level estimates of costs and benefits for the shortlisted options;
 - Identify 'emerging preferred option(s)' for further economic evaluation.



Source: Infrastructure Project Authority (2022) Project Routemap³

*Target for Government submission in June

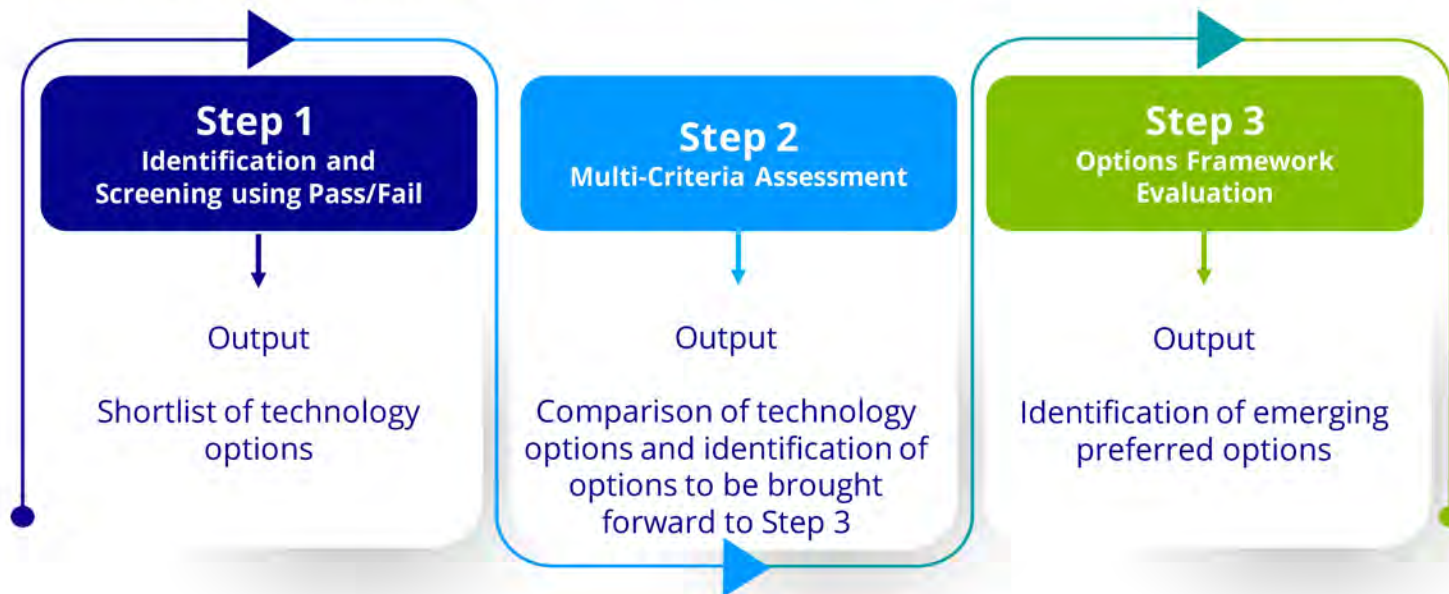
4 ¹Department of Public Expenditure NDP Delivery and Reform (2023), Infrastructure Guidelines: Strategic Assessment and Preliminary Business Case. Available [here](#)
²Infrastructure and Projects Authority (2022), Infrastructure Business Case: International Guidance. Available [here](#)
³Infrastructure and Projects Authority (2022), Project Routemap. Available [here](#)

2.2 Project Optioneering



2.2 Project Optioneering: Technology Selection Overview

- Project optioneering involves the development of a structured and systematic process for the purpose of identifying an emerging preferred option.
- A three-step process was developed as indicated below. This process aligns with the Infrastructure Guidelines¹ and Infrastructure and Projects Authority (IPA) Guidance².
- This process assess the impact of potential concepts and options on a wide range of factors that are critical to achieving the strategic objectives. In all three steps, scores are applied to judge the relative strength against these options; including amongst other criteria, scoring of strategic fit, affordability and deliverability. This optioneering process also considers environmental and climate related outcomes.



2.2 Project Optioneering: Alignment with Strategic Objectives

As required in the Infrastructure Guidelines, the Strategic Objectives have been used to assess the credibility of options at each stage of the process.

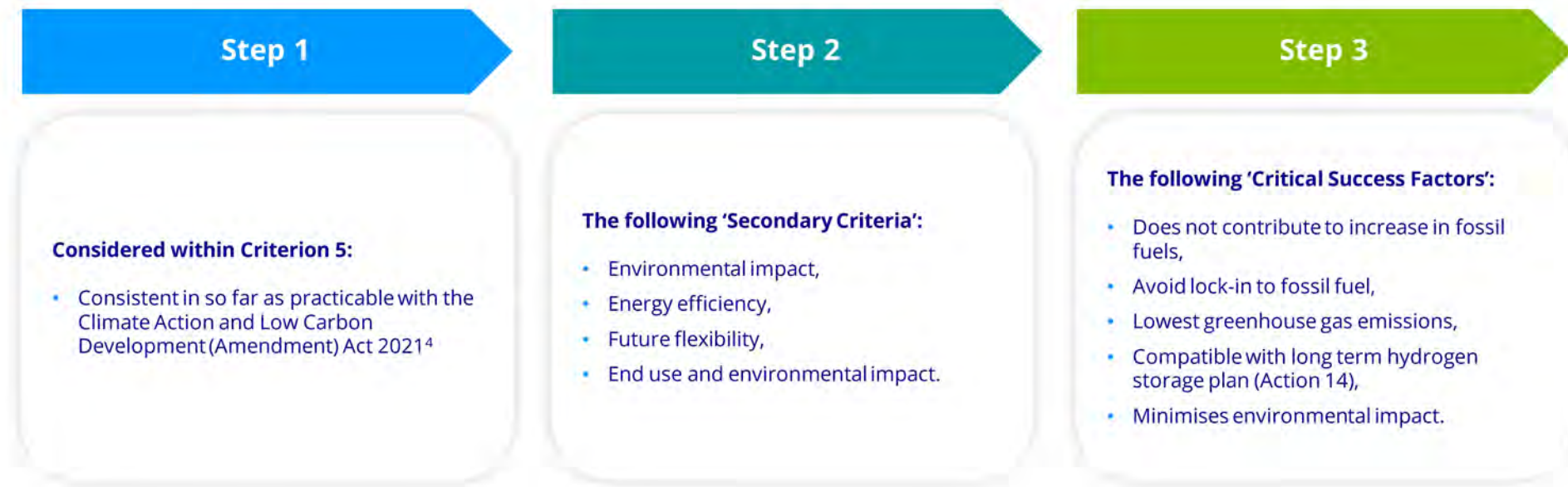
Strategic Objective		Relevant Criteria in Technology Selection Process		
No.	Description	Step 1	Step 2	Step 3
1	Deliver a solution as early as possible that will: - Satisfy Ireland's compliance with EU N-1 infrastructure standard - Enable rapid recovery from a system disruption - Provide sufficient resilience of gas supply to ensure future (2030) energy gas demand is reliably met	Criterion 1: Ability to ensure Ireland complies with EU N-1 infrastructure standard. Criterion 2: Steady Supply Criterion 3: Diversification of Supply (both source and route) Criterion 4: Technology proven at scale for the primary use	Duration, Ease of Replenishment, Minimal Operational Complexity, Ease and Reliability of Dispatch, Maintainability.	Strategic Need CSFs
2	Achieve a cost-effective, affordable solution that optimises EU grant funding and cost recovery options		Schedule Risk, Consenting Risk, Capital and Long – Term Cost, Operational Cost, Cost Risk, Constructability, System Complexity, Delivery Expense, Ease of Operating within Regulatory Framework and Operational Criteria.	Financial CSFs.
3	Design permanent or onshore enabling infrastructure in a manner that maximises potential future renewable gas uses to the extent possible, balancing cost and other efficiencies such as time to deployment	Criterion 5: Consistent in so far as practicable with the Climate Action and Low Carbon Development (Amendment) Act 2021⁴	Duration, Capital and Long – Term Cost, Operational Cost, Future Flexibility	Compatible with Long Term Hydrogen Storage Plan, Avoid Lock-in to Fossil Fuels CSFs.
4	Achieve a solution that is, in so far as practicable, consistent with the Climate Action and Low Carbon Development Act 2015–2021 ⁵	Criterion 5: Consistent in so far as practicable with the Climate Action and Low Carbon Development (Amendment) Act 2021	Environmental Impact, Energy Efficiency, Future Flexibility, End Use and Environmental Impact.	Sustainability CSFs.
5	Meet or exceed industry best practice in relation to safety and the environment	Criterion 4: Technology proven at scale for the primary use	Inherent Safety, Environmental Impact, Future Flexibility, End Use and Environmental Impact.	Safety CSFs, Minimises Environmental Impact CSF.

⁴Government of Ireland (2021), Climate Action and Low Carbon Development (Amendment) Act. Available [here](#)

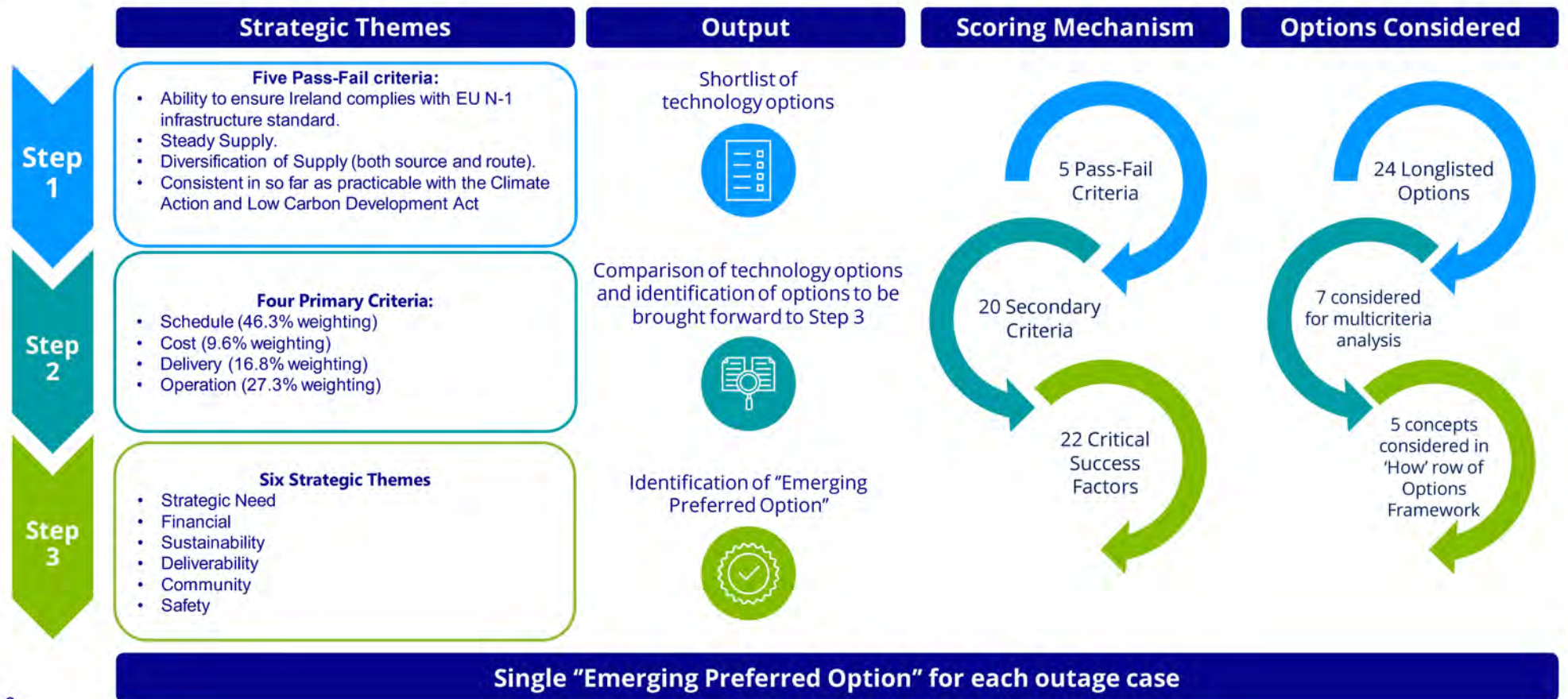
⁵Government of Ireland (2015), Climate Action and Low Carbon Development Act. Available [here](#)

2.2 Project Optioneering: Climate and Environmental Performance Criteria

- The Infrastructure Guidelines¹ state that the optioneering process must consider environmental and climate related outcomes.
- The environmental criteria and critical success factors set out below have been assessed in each step, both the delivery and operational phase have been considered:



2.2 Project Optioneering: Technology Selection Process Overview



2.2 Project Optioneering: Technology Selection

Step 1: Identification and Screening

- Safeguarding our energy system will involve the development of technologically advanced and complex solutions.
- These solutions may involve standalone technologies or the combination of multiple technological 'building blocks'.
- The Infrastructure Guidelines¹ require a long-list of options which should address all the feasible options which might achieve the desired outcomes.
- Where possible, the technology longlist is site agnostic – it is focused purely on the technology, rather than the specifics of a solution given site context.
- Where the technology required a geographical condition (e.g. marine access, gas field) an assessment was carried out to as to whether there were any candidate sites – one representative candidate site which was deemed the most favourable was chosen in order to test the technology.
- The next slide presents the 11 technologies considered, against which 24 longlisted concepts were identified.
- Refer to Appendix E.1 for further details.

2.2 Project Optioneering: Establishing the Long-List of Options

Eleven (11) technologies were considered in detail. Each are listed below:

- Gas interconnector
- LNG carrier
- Floating storage and regassification unit (FSRU)
- Floating storage unit (FSU)
- Salt cavern storage
- Depleted or active gas field storage
- Aquifer storage
- New gas field exploration
- Onshore regassification facility
- Onshore liquefaction and regassification facility
- Marine jetty

Within these technologies, 24 concepts were deemed to be able to potentially meet the Strategic Objectives – these are shown to the right.

Index	Longlisted Concept
1	Jetty Only with FSRU Support Arrangements
2	Leased FSRU (Full time on station) plus Jetty
3	Onshore LNG Regassification Facility
4	Onshore LNG Regassification Facility w/ Underground Storage
5	Standalone Onshore Liquefaction and Regassification Facility
6	Phased FSRU to Onshore LNG Regassification Facility
7	Phased FSU to Onshore LNG Regassification Facility
8	Offshore Development Salt Cavern Storage
9	Depleted or Active Gas Field Storage
10	Aquifer Storage
11	Leased FSRU plus Jetty with Onshore Salt Cavern Storage
12	Leased FSRU plus Jetty with Aquifer Storage
13	Leased FSRU plus Jetty with Depleted or Active Gas Field Storage
14	Interconnector to UK
15	Interconnector to France
16	Interconnector to UK with [REDACTED]
17	Recommissioning Existing FSRU Terminal and Leased FSRU (Full time on station)
18	Onshore LNG Regassification Facility w/ Modular Storage
19	Reopen Irish Offshore for New Gas Exploration
20	Build FSRU (Full time on station) plus Jetty
21	FSU Full Time on Station plus Jetty with Onshore Regassification
22	Onshore Regassification Plant with Direct LNGC Supply
23	Onshore Liquefaction and Regassification Facility with Strategic Marine Import Jetty
24	Onshore Development Salt Cavern Storage

2.2 Project Optioneering: Assessing the Long-list of Options

Step 1: Pass / Fail Assessment

Initial screening of the longlist considered the following criteria (further detail is provided in Appendix E.1):

- Ability to ensure Ireland complies with EU N-1 infrastructure standard.
- Steady Supply.
- Diversification of Supply (both source and route).
- Technology proven at scale for the primary use.
- Consistent in so far as practicable with the Climate Action and Low Carbon Development (Amendment) Act 2021⁴.

Each of the 24 concepts was deemed to either 'pass' or 'fail' to meet the criteria above.

The seven options to the right are those which were considered to pass all criteria and therefore moved through to Step 2.

Concept Description

- | | |
|----|---|
| 1 | Jetty Only with FSRU Support Arrangements |
| 2 | Leased FSRU (Full time on station) plus Jetty |
| 11 | Leased FSRU plus Jetty with Onshore Salt Cavern Storage |
| 15 | Interconnector to France |
| 16 | Interconnector to UK with [REDACTED] |
| 20 | Build FSRU (Full time on station) plus Jetty |
| 24 | Onshore Development Salt Cavern Storage |

2.2 Project Optioneering: Technology Selection

Step 2: Multi-Criteria Assessment

- Seven technology concepts brought forward to Step 2
- Scored against a range of pre-defined primary and secondary criteria. The short-listing process took account of factors including schedule, affordability, and deliverability.
- These criteria seek to further evaluate the relative alignment of each option with the strategic objectives, beyond the initial 'pass / fail' criteria used in Step 1.
- In total, there are 20 secondary criteria which are assets on a scale of 1 (worst) to 5 (best). A bespoke metric for assessing each secondary option was determined using quantitative and qualitative techniques.
- An analytical hierarchy process was used to determine the relative weight of the primary and secondary criteria towards the overall score. This is considered an international best practise form of 'multi-criteria analysis'.
- The perceived urgency and strategic importance of the project means that 'schedule' comprises 46.3% of the overall score.
- The results of this process are presented on the next slide.

Primary Criteria & Weighting			
Schedule	Cost	Delivery	Operation
46.3%	9.6%	16.8%	27.3%
Secondary Criteria & Weighting	Secondary Criteria & Weighting	Secondary Criteria & Weighting	Secondary Criteria & Weighting
Duration 60.00%	Capital and Long-Term Leasing Cost 49.67%	Constructability 12.85%	Ease of Replenishment 7.04%
Schedule Risk 20.00%	Operational Cost 10.66%	Environmental Impact 45.98%	Inherent Safety 29.18%
Consenting Risk 20.00%	Cost Risk 39.67%	System Capacity 18.22%	Minimal Operational Complexity 4.31%
		Delivery Expertise 6.54%	Minimise Operational Environmental Impact 15.60%
		Ease of Operating within Regulatory Environment 16.41%	Ease of Reliability of Dispatch 24.05%
			Energy Efficiency including Climate and CO2 10.35%
			Maintainability 1.31%
			Jurisdictional Simplicity 1.59%
			Future Flexibility, End Use and Environmental Impact 6.57%

2.2 Project Optioneering: Multicriteria Analysis Results

Step 2: Multi-Criteria Analysis Results

- The multi-criteria assessment highlighted that:
 - The *Interconnector to UK* is markedly more beneficial than *Interconnector to France*
 - Similarly, the *FSRU Jetty with onshore salt cavern* serves as an effective mitigation against some of the challenges posed by *Onshore Development Salt Cavern* and, as such, is markedly more beneficial
- Accordingly, the *Interconnector to France* and *Onshore Development Salt Cavern* were removed from further consideration while the breadth of technologies under consideration was maintained.
- The five technology options carried forward to 'Step 3: Options Framework Evaluation' are set out to the right.

Concept Description	
1	Jetty Only with FSRU Support Arrangements
2	Leased FSRU (Full time on station) plus Jetty
11	Leased FSRU plus Jetty with Onshore Salt Cavern Storage
16	Interconnector to UK with [REDACTED]
20	Build FSRU (Full time on station) plus Jetty

2.2 Project Optioneering: Options Framework Overview

Step 3: Options Framework Overview

- Step 3 builds on the foundational decisions made in earlier steps and informs further analysis using a structured and systematic framework aligned with the 'Options Framework' approach described in the Green Book⁶ and the Infrastructure Project's Authority Infrastructure Business Case: International Guidance⁷.
- This framework uses a sequential question matrix to refine project options across five areas (each row in the matrix assesses the different questions).
- The questions are answered sequentially. Each question progresses from the conclusions drawn from the previous question ensuring a coherent and focused development process from scope definition to financing strategies.
- New analysis required for the business case, separate from the technology optioneering process (Steps 1 and 2), has been undertaken to evaluate questions 1, 3, 4 and 5 below. This is aligned with the guidance. Appendix E.1 covers the analysis of each of the five questions in detail.

1 What? Project Scope

2 How? Project Solution

Sub tasks:

- Development of concept definitions for technology options
- Development of evaluation methodology
- Evaluation of options using Options Framework

3 Who? Project Delivery

4 When? Project Implementation

5 Where from? Project Funding & Finance

2.2 Project Optioneering: Development of Concept Definitions

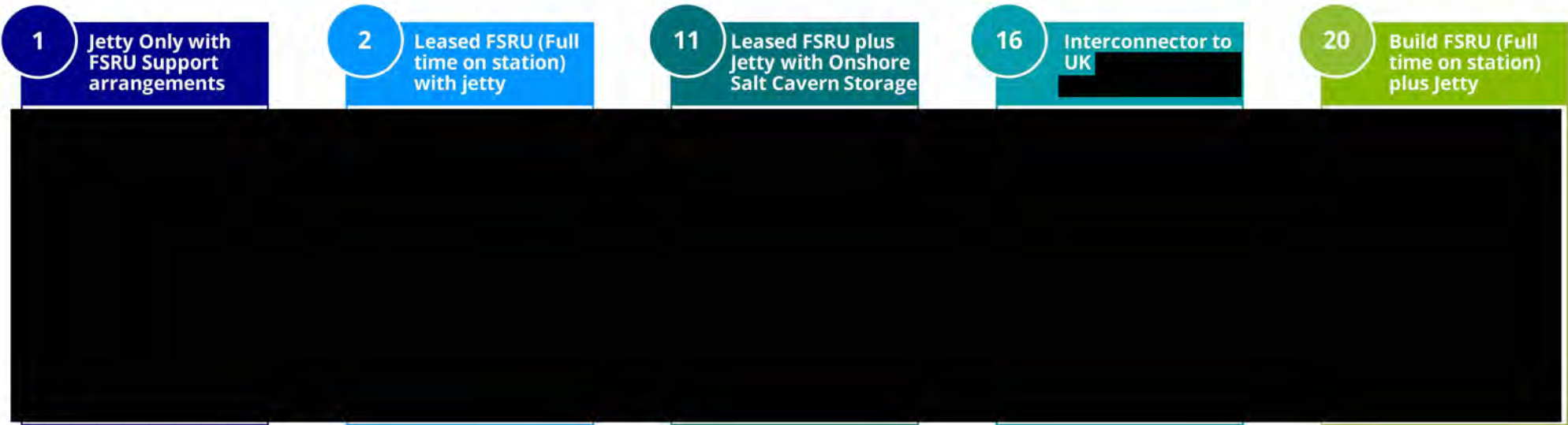


2.2 Project Optioneering: Development of Concept Definitions



Step 3: Development of Concept Definitions for Technology Options

To allow for an appropriate level of evaluation at Step 3, concept designs for the technology options carried forward from Step 2 were developed. The resultant development descriptions are presented in Appendix E.2 with a high-level summary below.



2.2 Project Optioneering: Development of Evaluation Methodology

Step 3: Development of Evaluation Methodology

The development of the evaluation methodology involved:

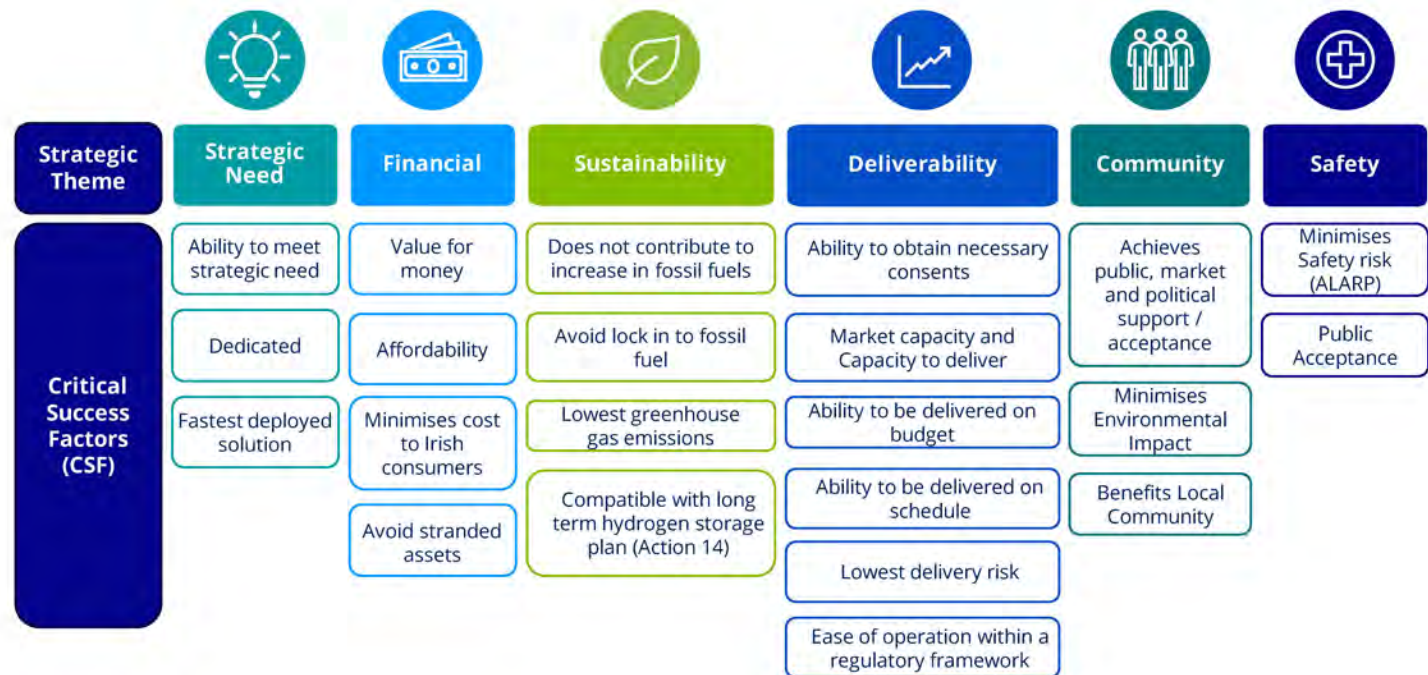
- **Definition of Critical Success factors (CSFs):**
 - CSFs are factors which are considered essential to project success. Informed by the Government's Energy Security in Ireland to 2030 report⁷, the project vision, strategic objectives and in consultation with stakeholders, twenty-two (22) CSF were developed. The CSFs are shown on the next slide.
- **Development of Measurement Metric:**
 - For every CSF, a measurement metric was developed. These metrics included qualitative and quantitative measures to identify the degree of alignment with each CSF. A 'red', 'amber', 'green' analysis was adopted to indicate the level of alignment. Where an option failed to secure a red, amber or green status, it was removed from further consideration.
- **Establishment of Options Framework:**
 - A comprehensive matrix that aligns the project areas / questions ('rows') with relevant CSFs and their associated metrics was developed, providing a framework for systematic analysis of options.

The resulting Options Framework provides a structured approach to decision making ensuring that project options are evaluated against defined criteria aligned with the project Critical Success Factors.

2.2 Project Optioneering: Critical Success Factors

Step 3: Critical Success Factors

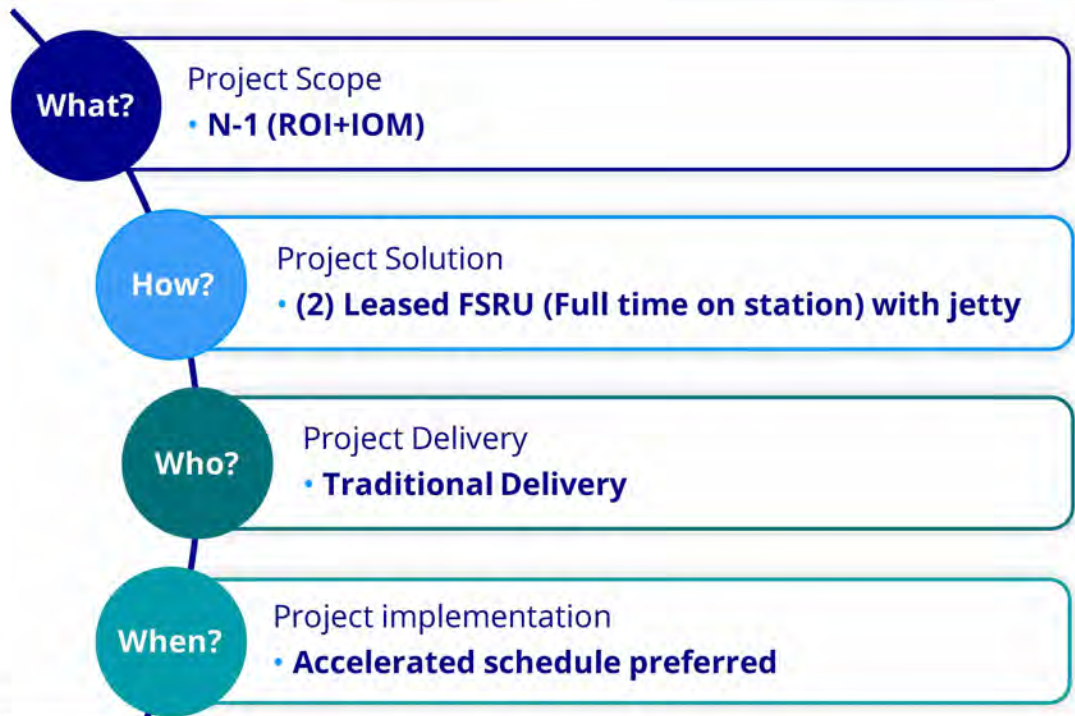
- The 22 CSFs align with one of six strategic themes, which were derived from the strategic objectives.
- A scoring criteria for each CSF was determined to provide auditable approach to assessing the strength of options.
- Relevant CSFs were filtered to provide the scoring criteria for each question. To see a list of which CSFs are applicable for each row, see Appendix E.1.



2.2 Project Optioneering: Results of Evaluation

Step 3: Options Framework Evaluation

- The developed methodology and concept level development descriptions were used to evaluate the project options.
- The evaluation is detailed in Appendix E.1 with the emerging preferred option summarised in the adjacent figure using the sequential question matrix outlined previously.
- The results identify that the two FSRU options (lease standard or build bespoke) are closely scored. Some important assumptions used to compare the technical arrangements for delivering a lease or build FSRU will be tested and verified through market engagement as set out in the Commercial Case. This sensitivity analysis will be needed before a decision on lease versus build FSRU can be made.
- The results of the options framework is subject to economic appraisal using cost benefit analysis in the next section.
- Although an emerging preferred option is identified, other options are carried forward for economic appraisal to ensure the option selected is likely to deliver the best value for money. The BAU ('do nothing') case is also carried forward as a reference case.
- The analysis will be reconsidered at Final Business Case stage, based on cost data received from tenderers and based on any changes to key assumptions.



2.2 Project Optioneering: Shortlist of Preferred Options

Step 3: Options Framework Evaluation – Results

- The results of the Options Framework provides a final list of viable ('green' and 'amber') options that is used to map a summary of the shortlist preferred options for the various outage scenarios, this is presented below. A more detailed summary of Step 3 is presented in Appendix E.1.
- The analysis will be reconsidered at Final Business Case stage, based on cost data received from tenderers and based on any changes to key assumptions.
- The analysis is subject to economic appraisal and dialogue with policy and regulatory stakeholders (especially rows 1, 4 and 5).
- The assumptions are subject to testing and validation, including market testing (especially rows 3, 4 and 5) – see Commercial Case.

Row	Questions		Emerging N-1 Solution	Emerging Full GB Outage Solution
1	Scope What? (N-1) case only for 6 months	What is the potential coverage of the project?	N-1 (ROI +IOM)	Full GB Outage (ROI+IOM+NI)
2	Solutions How?	How might the project be delivered?	FSRU (Leased / Build)	FSRU plus onshore salt cavern storage
3	Deliverer Who?	Who can deliver the services?	Traditional	Hybrid (PPP + Traditional)
4	Implementation: When	When can the project be delivered?	Accelerated	Accelerated
5	Funding & Financing Where from?:	Where might the funding of the project come from?		
		Where might the financing of the project come from?		

2.2 Project Optioneering: SWOT Analysis

SWOT Analysis	Emerging N-1 Solution		Emerging Full GB Outage Solution
	Lease standard FSRU	Build bespoke FSRU	Salt Cavern + FSRU
Strengths	- Fastest delivery - Standard existing vessels can be used - Fast response in case of emergency - Lowest risk of lock-in to fossil fuels if leased	- Zero gas send-out during standby (reducing the use of LNG) - Full inventory available - Complete control of asset	- Covers full-outage - Best resilience and fastest response - Filled from available existing gas supply during normal operation (reducing the use of LNG) - No FSRU on station during standby
Weaknesses			- High complexity and ambitious – delivery risk - More costly
Opportunities	Charter an existing vessel quickly	A build / retrofitted bespoke vessel would meet specific requirements.	- Opportunities for grant funding - Facilitates Ireland's path to net-Zero
Threats			

2.2 Emerging Solutions: Strategic Objectives Alignment

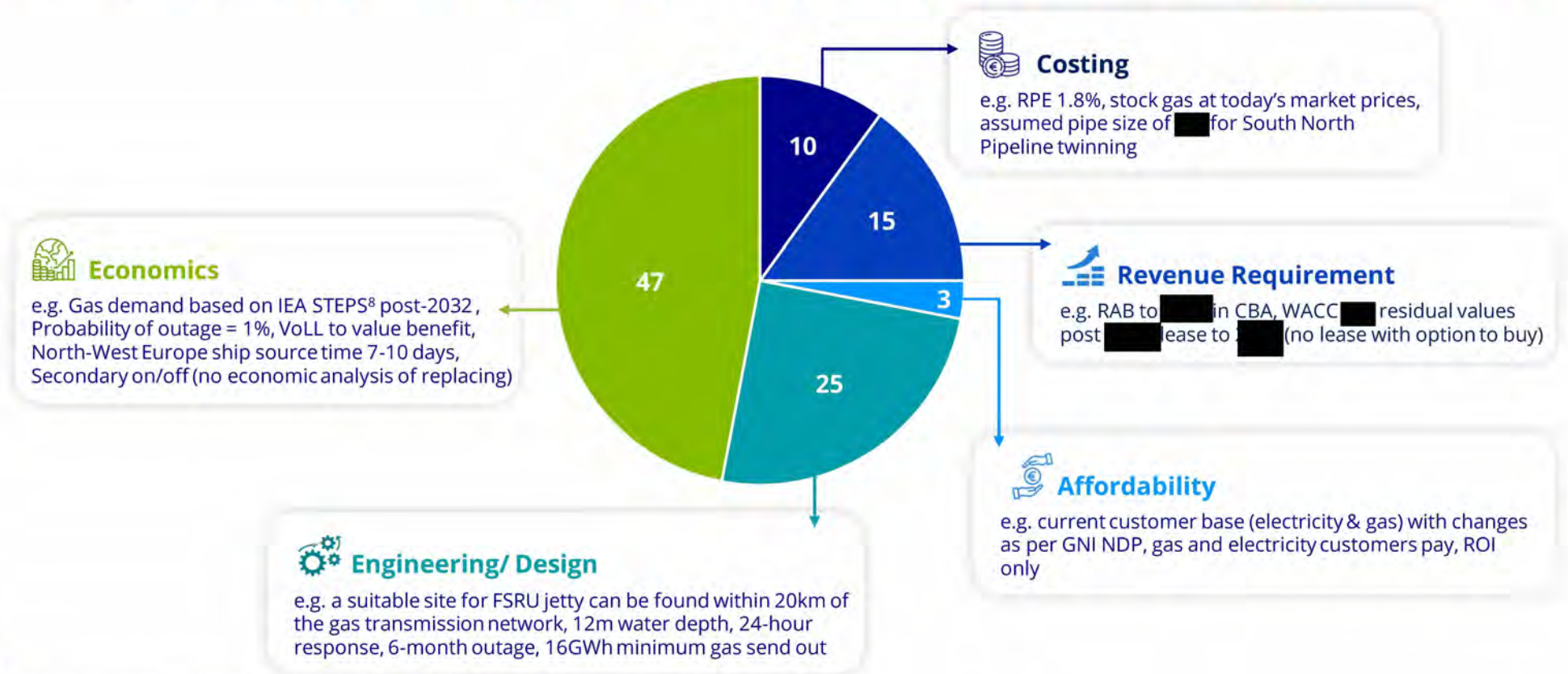
Row	Strategic Objective	Emerging N-1 Solution: FSRU	Emerging Full GB Outage Solution: FSRU & Salt Cavern
1	Deliver a solution as soon as possible that will: • satisfy Ireland's compliance with EU N-1 infrastructure standard • enable rapid recovery from a system disruption; and • provide sufficient resilience of gas supply to ensure future (2030) energy gas demand is reliably met	• Meets N-1 infrastructure standard • Enables a rapid recovery • Provides resilience	• Exceeds N-1 infrastructure standard • Enables a rapid recovery • Provides excellent resilience
2	Achieve a cost-effective, affordable solution that optimises EU grant funding and cost recovery options	• Affordable solution for customer • Limited scope for EU grant aid	
3	Design permanent or onshore enabling infrastructure in a manner that maximises potential future renewable gas uses, to the extent possible, balancing cost and other efficiencies such as time to deployment	• Permanent infrastructure (jetty and pipeline) will be designed to maximise future renewable gas use • Vessel can be divested	• Permanent infrastructure (jetty, pipelines and salt cavern) will be designed to maximise future renewable gas use • Salt caverns are proven technology for storage of hydrogen
4	Achieve a solution that is, in so far as practicable, consistent with the Climate Action and Low Carbon Development Act 2015 – 2021 ^{4, 5}	• Supports the delivery of renewable electricity through a secure back-up gas supply • Vessel can be divested	• Supports the delivery of renewable electricity through a secure back-up gas supply • Provides hydrogen-enabled permanent infrastructure that supports transition to renewable gases – facilitating the attainment of the national climate objective
5	Meet or exceed industry best practice in relation to safety and the environment	• Will be designed and operated to ALARP safety standard • Technology proven at scale • Will be designed, constructed and operated to minimise environmental impacts	• Will be designed and operated to ALARP safety standard • Technology proven at scale • Will be designed, constructed and operated to minimise environmental impacts

2.3 Economic Appraisal



Assumptions

The Project has made assumptions to enable the development of the Preliminary Business Case. These will be further validated as the project processes. The below gives a summary view of assumption type with some high-level examples. See Assumptions Management document within the supporting documents provided.



Multi-Method Approach to Forecast Cost – current status

Quantitative Risk Analysis

- Kick-off meeting held
- First iteration of QRA planned for Q2 2024

Base Cost Estimate

- Class 5 (High Level) cost estimates
- Past experience, preliminary market engagement and benchmarks
- Next steps - preliminary cost estimate based on concept designs

Design Development

- Technology selection (benchmarks of past projects)
- Initial design concepts (benchmarks of past projects)
- Next steps – Site selection, pre-FEED

Reference Class Forecasting

- [REDACTED] internationally recognised leading expert appointed
- Initial view of high-level cost and schedule risks the project is likely to encounter based on reference class ranges
- Next steps - Full cost and schedule Reference Class Forecasts (RCF) for options

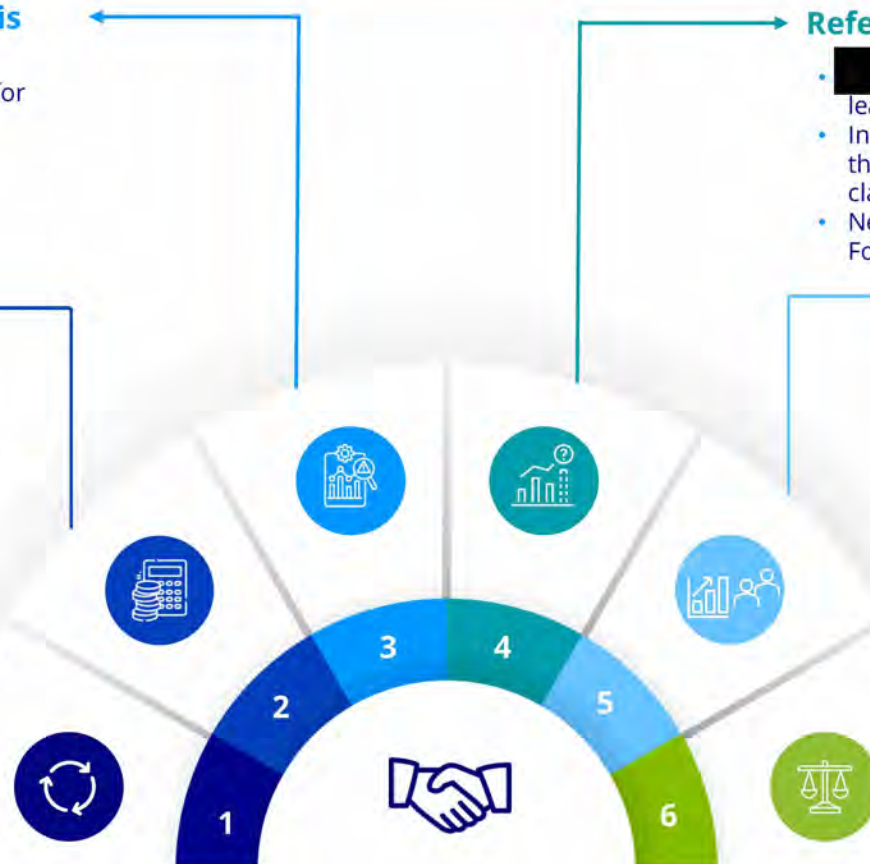
Expert Judgement

- Expert views of internal team plus external support

- Initial market engagement
- Meetings with industry players
- Publicly available information (SEC filings, EU papers, media coverage)

Cost Benefit Analysis

- Initial CBA based on the above inputs
 - Benefit Cost Ratios for options
 - Sensitivity analysis based on ranges and RCF



Economic Appraisal – Costs & Contingency used

Technology option	TOTEX Costs (€ Million, NPV, real 2024)	CAPEX (€ Millions) Excl. Contingency	Contingency used for CBA	Contingency Range	
				RCF: P50	RCF: P80
Lease FSRU					
Build FSRU					
Salt + FSRU					

OXFORD GLOBAL PROJECTS

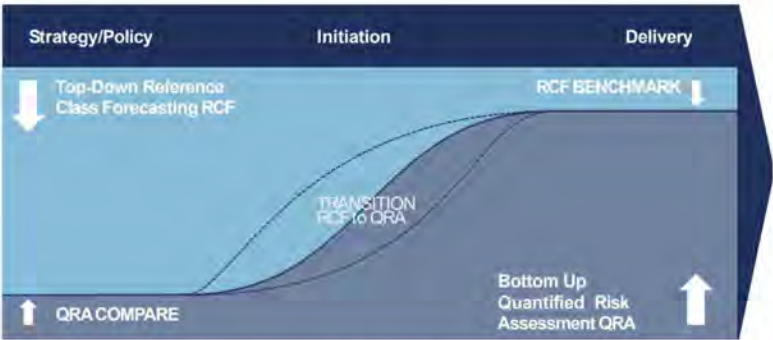


Figure 1 – Risk Assessment and Estimating methodologies as the design matures



Use of Reference Class Forecasting

"Reference class forecasting (RCF) is a top-down approach that uses past project results and relates them to the project in question. Top-down RCF is more appropriate at the beginning of a project, as there will be many uncertainties and opportunities for the project to evolve along different routes. As the project nears completion, a bottom-up QRA approach will be more applicable, as there will be detailed information available about most aspects of the project and fewer remaining uncertainties."⁹

2.3 Economic Appraisal – Cost profiles for Jetty + Leased FSRU



2.3 Economic Appraisal – Cost profiles for Jetty + build FSRU



N-1 scenario

jetty and
lease FSRU

Jetty and
build FSRU

Full GB Outage

Salt cavern,
FSRU build
and sub lease,
temporary
FSRU leased

2.3 Economic Appraisal – Cost profiles for FSRUs + Onshore Salt Cavern Storage



N-1 scenario

jetty and
lease FSRU

jetty and
build FSRU

Full GB Outage

Salt cavern,
FSRU build
and sub lease,
temporary
FSRU leased

construction period.

2.3 Economic Appraisal – Benefits overview

Benefits

- The following benefits categories have been included in the benefit estimate:

Security of Supply ("SoS")

The largest benefit of the investment is a more secure supply of gas to Ireland.

Green benefit

The main green benefit is the avoidance of more polluting secondary fuel use in case of emergency. This is captured in the security of supply benefit quantification for those scenarios that consider a fuel switch.

Commercial benefits

The commercial use of the investment by importing gas or promoting natural gas by regular storage withdrawals has been ruled out by assumption.

The only commercial benefit to Irish society that has been considered is the potential lease of a self-owned FSRU.

Residual value

The technical lifetime of the assets goes beyond the end of the evaluation period, which ends in 2050.

There is, therefore, residual value. Whether this value materialises depends on the speed of the energy transition and the ability to make effective use of the assets beyond 2050

2.3 Economic Appraisal – Non-monetary Benefits

The benefits listed below are not monetised in the CBA.

Note that these benefits are common for all options (although the extent of benefit could vary depending on the technology).



Create Direct & Indirect Jobs

- Designing, constructing, and operating the assets will generate employment
- This will directly (and indirectly through the supply chain) create jobs. According to the CSO, the indirect effect using the energy sector multiplier is 34%¹⁰ i.e. that for every 10 direct jobs created, 3.4 indirect jobs are created.
- Additionally, both direct and indirect employment lead to induced jobs, e.g. when workers spend their income (e.g., restaurant visits), it creates further employment opportunities¹¹.



Develop Skills for Energy Transition

- Experts have emphasised the importance of developing skills for energy transition, highlighting the need to enhance the skill base across all professions involved, from engineers to legal professionals¹².
- This project would enable Ireland to develop and attract skills in planning, constructing, and operating large-scale energy projects.



Comply with Regulation

- At a minimum, the project will be sized to meet the N-1 standard, thereby complying with EU regulation and avoiding infringement notices from the EU and/or fines levied on Ireland.



Enhance Investment Reputation

- The project will enhance the perception of Ireland as an energy-secure country. This could play a role for:
 - Investors in energy-intensive businesses (e.g., data centres), as it would reduce the likelihood of energy interruptions
 - The electricity sector, as it would serve as a guarantee that gas would be available during times of low renewable energy sources and high demand.



Progress Green Transition

- The project will provide greater security of gas supply, therefore promoting and sending a signal to gas-related investments that support the energy transition such as the required gas/hydrogen power plants and biogas.

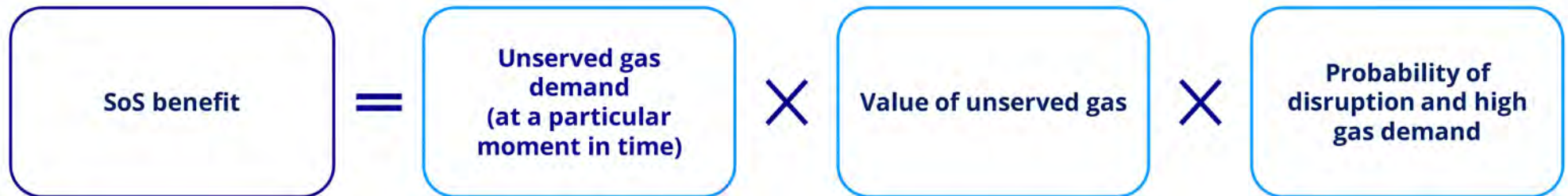
¹⁰Central Statistics Office (CSO) (2015), Supply and Use and Input-Output Tables for Ireland – Table 12. Available [here](#) (Please note that this multiplier is for GVA. We used this numbers as there is no specific estimate for employment.)

¹¹Central Statistics Office (CSO) (2015), Supply and Use and Input-Output Tables for Ireland – Table 12. Available [here](#) (Please note that induced jobs are calculated using Type 2 multipliers - we do not provide an estimate as CSO does not publish these.)

¹²Carbon Trust (2020), Harnessing our Potential. Available [here](#) / National Skill Council (2021), Skills for Zero Carbon, Available [here](#)

2.3 Economic Appraisal – SoS benefit quantification approach

The security of supply benefit is estimated as the expected avoided costs of disruption. Therefore, it considers the following on an annual basis to 2050 (discounted):



The formula is a pragmatic reflection of a much wider distribution of the high gas demand the system can face, the uncertainty around the time and likelihood of a disruption. The resulting estimated benefit should be considered with the value of unserved gas demand to be representative of the overall SoS benefit.

2.3 Economic Appraisal – Assumptions and Calculations

Cost-benefit analysis (CBA):



Economic Appraisal



2.3 Economic Appraisal – SoS benefit and green benefit

- We present results including and excluding the dual fuel obligation (called "fuel switch") in the power sector:
 - When fuel switching is assumed to occur in the power sector, investments mitigate against use of more polluting fuels, and create a green benefit.
 - At the same time, when fuel switching is assumed, more electricity demand can be met, and hence, there is a lower SoS benefit of the investments. There is, therefore, a trade-off between the two benefits. In general, assuming a fuel switch reduces the total net-benefit, i.e. unserved electricity demand creates a higher cost than the incremental cost of the fuel switch.
- Technical assumptions
 - When a fuel switch in the power sector is made, we assume a 69% success rate^{13,14}. DECC agreed to this assumption in CEPA's report.
 - We assume sufficient fuel switching capability is available to replace gas demand from the power sector on a continuous basis for the projected shortfall duration of 6 months.
 - We account for:
 - the incremental resource costs of diesel/light fuel oil; we rely on the International Energy Agency's (IEA) 'Stated Policies (STEPS)'¹⁵ to project gas and crude oil prices, and the historic mark-up of diesel/light fuel oil to crude oil.
 - the incremental carbon emissions, which are valued at the shadow price of carbon.
 - We do not evaluate the dual fuel/fuel switching obligation, and its ongoing costs are not considered in the CBA. We only present the effect of fuel switching taking place or not.
- We do not assume any other demand-side responses to an interruption:
 - Any increased electricity imports via the interconnector not yet captured in a risk assessment projection to be completed in the next phase of the project.
 - A response in the I&C or residential sector by lowering demand or switching to other fuels.

¹³CEPA (2022), Technical Analysis of the Security of Energy Supply of Ireland's Electricity and Natural Gas Systems. Available [here](#)

¹⁴EirGrid (2010), Secondary Fuel Testing Arrangements: Summary Document. Available [here](#)

¹⁵International Energy Agency (IEA) (2023), Global Energy and Climate Model. Available [here](#)

2.3 Economic Appraisal – SoS benefit unserved gas demand



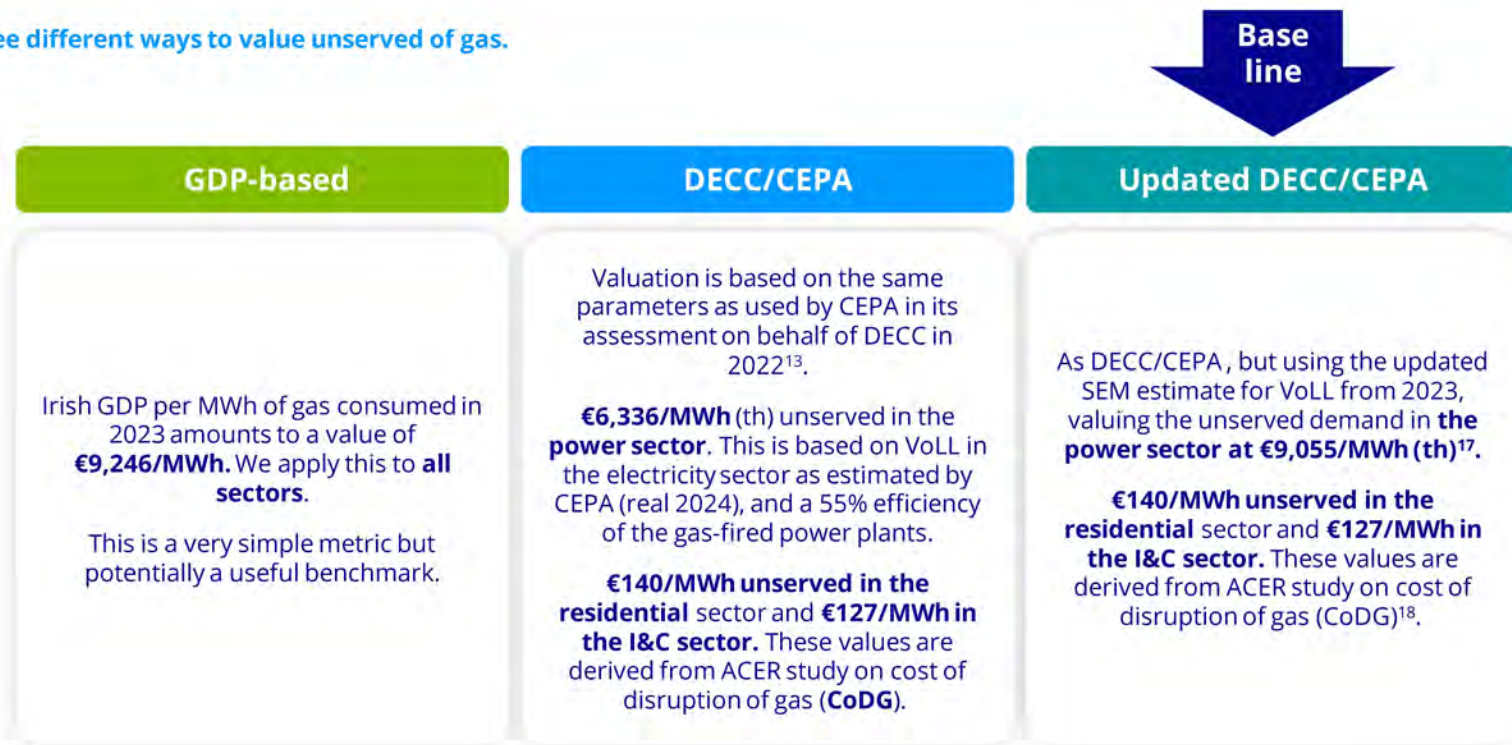
Projections of unserved gas demand

- The outage length considered in the economic appraisal is six months from the day of the 1-in-20 peak day. The six-month period is based on the estimated repair time as set out in the Strategic Case.
- The starting point for the analysis is the 24/25 projection of unserved demand in the 2022 National Risk Assessment (2022 NRA)¹⁵. This projection is then used to project unserved demand until 2050.
- Total gas demand is projected to fall in line with IEA 'Stated Policies (STEPS)'²⁸ scenario, i.e. by approx. 55% from 2022 to 2050.
 - For the full GB outage, we assume that the unserved gas demand falls in line with this scenario, as the outage represents almost all demand
 - For the N-1, any shortage longer than 10 days is impacted by the overall fall in gas demand. This means that, for the 6-month outage period, from 2031 onwards, in the N-1 scenario, the only unserved demand is that of the 10-day
- The allocation of gas to affected sectors is based on:
 - For the full GB outage, the annual demand per sector based on GNI's NDP 2023. The same allocation is applied to NI when it is included in the outage scenario.
 - For the N-1 disruption, the only impact is on the power sector. We assume that the 10-day shortfall, as modelled for 24/25, remains over time to reflect adverse weather conditions impacting the heat and power sector.

N-1	1-in-20 Peak (2022 NRA ¹⁶ 24/25)				
Gas Demand shortfall with IC2 outage (GWh)	10-D	30-D	3-mth	6-mth	
ROI					
ROI + IOM					
ROI + IOM + NI (via South North)					
Full GB Outage	1-in-20 Peak (2022 NRA ¹⁶ 24/25)				
Gas Demand shortfall with full GB outage (GWh)	10-D	30-D	3-mth	6-mth	1-yr
ROI					
ROI + IOM					
ROI + IOM + NI (via South North)					

2.3 Economic Appraisal – SoS benefit value of unserved gas

We considered three different ways to value unserved of gas.



2.3 Economic Appraisal – SoS benefit probability of disruption



- There is limited information to inform the probability of an N-1 outage occurring and leading to a six-month outage period.
- The six-month outage duration is based on the recent Balticconnector subsea pipeline repair (commissioning completed in April 2024).
- There is no available data to inform the probability of a full GB outage.
- To provide an anchor point for the results presented, we assume a 1% probability. This value has no further meaning or purpose. It does not represent a view on the true probability.
- The 1% probability has been used previously by the CRU in its decision on the 'twinning' of the Southwest Scotland Onshore System cross border CBA¹⁹ in 2015. The basis for the 1% probability is outlined in that decision and is linked to publicly available gas pipeline incidence reports from the European Gas Incident Group (EGIG).²⁰ Note that this does not take into account the three subsea outages in Europe in the past two years.
- To understand the impact of the valuation, we present a combination of the value of unserved demand and the likelihood of the disruption occurring that generates a neutral result in the CBA.

2.3 Economic Appraisal – SoS benefit worked example

To summarise and make our approach more tangible, we present a number of calculations for an expected value for a given year. The CBA sums and discounts all expected value to a total SoS benefit as of today/2024.

	Example 1	Example 2	Example 3
Outage	1 TWh in power sector (approx. N-1). No fuel switch	1 TWh in power sector (approx. N-1). Fuel switch for 69%	30 TWh across sectors (approx. Full GB outage) 50% power, 50% other. No fuel switch
Valuation	€6,336/MWh(th) as DECC agreed with CEPA ¹³	€6,336/MWh(th) as DECC agreed with CEPA + <u>Incremental</u> costs of diesel (€75/MWh in 2030)	€6,336/MWh(th) as DECC agreed with CEPA for power sector ¹⁷ + ACER values for other sectors (approx. €100 MWh) ¹⁸
Exposure	€6.3 billion	€2.0 billion	€95 billion in power sector €1.5 billion in other sectors. In total approx. 20% of RoI GDP
Probability	1%	1%	1%
Expected value	€63 million p.a.	€20 million p.a.	€965 million p.a.

Note: For comparison purposes a 6 month outage in 2025 during a 1 in 20 peak period is calculated - the exposure is estimated at c.€14bn for an N-1 outage and c.€64bn for a full GB outage based on updated SEM VoLL³⁵ and with fuel switching. Please note that the CBA presented in this case is a Project CBA and that any outage prior to commissioning is a societal loss that is not contained in the project CBA.

CBA Results – Baseline

1 **CBA is positive and investment makes sense using CEPA/DECC values updated with published 2023 SEM decision in relation to electricity outages.**

2	Emerging N-1 Solution	Emerging Full GB Outage Solution
Net Benefit		
Required Probability for a net benefit of zero		
Benefit Cost Ratio (BCR)	1.17	4.2

3 Key Assumptions

- An outage of 6 months from a 1-in-20 peak day
- The 6-month period is based on estimated repair time
- Benefits start at commissioning date
- Secondary Fuel is replaced by solution.
- 'Business as Usual' delivery schedule
- Any outage prior to commissioning is a loss to society and not modelled in this CBA

4 Model inputs and calculation

Assign a € value

Take the widely used EU Standard called **Value of Lost Load (VoLL)** that assigns a € amount to the loss of electricity/gas to society in every Member State – we used up-to-date Irish data from the CRU SEM decision in 2023¹⁷.

Assign a theoretical probability

1% → used in previous major EU grant funding CBA, 1% probability linked to European Gas Incident Group reports²⁰ (not taking into account the recent three subsea outages in Europe in past two years).

Calculate a € Benefit

These are applied to a forecast of gas demand left unserved using GNI/CRU forecasts (to 2032)²¹ and IEA Stated Policies (IEA STEPS)⁸ (in period to 2050) in the potential 6-month outage over the period from commissioning to 2050.

5 Sensitivities with positive impact on € Benefits

- Accelerated project delivery schedules increase project benefits
- Continued trend of society's increasing value of loss of electricity given increased electrification (i.e. electric cars, heat pumps, home heating, etc)
- Slower than forecasted transition from gas with higher annual and daily volumes
- Continued pressure on electricity supply to meet demand
- Different phasing of solution cost drivers could result in earlier benefits realisation
- Although not a societal benefit, the proposed project CBA would benefit from alternative revenue streams from obligation to use (Salt Caverns, unloading ships)

40 ⁸International Energy Agency (IEA) (2023), Global Energy and Climate Model. Available [here](#)
¹⁷SEM Committee (2023), Calculation of a Single Value of Lost Load within the Single Electricity Market. Available [here](#)
²⁰European Gas Pipeline Incident Group (n.d.), EGIG Reports. Available [here](#)
²¹GNI (2022), Gas Forecast Statement 2022. Available [here](#)

2.3 Economic Appraisal – N-1 options: Baseline Results

- For these results we assume:
 - the valuation of avoided unserved demand as per CEPA values in analysis for DECC¹³, but updated for the latest SEM VoLL figure¹⁷
 - 1% probability, that Fuel Switching possible on a continuous basis for 6 months.

NPV, real 2024	Lease FSRU	Build FSRU		Lease FSRU	Build FSRU
Fuel switch	No	No		Yes	Yes
Total costs (€bn)					
SoS benefits (€bn)					
Commercial benefits (€bn)					
Residual value (€bn)					
Net-benefit (€bn)					
Benefit Cost Ratio (BCR)					
Probability required for a net-benefit of zero (neutral CBA)					

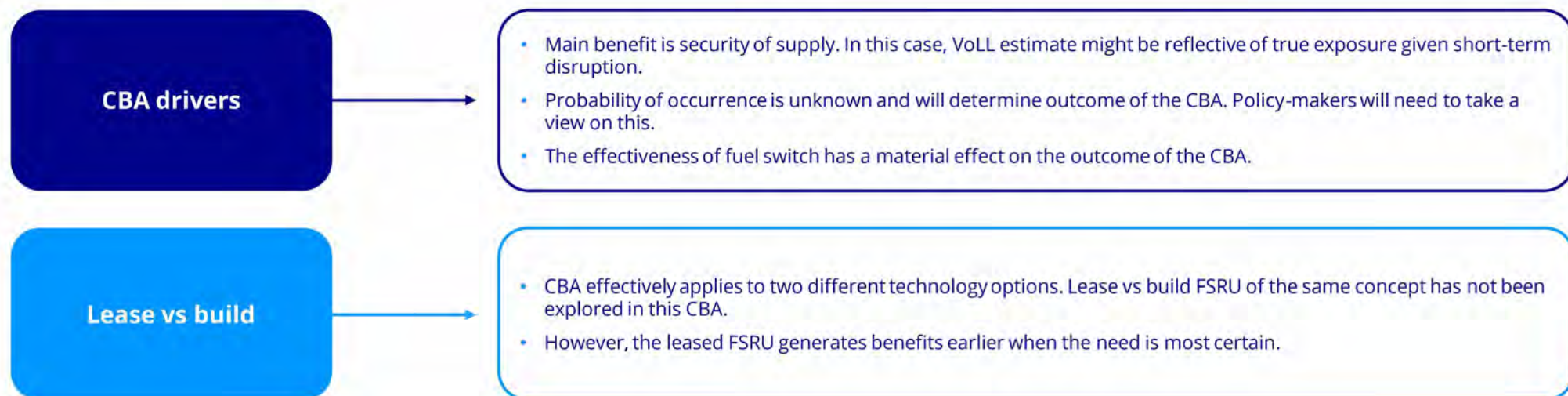
41 ¹³CEPA (2022), Technical Analysis of the Security of Energy Supply of Ireland's Electricity and Natural Gas Systems. Available [here](#).
¹⁷SEM Committee (2023), Calculation of a Single Value of Lost Load within the Single Electricity Market. Available [here](#).

2.3 Economic Appraisal – N-1 options: Sensitivity

- For these results we assume:
 - the valuation of avoided unserved demand as per CEPA values in analysis for DECC ⁴³
 - 1% probability, that Fuel Switching possible on a continuous basis for 6 months.

NPV, real 2024	Lease FSRU	Build FSRU		Lease FSRU	Build FSRU
Fuel switch	No	No		Yes	Yes
Total costs (€bn)					
SoS benefits (€bn)					
Commercial benefits (€bn)					
Residual value (€bn)					
Net-benefit (€bn)					
Probability required for a net-benefit of zero (neutral CBA)					

2.3 Economic Appraisal – N-1 options: Main Findings and Recommendations



2.3 Economic Appraisal – Full GB Outage options: Baseline Results

- For these results we assume:
 - the valuation of avoided unserved demand as per CEPA values in analysis for DECC¹³, but updated for the latest SEM VoLL figure¹⁷
 - 1% probability, that Fuel Switching possible on a continuous basis for 6 months.

NPV, real 2024	FSRUs & Onshore Salt Cavern Storage	FSRUs & Onshore Salt Cavern Storage
	No	Yes
Fuel switch		
Total costs (€bn)		
SoS benefits (€bn)		
Commercial benefits (€bn)		
Residual value (€bn)		
Net-benefit (€bn)		
Benefit Cost Ratio (BCR)		
Probability required for a net-benefit of zero (neutral CBA)		

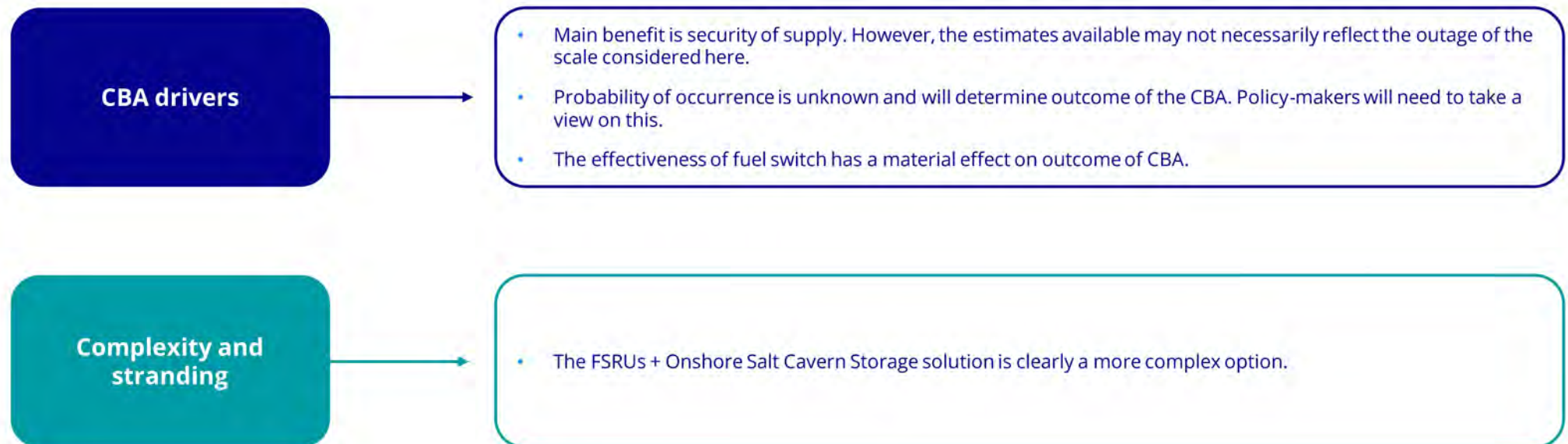
2.3 Economic Appraisal – Full GB Outage options: Sensitivity

- For these results we assume:
 - the valuation of avoided unserved demand as CEPA values in analysis for DECC⁴⁶,
 - 1% probability, that Fuel Switching possible on a continuous basis for 6 months.

NPV, real 2024	FSRUs & Onshore Salt Cavern Storage	FSRUs & Onshore Salt Cavern Storage
Fuel switch	No	Yes
Total costs (€bn)		
SoS benefits (€bn)		
Commercial benefits (€bn)		
Residual value (€bn)		
Net-benefit (€bn)		
Probability required for a net-benefit of zero (neutral CBA)		

45 ¹³CEPA (2022), Technical Analysis of the Security of Energy Supply of Ireland's Electricity and Natural Gas Systems. Available [here](#)

2.3 Economic Appraisal – Full GB Outage options: main findings and recommendations



2.3 Affordability Considerations - Resulting illustrative example of costs to the customer

1

Emerging N-1 Solution FSRU

RAB-based model. Regulated Asset and paid for via existing regulatory tariffs and/or Levy (tbc).

- Further analysis to be done on technology in terms of send out or not
- Any send out scenario could result in revenue stream to offset costs

2

Emerging Full GB Outage Solution Salt Cavern + FSRU

RAB based model. Regulated Asset and scenario modelling below shows indicative cost if paid for via existing regulatory tariffs and/or Levy (tbc).

- Larger cost but more grant opportunities (not included)
- Suggests wider customer base (not included)
- As a result indicative costs below likely to be lower after further analysis

3

Sensitivities not modelled at present (next phase)

- Exchequer or State funding
- Opportunities for EU and other funding with the Salt Cavern given transition to hydrogen
- Salt Cavern costs/revenues likely via some form of obligation and via Supplier charges (EU norm)
- FSRU utilisation for minimum send out could have revenue stream
- Further funding and allocation methods from cross-border CBA
- Further engagement with Power Generation stakeholders and Regulators re Fuel Switch / Secondary Fuel Policy

Commercially Sensitive

2.4 Confirmation of Emerging Preferred Option



2.4 Confirmation of Emerging Preferred Option(s)

To invest?

- If no commercial use is foreseen, whether the Security of Supply benefits justify the investment mainly depends on the risk perception and valuation of an outage by policy makers. This applies to both N-1 and Full GB Outage scenarios.

Next steps

- Whether the FSRU will need to be leased or built needs further consideration
- Whether greater investment to cover a Full GB Outage is justified needs further consideration

Recommendation & Next Steps



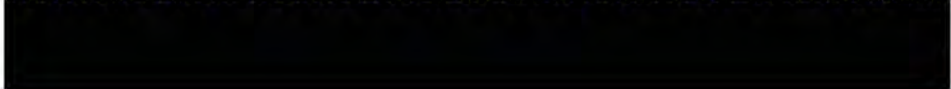
It is recommended that the following solutions be proposed as a Strategic Gas Emergency Reserve to secure Ireland's gas supplies:

N-1

It is recommended with respect to Ireland's compliance with the N-1 Standard that a Floating Storage and Regasification Unit ("FSRU") which meets DECC's criteria should be delivered as a transitional measure.

Full GB Outage

GNI is of the opinion that serious consideration should be given to the early implementation of a long-term solution which guarantees energy security during a full outage of gas from Great Britain to the island of Ireland. Our analysis suggests



Summary

GNI's above recommendations are supported by the information set out in the detailed proposal along with initial high-level analysis in terms of cost, risks and schedule to deliver either. It should be noted that work is ongoing to further refine and finalise certain aspects of the financial and economic models that were not fully completed in the time available. Notwithstanding this, the models provided at this juncture contain significant detail and should allow the Department to carry out its review.

The detailed proposal also outlines an ambitious plan to deliver the programme of works which includes an examination of options for an accelerated schedule.

As an FSRU forms a part of both recommendations, GNI proposes that work in relation to putting this into place should proceed as soon as possible whilst the Full GB Outage solution is given further consideration.

Next Steps



Appendix E1 Supplementary Optioneering Information



Appendix E.1: Step 1 – Pass/Fail Criteria - Methodology



The following table shows the criteria against which the 24 concepts were sifted and their definition.

Criteria	Criteria Description
Ability to ensure Ireland complies with EU N-1 infrastructure standard	The concept technology meets the N-1 infrastructure standard as per Ireland’s 2022 National Risk Assessment: Gas (17/11/2022) ¹⁶ . The volume of gas that would be required in an outage event is a function of the time taken to restore the N-1 infrastructure and the supply deficit in that period.
Steady Supply	The concept technology has the ability to consistently deliver supply over the duration of the outage event.
Diversification of Supply (both source and route)	The proposed source is diverse from the N-1 infrastructure gas source. The proposed geographical route is diverse from the routing of the N-1 infrastructure gas source.
Technology proven at scale for the primary use	The concept technology is being reliably implemented and operated at a similar scale for its primary use.
Consistent in so far as practicable with the Climate Action and Low Carbon Development (Amendment) Act 2021 ⁴	The concept technology, in so far as practicable, will facilitate and not prevent the attainment of the national climate objective as defined in the 2015 Act ⁵ i.e. the transition to a climate-resilient, biodiversity rich, environmentally sustainable and climate neutral economy no later than the end of the year 2050 and to a reduction in greenhouse gas emissions of 51% by 2030 (compared to 2018 levels). The concept technology must have demonstrated, at least to a pre-commercial demonstration level, potential to be substantially used and/or repurposed for use with renewable gas, in particular hydrogen as per the National Hydrogen Strategy 2023 ²² , and/or could be divested.

52 ⁴Government of Ireland (2021), Climate Action and Low Carbon Development (Amendment) Act. Available [here](#)
⁵Government of Ireland (2015), Climate Action and Low Carbon Development Act. Available [here](#)
¹⁶Commission for the Regulation of Utilities [CRU] (2022), Ireland’s 2022 National Risk Assessment: Gas.
²²Government of Ireland (2023), National Hydrogen Strategy. Available [here](#)

Appendix E.1: Step 1 – Pass/Fail Criteria – Scoring

- The scoring of each concept against the pass / fail criteria is presented below, with the green denoting that the technology is assessed to have 'passed' the criteria and red denoting that the technology is assessed to have 'failed' the criteria
- Concepts which have failed to meet all the criteria are not brought forward to Step 2 and are removed from the longlist

Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ability to ensure Ireland complies with EU N-1 infrastructure standard	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Red	Green	Green	Green	Green	Green
Steady Supply	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Green
Diversification of Supply (both source and route)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Green	Red	Green	Green	Green	Green	Green	Green	Green
Technology proven at scale for the primary use	Green	Green	Green	Green	Green	Green	Green	Red	Green	Red	Green	Red	Green	Green	Green	Green	Green	Red	Green	Green	Green	Red	Green	Green
Consistent in so far as practicable with the Climate Action and Low Carbon Development Act 2015 (as amended) (the 2015 Act) Project Carried forward to Step 3?	Green	Green	Red	Red	Red	Red	Red	Green	Red	Red	Green	Red	Red	Green	Green	Green	Red	Red	Red	Green	Red	Red	Red	Green
	Yes	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	Yes	Yes	No	No	No	Yes	No	No	No	Yes

Appendix E.1: Step 1 – Pass/Fail Criteria – Remaining Options

- The following concepts were considered to have met the pass / fail screening



Concept 1

Jetty Only with FSRU Support Arrangements



Concept 2

Leased FSRU (Full time on station) plus Jetty



Concept 11

Leased FSRU plus Jetty with Onshore Salt Cavern Storage



Concept 15

Interconnector to France



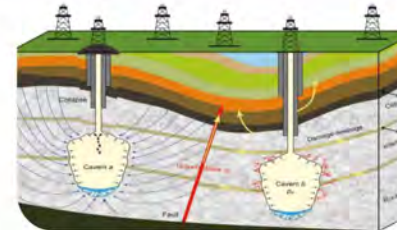
Concept 16

Interconnector to UK with



Concept 20

Build FSRU (Full time on station) plus Jetty



Concept 24

Onshore Development Salt Cavern Storage

Appendix E.1: Step 2 – Multi Criteria Concept Comparison - Scoring



Concept No.	Concept	Overall Score	Rank
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Appendix E.1: Step 3 – Options Framework – CSFs

- Each filtered CSF assessed is assumed to have an equal weighting in the overall scoring
- They are RAG rated, with metrics defined for each CSF in each row to provide a basis for assessment
- In general:
 - **Green Score** – the option has good alignment with the CSF - valued at a score of 3
 - **Amber Score** – option aligns with the CSF, but not as well as green - valued at a score of 2
 - **Red Score** – the option has significant constraints, but it is possible to align the CSF with mitigation - valued at score of 1
 - **Black Score** – it is not possible for the option to align with the CSF - option is removed from the longlist
- Options receiving the highest cumulative score are determined as the Emerging Preferred Option
- A list of the scoring metrics for each CSF is provided in the subsequent slides

Appendix E.1: Step 3 – Options Framework - CSFs

- Not all CSFs are relevant for judging the relative merit of each option to resolve each question
- To account for this, a filtering exercise was undertaken by Project Team to inform which CSFs are most pertinent in answering the questions posed, with CSFs decided to be not relevant for each question not considered
- For 'the Solution' question all CSFs were considered necessary
- Each filtered CSF assessed is assumed to have an equal weighting in the overall scoring

ID	CSFs	The Scope	The Solutions	The Deliverer	The Implementation Mechanism	Funding	Financing
1	Ability to meet Strategic need						
2	Dedicated						
3	Fastest Deployed solution						
4	Minimise cost to Irish consumers						
5	Affordability						
6	Avoid stranded assets						
7	Value for money						
8	Do not contribute to increase in fossil fuel usage						
9	Avoid lock in to fossil fuels						
10	Lowest GHG emissions						
11	Compatible with long term hydrogen storage (Action 14)						
12	Ability to obtain necessary consents						
13	Market capacity & capability to deliver						
14	Ability to be delivered on budget						
15	Ability to be delivered on schedule						
16	Lowest delivery risk						
17	Ease of operating within a regulatory framework						
18	Achieves public, market and political support / acceptance						
19	Minimise environmental impacts						
20	Benefits local community						
21	Minimise safety risk (ALARP)						
22	Public acceptance of safety						

Appendix E.1: Step 3 – Options Framework – Row 1: Scope



- Row 1 assessed four potential project scopes, all with varying gas requirements. These vary depending on the geography covered and whether it accounts for protection in the event of a full GB outage
- All address a common outage duration of 180 days
- These were assessed against the 14 CSFs previously identified for Row 1. The Emerging Preferred Option (EPO) is identified below

Geography	Capacity for Full GB outage?	Gas Requirement	Overall RAG Score
Republic of Ireland + Isle of Man	No		
Republic of Ireland + Isle of Man + Northern Ireland	No		
Republic of Ireland + Isle of Man	Yes		
Republic of Ireland + Isle of Man + Northern Ireland	Yes		

EPO

Appendix E.1: Step 3 – Options Framework – Row 2: Technology



- The five technologies carried forward from Step 2 are assessed in the solution row.
- As required by the Infrastructure Guidelines, a counterfactual of ‘do-nothing’ is represented by a ‘Business as Usual’ (BAU) option²³. The guidelines refer to this as the ‘benchmark’ or counterfactual required for comparative purposes.
- The five technology options and BAU were assessed against all 22 CSFs previously identified, with the cumulative scores presented below
- Note both the BAU and Concept 1 are scored failed to meet the expected response time to provide the N-1 deficit and are discounted. A cumulative score is therefore not presented.

Concept	Overall Score
Business as Usual	
Concept 1: Jetty only with FSRU support arrangements	
Concept 2: Leased FSRU (full time on station) plus jetty	
Concept 11: Leased FSRU plus jetty with onshore salt cavern storage	
Concept 16: Interconnector to UK with [REDACTED]	
Concept 20: Built FSRU (full time on station) plus jetty	

EPO

Appendix E.1: Step 3 – Options Framework – Row 3: Delivery



- Row 3 assesses the preferred delivery mechanism given the EPOs identified in Rows 1 and Row 2
- These are assessed against the five relevant CSFs, previously identified
- For the purpose of the analysis it is assumed that all delivery works are delivered using a single approach, apart from 'Hybrid' which assumes a mixed approach.
- The results are presented in the table below

Delivery Strategy	Definition	Overall Score
Traditional		
Public Private Partnership		
Public Private Joint Venture		
Hybrid		

Appendix E.1: Step 3 – Options Framework – Row 4: Implementation



- Row 4 assesses the preferred implementation strategy given the EPOs identified in Rows 1, 2 and 3.
- These are assessed against the six relevant CSFs, previously identified
- Three approaches to schedule delivery were developed with varying degrees of ambition. This row assesses the associated risks of accelerating the programme against the strategic benefits of doing so. Further details of the assumptions which inform implementation strategy are presented in the Management Case.
- The results are presented below.

Implementation Strategy	Definition	Overall Score
Standard		
Accelerated		
Accelerated with Risk		

Appendix E.1: Step 3 – Options Framework – Row 5: Funding & Finance

Appendix E.1: Step 3 – Options Framework – Summary



A completed version of the five-row Options Framework is shown below. The results of this scoring have been used to indicate the Emerging Preferred Options as detailed in the main slide pack.

Row	Question		Outage Duration = 180 days (TIME)
1	Scope What? (N-1) case only for 6 months	What is (SHORT)	
2	Solutions How?	Themes How	
3	Deliverer Who?	Who can	
4	Implementation When?	When	
5	Funding & Financing Where from?	Where not pr Where the p	

Appendix E2 Technological Overview of Options



Option 1: Jetty Only with FSRU Support Arrangements



Design Assumptions

Jetty

- New build or repurposed brownfield jetty

FSRU

- Leased FSRU sourced from available market, closed loop vaporisation
- Leased FSRU operates away from Ireland to transport commercial cargos as an LNGC
- Capacity for (N-1) ≥ 500 mmscfd (~ 14 MSCM/d, ~ 161 GWh/d)

Pipeline

- 20km pipeline connecting FSRU with gas network, (N-1) 24" diameter
- Modelling and design sensitivity work required for network.

Option 1: Jetty Only - Target Operating Model



Operational Assumptions

- Standby:
 - No vessel present in Ireland.
 - Leased FSRU operates as an LNGC away from Ireland; transports commercial cargoes – Europe, North Africa, East Coast Americas
- Emergency:
 - vessel returns and sends gas into the network.
 - considering 8,000 km radius of operations (4,500 Nm) at 16 knots average speed:
 - Return journey to ROI up to ~ 13 days
 - [REDACTED]
 - Suitable break clause in supply contract required
- Response time to emergency network demand: very slow

Option 2: Leased FSRU + Jetty



Design Assumptions

Jetty

- New build or repurposed brownfield jetty

FSRU

- FSRU sourced from available market (leased standard FSRU existing vessel, retrofit, new build), closed loop vaporisation (25% of existing fleet), no extras
- FSRU dedicated to strategic emergency reserve
- Capacity for (N-1) ≥ 500 mmscfd. (14 MSCM/d, ~161 GWh/d)

Pipeline

- 20km pipeline connecting FSRU with gas network, (N-1) 24" diameter
- Modelling and design sensitivity work required for network.

Option 2: Leased FSRU + Jetty - Target Operating Model



Operational Assumptions

Standby:

- Continuous operation
- Likely require minimum send out ~50 mmscfd. (1.4 MSCM/d, ~16 GWh/d)



Response Time: fast response time to emergency network demand

No requirement for periodic start-up/maintenance

Option 3: Purchased New Build FSRU+ Jetty



Design Assumptions

Jetty

- New build or repurposed brownfield jetty

FSRU

- New build FSRU, bespoke configuration

- Sub-cooling capability included
- Combined loop vaporisation with steam boilers
- SCRT on boiler and engine exhausts
- Shore-to-ship power during stand-by (2 to 6MW required)

Pipeline

- 20km pipeline connecting FSRU with gas network, (N-1) 24" diameter
- Modelling and design sensitivity work required for network.

Option 3: Purchased New Build FSRU + Jetty Target Operating Model



Operational Assumptions

Standby:

- Zero send out
- Sub-cooler running at all times
- Vaporisers cold stand-by. Boilers operate at winter to mitigate response time (assume burning HVO)

Emergency:



Response time: Slower response to emergency network demand

Winter season warm stand-by would partially mitigate requirement for periodic start-up/maintenance

Option 18: Salt Cavern Storage + Leased FSRU + New Build FSRU



Design Assumptions

Salt Cavern

- Salt Caverns proposed – [REDACTED] year construction
- Salt Caverns developed for (N-1) outage (without any vessel)

FSRU

- Short lease (~4 years) FSRU sourced from available market. Capacity for (N-1) ≥ 500 mmscfd. (14.16 MSCM/d, ~161.4 GWh/d)
- New Build FSRU, bespoke configuration

20km pipeline

- 20km pipeline connecting FSRU with gas network, (N-1) [REDACTED] diameter, up to [REDACTED] diameter being considered
- Modelling and design sensitivity work required for network pipe sizing.

Option 18: Salt Cavern Storage + Leased FSRU + New Build FSRU – Target Operating Model



Operational Assumptions

Standby:

- FSRU operates as per Option 2 while salt caverns [REDACTED]
- One salt caverns are online, FSRU operates away from Ireland as an LNGC trading LNG cargos
- Salt caverns operate as standard per Regulation (EU) 2022/1032 with regard to gas storage.

Emergency:

- Salt caverns respond immediately. FSRU only returns to ROI if required [REDACTED]
- For Full GB Outage [REDACTED] caverns can supply for approx. [REDACTED] days during winter peak demand. FSRU returns to ROI [REDACTED] and operates with the salt cavern.
- Salt caverns would be fully pressurised (full inventory) for winter season – rapid response to emergency network demand
- Salt caverns can be refilled during emergency at times when demand is less than supply

Hydrogen Ready:

- Salt caverns already used internationally to store hydrogen today
- Some equipment will need to be replaced for future hydrogen

Design Assumptions

- For N-1: 28" pipeline required
- For Full GB Outage: 36" pipeline required
- Modelling and design sensitivity work required for network pipe sizing.

Option 23:

Operational Assumptions

Standby:

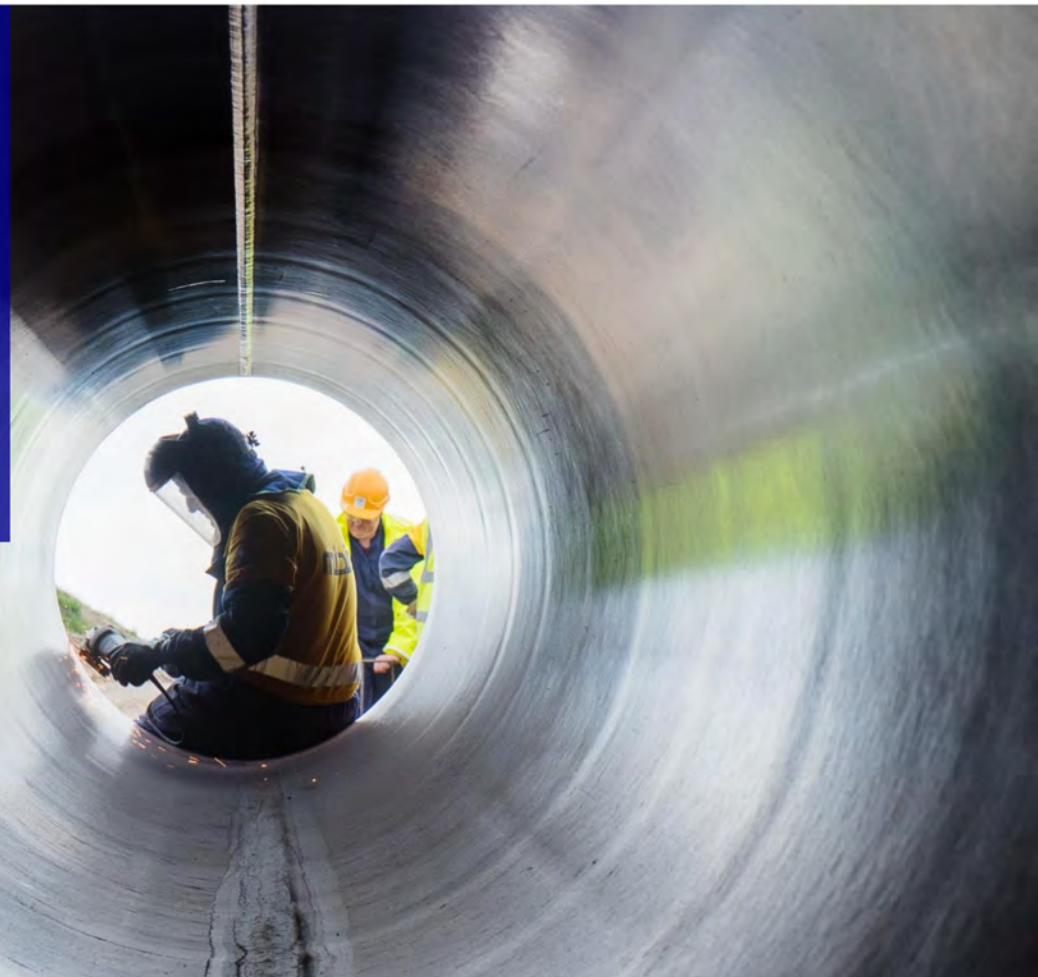
- Interconnector is live and pressurised
- Possibility to use with other interconnectors with a cap on gas imports to ROI
- Export compressors are shut down and tested on full-recycle every 3 months

Emergency:

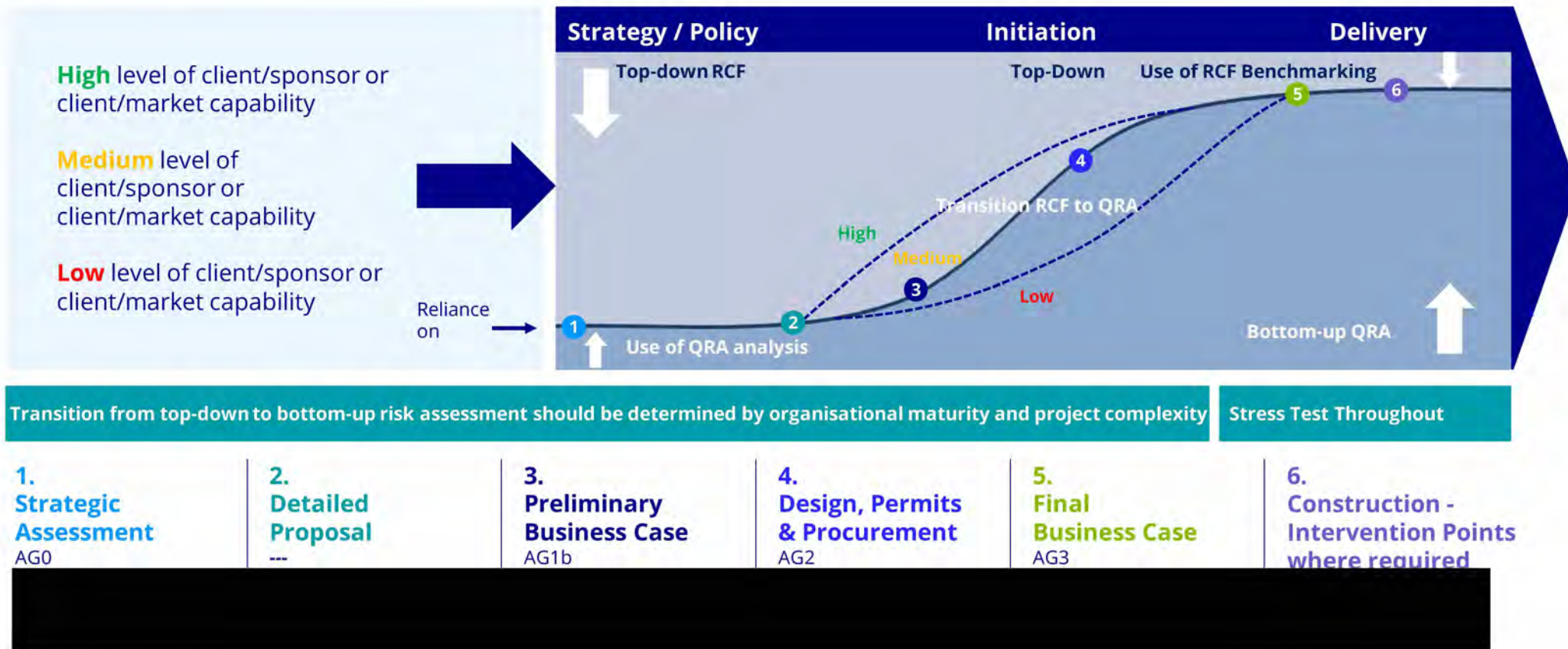
- Gas could be diverted within GB network to interconnector

Response: rapid response to outage

Appendix E3 Economical Appraisal



Evolution of Cost Estimation – RCF and QRA impact as design matures





High Level Analysis Cost RCF Results: Summary all options

RCF P-Value	
RCF P5	
RCF P10	
RCF P15	
RCF P20	
RCF P25	
RCF P30	
RCF P35	
RCF P40	
RCF P45	
RCF P50	
RCF P55	
RCF P60	
RCF P65	
RCF P70	
RCF P75	
RCF P80	
RCF P85	
RCF P90	
RCF P95	
Me	

- Options 1 & 2 have the lowest risk profile
- Option 20 is lower up to RCF 60 and then rises above 1 and 2
- Option 11 has the highest risk profile
- Option 16 is marginally lower than Option 11

High Level Analysis Schedule RCF Results: Summary all options

RCF P-Value	
RCF P5	
RCF P10	
RCF P15	
RCF P20	
RCF P25	
RCF P30	
RCF P35	
RCF P40	
RCF P45	
RCF P50	
RCF P55	
RCF P60	
RCF P65	
RCF P70	
RCF P75	
RCF P80	
RCF P85	
RCF P90	
RCF P95	
Me	

- Options 1, 2 and 20 have the lowest (and very similar) risk profiles
- Option 16 has the highest risk profile
- Option 11 is marginally lower than Option 16

2.3 Economic Appraisal – SoS benefit unserved gas demand N-1

Projections of unserved gas demand

- The avoided unserved gas demand, displayed below, is based on the expected commissioning dates and the scale of the infrastructure.
 - For the N-1 technology options we project that the leased FSRU is online earlier and therefore avoids more unserved demand. After 2031, both options are projected to only meet otherwise unserved demand for the 10-day period.
 - The benefits of the new build FSRU are therefore lower.

N-1 technology options avoided unserved demand

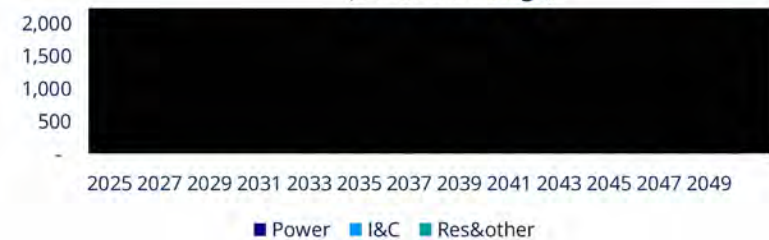
Lease FSRU

Avoided unserved gas demand by sector in GWh
(6-months outage)



Build FSRU

Avoided unserved gas demand by sector in GWh
(6-months outage)

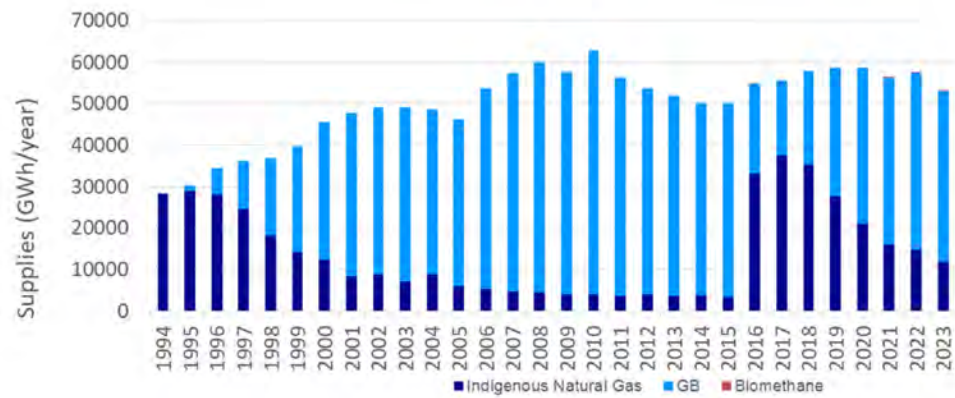


2.3 GNI Gas Demand Forecast



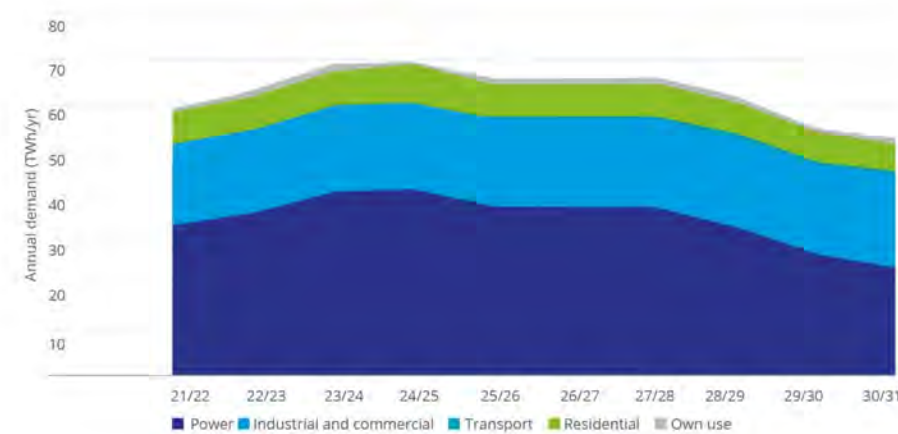
Historic Demand and Supply

In 2023, 22.4% of Ireland’s gas demand was met by indigenous sources, specifically from Corrib and biomethane.



Forecast Gas Demand in ROI – Best Estimate Scenario

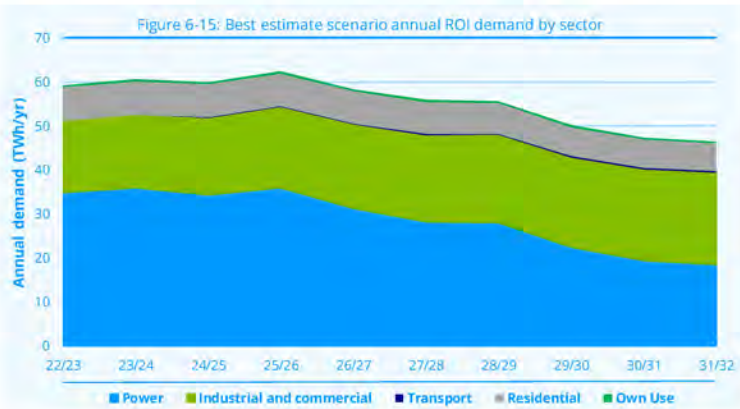
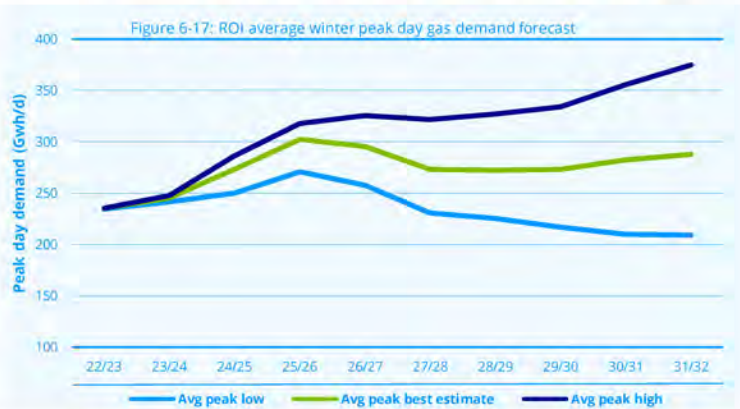
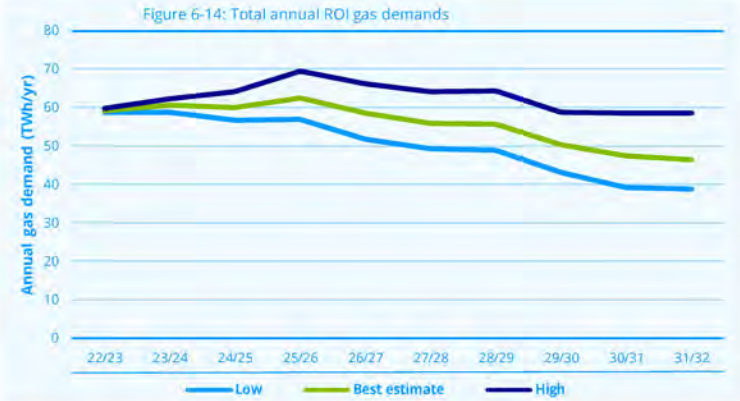
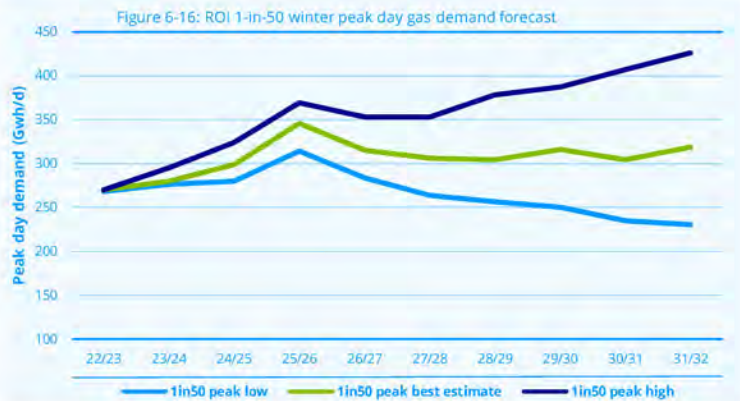
Based on these projections for demand and supply over a ten-year period, while annual demand is falling, peak demand is increasing in the near-term.



Source: CRU (2023), Consultation Paper on Transmission Development Plan 2023-2032. Available [here](#)

Source: GNI (2022), Gas Forecast Statement 2022. Available [here](#)

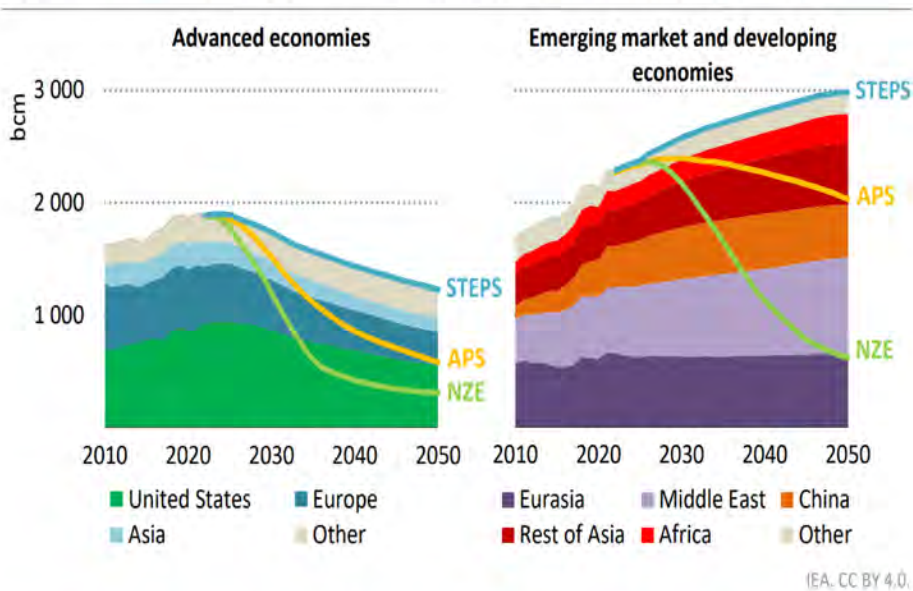
2.3 GNI Gas Demand Forecast 2023 NDP



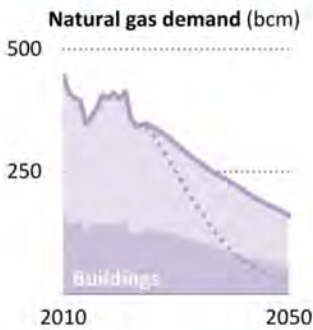
Source: GNI (2023), Gas Networks Development Plan [link](#)

2.3 IEA STEPS gas demand projections

Figure 3.24 ▶ Natural gas demand by region and scenario, 2010-2050



Natural gas demand declines in advanced economies in each scenario; in emerging market and developing economies the difference between scenario outcomes is larger



Natural Gas Demand (bcm)

	Historical			Stated Policies		Announced Pledges	
	2010	2021	2022	2030	2050	2030	2050
Europe	695	627	544	468	299	390	93
European Union	446	413	358	305	160	248	26

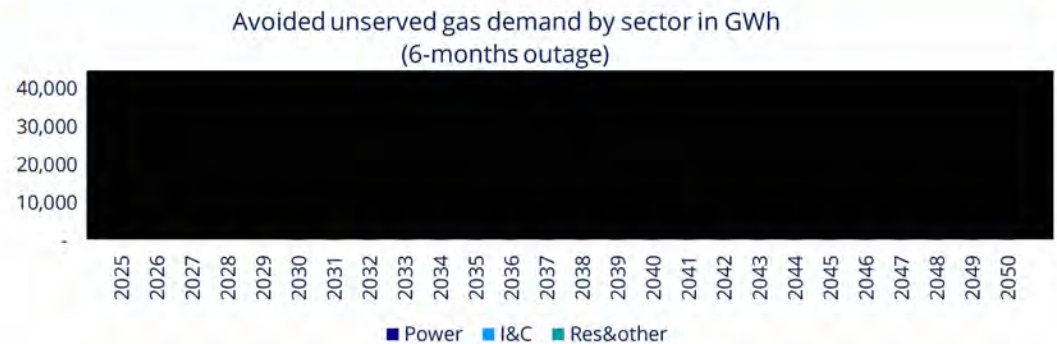
2.3 Economic Appraisal – SoS benefit unserved gas demand full GB outage

Projections of unserved gas demand

- The avoided unserved gas demand, displayed below, is based on the expected commissioning dates and the scale of the infrastructure.
 - The maximum throughput of the leased FSRU will not be sufficient to meet all unserved demand on peak days. We account for this shortfall and flexibility required by reducing the avoided unserved demand. The modelling does not allow us to provide a precise estimate. Therefore, we simply sum all shortfalls for the peak day, 10D, 30D and 90D assuming a flat demand profile. Further study of this will be undertaken during the next stage to test and verify this assumption.

N-1 technology options avoided unserved demand

FSRUs + Salt Cavern



Appendix E4 Miscellaneous



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Appendix E4: Project Acronyms (1/2)

Acronym	Description	Acronym	Description	Acronym	Description
ABP	An Bord Pleanála	DECC	Department of the Environment, Climate and Communications	FIDIC	International Federation of Consulting Engineers
ACER	Agency for the Cooperation of Energy Regulators	DG COMP	Directorate General for Competition	FSRU	Floating Storage and Regasification Unit
AGI	Above Ground Installation	DHLGH	Department of Housing, Local Government and Heritage	FTE	Full Time Equivalent
ALARP	As Low As Reasonably Practicable	DofE	Department of Energy (Northern Ireland)	GB	Great Britain
AMP	Asset Management Plan	Doff	Department of Finance (Northern Ireland)	GDP	Gross Domestic Product
ARC	Audit & Risk Committee	DPENDR	Department of Public Expenditure, NDP Delivery and Reform	GHG	Greenhouse Gas
BAT	Best Available Techniques	DPER	Department of Public Expenditure and Reform	HSA	Health and Safety Authority
BAU	Business as Usual	EAC	Expenditure Approvals Committee	HVO	Hydrogenated Vegetable Oil
BIM	Building Information Management	EC	European Commission	IAAP	Integrated Assurance and Approvals Plan
BIMCO	Baltic and International Maritime Council	EGIG	European Gas Pipeline Incident Group	IBP	Integrated Business Planning
BOG	Boil Off Gas	EIA	Environmental Impact Assessment	IC	Interconnector
CAP	Climate Action Plan	EIAR	Environmental Impact Assessment Report	ICChemE	Institution of Chemical Engineers
CAPEX	Capital Expenditure	EP	Equator Principles	IEA	International Energy Agency
CBA	Cost Benefit Analysis / Assessment	EPA	Environmental Protection Agency	IED	Industrial Emissions Directive
CBCA	Criteria Based Content Analysis	EPC	Engineer Procure Construct	IoM	Isle of Man
CEPA	Cambridge Economic Policy Associates	EPO	Emerging Preferred Option	IPA	Infrastructure and Projects Authority (UK)
CLO	Community Liaison Officer	EPRS	Emergency Pipeline Repair System	ISO	International Organisation for Standardisation
CoDG	Cost of Disruption of Gas	ESBN	ESB Networks	KPI	Key Performance Indicator
COMAH	Control of Major Accident Hazards	ESG	Environmental Social and Governance	LNG	Liquefied Natural Gas
CPO	Compulsory Purchase Order	ESG	Energy Security Group	LNGC	Liquefied Natural Gas Carrier
CRU	Commission for Regulation of Utilities	ESP	Engineering Services Provider	LSO	LNG System Operator
CSF	Critical Success Factors	FBC	Final Business Case	MAC	Maritime Area Consent
CSO	Central Statistics Office	FEED	Front End Engineering Design	MARA	Maritime Area Regulatory Authority
D&A	Depreciation & Amortisation	FFO	Funds From Operations	MSCM	Millions of Standard Cubic Metres
DAERA	Department of Agriculture, Environment and Rural Affairs	FID	Final Investment Decision	Msm	Mega Standard Cubic Metres
DB+OM	Design Build + Operate Maintain				

Appendix E4: Project Acronyms (2/2)

Acronym	Description	Acronym	Description	Acronym	Description
NDP	National Development Plan	RACI	Responsible Accountable Consulted Informed	TEG	Temporary Emergency Generation (Act)
NEC4	New Engineering Contract 4	RAG	Red, Amber, Green	TOC	Table of Contents
NGEM	Natural Gas Emergency Manager	RCF	Reference Class Forecasting	TPA	Third Party Access
NGEP	National Gas Emergency Plan	RED	Renewable Energy Directive (EU) 2023/2413	TPER	Total Primary Energy Requirement
NI	Northern Ireland	RES	Renewable Energy Source	TSO	Transmission System Operator
NPF	National Planning Framework	ROI	Republic of Ireland	UGS	Underground Gas Storage
NPV	Net Present Value	RPE	Real Price Effect	VfM	Value for Money
NPWS	National Parks and Wildlife Service	RTP	Route to Procurement	VoLL	Value of Lost Load
NSO	National Strategic Objective	S&P	Standard & Poor's	WACC	Weighted Average Cost of Capital
O&M	Operation & Maintenance	SBC	Strategic Business Case		
OJEU	The Official Journal of the European Union	SCRT	SCR + CRT (Selective Catalytic Reduction + Continuous Regenerating Technology)		
OOM	Order Of Magnitude	SDG	Sustainable Development Goal		
OPEX	Operating Expenditure	SEM	Single Electricity Market		
PDA	Planning and Development Act 2000 (as amended)	SGER	Strategic Gas Emergency Reserve		
PID	Piping Instrumentation Diagram	SGER	Strategic Gas Emergency Reserve Project		
PLT	Project Leadership Team	SGR	Sustainable Growth Rate		
PMO	Project Management Office	SID	Strategic Infrastructure Development		
PP JV	Public-Private Joint Venture	SME	Small and Medium-sized Enterprises		
PPP	Public-Private Partnership	SNIP	Scotland-Northern Ireland Pipeline		
PRAM	Project Risk Analysis and Management	SNP	South North Pipeline		
PSO	Public Service Obligation	SoLR	Supplier of Last Resort		
QA	Quality Assurance	SoS	Security of Supply		
QRA	Quantitative Risk Assessment	SRO	Senior Responsible Owner		
QSRA	Quantitative Schedule Risk Analysis	SWOT	Strengths, Weaknesses, Opportunities, Threats		
RAB	Regulated Asset Base	TBC	To Be Completed		