RESPONSE TO IRISH GOVERNMENT CONSULTATION "REVIEW OF THE SECURITY OF ENERGY SUPPLY OF IRELAND'S ELECTRICITY AND NATURAL GAS SYSTEMS"

27th October 2022

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Introduction

Net Zero Energy (NZE) is a recently formed renewables and storage company operating in Ireland. The team consists of energy industry professionals who have a proven track record in building successful renewable energy companies and delivering some of the most complex renewable energy and storage projects in Ireland over the past 2 decades. We are now focussed on high-impact projects that will enable Ireland to meet not only it's 80% RES-E target for 2030 but will also accelerate the country towards a net zero energy system in advance of our current 2050 target (as set out in the National Development Plan 2021-2030).

In our view, Ireland has a surplus of offshore wind, onshore wind and solar energy which can be paired with long duration storage technologies, flexible demand and interconnection to create a 100% zero carbon electricity system. While the official target for 2030 is 80% renewables, we see the 100% milestone coming only a few years later. Therefore while we recognise the urgency here in 2022 in the face of an international gas security of supply crisis, it is the unfortunate reality that most new power system infrastructure cannot be built quickly, but once it is built, it lasts for decades. It is our view that the correct backdrop against which to choose the most appropriate security of supply solutions must be this 100% renewables system with large volumes of interconnection and long duration storage, with heating and transport almost completely electrified. Fossil gas consumption and network utilisation will be falling throughout the 2020s, and should be zero in the early to mid-2030s. It is not at all clear that hydrogen will keep the gas network alive. Biomethane may be produced at scale, but certainly never close to the current consumption levels. Recognising the level of uncertainty, we feel that when selecting the most appropriate energy security of supply solutions,

(a) For the electricity system Ireland should focussed on strategic, long-life solutions that fit well with a fully decarbonised and electrified energy system, and
(b) For the gas system, Ireland should be focussed on temporary, low cost, leased solutions that can be quickly unwound.

Sizing electricity storage for a 100% renewables system comes down to the shape of demand, renewables, interconnection and the characteristics of the store itself, such as round-trip efficiency. Net Zero has built a simple Excel model looking at the hourly match between wind, solar and demand over the last 40 years. We modelled 7320MW of demand in 2030, 12,500MW of wind, 5,500MW of solar and enough MW of long duration storage to meet demand as long as there was energy in the store. The model yielded some interesting conclusions:

- Adding substantial solar to the mix reduces the need to move large volumes of energy from summer/winter. (Similar studies e.g. of the Belgian grid found the same result).
- It will always be more economic to discard some surplus wind and solar than to try to build a store large enough (in MW and MWh terms) to take it, but this surplus is not significant, perhaps 5%.
- A very large store of over 2000hrs would be required to ensure there is always enough energy to serve the demand for every hour of the 40 year period. Such a store is unlikely to be economic.
- There are difficult years such as 2010, and difficult groups of years where a series of fairly low wind cause the store to empty completely.
- However a much smaller store of around 300hrs would be sufficient to meet demand most years, and meet 98% of demand over the 40 year period. The other 2% is essentially the subject of the Security of Supply Consultation.

- Some simple operational rules such as "Refill your store to 80% every October" would mitigate the need for a large store, but would require a third source of energy such as importing over interconnectors or being prepared to burn fossil fuel reserves.
- Some long duration storage technology has a very low incremental cost for an hour of storage with a low round trip efficiency, making them very suitable for occasional use required for security of supply applications.

It is clear that security of supply in a high renewables system with very long duration storage is an integral factor in the system optimisation, and not something that can be "bolted onto" the electricity system.

Detailed response to consultation questions

Risks

1. *Are there any other security of supply risks that you can identify in addition to those set out in section 6?*

We agree with the risks identified but would recommend the consideration of a further sensitivity in relation to Shock scenarios 1,2 and 3 described. The basis for the choice of a 2-week period of Dunkelflaute conditions (i.e. low wind combined with low temperatures) is not clear. It is an oddly round number. A recent study[1] on Dunkelflaute events in North-western Europe does find that the typical event lasts less than 150 hours or about 6 days, but the concern should be with extreme events, not average or typical. We would recommend reviewing the 40 year wind and temperature data set to determine if two weeks was the worst case.

Furthermore when assessing a mitigation for Dunkelflaute on a high renewables system which is relying on long duration storage, or on energy security of supply mitigations that are energy limited such as secondary fuels, it is important to note that several Dunkelflaute events can occur over a given winter season (as described in more detail in the paper referenced) in quick succession. That means that storage used to mitigate the impact of these events may not have the opportunity to refill between events and so sizing the storage facility should be modelled over a long period of time (c40 years). The year 2010 for example saw wind capacity factors around 24%, compared to 32% long run average. Only 3 years in the last 40 have seen capacity factors in the range of 28-30%, so 2010 is a real outlier. Any solutions should be explicitly tested against 2010, or ideally the full 40 year time series.

2. *If there are other risks that you have identified, could you outline some mitigation options to address the risk(s)?*

Should the analysis of extreme years such as 2010, or series of Dunkelflaute events in one season prove to be more arduous than the 2 week scenario evaluated, then the mitigation measures are probably unchanged, it is simply a case of requiring a larger volume of them.

It is not clear whether or not the interconnectors are importing to Ireland in Scenario 1, presumably they were or there would not have been any point in running Scenario 2b (an outage on EWIC). We do also have some concern that this scenario does not represent the worst that can happen with

[1] https://www.researchgate.net/publication/355173603_A_Brief_Climatology_of_Dunkelflaute_Events_over_and_Surrounding_the_North_and_Baltic_Sea_Areas

interconnection. There are scenarios where all three GB interconnectors are unable to import energy to Ireland, not least if the same Dunkelflaute event was to straddle GB and Ireland at the same time. Or GB may have generation shortages flowing from gas shortages, and are simply unable to flow power to Ireland. Or a political event could cause a Brexit style breach of treaties, preventing all flows on interconnectors. While hopefully very unlikely, the principle of "unknown unknowns" would seem to indicate we should not be over-reliant on any one jurisdiction, and the loss of all three GB interconnectors should be modelled explicitly.

3. *Are the five shock scenarios that were considered, and the additional scenarios related to the Russian invasion of Ukraine, sufficiently broad?*

Yes we think so. Our only comment is that we would question the need to assess level of carbon emissions in the shock scenarios. If these are really rare events, the carbon emissions should not be a major factor in assessing the possible mitigations.

Mitigation Options

4. Do you have any additional mitigation options that you think should be considered?

[redacted]

If hydrogen could be blended with the natural gas network, then it is a mitigation both for a natural gas supply risk and an electricity supply risk. However we would have serious concerns that it is going to be possible to convert the gas network and all customers appliances to be able to run on hydrogen (either a blend or 100%), and in particular before 2030. For blending at less than 100%, the store needs to be located at a high flow point on the gas network, not a tail, as would be required for Corrib or Kinsale.

Notwithstanding the fact that blending is in our view fraught with difficulties, if the geology was suitable, it may be possible to locate a hydrogen store near to existing power plant clusters (e.g. Kinsale and the Cork harbour CCGT plant) or build new power plant directly connected to the hydrogen store, so that they can run on either gas or hydrogen, without the need to impose a hydrogen blend on all network users.

[redacted]

5. *Which gas supply mitigation options, if any, should be considered for implementation?*

As set out in our introduction, we believe that temporary or leased solutions are preferable, given the very large uncertainty over the future of fossil gas in a decarbonised world, so our preference would be for a strategic FSRU. This option is expensive if it is not being used "commercially", but the alternatives are even more so.

There will be a lot of focus on Kinsale, since it has already proven its capability as a store. If it was to be retained as fossil gas storage in the long run, this would be prohibitively expensive. The argument will no doubt be made that it could be transitioned to hydrogen storage in due course, thus mitigating the high up-front cost. However the physics of hydrogen are unhelpful, in that the density of hydrogen at reservoir temperatures and pressures is around 9x lower than for methane. Against that, the energy density of hydrogen is about 3x higher. This means that overall, Kinsale will likely store around 3x less energy if used for hydrogen compared to methane. Based on the 2.5TWh figure quoted by CEPA p.89, that implies less than 1TWh of hydrogen storage. This is not trivial, but is certainly nowhere near the total of 5TWh of "commercial" hydrogen storage our model estimates is required for Ireland in a 2030 fully decarbonised power system using hydrogen as the main long duration storage and so other solutions will be required in addition to Kinsale[2].

Furthermore there are a list of significant [redacted] risks in depleted gas fields:

- Hydrogen stored in a reservoir such as Kinsale may over time seep into remote parts of the reservoir and not be recoverable.

- A large volume of cushion gas (either methane, hydrogen or nitrogen) will be required to create a working pressure range to deliver adequate flows

- Biological and geochemical reactions may consume the hydrogen or block the pores in the reservoir.

- The original Kinsale field storage was proven for around 100 days charging and 100 days discharging. For an emergency backup aimed at covering a 14-day period, a period of 100 days is much too long, i.e. the volume is unnecessarily large in relation to the peak flow rate. Or in the alternate, based on the mitigation study results shown by CEPA, the flow rate is too small to cover an emergency shortage seen in Shock Scenario 5. The main technique used to increase the flow rate of a reservoir is fracking, but is that ever going to be acceptable in Ireland?

- Even if it were possible to expand Kinsale to a higher flow rate or volume for the purposes of power generation, then the onshore electrical grid infrastructure would become the limiting factor.

All of the concerns above will require significant reservoir engineering modelling to resolve. In summary, depleted gas fields are the most proven and cost-effective geological storage, but their locations are limited (Corrib and Kinsale). Ireland should almost definitely develop these depleted gas fields for hydrogen storage (and perhaps methane for an intervening period for security of supply reasons), but we will require additional storage if we want to run a fully decarbonised power system and also maintain a strategic store for security of supply.

Finally we note the proposal for a "Onshore Slow Liquefaction Scheme". As above, we would have concerns that such a permanent facility presumably with a design life of 40 years or more, runs a very high risk of being stranded in a zero-carbon world. Box 17 notes that "GNI has suggested the facility could be made hydrogen ready". This is a bold statement, in both senses of the word. Hydrogen liquefies at a much lower temperature than LNG, requiring completely different tank materials and much more significant insulation. A tank optimised for LNG could not be upgraded for hydrogen, it would need to be discarded. A tank suitable for hydrogen could hold natural gas, but

[2] We understand Corrib to be around 70% the size of Kinsale, but we don't have precise figures on flow rates, volumes and pressures, but the argument for requiring additional solutions remains.

would cost vastly more. The compressors and heat exchangers and liquefaction trains must be designed and tuned to one gas or the other and so are completely incompatible. The boil-off gas from hydrogen is much higher, and results in the store being forced to either re-liquefy or sell the gas at times the market does not require it. But most of all, the liquefaction of hydrogen requires 30% of the embodied energy, and this cannot easily be recovered as the hydrogen is regasified, in fact more energy is required for this process[3]. The concept of using above ground hydrogen storage is simply a non-runner in our view.

6. Which electricity supply mitigation options, if any, should be considered for implementation?

Below, we will comment on each of the mitigation options in turn:

Additional electricity interconnection

This may well be beneficial to the Irish system in the baseline scenario and, if so, will have welcome security of supply benefits. However interconnectors are not guaranteed to generate positive net societal benefit for Ireland, as they influence pricing. There is a complex interaction with renewables supports, which ultimately flow to the consumer via the PSO levy, and this is further complicated by uncertainty around Article 13 which governs the treatment of constraint and curtailment. Any techno-economic comparison would require a full market model study, and is very dependent on future assumptions around the development of the grid and renewables penetrations in the connecting jurisdiction. There is a diminishing economic value in interconnection, as each new project reduces the utilisation of existing interconnectors. But there is also a limit to the extent to which interconnectors to a single jurisdiction (e.g. GB or France) can be relied upon. We are not aware of any detailed study for Ireland to determine this “safe level”. It does feel as if any level over 2GW to either France or GB would be a bit risky, and would require matching additional plant and storage within Ireland to cover off the risk of a weather, political, regulatory, market, technical or legal risk that prevented Ireland relying on flows. OFGEM did complete one for GB before embarking on its current policy of increasing interconnection. In summary, interconnection is one of the best mitigation, but we recommend Ireland complete some analysis to set an upper limit and communicate that to the market.

Additional pumped storage

We do not agree with pursuing this option. The CEPA report itself illustrates the reason not to pursue further PHP in Ireland- it costs more than twice what the equivalent 6-hour lithium-ion battery storage would cost. It is a large, blocky infrastructure investment with complex permitting and risky timelines associated. The same products (energy arbitrage, capacity, ancillary services) can be delivered faster, cheaper and at lower risk by lithium-ion storage. These batteries can be distributed throughout the grid and thus meet other grid needs such as reactive power, with increased reliability given the distributed nature of the response. Furthermore we are not clear how this storage will be operated. If it is left to the vagaries of the market, is there not a risk it will not operate as required to mitigate the security of supply risk? If additional rules or constraints are applied to it, then does it not become partly a “strategic” rather than commercial asset, and is it then economically viable?

Biomass plant

[3] https://www.energy.gov/eere/fuelcells/liquid-hydrogen-delivery

We support this on the condition that the biomass can be sustainably sourced.

Secondary Fuel

We note this mitigation is relied on heavily in the shock scenarios modelled (even at the existing storage requirement). We also note the significant portion of units which are deemed unreliable in being able to actually operate on secondary fuel per the grid code requirements. While we agree that increasing the store of secondary fuel at plant is a valuable mitigation, it will only be as effective as the testing regime put in place to test the plant's ability to operate on secondary fuel. Therefore, we recommend a new testing regime is put in place to ensure compliance to this requirement with regular re-testing, and clear penalties. Emissions limits are not hard limits preventing operation on secondary fuel, they are an economic choice not to install Selective Catalytic Reduction equipment. The requirement to run on secondary fuel has been part of the generation licence since the deregulation of the market, it should come as a surprise to nobody. Over last two decades years we have built a series of wind farms all of which met the terms of the grid code and the generation licence. Frankly we are amazed that given the clear and present risk to gas supplies, there is any leniency whatsoever being shown towards fossil plant that are not able to prove that they can run on secondary fuel.

Overall however this option does seem to offer the best economic characteristics, since it is relatively cheap to construct, relying on existing power plant for the generation, and just adding to their flexibility. The stored fuel could be fossil, or if it was required to be zero carbon, there are options such as HVO that are zero carbon. Given it would likely only be called very rarely, we are not convinced there is a need for the fuel to be zero carbon. It may even be more cost effective to build additional liquid storage at existing power stations than to build additional hours of [redacted]. A full techno-economic comparison would reveal the optimum mix.

Hydrogen Plant conversion

As set out above, we have significant level of concern over whether it will be possible to convert all the gas network and all consumers to run on blends of hydrogen up to 100%.

We do however believe individual hydrogen clusters may be feasible, and these will be driven by availability of suitable geological hydrogen storage.

Much of the cost of producing hydrogen is the capital cost of the electrolyser, and so it is not necessarily optimum to place a restriction that they can only operate on "curtailed" wind. But in general, we would expect that an electrolyser would operate in any zero or negative priced hours, as well as some low-priced hours. Thus the 4TWh of electrical energy quoted might be more efficiently consumed with 1.4GW of electrolysers rather than the 2.8GW quoted. This could also be much more easily accommodated on the grid. Currently there is a shortage of capacity to accommodate generation on the power system, but as industry and homes electrify, a deficit in capacity to serve demand is likely to arise, so we should use demand sparingly and efficiently as possible.

Electrical Package

We very much support the exploitation of DSR and battery technology to improve security of supply. We note that it is not all that effective in mitigating Supply Shock 5 in 2025, but storage and flexibility bring clear benefits to consumers in reducing the cost of integrating variable renewables. It is our view that they are required and will be built regardless of any security of supply need, and if they can kill two birds with the one stone, so much the better.

However, our concern is that the volumes of additional 6-hour batteries which the CEPA report forecasts in 2025 and 2030 (335MW and 180MW respectively) is currently at high risk of not materialising due to the lack of a market framework to support the investment in long duration storage (LDS). The current market and network charging structures in Ireland were not designed with storage in mind, and they do not allow storage owners to capture the benefits their plant create. Other jurisdictions such as Australia have circumvented market and regulatory barriers by simply running long duration storage procurements, and we believe this is appropriate for Ireland as well.

7. *What measures should be considered on the demand side to support security of supply of electricity and gas?*

The design of network tariffs can have as much of an effect on consumers as wholesale costs, both at residential and commercial level. Consumers should be encouraged to move to time-of-day energy and network tariffs, and then they are more likely to make investments into home automation, energy efficiency and other demand side measures that will minimise their bills. Any resulting reduction in demand and increase in the responsiveness of demand will improve the robustness of the system in a security of supply shock situation.

Policy Measures

8. Do you support the policy measures proposed in section 8 of the consultation paper?

Overall we support the proposed Tools and Measures proposed in Section 8. The joint planning between GNI and EirGrid is a clearly necessary, although if blending is not found to be practical, and hydrogen is not used in heating (as should be the case), the level of interaction between the networks may not be as great as expected.

While not specifically called out in the policy section of the consultation, almost all the mitigation options are dependent on the proper functioning of the Irish planning system. Unfortunately that is not currently the case. This brings a risk that solutions are chosen which are easier or quicker to permit, rather than optimum for the system or consumers. The solution is for An Bord Pleanala to be staffed to a level that they can make planning decisions within their 18 week guideline, or better still the 8 week period that local authorities can already achieve. This would in turn eliminate most judicial reviews, as it would then be quicker and cheaper to cure a JR in the planning system than through the courts. Naturally this is at the heart of the current capacity market difficulties.

Given the potentially central role that [redacted] and gas can play in Ireland decarbonisation and security of supply, it is vital that the development process is clear and functioning smoothly. As set out in detail in our response to the [redacted], [redacted]. The CRU should also review its generation licences and authorisations to construct, [redacted] to ensure they are up to date and fit for purpose [redacted]. Similarly the EPA would need to prepare its policy documents and set out the required standards for such facilities. [redacted], and so a review of planning guidelines and processes in this area would also be prudent. If a Strategic

Environmental Assessment is required, it would be important to find a way that development can proceed in parallel with this.

10. What further tools and measures do you think would contribute the most to Ireland's energy security of supply?

It does appear that two recent important energy policies (geothermal and offshore wind) will have taken around 15 years from the first decision to proceed to the first project becoming operational. If, as appears to be the case, the security of supply situation and decarbonisation need is more urgent than that, then it will be necessary to revise the policymaking procedure.

We have no further proposals other than set out above.

- End -