ESB Generation and Trading’s Response to the Consultation on the Offshore Renewable Energy (ORE) Future Framework Policy Statement

23/02/2024

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Section 1: Draft Response Overview – Executive Summary:

ESB Generation and Trading (GT) welcome DECC's recently published 'Future Framework' and note that it is intended to be the long-term model and vision for offshore renewable energy in Ireland. It sets out the pathway Ireland will take to deliver 20GW of offshore wind by 2040 and at least 37GW in total by 2050. Our understanding is that this is the Framework that will co-ordinate the delivery of future policy which will be subject to further consultation in time. Key to delivering this will be the development of designated maritime area plans (DMAPs) which will provide for a clear pipeline of projects to deliver our 2040 and 2050 ambitions. Our proposal on how this should be done is set out below.

Given the limited time afforded to comment on this document and supporting analysis, we have focussed our response on several key themes which are outlined in this executive summary.

Integrated Energy System: ESB GT believe that an integrated systems approach is needed to understand the energy system as a whole, taking into account the interactions between different sectors rather than just focusing on individual sectors such as the power system. ESB GT highlight the need for a single overall masterplan for the transition to net zero by 2050 of the Irish energy sector (electricity, residential, industry and transport).

This approach can provide a comprehensive understanding of the infrastructure required for a secure, stable, and resilient net zero energy system by 2050, with interim targets for 2030 and 2040. Each infrastructure sector requires a policy framework that fosters its development and aligns with other decarbonisation initiatives, including public engagement and behaviour change. Significant work has been undertaken to inform the Future Framework through the development of economic and technology roadmap models by BVG, AFRY and SEAI. An opportunity to discuss these models and the assumptions in more detail with Industry would be valuable to get further clarity and ensure robustness. For instance, we have observed that the AFRY/BVG and SEAI/BVG models present different base case scenarios for offshore deployment by 2050, 16GW versus 9.6GW respectively. However, the rationale behind these divergent scenarios is unclear. ESB has developed similar models to explore net zero options for 2040 and we believe a comparative review of the assumptions made in both ESB and AFRY/BVG models would be beneficial. Specifically, assumptions around volumes of energy from dispatchable generation, the consideration of multiple years of weather data for Ireland and proposed interconnected systems, and the modelling of system-wide and local network constraints should be examined.

ESB GT acknowledge the important role interconnection has to play in efficient trading and the movement of bulk volumes of renewables between markets to optimise the supply-demand balance. However, total system cost is a key consideration, and this could be reduced by reducing the proposed scale of interconnection and increasing the load factor of thermal generation capacity. The scale of interconnection modelled has a negative correlation to the energy from indigenous dispatchable generation and related zero carbon fuel (such as hydrogen) required to ensure the security and resilience of the energy system. Interconnection has limited capability in contributing to security of supply when renewables output is low across northwest Europe as observed in Q3 2021. The scale of interconnection proposed in the Future Framework study, needs to be rigorously examined to explore the impact it has on efficient energy trading and its effectiveness in managing excess renewable energy and ensuring a secure energy supply, compared to other options like locally produced renewable hydrogen. The analysis should be based on weather data spanning several decades from Ireland, Great Britain, and Northwest Europe, rather than a "typical year".

Governance Structure: The governance structure which will manage the delivery of the 21 actions outlined in the Future Framework Policy Statement should be clarified. If Ireland wishes to develop a pathway to deliver 20GW of offshore infrastructure within the next 16 years, it is essential that policy is underpinned by the knowledge and

[1] https://techxplore.com/news/2021-10-europe-exceptionally-future-energy-grid.html
https://www.icis.com/explore/resources/news/2021/09/09/10683078/icis-briefing-the-causes-of-surgingeuropean-power-prices-and-a-short-term-outlook/

expertise to deliver at this scale. Therefore, industry needs to be at the table now to support policy evolution under the Future Framework. ESB GT welcome the new model proposed for engagement on Future Framework where industry and government work together in delivering these actions. We would recommend that industry representatives with experience of delivering projects of the scale required to meet 2040 targets should be included in the membership of relevant working groups.

Policy Coherency and Focus: Clarity is needed on how Future Framework will integrate with other key government policies. The Future Framework indicates ambition to deliver 20GW by 2040 and 37GW by 2050, although it lacks explicit guidance for the development of spatial plans which can ensure targets are realised. Given that 5GW of the total ambition is under Phase 1 and 2 policies, it will be important to understand how Future Framework policies will interact with activities ongoing under earlier phases and ensure that emerging policy will not undermine delivery of this initial 5GW. It will also be important to clarify how the Future Framework will interact with other key policy areas such as the Climate Action Plan; Hydrogen Strategy; Industrial Strategy; Offshore Transmission Strategy and how relevant actions from these policies will be integrated over time.

The intention of the Future Framework is to co-ordinate policies for 'components of the offshore renewable energy system' which are identified as Technology, Grid, Storage, Interconnection, Renewable Hydrogen and Ports. While we recognise that Future Framework should influence policy across this space, it needs to clearly outline policies which it will be directly responsible for and those it will influence but will not drive.

Focussed delivery: A significant challenge in the Future Framework document is that it does not clearly focus on the areas of policy for which it will be directly responsible, and we believe this clarity will be key to ensure successful delivery. We suggest that the focus for actions should be on policy development relevant to:

1. Marine spatial planning (DMAPs) for ORE
2. Competitive auction design (ORESS or MAC)
3. ORE technology
4. Grid developments required to support rollout of ORE
5. Route to market and demand

While the proposed consultation covers various aspects related to the above points (and more), ESB GT recommend the following complimentary actions.

1. **Marine spatial planning (DMAPs) for Offshore Renewable Energy:** The primary focus, and number 1 action of the future framework, must be the delivery of a clear plan-led system in 2024. Action 5 does propose to *'provide the structures and supports necessary to establish a DMAP roadmap'*, however, it is not clear what is meant by this. In the absence of a revised Offshore Renewable Energy Development Plan (OREDPII) / National Spatial Strategy for Offshore Renewable Energy (NSSORE), we propose that a 'Strategy for DMAP Proposal Areas' is outlined by Q3 2024 at the latest, which will:
   - Identify the proposed Designated Maritime Area Plan (DMAP) areas, ensuring these are sufficiently sized to meet 2040 targets, with an allowance for attrition and sufficient scope to accommodate project level decisions on site suitability.
   - Base the selection of DMAPs on the work already done under OREDPII and data collected under data procurement rounds.
   - Position DMAPs in locations which have access to sufficient grid and/or opportunities for alternative route to markets and to significant energy demand and/or can accommodate industrial development to create this demand, (e.g., Cork Harbour on the south coast and Shannon Estuary on the west coast).
   - Be aligned with Marine Area Planning (MAP) Act, Department of Housing, Local Government and Heritage (DHLGH) guidelines and Renewable Energy Directive (RED III) with respect to renewable accelerated areas (RAA) to enable agile and responsive public policy in support of deployment of large-scale renewables.
   - Propose mechanisms for selecting and awarding project site control within the DMAPs. Ideally a number of project areas within each DMAP should be identified. These may be grid connected or be eligible for non-grid auctions. Sites identified may be technology agnostic but should have known depth profiles.

Identifying project areas will improve pipeline visibility and give more transparency to industry and other stakeholders as to future site locations. It will allow a more robust Strategic Environmental Assessment (SEA) process which could account for the cumulative impacts of the overall project areas.

2. **Competitive auction design (ORESS or MAC):** We welcome the intention to progress an application to the EU for Offshore Renewable Electricity Support Scheme (ORESS) supports post 2026 as outlined in Action 9. We recommend introducing non-price criteria that will reward sustainability, innovation, and support for local supply chains within this new mechanism. We believe it will be important for projects to demonstrate the value add to Irish Society, via supporting local supply chain or enhancing biodiversity.

   With respect to Action 8 and the design of a competition for non-grid limited capacity in 2025, we recommend that Marine Area Consents (MACs) form the basis of this. The initial auctions could be considered for sites in the current south coast DMAP. Criteria for MAC competitions should be developed in consultation with industry but should take account of requirements to meet tests for fit and proper person, financial viability, and technical capability. Additional criteria should be considered to reward sustainability, innovation, support for local supply chain and partnerships with large demand energy users. Consideration will be required to ensure that the wider regulatory framework in the electricity sector supports the deployment of non-grid limited Offshore Renewable Energy (ORE) capacity, such as generation licensing. ORE capacity developed through corporate PPA structures will face significant counterparty risks, ESB believes that options to support the management of this risk should be explored, such as tools like aggregation and pooling mechanisms or guarantees underwritten or provided by a public body.

3. **Technology Development (Floating Wind):** We support the Action 1 and 2 in the Future Framework to consider a site specifically for floating wind. We propose that:

   - The capacity considered for the site be in the order of 400MW, anything less than this will not attract attention from the market, particularly for delivery in the early-mid 2030s.
   - The site can be included in a technology agnostic DMAP on the west coast and for future south Coast DMAPS with suitable depths (circa 100m).
   - In order to move the sector forward in Ireland, and to meet the ambition set out in the SEAI technology roadmap, sufficient pipeline visibility will be required, so this initial site should be followed by other sites identified.

   With respect to the intention to consider an auction framework for floating wind, it will be important to capture the parameters proposed for this in the negotiations with the EU on future ORESS, to define a new auction regime for rollout post 2026. Further engagement with industry on anticipated Levelized Costs of Energy (LCOE) would be advisable.

4. **Grid developments required to support ORE:**
   The Future Framework will have a part to play in influencing the future electricity and energy system evolution, but it will not be the only driver. In order to understand how best to ensure a sustainable and secure integrated energy system, ESB GT propose an integrated energy system modelling approach going forward rather than an ‘electricity system’ only modelling when assessing the scale of grid development required to deliver a net-zero energy system by 2050.

   ESB GT believe that a proactive and comprehensive approach to grid development is essential, with a focus on large-scale reinforcements to achieve net zero. Given that history has shown that such reinforcements can take decades to implement, ESB GT believe that they should be prioritized now. ESB GT strongly advocate for the development of the grid to facilitate the decarbonization of not only the electricity sector, but the entire Irish economy. By building grid infrastructure in anticipation of new renewable and thermal assets, developers can deliver the generation assets necessary to decarbonize Ireland’s electricity sector and, in turn, all energy sectors. ESB GT suggest that the current approach to planning, which primarily focuses on traditional electricity demand scenarios, should be replaced by considering the full electrification of transport and the production of hydrogen for a zero-carbon economy in all sectors.

The key will be to accelerate simultaneous development of the electricity network for onshore and offshore opportunities, and back-up net-zero dispatchable generation that will ensure security of supply. This holistic and co-optimised assessment of the offshore and onshore grid together will support the safe and efficient connection of offshore generation whilst ensuring consumer value by reducing the levels of constraint/curtailment.

Implementing an approach of anticipatory onshore and offshore grid investment is necessary to provide signals for future investment in areas with the greatest generation capacity and to ensure that the network is an enabler and not a blocker to decarbonisation. The future proofing of grid infrastructure to enable phased development of renewables and renewables-enabling technologies (such as Long Duration Energy Storage (LDES), Low Carbon Inertia Services (LCIS), and back-up Net Zero dispatchable generation) through anticipatory investment is critical to ORE delivery.

Alongside the anticipatory investment, improved usage of existing grid infrastructure is needed. For example, the use of innovative technologies for constraint management including harnessing the flexibility of demand associated with utility-scale electrolysis to produce green hydrogen and system services to assist with load balancing, provide system support and enable the full delivery of offshore wind generation in Ireland at the greatest benefit to consumers.

There is a need for Future Framework to influence grid and energy policy on areas such as interconnectors, private wires, and hybrid connections. ESB GT strongly support the concept of hybrid connections with dynamic sharing of Maximum Export Capacity (MEC) and private wires, as they will reduce delays in new connections, enable better use of existing infrastructure and enable market led decisions which have the potential to support the most economic and efficient means to meet net zero and offshore wind ambitions.

We note that the study does not include modelling of system-wide constraints and local network constraints. These constraints if not addressed through Transmission & Distribution system investment and reinforcement will have a significant impact on the path to Net-Zero and the ambition of achieving 37GW of ORE by 2050. Turn-down of RES is already an issue in Single Electricity Market (SEM) and will become a major issue as more and more renewables connect to the system without corresponding investment in the network. This will have the potential to significantly affect and undermine key assumptions in the study and limit the ambition of achieving 37GW ORE by 2050 and net-zero by 2050. Our own modelling shows system curtailments alone (if not alleviated fast enough), could more than double dispatch-down volumes of RES.

It would be useful to get more clarity on Action 11 and 12 in the Future Framework to understand the steps that will be progressed to deliver them.

5. **Route to Market:** ORE projects will require significant demand in order to be viable. Options to develop this demand and route to market will be essential and we welcome the efforts by the Department of Enterprise, Trade and Employment (DETE) to explore domestic demand and supply chain considerations as part of the development of the National Industrial Strategy for Offshore Wind. We also welcome indications that future policy development is expected to include a consideration of the co-location of industrial demand for renewable energy with development of large offshore wind projects.

   This aligns well with ESB's concept of 'Energy Hubs' which will be regional clean energy clusters that leverage offshore wind energy to provide zero-carbon energy products and services. The hubs will attract green industrial investment, promote emerging technologies, and create a hydrogen market in Ireland and beyond, by delivering large scale affordable storage and carbon-free electricity generation. The hub is paramount to support the delivery of ESB's goal of a net-zero electricity system by 2040 and Ireland's net-zero energy system by 2050.

However as noted above, the Future Framework is not clear on how this document will interact with other policy areas, e.g., in this case the National Industrial Strategy and how the actions from it will be taken forward; will it be under the Future Framework work stream or another? Clarity on this will be essential in the next iteration of this document.

We have provided responses to the questions which align with the views expressed in the Executive Summary above:

Section 2: Consultation Questions

1(a). Has this section adequately identified the general key priorities for ORE delivery in Ireland? Are there additional priorities that should be integrated into the holistic, plan-led approach?

We welcome the intention to have a plan which co-ordinates the delivery of future policy and sets out the pathway Ireland will take to deliver future ORE targets by accounting for all drivers and enablers of successful ORE delivery, e.g., technology; port; grid; route to market. However, to be truly holistic, additional consideration needs to be given to:

1. Be part of a net zero 'energy' system which takes account of ORE technology and their place within the wider energy system. Such a system should address security of energy supply; climate and environment benefit; cost effective energy for consumers and wider economic benefits (jobs, export potential, etc). To ensure that the momentum from Phase 1 and 2 is not lost and that the delivery of targets post 2030 remains realistic, any actions intended in guiding policy within the Future Framework should be stress-tested and align with the Climate Action Plan (CAP24).
2. Clarify how elements of the marine spatial planning will operate in a plan-led system post 2030. Currently we have no sight of a holistic and plan-led approach and in the absence of the OREDPII/NSSORE final publication this needs to be better addressed via a clear plan for developing DMAPs for ORE in the future. In addition, ESB GT is of the opinion that the Department should streamline the policy actions, paramount for the delivery of ORE targets:

    1. Marine spatial planning (DMAPs) for ORE
    2. Competitive auction design (ORESS or MAC)
    3. ORE technology
    4. Grid developments required to support rollout of ORE
    5. Route to market and demand

3. Take account of current efforts to develop an offshore renewable sector as part of Phase 1 and Phase 2 projects. Given that the projected target of 37GW of offshore wind by 2050 includes the 5 GW planned for delivery by 2030; the Future Framework should incorporate the planned phases to date. This will allow for a more coherent approach to current and future development and will provide a solution for attrition which will arise from these phases. There is no opportunity in current phases for projects to fill gaps where others fail, thus leaving the system open to the risk of failure if the targeted offshore wind volumes are not procured. Future amendments of the Future Framework should capture the way policy and targets across all phases interact, their interdependencies and the effects of project attrition.

4. With respect to the plan-led approach and the objective to meet the 2040 and 2050 targets, the primary focus, and number 1 action of the future framework, must be the delivery of a clear plan-led system in 2024. In the absence of a revised OREDPII / NSSORE, we propose that a 'Strategy for DMAP Proposal Areas' is outlined by Q3 2024 at the latest, which will:
    - Identify the proposed DMAP areas ensuring these are sufficiently sized to meet 2040 targets, with an allowance for attrition and sufficient scope to accommodate project level decisions on site suitability.

- Base the selection of DMAPs on the work already done under OREDPII and data collected under data procurement rounds.
- Position DMAPs in locations which have access to sufficient grid and/or opportunities for alternative route to markets and to significant energy demand and/or can accommodate industrial development to create this demand, (e.g., Cork Harbour on the south coast and Shannon Estuary on the west coast).
- Be aligned with MAP Act, DHLGH guidelines and live to RED III with respect to renewable accelerated areas (RAA) to enable agile and responsive public policy in support of deployment of at-scale renewables.
- Propose mechanisms for selecting and awarding project site control within the DMAPs. Ideally a number of project areas within each DMAP should be identified. These may be grid connected or be eligible for non-grid auctions. Sites identified may be technology agnostic but should have known depth profiles. Identifying project areas will improve pipeline visibility and give more transparency to industry and other stakeholders as to future site locations. It will allow a more robust SEA process which could account for the cumulative impacts of the overall project areas.

5. Consideration needs to be given to the model assumptions relating to security of supply in the economic analysis and subsequent supporting documentation guiding the policy framework. We acknowledge the significant work undertaken to inform the Future Framework via the commissioned models by BVG, AFRY and SEAI. ESB GT's internal Net Zero models broadly align with the choice of parameters and assumptions made, however divergence with the choice of 'weather year' raises questions around the resilience and security of supply of the proposed 2050 scenario. Studies based on less than several decades of weather data are liable to underestimate the need for energy from flexible, dispatchable generation, long-duration storage and potentially overestimate the availability of imported MWh from an interconnected power system with high penetration of renewable energy.[2]

    a. The studies have not investigated the correlation between Ireland's weather system and those of the existing and proposed interconnected systems. Ireland's weather is highly correlated with GB and France (Fig 1, Fig 2). Detailed analysis is needed to assess other systems' ability to a) import our surplus renewable and b) to export energy to Ireland when there is a shortfall of renewables in Ireland due to low wind and sun.

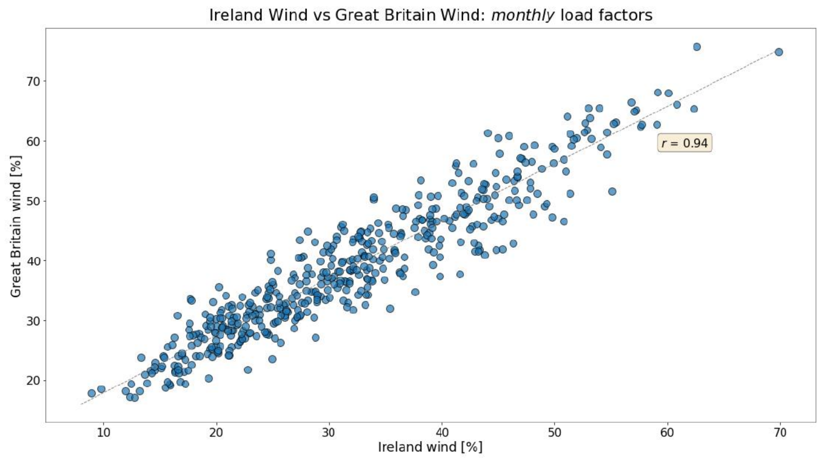


Fig 1: ESB analysis showing very strong correlation between wind patterns in Ireland and GB

[2] Royal Society, Large Scale Electricity Storage, September 2023

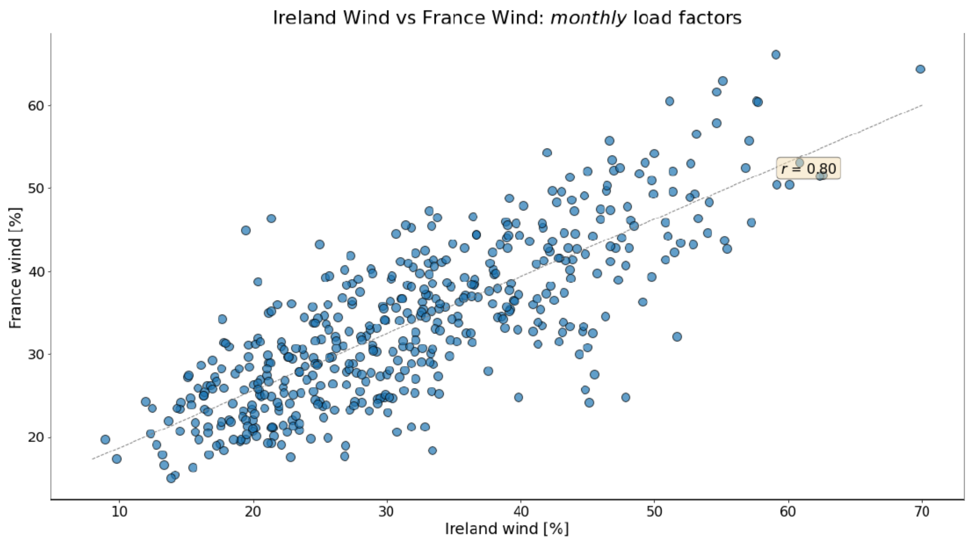


Fig 2: ESB analysis showing very strong correlation between wind patterns in Ireland and France

b. The studies have not investigated the impacts of weather extremes (for example, wind droughts) to ensure the energy system is robust to these extremes. A more detailed analysis taking account of the impacts of weather extremes in Ireland and interconnected energy systems will be required to test, validate, and refine the assumptions and overall conclusions of the study, taking account of the critical importance of security of supply of the electricity system.

ESB analysis of weather data 2005-2020 highlights wind drought in 2007, 2010, 2011 which was echoed in the GB analysis by Royal Society. During these years, interconnection between Ireland and GB will not support security of supply.

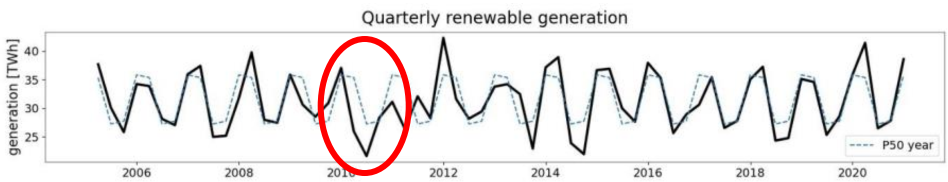


Fig 3: ESB analysis- quarterly renewable generation based on Irish weather data 2005-2020[3]

Interestingly, although there is negative correlation between solar in Spain and wind in Ireland suggesting complementarity at the monthly timescale, it is insightful to look at annual generation of wind in Ireland and solar in Spain over several years. Low wind years (e.g., 1984, 1987, 2010) in Ireland coincided with low solar years in Spain, undermining the effectiveness of interconnection between a wind-dominated Irish system and a solar-dominated Spanish system to contribute to energy security in Ireland.

[3] ESB analysis

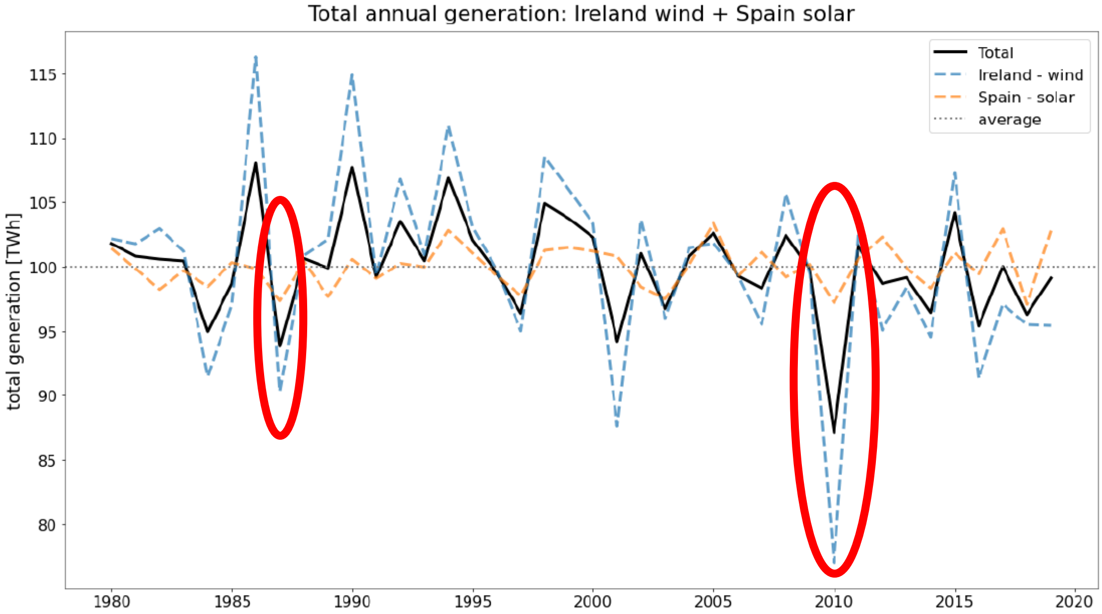


Fig 4: ESB analysis showing profile of Irish wind generation and Spanish solar generation based on almost 2 decades of weather data.

c. The study predicts a significant quantity (50TWh) of excess surplus renewable energy over and above domestic net-zero requirements. A more detailed Cost Benefit Analysis (CBA) will be required to develop the business case for this additional quantity of ORE and associated further interconnection capacity; in particular, the issue of the impact this has on driving down the wholesale price to uneconomic levels and the potential for negative impacts in adjacent interconnected markets.

A secure Net Zero Energy system will be based on renewables, backed up by zero-carbon dispatchable power generation with multiple weeks of energy storage. The zero-carbon fuel best aligned with our continental scale of offshore wind resources is renewable H2. Failure to rigorously analyse weather data from interconnected power systems over decades will result in underestimation of the energy required from (H2 fuelled) dispatchable generation to secure the energy system and the capacity of offshore wind to produce this H2.

Additional divergencies from our modelling assumptions include the following:

d. The study does not include modelling of system-wide constraints and local network constraints. These constraints, if not addressed through Transmission & Distribution system investment and reinforcement, will have a significant impact on the path to Net-Zero and the ambition of achieving 37GW of ORE by 2050. Turn-down of RES is already an issue in SEM and will become a major issue as more and more renewables connect to the system without corresponding investment in the network. This will have the potential to significantly affect and undermine key assumptions in the study and limit the ambition of achieving 37GW ORE by 2050 and net-zero by 2050. Our own modelling shows system curtailments alone (if not alleviated fast enough) could more than double dispatch-down volumes of RES.

ESB GT would welcome the opportunity to follow up and to review the models in more detail and to understand how to reflect any output changes into future iterations of the document.

1(b). Has each key priority been adequately described and considered all relevant components?

The key priorities as set out by DECC are:

- Environmental concerns
- Public and stakeholder consultation

- Return to the State and local communities.
- Cost competitiveness
- Delivery of targets
- Availability of relevant data
- Technology and supply chain development
- Industrial alignment including infrastructure, port facilities

Our comments relevant to each area described in the Future Framework document are set out below.

Environmental concerns: It is vital that DECC defines a coherent spatial strategy and delivery plan for ORE to achieve Ireland's ambitious deployment targets for 2040 and 2050 in line with the Climate Action Plan whilst affording appropriate protection to environmental assets. This must include transparent and robust processes, criteria and phasing for the preparation of regional Designated Maritime Area Plans (DMAPs) within which specific areas for ORE should be designated, together with details of how and when projects can then be delivered. Without such a strategy being set out on a national basis there is a clear risk that regional DMAPs, and subsequent project-level consenting may suffer from a lack of robustness and consistency in approach and fail to deliver sufficient ORE capacity to achieve Ireland's targets in a timely manner. Close engagement and coordination with DHLGH in relation to the designation of MPAs will also be essential to ensure coherence of MPA and DMAP designation.

In addition, it would be useful to understand the progress of relevant guidelines from DHLGH for Wind Development as well as for DMAPs. The Draft Revised Wind Energy Development Guidelines were issued in December 2019 but never finalized. The final version needs to be published to provide certainty to wind deployment.

Public consultation and benefits to local communities: A number of coastal stakeholders have raised concerns with us with respect to Ireland's marine and fishing areas being 'closed down' to the benefit of EU electricity needs. The general public does not appear to connect the need to build offshore renewable projects with the need to meet national targets for carbon emissions, reduce national risks around climate change, or indeed that these projects are required to meet their own electricity needs. The Government must be more proactive in their approach to informing the national debate on this. We understand that there is a planned communication strategy, but we have not seen anything to date. This strategy will need to clearly set out how the need for ORE projects will be relayed to the Irish public, and how the Government will promote the idea of security of supply; the average homeowner needs to understand what all this means to them personally if we are to get buy-in.

In addition, while we recognise the good work being progressed by the Seafood ORE Working Group, there is still a long way to go in bringing the fishing and aquaculture industry in step with the possibilities presented by ORE for their communities. We need to move beyond discussions of compensation and dispute resolution to discussions on coexistence, shared benefits and opportunities for these communities and sectors (e.g., jobs, shared resources (labour, vessels), training etc).

Return to the State and local communities: The government's primary focus is on the levies secured for seabed leases and the Community Benefit Fund. While both are useful mechanisms to accumulate and distribute financial benefits for State and community it is also very important to consider other societal benefits that these projects bring in the form of increased clean electricity generation, decreased carbon emissions, improved energy security, increased jobs in coastal regions etc. Again, we would recommend that these messages are clearly and proactively relayed by government via a planned communication strategy.

Cost Competitiveness: The Future Framework needs to consider both the price of delivering 37 GW of offshore wind and the use cases for it. We simply will not be able to "use" 37GW of offshore wind if the economics of the power produced are not competitive in comparison to our neighbours, and therefore consideration must be given to the controls which Ireland has, or needs to have, to reduce the price of delivering offshore wind, while maintaining a competitive and thriving supply chain. It is important that the drive to reduce the cost of electricity does not become a race to the bottom as this could exacerbate supply chain challenges which are already evident in the market, and we advocate non-price criteria in auctions as a means of combating this.

If we focus solely on exporting offshore wind by interconnection, then Ireland's competition becomes our wind versus the likes of French nuclear, for example. Therefore, we should be looking to maximise the use of that power domestically through creating value-added products and services using our wind.

Delivery of targets: Future Framework's key priority should be an accelerated implementation of the plan-led renewable energy deployment to 2050. The rapid development and deployment of ORE capacity is a key enabler of the continued decarbonisation of the electricity sector and the decarbonisation of Ireland's existing and future industrial base. An expanded version of 'Phase 2' is required with additional projects brought forward through an accelerated identification of suitable DMAP areas. A number of DMAPs should be identified with one on the west coast to harness floating offshore wind and to utilise the available grid there. ESB GT is calling for a more streamlined approach to the one seen to date, with DMAPs at a minimum being adequately sized, technology agnostic, while their roll out should be expedited in parallel (not consecutively) across Ireland's coasts, accelerating the delivery of offshore wind projects and realising community benefits across the country. Work already completed under OREDPII (National Spatial Strategy) could be used to inform the DMAPs.

Actionable and realistic auction timelines outlined to at least 2040, providing granular details, and going beyond the currently published, via NSEC, indicative timelines and volumes, should be carefully reviewed and announced in due course. The planned approach by government should set out a more detailed description of the location of sites within DMAPs, when they will be released, the design of the auction framework, the associated auction timeline and the enduring mechanism that will support its delivery. Further clarity is necessitated around auction parameters for the delivery of the ORESS and MAC processes, boosting auction competitiveness and spurring increased market participation.

The plan-led approach for 2050 should be linked to industrial policy and the two should complement each other. A hydrogen export economy could support economic activity but could also reduce the costs of developing the domestic hydrogen economy.

Technology and supply chain development: Alongside ensuring the ongoing facilitation and progression of fixed-bottom ORE development beyond Phase 1 and 2, ESB GT welcome actions which provide an enabling step for innovative technologies and, in particular, floating offshore wind. We encourage the department to continue supporting the roll out of early demonstrator projects and increase the scale of ambition for floating offshore wind, harnessing Ireland's unique potential. It seems inevitable that if Ireland is to meet its 2040 target of 20GW of operational offshore renewables that a significant portion of this, potentially as much as 5 – 10GW will need to be derived from floating foundation technology projects. On that basis for a floating offshore wind demonstrator site to serve a strong purpose it would need to be sufficiently sized (circa 400MW) and operational by the early 2030's with commercial scale floating projects being deployed from the mid- 2030's onwards.

With respect to the proposal to consider a dedicated floating offshore wind ORESS auction, we believe that floating offshore wind could provide a valuable contribution to renewable electricity in Ireland. It is no longer an immature technology and developments elsewhere are progressing – for example UK, France and Portugal all plan to have dedicated floating offshore wind auctions announced in 2024. A floating offshore wind ORESS auction for Ireland should be considered in the early stages of Future Framework.

Encouraging the growth of Ireland's supply-chain capacity will enhance economic growth, exportable skills in a global market and assist in the delivery of Ireland's targets. By addressing supply chain gaps, building cooperation through clustering, fostering innovation, and establishing Centres of Excellence, Ireland will position itself as a location to develop offshore wind and achieve its renewable energy goals. It will be important that Future Framework and the National Spatial Strategy are appropriately aligned to progress this ambition.

It is evident that the large-scale build-out of renewables requires back-up net zero dispatchable generation for security of supply in the energy transition. Original Equipment Manufacturers (OEMs) are making significant progress in advancing zero-carbon dispatchable generation technologies and developing solutions to retrofit existing thermal plants to facilitate running on zero carbon fuels. As a priority, capacity market auctions need to incentivise the transition of existing and new thermal plants to operate on sustainable zero carbon fuels.

Data availability-Marine Data: There are significant challenges and costs associated with gathering marine data to support the development of ORE and we acknowledge the efforts being made by government to explore ways to leverage data already available to inform Phase 2 and Future Framework. We would strongly support the re-use of data already gathered by the OREDPII to inform future DMAPs in combination with the data being actively procured by DECC. We note that there are data gaps in certain areas, however, would recommend that this does not hinder commencement of work to identify DMAPs. We also welcome the establishment of an expert advisory group under Offshore Wind Development Taskforce (OWDTF) to ensure collaborative delivery and would recommend that an additional objective of the advisory group ensures that future surveys and the usage of data acquired is fit for purpose.

Industrial alignment including infrastructure, port facilities: A key component of the development of an OWE sector is port infrastructure. The biggest opportunity for Ireland during the construction and operation of offshore wind farms will feed from the ports and focus should be given to this area. The associated economic benefit to the areas in proximity to ports, through the colocation of service providers, is widely evidenced in the offshore wind sector. Substantial investment is required in Irish ports to establish the supply chain for offshore wind and deliver further economic benefits to Ireland. While the Future Framework speaks to the importance of appropriate port infrastructure and points to policy development with respect to National Ports Policy, it is not clear how the Future Framework will influence the development of this policy (or vice versa).

Grid: ESB GT support the view that *'Grid capacity should not be a limiting factor leading up to 2040, as ORE targeted delivery has been according to the Ten-Year Network Development Plan (TYNDP)'*

1(c). How best should the 2GW of non-grid limited offshore wind capacity be procured?

Fundamentally, the framework for the development of ORE must provide for different routes to market across a range of offtakes, and should include but not be limited to ORESS, CPPA and the production of hydrogen or hydrogen derivatives. We acknowledge that Future Framework will not always be the 'owner' of the policy areas (for instance Hydrogen) so clear guidelines on how policies interact will be important to develop as part of the framework strategy.

With respect to competition for non-grid limited opportunities we recommend that MACs form the basis of this. The initial auctions could be considered for sites in the current south coast DMAP. Criteria for MAC competition should be developed in consultation with industry but should take account of requirements to meet tests for fit and proper person, financial viability, and technical capability. Additional criteria which go beyond this could be considered for sustainability, innovation, and support for local supply chain. In addition, partnerships with large demand energy users could be considered as part of the criteria and would provide proof of viable offtake.

Consideration will be required to ensure that the wider regulatory framework in the electricity sector supports the deployment of non-grid limited ORE capacity, such as generation licensing. Additionally, ORE capacity developed through corporate PPA structures will face significant counterparty risks. ESB GT believe that options to support the management of this risk should be explored, such as tools like aggregation and pooling mechanisms or guarantees underwritten or provided by a public body.

Across the EU and further afield, hydrogen policy is incentivising the development of hydrogen hubs or clusters. Ireland's National Hydrogen Strategy has proposed a similar approach, whereby an energy hub or cluster uses offshore wind energy to produce hydrogen for renewable energy storage, zero carbon electricity generation, and the decarbonisation of local industry. Where a non-grid connected ORE project is served by an energy hub, which includes a variety of offtakers, that project itself will be more attractive to investors.

"*Given this fact, it is likely that many of these initial clusters could develop in the vicinity of commercial ports which in turn enable offshore wind and are typically positioned in proximity to potential large end users. Further work is needed to determine the optimal locations of these regional clusters, with certain regions such as Cork, Shannon, and Dublin, appearing to be well positioned given their offshore renewable potential, ports infrastructure and proximity to industry, power generation and heavy transport end-use*."[4]

In addition, proximity to geological scale storage, and the development of long-term gas storage solutions which can store renewable gas, in particular hydrogen is a priority. For instance, ESB's 'Project KESTREL' is an integrated evolutionary project that involves the rehabilitation of the well proven offshore storage solution in South-West Kinsale that could improve medium term energy security initially with natural gas storage and subsequently transitioning to green hydrogen storage. This storage will form the cornerstone of the Cork cluster by enabling the harnessing of offshore wind, production and storage of hydrogen and provide a continuous supply for hydrogen fuelled generation.

'Power to hydrogen' is one important area of offtake. The draft Climate Action Plan 2024 includes increased zero emission gas-fired generation to enable a net zero power system under the 2030-2035 measures. Furthermore, zero-carbon dispatchable power generation will be vital in decarbonising energy use and in the provision of security of supply. Zero carbon fuels derived from the 2GW of non-grid limited offshore wind have the potential to contribute to the decarbonisation of the non-renewable portion of the electricity market (i.e., facilitate a move away from continued reliance on fossil fuels) and the hard to abate areas in the transport and industry sectors. Given the timelines associated with developing a mechanism to procure the 2GW, this must be prioritised.[5]

Additionally, consideration of the need/use of Private Wires in the timely development of the hydrogen sector needs to go further than just the 2 GW non-grid connected ambition. As the hydrogen market grows, locally and internationally, Private Wires may become an important element that facilitates the creation of hydrogen and Ireland's place in this international market.

1(d). What are your views on the design parameters for the successor scheme to ORESS, what else should/should not be considered?

With respect to the development of a competitive auction design for ORESS:

1) We welcome the intention to progress an application to the EU for ORESS supports post 2026 as outlined in Action 9 of the Draft Future Framework.

2) We encourage the publishing of future ORESS and RESS auction schedules along with indicative volumes to 2035 well in advance.

- At present, future renewables auctions dates are published three or so years in advance. Greater certainty can be achieved with a longer time horizon auction calendar. In conjunction with the CAP and the long-term emission reductions strategy, rolling updates out to 2030 could be provided in the first instance followed by a longer-term auction calendar.
- We support the adoption of recommendation in the Policy Framework by the EU commission on the European Wind Power Action Plan (EWPAP)6 with respect to market/auction bid parameters and the dissemination of auction schedules. Policy recommendations such as action 2 of the EWPAP "Member States to increase visibility of the wind projects pipeline through wind pledges, publication of mid-term

[4] National Hydrogen Strategy
[5] gov - Climate Action Plan 2024 (www.gov.ie)
[6] *EUR-Lex - 52023DC0669 - EN - EUR-Lex (europa.eu)*

auction schedules, long-term plans for renewables deployment" can enhance the implementation success of the Future Framework.
- There is a need for the design of the successor scheme to ORESS to be reflective of the risks that developers are best placed to effectively manage in the context of the plan-led approach where aspects of project siting decisions will have been taken centrally.

3) We welcome the recommendation for the inclusion of pre-qualification qualitative non-price auction criteria, and we recommend their alignment with Action 4 of the EU wind power action plan, specifically focusing on:
- Strengthening the clarity of non-price award criteria that are critical to rewarding sustainability, innovation, energy system integration, high-quality products, and the contribution to a resilient supply chain.
- Exploring the development of a European business conduct code that promotes, among other things, supply chain transparency and could be recommended for future wind auctions.
- Reinforcing the cyber-resilience of wind installations and of the infrastructure to which they are connected.
- Ensuring the full and timely execution of projects through appropriate incentives (i.e., price indexation) helping industry to better cope with cost increases due to inflation.

4) With respect to Action 8 and the design of a competition for non-grid opportunities we recommend that MACs form the basis of this. The initial auctions could be considered for sites in the current south coast DMAP. Criteria for MAC competition should be developed in consultation with industry but should take account of requirements to meet tests for fit and proper person, financial viability, and technical capability. Additional criteria which go beyond this could be considered for sustainability, innovation, and support for local supply chain. In addition, partnerships with large demand energy users could be considered as part of the criteria and would provide proof of viable offtake.

5) There is a need for a strand to support the production of hydrogen from offshore wind in the successor scheme to ORESS, which is due to expire in 2026. This is critical if we are to ensure that renewable hydrogen can be derived from offshore wind from the early to mid-2030s. The framework must consider ORESS support for electricity/hydrogen production projects, as well as dedicated hydrogen projects.

DECC has the opportunity to design a successor framework to ORESS that can facilitate and accelerate the development of hydrogen production from offshore wind. The successor framework should include a dedicated strand for hydrogen production, in line with the legislative framework according to the definition of a Renewable Fuel of Non-Biological Origin (RFNBO) and the framework according to the Renewable Energy Directive, that covers the following aspects:

- A clear definition and scope of eligible technologies and projects, including P2X and other innovative solutions.
- A competitive and transparent allocation mechanism that ensures a fair and efficient distribution of support which avoids overcompensation.
- A flexible and dynamic support level that reflects the costs and risks of hydrogen production and adjusts to the market conditions and technology development.
- A comprehensive and coherent set of rules and requirements that ensure compliance with environmental, social, and safety standards and facilitate grid connection, hydrogen transport, and end-use.

1(e). What frameworks and/or supports are required for alternate routes to market such as CPPAs, Power-to-X projects, interconnector-hybrid projects and export projects?

ESB GT is supportive of the view that in addition to the successor scheme to ORESS, emerging alternative routes to market such as Corporate Purchase Agreements (CPPAS), and novel routes to market such as Power-to-X and non-grid limited projects, backed by carefully designed policy supports and frameworks, can play a significant part in achieving the ORE targets set. This section looks into some of these cases and their associated benefits.

MAC eligibility for non-grid projects within a DMAP area:

The ability to secure seabed area via a MAC within DMAPs for non ORESS / non-auction projects is required, in order for projects to engage with An Bord Pleanála (ABP) and progress with planning. The initial auctions could be considered for sites in the current south coast DMAP. Criteria for MAC competitions should be developed in consultation with industry but should take account of requirements to meet tests for fit and proper person, financial viability, and technical capability. Additional criteria should be considered to reward sustainability, innovation, support for local supply chain and partnerships with large demand energy users. Consideration will also be required to ensure that the wider regulatory framework in the electricity sector supports the deployment of non-grid limited Offshore Renewable Energy (ORE) capacity, such as generation licensing.

Alternate routes to market: CPPAs

- In alignment with the European Wind Power Action Plan[7], ESB GT is echoing the view that the Future Framework should explore policy support mechanisms to facilitate alternate routes to market, such as CPPAs. Future policy should provide guidance on how centralised support for Power Purchase Agreements (PPA) with corporate consumers will be promoted. A centralised support process for Corporate PPAs (CPPAs), to help promote dialogues between renewable generations and consumers, will help consumers participate in the market and support the deployment of renewable energy generation. Corporate consumers are motivated to contract with renewable generators for multiple reasons. This may be to meet sustainability targets, prove green credentials, diversify sources of electricity, and/or control energy costs over long periods. Renewable generators are looking to corporate consumers to provide an additional option for contracting, one which offers sufficient credibility to facilitate project financing.
- To unlock greater renewable energy deployment, government policy should help consumers and generators define and agree on PPA structures which are mutually beneficial, reducing investment risks. This can be encouraged through increasing transparency requirements, providing example PPAs, and issuing advice on key terms such as timeframes, floor prices, passthrough costs, etc. with all publicly available information being anonymised and source data not being retained for any other purpose.
- The Future Framework should explore the policy and market mechanisms which will allow a route to grid connection for merchant (i.e., CPPA) projects under the plan-led approach. While a competitive MAC process will allow non-grid or private wire projects to progress inside DMAPs, there will need to be a mechanism for merchant projects within DMAPs to connect to the national grid.
- ORE capacity developed through corporate PPA structures will face significant counterparty risks, ESB believes that options to support the management of this risk should be explored, such as tools like aggregation and pooling mechanisms or guarantees underwritten or provided by a public body.

Going beyond CPPAs as alternate routes to market: ORE projects will require significant demand in order to be viable. Options to develop this demand and route to market will be essential and we welcome the efforts by DETE to explore domestic demand and supply chain considerations as part of the development of the National Industrial Strategy for Offshore Wind. We also welcome indications that future policy development is expected to include a

[7] Under the RED, Member States already have an obligation to publish a long-term schedule on the expected allocation of support for renewables "*covering at least the following five years and to introduce measures to ensure that power purchase agreements will also contribute to the required deployment of renewables'' (Source:* EUR-Lex - 52023DC0669 - EN - EUR-Lex (europa.eu)

consideration of the co-location of industrial demand for renewable energy with the development of large offshore wind projects.

As outlined in the consultation document, new types of projects, such Power-to-X, interconnector-hybrid projects, or non-grid limited projects may require bespoke supports or frameworks to achieve broader objectives. Draft and/ or existing EU legal frameworks, guidelines and criteria will inform the development of the supports, most notably the Climate, Energy and Environmental Aid Guidelines (CEEAG). For example, with respect to hydrogen, the Delegated Acts establish the EU definition of renewable hydrogen. It is therefore important to consider how this will interact with existing electricity support schemes, the connection arrangements to the grid in order to ensure optimum operation of the electrolyser and how a future framework for offshore wind can support an integrated energy system.

Several Member States have taken steps to support the roll out of schemes related to the production of hydrogen, with several of them approved by the European Commission over the past years. [8] While some of these were introduced under the Temporary Crisis and Transition Framework legal basis, there are also examples of enduring schemes for hydrogen derivatives administered on a competitive basis. A common approach among the schemes is demonstrating: 1) GHG emissions savings criteria of 70% compared to a fossil fuel comparator, 2) additionality according to the terms of the Delegated Act on Renewable Fuels of Non-Biological Origin (RFNBOs), and 3) meeting the sustainability criteria according to Article 28 (2) of the Renewable Energy Directive.

Power to X projects: Power to X provides the opportunity to create long-term storage options and substitute hydrogen, methane, and other synthetic fuels for fossil energy sources across a range of energy uses. When planning, permitting, and consenting of innovative projects are taken into account with the capital cost and time frame to develop, the financial framework to support the development of Power to X projects at scale will likely require a contract spanning to a 20-year timeframe. Currently, and as is often the case with the development of nascent industries, firm offtake agreements can be difficult to secure (for reasons of price discovery, policy development, lack of markets, regulatory uncertainty, lock-in concerns, counterparty risk etc).

EU supply side mechanisms such as ReFuel Aviation or the European Hydrogen Bank, may not currently provide adequate levels of certainty. Under ReFuel Aviation, the obligation for aviation fuel suppliers to ensure that all fuel made available to aircraft operators at EU airports contains a minimum share of SAF from 2025 and, from 2030, a minimum share of synthetic fuels, with both shares increasing progressively until 2050 may not be sufficient to incentivise domestic production. In the absence of national industrial policies to incentivise demand, the ability for fuel suppliers to aggregate supply across numerous jurisdictions to meet the target will not necessarily kick-start the development of projects.

Export projects: With respect to hydrogen, and as outlined in the consultation paper, the development of an effective renewable hydrogen industry will see a shift of domestic demand from fossils fuels to hydrogen in certain sectors. The export of hydrogen and hydrogen derivatives provides an opportunity to add scale and cost efficiencies once domestic energy needs are met. Another potential area for export is ammonia. Through a series of development phases, ESB's Green Atlantic @Moneypoint will develop a pilot, small ammonia-fired power plant using imported green ammonia with a view to scale to export.

Given the timeframes associated with developing cross border infrastructure, such as pipeline for export, a workstream on commencing the EU funding application process should be incorporated into the forthcoming workplan on implementing Ireland's National Hydrogen Strategy.

[8] For example, the Netherlands secured State Aid approval for a support scheme for the promotion of the production of hydrogen, one of the reference projects being a grid-connected, PPA with offshore wind: Microsoft Word - SA.104448_WLAL (europa.eu) Denmark received approval for a Power to X scheme in 2023.

1(f). What additional capacities and responsibilities should be held by industry in the context of the plan-led approach?

In order to answer this question, there is a need to clarify the 'plan-led approach' pathway intended under Future Framework. While Future Framework identifies some of the components of the plan-led approach in section 1.2.1 and table 2, it does not describe the sequence of these components. Understanding the pathway sequence and the division of the roles and responsibilities between project developers and state authorities is a key design decision of the implementation of the plan-led approach. A decision in this regard determines the point of competition for developers and scales the resourcing requirements of project developers and state authorities. The current sequence in Phase 2 is DMAP→ ORESS + Grid → MAC → Planning. The current pathway has been developed by government to reduce pressure on the government system and resources but would not be considered best practice, as it leaves planning to the last stage. Risks associated with this pathway have already been shared with DECC in earlier consultations on Phase 2.

A potentially more appropriate and less risky pathway (from the perspective of likely project success) would be DMAP→ Grid → MAC → Planning →ORESS. If this is the Future Framework pathway, then industry's interaction becomes clear and commences at the MAC stage. DMAP and grid planning remain under state level plan-led control. This sequence also means that government can commence DMAP identification in conjunction with future grid planning as outlined in Action 5 and 11 of the Future Framework.

Furthermore, to improve pipeline visibility and give more transparency to industry and stakeholders as to the level of ambition that government wishes to develop, DMAPs could identify a number of project areas within them that are opened to MAC competition. This would allow government to clearly show pipeline opportunity, matched with auction timelines as already indicated by NSEC. It would also increase the visibility of planned project areas for other stakeholders and would allow a more robust SEA process which could account for the cumulative impacts of the overall project areas. Finally, it could align DMAPs with the intentions of REDIII and the need to identify Renewable Accelerated Areas (RAAs) by 2026.

It is considered that the proposed pathway would facilitate the development of non-grid limited ORE capacity in tandem with grid connected ORE capacity by early identification of the ORE development areas with the longest timescales to grid connection and highlight to the industry at the point of MAC competition the ORE development areas most suited to non-grid limited development.

1(g). How can Government facilitate a more comprehensive and streamlined engagement process with developers to ensure national ORE targets are delivered?

If Ireland wishes to develop a pathway to deliver 20GW of offshore infrastructure within the next 16 years, it is essential that policy is underpinned by the knowledge and expertise to deliver at this scale. Therefore, industry needs to be at the table now to support policy evolution under the Future Framework. The current model of developing policy and then issuing for consultation is not efficient or effective and has resulted in a number of inadequate policy decisions and in some cases has stymied opportunity to deliver for 2030. If continued it may result in pull back of industry from the Irish system. A new model is needed for engagement on Future Framework with industry and government working together.

The governance structure which will manage the delivery of actions going forward should be clarified (i.e., will it be a sub-group of the OWDTF; will there be advisory groups or sub-work streams etc.). Ideally Industry should be included as a key partner for delivering these actions.

2(a). What grid infrastructure should be of particular focus in facilitating the build-out of capacity to support ORE generation targets?

There are significant challenges currently with grid capacity to support offshore development but there is also considerable work planned to alleviate the constraints within the electricity system within the next decade. Future proofing of grid infrastructure to enable phased development of generation through anticipatory investment is key. It is important to note that the Future Framework will have a part to play in influencing the future electricity and energy system evolution, but it will not be the only driver.

Consideration of onshore, offshore and interconnection development are all required to facilitate the build out of both onshore and offshore renewables to serve the growing demand associated with the ongoing electrification of energy and ensure that insufficient grid development does not remain a bottleneck for integrating additional renewables into the system.

In order to understand how best to ensure a sustainable and secure integrated energy system, ESB GT propose an integrated energy system modelling approach going forward rather than 'electricity system' only modelling. It would be more appropriate that this is managed at a Climate Action Plan level, rather than directed by the Future Framework. However, there will be a need for Future Framework to influence grid and energy policy on areas such as interconnectors, private wires, and hybrid connections (dynamic sharing of Maximum Exporting Capacity (MEC) and private wires).

ESB GT is supportive of a whole system approach, where any offshore grid developments designed to facilitate the build out of offshore capacity, need to be planned as part of the overall grid, and ensure that offshore development does not negatively impact on the potential for ongoing onshore renewable development. A holistic anticipatory approach to grid development, considering all aspects of grid infrastructure, is vital if renewable targets are to be met. This approach will support the safe and efficient connection of offshore generation whilst ensuring consumer value by reducing the levels of constraint/curtailment as Ireland decarbonises to a Net Zero Integrated Energy System by 2050.

Alongside the anticipatory investment, improved usage of existing grid infrastructure is needed. For example, the use of innovative technologies for constraint management including harnessing the flexibility of demand associated with utility-scale electrolysis to produce green hydrogen and system services to assist with load balancing, provide system support and enable the full delivery of offshore wind generation in Ireland at the greatest benefit to consumers.

While the specifics of grid development are beyond the scope of this consultation, there are two aspects of grid development that are worth highlighting:

- Hybrid connections:
    - ESB GT is of the view that hybrid connections have the potential to greatly enhance the growth in offshore renewable capacity build out. Through dynamic sharing of MEC, existing grid infrastructure would be better utilised, the need to develop new grid would be reduced, and the likelihood of project attrition would be minimised.
    - Using hybrid grid connections, in addition to anticipatory grid reinforcements, will ensure that grid capacity can be used to deliver policy on time and at the least cost.
    - To achieve this and deliver on the CAP23 action to "ensure that hybrid technology grid connections are facilitated, and remaining barriers removed" (CAP23 – EL/23/14, EL/23/16, and EL/23/17), hybrid connections need to be technology agnostic (not be restricted to solely renewables and battery storage) and allow two or more different technologies to dynamically share a single connection point under a single MEC.
- Private Wires:
    - ESB GT is supportive of DECC's view that private wires will be important components of achieving the ambition set out in the Future Frameworks consultation.
    - To utilise hybrid connections, ESB GT believe that Private Wires have an important role in enabling offshore wind farms to have the same connection point as the onshore generating asset and thus dynamically share their MEC and to lead to more efficient use of the network which will in turn ensure that consumers are best served.

- Further, to enable the DECC policy of 2GW of floating offshore wind capacity for non-grid uses to be realised, some form of Private Wire for offshore infrastructure will be needed. Where the use of Private Wires can assist in making this delivery more efficient, then Private Wires need to be adequately assessed and progressed bearing this, and the prudent safe development and operation of the network, in mind.

Additionally, consideration of the need/use of Private Wires in the timely development of the hydrogen sector needs to go further than just the Phase 3 offshore wind hydrogen production target. As the hydrogen market grows, locally and internationally, Private Wires may become an important element that facilitates the creation of hydrogen and Ireland's place in this international market.

2(b). In relation to National Security/Department of Defence interaction with ORE development, are there any issues you would like to highlight?

In addition to the considerations raised in the Draft consultation with regards to the development of ORE sites and the need to mitigate any possible adverse impacts on air deference radars or at-sea patrols, we believe that the highlighted necessity to protect energy infrastructure from external activities and limit repercussions to security actions is essential in protecting Ireland's energy generation sites.

Electricity production and energy storage come under the scope of Critical Entities Resilience Directive. Under the Directive, each Member State must have a plan in place to protect their critical assets by 2026. Adopting a regional approach would be of benefit and should come within scope of the North Seas Energy Cooperation, as well as captured in the policy actions and responsibilities guiding national frameworks.

In response to security of supply concerns, the European Union has introduced new legislation relating to the security of energy infrastructure, including storage. Amendments to the EU Gas Security of Supply Regulation (EU 2017/1938) has designated gas storage facilities as critical infrastructure. As outlined in "*Energy Security in Ireland to 2030"*, developing long-term gas storage solutions which can store renewable gas, in particular hydrogen, will be an important step from an energy security perspective[9], and therefore should be considered in the context of future policy frameworks.

4(a). What structures, measures, and interventions can the State and State agencies implement to assist in the development of a long-term, sustainable skills and workforce pipeline? Provide any recommendations on what the State can do to promote careers in ORE across a range of educational backgrounds and movement from other relevant sectors.

It is critical that an integrated approach is taken to address the multi-level skills requirement for the development of the ORE sector as skills, knowledge and resources will be required across multiple disciplines and levels. The existing education and training structures provide a framework, but it is essential that there is alignment of effort and progress pathways for those entering the sector or requiring upskilling.

Through stakeholder engagement, insight sharing and learnings from involvement in groupings such as the Shannon Estuary Task Force, we recognise the following as critical aspects:

- Clear pathways from Level 4 to Level 10 on the National Framework of Qualifications so that further and higher education providers can align their programme offerings to industry needs.
- Investment in education and training infrastructure in key locations creating centres of excellence. The scale and nature of investment demands that these Centres of Excellence are limited to a small number of locations.
- Work with industry to define clear roles across the sector for technical, engineering, science, business, finance, legal and other areas while also seeking to project anticipated quantum of jobs and upskilling required.

[9] https://www.gov.ie/pdf/?file=https://assets.gov.ie/278473/4919d4e2-44ea-454a-855a-0229eeda4f4f.pdf#page=null

- Engage with education and training providers to identify existing programmes which can be pivoted to address ORE specific requirements through e.g., specialisation, optional modules, or additional upskilling qualifications.
- Consider engagement with the National Apprenticeship Council to curate new apprenticeships in the energy sector.
- Early identification and ramping up of training in trades where demand for whom is likely to increase as a result of ORE developments e.g., slip-forming for concrete floating platform construction.

In terms of attracting people into the sector the experience of many education and training providers is that clear policy, development pathways and clear job descriptions are required to attract talent. Job security, clarity of roles, development pathways and upskilling journeys are critical to people making decisions to enter a new market.

Undoubtedly, skills development and adequately funded academic and other educational institutions are vital enablers of a thriving domestic offshore wind industry. Enhancing Ireland's ability to host net-zero industry skill academies as proposed under the draft NZIA, such as the one dedicated to support Member States to upskill and reskill workers, is of essence. As noted in the European Wind Power Action Plan[10], academies will develop content and aim to train 100,000 people within 3 years of establishment. In the longer term, for example the DETE-established Shannon Estuary Economic Taskforce projects 50 000 jobs ranging from vocational to academic to support the national ambition of 37 GW by 2050, of which 30 GW at the Atlantic coasts. On a broader basis, policy enabling the development of OSW could also contribute to improved connectivity at key Atlantic Coastal Centres, and other aspects to attract and retain the workforce. This is an equally important consideration given timelines associated with residential zoning, planning, and consenting.

Reflecting on suggested actions, raised in response to DETE's consultation on the National Industrial Strategy for Offshore Wind, we believe it is important to consider additional factors capable of organically accelerating the build out of skills, promotion of synergies and development of the appropriate supply chain capabilities to achieve the scale of ORE delivery envisioned in the Future Framework. More specifically, the following should be considered:

Building Cooperation:

- Developing policy to support the formation of clusters or networks that facilitate expertise sharing, innovation cooperation, and collaboration for large contracts.
- Learning from the European and US examples of industrial policies promoting cluster development and leveraging regional and EU funding.
- Nurturing clusters to evolve into cross-border renewable energy projects to achieve national and European significance.
- Utilising clustering initiatives as foundations for Important Projects of Common European Interest (IPCEI) and Projects of Common Interest, involving various stakeholders.

Research, Development & Innovation (RD&I):

- Identifying innovation challenges in the global OWE sector and participating actively in EU programs like the Strategic Energy Technology Plan.
- Leveraging Ireland's strengths in advanced manufacturing and technological innovation across the OWE project lifecycle.
- Developing policies and funding to address key innovation challenges, focusing on skills development, academia, and a potential Living Lab.

[10] European Wind Power Action Plan (europa.eu)

- Promoting collaboration between Small Medium Enterprises (SMEs), multinationals, and Further and Higher Education institutions to enhance innovation and research.

Establishing an Applied Centre of Excellence:

- Consolidating expertise and ambitions into a few well-chosen coastal Centres of Excellence to advance research and development, building upon existing strengths in institutes such as MaREI and to invest in a globally recognised innovation centre in offshore wind.
- Essentially, this has the potential to transform in a Living Lab at the Atlantic Coast comprised of several Centres of Excellence. Steps were taken by ESB and the Irish government to participate in the Dutch Irish Living Lab programme by the name of HybridLabs. There is a need to scale this significantly. As it coincides with ESB's commercial plans and asset development, it is timely to discuss the role of the State in incentivising this development, which is the underlying philosophy of the EU IPCEIs.

4(b). Are you aware of initiatives in other jurisdictions or at a European level that would be relevant to Ireland's ambition of building a sustainable skills and workforce pipeline for offshore wind?

At European level the following initiatives demonstrate how meaningful synergies between academic institutions and the wider industry can be nurtured, creating tailored curricula for professionals. Such success stories, amongst others, can be used as a guide for the development of upskilling and cross-skilling opportunities in the offshore wind sector, aiming at creating a sustainable, specialised workforce domestically. More specifically such initiatives include:

- The network of European Renewable Energy Research Centres (EUREC), which runs two European Masters Programmes, centred around Renewable Energy and Sustainable Energy Systems. Both involve mobility where the learner spends six months in a Core University (Belgium, Netherlands, or Ireland) and a second semester in a specialist University, followed by an applied, industry-based project placement. This highly successful programme delivers high quality graduates into the market, graduates who have a suitable mix of business, technical and market development skills, and knowledge, tested through the hands-on industry-based project. The international mix of students presents a potential avenue for ORE companies to secure employees from a pool of candidates who have already received practical experience in the sector. Technological University of the Shannon (TUS) is a member of EUREC and core provider for the Masters in Sustainable Energy Systems.
- The European Build Up Skills Initiative has had a strong focus on construction skills and has applied a model of developing a status quo report (state of play of current provision and options) followed by a Roadmap for future development. A similar approach could be followed for ORE in Ireland. TUS is the coordinator of the Irish Build Up Skills Roadmap, and the methodology and approach can be applied to the ORE sector. This includes addressing specific skills shortages, forecasting future jobs needs and alignment of education and training provision.

4(c). To what extent should an emphasis be placed on multipurpose sites for ORE delivery, including the colocation of devices? What Government structures should be developed to encourage and facilitate progress in this aspect?

Co-location will become an important feature of future marine spatial development and it is recommended that it should be a key consideration of the next iteration of the National Marine Planning Framework. In particular, when considering co-location of activities across sectors (e.g., ORE with aquaculture)

However, the initial focus of the Future Framework should be on the development of DMAPs for ORE technologies that will deliver 2040 ambitions, which in some cases may consider opportunities for co-location of ORE technologies if site conditions allow.

4(d). How can Government ensure policy is kept in line with evolving technological innovation and developments in ORE devices? What structures and government procedures should be implemented to future-proof the ORE planning process and account for technological shifts?

- ESB GT welcome the upcoming SEAI Technologies Roadmap publication, detailing the key ORE technologies and the role future innovation will play in accelerating ORE delivery. In the absence of visibility over the mix of preferred technology options, the ask to provide recommendations on the design of enduring policies becomes daunting. We therefore support that the ongoing review and revisioning of the Future Framework in the wider context of the SEAI technology report is necessitated, and we look forward to the opportunity to engage with stakeholders to work on its development.
- In general terms, we are supportive of a technology roadmap which facilitates the roll-out of various technology types. We highlight the need for policy to support hybrid connections for all technology types and ensure that hybrid co-located technology sites should not be restricted to solely renewables (wind and solar) and battery storage. In conjunction, the dynamic sharing of the Maximum Export Capacity (MEC) should be extended to all available technology types. This will have the benefit of future proofing for technology shifts, reduce the overall costs faced by customers, will minimise planning risk faced by developers, will create the real prospect of accelerating Ireland's transition to a low carbon system and will add to Ireland's security of supply by providing a source of more reliable power (when compared to the standalone alternative) on the electricity system.
- We are also calling for a careful review of policy areas which are captured within the Future Framework, but nonetheless their implementation is not adequately specified in the Draft Framework:
  - A supportive, revised National Planning Framework reflecting and enabling the transformative energy-system change on the horizon.
  - Industrial Innovation policy to develop port-industry-academic clusters in key coastal locations.
  - Strategy to enhance innovation in line with larger EU funding pathways (Green Deal, IPCEI).
- To future proof the ORE planning process we believe relevant departments guiding the planning policy should increase their dedicated resources and address any possible staffing needs. We greatly welcome the action set out in the Draft Future Framework "align resourcing needs across Government Departments and agencies to ensure all Government bodies in relevant marine and ORE disciplines are properly resourced to discharge the expanded responsibilities as set out under the FF".
- To progress all the projects necessary to achieve net zero, the workforce for supporting and approving planning applications needs to be expanded to avoid bottlenecks in deployment. The CAP23 includes "increase knowledge transfer and provide expertise in the development of policy" (CAP23 – RE/23/3). However, this needs to go further, and increased training programmes, university courses, and apprenticeships need to be introduced. A range of experience levels are needed; more experienced workers are needed to design policy, whilst, at a more junior level, workers must be proactively responding to queries and processing applications.

Section 3: Supporting docs: Economic Analysis

WS1 – Market Analysis: create relevant power market scenarios with varying ORE capacity and interconnection targets for elaboration in subsequent workstreams.

- Overall, the modelling approach implemented looks robust. More opportunity should be afforded to assess assumptions made in AFRY and BVG models which underpin the study.
- We note that the study has not investigated the impacts of weather extremes to ensure the system is robust to these extremes. A more detailed analysis taking account of the impacts of weather extremes will be required to test, validate, and refine the assumptions and overall conclusions of the study taking account of the critical importance of security of supply of the electricity system.
- It is important to recognise that the resilience of a renewables-based energy system cannot be rigorously quantified without assessing decades of weather data. Failure to do so will result in serious underestimation of the level of primary energy storage and dispatchable generated energy needed to ensure the security and resilience of the energy system.[11]
- If investigating security of supply is outside the scope of the study, using an average wind year is appropriate. Nevertheless, this might lead to underestimating the size of seasonal storage and energy sourced from dispatchable generation to guarantee the system's resilience to inter-annual weather fluctuations.
- This report on Large Scale energy storage for the GB system published by the Royal Society is very detailed and includes cost analysis, which makes it particularly useful. [12](GB system is about 10 times the size of the Irish system so the energy volumes cited below may be scaled accordingly.)

  "In Great Britain an electricity system largely powered by wind and solar energy will need tens of TWh of large-scale long-term storage, which would best be provided by storing hydrogen in solution-mined salt caverns. A model in which all of GB's future electricity demand is met by wind, solar and hydrogen provides a benchmark for comparison with other cases. This would require wind and solar supply averaging around 760 TWh/year supported by some 100 TWh of hydrogen storage. In this model, the average cost of electricity would be in the range £52 – 92/ MWh (in 2021 prices) depending on the cost of storage, the assumed discount rate and, most sensitively, the cost of wind and solar."

  The lead author, Sir Chris Llewellyn Smith is an award-winning Oxford University physics professor. He says that the need for long-term energy storage "*has been seriously underestimated*" and that '*other countries have ambitious plans to develop hydrogen storage starting now. If the UK does not emulate them, the electricity storage necessary to ensure low carbon, reliable and affordable energy supply will not be available when it is needed*'.

- ESB carried out similar analysis in the Irish context using 16 years of wind and solar data and the findings echoed those from the Royal Society report. Wind generation was very low in 2010-2011 so the challenge in a renewables-based weather system is not just the 'dunkelflaute'[13], one to two weeks of calm, dark, cold weather which typically occurs annually across northwest Europe and GB but, rather, multi-seasonal wind droughts which should determine the required size of primary energy storage. The size of hydrogen storage would have been significantly underestimated if the simulation was run on a single average wind year, or if the 2010-2011 window is not included in the analysis. There is more detail in Appendix A on the analysis. The main insights are:

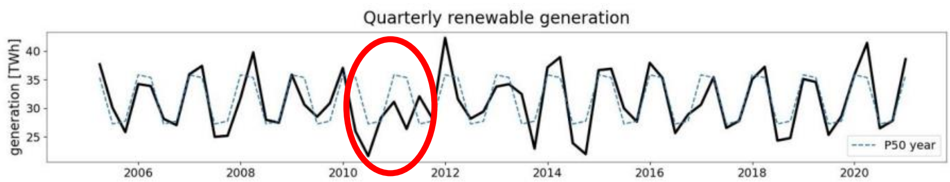
[11] https://royalsociety.org/-/media/policy/projects/large-scale-electricity-storage/Large-scale-electricity-storage-policy-briefing.pdf
[12] https://royalsociety.org/-/media/policy/projects/large-scale-electricity-storage/Large-scale-electricity-storage-report.pdf
[13] https://capital.com/dunkelflaute-what-is-definition

- **The need for adequacy assessment in a zero-carbon electricity system:** The transition to a renewable-based power system requires a careful evaluation of the adequacy of supply and demand, especially in periods of low wind output.
- **The role of hydrogen storage and dispatchable generation:** A similar approach to the Royal Society was taken whereby a fully independent energy system was modelled that relies on hydrogen storage and dispatchable generation to balance the variable output of wind and solar. The model shows that the size of hydrogen storage depends on the installed RES capacity and on the weather patterns over multiple years.
- **The impact of multi-seasonal wind drought:** The results highlight the risk of underestimating the need for storage and dispatchable generation if the simulation is based on a single average wind year. It uses historical data from 2010 and 2011 to illustrate the occurrence of prolonged periods of low wind output across Northwest Europe.
- **The limitations of interconnection:** While the importance of interconnection for moving renewable energy between markets is acknowledged, echoing the Royal Society authors' view, ESB cautions that interconnection will not provide security of supply when the wind output is low in the whole region. It suggests that Ireland needs to have a resilient dispatchable generation fleet and sufficient long-duration energy storage.

- Informed by our own analysis as well as other reports including WEI sponsored net zero study carried out by UCC [14] and the National Hydrogen Strategy[15], ESB has questions on the volume of energy from dispatchable generation proposed in the AFRY 2050 scenario and, consequently, the very small volume of green hydrogen needed for the power sector in 2050.

  There are a couple of assumptions contributing to this:

  - AFRY acknowledge: "*The system is secure under typical weather conditions. This study has not investigated the impacts of weather extremes and sought to ensure the system is robust to these extremes*." As articulated in the GB report, Large-scale electricity storage | Royal Society, failure to analyse decades of weather data will result in significant underestimation of the volume of dispatchable generation and energy storage needed to secure a weather-dependent based energy system.



ESB analysis- quarterly renewable generation based on Irish weather data 2005-2020

Both ESB analysis of Irish weather data and Royal Society analysis of GB weather data demonstrate significant wind drought in 2010-2011.

  - AFRY assume that 'Thermal generation accounts for only 3% of generation and the vast majority of this stems from the c.500MW of BECCS in Ireland and Northern Ireland.' BECCs is primarily used for negative CO_2 emissions and has a load factor of 82% generating 3.2TWh power. In the 2050 scenario there is effectively **9.3GW of H2 generation** running at **1.1% load factor** and, **3.6 GW CH4** generation running **at 0.8%** load factor contributing **1.2TWh** dispatchable generation over the year to a **110 TWh SEM 2050 power system**. This is in contrast to **10% load factor** of H2 powered generation in the WEI sponsored net

[14] https://windenergyireland.com/images/files/our-climate-neutral-future-0by50-final-report.pdf
[15] https://www.gov.ie/en/publication/624ab-national-hydrogen-strategy/

zero study carried out by UCC and **load factors of 5% to 15%** assumed for dispatchable generation in 2050 in **the National H2 Strategy.**

	TWh	Capacity (GW)	Load factor
3% dispatchable generation assumed	4.8		
H2 powered dispatchable generation	0.9	9.3	1.1%
500MW BECCs	3.6	0.5	82.2%
CH4 generation	0.3	3.6	0.8%

- AFRY acknowledge "*Natural gas has been assumed to be available when needed, effectively requiring 24/7 supply. The validity of this assumption is likely to be increasingly at risk from 2040 onwards*." The consequences of this assumption being invalid need to be further explored and their potential knock-on impact on the levels of H2 needed (and hence level of ORE development to produce it), in substitution for natural gas.

ESB would like the volume of energy from dispatchable generation to secure Ireland's net zero energy system (2050), and the associated renewable H2 and offshore wind requirements to be reviewed:

1. Using decades of weather data for Ireland and for proposed interconnected systems- GB, France, Belgium, Spain.
2. Assuming that natural gas is not available on demand.

- The study predicts a significant quantity of (50TWh) of excess surplus renewable energy over and above domestic net-zero requirements. A more detailed Cost Benefit Analysis will be required to develop the business case for this additional quantity of ORE and associated further interconnection capacity in particular the issue of the impact this has on driving down the wholesale price to un-economic levels and the potential for negative benefits in adjoining interconnected markets.
- We note that the study does not include modelling of system-wide constraints and local network constraints. These constraints if not addressed through Transmission & Distribution system investment and reinforcement will have a significant impact on the path to Net-Zero and the ambition of achieving 37GW of ORE by 2050. Turn-down of RES is already an issue in SEM and will become a major issue as more and more renewables connect to the system without corresponding investment in the network. This will have the potential to significantly affect and undermine key assumptions in the study and limit the ambition of achieving 37GW ORE by 2050 and net-zero by 2050. Network constraints and system curtailments are one of the major blockers towards net-zero and should be included in the modelling. From a modelling perspective, this likely would lead to a different set of capacity solutions, be it in higher storage levels, interconnectors, power-to-H2 etc.
- AFRY's power market model (BID3) is capable of modelling interconnections with other European markets. It would be particularly insightful to see the outcomes of simulations based on a low wind year or on a number of consecutive years to assess how system requirements and electricity import/export flows change compared to an average wind year.
- The electrolyser capacity looks quite low: 4.0 GW for SEM, 3.0 for ROI. In ESB's study with UCC, the electrolyser capacity required for ROI was 10.6 GW. The flexible, dispatchable demand associated with utility scale electrolysers will be of value to support an energy system for which the primary energy source is wind and solar.

▪ 12.2 GW of interconnection (including ~1 GW with Belgium) looks ambitious.

WS2 – Interconnection: assess the technical and financial viability of electricity export via interconnection predominantly to France, the UK, and other northern European countries.

- Interconnection has a role to play in our 2050 Net Zero Energy system, however, it has limited benefits in interconnected systems that are based on renewables and exposed to the same weather patterns (see graphs below (Figure 2-4) on correlation between wind in Ireland, GB, and France). Therefore, Ireland should not be overly dependent on interconnectors for security of supply or to address surplus renewables. A Royal Society Report analysed decades of weather data, with the results showing the essential role of seasonal-scale energy storage to ensure a net zero GB system is secure. ESB made the same conclusion when decades of Irish weather data were analysed in a study of Irish net zero. This is summarised in Appendix A.
- ESB have analysed 40 years of weather data (1980-2019) and noted the high correlation between wind patterns in Ireland, France, and GB. Indeed, this was experienced as recently as Q3 2021 (Figure 1) when there was a period of up to 6 weeks of no wind in Ireland, no wind in GB and no wind in North-West Europe.[16]

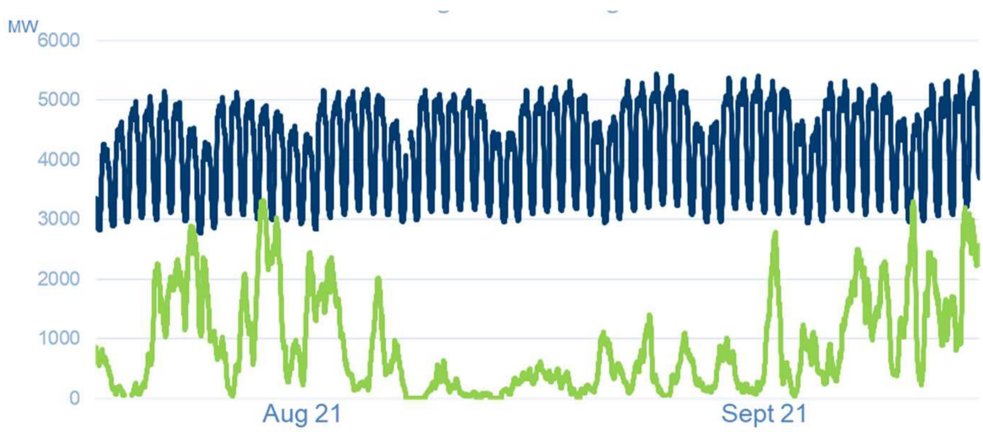


Figure 1: 2021 Wind generation, system demand data

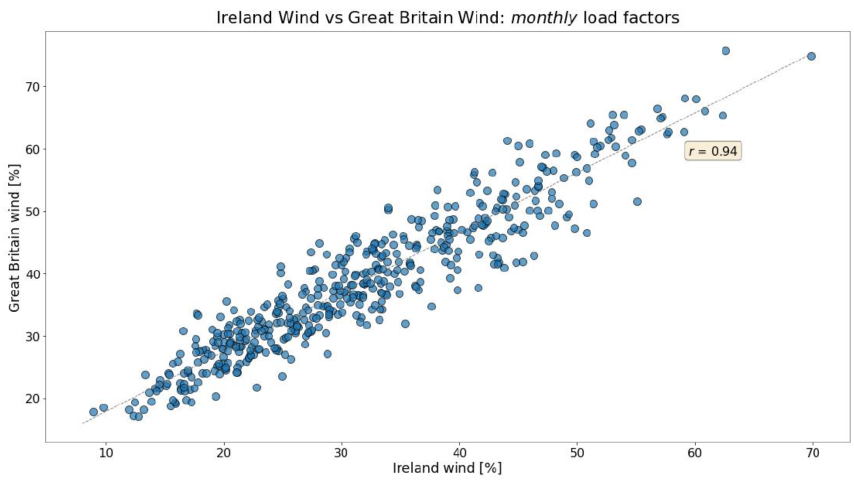


Figure 2: ESB analysis showing very strong correlation between wind patterns in Ireland and GB

[16] https://techxplore.com/news/2021-10-europe-exceptionally-future-energy-grid.html
https://www.icis.com/explore/resources/news/2021/09/09/10683078/icis-briefing-the-causes-of-surgingeuropean-power-prices-and-a-short-term-outlook/

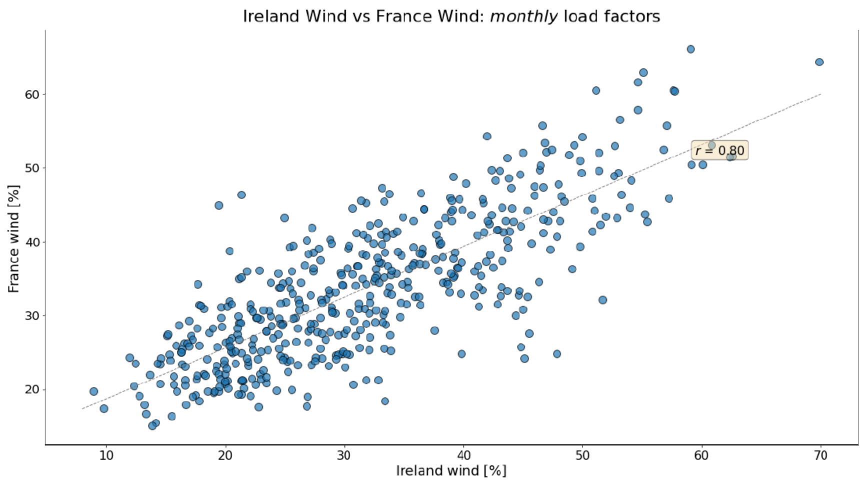


Figure 3: ESB analysis showing very strong correlation between wind patterns in Ireland and France

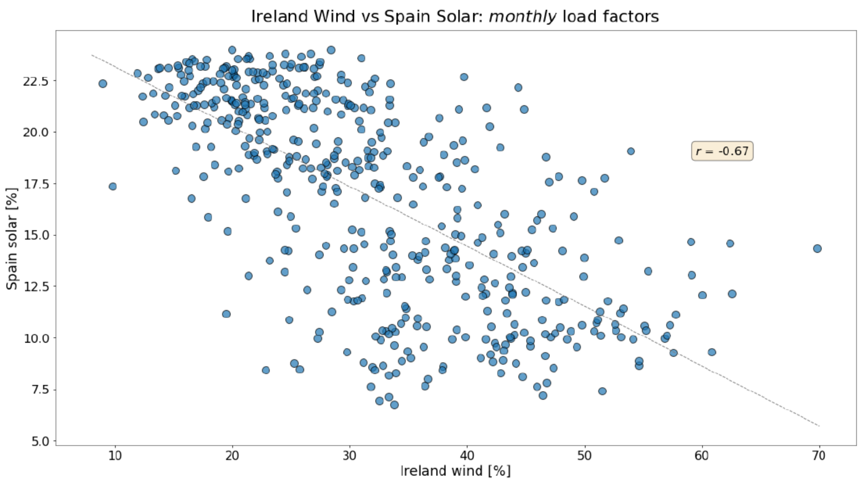


Figure 4: ESB analysis showing strong negative correlation between wind patterns in Ireland and solar in Spain.

- Although there is negative correlation between solar in Spain and wind in Ireland suggesting complementarity at the *monthly* timescale, it is insightful to look at *annual* generation of wind in Ireland and solar in Spain over several decades.
    - The blue line is Irish wind which averages 100TWh per annum over the period analysed but the profile each year swings considerably. The wind drought in 2010 and lesser droughts in 1984, 1987 and 2001 are also evident, as are the windy years of 1986 and 1990.
    - The orange line is Spanish solar which averages 100TWh per annum over the period analysed but the profile each year swings, albeit considerably much less than the Irish wind profile.
    - The black line is the average of the wind and solar. Again, this is an average of 100TWh annually over the full period. It is interesting to observe:
    - Wind drought in 2010 in Ireland coincided with a low solar year in Spain.
    - Low wind in Ireland 1984, 1987 coincided with low solar years in Spain.
    - High wind in Ireland 1994, 1998, 1999 coincided with high solar years in Spain.
    - The inter-annual variability of wind in Ireland is substantially larger than that of solar in Spain.

- This underpins the message that even if Ireland is interconnected with Spain which has solar to complement Ireland's wind, weather patterns are such that large energy storage is needed to manage coincident years of over/under supply of renewable energy in each jurisdiction.

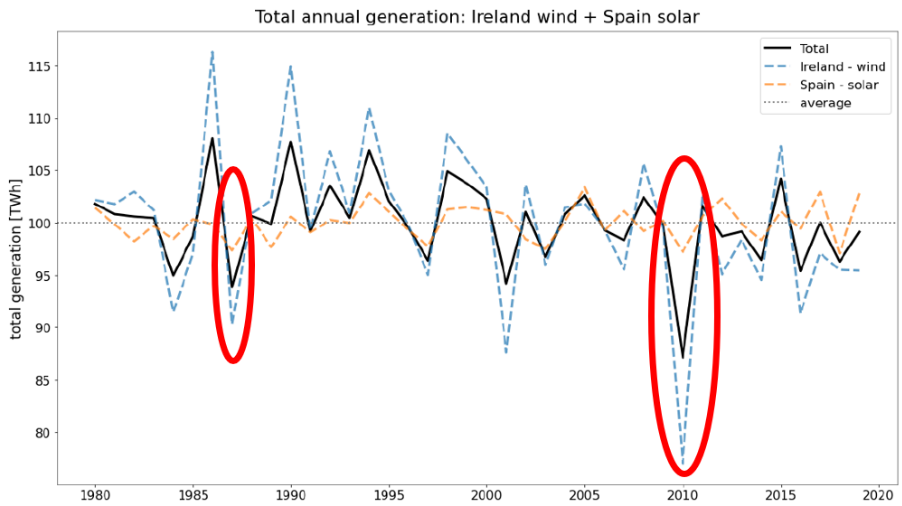


Figure 5: ESB analysis showing profile of Irish wind generation and Spanish solar generation based on almost 2 decades of weather data.

- Interconnection is assumed to be able to address oversupply of renewables. However, the assumption underpinning these need to be rigorously assessed.
  - The mitigation of oversupply by interconnection assumes that there are efficient trading arrangements in place in all sides of interconnection. This is not true at present and unlikely to be true when GB is outside EU arrangements, and we have an ex-post market design.
  - That there are no network limitations internal to each Member State to supply/consume the interconnector energy at that point; there are considerable limitations in existence. It is challenging to get 70% of existing interconnectors capacity to be made available to the market, let alone 100%.
  - That the prices in the relevant sides of interconnection determine the flow – the technical limitations on either side of the cross border are material and increasing.
  - That each Member State will be able to operate their power systems with very high levels of non-synchronous power sources in the future. However, no country currently has a plan to do so because they are more focused on trading power across borders. This is an important issue that needs to be addressed.

WS3 – Renewable hydrogen: analyse the potential hydrogen future in Ireland including maximising cost-competitiveness.

	Afry	**Irish H2 strategy**		**comment**	**average Afry shortfall compared to plausible H2 strategy**
H2 use case	**TWh H2**	**TWh H2 low**	**TWh H2 high**		**TWh H2**
Power ***(SEM)***	*1.8*	*3.6*	*13.3*	Irish H2 strategy based on 5-15% power demand in 2050 met by dispatchable generation fuelled by H2. If Afry followed same logic then 5-15% of power demand, 110TWh (excludes power for H2 production) is **5.5-16.5TWh** dispatchable	*20.2*

				generation which would require **11-33TWh H2**	
Commercial / residential	0.8	0	1.5	Average of high and low of H2 strategy, which is reasonable, given prioritisation of electrification in energy policy	
Road, rail	5.2	1	9.3	Average of high and low of H2 strategy which is reasonable, given prioritisation of electrification in energy policy	
industry	7.5	0	14.9	Average of high and low of H2 strategy which is reasonable, given prioritisation of electrification in energy policy	
Aviation	13.5	13	26	Afry assume low scenario of H2 strategy-given constraints on sustainable biofuels, average of High/low or high scenario is more plausible	**6**
Maritime	1.3	2.2	2.6	Afry not consistent with H2 strategy	**1.1**
Other (fertiliser)	3.5	0	7	Restarting fertiliser industry in Ireland (1) harnesses natural resources and (2) improves food security which was brought into sharp focus by Ukraine crisis. High scenario more plausible.	**3.5**

31TWh H2

31TWh H2 requires an additional 9.5GW offshore wind to produce it. [17]

- Although AFRY mention that the end use of H2 is based on an average of 'high' and 'low' scenarios in the National H2 strategy, this is not borne out in some of the numbers, in particular for power generation, maritime and aviation, consequently their estimates of H2 demand (and associated renewables to produce same) are on the low side. As discussed earlier, the proposed use of H2 for the power system is not consistent with the National H2 strategy or the WEI 2050 study completed by UCC.

WS4 – Export viability: evaluate the export viability and implications in terms of Gross Value Added and employment benefits as well as policy, trade, and investment considerations.

Hydrogen production, storage, and distribution: With respect to the assumptions on hydrogen production, storage, and distribution, it fails to take account of the potential of depleted gas fields, such as Kinsale Gas Field, in being repurposed for the storage of hydrogen. ESB, dCarbonX, and Bord Gáis Energy are proposing to redevelop the decommissioned gas reservoirs in the offshore Kinsale area gas fields for large-scale energy storage of renewable gas and green hydrogen with provision of storage of natural gas until large volumes of these gases are available for storage. This would provide the necessary storage capacity to provide security of supply to mitigate in the event of low levels of intermittent renewables.

[17] Assuming electrolyser efficiency 75% and offshore wind capacity factor 50%.

Appendix A: ESB analysis of needs of net zero system based on 16 years of weather data:

Projected domestic power demand: The transition to a zero-carbon electricity system powered mainly by variable renewables requires appropriate consideration in an adequacy assessment. The current energy system has significant on demand energy through fossil gas, but this isn't compatible with net zero. Wind and solar electricity will supply the majority of energy needs combined with short, medium and long-term storage. With high levels of variable renewables, there will be times of low output which need to be catered for in the adequacy assessment. Prolonged periods of low wind output will impact right across Northwest Europe and so its impact will not be confined to one country. In 2010 and 2011 Ireland experienced multiple prolonged periods of low wind output in relatively quick succession with these weather patterns mirrored elsewhere. As established in the *Royal Society Report on Large Scale Electricity Storage*, modelling over several decades of weather data prevents underestimating the need for storage and overestimating the need for other sources. This is because wind supply can vary over time scales.[18] Analysis undertaken by ESB in conjunction with UCC underpins the need to model weather data over multiple years rather than a single average wind year. A multi-seasonal wind drought constitutes the weather event that determines the required size of H2 storage and is correlated to hydrogen fuelled dispatchable power generation. The size of the H2 storage requirements is better informed by multiple wind years rather than a single average wind year. The basis of the model and its findings are outlined below.

- Slide 38 of WS3 illustrates SEM Domestic Hydrogen Demand (TWh) out to 2050. It notes:
    - The power sector demand is relatively low, based on 'normal' weather conditions (note that the modelling in this study has investigated the system under 5 representative weather patterns), there is sufficient renewables generation, energy storage, and interconnection to address the vast bulk of demand.
    - Thermal generation is only required when the system is very tight (e.g., when demand is high and renewables output is low in the SEM, GB and France leading to relatively low imports).
    - However, there is a risk that the weather profile has underestimated the wind profile, the correlating level of hydrogen storage required by the energy system and the dispatch of hydrogen fuelled power generation.

Background to model assumptions: The model assumes that generation is 100% renewable (onshore wind, offshore wind, solar PV), storage is 100% green hydrogen, and there is no interconnection with other markets nor energy import/export (that is, the energy system is modelled as fully independent). The installed capacities of onshore wind and solar PV are equal to 9 and 10 GW, respectively, and are kept constant in the simulations. The capacity of offshore wind changes through the simulations. System operation is simulated for 16 consecutive years, with RES generation being modelled using historical weather conditions (from 2005 to 2020). The hourly profile of the electricity load for year 2050 is provided by UCC's study; this demand profile is repeated over the 16 years. For each hour:

• when generation is higher than demand, the surplus electricity is converted to hydrogen and stored (H_2 storage level goes up)
• when generation is lower than demand, hydrogen is drawn from the storage and converted to electricity to supply the deficit of electricity (H_2 storage level goes down).

Level of hydrogen storage: Figure A.1 shows the level of hydrogen storage over 16 years for various levels of installed offshore capacity. The blue line shows the case for 18 GW of offshore wind; the grey lines represent higher capacities of offshore wind.

[18] Royal Society, Large Scale Electricity Storage, September 2023

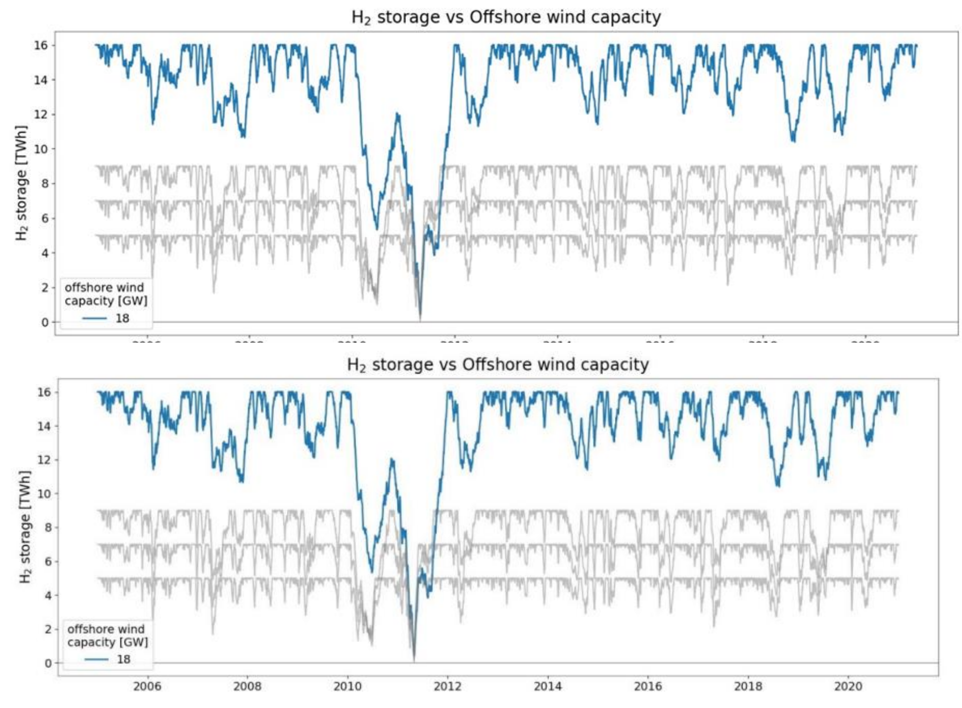


Figure A.1: Level of H_2 storage over time for different offshore wind capacity

In the 18 GW case (blue line), the required size of storage is 16 TWh. It can be seen how the hydrogen storage substantially depleted between 2010 and 2012, where it nearly reaches zero. This is a consequence of renewable generation being consistently lower than demand, and the hydrogen being used for dispatchable zero carbon generation.

Wind drought: In the bottom panel of Figure A.2 below, the black solid line shows the quarterly renewable generation over the 16 years. There is an evident seasonality effect in the output, with higher peaks in quarters 1 and 4 and lower in 2 and 3. This is expected, as typically wind, which provides the bulk of the generation is stronger in winter and weaker in the summer. In the same graph, the dashed blue line shows the quarterly renewable generation in an average (i.e., P50) year, repeated over the 16 years.

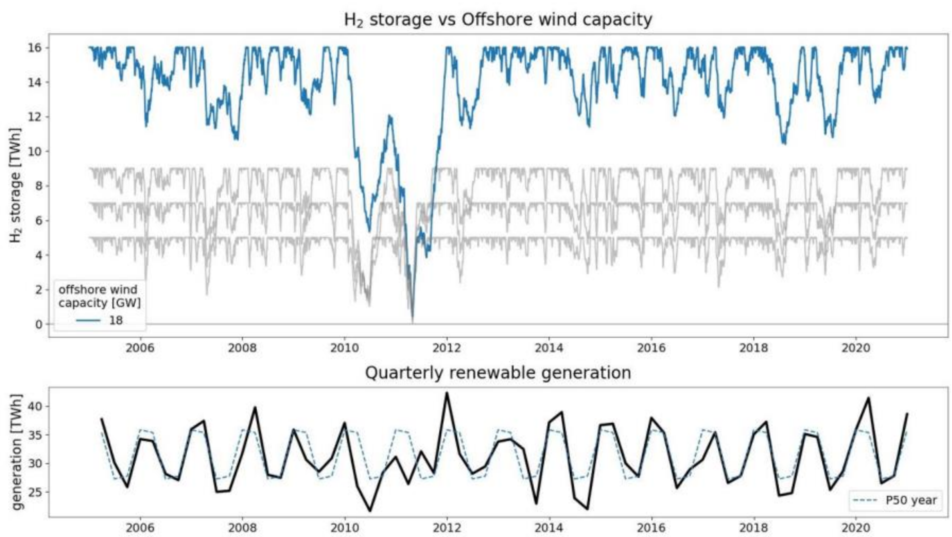


Figure A.2: H_2 storage vs Offshore wind capacity

During 2010-2011, the black line is significantly lower than the P50 line in 4 out of 5 consecutive quarters, namely: Q2 and Q3 in 2010 and Q1 and Q2 in 2011 (circled in red in the Figure A.3 below). In other words, wind generation was abnormally low in these periods. This is a multi-seasonal wind drought and determines the required size of hydrogen storage. The size of hydrogen storage would have been significantly underestimated if the simulation was run on a single average wind year, or if the 2010-2011 window was not included in the analysis.

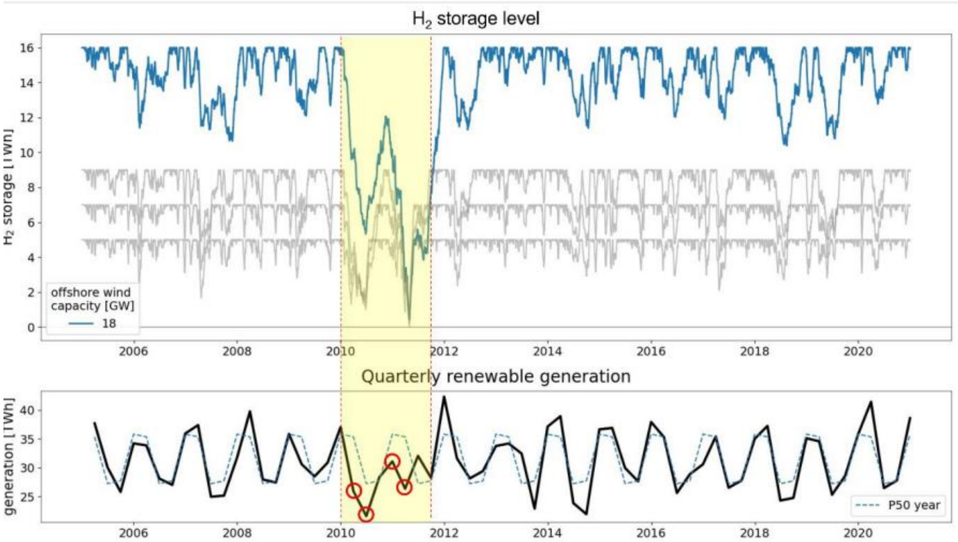


Figure A.3 H_2 storage level

Ireland must plan for resilience against the low renewables periods such as those seen in 2010 and 2011. This means that the starting point must be a resilient dispatchable generation fleet complimented by the required energy storage to meet the low renewables output periods. This closely interacts with the modelling of interconnection in the adequacy assessment. Electricity interconnection will be an important part of the zero-carbon electricity system and will move bulk volumes of renewables between markets to optimise the supply demand balance. However, interconnection will not play any significant role in security of supply when renewables output is low across northwest Europe.