Rialtas na hÉireann
Government of Ireland

# Electricity Storage Policy Framework for Ireland

## 2024



Prepared by the Department of
Department of the Environment, Climate and Communications
**gov.ie/DECC**

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# Minister's Foreword

Climate action is the most pressing long-term global challenge of our time and is a significant priority for the Government of Ireland. Through our strengthened climate legislation, the Programme for Government and our annually updated Climate Action Plan, we have set ourselves the ambition of halving Ireland's greenhouse gas emissions by the end of the decade and becoming carbon neutral by 2050. We are determined that Ireland will play its full part in EU and global efforts to stop climate change and in so doing, realise the rewards that come with a secure, low-carbon energy society.

It is vital that we take better care of our planet and ensure the best interests of our people through pursuing responsible and transformative policy approaches. While we still have a distance to travel, Government policies such as the *Electricity Storage Policy Framework for Ireland* contribute to these goals and are essential pieces in Ireland's energy transition from traditional fossil fuels to low carbon renewable sources.

This policy framework sets out the present role of electricity storage in meeting our 2030 climate goals as well as addressing the future deployment of electricity storage in Ireland up to 2040. Electricity storage systems enhance and ensure security of electricity supply in the electricity network by storing excess renewable generation; managing peak demand; providing system services and supporting strategic grid build out. It is vital that Ireland exploits the full potential of electricity storage, and the publication of this policy framework is an important step to achieving this goal.

This policy framework will provide certainty to all stakeholders to ensure the optimal amount of electricity storage is incorporated onto the grid while remaining neutral towards the various types of storage technologies capable of meeting these goals. While this policy framework is only a steppingstone in Ireland's energy transition it establishes electricity storage as an important building block upon which the Irish energy sector can grow and allows Ireland to explore and harness the opportunities offered by a low-carbon energy society.

## Eamon Ryan TD

**Minister for the Environment, Climate and Communications**

# Executive Summary

The aim of the Electricity Storage Policy Framework for Ireland is to clarify the role of electricity storage systems (ESS) in Ireland's climate objectives and energy transition. In 2019 the Climate Action Plan identified electricity storage as a key element in achieving these goals and the need for a first of kind policy framework to support the incorporation of electricity storage systems to the grid was identified.

To that end a public consultation "Consultation on Developing an Electricity Storage Policy framework for Ireland" was held in 2022, with a final summary of all responses published in May 2023. The 'Electricity storage policy framework for Ireland' is published with regard to the many responses received, the ongoing engagement and views of key stakeholders, industry and individuals. This policy framework highlights the valuable contributions by Ireland's electricity grids principal stakeholders, the Commission for the Regulation of Utilities and the two system operators, EirGrid and ESB Networks to this process.

This policy framework may be considered a steppingstone on Ireland's path to net zero carbon emissions and in securing Ireland's future energy supply by transitioning to an electricity-led system. This policy framework in the main refers to Front-of-Meter (FoM) electricity storage systems, i.e., electricity storage systems developed to provide grid supporting services, and their role in meeting Ireland's climate 2030 goals. It also addresses the Government's approach to Front-of-Meter electricity storage in the near-term (2030-2040) as well as the expected future of residential electricity storage and aggregated electric vehicle storage.

Since the first battery electricity storage system (BESS) in Ireland was energised in 2018 the role and technology of electricity storage systems on the grid has developed. There are now over 1GW of electricity storage systems providing specialist system services and demand flexibility. With peak renewable electricity generation in Ireland already above 5,800MW and growing, an increased focus on the efficient utilisation of this renewable electricity through the incorporation of electricity storage system through fit for purpose products and market access is paramount.

This policy framework outlines the present roles, processes, regulatory structures and market positions of electricity storage and addresses changes to the Enduring Connection

Policy, (non-)Firm connections, the DS3 system services replacement, SSFA (DASSA), the Schedule and Dispatch programme, Market access and Revenue stacking.

Further, this policy framework addresses the grids needs by supporting the immediate incorporation of targeted grid assisting demand flexibility and electricity storage system technologies to both the Distribution and Transmission networks, as well as committing to (long duration) electricity storage in-line with Ireland's Net Zero objective, through four actions designed to stimulate service provider participation and ensure the optimum level of electricity storage is incorporated on to the grid network.

This policy framework recognises that there are many potential future electricity storage technologies capable of accelerating the incorporation of renewable electricity efficiently onto the grid and will support both System Operators to trial emerging electricity storage technologies. This policy will also maintain a technological neutral approach and ensure that any associated Government supports will reflect this neutrality.

# 1 Electricity Storage Overview

## 1.1 Government Commitments: 10 Policy Actions

This policy framework presents 10 Government actions to support the role of electricity storage systems in Ireland's energy transitions. These 10 actions, the section in which they are discussed, the primary stakeholders and timelines are detailed below.

| **Policy Action 1** | | |
|---|---|---|
| *Maintain a technology neutral approach to all electricity storage systems.* | | |
| Section 1.3.3 | DECC | Commenced |

| **Policy Action 2** | | |
|---|---|---|
| *Creation of a 'sandbox' project to advance both System Operators' technological knowledge of emerging electricity storage technologies.* | | |
| Section 1.3.5 | DECC, EirGrid, ESB Networks | 2024 onward |

| **Policy Action 3** | | |
|---|---|---|
| *Convene an electricity storage and system services working group as part of the Accelerating Renewable Electricity Taskforce.* | | |
| Section 1.3.9 | DECC, CRU, EirGrid, ESB Networks | Commenced |

| **Policy Action 4** | | |
|---|---|---|
| *Convene a forum for an expanded group of stakeholders including statutory bodies, leading industry representatives and academic / interest groups.* | | |
| Section 1.3.11 | DECC & Wider Stakeholders | 2024-2025 |

| **Policy Action 5** | | |
|---|---|---|
| *Support access to the wholesale electricity markets, arbitrage and revenue stacking for electricity storage systems.* | | |
| Section 3.3.4 | CRU, SEMO, DECC with the assistance of System Operators | 2024-2027 |

| **Policy Action 6** | | |
|---|---|---|
| *Support the Immediate Procurement of Demand Flexibility products and of (long duration) electricity storage to meet specific network needs, in the Distribution and Transmission systems respectively.* | | |
| Section 3.7.4 | CRU, EirGrid, ESB Networks | 2024-2028 |

| **Policy Action 7** | | |
|---|---|---|
| *Initiate a 'Quantity' consultation to establish the optimal (long duration) electricity storage requirements to meet climate targets and electricity grid network expansion between 2030-2040.* | | |
| Section 3.8.1 | DECC with assistance from EirGrid, ESB Networks | 2024-2028 |

| **Policy Action 8** | | |
|---|---|---|
| *Initiate a 'Financial' consultation to establish if the expected market mechanisms due between 2025-2028 will provide sufficient service provider certainty to meet the optimum (long duration) electricity storage systems requirements of 2030-2040.* | | |
| Section 3.8.2 | DECC | By end of 2028 |

| **Policy Action 9** | | |
|---|---|---|
| *If required and pending the outcome of the 'Financial' consultation, develop a market framework to further incentivise the incorporation of (long duration) electricity storage system technologies to the grid to meet projected 2030-2040 requirements.* | | |
| Section 3.8.3 | DECC with assistance from CRU | By end of 2028 |

| **Policy Action 10** | | |
|---|---|---|
| *To ensure a route to market for the identified optimum (long duration) electricity storage requirements for 2030-2040 is in place before end of 2028.* | | |
| Section 3.8.4 | CRU with assistance from DECC | By end of 2028 |

## 1.2 Our Ambition

This policy underpins the role that electricity storage is expected to play in meeting our 2030 targets and beyond, in doing so it creates a framework to accelerate the incorporation of electricity storage to the grid network. This policy framework is published in line with Climate Action Plan action (CAP 24/16) and recognises the ability of electricity storage systems to tackle many of the challenges posed by Ireland's CAP programme including the ambitious renewable electricity deployment targets.

This policy framework recognises that an increased deployment of electricity storage systems is critical to maximising the integration of renewable electricity onto the grid while maintaining a secure supply of electricity throughout Ireland's energy transition, thereby reducing emissions ceilings for greenhouse gases in the electricity sector by 2030 and ultimately improving the overall affordability of energy to the consumer.

Electricity Storage Systems (ESS) have an important role to play in facilitating the following CAP and Sectoral Emissions targets:

- Increasing the penetration of Renewable Energy Sources (RES) in our Electricity (-E) sector to 80% by 2030.
- Supporting a target of 9GW of onshore wind generation by 2030.
- Supporting a target of 8GW solar generation by 2030.
- Supporting at least 5GW of offshore wind by 2030.
- Supporting 20-30% of demand side flexibility available to the system by 2030.
- Maximising the level of incorporation of renewably generated electricity to the grid network {Referred to as System Non-Synchronous Penetration - SNSP} by 2030 to 95%.
- Limiting Dispatch Down {excluding surplus generation} of renewables below 7%.
- Limiting sectoral carbon emission for the electricity sector for the periods 2021-2025 to the budget of 40 MtCO2eq and reducing this by a further 20 MTCO2eq for the second budgeting period 2026-2030.

This policy framework in the main refers to Front-of-Meter (FoM) electricity storage systems, i.e., electricity storage systems developed to provide grid supporting infrastructure services such as demand flexibility, strategic build out and system services. While the core focus is

on the 2030 goals, this policy framework also considers the grids needs beyond that timeframe. In this regard, this policy framework may be referred to as a steppingstone on Ireland's path to a net zero carbon energy system.

Electricity storage systems will maximise the incorporation of available renewable electricity across the grid system, further decarbonising our electricity system, reducing our dependence on fossil fuel generation and improving the overall operation of the electricity network through the provision of Targeted Demand flexibility, Strategic Grid Build Out and System services.

The Targeted Demand flexibility provided by electricity storage systems is vital to maximising the incorporation of renewable generation while maintaining a secure electricity supply, as it allows for the re-allocation of dispatchable renewable electricity through time by storing renewable electricity at times of surplus supply and exporting it back into the grid when required to meet customer demand and system needs.

The System services provided by electricity storage systems improve the overall operation and reliability of the network and facilitate the efficient integration of renewably generated electricity through a variety of processes (covered in Chapter 2), making electricity storage systems vital assets in supporting the effective functioning of the network and achieving our CAP targets for electricity.

The Strategic Grid Build Out provided by electricity storage systems is vital to the reinforcement of the grid. Renewable energy development projects can place strain on the System Operator's capacity to deliver an uninterrupted service. To that end, the incorporation of strategically located electricity storage systems will reduce this disruption and alleviate potential grid issues caused by upgrading infrastructure projects. It is the comparative ease and cost, with which electricity storage systems can be integrated to reinforce a regional or local grid network constraint that makes electricity storage systems particularly useful in the immediate management of local network grid build-out.

Therefore, in parallel with the European Union's Renewable Energy Directive (RED III), Electricity Market Design (EMD) and other EU Frameworks, Directives and Regulations regarding the deployment of renewable energy resources within the grid system and markets (further details may be found in Chapter 3), this policy framework while recognising the independent roles of both the System Operators and the Regulatory authority, welcomes

and supports the immediate incorporation of locational specific demand flexibility products and electricity storage systems to address identified system needs on both the distribution and transmission systems. Further, this policy framework includes actions to identify and incorporate the optimum amount of electricity storage to meet Ireland's near-term (2030-2040) requirements.

## 1.3 Approach overview

In this section of the policy framework the Government seeks to remove ambiguity in regard to the below aspects of electrical storage systems.

- Scope and Limits
- Technology neutral
- Emerging Technology
- Definitions
- Duration & Capacity
- Stakeholder alignment

### 1.3.1 Scope & Limits

This electricity storage system policy framework is primarily focused on the role of Front-of-Meter (FoM) electricity storage systems in achieving Ireland's CAP targets as outlined in Section 1.2 of this chapter. This policy framework has regard to both electricity storage systems at present in service on the grid as well as future electricity storage technologies not yet incorporated onto the grid system.

As stated previously, this policy framework is primarily focused on the role of electricity storage systems in achieving Ireland's 2030 CAP targets. However, the policy framework also takes consideration of the needs of the system beyond this timeframe and in-line with other Government policies.

This policy recognises that other Government Departments and Units within the Department of the Environment, Climate and Communications are addressing aspects of Ireland's response to the climate challenge through other policy documents. To that end a list of existing Government policy with relevance to, or which reference this electrical storage policy framework may be found in Annex F.

For clarity, this policy document is not designed to provide policy on:

- Energy Security
- Seasonal energy storage systems and processes (Hydrogen, Ammonia etc) and their associated markets
- Renewable Hubs
- Thermal storage systems for non-electricity uses
- Large Energy Users (LEU's)
- Residential heat

While this policy framework will address small scale distributed storage solutions such as Residential (Battery) Electrical Storage Systems (R-BESS), Electric Vehicle (EV) battery storage and distributed aggregate storage systems at domestic level, it will do so in-line with European Union policy and the expected implementation of these on the island of Ireland. (Chapter 2 refers).

### 1.3.2 Electricity Storage Technology

While the present composition of electricity storage on the island of Ireland is in the main comprised of Battery Energy Storage Systems (BESS) and a Pumped Hydro Storage (PHS) facility, this is in large part due to these technologies being to date the best equipped to provide grid services and to meet peak demand.

While this policy framework also recognises that BESS and PHS are the most widely deployed storage technologies globally today, this policy framework is aware that there may also be other technologies capable of meeting, individually or collectively, the system service requirements of the grid network and / or the demand flexibility needs of either the grid network or consumers.

The Government considers that to avoid distorting markets, influencing service providers and to ensure value for the consumer, it is important that where relevant this policy acts as a neutral market facilitator and does not preclude any eligible electricity storage product or demand flexibility technology.

### 1.3.3 Action #1: Technology neutral

This policy framework actions (Action #1) a '*Technology neutral*' approach, which means that this policy neither favours nor discourages one technology over another. This policy is

aware that to meet Ireland's targets in electricity transition to renewable energy, electricity storage systems will be required to provide services of differing speeds, durations, emission limits etc., and that at present no one technology is successful in all these areas.

Rather than limiting any procurement processes to specific electricity storage technology types, this policy seeks the incorporation of technology neutral market products, un-restricted by product type and regulated only by their capability to meet the requirements and service characteristics of the System Operators and the regulatory requirements of the Commission for Regulation of Utilities (CRU) or *Regulatory Authority*.

To ensure that electricity storage system product procurement processes are not limited to specific technology types, this Department will engage with the Regulatory Authority on their approach to technological selection criteria for electricity storage system products and to consider technology neutral procurement mechanisms based on technical service characteristics that best meet the grid networks needs as set out by the System Operators.

In this way the Government supports the potential for a portfolio of electricity storage technologies to be incorporated into the grid system based on system needs and the capacity to meet established minimal grid requirements, technical standard thresholds, and lower emission targets.

### 1.3.4 Emerging Technology

This policy framework recognises that electricity storage and electricity storage systems have many types and varied roles. The types of electricity storage technologies and their uses is a broad area and not all are included or intended to be covered in this policy framework. While this policy references in the main Lithium-ion batteries energy storage system (Li-BESS) and Pumped Hydro Electricity Storage Systems, this is because these two electricity storage system types are to date the most established to deal with grid and demand issues in the Irish context. Further information in regard to ESS technologies both in existence and in varying stages of development and deployment across the globe, are covered in Annex B.

It is clear that a balanced portfolio of technologies, including an array of storage technologies across various durations, will be required to support the transformation of the electricity system as the level of renewable penetration increases and that we cannot rely on any single electricity storage technology to meet our needs.

### 1.3.5 Action #2 Emerging Technology Sandbox

In conjunction with the System Operators (EirGrid and ESB Networks) this policy framework actions (Action #2) the creation of an electricity storage system 'Sandbox'. A 'Sandbox' is an environment in which technologies can be tested in Isolation. A Sandbox allows for research into new and emerging technologies whilst preventing them from impacting the wider system in which they would operate, in this case the electricity grid network. The aim of the 'Sandbox' is to facilitate the System Operators knowledge development of new and emerging technologies. This policy framework will support both System Operators to identify and pilot emerging electricity storage technology and / or processes potentially capable of incorporation onto the grid network. While potentially this 'Sandbox' may identify emerging technology capable of assisting the System Operators in meeting their immediate pre-2030 targets, it is considered that these 'Sandbox' trials should deliver to the System Operators an advantageous perspective in regard to emerging technologies capable of addressing Ireland's near and long-term carbon neutral objectives. This Department will engage with the System Operators through the Joint System Operator Programme (JSOP) and the Regulatory Authority to establish appropriate Terms of Reference (ToR), funding mechanism(s) and participatory parameters for this 'Sandbox'.

### 1.3.6 Definitions

The European Union Directive 2019/944 (S.I. 20/2022), which came into effect in January 2022, defines electricity storage, in the electricity system as:

"*Deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier*."

This policy framework is conscious that the terms 'electricity storage' or 'electricity generation' and 'energy storage' and 'energy generation' may initially appear interchangeable but that they are not. This policy is also aware that, and in-line with the EU definition above, while all electrical storage / generation is energy storage / generation, not all energy storage or generation is electrical and that both energy and electricity storage maybe utilised to produce a large variety of energy types apart from electricity, such as heat, steam and hydrogen amongst many. Therefore, for clarity where the term 'electricity storage' is used throughout this policy it refers to the above EU 2019/944 definition.

***Service providers:*** Unless otherwise directly addressed and where relevant this policy framework will refer to persons, apart from the key stakeholders; The Regulatory authority and both System Operators: EirGrid and ESB Networks, who participate in all matters related to electricity storage as '*service providers'*. The intention is to ensure that the information in this policy framework reaches the full spectrum of electricity storage participants and does not unintentionally exclude any electricity storage participants through the erroneous use of a specific activity (Investor / Developer / Customer etc.,). The term 'service provider(s)' therefore includes but is not limited to individuals or groups, such as investors, developers, designers, engineers, commercial entities, industries, associations, customers or end users etc.

### 1.3.7 Electricity Storage System Duration & Capacity

In progressing this electricity storage policy framework, the Department is aware that electricity storage systems of different strengths and duration are required for different purposes and it is of assistance to clarify the use of this nomenclature. This policy framework notes how the use of Long and Short term / duration storage in other Government documents is appropriate to facilitate an understanding of the type / duration of the electricity storage system relevant to that documents content.

However, this policy framework is cautious in its use of terms such as 'Long duration' or 'short duration or long-term, short-term' due to their subjectivity as a technical characteristic. It is considered that the use of terms such as short, medium, long may be open to numerous interpretations and may erroneously influence product development or investment choices.

It is the intention of this policy to use, where possible, the 'nameplate' electrical storage capacity of an electricity storage system, expressed in Mega Watts (MW) and Mega Watt hours (MWh) with the number equating to the designed Maximum Export Capacity (MEC) of the storage system when fully charged measured in wattage. I.e.: A 2MW electricity storage system with capacity to discharge for 2 hours equates to a 4MWh electricity storage system.

However, it is important to note that the use of (long duration*) electricity storage is used repeatedly in Chapter 3 as a description of a financial product created to incorporate electricity storage systems with the capacity to deliver electricity throughout a 4 hour period or more to the transmission system. The intentional use of (long duration*) in brackets and before electricity storage in this context is intended to acknowledge that all electricity storage technology types including those not yet available at the time of writing this policy framework

would be included once they meet the 4+ hour capacity parameter of the electricity storage product.

For further information on the types of electricity storage technologies, please refer to Annex B of this policy document. Within this section, a detailed description of the characteristics of various storage technologies is included. It is important to note that the list of technologies included in Annex B is not exhaustive, rather, this policy framework acknowledges that other storage technologies exist beyond this list and new technologies will emerge as research and development continues in the industry.

### 1.3.8 Stakeholder Engagement

This policy wishes to inform the public, the consumer, the service providers and all stakeholders, that this Government recognises and supports the important role of all stakeholders in regard to the development and incorporation of electricity storage systems to the national grid network both now and for many years to come. This policy framework in particular wishes to highlight the important role in the area of electricity storage systems shared by the principal stakeholders: the Commission for the Regulation of Utilities; the two System Operators, EirGrid and ESB Networks, as well as the Department of the Environment Climate & Communications. While each of the principal stakeholders are independent in their tasks, this Government recognises that for electricity storage systems in general and for this policy framework in particular to achieve its goals, a coordinated approach by all stakeholders to the role of electricity storage in Ireland is vital.

In November 2022 the Department of the Environment, Climate and Communications held a public consultation to assist in the development of an electricity storage policy framework on the island of Ireland. Sixty-eight responses were received and a summary report on the consultation findings was published by AZOROM consulting on behalf of the Department in May 2023. The public consultation brought together input from many different stakeholders, including the CRU, EirGrid, ESB Networks, electricity storage system service providers, industry bodies, small, medium and large Industries, academics, interest groups and members of the general public. The Department thanks all contributors.

It was clear from the responses received that for this policy to achieve its goal respondents felt that there must be alignment of objectives and a coherent implementation strategy between key the stakeholders, DECC, the CRU and the System Operators.

This policy framework recognises and acknowledges the valuable contributions of the principal stakeholders mentioned above and their on-going participations in various climate action working groups and stakeholder's forums on issues outside the remit of this policy framework. This policy framework also recognises the on-going bi-lateral and tri-lateral meetings held between stakeholders in regard to specific electricity storage matters such as the 'route to market' products discussed in Chapter 3.

### 1.3.9 Action #3: Storage & System Services Working group

However, in addition to the above and in order to address broader requirements of electricity storage systems this policy framework actions (Action #3) the creation of a new working group, to be known as the 'Storage and System Services Working group'. This working group is comprised of representatives from the four (4) main statutory institutions responsible for the incorporation of electricity storage systems to the grid network, CRU, ESB Networks, EirGrid and DECC and will report to the Accelerating Renewable Electricity (ARE) Taskforce which was established in line with the Climate Action Plan to identify, coordinate and prioritise the required policies needed to achieve our onshore renewable electricity targets and ensure that barriers to the implementation of such policies are removed or minimised to the greatest extent possible through direct input from all principal stakeholders. The ARE Taskforce is led by the Minister for the Environment, Climate and Communications and includes senior officials from Government Departments and relevant statutory bodies including:

- The Department of the Environment, Climate and Communications
- The Department of Public Expenditure, NDP Delivery and Reform
- The Department of Housing, Local Government and Heritage
- The Department of Enterprise, Trade and Employment
- The Commission for Regulation of Utilities
- EirGrid
- ESB Networks
- The Sustainable Energy Authority of Ireland
- New ERA
- The Ireland Strategic Investment Fund

This policy framework supports the Storage and System Services Working group in their remit to remove obstacles to the incorporation of additional electricity storage systems to

meet the established CAP targets as well as accelerating the incorporation electricity storage systems to the grid to meet immediate targeted locational and technological specific needs.

The targets (objectives and milestones) of the Storage and System Services Working group include the following:

- Review the Electricity Storage Policy Framework (ESPF) prior to publication.
- Reduce operational constraints to achieving the 2030, 80% renewable generation and 95% System Non-Synchronous Penetration (SNSP) targets.
- Assist in the development of market access roadmaps for electricity storage systems (ESS).
- Expedite the connection of 4+hour electricity storage systems to the grid.
- Support the CRU in the delivery of the National Energy Demand Strategy (NEDS)
- Support the delivery of ESB Network Demand Flexibility Products.
- Track and deliver the 'Schedule & Dispatch' programme.

The Working group is now an established forum and work continues apace to ensure that there is sufficient engagement and alignment amongst key stakeholders to drive home policy objectives necessary for the correct and proper functioning of electricity storage systems on the grid both now and into the future.

### 1.3.10 Key Stakeholders

This policy framework recognises that the role and incorporation of electricity storage on the grid network of the island of Ireland are in the main, matters for both the CRU and the Utility Regulator, the Northern Ireland Regulatory Authority, as well as the four System Operators. Brief outlines for each of these organisations are included here:

**Commission for Regulation of Utilities (CRU)**

The Commission for Regulation of Utilities (CRU) or *Regulatory authority* is Ireland's independent energy and water regulator. As an independent regulator, the CRU is accountable to a committee of the Oireachtas and not the Minister. Given the CRU's mission to protect the public interest in Water, Energy and Energy Safety, it was assigned responsibility for the regulation of the Irish electricity sector following the enactment of the Electricity Regulation Act, 1999 and subsequent legislation. The CRU is committed to playing its role to help deliver a secure, low carbon future while ensuring security of the

energy supply. It is further charged with empowering, protecting and ensuring value for money to the consumer and the regulation of the energy markets. Inter alia the Commission for the Regulation of Utilities (CRU) is also responsible for: Grid connection policy, the terms and conditions under which generators, storage and other system services technology projects connect to the electricity grid system; the DS3 and System Services Future Arrangements (SSFA) and in conjunction with the Transmission System Operator, the Schedule and Dispatch programme and the development of schemes to facilitate the 'route to market' of electricity storage products.

Further information on the CRU's role and relevant legislation can be found on the CRU's website at www.CRU.ie

**The Utility Regulator**

As an Independent, non-ministerial Government Department and the economic regulator for electricity gas and water in Northern Ireland, the Utility Regulator (UR) aims to promote and protect the short and long-term interests of consumers. Their remit is to ensure the regulation and development of the relevant industries within Northern Ireland.

**EIRGRID**

EirGrid is Ireland's Transmission System Operator (TSO). EirGrid is responsible for the planning and operation of the electricity transmission system. This system is vital to ensure the secure transportation of electricity from its generation point to its consumption point. In conjunction with their Northern Ireland counterparts, SONI, EirGrid's role as TSO is crucial not solely for existing customers but also continuing to identify the future needs of Ireland's transmission grid. EirGrid in conjunction with the Regulatory authority, plan investment needs accordingly, to ensure a safe, secure, economic and sustainable supply of electricity for Ireland, now and into the future.

In addition to the operation of the transmission grid, EirGrid's remit extends across multiple areas linked to electricity storage. These include the operation of the Single Electricity Market (SEM) and the DS3 system services, the development of the successor to DS3, the System services Future Arrangements (SSFA) and the exploration of potential routes to market for electricity storage technologies. For more information on the SEM, DS3 and SSFA please refer to Chapter 3 of this policy framework.

**SONI**

The System Operator for Northern Ireland (SONI) is the Transmission System Operator in Northern Ireland. Like EirGrid, SONI manages the transmission grid to ensure the flow of

electricity from where it is generated to where it is needed. SONI plays a crucial role in the balancing of consumer demand and electricity generation as well as ensuring Northern Ireland's future energy needs are met by developing projects to upgrade and enhance the grid. Under regulation and licensing of the Utility regulator, SONI work alongside EirGrid in operating the All-Island Single electricity markets (SEM).

**ESB Networks**

ESB Networks owns and maintains the Transmission Network (TSAO). It is also the owner and operator of the Distribution Network (DSO). ESB Networks strives for excellence in customer service and have served in this role for over 90 years and manage over 157,000 km of overhead network and 26,000 km of underground cables through more than 800 high voltage substations. The connection and delivery of electricity, including renewable generation, to over 2.4 million customers through this network is financed by ESB Networks under licence from the CRU. As the Distribution System Operator (DSO), ESB Networks ensure a safe and reliable distribution system, undertaking the functions related to asset management, planning, construction, maintenance, and operation of the high, medium, and low voltage distribution network.  Additionally, ESB Networks plays a vital role in the electricity market throughout Ireland, managing relationships with market participants and in support of the wholesale I-SEM through the provision of aggregated meter data.

**Northern Ireland Electricity (NIE) Networks**

As the owner of the electricity transmission and distribution networks, NIE Networks transports electricity across Northern Ireland. NIE operate as an independent organisation and are the Distribution System Operator for Northern Ireland. Like ESB Networks, this extends NIE's remit across a host of functions, including connections, market facilitation, network management and pricing.

### 1.3.11 Action #4: Stakeholder forum

This Department values the on-going engagement with all stakeholders, including industry, industry representative associations, regulatory bodies, academia and individual members of the public. While this Department will continue to commit to participation in various annual conventions and forums, it also seeks to engage with an expanded stakeholder pool in a more established manner in regard to new technologies and potential policy actions.

This Government through this policy framework commits to broader stakeholder engagement and values the role consistent clear messaging from a broad range of interested stakeholders plays. To that end and in addition to our on-going stakeholder commitments and engagements, this policy framework actions (Action #4) the Department of Environment, Climate and Communications to convening a stakeholder forum regarding the electricity storage policy framework once published. This forum will be directed at relevant statutory bodies, leading industry representations and academic / interest groups. It is the intention of this policy framework to convene this forum before the end of 2024.

## 1.4 Background to this policy framework

### 1.4.1 Challenges

*Unless otherwise stated all figures supplied refer to an all-island Single Electricity Market (SEM) which is operated by the two Transmission System Operators, EirGrid in Ireland and SONI in Northern Ireland.

As the first specific Government policy framework for electricity storage, it is important to note here that this policy is developed with regard to our European Union commitments and national policy objectives. This policy framework references throughout various national policy initiatives and documents as well as European Union frameworks, Directives and Regulations, further information on all the national and European publications referenced in this policy framework may be found in Annex F and Annex D respectively.

Ireland's present energy targets were created in conjunction with the 2019 European Green Deal goals of climate neutrality by 2050 and a reduction of 55% in greenhouse gas emissions by 2030 compared to 1990 levels.

2019 also saw the EU revision of its Energy policy framework to aid the continent's move away from fossil fuels, towards cleaner energy in line with European Green Deal objectives. Referred to as the Clean Energy Package, this package includes policy provisions for electricity storage, clarifying its role in the system, facilitating access to markets and harmonising the national policy framework's key provisions for electricity storage in the Clean Energy Package to include:

- Providing a technology neutral definition of electricity storage.
- Recognising electricity storage as an essential element in the energy transition.

- Requiring System Operators to move towards market-based tendering of flexibility services and to consider electricity storage in system planning.
- Establishing non-discrimination in network charging.

The Clean energy package consists of eight legislative instruments, those that are particularly relevant to energy storage are set out in Annex D.

### 1.4.2 The European Union

The European Union's Re-Power EU response to Russia's invasion of Ukraine in 2022 highlighted the importance of accelerating all forms of storage capacity, with the European Commission recognising the development of electricity storage assets as being 'in the overriding public interest'. Electricity Storage Systems are now intrinsic to the successful deployment of renewable energy and as overall renewable electricity, generation, supply and demand grows in Europe, so too must the role for electricity storage and other flexibility measures. It is this intricate role played by electricity storage in the overall electricity system that makes electricity storage system's a primary focus not only nationally but at an EU level also.

Further, with the energy crisis following the Russian invasion of Ukraine, there has been an increased emphasis on transitioning to renewables and on security of supply. It is acknowledged that there is an increased need for both short-term and long-term energy storage across Europe, requiring a broad range of new and existing solutions. It is understood that at present a variety of technologies will be required to achieve a net zero energy system, so it is vital that all storage technology innovations and especially the capacities of electricity storage system technologies are properly supported by effective European and national policy.

During 2022 the European Union introduced the regulatory document "*Laying Down A Framework To Accelerate The Deployment Of Renewable Energy*". Electricity storage systems, amongst other renewable technologies, are covered within this regulation. According to the regulation, electricity storage projects can benefit from numerous measures to facilitate their deployment. These measures include the planning and permit process for construction and operation of plants and installations, in which electricity storage projects are granted priority. Additionally, the regulation specifically gives mention to an accelerated permit-granted process for co-located renewable energy generation equipment and

electricity storage installations and electricity storage projects necessary to integrate renewables into the electricity system.

The European Union Renewable Energy Directive (RED) is 'the legal framework for the development of clean energy across all sectors of the EU economy, supporting cooperation between EU countries towards this goal. RED III, EU Directive EU/2023/2413, entered into force in November 2023. This most recent iteration sets a renewable energy target of at least 42.5% binding at EU level by 2030, with an aim of hitting 45%. Contained within the revised directive are multiple mandates to member states regarding storage, including requirements to establish a market mechanism framework for electricity storage systems. Further detail on markets in regard to electricity storage are included in Chapter 3.

### 1.4.3 Electricity Storage Systems in Ireland

Here in Ireland recent successful policy initiatives haves situated Ireland amongst the top in terms of our deployment of renewable generation assets. As a small island nation Ireland ranks in the top tier for installed wind power capacity per capita, with approximately 4.8GW of onshore wind generation capacity, 500MW of solar generation and a further 1GW of electricity storage connected to the grid. However, renewable energy generation alone will not suffice if we are to meet our targeted climate goals.

Intrinsic to achieving all of our electricity climate goals is an all-island electricity network capable of delivering this renewable electricity to the consumer. Renewable energy generation poses unique challenges to the electricity network such as un-scheduled scarcities and surpluses of supply which greatly challenge the capacity of the grid to continually maximise the incorporation and delivery of the renewable generated electricity.

At the end of 2023 the average total daily demand of the all-island Single Electric Market (SEM) was approximately 110,000 MWh per day with an all-island peak of 6,800MW. With renewable electricity generation capacity in Ireland already above 5,800MW and growing, it will be the efficient delivery of this electricity that is key to meeting our targets.

Accelerating and maximising the incorporation of renewable energy into the grid system is now a priority and electricity storage systems play an important role in this by consistently expanding the maximum level of renewables at any one time on the grid. Efficient and strategic placement of electric storage systems throughout the grid will enable us to reach our Climate Action Plan goal of achieving a System Non-Synchronous Penetration (SNSP) level of 85% by 2025 and 95% by 2030.

System Non-Synchronous Penetration (SNSP) is a real-time measure of the percentage of non-synchronous generation on the grid, expressed as a percentage of the total demand at a specific point in time.

In the first half of 2022, the System Operator reached its original target of 75% SNSP and is now working to increase this limit to 95% by 2030. However, there are four main factors which impact the ability of the SOs to meet this target:

1. The variable nature of renewable generation (scarcity and surplus).
2. How the (non-synchronous) electricity created by renewables affects the grid network.
3. The legacy of the original Irish power grid system constructed to carry controllable power (synchronous) from large traditional centralised generation installations.
4. The lack of capacity of localised grid infrastructure (containment) where renewable energy is now both generated and required.

In their publication ‘Shaping Our Electricity Future Roadmap version 1.1’, an update on the previous version published in 2021, EirGrid and SONI, the all-island Transmission System Operators, set out a plan-led approach to deliver an electricity system in 2030 which meets Ireland’s climate targets, to include 80% of electricity demand being met from renewable energy, and comply with legally binding Carbon Budgets and allow for electricity demand growth.

As part of the update to ‘Shaping Our Electricity Future Roadmap version 1.1’ the transmission operators have identified 16 further grid reinforcement projects and 4 Renewable Hubs which are required in addition to the previously identified transmission grid upgrade works. In total EirGrid have identified more than 350 projects which are required by 2030 to deliver the required transmission network.

Similarly, in January last year ESB Networks, Ireland’s Distribution System Operator, launched its Networks for Net Zero Strategy which outlines its commitment to futureproofing Ireland’s electricity network and making the country’s goal of net zero by 2050 a reality. In order to meet the changing needs of society and to achieve climate action targets, ESB Networks has set out an estimated €10 billion investment to 2030 to develop a smarter and more flexible electricity network. The Networks for Net Zero Strategy outlines ESB Networks’

drive to develop a Net Zero Ready Distribution Network by 2040 which will enable Ireland's achievement of net zero no later than 2050.

It is noted that the EirGrid Generation Capacity Statement forecasts strong demand growth driven by on-going electrification of heat and transport and the expected expansion of large energy users (LEU) such as data centres, please note further information on Large Energy Users (LEU's) is contained in the ongoing CRU LEU Policy consultation as part of the National Energy Demand Strategy, details of which may be found on the CRU web-site here.

CRU Consultation on Large Energy Users

As the electricity generation and demand landscape changes, all of the System Operators are working hard to develop a stronger and more flexible electricity grid. At both transmission and distribution level, electricity storage is identified as an important element in facilitating this transition.

In fact, electricity storage already plays a significant role in the Irish electricity system, with a combined storage capacity of over 1GW connected to the Irish grid by early 2024. This 1GW+ capacity is comprised of 18 Lithium-ion batteries (Li-BESS) sites with a nameplate capacity of over 730MW providing on-demand dispatchable power as well as "system services" used to keep the national grid working effectively. Information on these sites can be found in Annex A. It is notable that at present the majority of these BESS have a duration capacity of two hours or less. The remainder of the electricity storage is derived from the pumped storage station at Turlough Hill, Co. Wicklow, which has the capacity to generate a further 292MW of dispatchable electricity for up to six hours.

However, more storage is required and this Government, in recognition of this fact and through this policy framework, assists the System Operators and Regulatory authority to incorporate further electricity storage technology to the national grid in a safe and regulated manner and in tandem with the grid network future needs. Further detail and 'Routes to market' are covered in Chapter 3.

# 2. The Role of Electricity Storage in the Electricity Transition

## 2.1 Grid Management and Build Out

Electricity storage systems are well placed to play a variety of roles in Ireland's transition to renewable energy and to do so in an efficient, controlled, safe and regulated manner. A grid with fit for purpose electricity storage systems will assist in securing the supply of cheap green renewable energy to the Irish consumer, reducing the need for costly fossil fuel generation. This chapter sets out the role of electricity storage systems in regard to the electricity grid network.

### 2.1.1 Overview of grid management

The Irish electricity grid network is divided into two parts.

- The Transmission Network, operated by the Transmission System Operator (TSO) EirGrid (Ireland).
- The Distribution Network, operated by the Distribution System Operator (DSO) ESB Networks (Ireland).
- Both of these System Operators work in tandem with their counterparts in Northern Ireland. System Operator Northern Ireland (SONI) is the Transmission System Operator (TSO) for Northern Ireland and Northern Ireland Electricity (NEI) Networks is the Distribution System Operator.

Both of the Irish System Operators (SOs) are regulated by the Commission for the Regulation of Utilities (CRU) and the Northern Ireland System Operators are regulated by the Utilities Regulator (UR). Further information on all of the above is included under the 'Key Stakeholder' heading in Chapter 1

### 2.1.2 Electricity storage in grid build-out

As Ireland progresses along its energy transition pathway, an increase in renewable generation will necessitate a parallel growth of transmission and distribution infrastructure in order to meet future supply and demand and system requirements. The approaches of both of Ireland's System Operators to developing a 'fit for purpose' grid system are set out in EirGrid's "Shaping Our Electricity Future" and ESB Networks "Networks for Net Zero". Both

documents outline the role Electricity storage systems will play in facilitating future growth of Ireland's electricity grid.

In July 2023, EirGrid published 'Shaping Our Electricity Future (SOEF) Roadmap version 1.1', an update on the previous version published in 2021. SOEF is a plan led approach to deliver an electricity system in 2030 which meets Ireland's climate targets, to include 80% of electricity demand being met from renewable energy, complies with carbon budgets and allows for electricity demand growth. EirGrid, as part of the update to SOEF, have identified 16 further grid reinforcement projects and 4 Renewable Hubs which are required in addition to the previously identified transmission grid upgrade works. In total EirGrid have identified in excess of 350 projects which are required by 2030 to deliver the required transmission network.

In order to meet decarbonisation objectives SOEF 1 highlights the need for a balanced portfolio of technologies to provide system flexibility, including demand side management, long-duration storage and low carbon technologies amongst others. Delivering a balanced portfolio of generation, interconnection, storage, renewables and demand response will ensure the lowest possible emissions from the fleet to meet 2030 objectives and beyond. The roadmap also recognises the strategic deployment of energy storage technologies in constrained regions of the network. This approach works to somewhat reduce constraint of renewable generation, by taking in excess generation during hours of constraint.

The roadmap assumes that existing pumped hydro energy storage (PHES) will continue to operate in Ireland by 2030, and that there will be growth in battery energy storage capacities in both jurisdictions. It also assumes battery energy storage (BES) technologies are required in 2030 for:

- reserve provision
- capacity adequacy
- to assist with congestion management
- and to help manage surplus renewable generation while minimising the amount of renewable generation required to deliver the Government's target.

It is assumed that the energy-to-power ratio of the battery fleet will increase over the period to 2030 with mostly reserve-only batteries expected before 2025 followed by longer duration batteries capable of providing capacity, flexibility and reserve.

The technology enablement workstream includes a commitment to addressing the challenges associated with the integration of large-scale electricity storage technology.

Like SOEF, the Networks for Net Zero Strategy sets out ESB Network's role in supporting the decarbonisation of the electricity system. It is centred on their role as the DSO, empowering consumers to decarbonise their energy consumption as well as through their role as transmission asset owner. The strategy sets out the expected development of the distribution network by 2030, highlighting increasing amounts of energy storage as a key component. Storage is included in two of the three elements of the overall strategy, firstly in regard to decarbonised electricity, in which storage is mentioned in the context of connecting renewables and system flexibility and then in regard to resilient infrastructure which highlights high-capacity storage as a requirement for the transition to a low carbon future.

The cost of funding the development, operation and maintenance of the Irish electricity grid is established in 5 year-price review' (PR) cycles and sourced from charges to the electricity networks customers, all of which is also regulated by the CRU also.

We are at present in 'price review' cycle (PR5) spanning 2021 to 2025, which is investing over €4 billion into the electricity network to secure the electricity grid throughout Ireland's energy transition. The initial phases of the PR6 cycle spanning 2026-2030 have now begun.

While new infrastructure systems are being built to meet future demands, the capacity to improve efficiency and optimise the existing infrastructure (re-powering) is also under way. This re-powering is a key step in a future-proofed grid system and involves the upgrading, replacement, and placement of specific equipment to increase the capacity of the local transmission and distribution systems.

All these development projects to reinforcement the grid, can also place strain on the System Operator's capacity to deliver an uninterrupted service. To that end, the incorporation of strategically located demand flexibility products and electricity storage systems will reduce this disruption and alleviate potential grid issues caused by upgrading infrastructure projects. It is the comparative ease and cost with which electricity storage systems can be integrated to reinforce a regional or local grid network that makes electricity storage systems particularly useful in the immediate management of local network grid build-out.

This policy fully supports the System Operator's strategic use and immediate incorporation of locationally specific demand flexibility products and electrical storage systems, particularly where the incorporation of these will accommodate the incorporation of greater quantities of renewable energy generation and mitigate connection and supply issues during grid build-out.

## 2.2 Benefits of Electricity Storage

### 2.2.1 Principal Benefits of Electricity Storage Systems

Electricity storage systems have three principal functions that assist the effective and efficient functioning of the electricity grid network, Demand Flexibility of dispatchable electricity, Strategic Grid Build-out and System services.

It is expected that the grid's need for these three electricity storage attributes, either daily, weekly and even monthly will increase in the coming years. However, at present a role for electricity storage to meet inter-seasonal or inter-annual needs is not envisaged given the present characteristics and limits of available electricity storage system technologies other than Pumped Hydro Electrical storage.

### 2.2.2 Electricity Storage System Dispatch

The first attribute, demand flexibility allows for the storage of dispatchable renewable electricity from one time period to another. It refers to the capacity of electricity storage systems to reduce renewable generation '*curtailment'* by storing (or importing) renewable energy from various sources during times of excess supply and releasing (or exporting) dispatchable electricity at times of peak demand.

The second, assisting strategic grid build out, follows the same principle but with the addition that the excess renewable generation can be moved, maintained and used throughout the grid during times of increased demand in *locational pinch points*. In this way electricity storage systems are not only able to meet localised peak-time demands but can also off-set localised system constraints during infrastructure repowering or upgrading. The facility with which electricity storage systems can be incorporated to dispatch electricity into the grid network at specific times *in specific locations* is key to maintaining a resilient and dependable energy grid system, a system that is required to meet the challenges posed by the necessary transition to renewable energies across all services and sectors. The third attribute 'System services' is covered in greater detail in Section: 2.3 below.

While at present there are insufficient electricity storage systems capable of delivering sufficient quantities of storage to lower the grid's dependence on traditional carbon generation plants to meet capacity, it is expected that in the future and through an incentivised development process, sufficient electricity storage systems may be incorporated onto the grid that, when acting in concert with the fleet of wind and solar powered renewable generators, will be capable of reducing the strain on the grid and ultimately reduce future dependence on traditional fossil fuel generation plants.

It is also expected that as electricity storage systems develop and their capacities increase, the re-powering (upgrading) of these electricity storage systems will further reduce the grids dependence on traditional carbon heavy electricity generation assets. To achieve this goal, investor led repowering of electricity storage systems is required and in order to incentive this, this policy framework considers that electricity storage systems must be able to fully compete in all energy markets (arbitrage), in a complementary and regulated manner akin to renewable generation, thereby promoting greater competition and a price reduction for the consumer. Further detail of this full market access is included in Chapter 3 Markets.

### 2.2.3 Congestion Management – Constraint and Curtailment

Congestion Management is a major concern for the Transmission System and Distribution System Operators, particularly where weaknesses in the grid infrastructure such as regional pinch-points are concerned.

Two of the primary challenges faced by a grid system incorporating an ever-expanding amount of renewable energy generation, is when its incorporation and use throughout the grid system is constrained and / or curtailed. As the traditional map of centralised electricity generation leading to regional disbursement is no longer the norm and the ever-changing locational profile of renewable generation spreads across the whole grid, localised pinch-points in the system can cause constraints and / or curtailments.

Constraint is where {renewable} energy generation, providing electricity destined for incorporation into the grid to be used by the market or an operator is not added to the grid due to the physical limitations of the power grid system.

Curtailment is where {renewable} energy generation, providing electricity destined for incorporation into the grid to be used by the market or an operator is reduced or restricted by the System Operator to ensure the proper functioning of the power grid system.

To summarise constraints are the physical limitations within the grid that may necessitate such actions as curtailment and curtailments are actions taken to manage the system, often in response to constraints in the power grid.

### 2.2.4 Congestion Management – Surplus Management & Dispatch Down

Another element of congestion management is the ability to manage and incorporate excess generated electricity onto the grid. Though the grid may have the capacity to transmit the electricity between generator and consumer, the amount of electricity generated may exceed

consumer needs due to insufficient demand (load) on the system or access to other markets in which to sell this excess electricity. When this happens, the generating installation may be requested to either reduce generation output or shut down generation completely (dispatch-down). None of which are optimal scenarios for Renewable Electricity Generation (REG) service providers.

The goal of successful congestion management is to overcome these challenges while progressively incorporating greater amounts of renewable electricity and electricity storage systems have a significant role to play by adding flexibility to the grid network. As discussed above electricity storage has the ability to charge at times of surplus renewable generation and discharge again at times of high demand which provides the System Operator with greater operational flexibility.

Further, the ability of an electricity storage system, located in an area with network constraint to charge at times of surplus renewable electricity can off-set curtailment and delay Dispatch Down. In this case electricity storage systems can store this excess electricity until there is capacity on the grid network to use it, transfer the electricity to another region where it is needed or store it until there is an increase in local demand.

Ultimately the grid flexibility that electricity system storage provides, assists the System Operators in ensuring security of supply, helps reduce the need for costly network upgrades and reduces CO2 emissions through increased renewable electricity incorporation, all of which can place downward pressures on wholesale energy prices.

### 2.2.5 Non-Synchronous Electricity

The third attribute is the capability of electricity storage systems to act in a ‘System service’ capacity. To ensure the proper functioning and overall grid stability, the electricity network must remain ‘balanced’. Frequency and voltage must be maintained at all times. This is less of an issue in traditional centralised generation networks, where synchronous controlled electricity generation output was aligned with the grid network’s balancing needs.

However, wind and solar electricity generation provide non-synchronous power, a supply of electricity that increases and decreases in strength and power depending on factors such as wind strength and sunshine. The incorporation of this non-synchronous power on to the grid network can generate issues and the incorporation of non-synchronous power requires the support of necessary ‘System services’.

## 2.3 Electricity Storage System Services

### 2.3.1 Electricity Storage System Services

Increased renewable electricity on the power system presents challenges for the operation of the electricity grid. These challenges are in the context of dispatchable and non-dispatchable generation. Conventional thermal generation, such as gas turbines, is predictable, relatively reliable and their output can be controlled to meet the systems demand; this is dispatchable generation. Variable renewable electricity sources like wind or solar are non-dispatchable.

To operate the grid using increased volumes of variable renewable energy sources, the TSO, EirGrid, needs increased amounts of specialist services referred to as "*system services*" to ensure grid stability. Delivering a Secure, Sustainable Electricity System (DS3) is EirGrid's programme of work designed to enable power sector decarbonisation and to increase the levels of System Non-Synchronous Penetration. Through DS3, market participants can provide 'DS3 services', ancillary products such as reserve, inertia, and reactive power, which are required to keep the grid stable and support ever greater volumes of renewable energy.

These system services can be provided, to varying degrees, by variable renewable generation, dispatchable generators, electricity storage units such as batteries, pumped hydro storage, and flywheels, as well as synchronous condensers that are connected to the electricity grid.

Low carbon providers of 'system services' such as storage have many advantages over fossil fuelled generated 'system services'. Not only is the cost saving favourable compared to the construction of traditional fossil fuel generated 'system services' but the ability to locate and connect electricity storage system powered 'system services' into the grid network where they can maximise grid efficiency and flexibility, will assist in future proofing the smooth functioning of the grid network in the face of the challenges posed by advances in renewable technology.
'System services' not only support the incorporation of renewable energy onto the grid network, but facilitate ongoing grid development, ensure grid security of supply, reduce grid running costs and improve energy affordability to the consumer by maximizing overall grid efficiency. It is therefore imperative that the portfolio of system services transitions towards low carbon sources over time.

At present 0.5MWh (30 minute) to 4MWh (4 hour) electricity storage systems provide the grid network with a wide range of 'system service' functions through the DS3 markets, as listed below:

| **Fast Frequency Response** | **FFR** |
|---|---|
| Primary Operating Reserve | POR |
| Secondary Operating Reserve | SOR |
| Tertiary Operating Reserve 1 | TOR1 |
| Tertiary Operating Reserve 2 | TOR2 |
| Replacement Reserve – Synchronised | RRS |
| Replacement Reserve – De-Synchronised | RRD |
| Synchronous Inertial Response | SIR |
| Ramping Margin 1 | RM1 |
| Ramping Margin 3 | RM3 |
| Ramping Margin 8 | RM8 |
| Fast Post Fault Active Power Recovery | FPFAPR |
| Steady State Reactive Power | SSRP |
| Dynamic Reactive Response | DRR |

As the electricity network grows to meet Ireland's future supply and demand requirements, the strategic location and operation that electricity Storage Systems 'system services' offer, will help maximise renewable integration by reducing localised '*containment*' and alleviating operational and grid issues. It is the comparative ease and cost, as compared to traditional processes, with which electricity storage systems can be integrated into a regional or local network that makes electricity storage systems particularly useful in providing localised 'system services'.

### 2.3.2 System Services Future Arrangements

The successor to the DS3 programme, the SSFA programme is currently being designed by the Regulatory Authority to facilitate Ireland's next step towards a functioning grid system capable of achieving a target of 95% SNSP by 2030. This policy framework fully supports this approach and further detail in regard to the System Services Future Arrangements are contained in Chapter 3 Markets.

## 2.4 ECP & Hybrid Connections

### 2.4.1 Enduring Connection Policy (ECP)

In Ireland, the Commission for Regulation of Utilities (CRU) is responsible for grid connection policy. The grid connection policy provides for the terms and conditions upon which an offer for connection to the transmission or distribution system is made. Connection policy is developed in a manner which does not discriminate unfairly between relevant stakeholders, and also has regard, among other things, to the need to:

- protect the interests of final customers and to secure that all their reasonable demands for electricity are satisfied.
- promote the continuity, security and quality of supplies of electricity.
- promote competition; and
- promote efficiency and the use of renewable, sustainable or alternative forms of energy.

The CRU published the Enduring Connection Policy (ECP-1) in March 2018 which was the first step in a fundamental redesign of Irish grid connection policy. In 2020, the CRU published its decision on ECP-2, which built on the objectives to ECP-1 to provide a pathway for generators, storage and other system services technology projects to connect to the electricity system. ECP-2, which supports increased prioritisation of large renewable energy projects to facilitate a low-carbon future, set policy for three annual batches of connection offers with a target of 115 connection offers in total for each ECP-2 batch year. ECP-2 limits the number of storage and other system services projects that would receive connection offers to 10 per annum.

In April 2023, the CRU extended ECP-2 with the introduction of ECP 2.4, which was designed to facilitate a transition while a new connection policy is being developed. ECP 2.4

opened for applications in October last year and targeted connection offers for 100 projects in total, comprised of 70 large projects, 15 non-batch projects and 15 community-led projects. This reduction in number reflected the expected pipeline of projects and the workload of the TSO and DSO in processing offers. As with previous rounds of ECP-2, ECP 2.4 prioritised applications from the largest renewable generation projects (first 25 connection offers) and the remainder by earliest planning permission grant date. There storage cap in ECP 2.4 remains at 10 and in this context means that 100% of the MEC is storage. This is a change from the ECP-2 Decision.

In accordance with Climate Action Plan, the CRU are tasked with reviewing and publishing a successor policy to ECP 2. The CRU held a consultation, which closed in February 2024, on the 'Electricity Generation and System Services Connection' Policy, the responses to which will inform the introduction of a new policy framework that will continue to connect onshore generators, storage and other systems services technology projects to the grid. Responses were sought on several topics, including, inter alia, locational prioritisation, charging methodology, application fee structure and repowering. The policy also sought responses on the CRU's 'minded to' approach to introduce a bi-annual application process without caps for renewable generators.

This new connection policy will require significant changes to previous iterations of ECP-2, including a review of timelines to support the implementation of Article 16 of the RED III Directive. There are significant challenges to be addressed such as the interaction with the timelines for environmental and planning permits, as well as the processing times for grid connection offers. To date, the permitting timelines have been considerably longer than those outlined in Article 16, and delays have been experienced relative to expected timelines. The Electricity Generation and System Services Connection Policy will be published in Q3, 2024.

### 2.4.2 ECP Policy Objectives

Respondents to the public "*Consultation on developing an Electricity Storage Policy Framework for Ireland*" considered that the current cap on the number of electricity storage projects within a batch should be removed. Other responses supported a connection policy which incentivises higher MWh storage and others felt it should also incorporate appropriate locational signals.

The new '*Electricity generation and system services*' connection policy, is expected to facilitate more frequent processing of onshore renewable and conventional generators

(including auto-producers), storage, and other system services technology projects to connect to the electricity system.

### 2.4.3 ECP Application Process and Batch Size

Currently, ECP entails a single batch window which opens in October each year. Various proposals have been put forward to replace this, including more regular batches (bi-annually or quarterly) or removing the batch process altogether and replacing with a rolling application process.

It has also been suggested that category caps, used in ECP, be removed altogether. The CRU's 'minded-to' approach is to introduce a bi-annual batch application process without caps for renewable generators. In the consultation paper the CRU considers that two batches a year would be the most appropriate frequency when considering the number of expected applications, the ability of the SOs to process applications, the potential for overlapping batches, and the targets and timelines for processing.

### 2.4.4 Hybrid Connections

This policy framework fully supports the incorporation of electricity storage systems on to the grid. One efficient approach is the evolution of established renewable electricity generation installations to co-locate with electricity storage system through a *Hybrid* connection.

Hybrid projects allow electricity storage systems to share connections to the grid with other renewable assets, maximising generation and supply through each connection point and this Government fully supports the concept of dual or triple (wind, solar and storage) electricity systems exporting to the grid via the same connection point.

For new and existing renewable electricity generation service providers and electricity generation / storage service providers, clarity in regard to hybrid connections will assist in project development and the maximisation of investment capital and revenue returns. In line with the Climate Action Plan, the CRU are currently working to remove remaining barriers to the hybrid generation projects.

Co-location of electricity storage systems and renewable electricity generation assets already exists through 'single entity' hybrid connections. To date three barriers have been identified, where their removal could promote the co-location of electricity storage with existing wind and / or solar assets:

(1) Removal of the 120% installed capacity cap of the contracted maximum export capacity (MEC).
(2) Sharing of Maximum Export Capacity (MEC) by different technologies behind a connection point.
(3) Allowing multiple legal entities behind a single connection point.

The CRU published a decision paper (CRU202402) on the removal of the installed capacity cap in January 2024. A consultation on the second barrier, Sharing of MEC is due to be published in the coming months with a decision anticipated in 2024. The Government accepts that the challenge posed by multiple legal entities is complicated and on-going and this policy framework fully supports the Regulatory authority's efforts to facilitate a solution.

### 2.4.5 Interaction With the Planning Process

Under the existing ECP, all projects (exc. Community projects) must be granted planning permission prior to applying for a grid connection. This new connection policy is expected to expedite the process in line with the RED III legislation, which will necessitate greater alignment between the planning and grid permitting processes in order to meet permitting deadlines.

However, the two-year permit granting deadline set out in Article 16 (RED III) refers to both planning and grid-related permitting and will necessitate measures to align all elements of the two systems (planning and grid). Further details on all of the above maybe found in the CRU's Electricity Generation and System Services Connection Policy due for publication in 2024.

### 2.4.6 Locational Signals

The public "*Consultation on developing an Electricity Storage Policy Framework for Ireland*" also asked whether more locational signals are needed to support the connection of renewable projects in specific locations. There are potential benefits to the service providers if projects can locate in areas where there is available capacity, lower constraints, lower connection costs and faster timelines for connection. It is also acknowledged that connection offers for certain locations might reflect the challenges associated with connection to those locations, such as timelines, costs and access conditions, for example. The involvement of the Transmission System Operator (TSO) and Distribution System Operator (DSO) are imperative to ensure the appropriate decisions are made on the type and location of electrical energy store system connections. Further details regarding 'Locational signals' are

included in the ESB Networks' 'Demand Flexibility Product' consultation covered in Chapter 3 (Markets).

### 2.4.7 Potential for Market Saturation

While there is a strong case for electrical storage systems in general the Department is aware of concerns that the demand for shorter duration electricity storage systems, such as 0.5MW (30 minute) to 4MWh (4 hour) systems, which are at present the preferred electricity storage system for *system service* roles may reach a saturation point.

This Government will monitor the potential for saturation of a particular electricity storage system type / duration / technology through on-going engagement with all relevant stakeholders. This policy framework also notes that there is now a shift in focus onto electricity storage systems capable of delivering a minimum of 4+hour and potentially even longer 100+hour capacity.

## 2.5 Demand Flexibility, EVs, Domestic and LEUs

### 2.5.1 Demand Flexibility

This policy fully supports CRU's approach of including electricity storage systems as part of their National Energy Demands Strategy (NEDS). This policy recognises that investment in electricity storage systems alone is insufficient to meet the flexibility demand targets set through the Climate Action Plan. That said, electricity storage is required and the present 'route to market' for electricity storage systems is covered in detail in Chapter 3 Markets and includes further details on how the CRU, in conjunction with the System Operators, will bring to market new products to meet specific, System Operator identified demand flexibility needs.

The CRU highlight in their National Energy Demand Strategy that "significant efforts are required to unlock the behavioural changes, incentives and investment sufficient to meet the 2025 and 2030 targets for demand flexibility". Within this falls a role for domestic consumers to actively participate in the electricity markets and provide flexibility. This can be achieved through domestic storage, EV flexibility and aggregation of assets, amongst other mechanism.

This Policy Framework is in full support of the role of both domestic and commercial storage in providing flexibility to the Irish system. As outlined in the CRU National Energy Demand

Strategy, there are many technologies and components that can support both implicit and explicit flexibility. To that end, the Policy Framework fully supports the Regulatory Authority, alongside additional stakeholders, in their work to develop and implement these mechanisms in line with the relevant European regulation.

### 2.5.2 RED III and the Electricity Market Design

The third and latest iteration European Renewable Energy Directive (RED III), part of the Clean Energy Package (CEP), directs that member states should ensure the participation of small or mobile decentralised energy sources, such as domestic batteries and electric vehicles, in the electricity market, with the goal to provide congestion management, flexibility, and balancing services individually and through aggregation.

Aggregation is the function of combining 'multiple customer loads on generated electricity for sale, purchase or auction in any electricity market'.

To enable the competitive development of the aggregation of distributed storage assets, RED III requires Member States to ensure that real-time access to basic battery information such as state of health, state of charge, capacity and power set point is provided by manufacturers. This must be done under non-discriminatory terms and free of charge to the owners or users of the batteries and the entities acting on their behalf.

The recent revision, signed off on the 21st of May 2024, to the European electricity market design (EMD), aims to make the market more resilient and reduce the dependency of consumer bills on unstable fossil fuel prices. For more information on the EMD, please refer to Annex D. As part of its overall aim, the EMD facilitates the active participation of consumers in the electricity market and will establish the right of active consumers to share renewable energy generated or stores either individually or through a third party (aggregation).

The definition of an active consumer as per the proposed electricity market redesign is as follows:

'Active customer' means a final customer, or a group of jointly acting final customers, who consumes, or stores electricity generated within its premises located within confined boundaries or self-generated or shared electricity within other premises located within the same bidding zone, or who sells self-generated electricity or participates in flexibility or energy efficiency schemes, provided that those activities do not constitute its primary commercial or professional activity.

### 2.5.3 The National Energy Demand Strategy

In line with RED III and the CEP, CRU published their Roadmap for the Clean Energy Package and Renewable directives in June 2023. This roadmap is referenced in the Regulatory Authority's National Energy Demand strategy (NEDs), in which Electric Vehicles and domestic batteries are included in the domestic sources of demand flexibility under '*Area 1- Smart Services- Supporting Customer Participation'*. The NEDs considers the ways in which flexibility can be incorporated into the energy consumption of all customer groups to reduce the overall carbon intensity of energy demand in Ireland. Area 1 of the strategy is focussed on the demand flexibility that can be provided by domestic customers and smaller businesses, concentrating on the ways in which these customers can be encouraged to provide flexibility.

The NEDs estimates that domestic and transport sources have the potential to provide 17% and 15% of Ireland's flexibility needs respectively. The document sets out key aspects of the flexibility within these wider sources, highlighting their barriers as well ongoing and future work by CRU and other relevant stakeholders in overcoming these barriers to encourage active customers and greater flexibility. (Further information on NEDS Area 2 – Demand Flexibility and Response is included in Section 3.7.7)

### 2.5.4 Electric Vehicle Flexibility

The NEDS recognises the challenges to Electric Vehicle (EV) Flexibility, highlighting both Smart charging and V2G technologies as key elements in the role EVs can play in demand flexibility. Management of energy flows to plugged-in EVs is enabled by smart charging and may be optimised to put less pressure on the grid through aligning charging with high renewable periods. Unlocking the potential of EVs to provide these services, not only offers a large portfolio of EV storage to facilitate flexibility but will undoubtedly play a huge role in meeting sectoral emission ceilings and wider net-zero targets.

The Zero Emissions Vehicles Ireland (ZEVI) is a dedicated Office within the Department of Transport, charged with supporting consumers, the public sector and businesses to continue to make the switch to zero emission vehicles. The Office leads on the delivery of the Ireland's ambitious targets under the Climate Action Plan 2023 to have an expected 30% of our private car fleet switched to electric by 2030. ZEVI provides funding for the ZEVI Home Charger Grant Scheme and Apartment Charger Grant Scheme which assists residents and homeowners to install an EV charge point on their property.

These and other supporting initiatives such as the Electric Ireland's Home Electric+ Night boost tariff are expected to contribute to EV connectivity and flexibility in the near term. It is

recognised that future initiatives may include the aggregation of EV charging points, and thus will be supported by the work of aggregation licences, discussed in Section 2.5.6 below.

### 2.5.5 Residential Electricity Storage Systems

Residential (Domestic) battery electricity storage systems (R-BESS) will allow active consumers to provide flexibility to the grid, charging their installed battery in times of renewable surplus and exporting it to assist in meeting peak demand times. In line with European requirements, the Renewable Energy Regulation Directive 2413/2023 mandates the Regulatory Authority to address connection offers, double charging, licencing requirements/fees and service provision, in order to facilitate the ability of active customers that own an energy storage facility to participate in flexibility schemes and sell self-generated electricity back to the grid. In line with this, the CRU are working on the development of a Framework for Relevant Market Participants.

The ESB Networks National Networks, Local Connection Programme aims to enable an active role for all customers and communities in climate through storing electricity. The programme looks to pilot new flexibility services, including V2G technologies.

### 2.5.6 Aggregated Storage

Aggregation is performed by a natural or legal person. ‘Aggregated storage’ is the aggregation of multiple storage systems. Both active consumers and Citizen energy communities may operate via aggregation to access electricity markets. In line with the CEP, the 2022 Amendment of the 1999 Electricity regulation act, known as The Renewable Energy Regulation 2022, tasked CRU with designing licences for aggregation. The Regulatory Authority intends to initiate the development of licences for aggregation in 2024.

### 2.5.7 Data Centres and Large Energy Users

With over 2,300 Megavolt Amperes (MVA) already contracted throughout the electricity network and further expansion of the data Centre / LEU sectors pending electricity connection and capacity availability, new approaches must be considered in order to ameliorate potential infrastructural and supply stresses and maintain carbon emission reductions.

As part of the National Energy Demand Strategy, the CRU is undertaking a review of the processing of new, large energy demand connections to the electricity and gas systems. The aim of this review is to provide a pathway for new Large Energy User (LEU) connections to the electricity and gas systems which minimises the impact on national carbon emissions

while considering the capacity of the system in relation to supply of energy and grid infrastructure. Further details maybe found here:
CRU consultation on the Review of Large Energy Users Connection Policy

# 3 Markets

## 3.1 Key Message: Present Position and Concerns

Responses to the *Consultation on Developing an Electricity Storage Policy framework for Ireland* highlighted service provider concerns surrounding electricity storage systems, in particular market access and potential remuneration / funding gaps for future storage units on the grid.

Currently, electricity storage technologies can be remunerated through a number of revenue streams, these include the Single electricity market (SEM) specifically the Forwards and Day Ahead markets, the Capacity Remuneration Mechanism (CRM), the Renewable Electricity Support Scheme (RESS) auctions and the Delivering a Secure Sustainable electricity System (DS3) ancillary service programme.

Responses also sought clarity on:

- Arbitrage and Revenue stacking for electricity storage units in the SEM Intra-day and Balancing wholesale electricity markets.
- The Scheduling and Dispatch programme, Hybrid projects, (non-)Firm access and Tariffs, all of which are under review at present.
- The upcoming changes to the DS3 arrangements, known as the System Services Future Arrangements (SSFA) programme and the associated Day Ahead System Services Auction (DASSA).
- Any other revenue streams or storage products to be made available to electricity storage in both the immediate and near-term.

This chapter sets out this Government's commitment to address these concerns, addressing on-going work programmes to facilitate market access. It also outlines both the current and expected 'Route(s) to Market' in both the immediate and near-term futures. This includes the immediate incorporation of both demand flexibility and (long duration) electricity storage systems to the distribution and transmission grids respectively as well outlining the Government's actions and commitment to the future of electricity storage in the near-term

2030-2040. (Sections 3.7 and 3.8 below refer). It is expected that a large portfolio of technologies capable of further reducing renewable electricity curtailment, increasing security of supply, demand flexibility and grid efficiency will be available in the near-term (2030-2040) and these actions aim to provide certainty to service providers in the development of electricity storage systems, given the rapid pace of innovation and technology development.

This chapter will commence with market relevant EU Directives, policy and the reform of the SEM in-line with the same, as well as the planned re-integration of the SEM with both the Great Britain (GB) and European Markets. It will also provide an overview of the Markets, the current state of play, the DS3 / System Services Future Arrangements and other relevant factors to electricity storage system market access.

This policy remains 'Technology neutral' in order to create equal market conditions for all forms of electrical storage system technologies and to avoid market distortion. In line with EU Directive 2019/944 and EU Regulation 2019/943 on the internal market for electricity, this policy will not favour or preclude the incorporation of any eligible electrical storage system product once it is within the technical and regulatory criteria as set out by the System Operators and the Regulatory Authority.

It is important to note here that the markets and access to the markets for electricity storage system products are a matter for the Single Electricity Market Committee (SEMC) and the Commission for Regulation of Utilities (CRU) in the first instance and the CRU is independent in its function in this regard. Further details in regard to the role of CRU as the Regulatory Authority and their ongoing engagement with the System Operators on addressing routes to market are contained throughout this chapter.

### 3.1.1 Technology Neutral

As stated in the initial chapter of this policy framework (Chapter 1) this policy will remain technology agnostic to avoid distorting markets, influencing service providers and thereby ensure value for the consumer.

Where relevant this policy acts as a neutral market facilitator and does not preclude any eligible electricity storage product or demand flexibility technology. This Government considers that electricity storage systems of different types, strengths, durations, emission limits, and technological makeup will be incorporated into the grid system in the future and

that a technology neutral approach will allow service providers to independently assess all potential electricity storage systems based on their capacity to deliver value for money.

Though battery electricity storage systems (BESS) technology is referenced frequently within this policy framework this is due to the fact that BESS technologies are the main form of the electricity storage systems presently functioning on the grid. This policy also recognises that BESS technologies are both commercially available and suitable to provide revenue earning services.

However, it is also understood that global investment has accelerated the already rapid pace of innovation and technology development and that new yet unheard-of technologies may yet be best placed to meet Ireland's electricity storage needs. Further, given the future role for electricity storage systems in a renewables market to smooth out market peaks and troughs through 'arbitrage', this technologically neutral approach aims to allow new and existing energy storage service providers to consider all electricity storage products that may function in this role.

This policy framework will ensure that grid scale electricity storage system product procurement processes are not limited to specific technology types, through engagement with the regulatory authority on their approach to the selection criteria for electricity storage system products. This policy framework will seek consideration of technology neutral procurement mechanisms based on system and / or locational needs, technical standards thresholds and / or lower emission technologies as set out by the System Operators.

## 3.2 EU Market Policy

### 3.2.1 Renewable Energy Directive (RED)

Ireland and Europe are aware of the important role electricity storage must play in our energy transition as referenced in the recently published EU Renewable Energy Directive (RED), a *'Legal framework for the development of clean energy across all sectors of the EU economy, supporting cooperation between EU countries towards this goal*.' RED III, EU Directive EU/2023/2413, which amends or repeals EU Regulations and Directives, entered into force in November 2023. This most recent iteration of the RED framework sets a renewable energy target of at least 42.5% binding at EU level by 2030.

Within the revised Directive are multiple Member state mandates regarding storage. These include the requirements to establish a market mechanism framework for electricity storage, the simplification of permit granting procedures and a designation under renewable acceleration for co-located energy storage, amongst various other storage-related initiatives. The transposition of these provisions into national law by Member states including Ireland is ongoing.

Electricity storage is mentioned within:
**Article 15**: where Member States designate dedicated infrastructure areas for the development of grid and storage projects that are necessary to integrate renewable energy into the electricity system.

**Article 16**: designates electricity storage as being in the overriding public interest and explains the accelerated permit-granting process, addressing the screening process, the administrative procedures involved and the time frames for various technologies.

**Article 20**: directs Member States to ensure a level playing field for small, decentralised electricity generation and storage systems, including residential batteries and electric vehicles so they are able to participate in the electricity markets.

It also addresses the provision for their inclusion in congestion management, flexibility and balancing services in a non-discriminatory manner as compared to other electricity generation and electricity storage systems and to be without disproportionate administrative or regulatory burden.

Further, Member States should encourage self-consumers and renewable energy communities to actively participate in those electricity markets by providing flexibility services through aggregated demand response and electricity storage including through batteries and electric vehicles.

### 3.2.2 Electricity Market Design (EMD)

In line with the European Commission's reform to the Electricity Market Design (EMD), to amend EU Directive 2019/944, EU 2018/2001 and EU Regulations 2019/943, EU 2019/942, this policy, among other things, affirms this Government's commitment, in regard to the internal EU wholesale market for electricity, to increase consumer protections from future price spikes through facilitating market access for electricity storage system technologies and to create favourable market conditions while avoiding market distortion in order to make Ireland's and the EU's electricity industry cleaner and more competitive.

The five key areas of the EMD are:

- Greater consumer empowerment and protection by driving prosumer behaviour via smart meters and similar type of initiatives etc.
- Stabilising consumer electricity prices through longer Power Purchase Agreements (PPA), two-way Contracts for Difference (CfDs) and boosting the Forwards Market.
- Driving renewable investment through appropriate regulatory and administrative action to drive increase in renewables, energy efficiency etc (EU-RePower)
- Incentivizing the development of flexibility assets i.e., demand response, storage etc
- Stronger protection against market manipulation and transparency through REMIT.

Electricity storage is addressed within the proposal in the context of non-fossil flexibility. The proposal sets out the aim to take measures improving the integration of renewable and low-carbon energies into the short-term markets highlighting the lack of non-fossil flexibility as a shortcoming of the current design considering the energy crisis. The proposal highlights the role of the intra-day market as a key tool for flexibility integration, pointing to the importance of adaption to allow for the participation of technologies such as electricity storage.

Regarding the third area of the proposal, renewable investment, electricity storage's role in stabilising prices and increasing renewable integration is recognised and thus its participation in the markets should be encouraged. With further relevance to electricity storage systems is the European Commission's aim to streamline and simplify the process for assessing capacity. To that end, the proposal encourages the use of flexibility support schemes for storage. The specifics of this are summarised in Article 19.

- **Article 19c**: Sets the requirement for Member states to draw up a flexibility needs assessment on a biennial basis. Included in this assessment should be an evaluation on the potential of electricity storage to fulfil needs at the transmission and distribution level.
- **Article 19d**: Mandates Member states to define an indicative national objective for electricity storage based on the flexibility needs assessment.
- **Article 19e**: Titled flexibility support schemes, encourages consideration for the promotion of storage in the design of capacity mechanism, for those Member states that apply them. Where this may not be sufficient to meet their national objective for electricity storage, Member states are encouraged to provide payments based on non- fossil flexible capacity availability, such as storage, through support schemes.

Member states without a capacity mechanism are equally encouraged to offer these schemes.

- **Article 19f**: Lists a set of design principles for flexibility support schemes.

The proposal also touches briefly on the role of network tariffs in incentivising flexibility services, suggesting these should be set in a way to encourage the use of flexibility services by the System Operators.

Finally, article 7b includes storage systems under the requirement for Member states to allow the System Operators use of dedicated metering devices to obtain data for the observability and settlement of flexibility services.

### 3.2.3 Regulations on wholesale Energy Market Integrity and Transparency (REMIT)

Alongside the revision of the EMD, is the revision of the Regulations on Wholesale Energy Market Integrity and Transparency (REMIT). This policy also supports the EU's reforms to support the EMD through the revised REMIT. These regulations aim to provide stronger protection against market manipulation in energy trading, enhancing confidence and integrity in relation to REMIT. It is important to note that with the revision of REMIT comes an expansion of its scope to include energy {electricity} storage.

Further, this policy supports the EU's legislative reforms to better protect consumers from excessive price volatility, support their access to secure energy from clean sources, and make the market more resilient.

## 3.3 SEM & Revenue streams

### 3.3.1 The Single Electricity Market (SEM)

Ireland operates as part of a Single Electricity Market (SEM), which is the wholesale electricity market on the island. It is jointly administered and regulated with the Irish and Northern Irish authorities via their regulatory authorities (Commission for Regulation of Utilities (CRU) in Ireland and the Utility Regulator (UR) in Northern Ireland) and the transmission System Operators (TSOs) – EirGrid in Ireland and SONI in Northern Ireland. By combining what were two separate jurisdictional electricity markets (for Ireland and Northern Ireland), the SEM became one of the first of its kind in Europe when it went live on 1 November 2007.

The SEM, including its Market Design, is overseen and administered by a statutory SEM Committee comprising the two energy regulatory authorities and independent members. The SEM promotes the interests of consumers by enabling greater competition through cost reflective prices, while also working to secure a diverse, viable and environmentally sustainable long-term energy supply. It has also created the climate for investment in renewable generation, electricity and energy storage and other ancillary services relevant to the islands grid network.

Following Brexit, the continued operation of the SEM is explicitly provided for in the Withdrawal Agreement, including the Protocol on Ireland/Northern Ireland which entered into force on 1 February 2020 and was negotiated between the European Commission and UK Government.

Ireland is interconnected to Northern Ireland through three transmission connections. Only one of these has significant capacity, the Louth – Tandragee 275 kV line is the primary means for power to flow between Ireland and Northern Ireland today. The two other connections are 110 kV lines from Corraclassy to Enniskillen and from Letterkenny to Strabane. They only provide local support to the network and because of this, they don't have sufficient capacity to carry surplus power. There are plans in progress for the development of a second North-South interconnector.

There are currently two interconnectors connecting the SEM to other markets, the 500MW East West Interconnector which connects Ireland and GB and the 500MW Moyle Interconnector between Northern Ireland and Scotland.

Trade in electricity across the interconnectors between Great Britain and the SEM has continued without tariffs since 1 January 2021. As of 1 January 2021, the Day Ahead Market (DAM) in the SEM were no longer coupled, with cross border trading taking place only in the intraday timeframe (IDA) with GB.

However, this trade is less efficient, as day ahead trading can no longer be used on these interconnectors. Scheduling of flows on each of the interconnectors is determined by the price spread between the SEM and GB in the IDA 1 and IDA 2 auctions. The Trade & Cooperation Agreement (TCA) provides a mechanism to ensure that the current system is made more efficient and should be based on the concept of multi-regional loose volume coupling (MRLVC).

A new market design for the SEM, substantially different to the original 2007 design took place under the Integrated Single Electricity Market (I-SEM) Project over six years going live in 2018. This included the establishment of new Day-Ahead, Intra-Day and Balancing

Markets, with an ex-ante clearing price compared to the previous ex-post gross mandatory pool system, and a new obligation on participants to take responsibility for imbalances. This market redesign had the objectives of facilitating greater market integration through the application of internal energy market rules and enhancing competitive outcomes to benefit consumers. It also had the objective of ensuring compliance with the network codes and guidelines developed under Regulation (EC) 714/2009 within the EU's Third Energy Package and with the principles of wholesale market design laid out in the Clean Energy Package, and in particular the recast electricity market regulation.

### 3.3.2 The Strategic Markets Programme (SMP)

The Strategic Markets Programme (SMP) was set up by the Single Electricity Market Operator (SEMO) which is composed of both EirGrid and SONI in 2023 to fully integrate the SEM with the European markets and grid structure. These and other relevant matters are covered under Pillar 2 of the Shaping Our Electricity Future Roadmap.

The roadmap addresses full integration of the SEM with the European grid, beginning with the physical connection of Ireland with continental Europe via the Celtic Interconnector to France, which is designated as a European Project of Common Interest (PCI) and estimated for connection in late 2026. Prior to the SEM's physical connection with continental Europe, it must be ready for full integration of the various markets, namely the forwards, day-ahead (SDAC), Intraday (SIDC), and balancing markets (PICASSO, TERRE & MARI). This process will also include the full re-coupling of the day-ahead market with the EU as well as new arrangements for electricity storage systems in the intraday and balancing markets both in the EU and Great Britain. In preparation of this SEMO are working on the delivery of revised market arrangements, including a revision of the Trading and Settlement codes, Grid codes and licences.

### 3.3.3 Revenue stacking & Arbitrage

'Revenue stacking' for electricity storage systems is the ability to generate financial revenues from specific electricity storage products and / or competing in one or more market(s). This policy framework is in favour of revenue stacking and electricity storage access to all markets in-line with the market operating parameters, rules, regulations and technical capacities as set out by SEMO, CRU and the System Operators. This policy framework also recognises that while revenue stacking / access to all markets in the immediate is the preferred option, the process of full integration of electricity storage in the marketplace is challenging and this policy framework fully supports the on-going work of all stakeholders towards reaching this goal.

There are at present three distinct revenue generating routes within the SEM that electricity storage service providers may participate in:

1. The Energy Market (Energy Trading Arrangements (ETA)).
    - Forwards Market
    - Day Ahead Markets

2. The Capacity Remuneration Mechanism (CRM)

3. Delivering a Secure Sustainable Electricity System (DS3).

Further details on these three streams are covered later in this chapter.

It is understood that multiple revenue streams may create a stronger business incentive for electricity storage systems as well providing greater service provider certainty around electricity storage system projects.

### 3.3.4 Action #5: Support Market Access, Arbitrage and Revenue Stacking.

This policy framework actions (Action #5) the Government's commitment to revenue stacking and electricity storage access to all markets in line with the market operating parameters, rules, regulations and technical capacities as set out by SEMO, CRU and the System Operators. It is the aim of this policy, in line with EU regulation to facilitate through engagement with SEMO and CRU access for electricity storage systems to all potential markets.

At present electricity storage system access to the Intraday and Balancing market through the transmission System Operator's (EirGrid) Scheduling and Dispatch (S&D) programme is restricted and this prevents electricity storage units from '*arbitraging*' in the Intra-day and Balancing wholesale electricity markets.

As referenced earlier in this chapter, SEMO is working to fully integrate the SEM with all of the European markets including the forwards, day-ahead, intraday, and balancing markets through the Strategic Markets Programme (SMP) and this work will require updating the Scheduling and Dispatch system to facilitate electricity storage systems in both the intraday and balancing markets. For further detail please see Section 3.3.5 of this chapter.

This policy framework also recognises that as the market structures surrounding electricity storage evolve, revenue stacking alone may not incentivise the optimum amount of electricity storage required to meet Ireland's electricity storage requirements between 2030 - 2040. To that end four policy framework actions are set out in section 3.8 of this chapter which will ensure, *if required*, a suitable 'route to market' and sufficient revenue certainty for service providers.

### 3.3.5 Scheduling and Dispatch

As outlined in the Shaping Our Electricity Future Roadmap (Pillar 1), the Single Electricity Market Operator (SEMO) comprised of the all-island Transmission System Operators (TSO's) are currently undertaking work on the Scheduling & Dispatch (S&D) systems, in order to remove barriers for electricity storage systems to participate in ex-ante markets amongst other matters. This updated system will include the incorporation of electricity storage systems in their role of system service providers and electricity market participants in line with the EU's Electricity Market Design framework (EMD) (See Section 3.2) and the ACER Network Code on demand-side flexibility. (See Section 3.7).

The Scheduling and Dispatch Programme is composed of six initiatives, split into two tranches, with tranche 1 targeting a 'go live' date of April 2025:

Tranche 1:

- SDP-01 Operation of Non-Priority Dispatch Renewables (NPDR)
- SDP-02 Energy Storage Power Station (ESPS) integration
- SDP-04 Wind dispatchability improvements

Tranche 2:

- SDP-03 Fast Frequency Response (FFR)
- SDP-05 Reserve services scheduling and dispatch
- SDP-06 Synchronous condenser scheduling and dispatch

Service providers have also raised concerns around how accurately the ability of battery electricity storage systems (BESS) to charge is reflected in the markets. At present, battery electrical storage systems are registered in the market as generator units and may freely charge up to a limit set by the System Operators without an instruction from the grid controllers. While this ability to charge without instruction from the control centre of up to 1 MW of charge will remain, it is intended that the Scheduling and Dispatch Programme battery initiative, as outlined above due mid-2025, will re-register BESS as electricity storage units in the market.

This designation will enhance the participation of electricity storage units in ex-ante markets, through the submission of negative or positive physical notifications as well as managing their state of charge through ex-ante trading. BESS will then be scheduled to dispatch in line, where possible, with physical notifications submitted by market participants. It is intended that the TSO will retain the capacity in specific 'system security' or 'priority dispatch' scenarios to deviate from this scheduling process.

### 3.3.6 (NON-)Firm Connections

This policy framework also recognises that for new and existing energy storage service providers, clarity in regard to (non-)firm connections will assist in project development and the maximisation of investment capital and revenue returns. Firm access is a market measure which guarantees revenue streams to service providers, service providers with (non-)firm access do not receive compensation for any loss due to grid constraints. It is understood that the (non-)firm connection criteria are considered by services providers in the selection of their operating model.

Future decisions on (non)-firm connections lies with the CRU who published in November 2023 their decision paper on this matter. This Government accepts the challenges posed by (non)-firm connections for electricity storage to an already constrained grid are complicated and the intention of this policy is to assist and support the Regulatory Authority in their on-going review of this matter. On-going engagement on the matter is taking place through the ARE Taskforce as set out in Chapter 1. The aforementioned CRU Decision paper is available here: CRU2023114_Firm_Access_detailed_methodology_decision.pdf (divio-media.com)

### 3.3.7 Tariffs

The Commission for Regulation of Utilities (CRU) or Regulatory authority is Ireland's independent energy and water regulator and was assigned responsibility for the regulation of the Irish electricity sector following the enactment of the Electricity Regulation Act, 1999 and subsequent legislation. Inter alia the Commission for the Regulation of Utilities (CRU) is responsible for the economic regulation of the network, including setting the tariffs for use of the system and reviewing and approving other network charges. Essential capital investment is recovered through Transmission Use of System (TUoS) and Distribution Use of System (DUoS) charges which cover the costs for the System Operators to operate, safely maintain and develop the transmission and distribution networks.

In 2020, The Commission for Regulation of Utilities published their Network Charges for Commercial Storage Units Interim Solution which amended the regime under which electricity storage systems paid system charges. An interim decision led to the cessation of Generator Transmission Use of System charges (G-TUoS) charges on the 1st of October 2020 and the application of Demand Transmission Use of System charges (D-TUoS) charges only. This was and is considered an interim solution and the present Tariff regime in regard to electricity storage systems is under review by the Regulatory authority.

## 3.4 The Energy Markets

Energy trading arrangements (ETA) are conducted as part of the Single Electricity Market (SEM), the all-island electricity market where electricity is traded on the island of Ireland. These arrangements came into place in October 2018 and include hedging, day ahead and intra-day trading, offering flexibility to participants through several different markets that each reflect a different trading timeframe. These markets are in place to promote open competition in the generation and supply of electricity, ensure reasonable prices for both service providers and consumers and ensure the equilibrium of the demand and supply of electricity on the power grid. These markets include:

- The Balancing market
- The Intraday market
- The Day-Ahead market
- The Capacity market
- The Forwards market
- The Financial transmission rights auctions

### 3.4.1 The Balancing Market (BM)

The Balancing Market (BM) reflects the actions taken by the TSO to ensure a balanced and secure system. All electricity dispatchable assets with a maximum export capacity (MEC) above the minimum requirement set by the TSO are required to participate in the BM. The BM trading day comprises of 48 imbalance settlement periods of 30-minutes each. Each of these periods consist of a further 6 secondary imbalance pricing periods of 5-minutes each, which collectively determine the settlement prices for that 30-minute imbalance settlement period. The submission window for the BM markets runs until 1 hour before the given imbalance settlement period, opening 19 days prior to that period.

### 3.4.2 The Intra-day Market (IDM)

The Intra-day Market (IDM) is an ex-ante market, a market that operates before the delivery of the electricity and like the BM also runs until 1 hour prior to trading. Unscheduled events, such as interconnector congestion and plant shutdowns alter the landscape of the market and thus the IDM allows participants to alter their positions based on up-to-date market information. There are three daily auctions within the IDM. The first two of three, daily auctions within the IDM are coupled with the Great Britain (GB) market via interconnectors. These are IDA-1 and IDA-2. The third and final auction, IDA-3, is a local one, independent from the GB bidding area.

### 3.4.3 The Day-ahead Market (DAM)

The Day-ahead Market (DAM) is the largest ex-ante market in value and volume. The DAM is a daily auction occurring at 11am each calendar day. Bids and offers can be submitted in the DAM from 19 days prior to its closure. The trading day is comprised of 24 periods of 1-hour each, concluding at 11am the day before delivery. Following the closure of the DAM auction, participants can adjust their position through the Intra-day Market (IDM), as discussed above.

### 3.4.4 The Capacity Market (CM)

The Capacity Market (CM) provides for future demand  needs through ensuring adequate generation capacity is contracted in an approved and timely manner. This market and its mechanisms are covered further below in this chapter under the Capacity Renumeration Mechanism (CRM).

### 3.4.5 The Forward's Market (FM)

The Forward's Market (FM) is a financial instrument market, which facilitates trading in 'Hedging' contracts, the re-trading of transactions that take place long before that power will be used, ranging months up to years. Participation in the FM provides the opportunity to 'Hedge' a position in the other three markets (BM, IDM and DAM) through the use of *contracts for difference* (CfD) products traded between market participants or through *direct contracts* in which the Regulatory Authorities set the price and volume for trades.

### 3.4.6 The Financial Transmission Right market (FTR)

The Financial Transmission Right market (FTR) is also a financial instrument market which allows participants to 'Hedge' between two coupled markets the rights to transmit

electricity provided through interconnectors. The difference price is set in-line with the DAM of both markets.

### 3.4.7 Electricity storage present position

At present, there is an inability for storage to fully participate in the IDM and BM due to current restrictions in the schedule and dispatch system, which limits the potential for electricity storage to fully participate and 'arbitrage' in the wholesale markets. The Government is aware that this may reduce revenue and product stacking options for electricity storage systems service providers, dampening the business case for the development of electricity storage systems. To that end, the Government fully supports the work of the scheduling and dispatch programme currently underway by the TSO to allocate electricity storge full access to the wholesale market.

## 3.5 Storage Financing

### 3.5.1 Capacity Remuneration Mechanism (CRM)

The SEM capacity market is designed to help ensure that the generation capacity in Ireland and Northern Ireland (including Electricity storage, Demand Side Units and Interconnector capacity) is sufficient to meet demand and that the regulatory approved generation adequacy standard is satisfied.

Initial positions in this market are achieved through the Capacity Remuneration Mechanism (CRM). The CRM determines the value of capacity in the market through use of competitive auctions. The CRM's competitive auction-based design ensures the most efficient and lowest cost capacity is most likely to be successful. The market is designed to find the lowest cost capacity that meets the demand curve. This design helps to promote the short-term and long-term interests of consumers of electricity with respect to price, quality, reliability and security of supply of electricity.

Following state aid approval granted by the European Commission in 2017, the CRM was introduced to the SEM in October 2018, replacing the previous arrangement, the Capacity Payment Mechanism (CPM). Participants must first pass the qualification criteria to take part in these auctions. Reliability and confidence are instilled by the qualification process as it helps ensure participants will deliver on their obligations. Once cleared, the participants are permitted to compete in the capacity auctions.

Prior to each auction, the TSO calculate and approve the volume of capacity required. After bids have been considered, successful participants are awarded new capacity contracts and paid capacity payments regularly. Additionally, successful participants are obliged to refund consumers when energy market prices exceed the strike price. If participants fail to provide capacity at a time of scarcity, they will be penalised.

The CRM process commences with an auction called a T-4 auction, for the delivery of the forecast required capacity approximately four years out. This may be supplemented by a T-1 auction, approximately one year out, or a T-2 auction, two years out from the required availability of capacity, if required. These secondary auctions are designed to compensate for forecast errors in the T-4 auction held previously, termination of contracted units and to allow further demand response units to participate closer to real time, given the difficulty faced by some demand response unit service providers in gauging and accurately predicting the availability of their assets several years in advance.

The CRM accounts for imperfect reliability of generation and electricity storage assets by using a de-rating system. This is where the nameplate export of an asset is adjusted down to take account of considerations such as asset reliability, technical characteristics and overall benefit to grid security of supply. Reliability, for example, may include consideration of potential technical or maintenance issues or days of low renewable generation.  De-rating factors are technology specific and energy storage assets are assigned a de-rating factor based on their capacity and duration. This means that assets that clear in the capacity auction only receive payments based on their de-rated capacity. The exact de-rating figure depends on capacity and number of hours of storage capability, with the figure becoming ‘heavier’ as duration increases. In November 2022 the SEM Committee published their decision to remove the storage scaling factor. This factor was causing the contribution of storage unit capacity adequacy to be overestimated. Thus, its removal reduced the de-rating factor for batteries, more accurately capturing their contribution. A high de-rating factor for Electrical storage systems was highlighted by some respondents to the Consultation on Developing an Electricity Storage Policy Framework for Ireland as a major revenue-limiting factor.

During the recent EMD negotiations, the European Commission announced a proposal to streamline and simplify the process for assessing Capacity Remuneration Mechanisms shortly after entry into force of the EMD Regulation. This should promote the participation of non-fossil flexibility, such as electricity storage. This workstream is expected to commence during summer 2024.

### 3.5.2 Renewable Electricity Support Scheme (RESS)

In-line with the Climate Action Plan a Renewable Electricity Support Scheme (RESS) was established through the Climate Action Plan to support the development of renewable electricity projects that will assist Ireland in achieving its ambitious 2030 goals such as the 80% RES-E target. The RESS auction approach delivers cost effective generation and supply of electricity while simultaneously encouraging a variety of renewable electricity projects in Ireland. The present RESS process is the fourth such Renewable Electricity Support Scheme and is referred to as RESS 4.

RESS takes a Contract for Difference (CfD) structure that operates through competitive auctions. Eligible participants bid based on the price of electricity they can offer. Each auction has a pre-determined maximum and minimum quantity (measured in annual GWh). Successful applicants are offered a guaranteed price for their generated electricity.

Electricity storage was first named as an eligible technology in the second iteration of RESS, RESS 2, when used in conjunction with wind and solar energy as hybrid projects. These hybrid assets are listed as Hybrid Wind and Storage and Hybrid Solar and Storage. The hybrid electricity storage asset is required to be electrically connected behind the meter of the RESS project so that charging of the storage facility will be reflected as decreased exports across that meter and discharging of the storage facility will be reflected as increased exports across that meter. Thus, a RESS hybrid storage project can only be paid for the electricity generated in the hybrid project itself. The role of hybrid electricity storage in the most recent iteration of RESS, RESS 4 remained the same, with the further inclusion of a ‘Hybrid Wind and Solar and Storage’ category.

The future of the Renewable Electricity Support Scheme is being reviewed and assessed as part of the EU State Aid approval for the scheme with a revised support scheme due to be developed over the coming years. As part of this review and design of any new scheme consideration will be given to the role of storage and hybrid assets in line with the relevant State Aid guidelines and EU rules on support schemes set out in the Electricity Market Design Regulation and Article 4 of the Renewable Energy Directive. This policy fully recognises the potential benefits of increased hybrid generation and storage assets and further details on hybrid generation / storage assets is included in Chapter 2.

## 3.6 System Services

### 3.6.1 Introduction

Synchronicity and synchronous inertia in electricity systems refers to the ability to onboard generated electricity to the grid and move it around in a consistent manner and are vital aspects of a stable and secure of an electricity system. Ireland operates an electricity system which is synchronised to a system frequency of 50 Hertz Alternating Current (AC).

Conventional thermal generation such as oil and gas turbines, either generate Alternating Current (AC) or are readily converted to Alternating Current and given their predictability and the capacity to control their generation, conventional thermal generators are readily matched to the grid frequency (inertia).

However, the increased volume of renewable electricity generation from both wind and solar arriving on the power system presents a different challenge. Variable renewable electricity generation is non-synchronous or non-dispatchable. Non-synchronous renewable generators such as solar and wind not only generate Direct Current (DC) but are dependent on exogenous factors such as the wind blowing and the sun shining.

While DC current is converted to AC via an Inverter, the variable nature of renewable generation means its incorporation onto the grid must be carefully managed. As increased amounts of renewable electricity are brought onto the grid and to avoid risking system stability, grid infrastructure must be ‘upgraded’ to accommodate this non-synchronous generation. These upgrades require specialist technical characteristics and are referred to as “system services”.

These system services can be provided, to varying degrees, by numerous sources connected to the electricity grid, including variable renewable generation; dispatchable generators; demand-side units; and electricity storage units such as batteries and pumped hydro storage, as well as flywheels and synchronous condensers.

While all of the above may be used for system services, it is both the capacity and comparatively low cost of electricity storage systems to be deployed at all system voltage levels, that means these specialist technical requirements are, in the main, best met by electricity storage systems.

### 3.6.2 DS3 ('Delivering a Secure, Sustainable Electricity System')

The DS3 ('Delivering a Secure, Sustainable Electricity System') programme was established by the Single Electricity Market Committee in 2011 to address some of the potential problems resulting from an electricity system comprised of higher rates of non-synchronous generation (i.e., wind and solar) and lower rates of thermal or synchronous generation (i.e., oil and gas). The programme is operated by the transmission System Operators EirGrid and SONI and is a crucial pillar of Ireland's decarbonisation effort. Provision of system services through the DS3 programme is one of two main revenue streams for storage projects.

DS3 was designed as a response to the binding national and European targets which were set for renewable electricity generation across the island of Ireland. Focusing on the key areas of system performance, system policies and system tools, the DS3 programme originally aimed at increasing the penetration of non-synchronous penetration to 75%. The SNSP limit is a TSO operational constraint which limits the amount of variable generation (solar & wind) that can provide energy to the system at any one time.

Given Ireland's isolated island status, the dramatic increase in wind penetration levels in recent years and the incorporation of highly technical ancillary/system services from electricity market participants, the level of non-synchronous power on the electricity system has risen at a faster rate than in any other region in Europe over a similar timeframe.

The TSOs, via the DS3 regulated arrangements, pay for these highly technical ancillary/system services from electricity market participants. System services are products, other than energy, that are required for the continuous, secure operation of the power system. These system services include BESS and are essential for facilitating the deployment of renewable generation on the electricity grid in a safe and secure manner.

A key element of the DS3 Project was the establishment of enhanced system services. Starting in 2012, the Regulatory Authorities ("RAs") and Transmission System Operators ("TSOs") in Ireland and Northern Ireland commenced a redesign of the pre-existing Ancillary Services arrangements to better meet the needs of the system by 2020 through the development of the all-island System Services framework.

Ultimately, the SEM Committee issued a decision in 2013 detailing the outcome of the technical review (SEM-13-098). This expanded the product offering out to a total of 14 services, which would be rolled out over several years. The services provided through DS3 offer an enhanced portfolio of options to the TSOs for managing an electricity system with

higher rates of system non-synchronous penetration (i.e. the level of renewable generation that can be accommodated on the system at a given point in time) in a safe and secure manner.

12 of the 14 services have so far been rolled out, a table of the services is included below. Under DS3 a range of providers, including conventional generators, wind farms, electricity storage and demand side units, receive availability payments under regulated arrangements for offering these services. The procurement process for DS3 is non-discriminatory; any service provider that can prove its ability to provide these services, no matter the technology used, is able to secure a contract for payment. Payment is based on availability of service provision, with a fixed tariff in place for each service and payments adjusted by scalars based on enhanced technical delivery or scarcity due to high levels of RES.

| Service | Abbreviation | Description |
|---|---|---|
| Fast Frequency Response | FFR | MW of reserve energy delivered between .15 and 10 secs |
| Primary Operating Reserve | POR | MW of reserve energy delivered between 5 and 15 secs |
| Secondary Operating Reserve | SOR | MW delivered between 15 and 90 secs |
| Tertiary Operating Reserve 1 | TOR1 | MW delivered between 90 secs and 5 mins |
| Tertiary Operating Reserve 2 | TOR2 | MW delivered between 5 mins and 20 mins |
| Replacement Reserve – Synchronised | RRS | MW delivered between 20 mins and 1 hour |
| Replacement Reserve – Desynchronised | RRD | Same as RRS – unit has capability to ramp up from desynchronized state |
| Synchronous Inertial Response | SIR | Stored Kinetic Energy – Rotating mass of a unit, not active power |
| Ramping Margin 1 | RM1 | Increased MW Output that can be delivered within 1 hour for 2 hours |
| Ramping Margin 3 | RM3 | Increased MW Output that can be delivered within 3 hours for 5 hours |
| Ramping Margin 8 | RM8 | Increased MW Output that can be delivered within 8 hours for 8 hours |

| | | |
|---|---|---|
| Fast Post Fault Active Power Recovery | FPFAPR | Recovery of a providing unit's MW output following a fault (90% of pre-fault output within 250ms of voltage recovery) |
| Steady State Reactive Power | SSRP | (MVAr capability)*(% of capacity that MVAr capability is achievable) |
| Dynamic Reactive Response | DRR | MVAr capability during large (>30%) voltage dips |

* As of 2023 FPFAPR and DRR have not been rolled out.

Following a period of framework development and consultation, in 2017 the SEM Committee issued its decision on the tariffs and scalars (SEM-17-080) and the contractual arrangements (SEM-17-094) of the Regulated Arrangements. These decisions set tariff rates against each of the services, including those provided by storage, along with a glide path up to an expenditure cap of €235m on the island of Ireland by 2020. This budget cap was set by reference to an analysis of the estimated energy market savings of enabling 75% SNSP. It is important to highlight the overwhelming success of the DS3 programme, and in particular the role of electricity storage in DS3, in facilitating the integration of renewables on the SEM system, which in terms of SNSP penetration internationally is unprecedented.

System Services contracts are offered through a process involving procurement 'gates' which have occurred every six months (in April and October each year) since May 2018. Approximately 1.2GW of fast-acting capacity has come through these gates and received administratively set standard contracts which end in May 2024.

In recent years and as more fast acting technologies such as battery storage have connected, expenditure has exceeded the budget cap. In May 2021, a tariff consultation was led by the TSOs at the request of the Regulatory authorities (RAs). Following a recommendations paper submitted to the RAs in August 2021, the SEM Committee made the decision to reduce tariffs by 10% for its 'fast five' services which had a negative impact on revenues for the electricity storage units providing those services. Recently, the SEM Committee instructed the TSOs to initiate another system services tariff review to avoid another breach in expenditure; this review is currently under way.

In addition to the Regulated Arrangements, the RAs have developed Fixed Contract Arrangements alongside the TSOs which are designed to offer multi-year contracts for specific services in order to remove barriers to entry for new technology types. The first Fixed Contract procurement commenced in 2018 and was designed to target high availability provision of reserve services by fast acting technologies. Specifically, the reserve services sought for procurement were FFR, POR, SOR, TOR 1 and TOR 2 as detailed in the table above.

This *fast-acting* technology moniker relates to technologies which are capable of rapidly responding to provide reserve energy if called upon. The outcome of this was the awarding of six-year contracts to three battery electricity storage projects totalling 110MW of reserve provision. Beyond the three winning providers, this competition sent a strong signal to battery electricity storage service providers and led to significant growth in the roll out of

electricity storage projects. These actions are playing an important role in reducing Ireland's reliance on carbon intensive technologies for reserves and is enabling the RAs to explore the potential for further competitive procurement of system services.

DS3 has been successfully incentivising the generation fleet to improve their operational capability through System services which in turn enables the TSOs on the island of Ireland to operate the system with increased levels of renewables and less carbon intensive generation. To date, System services and other work on the DS3 Programme have successfully facilitated the increasing of the SNSP limit to 75%. Work has now begun on increasing the figure to 95% by 2030 to support the further decarbonisation of the electricity sector.

During a period of considerable change, the System Services have provided a reasonably predictable revenue stream to service providers, including storage, which in conjunction with energy market revenues in the Capacity Remuneration Mechanism (CRM), facilitated the necessary investment in flexible generation to meet Ireland's ambitious climate action goals.

Through increasing SNSP and reducing the amount of minimum conventional generation, Ireland will be able to further enhance its position as a world leader in this area. The presence of low carbon sources of reserves and inertia enables the TSOs to dispatch less conventional generation and reduce the curtailment of wind and solar. It is therefore vital that DS3 is progressed to further reduce greenhouse gas emissions and contribute to security of supply for the whole island.

The current DS3 arrangements were originally due to expire in April 2024 but have now been extended until April 2026.

### 3.6.3 System Services Future Arrangements (SSFA)

It is important to highlight that the nature of System Services on the Irish system is continuously evolving. The original aim of the DS3 programme was to ensure the power system can be operated securely with increasing amounts of non-synchronous generation, to meet renewable electricity targets by 2020. With a higher SNSP target of 95% by 2030 now set through CAP, a new system services programme is required.

In 2020, work commenced on the successor to DS3, titled the System Services Future Arrangements (SSFA). The aim of this was to introduce competitive procurement for System Services while continuing to remove operational constraints, facilitating increases to the

SNSP limit and reductions to the number of conventional generation units. The goal of this work is the introduction of daily auctions for system services by 2030. The introduction of competitive markets for ancillary services has been the overall ambition of the SEM Committee since the commencement of the system services project.

The SSFA programme is working to reassess the system services requirements for 2030 and beyond and to develop competitive arrangements that will be compliant with European legislation and facilitate the provision of greater volumes of system services from low carbon technologies. The programme will work to reassess system service requirements, reflect increased carbon budgets, and ultimately ensure a greater role for electricity storage projects.

To achieve this goal, the TSOs will need to make significant changes in how the system is operated. This will see the DS3 programme moving away from administratively set tariffs and scalars to competitive daily auctions for system services under the System Services Future Arrangements (SSFA)

The RAs are working closely with the TSOs on the implementation of this project. As mentioned, Ireland's ambitious renewable energy targets create a host of new challenges for our all-island electricity system. In this regard, the next phase of the TSO System Services programme will be critical in meeting these challenges and storage will play a central role. Extensive engagement has taken place on this matter with all stakeholders, including workshops with industry.

A Phased Implementation Roadmap (PIR) for SSFA was approved by the SEM Committee and subsequently published by the transmission System Operator in March 2023. It provides a pathway for the delivery of a suite of actions under SSFA, including the implementation of a Day Ahead System Services Auction (daily auction/DASSA); a layered procurement framework for products that are not amenable to daily auctions; and fixed term contracts.

**Day Ahead System Services Auction (DASSA):**
The TSO is undergoing a process of structuring the DASSA. This will include a day ahead auction designed to maintain competition and system security in reserve service procurement.

**Layered Procurement Framework (LPF):**
The LPF framework is being set in place to ensure long term security of supply by competitively procuring system services in timeframes from pre-day-ahead up to one-year ahead.

The design of the full set of arrangements, including the daily auctions, is complex. Therefore, the SEM Committee has decided to introduce competitive arrangements incrementally; reserve services will be the first to become competitive.

The new SSFA arrangements will aim to promote innovation in systems services, localising parts of the network as the nature of electricity supply and demand changes due to various drivers for change in the electricity landscape, in the coming years. It will aim to increase in embedded distribution level generation, such as micro and mini generation, the continuing smart metering rollout, and increase demand side response and the uptake of Electric Vehicles (EVs), heat pumps and new storage technologies. This will introduce new challenges for network companies and new opportunities for stakeholders and consumers to play a more active and engaged role. These changes are all set to accelerate in the coming years as the energy transition continues. Implementation for the future arrangements of system services is continuing with a Systems Services Code due for publication in Q3 of 2024 ahead of wider industry engagement through consultation.

### 3.6.4 Low Carbon Inertia Service

In 2021, the SEM Committee directed the TSOs to commence exploring the use of the Fixed Contract Arrangements to procure low carbon sources of inertia. The RAs understood that there was potential for new, lower carbon technologies which could provide inertia to the system, which would reduce the need for carbon intensive unit services. This would then enable the TSOs to commence reductions in the minimum number of operational carbon intensive units to be running on the island at all times to provide stability to the system. This currently requires eight conventional units.

The SEM Committee published its decision on the procurement of Low Carbon Inertia Services (LCIS) in 2023 (SEM-23-002) and upon recommendations from the TSOs, it published its decision on the Contractual Arrangements for LCIS (SEM-23-064), detailing Phase 1 of the procurement to meet LCIS requirements for 2026. The targeted volume for Phase 1 is 4,000 MVA.s in Northern Ireland and 6,000 MVA.s (Megavolt-amperes) in Ireland. Following Phase 1, Phase 2 will commence as soon as possible to ensure 2030 targets are met.

The TSOs initiated Phase 1 of the LCIS procurement for both Ireland and Northern Ireland in December 2023. Successful units will be offered a six-year duration contract from their go-live date, which are expected to be energised in 2025/2026. It is hoped that this competition, alongside other measures, will enable the TSOs to reduce the minimum units of operational carbon intensive units providing stability services to five by 2026, with additional initiatives enabling further reductions by 2030. To meet decarbonisation targets, it is vital that reliance on conventional generation is reduced, not just in terms of energy provision, but also in terms of operational constraints, and the RAs expect that this competition will aid progression in this area.

## 3.7 'Routes to market' for electricity storage

### 3.7.1 Important note on (long duration*) electricity storage

**(Long duration*)**: This policy framework is cautious in its use of terms such as 'long duration' or 'short duration' or 'long-term', 'short-term' etc., due to their subjectivity as a technical characteristic. It is considered that the use of terms such as short, medium and long may be open to numerous interpretations and may erroneously influence product development or investment choices.

Further and as expressed in Chapter 1, it is the intention of this policy to use, where possible, the 'nameplate' electrical storage capacity of an electricity storage system, expressed in Mega Watts (MW) and Mega Watt hours (MWh) with the number equating to the designed Maximum Export Capacity (MEC) of the storage system when fully charged measured in wattage. I.e.: A 2MW electricity storage system with capacity to discharge for 2 hours equates to a 4MWh electricity storage system.

However, it is important to note that the use of (long duration*) electricity storage here is intended to identify a minimum 4+hour duration required of an electricity storage system tendered for consideration and incorporation on the grid network through a tailored 'route to market' (long duration*) electricity storage product.

The intentional use of (long duration*) in brackets and before electricity storage in this context is intended to acknowledge that while all electricity storage technology types, including those not yet commercially available at the time of writing of this policy framework, may tender for a tailored 'route to market' product, they may only do so once they meet a minimum bulk electricity time shift capacity of 4+hrs, that is to say the capacity to deliver

electricity throughout a 4 hour period or more to the system. It is expected that these products in the main and particularly those developed to meet the near-term (2030-2040) requirements will seek bulk electricity time shift capacity beyond the Intra-day.

### 3.7.2 Addressing future concerns

As this policy framework has set out, the need for increased amounts of electricity storage systems with the capacity to bulk time shift electricity is clear. A fit for purpose electricity storage systems capable of playing a key role through the storage of excess renewable generation will provide demand side flexibility, improved grid management and ultimately reduced electricity costs. This policy framework also recognises that though the future of electricity storage looks bright with full market access, arbitrage and revenue stacking expected in the near future, the rapid advancements in electricity storage technologies may generate a sense of caution and hesitancy in service providers.

This policy framework in the first instance relies on the market process and it acknowledges that investment in electricity storage systems must first be driven by market supply and demand forces. However, with the third Carbon budget in 2031-2035 in mind this Government believes that business cases for service providers to develop the necessary electricity storage systems must not only be clear but that there must be sufficient incentives to ensure the procurement of the optimum amount of electricity storage systems required to meet the grid's needs.

Therefore, in response to these challenges this policy framework recognises that solid commitments at this time by Government would contribute a level of certainty and re-affirm services providers' commitments to electricity storage systems, both in the immediate and into the near-term (2030-2040) horizon.

### 3.7.3 Decarbonised Electricity System Study

To address Ireland's decarbonisation targets more comprehensively the Sustainable Energy Ireland Authority of Ireland, in conjunction with the Department of the Environment, Climate and Communications, are undertaking the Decarbonised Electricity System Study (DESS). The objectives of the DESS are to provide Government with an evidence-based pathway (or choice of robust alternative pathways) for decarbonising the Irish electricity system, with consideration of sector coupling, technology readiness, energy security, social acceptance, and infrastructural, policy, legislation and regulation needs. It is currently entering stage 2 which is expected to run thirty-three Months in total, into 2026. The objectives of stage 2 are to support and inform energy policy development during the term of the study and to begin

the stakeholder process in order to build support for acceptance of its ultimate outcomes, in which storage will undoubtedly form a key part.

### 3.7.4 Action #6: Immediate 'Additional' Procurement

The following action (Action #6) of this policy framework addresses the immediate procurement of Demand Flexibility and (long duration*) electricity storage on to the grid system. It is important to note that the following procurement processes for both Demand Flexibility Products and for (long duration*) electricity storage are separate and additional to the electricity storage systems procured through the Capacity Renumeration Mechanism, the Renewable Electricity Support Scheme and the DS3 programme.(See Section 3.5.1, Section 3.5.2 and Section 3.6.2).

Firstly, this policy framework welcomes and supports the ongoing development of the ESB Networks Demand Flexibility Product procurement process, which is expected to incorporate up to 500MW of demand flexibility products onto the Distribution system. ESB Networks have identified this procurement process as the best approach to address identified congestion issues on the Distribution system. It is also noted that the ESB Network Demand Flexibility Product procurement process is independent of this policy and in conjunction with the Regulatory Authority. (Further details below in Section 3.7.8).

Secondly, this policy framework actions (Action #6) the immediate incorporation, through an initial procurement round with a guide volume of 500MW, of (long duration*) electricity storage onto the Transmission system in order to address specific system needs identified by the System Operator (EirGrid). The procurement of this 500MW will be obtained through a first of kind (long duration*) electricity storage 'route to market' developed by the Regulatory Authority in conjunction with the Transmission System Operator. This (long duration*) electricity storage 'route to market' is already under development and further details are contained in Section 3.7.9 below.

In order to ensure the procurement of sufficient electricity storage to meet the system needs, following the initial procurement round, a subsequent procurement round, or rounds, of up to 500MW of (long duration*) electricity storage each, may follow. Prior to the commencement of any further procurement round a review will be completed. This review will begin and conclude before the commencement of any further procurement round.

This review process will provide an update on the 'needs case' for electricity storage and analyse whether a new 'route to market' process is required. The Terms of Reference (ToR)

for this review process will be decided by the Regulatory Authority, the System Operator and the Department of the Environment, Climate and Communications, and will include the following parameters.

- At each 'needs case' review, relevant data such as up to date modelling provided by the System Operator or through the Departments own modelling processes, will be used to identify an updated system 'needs case'.
- At each 'route to market' review process, consideration will be given to any requirement for the development of a further market framework or procurement approach as per Action #9 (Section 3.8.3) and Action #10 (Section 3.8.4) of this policy framework.

### 3.7.5 Role of the Commission for Regulation of Utilities (CRU)

In addition to the summary in Chapter 1 of the Commission for Regulation of Utilities (CRU) or *Regulatory Authority,* it is important to note again that the CRU are charged with empowering, protecting and ensuring value for money to the consumer and the regulation of the energy markets. The CRU was assigned the responsibility for the regulation of the Irish electricity sector following the enactment of the Electricity Regulation Act, 1999 and subsequent legislation and is an independent regulator, accountable to a committee of the Oireachtas and not the Minister. In this function, the CRU develop the regulatory framework necessary to achieve Government policy objectives and for 'route(s) to market' for the System Operator's electricity storage products in line with legislation and in an independent manner. Further information on the CRU's role and relevant legislation can be found on the CRU's website at www.cru.ie

### 3.7.6 EU ACER Framework Guideline on Demand Response

Having been mandated by the European Commission, in 2022 the European Union Agency for the Cooperation of Energy Regulators (ACER) published a Framework Guideline on Demand Response. The documents sought to set out clear principles for the harmonised development of rules regarding demand response, including electricity storage, to the European Network of Transmission System Operators for Electricity (ENTSOE) and European Union Distribution System Operators (EDSOs). Rules regarding electricity storage, amongst others, were established by the framework and it provides key principles for addressing demand curtailment through demand response products and markets, as well as product procurement rules in regard to electricity storage and the aggregation of same.

### 3.7.7 National Energy Demand Strategy (NEDS)

In their National Energy Demand Strategy (NEDS) consultation paper, the CRU highlight electricity storage as a key contributor to demand flexibility, including it, other than those systems being used for provision of system services, within the flexibility definition. The publication also outlines the difficulty of meeting flexibility targets if electricity storage was to be disregarded from the definition, highlighting its ability to reduce curtailment and consumption of high carbon intensive electricity in the absence of sufficient renewable generation as well as its role as a source of energy supply during peak demand periods.

Further to the existing market access for electricity storage systems already covered earlier in this chapter, the CRU, in conjunction with the Distribution System Operator ESB Networks, are in the process of bringing to market a new product designed to meet identified *Demand Flexibility* needs.

The ESB Networks' *Demand Flexibility P*roduct is at an advanced stage of development at time of publication and is now under consideration by the Regulatory authority. It is considered that this product could be tailored in conjunction with locational signalling to meet some of the immediate needs of the distribution System Operator, potentially utilising a direct tender procurement over an open market approach. The contracting of demand flexibility in this manner would meet certain immediate congestion needs, in specific locations, while also offering guarantees and incentives to service providers.

### 3.7.8 ESB Networks' Demand Flexibility Product.

On the 20th of December 2023, ESB Networks published their *Demand Flexibility Product Proposal* Consultation. The consultation references CAP23 demand flexibility targets, namely aiming to procure up to 500MW of flexibility on the distribution system, through an initial procurement process. The consultation outlined ESB Networks' demand flexibility product proposal, providing the context behind it, the guiding principles and the expected procurement approach. From this consultation the development of the final Demand Flexibility product including a route to market is ongoing between ESB Networks and the CRU and is expected to enter the marketplace in due course. It is important to note here that at the time of writing this policy framework the ultimate design of this procurement product is pending finalisation by ESB Networks (and CRU approval further to its role under Section 35 of the 1999 Act and Regulation 22A of the European Communities (Internal Market in Electricity) Regulations, 2000 (as amended)).

The ESB Networks' Demand Flexibility product is designed to meet specific system locational needs while remaining technology agnostic. Work has been undertaken by ESB Networks to identify locations in which demand flexibility products are required to address projected 2030 capacity shortfalls due to existing network infrastructure and reinforcement infeasibility. ESB Networks have designed a multi-criteria tender process to be used in the procurement process of these flexibility products. Assessment criteria include framework parameters such as value for money, operability and deliverability and within this framework, a locational batching process, comprising of three procurement stages, will be used.

Pending finalisation of the design by ESB Networks and subsequent CRU approval, in addition to location, eligibility for tender for technologies may also be considered based on other flexibility requirements. This procurement approach helps create a comprehensive assessment in which competition is maximised and reliability is enhanced. It is envisaged that successful applications may be tendered with long-term contracts of up to 15 years.

**Floor and Share Payment Approach**

The proposed payment mechanism within this product is a '*floor-and-share*' payment, based on guaranteed asset availability. ESB Networks will remunerate service providers by guaranteeing a minimum 'floor' price, ensuring certainty of revenue. In exchange, contracted assets must meet flexibility requirements as determined by the DSO. Failure to meet flexibility requirements will result in penalty charges for the service provider. The '*share*' element of the payment mechanism is there to incentivise asset managers to maximise gains through the arbitrage of cheap renewable electricity. However, given that the contracts include guaranteed '*floor*' payments, service providers may be required to pay a percentage of profits back to consumers through the ***'share'*** element, maximising consumer saving and ensuring the continued maximisation of the import / export capabilities of the asset.

Where feasible, the flexibility product payment mechanism for this product will facilitate revenue stacking. Service providers should have full access to other markets and the capacity to compete in them to maximise revenue through 'arbitrage' or product stacking, as long as they are meeting the flexibility requirements as determined by the DSO**.**

The Government, through Action #6 of this policy framework both welcomes and fully supports ESB Network's Demand Flexibility procurement approach and recognises the System Operators initiative as well as the on-going work between themselves and the Regulatory Authority in curating this approach. Contracted demand flexibility will act to alleviate problems such as network constraints and supply disruptions and ultimately allow

for demand flexibility and an increase in renewable penetration. As stated in ESB Networks consultation on this proposal, there exists a trade-off between time and efficiency of procurement regarding the costs consumers will bear as a result, and this approach builds a strong business case for flexibility products whilst considering this trade off. Further, the Government believes that this proposed approach will result in procurement of the right technologies to reduce congestion and in the desired locations and ultimately increase the incorporation of renewable electricity onto the grid, reduce traditional generation dependence and create a market for cheaper electricity to the consumer.

This policy can confirm that the proposed procurement process under consideration will remain technology neutral and will be designed to contract any technology or demand flexibility approach that is capable of meeting the required technical specification for each location.

### 3.7.9 EirGrid's Long Duration Energy Storage Product (LDES)

This policy framework notes that in October 2023 EirGrid published '*A Call for Evidence on the Market Procurements Option for Long Duration Energy Storage (LDES)*'. In the Call for Evidence (CfE) EirGrid define LDES as electricity storage systems with a capacity of 8+hours duration or above. This call for evidence stemmed from EirGrid's findings in the Shaping Our Electricity Future (SOEF) roadmap.

The SOEF findings identified electricity storage as a critical technology for the 2030 transition targets through its roles in reserve provision, increasing renewable penetration and congestion management.

The basis of the CfE was to develop a business case for LDES on the transmission system as well as identify the barriers to its incorporation, the service it may provide and explore potential options to provide revenue streams.

The CfE analysed the needs case for storage as considered by EirGrid and presented various procurement plans to incorporate LDES onto the grid. It proposed four financing schemes to incentivise LDES connection for consideration by respondents.

1. Status Quo: Leave the current markets as they are.
2. Amended Current: Aims to facilitate revenue stacking through refinements of the current market schemes.
3. Storage Support Scheme Auction: Establish an auction, similar to that of RESS, solely for storage units.

4. System Services: Offering a long-term contract for LDES, in-line with system service contracts.

The CfE also provided further detail on EirGrid's considerations for all four approaches, as well as examining them through a multi-criteria assessment process and sought feedback from service providers on these matters.

Having now closed their CfE, EirGrid has subsequently published a summary of responses to it in March 2024. The CfE received 38 responses, which will aid EirGrid in the further development of this project. EirGrid in conjunction with CRU will continue to work on the development of this project including potential procurement options and specific locational indicators for LDES.

This policy framework is mindful of the challenge that bringing a first of kind (long duration*) electricity storage 'route to market' presents for both the Regulatory authority and the Transmission System Operator. In order to expedite matters this policy framework fully supports through Action #6 the procurement of up to 500MW of (long duration*) electricity storage on to the transmission grid system, with the potential for subsequent procurement round(s) pending a review process to ensure the proper functioning of the transmission grid system. (See Action #6, Section 3.7.4)

The development of this (long duration*) electricity storage product is a high priority for this Government and the Department of Environment, Climate and Communications will, through the Accelerating Renewable Electricity Taskforce, promote the rapid progress of this product throughout 2024 and 2025.

## 3.8 Electricity Storage in the near-term (2030-2040)

The next challenge, beyond the immediate term, is to ensure the development of sufficient electricity storage systems to meet the third Carbon Budget. To do so it is the view of this Government that large quantities of electricity storage are required to be added to the electricity grid in the near-term (2030-2040). Therefore, in addition to the immediate procurement of demand flexibility and (long duration*) electricity storage, this policy framework also sets out four further Actions to confirm the Government's commitment to electricity storage systems in the near-term (2030-2040) timeframe.

The following four Actions of this policy framework are to maintain service provider certainty and ensure continued investment in electricity storage systems capable of bulk electricity time shifting to meet the needs of both intra-day and beyond demand, throughout the near-term (2030-2040) horizon.

### 3.8.1 Action #7: 2030-2040 - Quantitative consultation / study

Firstly, while the 2030 requirements of the grid system have been estimated by both System Operators, setting out their modelling in documents such as EirGrid's Shaping Our Electricity Future (SOEF) roadmap and ESB Networks Net Zero Strategy, it is an action (Action #7) of this policy framework that the Department of Environment, Climate and Communications will engage an external consultancy to establish an optimum quantity of electricity storage system required in regard to the near-term (2030-2040) needs of a Net Zero network in line with the SEAI DESS Net-Zero Study. (For further information on the SEAI: DESS Net-Zero study see Section 3.7.3)

While Terms of Reference (ToR) are yet to be decided this will be a 'Quantitative consultation / study' to model Ireland's future electricity storage system requirements over a minimum 10-year time-frame. I.e.: 2030 to 2040. It is expected the Quantitative consultation process will commence during 2024 and will entail the commissioning of an external consultancy to engage with the Regulatory authority, System Operators and conduct a Call for Evidence with a view to determining the optimum amount of electricity storage capable of bulk electricity time shifting, required to meet Ireland's ambitious Net-Zero and de-carbonisation goals throughout the near-term (2030-2040) horizon.

### 3.8.2 Action #8: 2030-2040 – Financial consultation / study

Secondly, this policy framework is aware that the large capital expenditure associated with electricity storage technologies creates the need for a strong business case to create certainty and reduce risk around the development and connection of electricity storage systems at both transmission and distribution level.

It is also understood that the condition of market forces and 'routes to market' for service providers in the near-term (2030-2040) are unclear and that market conditions at that time may potentially not provide sufficient or a minimum necessary revenue to guarantee investment.

To that end this policy framework actions (Action #8) a Government commitment to undertake a ''Financial consultation / study' to determine whether sufficient financial incentives for service providers are in place in order to incorporate the optimum quantity of electricity storage systems required by the grid network, as established through this policy framework's Action #7.

This ‘Financial consultation / study’ will review market conditions in line with the introduction of the Schedule & Dispatch programme, the completion of the SEM market reform, the Celtic interconnector connection and the introduction of the two ‘route to market’ products under development. The ‘Financial consultation / study’ will determine whether the outcome of these changes provides sufficient financial incentives to service providers in order to meet the near-term (2030-2040) grid requirements.

### 3.8.3 Action #9: Supplementary Financial Analysis

Thirdly, *should* a potential ‘missing money’ gap be identified in the aforementioned ‘Financial consultation / study’ (Action #8) this policy framework will action a ‘Supplementary financial analysis’ (Action #9). The goal of this action (Action #9) is to ensure that, *should it be required*, a sufficient financial incentive for service providers to meet the projected system requirements for electricity storage would be in place by the end of 2028. It is considered that this date is the latest date permissible to allow service providers sufficient time to begin the development of electricity storage systems required by the grid network throughout 2030-2040.

*Should it be required*, this ‘Supplementary financial analysis’ will propose and develop a suitable market framework to ensure electricity storage systems that meet a ‘route to market’ product developed by the Regulatory authority and the relevant System Operator, have available a sufficient and effective business case. This policy framework ensures that this ‘market framework’ will remain ‘technology neutral’ and will be in situ, *if required,* before the end of 2028.

### 3.8.4 Action #10: 2030-2040 – Route to Market

The fourth and final action designed to meet the third Carbon Budget and the near-term (2030-2040) needs of a Net Zero network is based on Actions #7 and #8 and in parallel with Action #9 of this policy framework. This action (Action #10) will engage with the Regulatory Authority to develop *if required,* a ‘route to market’ to ensure the incorporation of sufficient electricity storage systems as required by the grid throughout 2030-2040. This ‘route to market’ *if required,* will be in place by the end of 2028 and will utilise any potential market framework developed through Action #9 in order to achieve its goal. This policy framework ensures that this ‘route to market’ process will remain ‘technology neutral’ and be in situ before the end of 2028. It is considered that this date is the latest date permissible to allow service providers sufficient time to begin the development of electricity storage systems

required by the grid network throughout 2030-2040 and in time to meet the third Carbon Budget.

It is expected that this 'route to market' mechanism will enable electricity storage systems to bulk electricity time shift beyond the intra-day by purchasing in-expensive electricity energy and subsequently reselling at a later date and time. This large scale 'Arbitrage' is expected to be designed around societal values as well as technical characteristics such as suitable locational signals, CO2 reduction profiles, marginal cost abatement and the cross comparison of different technologies in a neutral manner. It should be noted that any further route to market mechanisms for storage would need to comply with relevant State Aid rules.

# 4 Safety and Regulation

## 4.1 Key Message

This policy framework recognises that one of the most important elements of Ireland's successful transition away from fossil fuels to green renewable energy are safe, regulated, and reliable electricity storage systems working in tandem with the national grid system. This policy framework also recognises that the safe and regulated integration of electricity storage projects into the grid system is fundamental for both the public and industry confidence in the development of electricity storage projects.

The Government acknowledges that while the public recognises the benefits of renewable energy infrastructure in general there remains concerns regarding the safety and regulation of electricity storage systems and Battery Electricity Storage Systems (BESS) in particular. This Government believes that a public fully informed of the safety and regulation measures that govern the incorporation of electricity storage in Ireland will help to ally these concerns and increase the acceptance and understanding of these technologies.

In-line with the Climate Action Plan 2023, the Department of the Environment, Climate and Communications sought public and industry contributions as part of its *Electricity Storage Policy Framework for Ireland* consultation questionnaire, this questionnaire included a Safety and Regulation question seeking opinions on engagement in regard to safety and regulation of future electricity storage systems in Ireland. Responses to this public consultation highlighted the concerns of both industry and the public regarding electricity storage systems and this chapter aims to address these and any other safety concerns that the deployment of these nascent technologies on the grid, may bring. Therefore, set out below is the present safety and regulatory framework which govern these technologies.

### 4.1.1 Already in use

It is important to note here that electricity storage systems are already playing an important role in supporting the energy transition on the island of Ireland, with over 1GW of electricity storage energised to-date. 292MW of this is available through Hydro Electric Storage in Turlough Hill, Co. Wicklow and the remaining 700+MW is predominantly comprised of battery electricity storage systems (BESS), with the first battery electricity storage system (BESS) energised in Ireland in 2018. Lithium-ion Batteries Energy Storage Systems (Li-BESS) are the predominant system currently active on the system. The Li-BESS product is a safe and proven electricity storage system technology incorporated into energy systems worldwide. This policy recognises that there were valid safety concerns regarding this nascent technology in the early stages of its development, however, the safety and regulation of this technology has advanced considerably since.

This chapter sets out the existing International, European Union and Irish regulation and standards which govern BESS and other electricity storage systems in Ireland, as well as the many layered institutional protection, prevention and mitigation processes in place.

As further detailed throughout this chapter, different aspects of the safety of (Battery) electricity storage systems are handled by different sets of regulations and agencies. This policy delivers an overview but does not address the minutia and how each institution addresses the specifics of their remits.

Electricity storage system product standards conform to the European (EN) standards, and it is the National Standards Authority of Ireland (NSAI) who ensure the adoption of these European standards in Ireland. The Safety, Health and Welfare at Work Act as well as the EU Chemicals Act and Regulations (COMAH) are the remit of the Health and Safety Authority.

Battery electricity storage systems are subject to the requirement for planning permission under the Planning and Development Act 2000 and associated Regulations. The planning authorities ensure that battery electricity storage installations are planning legislation compliant. (See Section 4.4.2 below)

Where battery electricity storage systems are to be installed at an existing or proposed Environmental Protection Agency (EPA) licensable activity (First Schedule of the EPA Act 1992, as amended or Waste Management Act 1996, as amended) the battery electricity storage system will be included within the license boundary, considered as part of the

licence assessment and subject to conditions of any subsequent licence granted and enforced by the EPA. (See Section 4.4.4)

The CRU is responsible inter alia, for the licencing of electricity storage, the regulation of electricity storage in the electricity market, electricity storage grid connections, including hybrid co-location of electricity storage assets with renewable generation assets.

## 4.2 Regulation Overview

### 4.2.1 Universal Regulation, Standards, and Certification

First and foremost, it is important to highlight at the outset that all system components and products used in the Irish context are manufactured under a large range of high standards, regulations, and best practice processes, ensuring that no matter the technology, the electricity storage systems being sourced and installed on the island of Ireland are fit for purpose and certified to a European, and therefore Irish standard.

### 4.2.2 European Union Directives

The European Union in 2020 presented an initial proposal for a regulatory framework for electricity storage batteries to ensure sustainability (such as carbon footprint rules, minimum recycled content, performance and durability criteria), to address social and environmental risks not presently covered by EU legislation and to establish mandatory harmonisation of safety certification and labelling for the marketing and putting into service of electrical storage system batteries. The framework also addressed the requirements for end-of-life management and recycling markets as well as obligations for economic operators in regard to the sourcing of raw materials for batteries and associated products.

In-line with this framework, European Union (EU) Directives and Regulations outline stringent regulatory and safety parameters for electricity storage systems:

EU Regulation (2022/2577) - '*Laying down a framework to accelerate the deployment of renewable energy'* references the planning, permit granting process, construction, and operation of electricity storage plants and installations, Including Li-BESS as being 'in the overriding public interest'. This regulation includes a number of articles to support the greater integration of renewables by member states through establishing time-limits for the permit-granting process for the installation of solar energy equipment and co-located energy storage assets of three months.

Regarding Battery Electricity Storage systems (BESS) the European Union in August 2023 introduced EU Regulation (2023/1542) – '*Concerning Batteries & waste batteries'*, which

sets out the harmonisation of electricity storage batteries as well as safety testing and certification requirements relevant to battery energy storage systems, such as Li-BESS that deliver electric energy to the grid or store electricity for delivery to electric energy end users.

Article 12 of EU Directive (2023/1542), titled ‘Safety of stationary battery energy storage systems’, stipulates that battery storage systems that are placed on the market or put into operation shall be safe during their normal operation and use. The technical documentation (see annex VIII below) for these systems must include evidence that they have been successfully tested to meet the required safety standards set out in Annex V.

EU Directive (2023/1542) Annex V list of system safety issues that require testing certification.

- Thermal shock and cycling
- External short circuit protection
- Overcharge protection
- Over-discharge protection
- Over-temperature protection
- Thermal propagation protection
- Mechanical damage by external forces
- Internal short circuit
- Thermal abuse
- Fire test
- Emission of gasses

Articles 15 to 18 of EU Directive (2023/1542) set out requirements in relation to the conformity of batteries in respect to the requirements laid out in Article 12. More specifically:

- Article 17 lays out the conformity assessment procedures for stationary batteries for energy storage in respect Article 12.
- Article 18 stipulates the requirement for EU declaration of conformity to state compliance with Article 12 obligations.
- Annex VIII outlines the details of these conformity procedures, including information on technical documentation, EU declaration and CE marking (Article 20).

Also outlined in Annex VIII is the respective roles of the various bodies who are obligated to be involved in the conformity assessment process. This includes conformity assessment bodies, who perform conformity assessment procedures and a notifying authority who, as in

Article 22a, is responsible for setting up and carrying our procedures for the assessment and notification of conformity assessment bodies and monitoring of notified bodies.

## 4.3 Standards Overview

### 4.3.1 International and European Standards

Internationally, the International Electrotechnical commission (IEC) are the world's leading organisation for the establishment of international standards for all electrical, electronic and related technologies. These standards are technical documents designed to be used as a rule, guideline, or definition. The IEC have a range of standards for all electrical related technologies, including electricity storage systems and these standards cover technical, testing and system integration for systems such as Lithium-ion Batteries Energy Storage Systems (Li-BESS). It is important to note here that the IEC would be, in the development of their standards, cognisant of other similar standards published by other leading international safety organisations such as the Underwriters Laboratories (UL) and the National Fire Protection Association (NFPA) in the United States of America, further details on which are included below.

At the European level, almost 80% of '*European Norm'* (EN) Standards are IEC standards incorporated through the Frankfurt agreement, an agreement which facilitates a consensus-finding process in the electrical sector between the IEC and the European standards development agencies. It is the European committee for standardisation (CEN), the European committee for electrotechnical standardisation (CENELEC) and the European telecommunication standards institute (ETSI) who set the European Standards (EN), relevant to Electrical storage systems.

### 4.3.2 IEC & EN Standards

The electricity storage systems in place on the Irish grid conform to the EN and IEC standards. An extensive list of these standards in regard to electricity storage systems can be found in Annex's C and E respectively.

### 4.3.3 Incorporation of EU standards by member states

A European standard (EN) once published by the CEN and CENELEC is included in the standards catalogue of CEN and CENELEC's thirty-four Members and considered a *National standard* in those countries. With the European standard now holding the status of a national standard in all member countries, member states have the obligation to withdraw any national standards that conflict with it. This process ensures a uniform approach to electricity

storage systems throughout the EU and allows all electrical and electronic products and related technologies with European standards applied, to have access to the European market whether the manufacturer is based in a member's territory or not.

### 4.3.4 National Standards Authority of Ireland (NSAI)

The National Standards Authority of Ireland, through their Electrotechnical Standards Programme and Electro Technical Committee (and other relevant Technical Committees), can, through consultation with national voluntary experts monitor and contribute to the development of standards in relation to the safety and regulation of electricity storage systems. NSAI will ensure the adoption of European standards in this area in Ireland. This work is essential in ensuring suitable standards across the entire value chain of all electricity storage system technologies.

### 4.3.5 CE Marking

Further, within the European Economic Area (EEA) electricity storage systems sold carry a '*conformité européenne'* CE marking. While not a standard or certification marking, a CE marking demonstrates a product's conformity with European health, safety and environmental protection standards and that it is compliant with EU legislation. It is the responsibility of the product's manufacturer to ensure its products compliance with these standards and subsequently affix the CE marking. Whilst affixing a mark does not require a license, CE marking under the European Union's Harmonization legislation is managed by the Directorate General for internal market, industry, entrepreneurship, and Small Medium Enterprises or by the Directorate General for Environment for hazardous substances.

## 4.4 Irish Context

There are a variety of safety and regulatory stages incorporated into the planning, development, integration and running of new electricity storage installations on the island of Ireland. The Government believes that clarity of these processes is vital for public confidence in the work carried out by the electricity storage sector.

### 4.4.1 Site Identification/Selection

While the development and management of all new electricity storage system installations is independent of both Government and the designated electricity grid System Operators (EirGrid and ESB Networks), the System Operators in conjunction with the Commission for Regulation of Utilities (CRU) have brought and will continue to bring to market a variety of products which will incentivise the development of electricity storage systems on the Irish

grid based on specific criteria. These products are discussed in more detail in Chapter 3 Markets.

While both System Operators may set out locational criteria, the identification of suitable sites for electricity storage projects is service provider led. System Operators may direct the market to source and develop the best electricity storage solution, specific to the needs of the system in a broad area or location but will not issue preference for any specific site. Apart from meeting the locational criteria associated with a specific System Operator product, there are a variety of other criteria that may influence a service provider's site selection, such as the potential for co-location of both renewable electricity generation and electricity storage in order to maximize revenue, the proximity to the existing network, the development of connection infrastructure, the local area networks capacity to incorporate the service providers expected import/export capacity (constrained) and the economic potential of the product offered by the System Operator to meet the service providers costs and required revenue stream(s).

### 4.4.2 Planning

An electricity storage system development is obliged to receive planning permission and be developed in accordance with relevant building control regulations, where applicable. Planning legislation and building regulations are the remit of the Department of Housing, Local Government and Heritage. The development process of an electricity storage system begins with an application for planning permission, at present a pre-requisite for the procurement of an electrical storage system contract for any of the System Operators' products. The Government is conscious that planning permission as a pre-requisite is a major hurdle in regard to the financial planning of projects and may delay a service provider's inclusion in a System Operator's product auctions and associated incentive schemes. However, while this approach remains under review it is considered at present that only proposals with pre-approved planning permission should be considered for inclusion in the procurement process by the System Operator's, in order to allow local planning authorities and associated fires services time to consider the suitability of the project. This approach in turn both shortens and gives certainty to the System Operators procurement process and connection timeline.

With a site selected a service provider will put forward an electrical storage system proposal for planning permission to their local planning authority who will review the proposed project, take consideration of environmental impact assessments (EIA's), where required.

The local/planning authority plays a significant role in relation to electricity storage facility developments in its capacity as planning authority, building authority and fire authority. The planning authorities assess individual electricity storage planning applications with recourse to all relevant policy documentation, including regional spatial and economic strategies and development plans (which must be consistent with the National Planning Framework). Principal assessment criteria, in addition to compliance with national, regional and local policies, will depend on the specific electricity storage project under review and the proposed location but considerations include: the most efficient use of land and infrastructure; the visual impacts of storage units as well as potential environmental/ecological risks posed by electricity storage projects in the proposed location.

At present electricity storage systems such as Li-BESS depending on their power capacity, measured in Kilo-Volt-Amperes (kVA), are processed either through the two-stage planning process, where applications under Section 34 of the Planning and Development Act 2000 are first made to the local authority with an appeal process under Section 37 of the Act facilitated by An Bord Pleanála if required. Or in the case of certain electricity storage systems may be considered Strategic Infrastructure and seek planning permission under Section 37E directly from An Bord Pleanála, where appropriate.

If a service provider's planning application is refused at local level under Section 34, they may appeal to An Bord Pleanála. It is important to note that planning policy and related guidelines are a matter for the Minister for Housing, Local Government and Heritage (DHLGH) in the first instance.

The new Planning and Development Bill (2023) is considering the designation of all electricity storage systems as integral parts of the electricity network system and therefore Strategic Infrastructure Development (SID). Electricity storage systems would therefore be treated in a similar manner to all renewable energy generation and grid infrastructure and will as Strategic Infrastructure Development require only an application to An Bord Pleanála. Further, planning permission timelines for electricity storage systems will adhere to those set out for Strategic Infrastructure Developments in the Planning and Development Bill.

Once a project is granted planning permission the service provider will then apply for a grid connection to the relevant System Operator via the Enduring Connection Process (ECP). Please note further detail in regard to the ECP is outlined in Chapter 2.

### 4.4.3 Fire Services

Under Section 13 of the Fire Services Acts 1981 & 2003, Fire Authorities may advise a planning authority in relation applications for planning permission for development and permission for the retention of structures, Section 34 (which relates to permission for development and for the retention of structures) of the Planning and Development Act 2000.

### 4.4.4 Installation with an EPA licence

Where an installation which holds an EPA licence proposes to install a battery electricity storage system, the installation should contact the EPA and may require a licence alteration or licence review. Licensable activities which also propose installation of battery electricity storage system will have the storage infrastructure assessed as part of the licence assessment and the conditions of any licence granted will apply to the licensable activity and the storage infrastructure.

The EPA, with local authorities, lead the national enforcement of the Batteries Regulations and the Waste Electronic and Electrical Equipment (WEEE) Regulations. The EPA enforce the obligations on producers and oversee battery collection, recycling and disposal processes to ensure adherence with environmental standards. Any person who places batteries and/or electrical and electronic equipment (EEE)[1] on the market in Ireland for the first time on a professional basis, whether by manufacturing or by importing the product, is a 'producer'.

The Batteries Regulations (S.I. No. 283 of 2014), the Batteries and Waste Batteries Regulation (EU 2023/1542) and the WEEE Regulations (S.I. No. 149 of 2014) require a producer to:

- Register with the National Registration body (Producer Register Limited).
- Finance the environmentally sound management of the batteries and/or EEE for when the products become waste, generally by joining a compliance scheme.
- Ensure batteries and/or EEE placed on the market comply with relevant product, sustainability, safety and labelling requirements.

Batteries and EEE used in battery electricity storage systems are required to be sourced from a registered supply chain, i.e., from a producer who meets the requirement to be registered, up to date, with the national registration body (Producer Register Limited).

### 4.4.5 Construction

Many of the electricity storage systems such as the Lithium-ion battery storage systems presently participating on the Irish grid arrive pre-packed and ready for assembly and connection. As referenced above, these systems must conform to International and European standards during production, transportation and construction stages.

### 4.4.6 HSA the SHAW Act & SEVESO III Directive

The Health and Safety Authority (HSA) has responsibility for ensuring workers and those affected by a work activity are protected from work related injury and ill health. This role is undertaken under the occupational Safety, Health, and Welfare at Work Act 2005.

The Safety, Health, and Welfare at Work (Construction) Regulations 2013 set out the main requirements for the protection of the safety, health, and welfare of persons at work on construction sites. The regulations set out the general duties of all parties involved in construction work, including those of the Clients, Project Supervisors, Designers, Contractors, and Employees.

The principals of electrical safety are set out in the Safety, Health, and Welfare at Work (General Application) Regulations 2007. In the context of worker/workplace safety, based on the current legislation and the hazards associated with battery energy storage systems, protection of occupational health and safety in the workplace is addressed under the general duties on employers to risk assess work activities and emergency preparedness.

The Health and Safety Authority is the Central Competent Authority for the purpose of the Seveso III Directive 2012/18/EU. This Directive is implemented by SI 209 of 2015 – the Chemicals Act (Control of Major Accident Hazards involving Dangerous Substances) Regulations 2015 – COMAH Regulations. The purpose of both the Directive and the COMAH Regulations is to lay down rules for the prevention of major accidents involving dangerous substances and to seek to limit as far as possible the consequences for human health and the environment. The COMAH Regulations have a strong and explicit link to the Classification, Labelling and Packaging Regulations, covering only substances and mixtures classified in accordance with Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures (CLP). Battery Energy and Electricity Storage Systems are not considered substances or mixtures under CLP and therefore are not dangerous substances under Seveso/COMAH. Consequently, the COMAH Regulations do not apply to any type of battery storage system.

### 4.4.7 Connection

Service providers of Front of Meter (FoM) electricity storage systems must request connection from the System Operator via the Connection Offer Process as approved by the Commission for Regulation of Utilities (CRU).

This grid connection process is required for connection of all generating and/or storage and other system service technologies. Service providers must also engage with either EirGrid or ESB Networks, the System Operators, as appropriate and conform to the standards and processes set out in the relevant 'Grid Code'. Once the electrical storage system is ready and all relevant licensing documentation is in place, the connection is facilitated and finalised by the System Operator when the Final Operational Notification is issued post energisation and once all tests have been completed. This testing is carried out to ensure the system is installed properly, deemed fit for purpose and that no defects have occurred during parts supply or assembly and that the system works in a proper and safe manner with the grid systems.

### 4.4.8 Licensing

The Commission for the Regulation of Utilities (CRU) established by the 1999 Electricity Regulation Act, has regarding licensing, charging and market incentives for electricity undertakings, commenced in-line with CAP Action (23/23) a review of the regulatory treatment of electricity storage systems.

Under Section 14(1)(n) (as amended by the Renewable Energy Regulation S.I. 20/2022) CRU are now authorised to license electricity storage systems. Further, service providers of electricity storage systems (in their capacity as generators) are also required to apply for an Authorisation to Construct (under Section 16), even though electricity storage systems are not explicitly referred to in Section 16.

Further, the CRU is engaging with industry to consider how it can best enable industry to work with storage aggregation and demand response assets. As aggregated electricity storage system service providers may engage not just with larger energy users but with smaller businesses and perhaps even domestic customers also, the CRU are continuing to work on measures that will ensure customer protection are in place.

### 4.4.9 New Technology Risk Management

This Government also recognises that the rapid pace and innovation of the ever-evolving technology associated with electricity storage systems will bring future challenges particularly with regard to Safety and Regulation and that the pace of technology may outpace the supporting safety and regulatory structure. This is particularly notable in test technologies where the IEC or the European Union standards and regulations are not yet directly addressing the challenges posed by these new technologies.

It is important to note that industry best practice considers safety fundamental to product development with public confidence in electricity storage systems vital to their commercial interests. To that end industry conforms to pre-existing standards such as the United Nations Model Regulations on the Transport of Dangerous Goods or incorporates vanguard safety approaches devised by internationally recognised leaders in safety regulation and research.

It is also important to note here that Irish industry through associations such as Energy Storage Ireland, who are a representative association of public and private sector organisations interested and active in the development of energy storage in Ireland and Northern Ireland have also produced '*Best practice guidelines for Battery Energy Storage Systems*' which outline the above standards and regulation as well as incorporating many of the following UL and NFPA standards and guidelines.

Amongst other internationally recognised leaders in safety standards, regulation and guidelines are the Underwriters Laboratories (UL) and the National Fire Protection Association (NFPA). These institutions have created internationally recognised guidance and commercial safety standards and test methodologies for industry, that act as a safety aid and regulatory guide to service providers in the design and development of new electricity storage systems. This global approach by industry to hazard management ensures safe and regulated development and subsequent secure operation processes for new energy storage projects.

UL who are a global leader in applied safety science, for testing, inspection, certification, auditing, and validation have set internationally accepted best standards for new technologies since 1894 and the NFPA who are global leaders in fire prevention for more than 125 years provide codes and standards to meet the challenges posed by electricity storage system technology of electrical safety, hazardous materials, public and community risk reduction.

These institutions have developed standards, regulation and guidance which aim to protect, prevent, and mitigate against hazards associated with both established and developing Energy Storage Systems. A list of the relevant regulation developed by these institutions can be found in Annex H.

# Annexes

## Annex A: 18 BESS Installations

| No. | Battery Name | Capacity (MW) | Energised Date | Owner |
|---|---|---|---|---|
| 1 | Aghada I BESS 01 | 19 | Dec 2021 | ESB GEN |
| 2* | Aghada II | 75 | Mar 2024 | ESB GEN |
| | Aghada II | 75 | Apr 2024 | |
| 3 | Avonbeg Battery | 16 | Oct 2022 | Avonbeg Storage Ltd |
| 4 | Gardnershill | 8.5 | Dec 2020 | Flexilia Power Ltd |
| 5 | Gorey Battery | 9 | Dec 2021 | RES Storage Ireland Ltd |
| 6 | Barnesmore ESS Golagh | 3 | Mar 2022 | Scottish Renewables |
| 7 | Gorman ES | 50 | Dec 2021 | Scottish Renewables |
| 8 | KelwinP1 | 2.6 | Jul 2018 | Ronaver Energy Limited |
| 9 | KelwinP2 | 26.6 | Dec 2020 | Ronaver Energy Limited |
| 10 | Kilathmoy / Beenanaspuck | 11 | Dec 2019 | Winter Winds Limited |
| 11 | Killala Phase 2 | 10.8 | Dec 2021 | Community Wind Farm |
| 12 | Kylemore BESS | 30 | May 2022 | ESB |
| 13 | Lisdrumdoagh ESS | 60 | Dec 2021 | RWE Renewables |
| 14 | Lumcloon ESS | 100 | Dec 2020 | Lumcloon Power Ltd |
| 15 | Poolbeg Battery | 75 | Jun 2023 | ESB |

| | | | | |
|---|---|---|---|---|
| 16 | Porterstown Battery | 30 | Feb 2022 | Porterstown Battery Storage Ltd |
| 17 | Shannonbridge A ESS | 100 | Apr 2021 | Shannonbridge Power Ltd |
| 18 | South Wall | 30 | Mar 2024 | ESB |

- *Only 75MW of the Aghada II BESS system was energised as of March 2024. The remaining 75MW was energised the following month (April 2024)*

# Annex B: Electricity Storage System Technologies

This policy framework recognises that electricity storage and electricity storage systems have many types and varied roles. The types of technologies and their uses is a broad area and not all are included or intended to be covered in this policy framework.

While the present composition of electricity storage on the island of Ireland is chiefly comprised of Batteries Energy Storage Systems (BESS), mainly Lithium-ion batteries energy storage system (Li-BESS) and one Pumped Hydro Storage facility, this is in large part due to these technologies being to date, and given their commercial readiness and technical characteristics, the best equipped to deal with grid and demand issues in the Irish context.

This policy framework is aware that there may also be other technologies capable of meeting, individually or collectively, the system service requirements and the demand flexibility needs of the grid network and consumers.

This policy Annex reviews various electricity storage technologies, in varying stages of development and deployment across the globe. It must be pointed out that potential future technologies are not limited to those discussed in this policy. This policy considers that many new chemical, electrochemical, mechanical, thermal, and as yet unknown storage technologies will be developed to meet present and future system needs as electricity demand changes into the future.

## Chemical Storage

Chemical electricity storage uses chemical fuels to store electricity. When required, the electricity can be discharged through re-electrification of the chemical.

**Hydrogen** storage is a chemical electricity storage technology. The process of electrolysis enables the conversion of renewable energy to hydrogen, which can be stored through a variety of methods, including *Compressed tanker, Line pack, Geological storage solution* and *Hydrogen derived carrier storage*. 'Green Hydrogen' is a term used for high purity hydrogen with no associated emissions. Due to its low-carbon production methods and various end use applications, green hydrogen has been widely suggested to have the potential to provide long-term electricity storage. Its large capacity, energy density and long discharge durations, mean it could offer inter-seasonal storage. Like many other countries across Europe and the world, Ireland has Identified Hydrogen to be a key component in its net zero transition of the energy sector. In July 2023, the Department of the Environment, Climate and Communications published its '*National Hydrogen Strategy'*, outlining the nations position on hydrogen. For more information on Hydrogen and its potential as a storage medium, please refer to the National Hydrogen Strategy, which can be found here.

National Hydrogen Strategy (www.gov.ie)

## Electrochemical Storage

Electrochemical electricity storage systems work through the charge and discharge reactions between positive and negative electrodes. When charged, electrons in the battery will flow towards its cathode, from its anode, where they build up and store electricity. The opposite process will occur whilst a battery is discharging.

**Lithium-ion batteries** are the most common form of grid scale battery at present in Ireland and across the globe. These batteries usually operate at durations of between 30 minutes and 4 hours, with technological developments indicating a possible development of 6 and 8 hours batteries with the potential to deliver more storage capability in the near future. These batteries are generally modular in nature, have a relatively high energy density and long cycle life (typically three thousand full depth of discharge cycles, though partial discharge is less onerous on the battery than full depth of discharge). Currently, on the all-island system, there are over 700MW of battery electricity storage systems, with an average duration of less than one hour and in the main providing system services.

At present the development pipeline of electricity storage systems is expected to deliver over 900MW of existing and new systems by 2026, adding much needed additional capacity and storage duration to the all-island power system. It is expected the duration of these batteries will provide more storage capability by increasing to an average duration of around two hours. Today, grid scale Lithium-ion batteries are predominantly used to provide fast-acting frequency response and reserve grid services (DS3 System Services) that reduces the need

to use fossil fuel generators for these services. Although grid-scale batteries could plausibly store enough electricity to cope with day-to-day peaks in demand, they are not yet a solution to monthly or seasonal fluctuations, which is by far the biggest challenge in creating a fully net zero power system. Lithium-ion storage technologies are also used at residential and commercial level (for example batteries connected to solar PV and in electric vehicles).

**Flow batteries** are another type of electrochemical storage that use two liquid electrolytes, one positive the other negative, to store fluid. Electricity can be generated by pumping the fluids in both electrolyte tanks around a cell that is separated by a membrane. When charging /discharging, this membrane will allow ions within the fluids to pass through. Ions will chemically react with ions pumped from the alternative tank, resulting in an electron transfer between the two. Whilst not a current major player within Ireland, flow batteries could compete with Lithium-Ion systems in the future. Flow Batteries Europe (FBE) is a stakeholder group in Europe aiming to drive the creation of a long-term strategy for the flow battery sector within the continent.  According to a position paper published in March 2023 by the organisation, 3-5% of the LDES market was represented by flow batteries, with the largest installed one having a capacity of 100 MW. FBE have set a 200GW flow battery target to be achieved by 2030.

**Iron-air batteries** use the processes of rusting and reverse rusting caused by reactions between an air electrode and an iron electrode. When charged with an electric current, oxygen is removed from rust on the iron electrode, causing the electrode to return to its original from and storing the electricity. When discharged, iron molecules are exposed to the air, oxidised and cause the battery to rust, releasing the electricity.

**Sodium-ion batteries** involve reactions between a positive electrode containing sodium and a negative electrode. When charged sodium atoms release electrons towards the negative electrode. The opposing process happens during discharge.

Like previous examples, **Lead-Acid batteries** are composed of a lead dioxide containing positive electrode and a negative electrode that contains spongy lead. Charge and discharge reactions between the two occur in an acid in which they are both immerged in.

## Mechanical Storage

Mechanical storage stores electricity by taking advantage of kinetic energy.

**Pumped-Hydro Storage (PHS)** is a mature form of hydroelectric energy infrastructure that involves storing energy by using electricity to pump water from a lower reservoir to an upper reservoir. This energy is released by allowing the water to flow back down to the lower

reservoir where it spins a turbine connected to a generator to create electricity. When electricity prices are cheap, the system will charge by pumping water back up to be stored in an upper reservoir. Multi-hour PHS is responsible for the largest share of grid-scale electricity storage around the globe. Currently, in Ireland, Turlough Hill in County Wicklow, which comprises four reversible pump turbines has a rated power of 292MW and a capacity of 1.7 GWh is the only PHS facility in the country and has been operational since 1974.

A second PHS site, Silvermines, Co. Tipperary, has been included on the EUs Project of Common Interest (PCI) 6$^{th}$ list. For further information on Silvermines, please refer to Annex G.

**Compressed Air Energy Storage (CAES)** uses electricity to compress air into an enclosed space, like a cavern, where it is stored. When the electricity is needed, the air is heated and released to spin a turbine and generate electricity. The two types of CAES are Diabatic and Adiabatic. The former uses combustion of natural gas or fuel for the heating of the released air and hence has higher associated emission. The newer, advanced adiabatic CAES technology allows for elimination of emissions by storing the heat generated from the compression as thermal storage which is later used to heat the air upon its release. Conversely, a different form of Adiabatic CAES doesn't cool the air after compression and do not require to be heated later. CAES is a technology used widely across Europe. The Huntorf Plant in Germany was the world's first CAES power plant within Europe. Like most existing CAES plants, the Huntorf is Diabatic, using a gas turbine to generate heat. However, the push to transition to Adiabatic plants is clear. By pushing the limits of large-scale energy storage, an optimised combined cycle CAES (PUSH-CCC) project looks to solve the key challenges associate with CAES. The EU-funded project was signed in June 2023, commencing operation in October 2023.

**Liquid Air Electricity storage (LAES)** is a mechanical storage system in which electricity is used to liquify air, which is then stored in an insulated tank. To discharge, the system will heat the liquified air at high pressure, causing it to evaporate and turn a generator-connected turbine. Europe is a world leader in liquid air electricity storage development.

A **synchronous condenser** is akin to a conventional generator that is not connected to a turbine. A synchronous condenser stores electrical energy in the form of a rotating mass synchronised to the grid. This energy is released as inertia when grid frequency fluctuates. Whilst its purpose is not to store electricity as such, a synchronous condenser will be vital to stability of the system when conventional heavy synchronous plants are no longer available.

**Flywheels** are mechanical masses that stores mechanical energy in the form of kinetic energy. Electricity is used to speed up the flywheel and the flywheel releases electricity as it slows down.

## Thermal Storage

Thermal storage involves the heating and cooling of various substances. Electricity can be stored as thermal energy that can later be released as electricity or remain thermal. Thermal storage can take many different forms, namely sensible heat (thermal energy) storage (STES), latent heat (thermal energy) storage (LTES) and thermochemical energy storage (TCES). Another type is mechanical-thermal energy storage, which integrates the use of kinetic and thermal energy, Examples of which includes CAES and LAES, discussed previously. Within these different types of thermal storage sit a variety of technologies.

**Sensible heat (thermal energy) storage (STES)** utilises a materials capacity to store heat. Charging and discharging with the fluctuation in temperature of a given material. To charge, the material which can be solid or liquid, is heated up, storing energy as heat. When the material is cooled the energy will be discharged. Molten salt thermal energy storage (MSTES) is one of the various STES technologies. Molten salts' efficient heat retention and high temperature stability make it a favourable thermal storage technology.

**Latent heat (thermal energy) storage (LTES)** technologies work on the heat discharged during a substance change. Phase change material (PCMs) can transition between gas, liquid and solid and are used to store and discharge thermal energy throughout these processes, this can be done at a range of temperatures.

Finally, **Thermochemical energy storage (TCES)** involves the absorption of heat and emitting of heat based on chemical reaction. Heat is absorbed during an endothermic reaction and emitted during an exothermic one.

An emerging thermal storage technology to note is the Sand battery. The technology is relatively simple, using sand (or sand-like material) as the storage medium. Excess renewable generation is used to heat the sand, storing the electricity for up to months at a time. When needed, the energy can be discharged through the release of heat outputted as hot water, steam or hot air which can in turn be used to generate electricity.

Thermal storage is an extensive area with development in the various technologies on-going across Europe and the world. It is recognised in its potential to contribute to European climate goals. The technologies have differing readiness levels, value chains and market

presence meaning whilst established solution exists for some, development is ongoing for others.

**Hybrid Thermal storage units** - incorporated into existing hydro/gas/heat electricity generation and industrial production facilities. Dual purpose Hybrid Thermal storage units permit direct energy generation through renewable resources, decarbonising some parts of high-temperature processing. A blend of various energy storage technologies Hybrid Thermal Storage units store electricity to be later emitted as electrical or thermal energy.

This optimisation of renewable generation may improve energy efficiency and make Ireland an attractive prospect for large scale industrial processing operation, as well as offering a long duration storage option of electricity that could be used as required for system services.

## Electricity Storage Technology Overview

The below chart summarises the characteristic of some storage technologies discussed above.

| Storage Technology | Power Range/ Capacity | Duration | Advantages | Challenges |
|---|---|---|---|---|
| Pumped Hydro | 100MW-1GW | Several hours | Mature technology<br>Long lifetime<br>Non-fossil fuel Synchronous generation | Geographical limits<br>High Capex<br>Slow response time<br>Long lead time |
| Lithium-Ion Battery | Up to 100MW+ | 30 Minutes-6 hours | Good life cycle<br>High energy efficiency<br>Scalable<br>Low coast | Supply chain concerns<br>Temperature sensitivity<br>Limited long duration potential. |
| Hydrogen Storage | Multiple GW | Several hours/months, Inter-seasonal | Long Duration | Expensive |

| | | | | |
|---|---|---|---|---|
| | | | Major contributor to decarbonisation<br>Excess offshore wind means potential significant export opportunity. | Yet to be demonstrated at scale<br>Poor efficiency |
| Flow Batteries | Less than 10MW | 10-12 hours | Long life<br>No fire hazard.<br>High number of discharge cycles<br>Low cost of additional storage potential | Low energy density<br>Design complication<br>Immature technology |
| Compressed air electricity storage | 10MW-300MW | Several hours | Mature Technology<br>Non fossil fuel synchronous generation | Geographical limits<br>Low efficiency<br>Potential adverse environmental impacts |
| Thermal Storage | Large variation amongst technologies | Large variation amongst technologies | Robust technology<br>Potentially low cost | Low efficiency<br>Slow response time |
| Liquid air electricity storage | 5MW-650MW | 2-24 hours | Non fossil fuel synchronous generation | Low efficiency<br>Relatively large scale |

# Annex C: EN Specific Standards

**EN 54** - Fire detection and fire alarm systems - is a series of standards in which each section concentrates on a specific area of overall fire mitigation, outlining product characteristic, test methods and performance criteria to ensure the effectiveness and reliability of all aspects of fire detection and alarm systems.

**EN 15004** - Provides standards that set out the design, installation, testing, maintenance, and safety requirements of gas extinguishing systems in buildings, plants and other structures. EN 15004 consists of ten parts all of which cover a different type of extinguishant.

**EN 15276** - Consists of two parts setting standards for different aspects of condensed aerosol extinguishing systems. The two parts outline the requirements and tests methods for components of the system and its design, installation, and maintenance respectively.

**EN 50272**- Sets safety standards for secondary batteries and battery installation. It is a multi-part document in which each section covers a different area of the overall topic.

- EN 50272-1: General safety information.
- EN 50272-2: Stationary batteries
- EN 50272-3: Traction Batteries
- EN 50272-4: Batteries for use in portable appliances.

# Annex D: EU Regulation

This policy is the first specific Government policy framework for electricity storage, it is important to note here that this policy is developed in regard to various European Union initiatives, Frameworks, Directives and Regulations as well the Irish Government commitments, actions and objectives in the electricity storage area. Included below is a summary of European Union publications where electricity storage systems are referenced. It is important to note that the following is not an exhaustive list and other regulation concerning storage may exist.

## The European Union Context

Again, as this policy is the first specific Government policy framework for electricity storage, it is important to note here that this policy is developed with regard to various European Union commitments, actions and objectives related to electricity storage published in the following European Union publications.

## The European Green Deal (2019)

Published in December 2019, the European Green Deal recognises the threat of climate change to Europe. In a bid to become the first climate-neutral continent by 2050, the Green Deal aims to transform Europe in a way that will help overcome the challenges of climate change, focusing on several key principles including, ensuring secure and affordable energy supply in the EU, and developing renewable energy.

## The Clean Energy Package (2019)

In 2019 the EU saw a renovation of its Energy policy framework to aid the continents move away from fossil fuels, towards cleaner energy in line with European Green Deal objectives. This is the Clean Energy Package. The package Includes policy provisions for electricity storage, clarifying its role in the system, facilitating access to markets and harmonising national policy frameworks. Key provisions for storage in the Clean Energy Package include:

- Providing a technology neutral definition of energy storage.
- Recognising energy storage as an essential element in the energy transition.
- Requiring System Operators to move towards market-based tendering of flexibility services and to consider energy storage in system planning.
- Establishing non-discrimination in network charging.

The Clean energy package consists of eight legislative instruments, those that are particularly relevant to electricity storage include:

- Regulation (EU) 2018/1999: Is concerned with the governance of Energy Union and Climate Action. This regulation sets out legislative foundation for successful governance of the energy union and climate action. Energy security and the internal energy market are two of five dimensions in which the energy union covers.
- Directive (EU) 2018/2001: Renewable energy directive (RED), discussed below.
- Directive (EU) 2018/2002: Amendment to Directive 2012/27/EU on energy efficiency. This directive adapts EU energy law in line with 2030 climate goals.
- Regulation (EU) 2019/942: This regulation was aimed towards establishing a European Union Agency for the cooperation of Energy Regulators (ACER). ACER are responsible for numerous tasks concerned with improving cross border coordination between regulatory authorities. A document published by ACER that is particularly relevant to electricity storage is discussed below.

- Regulation (EU) 2019/943: Concerns the internal market for electricity. Through setting key principles for new market design, this regulation enables increased flexibility and established rules for the functioning of the internal market for electricity.
- Directive (EU) 2019/944: Amending Directive 2012/27/EU, this directive concerns establishing common rules for the internal market for electricity. It introduces mechanisms to enhance the right of EU consumers by presenting them with improved access to actively participate in the electricity market.
- Article 32 of this directive covers the Distribution System Operator (DSO) responsibility to establish standard products and services, and a market framework, for flexibility services. These services offer a route to market for storage technologies connecting at distribution level, and an important revenue stream within an overall revenue stack including, inter alia, energy, capacity, ancillary services, and other revenues. This is progressing in Ireland through the delivery of ESB Network's National Network, Local Connections Programme. As set out in the previous section, there are many locations where the scale of congestion arising means that electricity storage is the only viable flexibility solution.

The Clean Energy package also consists of non-legislative initiatives, such as the clean energy for EU Islands, which is discussed below.

## Fit for 55 (2021)

The EU fit for 55 contains a host of legislative packages revising existing EU acts on climate and energy and setting out the requisite actions to deliver the proposals set in the Grean Deal. The overarching aim is to reduce EU emissions by at least 55 per cent by 2030 compared to 1990 levels and subsequently make the EU carbon neural by 2050. The TEN-E Regulation, the NZIA Act and the Renewable Energy Directive all form part of the fit for 55 package and are covered below.

## Trans-European Networks for Energy (TEN-E) & PCI List

The Trans-European Networks for Energy or TEN-E regulations focus on linking the energy infrastructure of EU countries as well as selecting Projects of Common Interest (PCI's). PCIs are infrastructure projects which are consider essential in delivering EU objectives in the energy field, including improved interconnection between national markets, greater competitiveness, security of supply, and promotion of renewable energy sources. PCI projects are subject to strict regulatory and reporting structures and must comply amongst other matters to mandatory sustainability criteria as set out in the Green Deal.

As part of the EU Fit for 55 package the original 2013 TEN-E regulation (EU 347/2013) were revised, updated, and subsequently replaced by EU 869/2022 in June 2022. This revision saw new guidelines and regulation, including amongst others those to address the development of energy storage facilities more effectively and those relevant to external EU cross-border energy infrastructure. Designated PCI projects may benefit from EU Connecting Europe Facility (CEF) funding and a special regulatory process intended to accelerate the development of PCI designated energy projects.

- Article 7: Allocates priority status to a PCI project of sufficient maturity, which ensures a streamlined administrative and permit granting process. (planning, licencing and environmental assessments etc).
- Article 8: Designates one competent authority for the permit granting process.
- Article 10: Accelerates the permit granting process to take no more than 42 months for both the pre-application and the statutory granting processes.
- Article 16: Enacts the investment process for a PCI project that has reached sufficient maturity, the project developers are required to submit an investment request to the national regulatory authority, who will then inform the EU. In Ireland, this falls under the remit of the Commission for Regulation of Utilities.
- Article 17: May allocate the incurred cost of the PCI project as set out in the investment request. Should the investment request received by the relevant national authorities be accepted, the national authorities will proceed to decide on how the costs of the project will be covered
- Article 18: Outlines EU financial assistance of eligible PCI projects for study, financial instrument and / or works grants.

Under the TEN-E, an EU Projects of Common Interest list (PCI list) is developed and published every two years. The most recent (6th) PCI list was the first to incorporate projects of mutual interest alongside PCIs. Projects of Mutual Interest (PMI's) connect the EU with third party countries, such as the UK.

There are currently two Irish electricity projects on the PCI list, which entered into force in April 2024:

- Project 1.13 - The Silvermines Pumped Hydro Storage Facility, a 360MW pumped-hydro generation / storage facility located in Co. Tipperary.
- Project 1.3 - The Celtic interconnector, a 700 MW interconnection between Ireland (Cork) and Brittany in France.

Both the Celtic interconnector and the Silvermines pumped-hydro facility were included on the 6th PCI list under the North-South Electricity interconnection in Western Europe (NSI West Electricity) corridor. Further details regarding the Silvermines Pumped Hydro Storage Facility and relevant TEN-E Regulations are included in Annex G: Silvermines.

## The Net-Zero Industry act (NZIA)

NZIA was proposed by the European Commission in March 2023. The Act will support the strength of the European manufacturing capacity of net-zero technologies, aiding the delivery of Fit-for 55 and REPowerEU objectives. NZAI is part of the Green Deal industrial plan in which Net-zero technologies can be selected based on criteria to become strategic projects, offering them additional benefits. Battery/storage technologies is included in the list under the NZIA.

## The 2030 climate and energy framework

The EU climate and energy framework outlines continent-wide targets and policy objectives for 2021-2030. Its key targets are centred around greenhouse gas emissions - at least a 40% reduction compared to 1990 levels, Renewable energy, at least a 27% share of renewable energy consumption and energy efficiency- Achieve greater energy efficient across the EU. The framework also commits to reform the EU emission trading scheme.

## REPowerEU (2022)

On 18 May 2022, the European Commission published “REPowerEU – A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition”. Whilst the document refers to storage in many places, it is primarily in the context of ensuring oil and natural gas storage resources are sufficient, alongside some mention of hydrogen storage. The plan notes that “slow and complex permitting processes are a key obstacle” to realising the potential of renewable energy. REPowerEU promotes the development of electricity storage projects as “being in the overriding public interest” and calls on EU member states to “facilitate permitting for their deployment”.

## The Renewable Energy Directive (RED)

RED is ‘the legal framework for the development of clean energy across all sectors of the EU economy, supporting cooperation between EU countries towards this goal. RED I, the original Renewable Energy Directive was adopted in April 2009. It’s second Iteration, RED II (Directive (2018/2001)) was adopted in 2018. Finally, RED II was revised in 2023, curating RED III, directive EU/2023/2413, which entered into force in November 2023. The most

recent iterations, sets a renewable energy target of at least 42.5% binding at EU level by 2030, with an aim of hitting 45%. Within the revised directive are multiple Member state mandates regarding electricity storage. These include the requirements to establish a market mechanism framework for storage facilities, at present supported in Ireland by the DS3 programme, simplification of permit granting procedures, installations and designation of renewable acceleration for co-located energy storage, assisted by RESS in Ireland amongst various other storage-related initiatives. Member states have 18-months to transpose most of the directive's provisions into national law, with a shorter time, deadline July 2024, for those relating to the permitting of renewables, covered under Article 16 of the revised act.

Storage is mentioned within:

Article 15e: where Member States designate dedicated infrastructure areas for the development of grid and storage projects that are necessary to integrate renewable energy into the electricity system.

Article 16:  where the accelerated permit-granting process is explained, addressing the screening process, the administrative procedures involved and time frames for various technologies.

Article 20a: where Member States should ensure a level playing field for small, decentralised electricity generation and storage systems, including through batteries and electric vehicles, so they are able to participate in the electricity markets, including congestion management, this provides for the inclusion of flexibility and balancing services in a non-discriminatory manner as compared to other electricity generation and storage systems, and without disproportionate administrative or regulatory burden.

Further, Member States should encourage self-consumers and renewable energy communities to actively participate in those electricity markets by providing flexibility services through demand response and storage including through batteries and electric vehicles.

## The Clean energy for EU Islands

Launched in 2017, as part of the Clean Energy for all European package, Clean Energy for EU Islands established a framework to aid EU islands in generating their own sustainable, low-cost strategy. One of the listed results of the framework is the construction of energy storage facilities and demand response system, using the latest technologies.

## Framework Guideline on Demand Response

Having been mandated by the European Commission, ACER published a guideline on Demand Response in 2022. The documents seek to set out clear principles for the harmonised development of rules regarding demand response, in which energy storage falls under. Rules regarding energy storage, amongst others are set out in the framework, which binds on the European Network of Transmission System Operator for Electricity (ENTSOE) and the EU DSO entity.

## The Future Role and Challenges of Energy Storage

First published in 2013 by the European commissions, this working paper highlights the lack of a valid business case which adequately values the benefits of storage. The paper recommends energy regulators to create a clear, level playing field for the development and provision of storage services. This includes non-discrimination among different storage technologies, size, and location in the system, but also equal access by energy storage to potential revenue streams such as in energy and system services markets.

## Commission Recommendation on Energy Storage

On 14 March 2023 the European Commission Recommendation on Energy Storage was adopted. The document addresses issues contributing to the broad deployment of energy storage. This includes the application of the EU electricity regulatory framework and removal of barriers as well as the facilitating of permitting procedures. It also addresses financing with recommendations relating to remuneration to operators and the consideration of competitive bidding procedures to achieve necessary flexibility improvements. The recommendations also set out the Europe-wide need for additional system flexibility due to increased renewable energy. Within this Recommendation was reference to regulation 2022/2577, discussed below.

## A Framework to Accelerate the Deployment of Renewable Energy

EU Regulation (2022/2577) - '*Laying down a framework to accelerate the deployment of renewable energy'* references the planning, permit granting process, construction, and operation of electricity storage plants and installations, including Li-BESS as being in the overriding public interest. These regulations include, amongst others, greater integration of renewables by member states through establishing time-limits for the permit-granting process for the installation of solar energy equipment and co-located energy storage assets of three months.

Additionally, under Article 6 of the regulation, provided that the project is located in a dedicated renewable or grid area for a related grid infrastructure which is necessary to integrate renewables into the system, member states may exempt energy storage projects from environmental impact and species protection assessment (detailed in Articles 2(1) of Directive 2011/92/EU and Article 12(1) of Directive 92/43/EEC and Article 5 of Directive 2009/147/EC respectively).

## The Integrated Strategic Energy Technology Plan (SET-Plan)

The SET-Plan, established in 2007, aims to accelerate the climate neutral transition of the energy system through the coordination of research and development in low-carbon technologies amongst member states. The recent revision of the plan, incorporated storage in the key action area, the integration of renewable technologies in the energy system. The 2023 SET plan progress report emphasises the importance of energy storage in the shift to renewables. The report highlights Batteries Europe a group stemming from the SET plan, composed of over 700 stakeholders, work to develop a sustainable and competitive battery value chain in Europe.

## The EU Regulatory Framework for Batteries

Established in 2023, this framework aims to secure a sustainable and competitive value chain for batteries. Mandatory requirements regarding the sustainability, safety, labelling and end of life management for batteries are set out by the framework.

## EU Battery Safety Standards (See also 4.2.2 EU Directives)

EU Directive (2023/1542) – '*Concerning Batteries & waste batteries'*, sets out the homogenisation of electricity storage products as well as safety testing and certification requirements relevant to battery energy storage systems, such as Li-BESS that deliver electric energy to the grid or store electricity for delivery to electric energy end users.

Article 12 of EU Directive (2023/1542), titled 'Safety of stationary battery energy storage systems', stipulates that battery storage systems that are placed on the market or put into shall be safe during their normal operation and use. The technical documentation (see annex VIII below) for these systems must include evidence that they have been successfully tested to meet the required safety standards set out in Annex V.

EU Directive (2023/1542) Annex V list of system safety issues that require testing certification.

- Thermal shock and cycling

- External short circuit protection
- Overcharge protection
- Over-discharge protection
- Over-temperature protection
- Thermal propagation protection
- Mechanical damage by external forces
- Internal short circuit
- Thermal abuse
- Fire test
- Emission of gasses

Articles 15 to 18 of EU Directive (2023/1542) set out requirements in relation to the conformity of batteries in respect to the requirements laid out in Article 12. More specifically:

- Article 17 lays out the conformity assessment procedures for stationary batteries for energy storage in respect Article 12.
- Article 18 stipulates the requirement for EU declaration of conformity to state compliance with Article 12 obligations.
- Annex VIII outlines the details of these conformity procedures, including information on technical documentation, EU declaration and CE marking (Article 20).

Also outlined in Annex VIII is the respective roles of the various bodies who are obligated to be involved in the conformity assessment process. This includes conformity assessment bodies, who perform conformity assessment procedures and a notifying authority who, as in Article 22a, is responsible for setting up and carrying our procedures for the assessment and notification of conformity assessment bodies and monitoring of notified bodies.

## Market surveillance and compliance of products

EU directive 2019/1020 focuses on market surveillance and the compliance of products. The directive sets to ensure that products comply with union harmonization legislation in which protection in terms of health and safety of consumers and the environment is at the forefront. Whilst the directive doesn't directly link to energy storage, it forms part of overarching regulatory landscape that ensures the safe deployment of storage technologies.

## Electricity Market Design

The European Commission published proposals to reform the EU's Electricity Market Design in March 2023. The proposal concerns amending regulations (EU) 2019/943 and (EU) 2019/942 as well as directives (EU) 2018/2001 and (EU) 2019/944. The proposal aims to make consumer bills less dependent on unstable fossil fuel process, increase consumer

protections from future price spikes and potential market manipulation and make the EU's industry clean and more competitive. In December 2023, the Council and Parliament reached a provisional agreement to reform the EU's Electricity Market Design (EM). The text emphasises energy storage as a key solution in achieving energy security and decarbonisation.

Storage is discussed in the context of the lack of sufficient non-fossil fuel flexibility, one of several shortcomings associated with existing electricity markets exposed by the current energy crisis. As such, the proposal sets to boost storages, alongside other non-fossil fuel flexibility alternatives, integration into electricity markets, proposing the introduction of new support schemes for these technologies within member states. Alongside this, the proposal discusses serval storage related actions including aims to facilitate the ability of storage to compete on a level playing field, setting out the importance of granting storage the ability to compete in intraday markets, the design of networks tariffs to encourage storage procurement and the (re)design of capacity mechanism to promote storage participation. It is important to note that only a provisional agreement was reached, and the proposal will act as a mandate for European parliament negotiations. The Electricity market reform is discussed further in Section 3 of this the policy framework.

## Annex E: IEC Standards

**IEC TC 4:** Publishes standards in relation to pumped-hydro storage power plants.

**IEC 61882:2016** - Offers an application guide on Hazard and Operability studies (HAZOP) for a system. This is relevant to the operation and maintenance for large commercial, industrial and grid scale Electrical Energy Storage Systems (EESS).

**IEC 61619:1997** - Sets specific measures relating to insulating liquids, which are used in EESS for various mechanisms, such as cooling.

**IEC 62133-2:2017**- Sets International Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications.

**IEC 62485** - Is a series of standards specifically related to safety requirements for secondary batteries and their installation. This standard comprises of multiples parts, all of which focus on a specific area within the overarching topic.

- IEC 62485-1:2015 - General safety information.

- IEC 62485-2:2010 - Stationary batteries.
- IEC 62485-3:2014 - Traction batteries.
- IEC 62485-4:2015 - Valve-regulated lead-acid batteries for use in portable appliances.
- IEC 62485-5:2020 - Safe operation of stationary lithium-ion batteries.
- IEC 62485-6:2021 - Safe operation of lithium-ion batteries in traction applications

**IEC 62619:2022** - Sets requirements and outlines tests that ensure secondary lithium cells and batteries used in industrial application are operated safely.

**IEC 62620-** Sets marking, tests and requirements for secondary lithium cells and batteries for use in industrial applications.

**IEC 62932** - Is a series of standards specifically for stationary application of flow battery energy systems.

- IEC 69232-1:2020 - Outlines the terminology and aspects associated with the technology.
- IEC 69232-2-1:2020 - Describes methods for testing and outlines performance requirements for flow battery energy systems.
- IEC62932-2-2:2020: Set the safety requirements that apply to flow battery energy systems when used in stationary applications.

**IEC 62933**: Is a series of standards specifically related to Electrical Energy Storage (EES). These standards are as follows:

- IEC 62933-1:2018 - Highlights terms applicable to EES
- IEC 62933-2-1:2017- Provides a general specification regarding EES unit parameters and testing methods.
- IEC TS 62933-2-2:2022 - Defines testing method used to authenticate EES system performance.
- IEC TS 62933-3-1:2018 - Provides a general specification for the planning and performance of EES systems.
- IEC TS 62933-3-2:2023 - Outlines requirements for power intensive and renewable energy sources Integration, in addition to those highlighted in the general specification.
- IEC TS 62933-3-3:2022 - Outlines requirements for energy intensive and backup power applications, in addition to those highlighted in the general specification.

- IEC TS 62933-4-1:2017 - Highlights the associated environmental issues of EES systems.
- IEC TS 62933-5-1:2017 - Provides a general specification outlining the safety considerations relevant to EES integrated in the grid.
- IEC62933-5-2:2020 - Describes aspects regarding the safety of electrochemical-based systems.
- IEC62933-5-3:2023: Must be confirmed to when performing unplanned modification of an electrochemical based system.

**IEC 63056:2020** - Outlines the requirements and test for safety of secondary cell and battery uses in Electrical Energy Storage Systems.

# Annex F: National Regulation

This policy is the first specific Government policy framework for electricity storage, it is important to note here that this policy is developed in regard to various European Union initiative, Directives and Regulations as well the Irish Government commitments, actions and objectives in the electricity storage area. Included below is a summary of Irish Government publications where electricity storage systems are referenced. It is important to note that the following is not an exhaustive list and other policy, commitments concerning storage may exist.

## The National Policy Position (2013)

First published in 2013, the National Policy Position in Ireland recognises the threat of climate change and the importance of an international response to it. The documents provided high-level direction for the implementation of plans to enable Ireland's transition to a low carbon economy.

## The Programme for Government: Our Shared Future (2020)

The Programme for Government seeks to deliver a better life for all. Within the mission: A Green New Deal, the government focuses on the decarbonisation of the Irish economy. This mission contains key targets relating to climate action with specific targets to reduce overall greenhouse gas emissions by 51% over this decade as part of the net zero emissions by 2050 objective. Specific commitments regarding storage included in the programme are as follows.

- Strengthen the policy framework to incentivise electricity storage and interconnection.

- Invest in research and development in 'green' hydrogen as a fuel for power generation, manufacturing, energy storage and transport.

## The Climate Action Plan (CAP) 2024

CAP 24 sets out the actions Ireland will take to stop climate change and ensure greater energy security, stable prices, more jobs, and regional development. Within CAP 24 is the commitment to adopt and Electricity Storage Policy Framework (Action: EL/24/16). Throughout CAP 24 electricity storage is recognised as a key technology under several aspects of the renewable transition. These include its major roles in offering demand-side flexibility, increasing grid-scale renewables and contributing to the decarbonisation of the energy sector, making electricity storage a vital component in reaching the 2030 targets set out in these areas. These targets include 9 GW of onshore wind, at least 5 GW of offshore wind and 8GW of solar connected to the electricity system, between 20-30% demand side flexibility (12-20% by 2025) and an 80% share of renewable electricity.

Aside from Action EL/24.16 this policy relates to a number of other actions set out in CAP24, these include:

- EL/24/20: Implementation of CRU Energy Demand Strategy.
- EL/24/23 Incentivise and enable large energy users to precipitate on flexible demand initiatives designed to enable low/zero carbon demand growth.
- EL/24/24 Create a route to market for medium and long duration storage facilities which can provide flexible demand.
- EL/24/28 Enable distributed flexible customers to participate in wholesale and system services markets.

## The White Paper: Ireland’s Transition to a Low Carbon Energy Future 2015-2030

The White Paper sets out a framework to guide Government policy and actions within the energy sector. Actions within the paper are informed by Ireland vision to transform itself to a low carbon economy by 2050. The White Paper recognises the role of grid electricity storage can play in mitigating the challenges associated with grid-connection, its contribution to better management of the overall electricity system and its part in facilitation the deployment of renewable energy technologies. Considering this, the document commits to addressing any administrative, market or regulatory barriers to the implementation of electricity storage

projects, as well as examining the case for designating large scale electricity storage projects as strategic energy infrastructure.

## The Electricity Regulation Act 1999

This is the main legalisation dictating the governance of the Irish energy sector. Energy storage is mentioned throughout the act in various sections.

Section 2: sets out various definitions, including that for electricity storage.

- Deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carriers.

Section 9 outlines the functions of the Regulator. Functions relating specifically to energy storage are:

- To have regard to the benefits of developing demand-side participation in electricity market, including energy storage.
- To have regard to the use of energy storage technologies in participation in the balancing of electricity demand and supply.

Section 14 covers electricity generation and supply licences, stating:

- The commission may grant of refuse to grant to any person who is an electricity undertaking or who intends to carry out a function of an electricity undertaking a licence to carry out the function of energy storage.

## Climate Action and Low Carbon Development (Amendment) Act 2021

The Climate Action and Low Carbon Development Act 2021 commits Ireland to a legally binding target of a climate neutral economy no later than 2050 and a 51% emission reduction by 2030. The amended act sets out the system of sectoral emission ceilings and carbon budgets, providing a framework for Ireland to meet its targets. The Government reached agreement on these ceilings in July 2022, included in this was the target for a 75 per cent reduction in electricity sector emissions by 2030.

## The National Energy and Climate Plan (NECP): 2021-2030

The NECP is a consolidated plan which brings energy and climate planning together into a single process. As an EU Member State Ireland is required to prepare a NECP in accordance with Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. The NECP sets out the nation's roadmap over a 10-year period and is assessed by the European Commission to track Member States progress towards climate and energy targets. Energy security is a key objective outlined in the 2021-2030 NECP. Additionally, specific mentions of electricity storage in the NECP can be seen in the context of reduced energy costs, increased production of renewable energy and national objectives for increased flexibility and demand response systems, amongst other areas.

## The National Energy Security Framework

The National Energy Security Framework sets out a whole of Government response to the challenges posed to energy security and energy affordability in the context of the war in Ukraine. Response 26 reviews grid connection arrangements for renewable electricity projects and the development of system services to accelerate the growth in renewable electricity. Electricity storage is explicitly outlined in relation to its role in balancing supply and demand for renewable power. Likewise, response 27 is explicitly in relation to accelerating investment in the electricity grid and the development of electricity storage technologies.

## Policy Statement on Security of Electricity Supply

Published in 2021, the Policy Statement on Security of Electricity Supply sets out several updates to national policy in the context of the 2020 Programme for Government commitments relevant to the electricity sector, planning authorities and service providers. In the statement the Government recognises the need for significant investment in storage and approve that the permitting and development of electricity storage, among a range of other technologies, is appropriate to support the growth of renewable energy and security of electricity supply. This policy framework has been developed as part of specific actions from the Climate Action Plan (CAP) 2021 and updated as part of CAP 2023.

## Energy Security in Ireland to 2030

Part of the Energy security package, this document analyses the importance of Ireland's renewable energy policy agenda. It highlights the approach Ireland will take in enhancing its energy security up to 2030, underlining key strategic risks and the measures to take to

implement the approach. Electricity storage, both before and behind the meter, will play a vital role in plans for the Irish electricity system and its security of supply. Actions 3, 5, 7 and 12 within the document all highlight the importance of storage in their respective areas: active consumers, large-scale demand sustainability, Emissions associated with Ireland's conventional capacity and power system flexibility respectively, representing the breadth of importance electricity storage systems hold across the energy sector.

## Ireland's Long-term Strategy in Greenhouse Gas Emission Reduction

Published in June 2023, this strategy builds on the decarbonisation pathways set by the carbon budgets, sectoral emission ceilings and CAP23, to ensure coherent and effective climate policy. The strategy sets out indicative pathways, beyond 2030 and towards achieving carbon neutrality for Ireland by 2050, in which energy storage in discussed in the context of Net-zero data centres.

## National Hydrogen Strategy (2023)

The hydrogen strategy sets out to reduce the uncertainty around renewable hydrogen. The strategy directly mentions hydrogen storage as having an important role in balancing fluctuations in supply from variable renewables and seasonality changes in end user demand as well as aiding in security of supply in the event of unforeseen supply disruptions. Although this form of storage is outside the scope of this policy statement, hydrogen can act as long duration storage, however the exact volumes required at this point are unclear. Hydrogen storage can take the form of various methods including compressed tankers, line pack, geological storage, and hydrogen derived carrier storage.

## The Renewable Electricity Support Scheme (RESS)

RESS provides support to renewable electricity projects in Ireland. The most recent revision of the RESS auction, RESS 3 and 4 lists storage alongside wind and solar as hybrid projects under eligible technologies. Further information on the Renewable Electricity Support Scheme is included in the Markets section of Chapter 3.

## Private wires consultation

The Private Wire Consultation, published in 2023, introduces the potential of private wires in providing an off-grid solution for electricity generation and supply in Ireland. The document outlines the opportunities, regulation and barriers associated with private wires and looks to

gather views of various stakeholders to consolidate understanding of this area and the role private wires can play in the future Irish electricity ecosystem. Whilst brief, discussion regarding the relationship between private wires and energy storage exists within the consultation. It is the view of some that private wires will facilitate 'off-grid' energy storage, aiding generation and congestion issues. The consultation also looks for explanation on the relationship between private wires and hybrid connections, an area in which storage is largely relevant.

## Government Statement on the Role of Data centres in Ireland Enterprise Strategy

The Department of Enterprise, Trade and Employment have highlighted the role of data centres in Ireland Enterprise Strategy. Published in July 2022, the statement seeks to enable the 'twin transition' of digitalisation and decarbonisation of our economy and society. Within this is the preference for data centres to be co-located with advanced electricity storage technologies, to aid them in meeting their own electrical demand, provide flexibility and ultimately contribute to the decarbonisation of the power system.

## The National Smart Metering Plan

Established by the Commission for the Regulation of Utilities (CRU), the plan outlines the roll out strategy for smart meters across the country. The increased use of smart meters is likely to see an improvement in the development and uptake of behind the meter electrical storage.

## Shaping Our Electricity Future (SOEF)

SOEF lays out EirGrid's roadmap to achieving Ireland's renewable electricity ambitions, namely 80% renewable electricity share by 2030. The transition to low carbon electricity mandates a stronger more flexible grid and thus requires extensive planning. The initial iteration, SOEF 1 captured a whole system approach considering several network scenarios. The updated iteration, SOEF 1.1, builds on this in regard to the ongoing development of European electricity policy, whilst considering the broader transition to net zero by 2050.

SOEF 1, identified electricity storage as a critical technology for the 2030 transitions, required for reserve provision, capacity adequacy and congestion management, recognising the variety of electricity storage technologies and how these will development going forward. The technology enablement workstream includes a commitment to addressing the challenges associated with the integration of large-scale electricity storage technology.

## Networks for Net Zero Strategy

Similarly, to SOEF, Networks for Net Zero Strategy sets out ESB Networks' role in delivery of the 2023 CAP, supporting the decarbonisation of the electricity system. It is centred around their role as the DSO, empowering consumers to decarbonise their energy consumption as well as through their role of transmission asset owner. The strategy sets out expected development of the electricity network by 2030, highlighting increasing amounts of energy storage as a key component. Storage is included in two of the three elements of the overall strategy, firstly in regard to decarbonized electricity, in which storage is mentioned in the context of connecting renewables and system flexibility and then in regard to resilient infrastructure which draws attention to high-capacity storage as a requirement for the transition to a low carbon future.

# Annex G: Silvermines Pumped-Hydro Electricity storage system.

While this policy framework remains technology neutral a notable mention is made here of the Silvermines Hydro Electric Power Station / Pumped Hydro storage technology project in Co. Tipperary.

This notable mention is due to this projects designation as a Project of Common Interest (PCI) and subsequent inclusion on the PCI list by the European Commission under the Trans-European Networks for Energy (TEN-E) regulations. Further details on the TEN-E regulations and PCI list are covered under the Trans-European Networks for Energy (TEN-E) and PCI sections of this chapter.

The Silvermines pumped-hydro generation / storage facility developed by Siga-Hydro Limited is located on a former open-cast mining site in Co. Tipperary. Engagements between Siga-hydro and the relevant national regulatory bodies are on-going with a view to the commissioning of this major infrastructure project in 2030. Once fully operational, it is expected that the Silvermines pumped-hydro generation / storage facility will provide up to 1.8 GWh of electricity storage with a 360MW export capacity.

Having initially been included on the 4th and 5th PCI lists, the Silvermines pumped-hydro project remains a PCI designated project in the updated 6th PCI list, which entered into force April 2024.

Silvermines as a PCI designated project is subject to the TEN-E regulations which were revised in June 2022. This revision introduced new guidelines and regulation which amongst other matters, addressed the development of energy storage facilities more effectively. As a

designated PCI project, the Silvermines Pumped-hydro project benefits from the EU Connecting Europe Facility (CEF) funding, which is provided for projects that are not viable with public funding. The revision also updated existing regulations to accelerate the development of renewable projects under the revised TEN-E rules, such as the allocation of priority status to a PCI project of sufficient maturity, which ensures a streamlined administrative and permit granting process. (planning, licencing and environmental assessments etc).

The Government through this policy framework expresses its full support of the on-going engagement between the Regulatory authority, System Operators and Siga-Hydro Ltd in regard to the PCI 'Silvermines' pumped-hydro project.

## Annex H: UL & NFPA Specific Standards

**UL 991**- Safety Standard applies to controls using solid-state devices. Significant in ensuring the safe operation of Electrical storage system through monitoring of aspects such as the Battery Management System (BMS).

**UL 1642**- A battery standard covering both rechargeable and non-rechargeable lithium batteries. Its overarching aim is to reduce the fire and explosion risk of lithium batteries.

**UL 1973**- Safety standard for energy storage application using stationary batteries. Safety performance test, construction requirements and production test are all covered by this standard.

**UL 1998**- Standard for embedded software utilised by various energy systems, including Electrical storage system. Significant in ensuring the safe operation of Electrical storage system through monitoring of aspects such as the Battery Management System (BMS).

**UL 9540**- Outlines requirements for Energy Storage Systems (ESS). UL 9540 covers factors such as maximum capacity of Electrical storage system systems, minimum distance between adjacent Electrical storage system unit amongst other aspects.

**UL 9540A**- Test method for evaluating thermal runaway fire propagation in Battery Energy Storage Systems. Exception to measures set in UL 9540 can be made in accordance with this test method.

**NFPA 1**- Fire code that includes specific requirement relating to Electrical Energy Storage.

**NFPA 70E**- Standard for electrical safety in the workplace. Reduces risk of major electrical hazards by outlining the best personnel protection practices.

**NFPA 855**- Sets standards for the installation of Stationary Energy Storage Systems. Multiple areas for consideration are covered within this standard, including emergency planning, fire control, detection and mitigation and explosion control.

# List of Abbreviations

ACER - European Union Agency for the Cooperation of Energy Regulators

ARE- Accelerating Renewable Electricity

BESS - Battery Electric Storage Systems

BMS - Battery Management System

BSU - Battery (energy) Storage Unit

BTMS - Behind the Meter Storage – Residential/Commercial (self-generated) storage

CAP - Climate Action Plan

CEF - Connecting Europe Facility

COMAH - 2015 Chemicals Act (Control of Major Accident Hazards involving Dangerous Substances)

COP - Conference of the Parties

CPM - Capacity Payment Mechanism

CRM - Capacity Renumeration Mechanism – Auctions for pre-agreed capacity delivery

CRU - Commission for Regulation of Utilities

DAM - Day Ahead Market

DAO - Distribution Asset Owner

DASSA - Day Ahead System Services Arrangements

DSO - Distribution System Operator

DSU - Demand Side Units

DUoS - Distribution Use of System

ECP - The Enduring Connection Policy

EMD - Electricity market design

ENTSO-E - European Network of Transmission System Operators for Electricity

EPRI - Electric Power Research Institute

ERA - Electricity Regulations Act

ESPF - Electricity Storage Policy Framework

EESS - Electrical Energy Storage Systems

ESS - Electricity Storage Systems

ESI - Energy Storage Ireland

EV - Electric vehicle

FBE - Flow Batteries Europe

FoM - Front of Meter

FPN’s - Final physical notification

HSA - Health & Safety Authority

HAZOP - Hazard and Operability studies

IEC - International Electrotechnical Commission

ISEA - Irish Solar Energy Association

JSOP - Joint System Operator Programme

kV[A] - kilovolt [amps]

LCIS - Low Carbon Inertia Services

LD(E)S - long duration (energy) storage

LEU - Large Energy User

LIB - LITHIUM-ION BATTERIES

Li-BESS - Lithium-ion battery energy storage systems

LPF - Layered procurement Framework

MARI - Manually Activated Reserve Initiative

MEC - Maximum Export Capacity

MIC - Maximum Import Capacity

MtCO2eq - metric tons of carbon dioxide equivalent

MV - Millivolt

MVAr - Mega volt-ampere reactive

MW - Megawatt

MwH - Megawatt hours

NECP - National Energy and Climate Plan

NEDS - National Energy Demand Strategy (CRU lead)

NFPA - National Fire Protection Association

NIE - Northern Ireland Electricity

NNLC - National Network, Local Connections Programme

NPDR - Non-Priority Dispatch Renewables

NSAI - National Standards Authority of Ireland

NZIA - Net-zero Industry act

PCI - Project of Common Interest

PHS - Pumped Hydro Storage

PICASSO - Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation

PMI - Project of Mutual Interest

PN’s - Physical Notifications

PPA - Power purchase agreement

PR - Price Review

RED III - Renewable Energy Directive (3rd revision)

RA - Regional / Responsible Authority

R-BESS - Residential Battery Electrical Storage Systems

REG - Renewable Electricity Generation

REMIT - Regulation on wholesale energy market integrity and transparency

RES - Renewable Energy Sources

RES-E - Renewable energy share in electricity.

RESS - Renewable Electricity Support Scheme

SDAC - Single Day-ahead Coupling

SD(E)S - Short Duration (Energy) Storage

SEM - Single Electric Market

SEMC - Single Electric Market Committee

SEMO - Single Electric Market Operator

SET - Strategic Energy Technology

SIDC - Single Intraday Coupling

SNSP - System Non-synchronous Penetration

SOEF- Shaping our Electricity Future

SONI - System Operator Northern Ireland

SSFA - System Service Future Arrangements

TAO - Transmission Asset Owner

TEN-E - Trans European Networks for Energy

TERRE - Trans European Replacement Reserves Exchange

ToR - Terms of Reference

TRL Scale - Technology Readiness Level scale

TSC - Trading and Settlement Code

TSO - Transmission Service Operator (EirGrid)

TUoS - Transmission Use of System

UL - Underwriter Laboratories

UR - Utility Regulator

UoS - Use of System

VRE - Variable renewable energy