20/05/2025

Shaping Our Electricity Future Advisory Council

Supernode Ltd, Dublin

Meeting #11

Welcome!

A word from our co-Chairs

Liam Ryan & Gerard Carlin

Moderator: Welcome Message

Colleen Savage

Agenda: SOEF Advisory Council #11

Supernode Plant, Red Cow Business Park, 20th May, 2025

START TIME	DURATION	TOPIC		PRESENTER/S
09:00	55 min	Coffee & Networking		All
09:55	10 min	Introduction, Agenda, Open Actions		Co-Chairs, John Fitzgerald
10:05	30 min	Q&A On pre-read		Workstream Leads
10:35	10 min	Dispatch Down Working Group Update		Marc Senouci
10:45	35 min	Collaboration & Engagement: What's working/what's not ?		AC Members
11:20	15 min	Technology and Innovation at Supernode		John Fitzgerald, Andrew Carlisle (CTO)
11:35	90 min	Tour of Plant / Operational Policy Roadmap 1. Safety briefing, split into 2 groups (15min) 2. Group 1 on tour, group 2 discuss Operation Policy Roadmap (25min) – Overcoming risks for successful delivery 3. Group 2 on tour, group 1 discuss OPR (25min) 4. Structured recap on OPR deployment (25min)		Plant tour with John Fitzgerald OPR with Eoin Kennedy, Simon Tweed, David McGowan
13:05	45 min	Lunch		
13:50	45 min	Members Insight: Storage Innovation 1. Long Duration Storage solutions: Hydrogen and BESS 2. Discussion, Q&A		Paul Blount, Peter Harte, Bobby Smith
14:35	30 min	Coffee chats: Discussion and Reflection Circles		
15:15	20 min	Members Insight: Tackling DC Fault Ridethrough		Graeme McWilliams
15:35	25 min	Reflection, Next Steps and Closing Messages		Co-Chairs
16:00		***Meeting End***		

Meeting Chairs:

Liam Ryan

Gerard Carlin

Moderator:
Colleen Savage

A pre-read is shared ahead of the meeting. Members provide questions offline in advance of May 13th. Answers are sought in advance of May 20th.

Actions

Action	Raised	Detail	Status
Future Power Markets Engagement	AC10	Head of Future Power Markets to look for ways to enable more granular discussion of topics for industry engagement as part of the monthly future power markets industry call.	Message sent to programme leads (SDP, FASS, SMP, EMP and LDES). FASS held a topic deep-dive in April 2025, others planned. CLOSED
Addressing Dispatch Down	AC10	Set up a meeting with members in both IRE and NI to agree on what is needed regarding source data on dispatch down levels.	In Progress
Dispatch Down working group	AC9	Members to set up a taskforce with an EirGrid and SONI representative to address concerns around market drivers for interconnector imports and dispatch down levels.	Initial meeting convened April 2025 with 6 meetings planned. IN PROGRESS
DLR trial results	AC9	The TSOs to share the performance of the Lisheen-Thurles DLR project trial.	These were shared with members in November 2024 CLOSED

Opportunity for Members Questions

Workstreams Q&A

Stephen Gannon
Head of Future Power Markets, EirGrid

Bryan Murray
Head of Future Operations, EirGrid

Eoin Kennedy
Director of Innovation and Planning, EirGrid

Sinead Dooley
Head of Public Engagement, EirGrid

Jason Kenna
Head of Network Projects, EirGrid

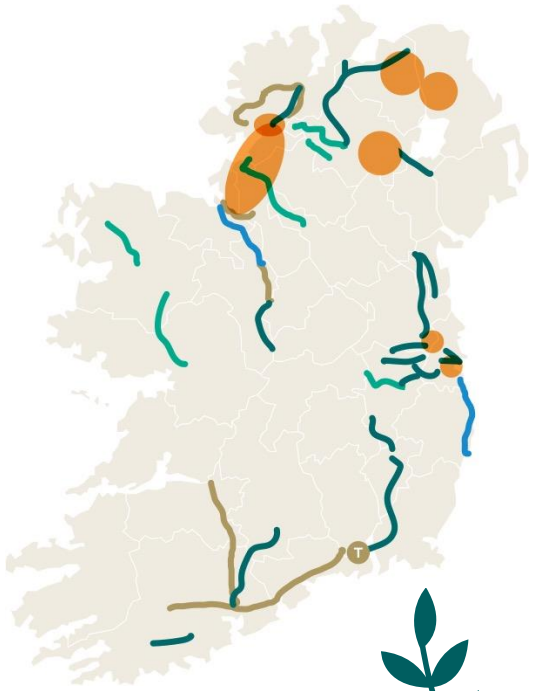
Eimear Watson
Head of Networks, SONI

Q&A Themes

- Strategic Programmes status and overcoming delays – SDP, FASS, SMP – **Stephen Gannon**
- Grid Development/Network Infrastructure – **Jason Kenna**
- 80% SNSP Trial – status and development – **Eoin Kennedy**
- North South Interconnector progress – **Jason Kenna**
- General update on SOEF progress toward 2030 targets – **Liam Ryan**
- Dispatch Down – **Marc Senouci** (dedicated segment)
- LDES: procurement consultation split – **Bryan Murray**
- Iberian Blackout – **Liam Ryan**

EirGrid SONI

Shaping Our Electricity Future
Roadmap – Recent Achievements



SOEF v1.1: Jan – Mar '25

NI Negative Reserve pre-trial testing completed 14 April on Phase 1 wind farms.

The Operational Policy Roadmap 2025-2035 | EirGrid was published on EirGrid and SONI websites in March 2025.

The 80% SNSP study report has been reviewed and approved by Operational Policy Review Committee (OPRC) members

Markets

Scheduling and Dispatch (SDP)

-SDP_06 Synchronous Condenser Mod_01_25 V3 approved in April.

Future Arrangements System Services (FASS)

-DASSA Top Up Mechanism (FAM Alternative) consultation finalised.

-SEMC Decisions on the FASS Charge and Volume Forecasting Methodology published.

-DASSA Top Up Mechanism Consultation Paper issued to Industry.

Strategic Markets Program (SMP)

- Detailed requirements gathering activities complete for SDAC/SIDC, Multi-NEMO Arrangements and CORE CCR.

Network Infra Enablers & Engagement

- Cashla-Dalton 110kV DLR and Killonan 220 kV Station Refurbishment energised and Flagford - Sliabh Bawn 110 kV circuit uprate partially energised to be finalised in June.
- Planning Grant received from an Bord Pleanála without objections for East Meath North Dublin and Kildare Meath in February and March, respectively.
- Construction of 2nd North-South Interconnector progressing well.
- Joint SONI-NIE Networks Programme Management Office has determined estimated completion dates for all transmission projects.

MARKETS

Overall Summary and Status

- **SDP:** The Scheduling and Dispatch Programme (SDP) continues at pace; however, the programme status is amber reflecting delays experienced in the Tranche 1 system build with one of our IT system vendors. Revised go-live is now June 2025 for battery changes (SDP_02). Non-Priority Dispatch Renewables and Wind/Solar Dispatchability Improvements changes (SDP_01/04) remains scheduled for September 2025.
- **FASS:** The Future Arrangements for System Services (FASS) Programme continues at pace; however, the overall programme status is red reflecting delays to vendor contracting (expected to close early May), and finalisation of consultation/recommendation/decision papers.
- **LDES:** EirGrid following direction from CRU and in discussion with DECC on procurement and timelines; drafting consultation paper on procurement models.

Key Highlights

- **SDP:**
  - **April 2025:** SDP_06 Synchronous Condenser Mod_01_25 V3 approved at Mods meeting 128 on 09-Apr-25.
- **FASS:**
  - **January 2025:** DASSA Top Up Mechanism (FAM Alternative) consultation finalised.
  - **March 2025:** SEMC Decisions on the FASS Charge and Volume Forecasting Methodology published. DASSA Top Up Mechanism Consultation Paper issued to Industry.
- **LDES:** Decision to split LDES procurement consultation in two: one consultation on procurement models and another on contractual arrangements. Informed by CRU's lessons learned from ESBN's Demand Flexibility Product and LCIS procurement.

Upcoming Milestones

- **SDP:**
  - **May 2025:** Commencement of Participant Interface Testing for market participants operating batteries in advance of SDP_02 (ESPS) go-live.
  - **June 2025:** Planned SDP_02 (ESPS) initiative go-live.
- **FASS:**
  - **May 2025:** DS3 Tariffs to FASS 'The Gap' Recommendations Paper to be submitted to the RAs. Parameters & Scalars and Consultation Paper to be issued to Industry and publication of PIR 3.0.
  - **June 2025:** SEMC Decision on 'The Gap' anticipated. Non-Reserves Consultation Paper to be issued to Industry.
- **LDES:**
  - **Q2 2025:** EirGrid to publish a first consultation paper on procurement models.

Key Risks or Issues

- **Multi Year Plan:** Work ongoing with RAs on developing a multi year market plan. This is needed to facilitate longer term resource and system planning
- **SDP:** Delays are being experienced with one of our IT system vendor's build. We are mitigating the risk of this to other programmes.
- **FASS:** There is a risk programme timelines may be impacted by the overlap of multiple design activities.
  - There is a risk that the arrangements chosen to transition from the current DS3 System Services Regulated Arrangements to FASS are complex. Any new arrangements would require resources to be reassigned from the FASS programme, resulting in delays to the FASS go-live date.

EirGrid SONI

SYSTEM OPERATIONS

Overall Summary and Status

- The Operational Policy Roadmap 2025 – 2035 was published on EirGrid and SONI websites in March 2025. The roadmap updates our plan to 2035 to accommodate continued growth in variable, nonsynchronous renewable generation. It outlines the context, drivers, timelines, milestones, actions, and stakeholder impacts that are needed in each operational policy area to achieve the ambition of the governments' decarbonisation targets for the electricity sector.
- The overall SOEF Operations programme status is Amber. Commencement of the 80% SNSP trial is delayed pending further OPRC consideration of mitigations for existing Demand Facility fault ride through issue. Proposed mitigations are under development.

Key Highlights

- The 80% SNSP study report has been reviewed and approved by Operational Policy Review Committee (OPRC) members.
- The Operational Policy Roadmap 2025-2035 | EirGrid was published on EirGrid and SONI websites in March 2025.
- NI Negative Reserve pre-trial testing completed 14 April on Phase 1 wind farms.
- Operational Tools & Capability Enhancement (OTCE) programme underway.

Upcoming Milestones

- A paper setting out the background to the Demand Facility fault ride through issue, the results of studies and updated draft text of the proposed Grid Code modification will be published in May 2025. Industry webinar to follow publication.
- Qualification Trial Process (QTP) TSO Call for Information to be published in May 2025.
- Consultation on LCIS Phase 2 procurement arrangements to be published.
- Following successful testing, full trial on NI negative reserves to commence end of August subject to OPRC approval.
- EirGrid / ESBN industry webinars to share updates on the TSO-DSO future operating model.

Key Risks or Issues

- Commencement of the 80% SNSP trial is delayed pending further OPRC consideration of mitigations for the existing Demand Facility fault ride through issue.
- SONI working with Utility Regulator NI on funding submission for OTCE.

STRATEGIC MARKETS PROGRAMME

Overall Summary and Status

- Programme continuing to progress through detailed requirements gathering, process design required for release 1 scope and vendor engagement.
- High Level delivery planning for Release 2 scope items is progressing (e.g., Balancing Market Reform and Post Brexit arrangements)

Key Highlights

- Engagement with EU market operators and regulators ongoing
- Engagement between RTE and EirGrid ongoing
- Detailed requirements gathering activities complete for SDAC/SIDC, Multi-NEMO Arrangements and CORE CCR
- Change Impact Assessment of processes on end-to-end basis under development to map impact on TSOs and MOs

Upcoming Milestones

- Core CCR Detailed Requirements Signoff
- Release 2 planning complete
- RA funding submission
- Organisation Impact assessment complete
- Commence Go-live and Cutover planning

Key Risks or Issues

- Capacity to deliver: There is a risk that the delivery of SMP may impact other concurrent or sequential projects in the multiyear plan due to system interactions and vendor capacity, draw on external stakeholders, and availability of internal SMEs. Mitigating actions in place.

PUBLIC ENGAGEMENT

Overall Summary and Status

- The SOEF Roadmap underpins all Consultations, engagements and initiatives undertaken across the Public Engagement Team and is a key enabler to the delivery of an accelerated grid expansion programme.

Key Highlights

- **East Meath North Dublin:** Planning Grant received from an Bord Pleanála in February ’25, without objections.
- **Kildare Meath:** Planning Grant received from an Bord Pleanála in March ’25, without objections.
- **Powering Up Public Consultations on: Offshore - South Coast -** Comprehensive engagement completed with coastal communities and fisheries. Landowner engagement is ongoing.
- **Fingal East Meath Grid Reinforcement -**Step 3 ended 8th November. Stakeholder feedback and landowner engagement will inform Step 4 consultation.
- **Dublin Programme** – Activation of Schools Education Programme across the project areas.

Upcoming Milestones

- **Fingal East Meath Grid Reinforcement** – Public Consultation planned on Best performing route option in June '25
- Commence Step 3 Public Consultation on **Kildare/Dublin Grid Reinforcements** in June/July '25.
- Public Information/Consultation on design options for **Substation East Wall Road** end of May '25
- **EirGrid Energy Citizen Roadshows** in Co. Leitrim May 6th.

Key Risks or Issues

- Third Party access to lands
- Third party land acquisition
- Public acceptance continues to be challenging.

NETWORKS INFRASTRUCTURE ROI

Overall Summary and Status

- Significant progress in terms of Planning Consents/ Project Agreements/ Tendering/ land acquisition for a number of the large SOEF Capital projects.

Key Highlights

Planning Applications

- **East Meath North Dublin:** Planning Grant received from an Bord Pleanála in February ’25.
- **Kildare Meath:** Planning Grant received from an Bord Pleanála in March ’25.
- **Athlone - Lanesboro 110 kV circuit 1:** Planning application submitted to Roscommon CC.

Capital Approvals

- **Great Island – Waterford 1 110 kV:** May ’25
- **Deenes – Drybridge 110 kV:** May ‘25
- **Baltrasna – Corduff 110 kV:** May ‘25

Project Agreements

- **Belcamp 220kV Station:** March ’25.
- **Carlow 110 kV Station Busbar Uprate:** February ’25
- **Bandon 110 kV Busbar Rating Needs:** March ’25

Project Energisations

- **Cashla-Dalton 110kV DLR:** Energised January ’25
- **Flagford - Sliabh Bawn 110 kV circuit uprate:** Partial energization March ’25; final energization June ’25
- **Killonan 220 kV Station Refurbishment - Killonan Station Works:** Energised March ‘25

- **Project Updates**
  - **Maynooth 220kV Station Reconfiguration:** Land acquisition ongoing. Work to commence in July ‘25.
  - **Flagford-Sligo Capacity Needs:** Public engagement ongoing; landowner engagement pilot in Q1 received positive response.
  - **Cashla-Galway 110kV Circuits:** Engagement ongoing with landowners and Galway CC. Full public consultation required.
  - **Louth - Oriel 220 kV circuit 1:** Outages granted and work to commence in TOP25.
- **Powering Up Dublin:**
  - **Dublin 220kV Cables:** Tender released for Finglas Northwall. Approval of MACs for Carrickmines/Poolbeg and Poolbeg/ Northwall expected in Q2'25 with key MUL approval required for marine surveys for the Blackrock Park to Poolbeg section.
  - PA signed for **Belcamp 220kV station** in March '25 following land transfer agreement from IDA to ESBN. ESBN preparing to issue EPC tender for the new **Poolbeg 220kV station**
  - **Grid Reinforcement/Bulk Supply Projects (BSP)** Preparing planning application for Dublin Central BSP to be submitted by mid '25. Preparing to consult with the public in late Q2 '25 for the emerging best performing options for new station and circuits on the Fingal East Meath scheme. Preparing final best performing technology options on the Kildare Dublin scheme.

Upcoming Milestones

- **Upcoming Capital Approvals**
  - **Maynooth-Castlelost 220kV Uprate:** July ‘25
  - **Letterkenny-Golagh T 110kV Uprate:** July ‘25
  - **Drumkeen-Clogher 110 kV Uprate:** July ’25
  - **Kildare-Dublin Grid Reinforcement:** Aug ‘25

Key Risks or Issues

- Third party Land Acquisition
- MARA/MAC application time
- Outage availability – OTP
- DLR: On track to EI first 2 no. in 2025 another 8 are in CPP-PA process with PA scheduled for 2026.

NETWORKS INFRASTRUCTURE (NI)

Overall Summary and Status

- Joint SONI-NIE Networks Programme Management Office established with baseline programme. SONI & NIEN have established programme efficiencies and estimated project completion dates. Following stakeholder engagement, these will be communicated externally in Q2 25.
- Construction on the 2nd North-South Interconnector continues with SONI preparing to execute a further batch of easements and we continue to engage with DfE on the Necessary Wayleave process. Overall timeline for delivery has been delayed to 2031.
- Mid-Antrim Upgrade: Landowner engagement ongoing on optimum substation site location, outline design for overhead line route produced by NIEN and landowner engagement ongoing to determine final pole locations.
- Tamnamore-Drumnakelly Reinforcement: conductor selection ongoing with NIEN, underground cable route finalised.
- Cam Cluster Extension: substation design being finalised and circuit turn-ins being designed.
- Connect West: Deliverability assessment of preferred option is ongoing to include 275 kV solution to address large increase in RES generation.
- Coolkeeragh-Strabane: Preliminary preferred option determined, will provide significant additional transmission capacity.

Key Highlights

- Construction of 2nd North-South Interconnector progressing well.
- Joint SONI-NIE Networks Programme Management Office has determined estimated completion dates for all transmission projects.
- SONI's model for easements has been finalised. To be implemented with Mid-Antrim Upgrade.
- SONI and NIEN have set up an innovation group to discussion non wire solutions requiring TSO/DSO coordination. DLR solution for Magherakeel cluster progressing.

Upcoming Milestones

- Consultation on SONI's proposed Transmission Cluster policy (May 25).
- Joint SONI-NIE Networks Programme Management Office programme communicated externally (Q2 25).

Key Risks or Issues

- JR in relation to the approval of the discharge of a pre-commencement condition of the the 2nd North-South Interconnector – hearing paused until June.
- Elements of grid delivery are outside the control of SONI & NIEN so we will continue to engage with the relevant stakeholders on these elements of grid delivery.

Dispatch Down Working Group Update

- Objective:
  - Create a time-bound collaborative forum for EirGrid and industry
  - To further understand the management of Dispatch Down
  - To work with industry to identify additional solutions that may help manage Dispatch Down in near to long term future
- Membership
- Meeting Cadence: monthly for 6 months
- Final outcomes/insights presented to SOEF Advisory Council

Marc Senouci
Head of Power System
Research & Insights
Authority

Collaboration & Engagement: **What's working, what's not?**

Technology and Innovation at Supernode

SUPERNODE™

Connecting the Future

COMPANY OVERVIEW

SuperNode is a cutting-edge technology company developing **next generation superconducting cable systems.**

Our cable can **carry 5x more electricity** in a single line than conventional transmission technology.

Delivering step change innovation through **novel materials, designs and manufacturing techniques.**

Design focus on **cost, higher powers and longer distances** with our most mature product **at TRL 7.**

Our goal is to **deliver efficient underground bulk power transfer** which is cost effective and can be manufactured at scale.

ACHIEVEMENTS TO DATE

SUPERNODE™
Connecting the Future

2021

Aker Horizons Investment

Secured a major investment from Aker Horizons with support to reach full scale prototype

2022

State Of The Art R&D Headquarters

Centre of excellence to accelerate the development of next-generation superconducting cables.

2022

CERN Partnership

Established a key partnership with CERN to develop a novel type of insultation for superconducting cables.

2023

IDA Grant Support

Received significant grant support from the IDA for our prototype development programme.

2024

Opened Assembly Facility in UK

Moved to our purpose-built facility to manufacture and test up to 30 metre prototypes for early projects

2024

Development of Patent Portfolio

Patent for proprietary LCP cryostat was granted by the EPO with three more published which include an additional proprietary cryostat using reinforced thermoplastics.

WHAT IS THE PROBLEM THAT SUPERNODE SOLVES?

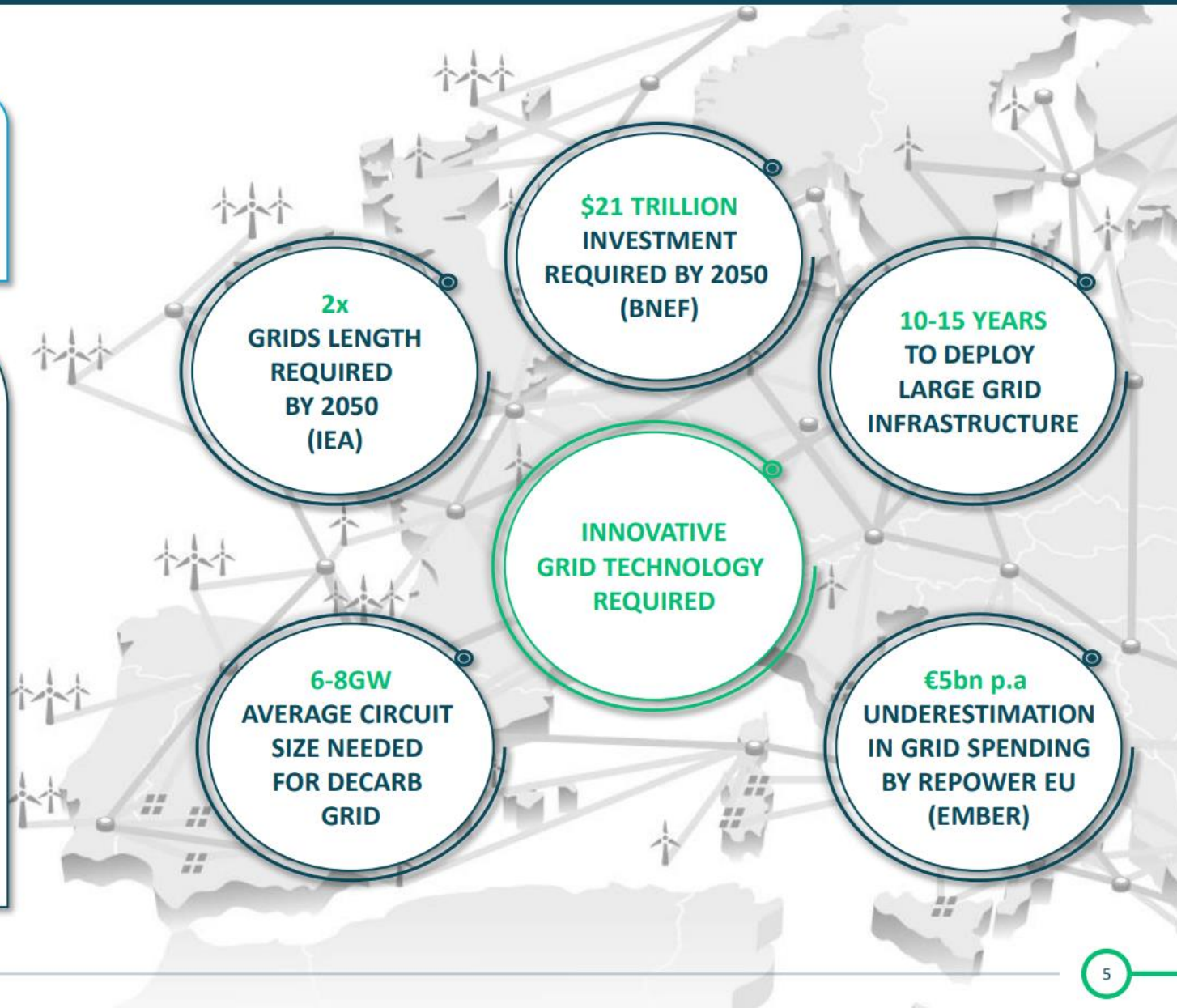
SUPERNODE™
Connecting the Future

What's the problem?

Grids are struggling to keep up! They lack the transfer capabilities and power capacity for an electrified future.

Why it exists?

1. **Increasing Energy Demand:** Population growth, AI and electrification is pushing up energy demand. IEA expects a **2.5x increase** in electricity demand by 2050.
2. **Grid Congestion:** Existing **infrastructure is struggling** with the increased demand putting the reliability of the whole system at risk.
3. **Space Constraints:** Urban congestion and space limitation make **upgrading grid capacity complex and costly**.
4. **Aging Infrastructure:** Existing **cables can be over 50 years** and well past their useful life. Increasing their loading also accelerates the cable aging process.



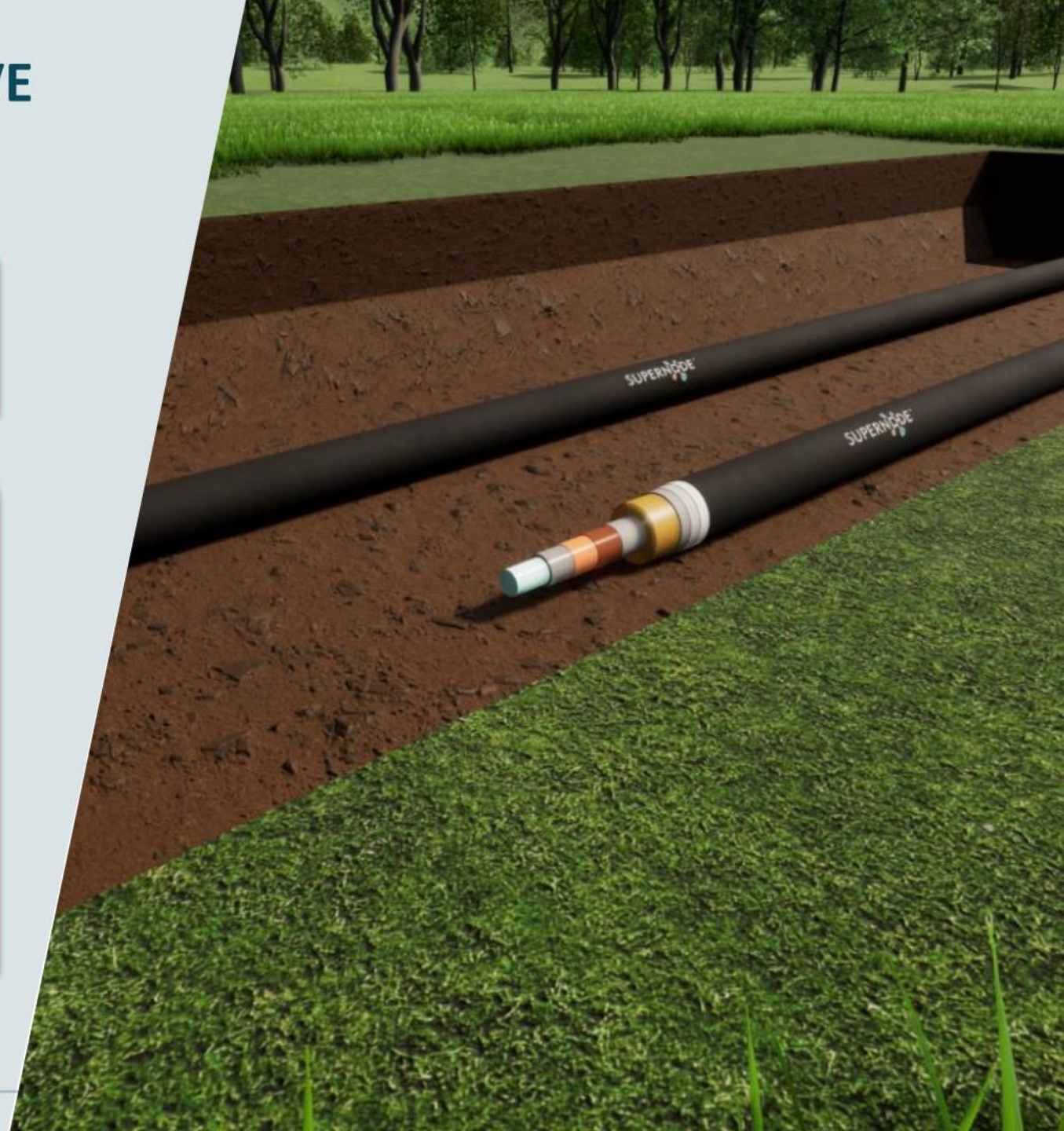
SOLUTION: EFFICIENT UNOBTRUSIVE COMPACT POWER TRANSFER

Superconducting cables are the **only solution** which:

- Can deliver **5x more power than conventional cables**.
- Become increasingly **cost competitive at higher power**.

Benefits

1. **Cheaper:** High power density reduces the number of cables significantly reducing costs at higher power capacities.
2. **Smaller footprint:** Narrower corridors or use of existing ducts significantly **reduces civils and disruption**.
3. **Increased resilience and reliability:** Higher carrying capacity **reduces system overloads and future proofs** the grid to handle ever growing demand.
4. **Fewer substations:** Transfer **more power at lower voltages** reduces need for step down transformers and substation upgrades.



SOLUTION: SUPERCONDUCTIVTY & RECENT APPLICABLE PROJECTS

SUPERCONDUCTIVITY occurs in some materials, when cooled below a certain temperature, display unique characteristics:

- Zero electrical resistance
- High power density

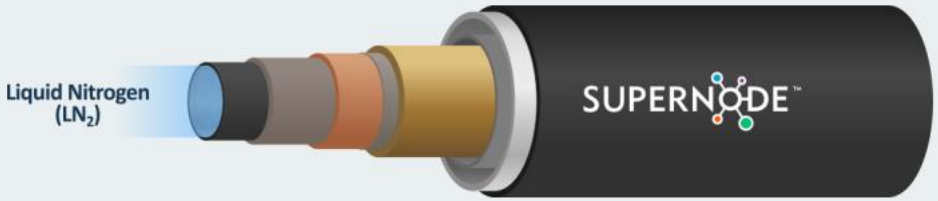
HOW TO ACHIEVE SUPERCONDUCTIVITY:

- A material must be cooled to below its 'critical temperature'
- High temperature superconductors (HTS) are superconductive around -200◦c

Recent Superconductor Projects

2013	Nexans ELECTRIFY THE FUTURE	Ampacity, Essen	1km, 40MVA, 10kV, AC
2018	Best Paths	EU Horizon's 'Best Paths' Project	30m, 3.2GW, 320kV, DC
2019	KEPCO	Shingal, Seoul	1km, 50MVA, 23kV, AC
2021	amsc	REG, Chicago	62MVA, 12kV, AC
2026+	NKT We connect a greener world	Superlink, Munich	12km, 500MVA, 110kV, AC

Nexans cable Ampacity, 2013



Next Generation Superconducting Cable

SUPERNODE TECHNOLOGY INNOVATIONS

SUPERNODE™
Connecting the Future

1

Novel cryostat approach

- Smooth-bore inner cryostat – less friction.
- Zero co-efficient of thermal expansion.
- Cost effective and can be easily scaled.

2

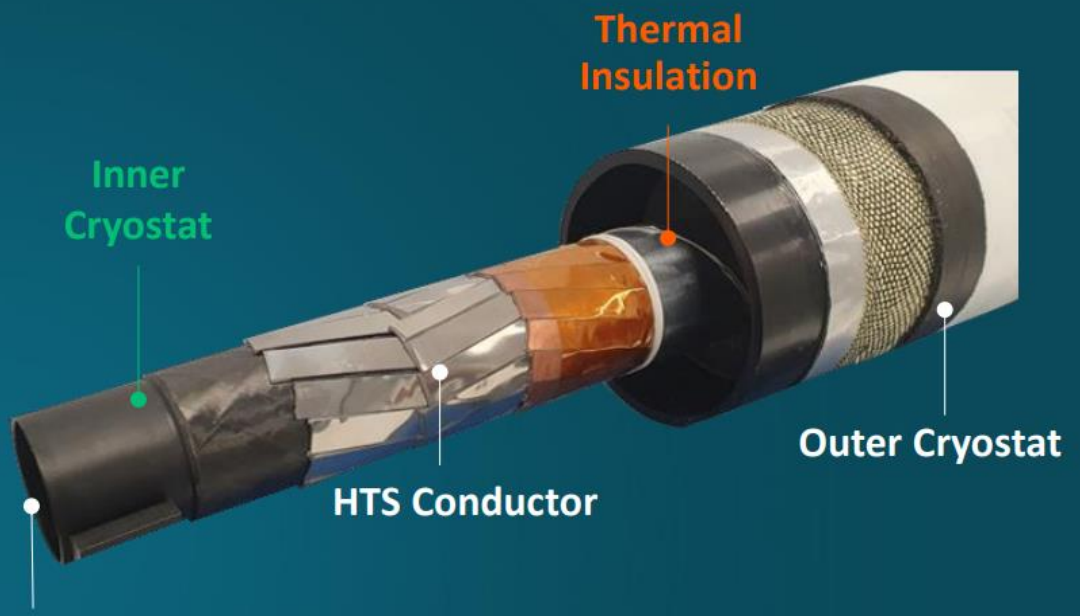
Optimal thermal management

- World class insulation to prevent heat leakage.
- Broke Nasa's record for soft vacuum insulation.
- Innovative pumped liquid nitrogen cooling solution.

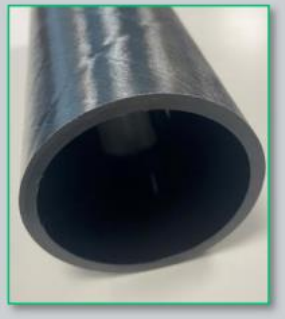
3

Scale manufacture

- World Class Manufacturing Processing Solutions.
- First of a kind automated process of superconducting cables.



PATENT PROTECTED INNER CRYOSTAT DESIGN

Current Technology	SuperNode Technology
 **Stainless steel**	 **Polymeric Design**
Corrugated design for thermal contraction and manufacturability ➢ Induces high **pumping losses**. ➢ Limits **pressure rating (20 bar)** ➢ High **weight** and **cost**. ➢ Limited **tension capacity.** ➢ Requires continuous welding	Novel design with **Zero CTE** for low stress cryogenic operation ➢ Smooth bore –**3x less losses** ➢ **90bar+** pressure rating. ➢ **40-50% lighter** ➢ **Road-reelable** bend radius for transport. ➢ Enables a continuous manufacturing process

Benefits

- ✓ Better thermal performance
- ✓ Longer distance between re-cooling (>25km)
- ✓ Improved Installability
- ✓ Scalable Manufacture
- ✓ Cost effective material

Result

The most cost competitive superconducting cable system

OPTIMAL THERMAL MANAGEMENT

Thermal Insulation

World class insulation prevents heat leakage into inner cryostat.

Broken Nasa's record for soft vacuum insultation (1Pa – 10Pa).

Custom-made equipment to test insulations:

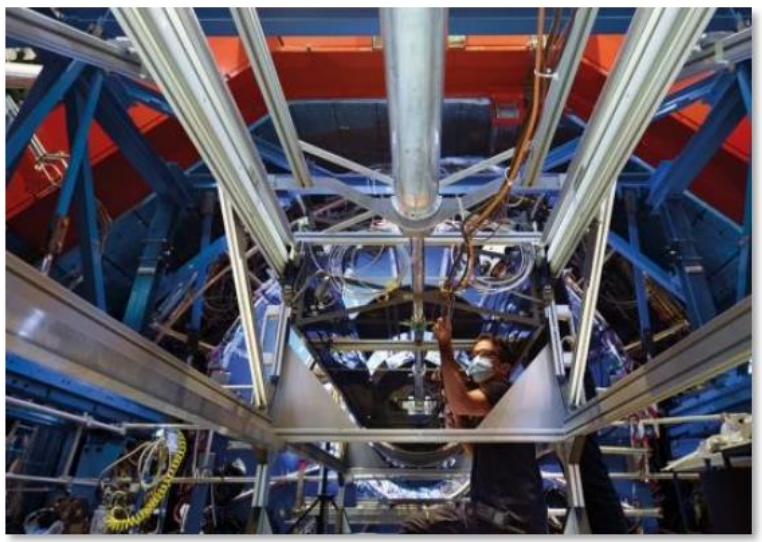
- Test rigs for insulation characterisation and validation on prototypes.
- Tests insulation performance under range of vacuums at cryogenic temperatures.

Vacuum & CERN Partnership

Vacuum essential to ensure **minimum thermal losses** of the cryostat.

CERN Partnership:

- CERN is a world leader in cryogenics and vacuum.
- SuperNode employees deployed to CERN.
- Materials testing and model development ongoing.
- Test rigs on site at CERN and custom rig in build to be installed in SuperNode headquarters.



SCALE MANUFACTURING

System Designed for continuous manufacture

- Cable can be constructed through a **series of extrusion & wrapping processes**.
- Working with suppliers throughout the chain to demonstrate & develop capability.
- Understanding of long-term cost potential, from materials to machinery.

SuperNode Cable Technology Centre

- Opened in Blyth, UK, which produces reeled cables for qualification, demonstration and pilot projects.
- Full scale **manufacturing facility footprint, machinery & personnel requirements developed.**

High Voltage Testing

Voltage testing programme at OREC HV labs – up to 130kV DC Withstand

High Current Testing

High current (5kA) testing and demonstration of DC cable loops, will be inviting attendees to site this summer

SUPERNODE PRODUCT OFFERING

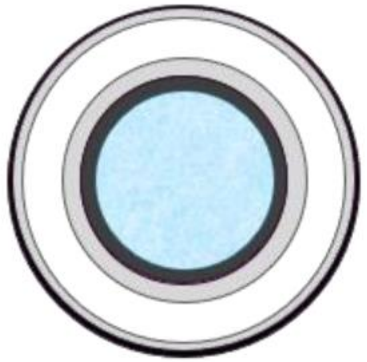
SUPERNODE™
Connecting the Future

1

Small RTP Pipe as AC former

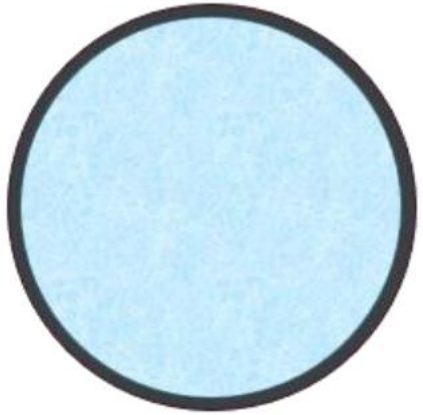
2

Complete Small AC cryostat



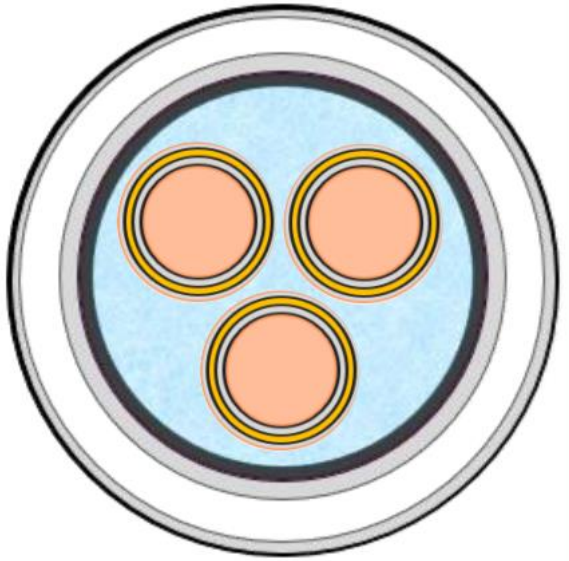
3

Large RTP Pipe for AC Cryostat



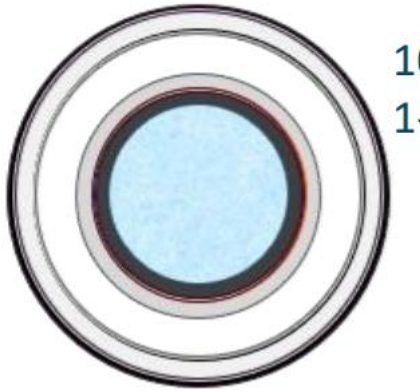
4

Complete AC Cryostat for conductor pull-through

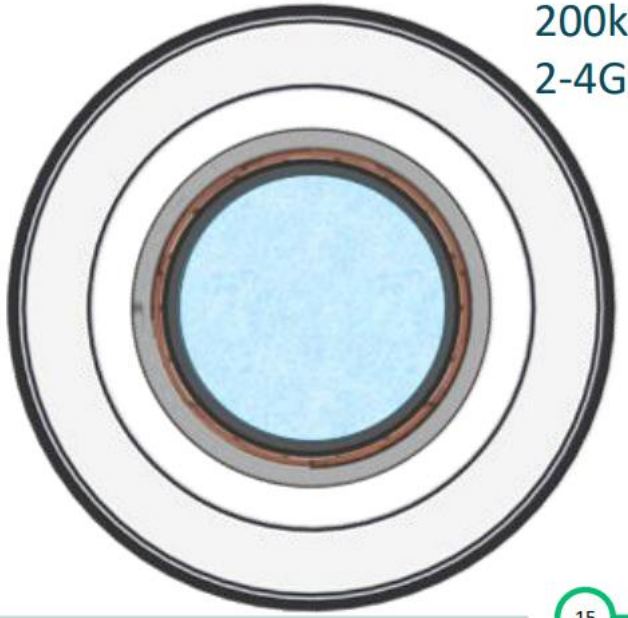


5

DC Cable



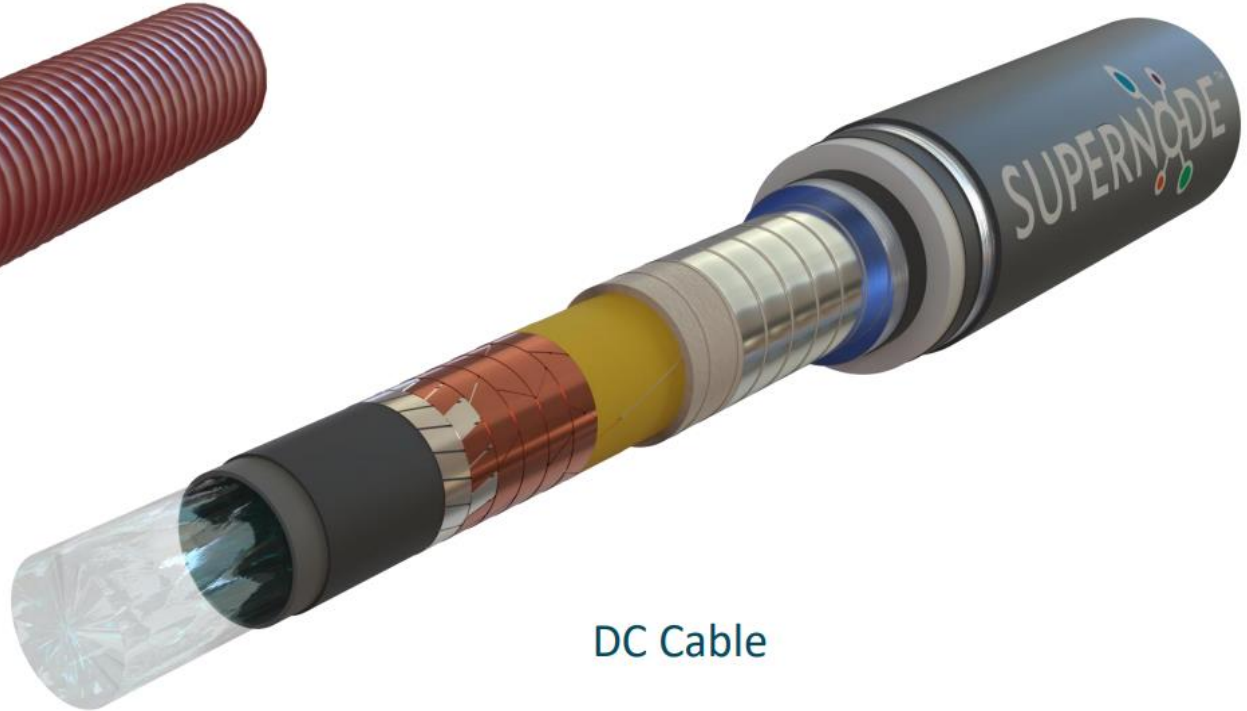
100kV
1-2GW



200kV
2-4GW

SUPERNODE PRODUCT OFFERING

Complete
AC cryostat for
conductor pull



DC Cable

TECHNOLOGY DEPLOYMENT TO MARKET

2025

Demonstration at UK Facility

Product Qualification with Customer Input

2025

2026

First Product Order
Cryostat subsystem for AC application

Terrestrial Pilot
capable of re-cooling every 30km

2027

2028

Multiple order for range of products with customer input

Use Cases

1. Urban Congestion
2. Network Upgrades
3. Energy Parks
4. Data Centres
5. DC Links

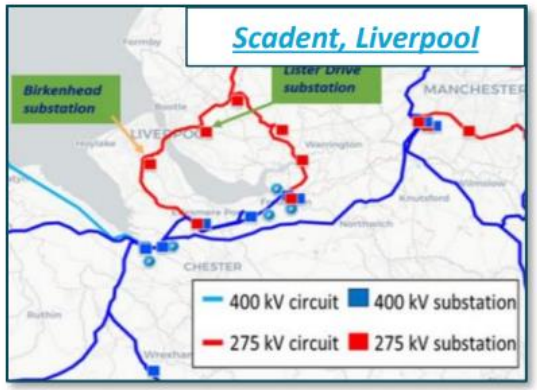
1. Urban Congestion

Application:

- Urban environments or protected areas of nature

Benefits:

- More power, lower voltage, smaller footprint
- Use of existing ducts, tunnels or rights of way
- Avoid substation upgrades



SuperLink, Germany

110kV circuit between substations across Munich

- Use of existing ducts
- Remove need for 5 parallel copper circuits
- Significant saving on civils

CAPEX saving: 32%

Examples

1. **Montparnasse, Paris –** Use of existing ducts (1km). €10m saving in civils.
2. **Scadent, Liverpool –** Avoiding substation upgrades.
3. **South Korea**, LS Cables Data Centre.
4. **REG, Chicago –** Avoiding substation upgrades.
5. **Ampacity, Essen** – Space restricted urban environment.

2. Network Upgrades

Case Study with European TSO

- 8km underground link from coast
- Voltage matching
- Avoid transformation to 380KV
- Avoid overhead line

Undergrounding Transmission Corridors

Overhead routes require undergrounding when entering urban or protected environments.

- Remove need for multiple parallel circuits
- Extend undergrounding distance
- Reduce reactive compensation.
- Significantly reduce corridor footprint.

Overhead Transmission	Superconductor	Conventional Cables

3. ENERGY PARKS

- **Interconnection of Energy parks High Voltage substation at Medium Voltage Level to facilitate:**

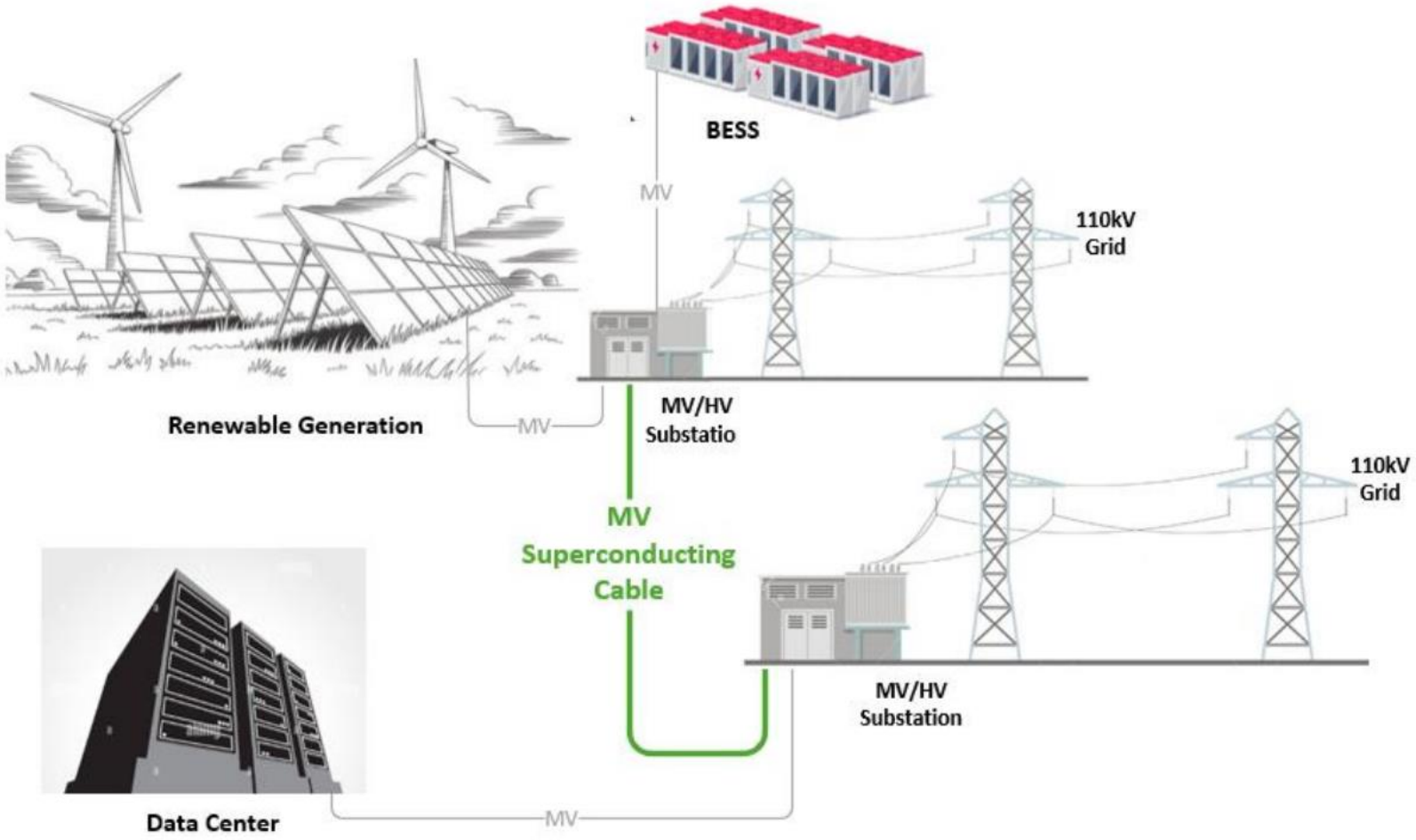
✓ Release of Generation Capacity.

✓ Resilience and Redundancy.

✓ Faster Renewables Deployment

✓ High power in smaller corridor

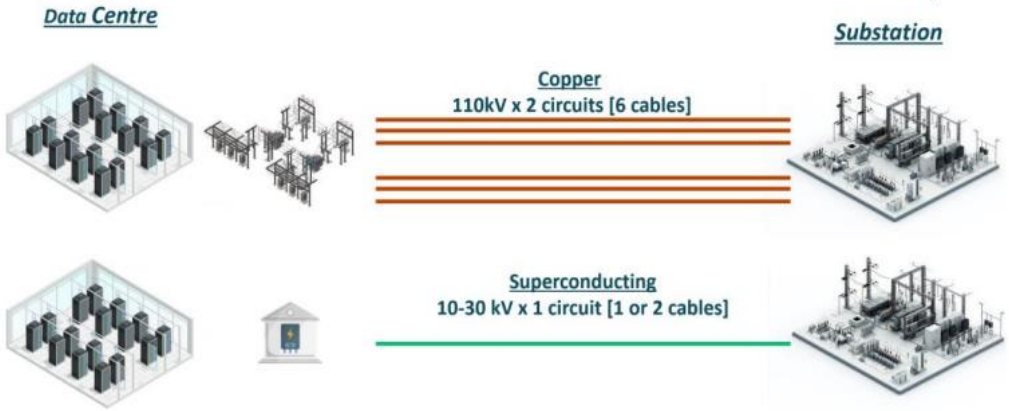
✓ Other Objectives



4. DATA CENTRE APPLICATIONS

As energy demand and power density continue to soar in data centers, superconducting cables provide a viable path forward to building more efficient, scalable, and sustainable electrical infrastructure.

To the fence



- ✓ Reduced cables & more power
- ✓ Smaller substation
- ✓ Improved permitting

Around the campus

- ✓ Reduced cables & more power
- ✓ Smaller footprint
- ✓ Lower distribution voltage

Inside building

- ✓ Smaller busbars
- ✓ Reduced heat
- ✓ Reduced latency

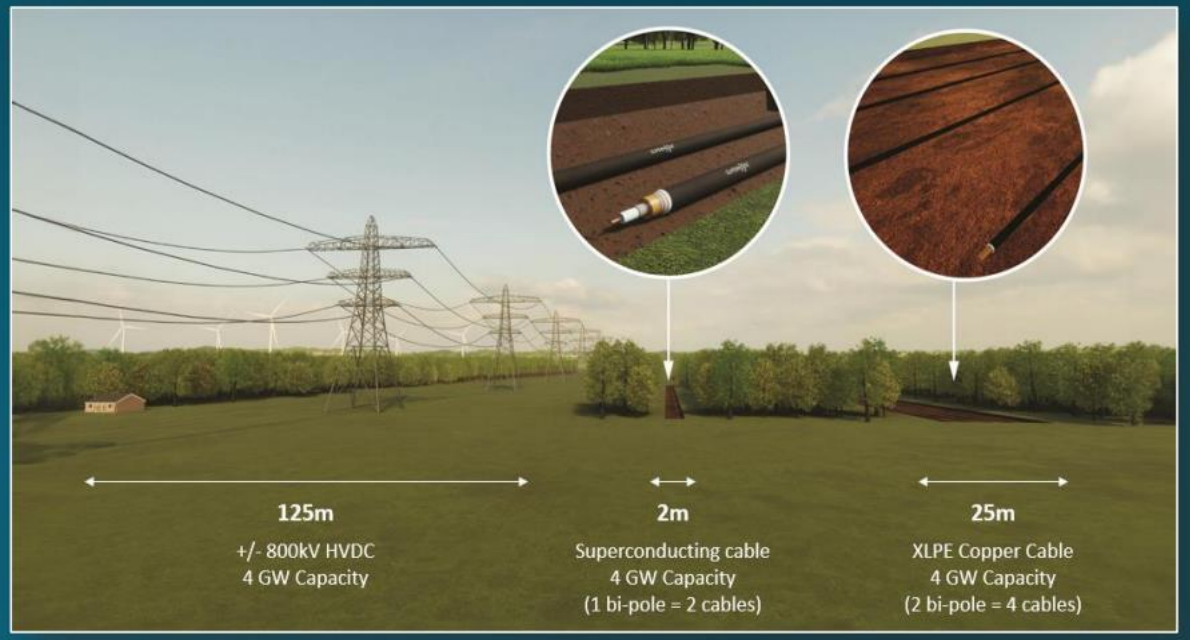
5. DC Cables

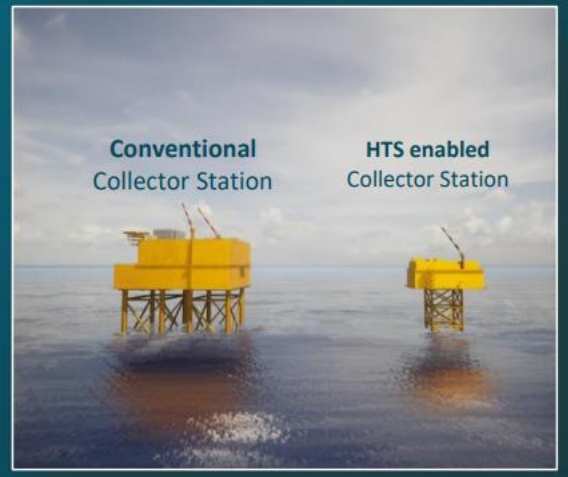
Applications

- Interconnectors & Grid Backbones
- Large Offshore Wind
- Protected areas of nature.
- Existing rights-of-way, ducts or tunnels.

Value Proposition

- ✓ Increased circuit capacity
- ✓ Lower voltage – (optimisation of conversion)
- ✓ Reduced corridor width
- ✓ Reduced Civil costs, environmental impact & consenting.



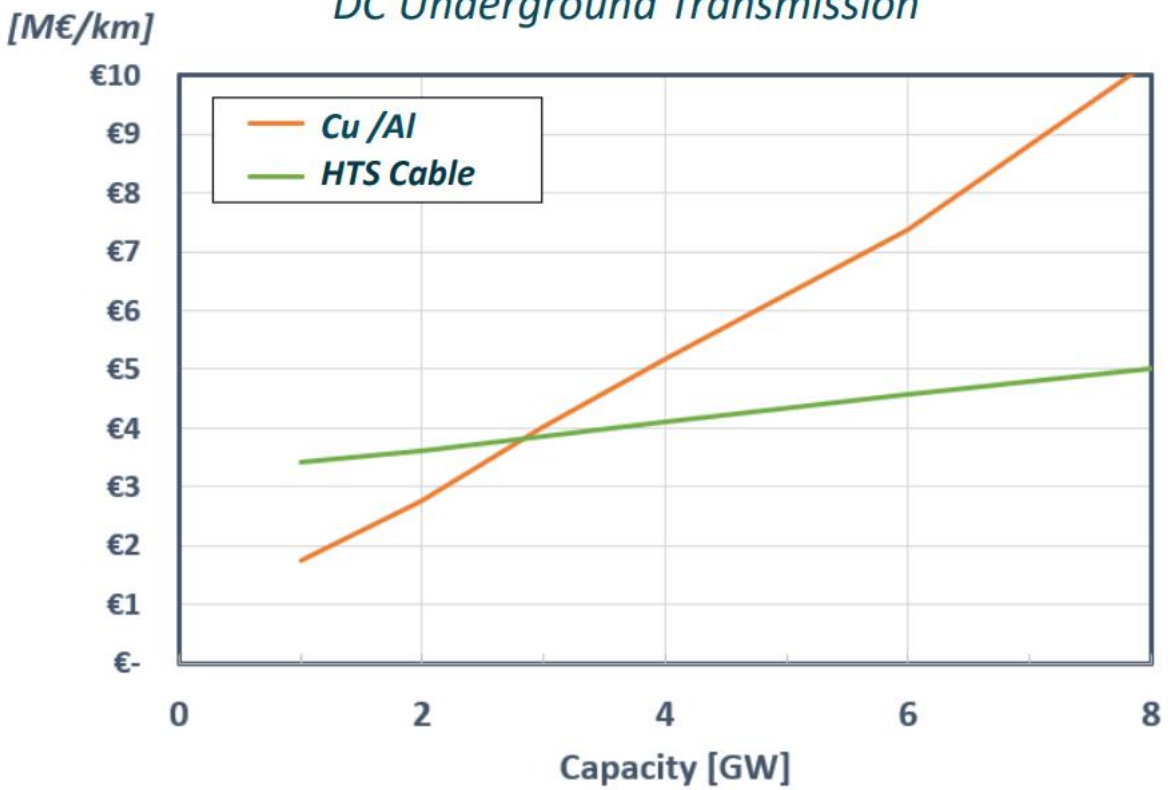


5. DC Links

❖ **Most cost-effective solution for multi-GW scale transmission**

Cable Lifecycle Cost Comparison

DC Underground Transmission

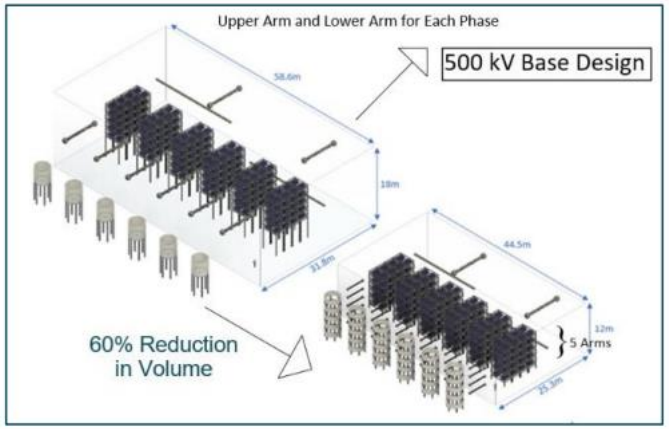


AC/DC Conversion

Typical cost: *250 M€/GW (each end)*

Benefits of lowering DC voltage;

- More standardised, readily available equipment.
- Optimised valve hall design (size & weight).
- Cheaper solution.



Convertor Station Configuration for MVDC Systems using Superconducting Cables (2024)

Your Support is Appreciated

Supernode Safety Briefing

Tour of Plant – 2 Groups

EirGrid SONI

SUPERNODE™ Connecting the Future

20/05/2025

Operational Policy Roadmap Workshop

Eoin Kennedy
Director of Innovation and Planning, EirGrid

David McGowan
Head of Power System Insights & Research, SONI

Simon Tweed
Future Operations, EirGrid

Operational Policy Roadmap 2025-2035

SOEF Advisory Council

20 May 2025

Key Messages

- EirGrid and SONI first published a long term Operational Policy Roadmap in 2022. This 2023-2030 roadmap sets out the operational policy development required to enable secure operation a decarbonised power system with high levels of non-synchronous renewable generation (i.e. wind / solar).
- This original roadmap has been reviewed and updated to reflect the current state of its implementation, new initiatives and updated policies and targets. The new roadmap covers the 2025-2035 timeframe.
- Our target is operation of the power system at System Non-Synchronous Penetration (SNSP) levels up to 95% SNSP by 2030 and up to 100% by 2035.
- We are at the forefront internationally of managing the integration of non-synchronous renewable generation and the targeted operational policy changes are ambitious. Achieving the objectives of this roadmap is dependent on a number of key factors, including delivery of:
  - New operational capabilities under the Operational Tools and Capability Enhancement (OTCE) programme;
  - Enhanced performance capability of system users such as data centres;
  - New System Services such as Low Carbon Inertia Services (LCIS) projects;
  - Grid infrastructure to remove constraints.

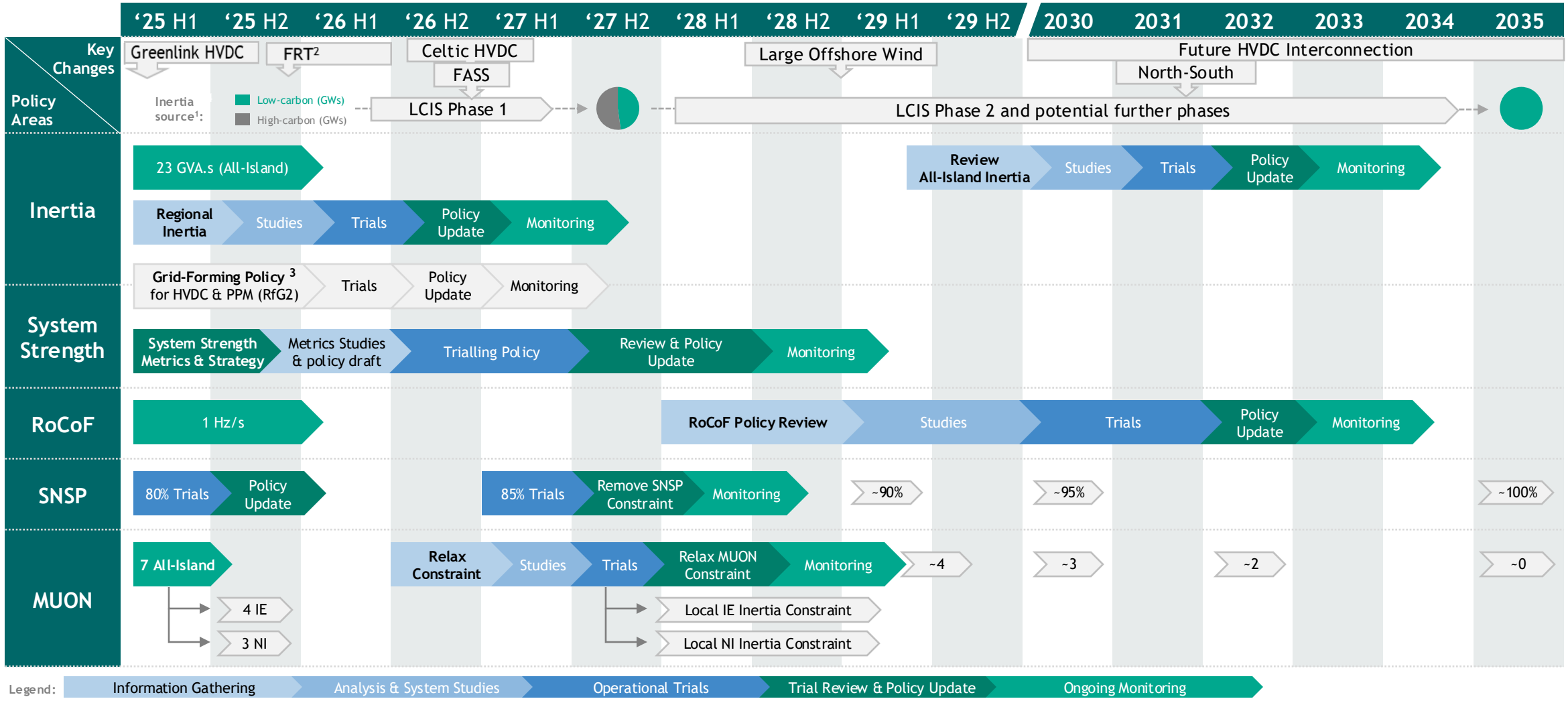
EirGrid SONI

Dynamic Stability – Key Objectives

Between 2025 and 2035, EirGrid and SONI will continue to operate the system securely, in accordance with its license and regulator obligations, with respect to dynamic stability while also aiming to:

1. **Transition from a single, All-Island inertia floor to a model of regional inertia** for Ireland and Northern Ireland.
2. **Introduce a new *System Strength* policy including metrics for** EirGrid and SONI that must be monitored for real-time operations.
3. **Maintain the system-wide RoCoF limit** at 1 Hz/s subject to review of the RoCoF policy in the coming years, based on system needs and evolving capabilities.
4. **Relax and eventually remove SNSP** as a constraint but maintain it as a key operational reporting metric. Our aim is to achieve the ability to operate up to 95% SNSP by 2030 and close to 100% SNSP by 2035.
5. **Relax and eventually remove the minimum unit constraint for system stability,** while ensuring any local constraints are satisfied and linked to specific system dynamic stability scarcities. The aim is to achieve secure system operation with three or less conventional generation units by 2030 and the ability to operate with no conventional generation units online by 2035.

Dynamic Stability – Milestones & Timeline 2025-2035*



[1] Indicative values.
[2] Grid Code requirements for Fault-Ride Through capability of Demand Facilities in place.
[3] Indicative timeline for information purposes only, there is a dependency with the ENTSO-E RfG and HVDC 2.0 and associated Grid Code changes.
* The timelines and assumptions outlined in this roadmap take precedence over those found in SOEF V 1.1).

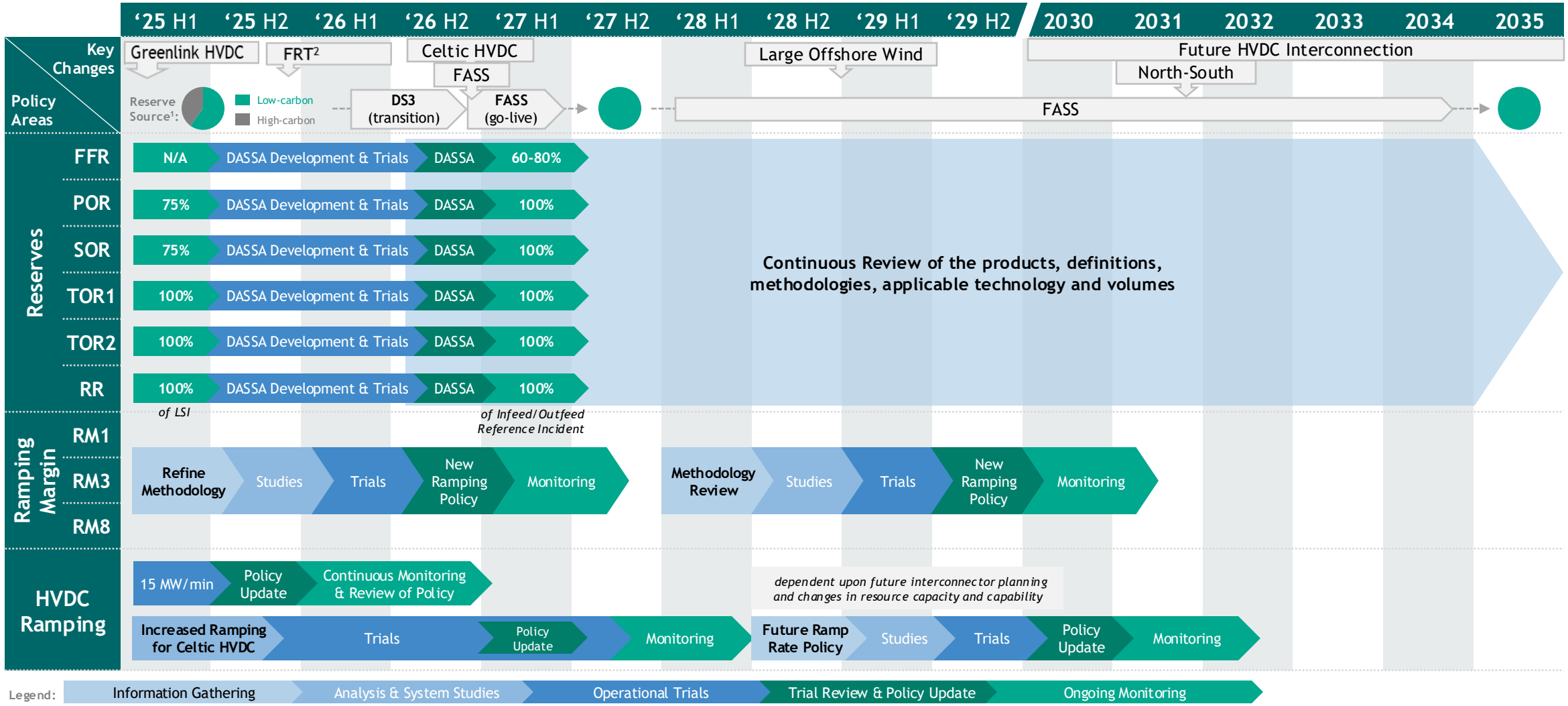
Reserves and Ramping – Key Objectives

Between 2025 and 2035, EirGrid and SONI will continue to operate the system securely while also aiming to:

1. **Consolidate on all reserve definitions and volumes, by defining a reference incident for contingency reserves,** including upward and downward reserve, fast frequency response and regulating reserves.
2. **Align with European network code requirements** for reserves with 100% containment coverage for reference incidents.
3. **Deploy new day-ahead reserve auction platform for more competitive procurement of reserves.**
4. Couple to European markets for reserve, post-connection of Celtic HVDC.
5. **Schedule and dispatch non-conventional resources such as inverter-connected RES and BESS for reserve provision** across all tranches.
6. **Refine the ramping margin policy** and RM system service volume requirements.
7. **Increase the All-Island interconnector ramping rates in stages** in line with Greenlink, Celtic and potential new HVDC interconnections and offshore wind.

EirGrid SONI

Reserves & Ramping – Milestones & Timeline 2025-2035*



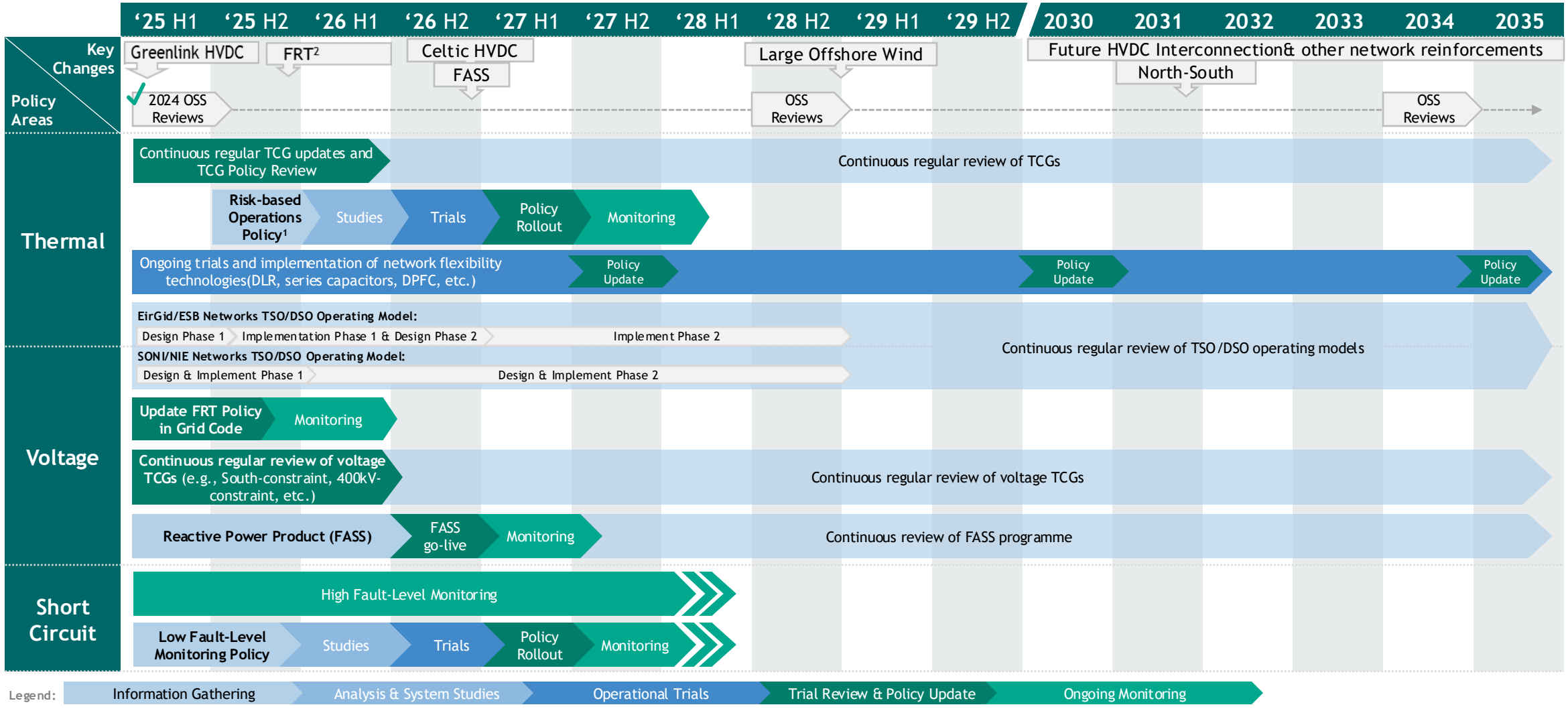
[1] Indicative values. EirGrid and SONI are developing capabilities to enable all reserves to come from low-carbon sources. Ultimately, the market will determine make up of these reserves and facilitating the transition to zero carbon reserves.
[2] Grid Code requirements for Fault-Ride Through capability of Demand Facilities in place.
* The timelines and assumptions outlined in this roadmap take precedence over those found in SOEF V 1.1).

Operational Security – Key Objectives

Between 2025 and 2035, EirGrid and SONI will continue to operate the system securely while also aiming to:

1. **Continue actively managing the thermal and voltage transmission constraint groups (TCGs)** that are active in the market and develop plans to remove TCGs post-reinforcement.
2. Develop a framework for **regular assessment and update of thermal and voltage transmission constraints** on the network.
3. Develop a framework for managing operational security using **risk-based approaches (probability and impact) in line with European obligations.**
4. Develop **policies for managing high- and low-fault levels** on the EirGrid and SONI networks.

Operational Security – Milestones & Timeline 2025-2035*



[1] Evolution of the risk-based operations policy, as the current approach is also risk based but not probabilistic.
[2] Grid Code requirements for Fault-Ride Through capability of Demand Facilities in place.
* The timelines and assumptions outlined in this roadmap take precedence over those found in SOEF V 1.1).

Overarching Dependencies and Risks

Performance of System Users	The ability to run operational trials and to change policy will be dependent **on the evolving performance of system users** (in particular, Demand Facilities and Distributed Energy Resources). The development and application of new user performance requirements will be key to the TSOs being able to deliver the operational policy changes outlined in this document.
Network and System Services Development	Timely delivery and commissioning of system services providers, new flexible generation, major infrastructure projects (e.g., second North-South Interconnector) and other transmission reinforcements are required to assist with future challenges and meet the decarbonisation targets.
Security of Supply	Operational trials will be dependent on system operational conditions and the need to ensure continued security of supply to customers in Ireland and Northern Ireland.
Operational Capability	Operational capability must be uplifted to align with the new challenges and requirements introduced by the increased complexity of system operations (e.g. forecasting, observability).
Operational Studies	Analysis is crucial for determining constraint values and policy direction. Advancing capabilities for analyses, such as EMT simulations for IBR-dominated networks, and increasing automation are essential for more frequent assessments of system constraints. These capabilities are vital for delivering the roadmap.

EirGrid SONI

Lunch

Recommence at 13:50

Members Hour: Storage Innovation

Long Duration Energy Storage Solutions

Shaping Advisory Council Meeting, Dublin

20th May 2025

Peter Harte
Advisory Council Member

Paul Blount
Advisory Council Member

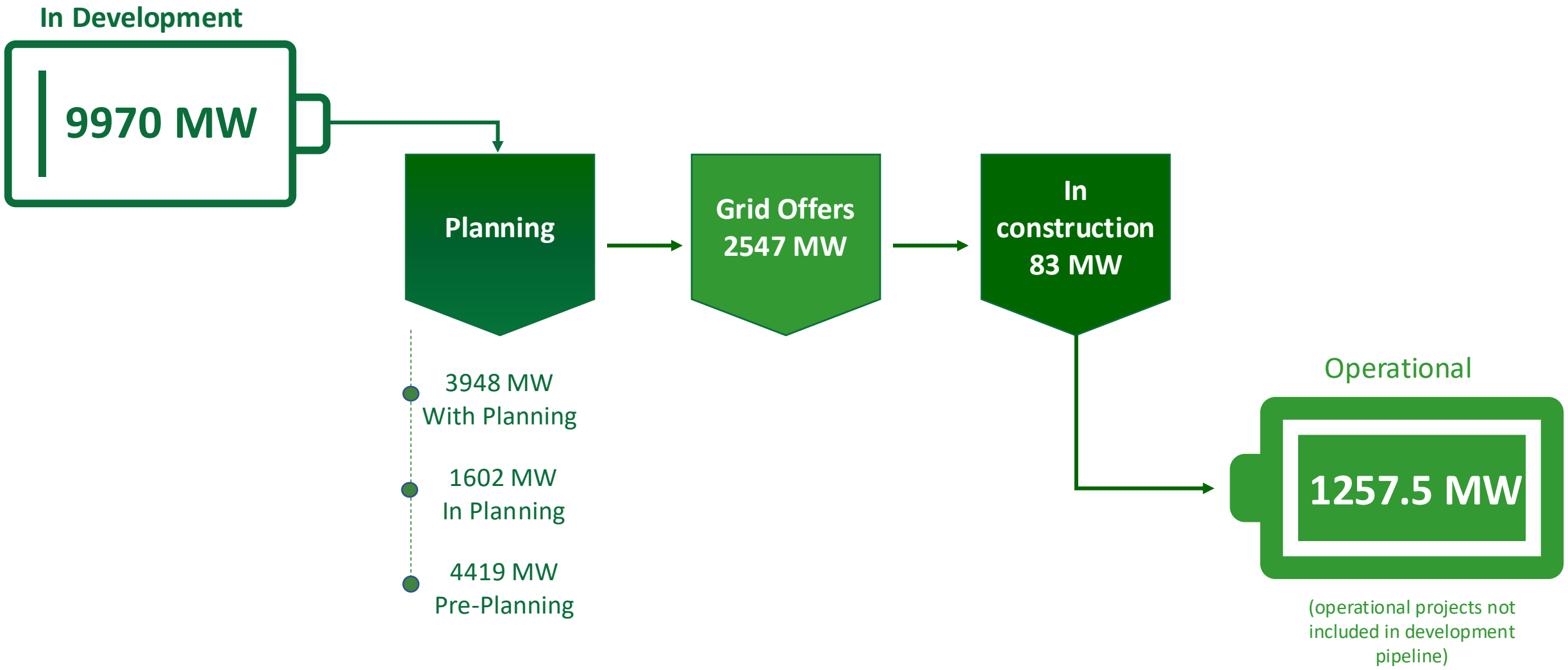
Bobby Smith
Advisory Council Member

EirGrid SONI

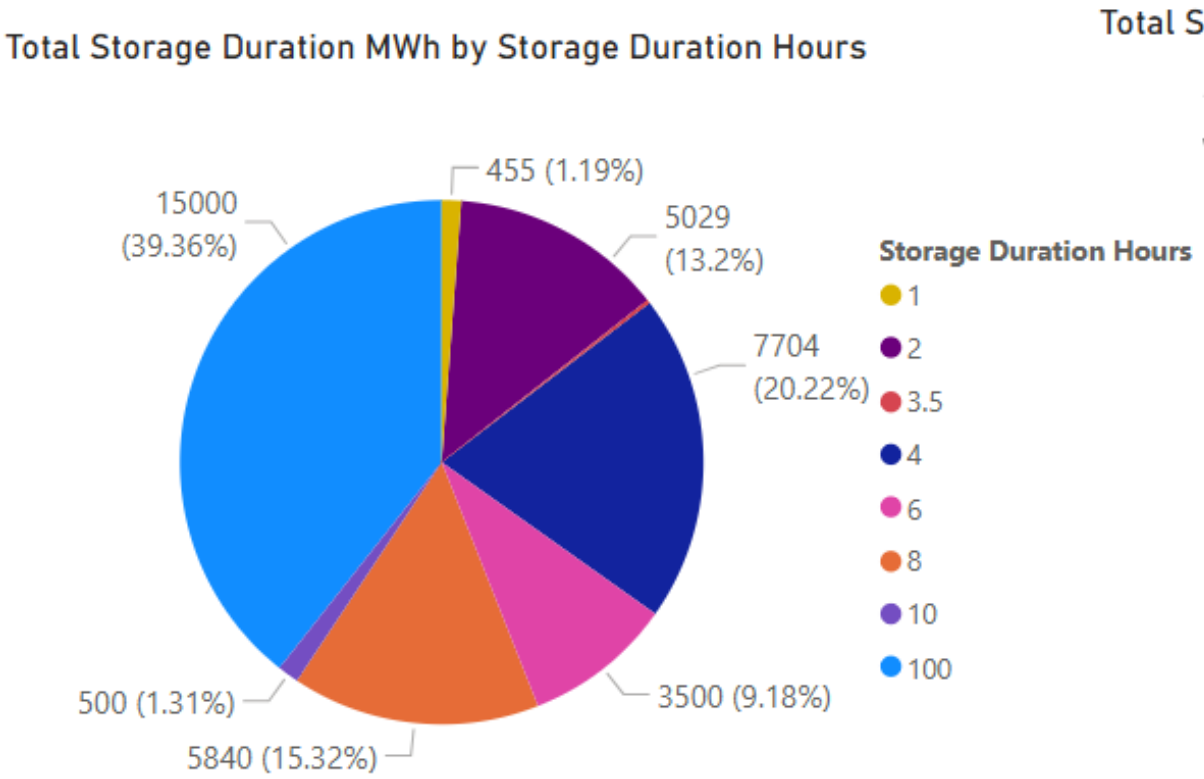
Energy Storage Ireland Pipeline Survey 2025

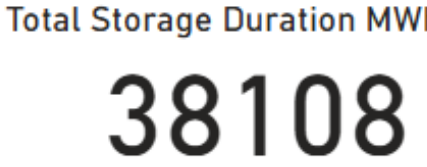
20 May 2025

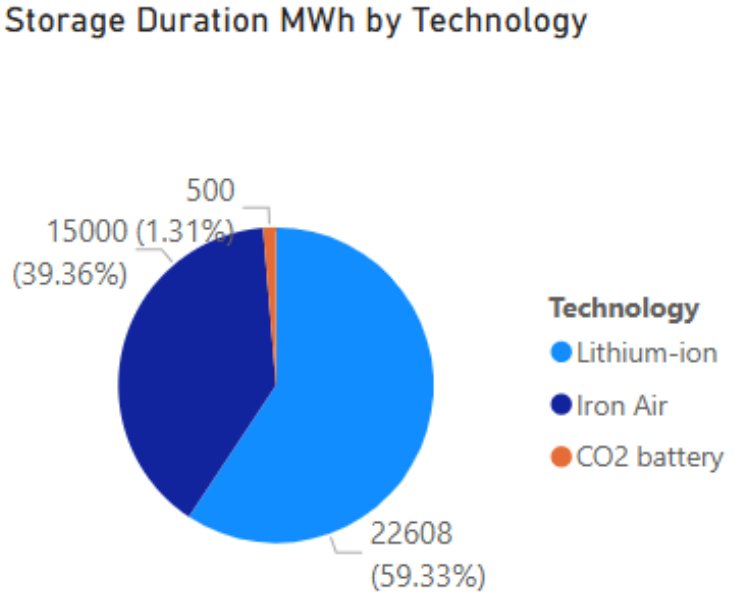
All-Island Energy Storage Development Pipeline



Storage Durations

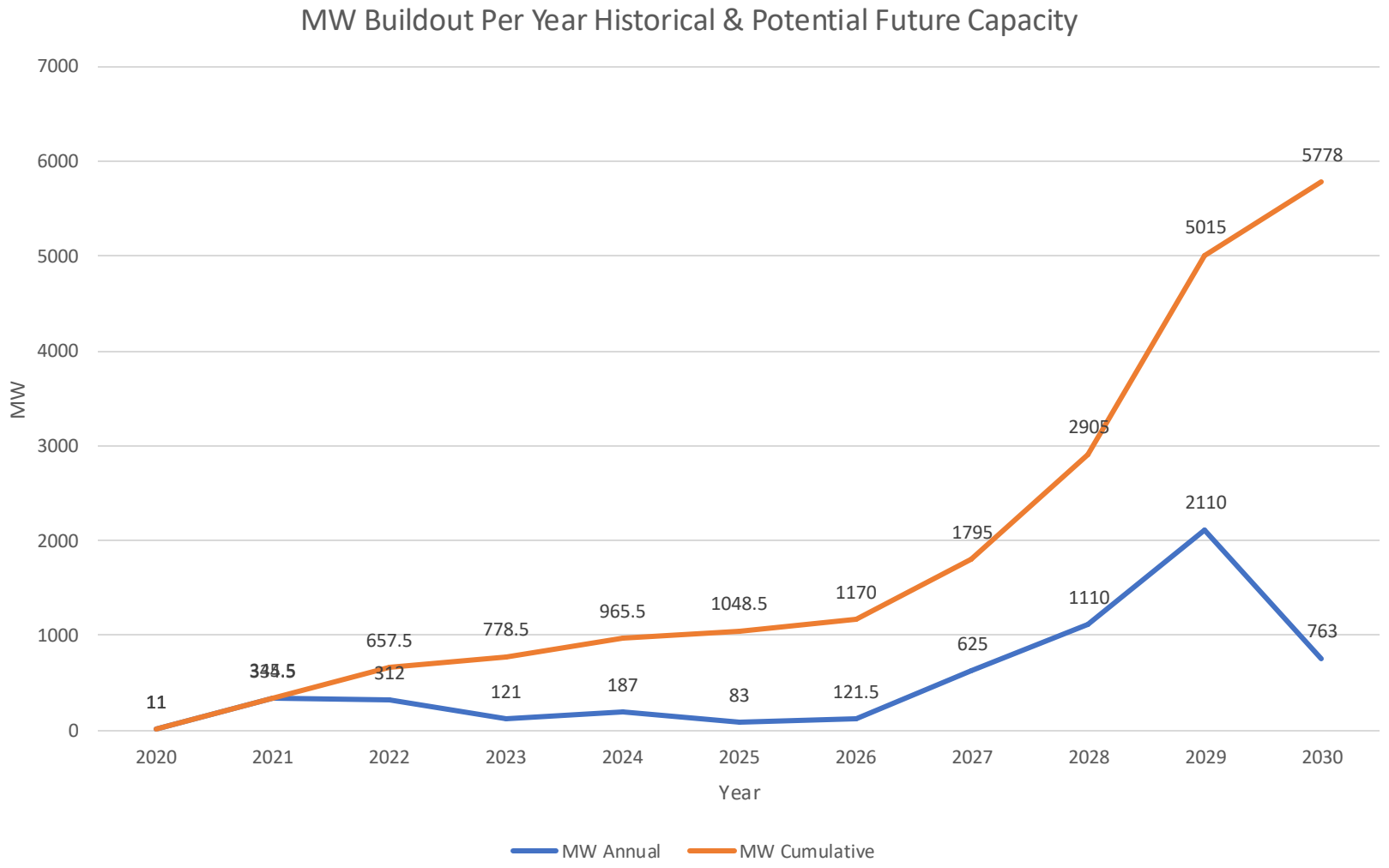






* 3691 MW where duration info was 'Blank' are not included in the total MWh figure

Massive ramp up required but future beyond 2026 is uncertain



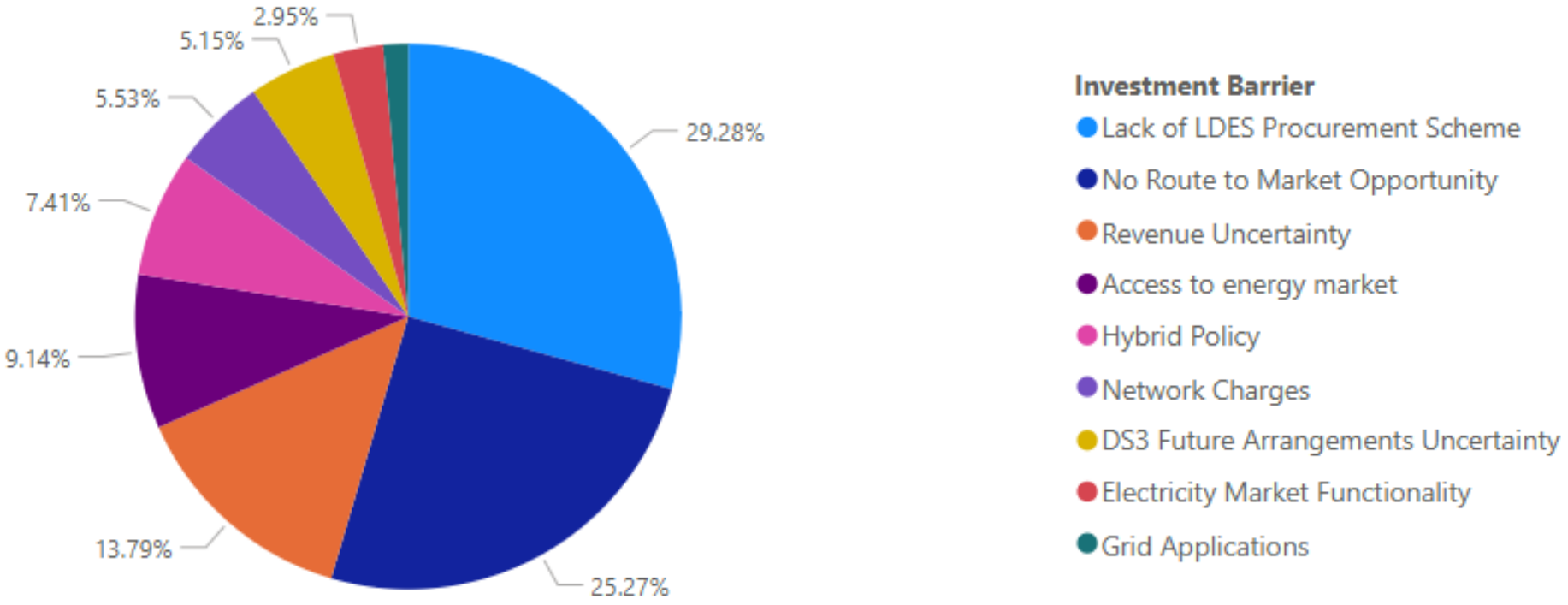
It should be noted that deployment beyond 2026 is uncertain.

This chart represents the potential capacity in the storage sector in line with target go-live dates provided by respondents.

Delays to TSO/DSO procurements and uncertainty regarding other market revenue streams would likely impact the delivery dates provided.

Investment Barriers

What is the main investment barrier?



SOEF Advisory Council Meeting #11

Long duration storage – system benefits & key enablers

20th May 2025

What can storage do for the system

Acknowledging the oversimplification!

1. Long duration storage (24hr+) can compliment renewables by absorbing constraint, curtailment and oversupply, displacing the most expensive thermal generation. It is a critical component of any affordable deeply decarbonised power system

2. Medium generation (4hr+) storage can provide peaking capacity (charging from both renewables and fossil generation). It is an alternative to OCGT or other peakers but in order to provide a capacity service, it requires some minimum level of thermal generation to reliably charge during off peak periods. As proportionately more is added, capacity value diminishes Decarbonisation benefits could be very modest

3. Strategically located medium duration storage can also relieve demand side network congestion (i.e. if the grid can't carry power from generation to load during peak demand periods, storage located on the load side of this congestion, can absorb power off peak and meet the load during the peak. Again this storage would require sufficient thermal generation to reliably charge off peak, and decarbonization benefits would be very modest.

4. Short duration storage (c.a. <1hr) can provide zero carbon system services. This can have significant decarbonization benefits if it is helping to resolve binding operational constraints

We need clarity on the objectives of LDES procurement

- Frequency response / reserve services = system service markets
- Peaking capacity = CRM (look at de-rating factors but apply caps on energy limited technologies?)
- Demand side network congestion = (targeted procurement of medium duration storage / DSR to ensure demand can be met with accepted reliability standards – CBA based?)
- To meet the Governments Climate action plan flexibility targets 20-30%? But what is the purpose of this flexibility?

Least cost decarbonised and secure power system

- As we add more wind and solar, we will see ever increasing levels of dispatch down: Constraint, Curtailment and Oversupply all projected to increase significantly.
- We need new technical capabilities to bulk time shift very large energy volumes to manage this level of dispatch down

The Dispatch Down Challenge

ECP 2.4 constraint reports

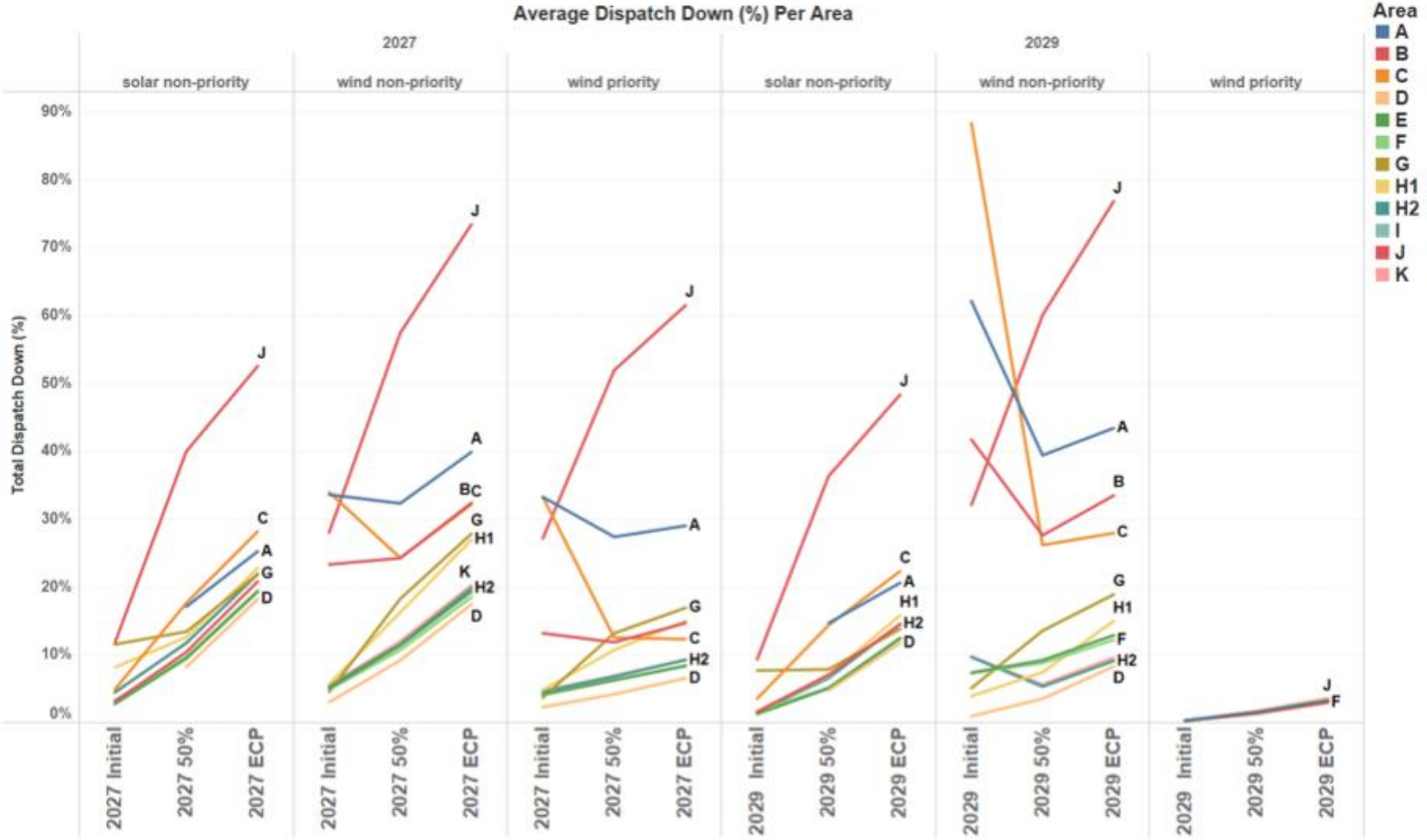
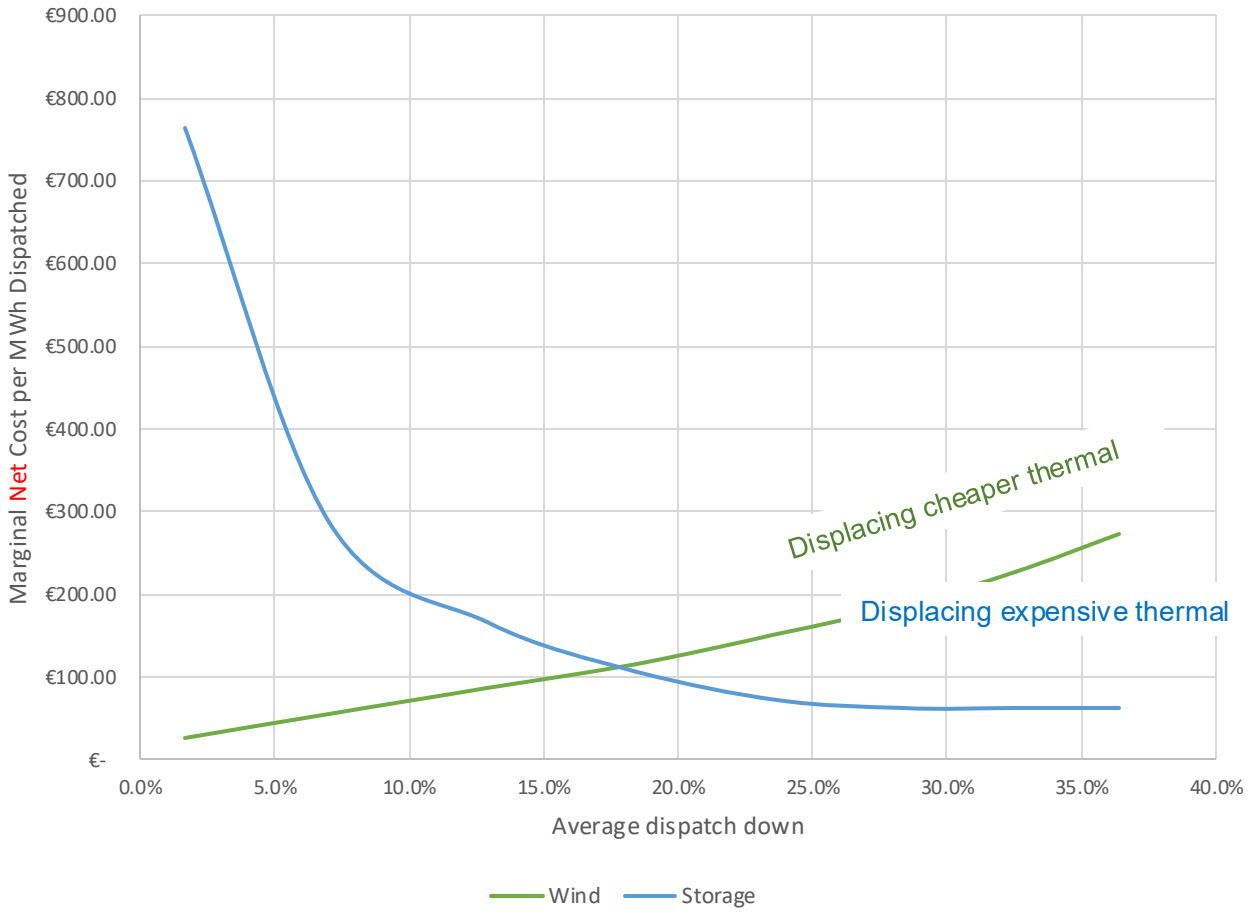


Figure 5-3 Total Dispatch Down Percentage per Area

How LDES compliments renewables

Simplified Illustration of the economic investment trade off's between wind and storage

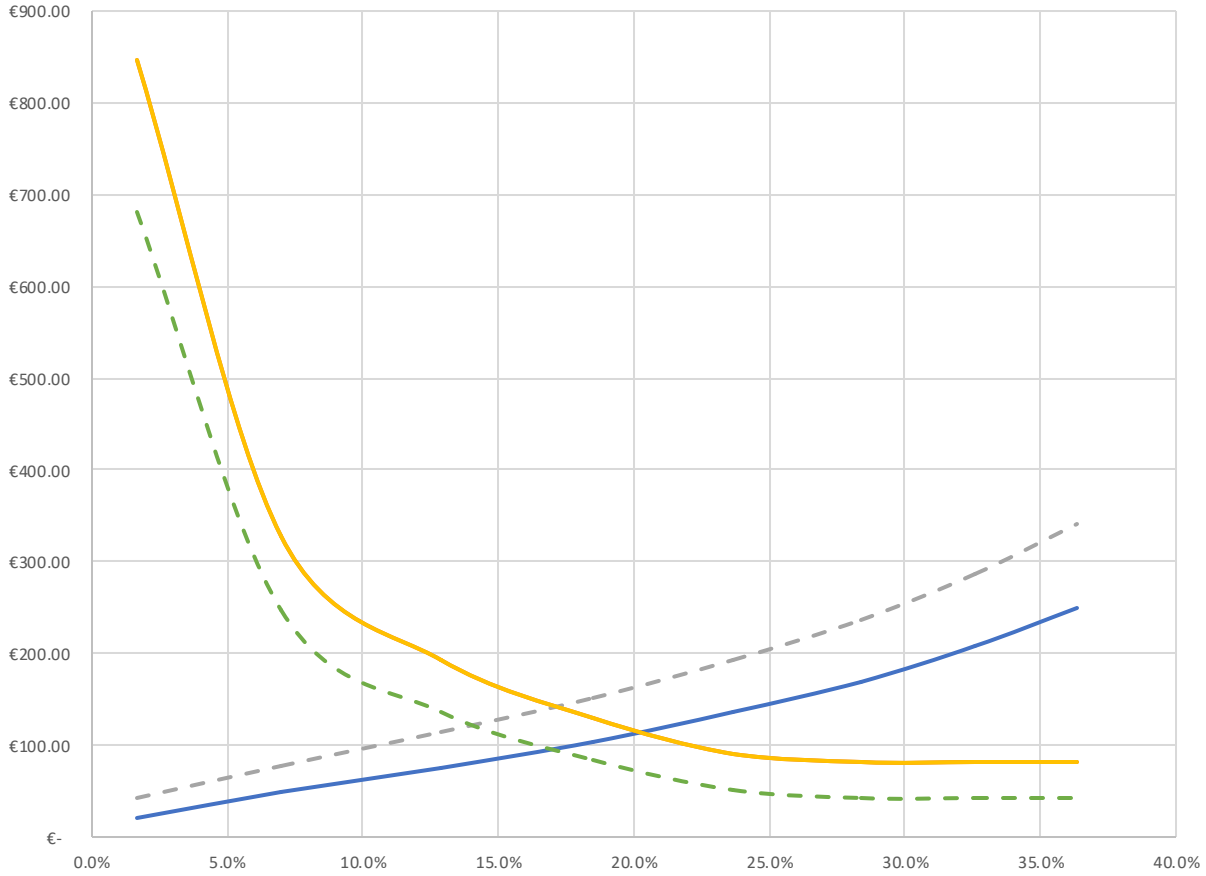


- As wind capacity increases, dispatch down of wind due to network or system wide limitations also increase, at a certain point exponentially.
- This means the investment cost per MWh of energy dispatched also starts to increase exponentially.
- As dispatch down increases, the net cost per MWh dispatched from a marginal storage investment decreases.

At a certain level of renewable penetration, the next best investment to make to reduce emissions will be storage.
But there isn't a single price or technology for renewable energy or for storage!

Key Enablers - Efficient Investment in a Net Zero System

Simplified Illustration of the economic investment trade off's between wind and storage



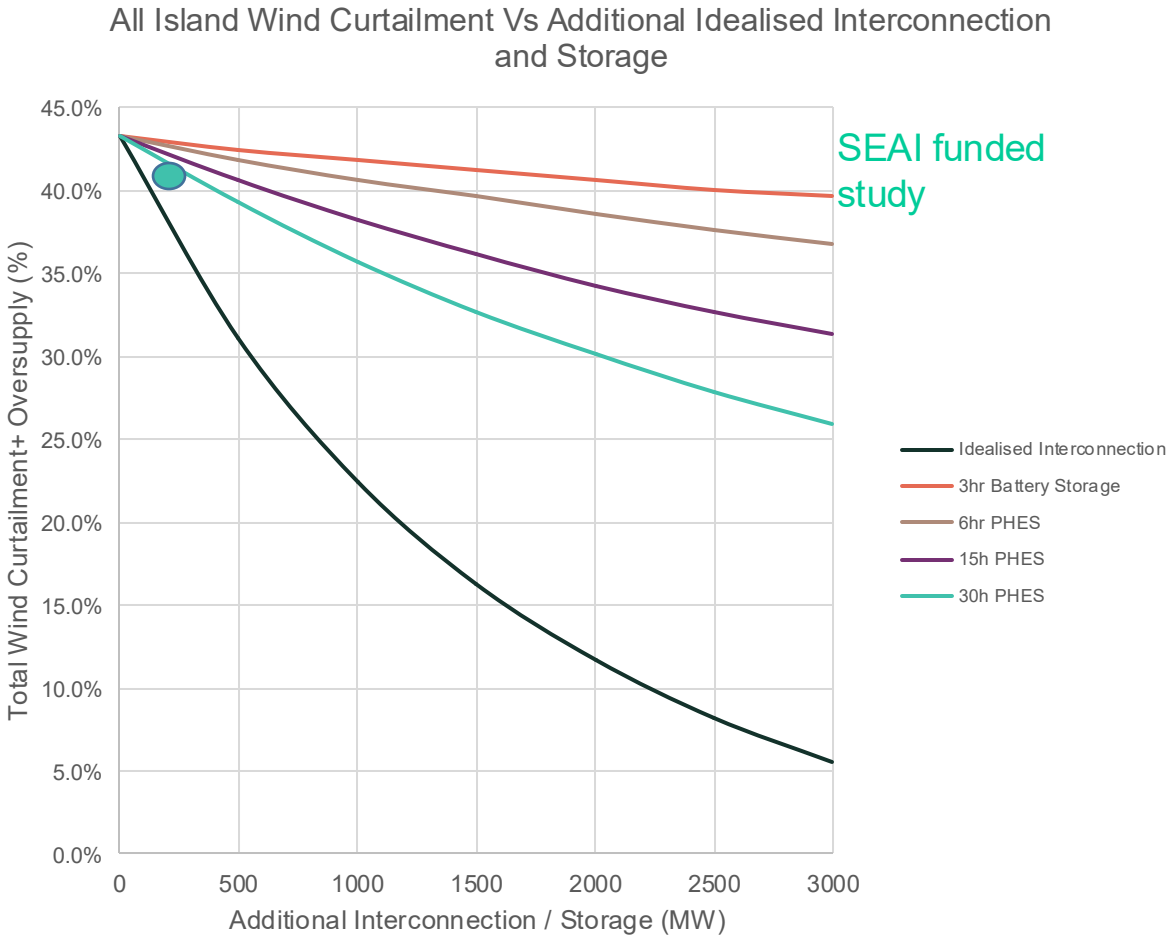
But the point at which the storage investment becomes economic depends on:

- The cost of storage (floor revenue requirement)
- The efficiency of storage
- The energy capacity of storage
- The cost of wind and solar in different locations
- The amount of network capacity in these locations.

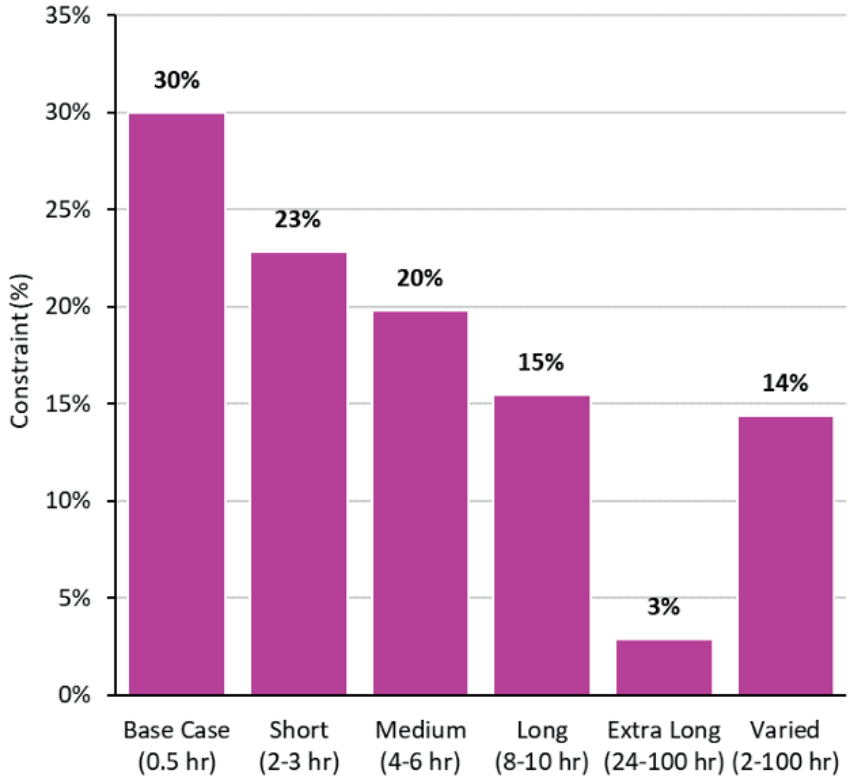
The challenge for policy makers is how to design competitive long term auctions in a way that these equilibrium / cross over points can be found across complex grid systems, with a wide array of technology solutions and projects with different costs and technical characteristics

Absorbing surplus renewables

Why energy capacity matters



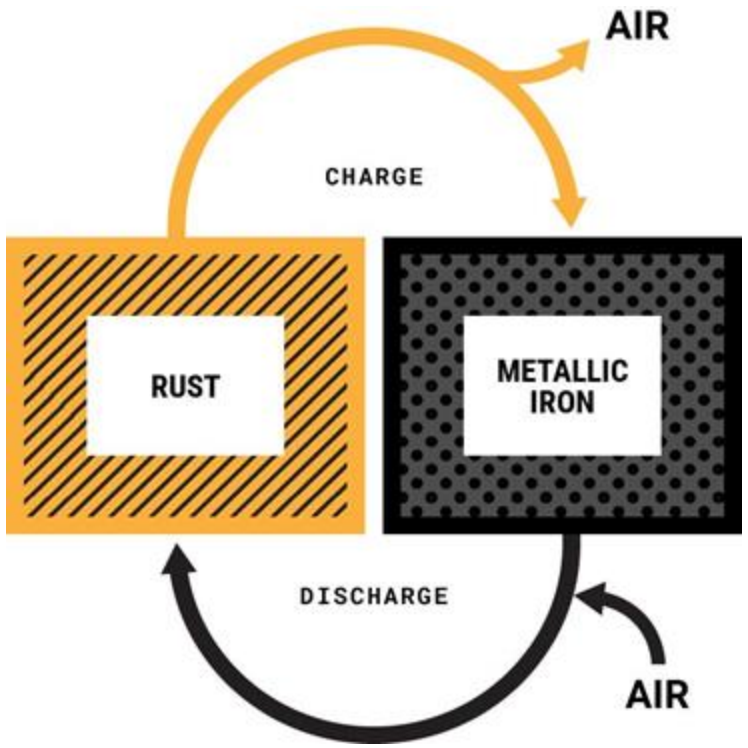
SEAI funded study



Baringa Gamechanger study

An emerging ultra-low cost multi day storage solution

100-hour Reversible Rust Battery



COST

Lowest cost rechargeable battery chemistry.
Less than 1/10th the cost of lithium-ion batteries

SAFETY

Non-flammable aqueous electrolyte. No risk of thermal runaway.

SCALE

Uses materials available at the global scale needed for a zero carbon economy. High recyclability.

DURABILITY

Iron electrode durability proven through decades of life and 1000's of cycles

Form Factory 1: Commercial-Scale Manufacturing

Transforming Weirton Steel Land for Battery Manufacturing in West Virginia

Building rendering

- **Total Local Investment:** $760 million
- **Construction Start:** Early 2023
- **Production Start:** Late 2024
- **Jobs:** Minimum of 750 full-time jobs

Location Benefits

- Close to our existing pilot manufacturing facility in PA
- Strong natural infrastructure
- Local manufacturing know-how

Factory Function

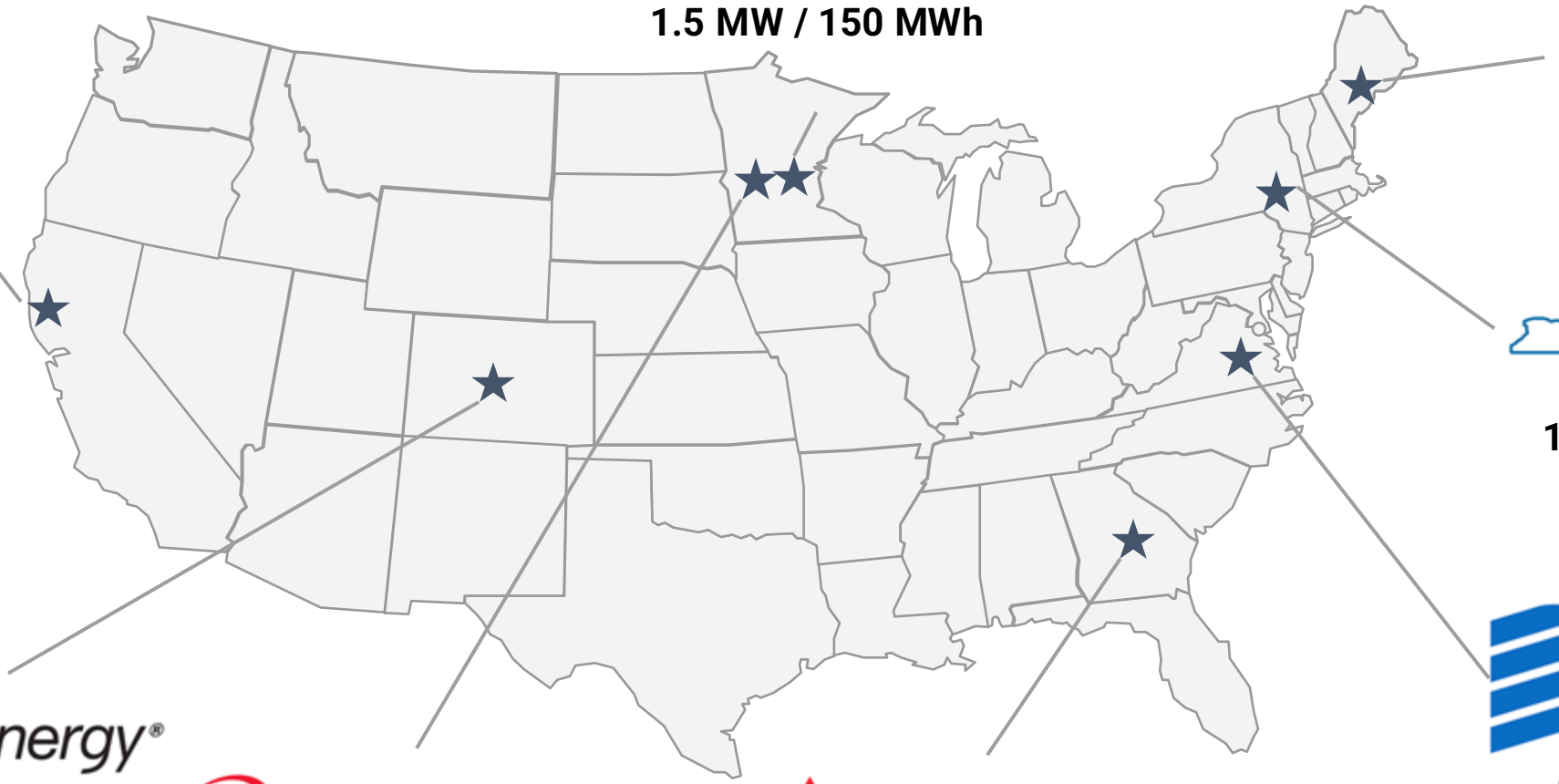
- Semi-to-fully automated cell, module, & enclosure assembly
- Ability to scale production in modular blocks

Form energy

FuturEnergy Ireland

https://formenergy.com/form-factory-1/

Over 14 GWh of contracted multi-day storage projects



GREAT RIVER ENERGY

Broke ground Summer 2024

1.5 MW / 150 MWh

85 MW / 8500 MWh

5 MW / 500 MWh

NEW YORK STATE | NYSERDA

10 MW / 1,000 MWh

CO regulatory approval ✅

Xcel Energy®

10 MW / 1,000 MWh

Dominion Energy®

5 MW / 500 MWh

Xcel Energy®

10 MW / 1,000 MWh

MN regulatory approval ✅

Georgia Power

15 MW / 1,500 MWh

VA regulatory approval ✅

Form energy

FutureEnergy Ireland

Key enablers

1) Bulk energy time shifting auctions with the following critical characteristics:

- Capable of comparing projects with different MEC / MIC / MWh / RTE / locations to determine relative system values.
- Provide long term revenue certainty to the projects with greatest value vs cost (CBA based procurement – GB LDES auctions)
- Maintain exposure to short term markets to incentivise efficient operation (cap and floor / floor with shared upside)

2) Network charging reforms:

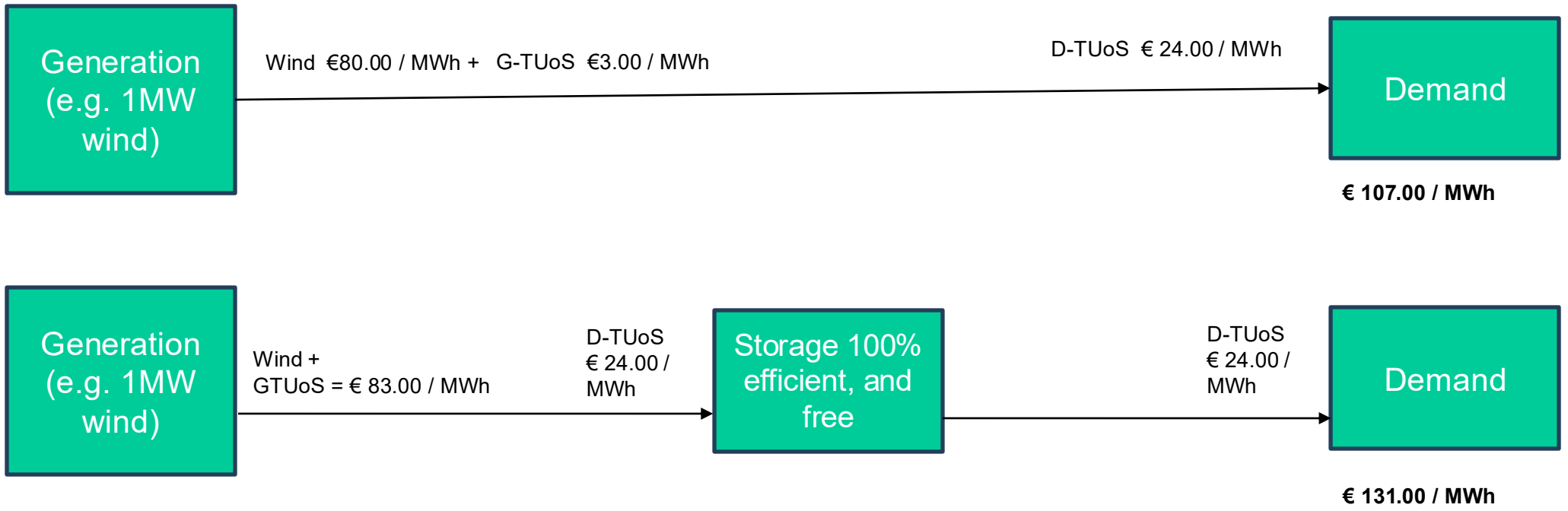
- As an interim near term solution storage should be exempt from network charges,
- In the medium to longer term, congestion management revenues should form part of the revenue stack. The network service provided should be recognised.

3) Scheduling and Dispatch systems (ex ante & balancing)

4) Flexible connections

Network charging reforms

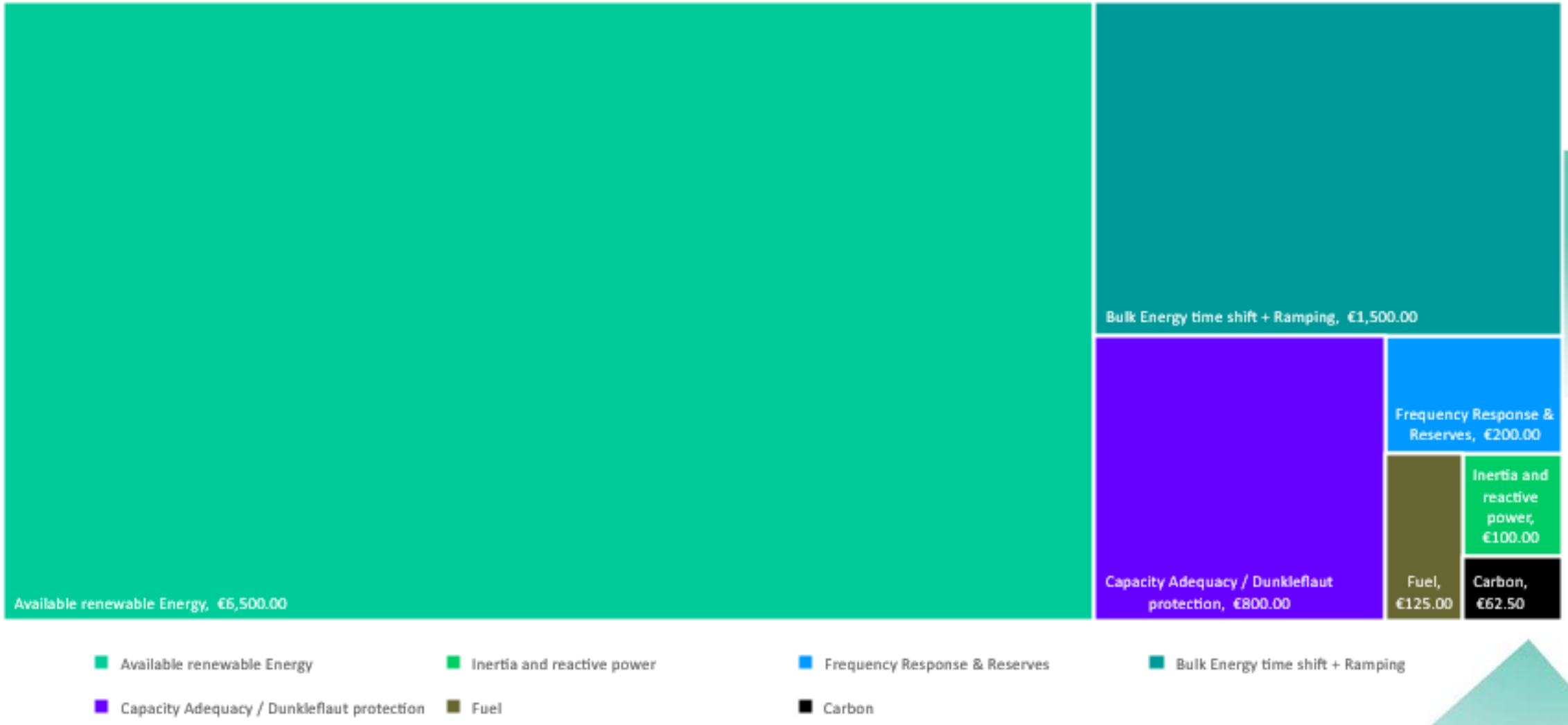
Whats wrong with what we have:



We are using the same network more efficiently, but consumers end up paying double grid charges as these get incorporated in storage project investment decisions.

A vision for a 2035 net zero power system

Illustrative split of annuitized capex, fixed opex, fuel and carbon costs for a net zero power system in 2035



Annuitized capex + fixed opex in €m p.a. Assuming long term contracts offered to all providers approx. equal to each assets useful life. This graphic doesn't consider interconnectors. It is important to note that interconnectors also play a key role on net zero systems and existing energy markets will continue to have an important role to play in incentivising optimal IC flows for the foreseeable future

End

Ireland FutureEnergy
futurenergyireland.ie

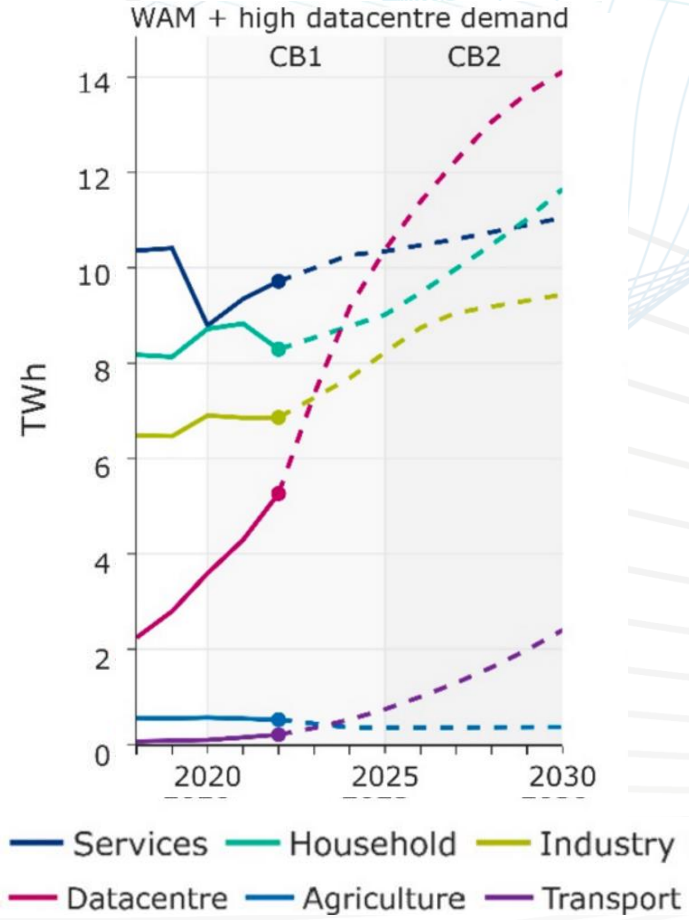
100% Energy Self Sufficiency for Ireland's Electricity System and Data Centres

SOEF Advisory Council May 2025

EirGrid SONI

www.netzeroenergy.ie

Explosive growth in demand



1. Ireland likes data centres. We host Google, Microsoft, Amazon, TikTok, Equinix, Facebook.
2. But they make up 21% of our electricity demand (c.30TWh) today, growing fast, leading to Ireland having a deficit in peak generation capacity.
3. Since 2017, new data centre growth has absorbed more than all the new wind connected (c.6TWh). Ireland is thus projected to miss our decarbonisation targets (-50% by 2030).
4. Irish government policy "*has a preference for data centres that can demonstrate a clear pathway to decarbonisation…Growth in 'islanded' data centres [connected only to the gas network] would result in security of supply risk being transferred from the electricity system to the gas network*"
5. The majority of planning applications for data centres in Ireland recently have been rejected due to inadequate energy strategies and defacto grid moratorium. The recent LEU Proposed Decision has done little to bring clarity.
6. Many data centres have signed corporate PPAs in Ireland. A corporate PPA with "over-build", wind, solar and 2hr battery can achieve max. c.80% matching/hedging/decarbonisation, with additionality, within Ireland.

The "missing" 20% is really important for peak capacity planning, hedging, security of supply. If you close this gap you have achieved a "100% 24/7 PPA".

https://www.friendsoftheearth.ie/assets/files/pdf/data_centrres_and_the_carbon_budgets_-_prof_hannah_daly_dec_2024.pdf (SEAI energy scenario "With Additional Measures" required to achieve carbon budgets to 2030.)
https://enterprise.gov.ie/en/news-and-events/department-news/2022/july/new-statement-on-the-role-of-data-centres-in-irelands-enterprise-strategy-published.html

What storage can close the 20% gap?

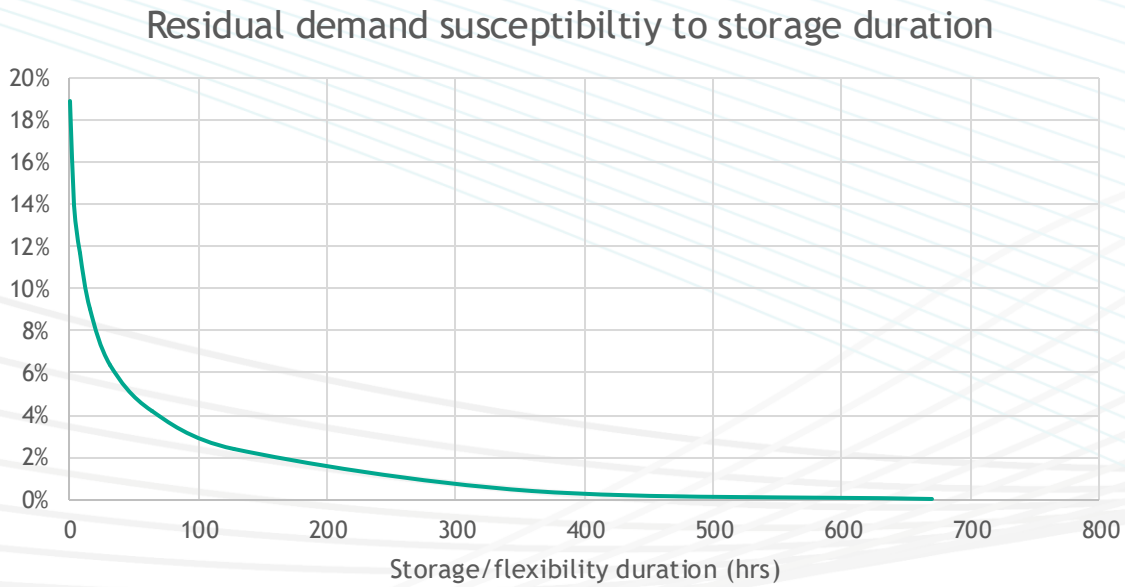
5+2 GW	offshore wind
8 GW	solar
9 GW	onshore wind
2.2+ GW	interconnection
20 GWs	low carbon inertia

National targets
2030 RES-E 80%
(EirGrid SOEF1.1)

The 2030 renewables only system above (peak 7GW) matches 80% demand, but has a surplus of c.45% energy, and a deficit ("Residual Demand") of around 20%. Storage/flexibility of varying duration can shift the surplus to the deficit.

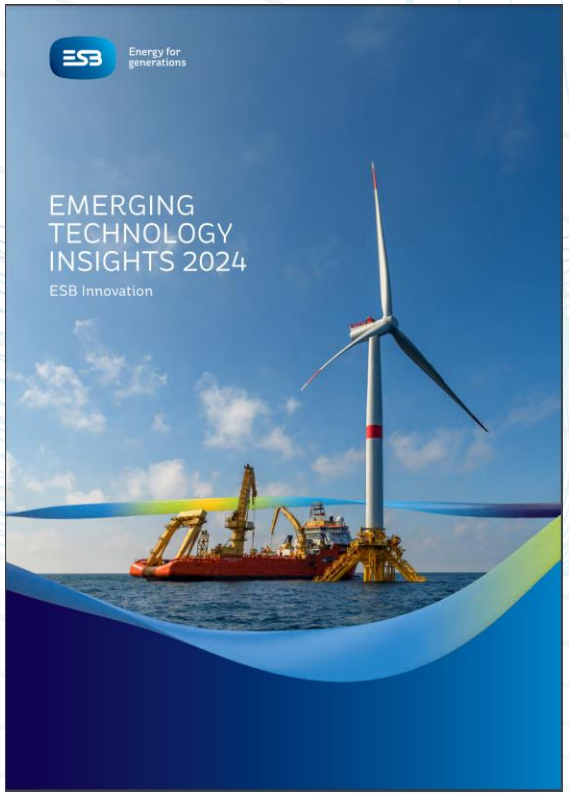
Ireland would achieve 100% energy independence in its electricity system, simply by adding Long Duration Energy Storage (LDES).

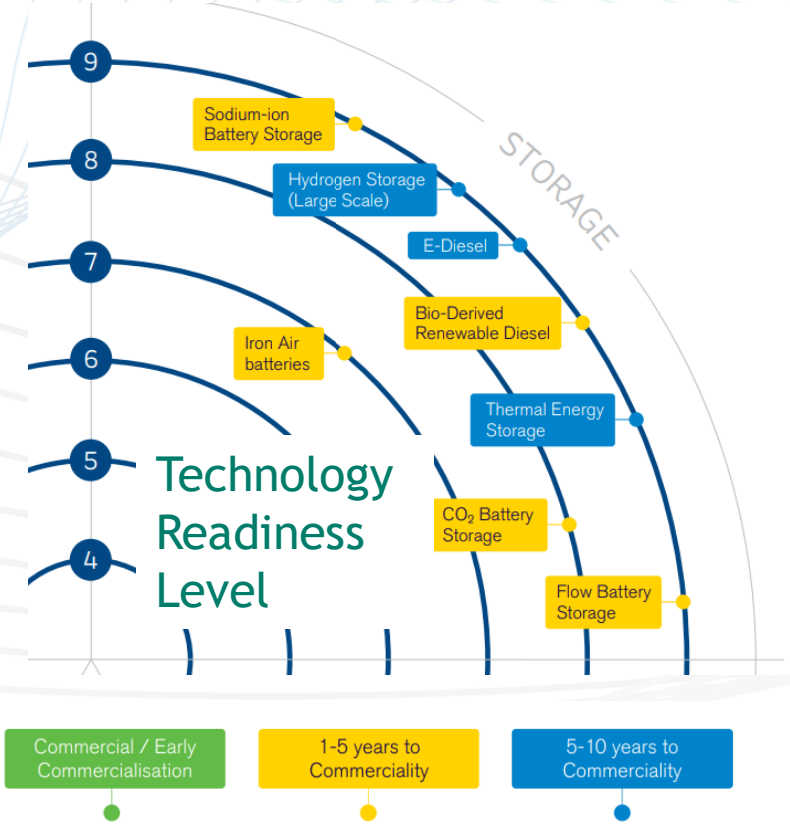
Ireland (and our data centres) would no longer be exposed to a gas price crisis as caused by the Ukraine war.



Low/zero capacity value	High capacity/resilience value
Medium utilisation	Very Low utilisation
Mid-merit	Peaker
Medium decarbonisation	Low decarbonisation

LDES technology options





Project Pipeline Ireland

- "Kestrel" project up to 90 days storage in depleted gas field in development
- First Iron-Air 100hr battery permitted in Co. Donegal
- Net Zero Energy developing 620MW x 100hr storage
- ~~Silvermines pumped hydro has PCI status, Co. Tipperary (5hrs)~~
- ~~Carbon dioxide "Energy Dome" in planning Co. Offaly (c.12hrs)~~
- ~~10GW Li-Ion batteries (4-8hrs) in pipeline~~

https://cdn.esb.ie/media/docs/default-source/innovation/emerging-technology-insights-2024.pdf

LDES role in zero fossil system/PPA

An cost-optimised zero carbon system or PPA:

	Energy Split	Capacity (GW)	Cost split
Renewables	80%	22	65%
Interconnectors	8%	2.2	6%
Li-Ion	7%	4.5	8%
LDES	4%	7	12%
Green Peakers	1%	7	9%
Fossil	0%	0	0%
	100%	43	100%

- LDES and green peakers aren't so much about energy and decarbonisation.
- Rather they are critical to peak generation capacity, security of supply, self sufficiency, isolation from international fuel price crises.

But wait, couldn't you get by with:

RES + Interconnectors only (Supergrid)? – Technically possible, but is it too much to subcontract our energy to our neighbours completely?

RES + Li-Ion only? – Li-Ion uneconomic in 2030 over 10hrs.

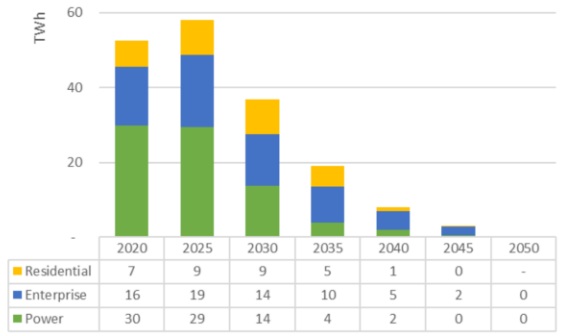
RES + LDES only? –Possible, but more efficient to let Li-Ion (85% round trip efficiency) do the heavy lifting on energy. Still need >150hr.

RES + Peakers only? – Too much liquid fuel to procure within Ireland (20% of 40TWh, Chat GPT says biodiesel would require 5.3m acres, which exceeds Ireland's total arable land of 3.6m acres. And total electrical load could double to 80TWh by 2050.)

Could we not use the gas network on CCS/hydrogen/biomethane to feed the peakers or existing fossil plant?

What future for the gas network?

A carbon budget compliant fossil gas forecast from Marei (2022)



	Today	Future?	
	2024	2035	
Throughput (TWh)	52	19	Carbon budget compliant
Carbon price (€/t)	56	100	Irish carbon tax
Cost of 1.5% leakage	-	738	EU Methane Strategy
			Shrinkage 0.5%, AD 1%
Tx RAB (€m)	1,522	2,522	Kinsale or FSRU
Dx RAB (€m)	1,645	1,645	From CRU
WACC	3.6%	6.0%	Taxpayer or bondholder?
Asset life (25-50yrs)	40	15	Accelerate depreciation
Tx Opex €m/yr	124	206	Scaled up for Kinsale and FSRU
Tx RAB €m/yr	72	260	Recalculated
Tx New capex	55	-	Presume stop investing
Dx Opex	89	89	Unchanged
Dx New Capex	58	-	Presume stop investing
Dx RAB	78	169	Recalculated
Total annual cost (€m)	476	1,462	
Total cost (€/MWh)	9.2	77	

1. UAG (Unaccounted for Gas) on the gas networks – leaks are proportional to pressure not throughput. So 0.5% today could be up to 5% if throughput is 10x reduced*. GWP_{20} of methane is 82x, so more than 3.2% leaks cause as much global warming as burning the other 96.8%. The worst leaks are outside of the control of the gas network operators (e.g. LNG at over 7% making it dirtier than coal. Biomethane has a very wide range depending on the study). At the consumption end, gas recips for example can "slip" 2% methane, but gas turbines do not. A methane tax is in our view inevitable.

2. Risk of uncontrolled self-reinforcing cost spiral – more cost, less customers, more cost….

3. The fossil gas network needs new storage/flexibility and strategic reserves costing €bns. And that's before building new hydrogen networks, also €bns.

Is it economic to maintain a large, leaky, expensive gas network to handle small volumes of biomethane for green peakers?
(Hydrogen is separate question, needing new network).

https://www.marei.ie/wp-content/uploads/2022/12/Friends-of-the-Earth-Research-Report.pdf

- Leaks might reduce if premises are disconnected as throughput reduces and it turns out the leaks were at the premises end of the system, or if the distribution system (or parts there-of) was decommissioned.
- The RAB calculation is illustrative only, a full analysis would require detailed modelling

https://www.biogastradeshow.com/why-now-is-the-time-to-tackle-biogas-leakage/
https://www.cru.ie/publications/27824/
https://arrow.tudublin.ie/cgi/viewcontent.cgi?article=1090&context=engschmecart
https://data.oireachtas.ie/ie/oireachtas/parliamentaryBudgetOffice/2024/2024-02-29_carbon-tax-series-part-1-of-3-what-is-the-carbon-tax_en.pdf
https://energy.ec.europa.eu/news/new-eu-methane-regulation-reduce-harmful-emissions-fossil-fuels-europe-and-abroad-2024-05-27_en

A 24/7 Green Power Solution

Our Solution for data centres (and the entire system?) post 2030

- An optimised portfolio of wind/ solar/ Long Duration Energy Storage (LDES) sized to provide 24/7 cover to a flat load
- 220kV transmission-connected with c. 620MW import and export for 50-150hrs (cost optimisation point).
- The LDES would not be connected to the fossil gas grid
- No hard requirement to be "proximate" to load or wind or energy parks or valleys.
- A 24/7 CfD/PPA structure would link the ‘additional’ renewables, storage and flat demand commercially.
- Such a PPA can rightly claim to be neutral in terms of both power (MW) and energy(MWh) and carbon
- Each plant would store **30-50x more energy than Turlough Hill**, on a smaller footprint.

Feasibility

- All elements of the LDES plant are proven technologies, commercially available today from Tier 1 suppliers
- The solution could operate within existing Irish electricity market frameworks (though network tariffs hurt).
- We have secured and are developing multiple full-scale sites around Ireland
- Planning submission on first site Q3 2025, 1-2 year permitting, 4-5 years construction, so deployed by 2030-2032

National network model 2030

Hourly resolution dispatch, full network DC flow, benchmarked against ECP, optional capacity expansion.

7/8/9GW RES-E, plus 6.3GW LDES, minus all fossil generation

Site Number	Site Name	Node	County	220kV Sub or line	MW
1	Site 1	Node 1	County 1	Sub 1	700
2a	Site 2	Node 2	County 2	Line 1	700
2b	Site 2	Node 3	County 2	Line 2	500
3	Site 3	Node 4	County 3	Line 3	700
4	Site 4	Node 5	County 4	Sub 2	700
5	Site 5	Node 6	County 2	Sub 3	700
6	Site 6	Node 7	County 5	Sub 4	700
7	Site 7	Node 8	County 6	Sub 5	1400
1	Site 1 NI	Node 9	County 1 NI	Sub 6	700
2	Site 2 NI	Node 10	County 1 NI	Sub 7	700

Complete energy independence, 100% RES-E, 100% decarbonisation, minor dispatch down

	Solar	Wind Off	Wind On	RES
	System Level			
Available (GWh)	9679	31237	32540	73455
Oversupply (GWh)	249	544	347	1140
Curtailment (GWh)	83	286	355	724
Constraint (GWh)	224	976	3144	4344
Dispatch Down	557	1806	3846	6208
Oversupply%	2.58	1.74	1.07	1.55
Curtailment%	0.86	0.92	1.09	0.99
Constraint%	2.32	3.12	9.66	5.91
Dispatch Down%	5.75	5.78	11.82	8.45

vs c.40%

The study year is **2030.** ▫ Full hourly resolution 1 year DC network flow model with generation dispatch and interconnection modelled. All fossil plant removed. The demand in Ireland (including data centres) **is 46.6 TWh** (All Island demand 56.3 TWh) ▫ The MW capacity of each NZE LDES site represents both import and export. ▫ The renewable portfolio consists of **7 GW of offshore wind generation, 8 GW of solar generation and 9 GW of onshore wind** generation per Ireland's Climate Action Plan targets for 2030. ▫ The wind generation capacities are sited at existing / proposed projects from Energy Reform's master list which was used to validate the model against ECP 2.1 constraint reports. ▫ For solar, onshore and offshore wind generation, the capacity is higher than either the ECP dataset or the Energy Reform master list. Existing datasets have been used to expand generation capacity as far as possible. But capacities at sites close to the NZE plants have also been scaled up to meet the target of 7/8/9 GW. Grid is per SOEF 1.1 from EirGrid. **Full data centre growth accommodated per EirGrid forecast for 2030.**

Irelands security of supply

- Ireland is currently not even N-1 compliant at times, i.e. the loss of one of the two gas sub-sea pipelines could result in load shedding (electrical and/or gas). Repair times far exceed the **5 days liquid fuel backup** at our CCGT plant.
- The loss of the compressor station or both sub-sea pipelines (e.g. deliberate sabotage) would result in losing electricity generation for the repair period (some months), costing around half our GDP (ESRI 2010).
- The FSRU was inevitable, a necessary stopgap measure. But it must be temporary, because LNG is far from secure in an EU wide crisis, and dirtier than coal.
- There must now be a serious doubt over relying completely on Corrib, Kinsale or any other offshore asset as Ireland's strategic reserves. (They could still however offer very low cost long duration flexibility.)
- Our modelling shows that c.350hrs (**14 days) of liquid fuel storage** in the "car park" beside existing (or new) gas turbine fleet will meet all hours of electricity demand over 40 years in a system with only renewables, short duration and long duration storage. An annual "top up" from NORA is assumed. Road traffic movements have been modelled and look manageable. Ships may be useful too. Any contribution from electricity interconnectors would be a bonus, but not required.
- The liquid fuel could be anything that a CCGT can burn, including methanol (green or brown), e-SAF, biodiesel, hydrogenated vegetable oil, e-diesel, e-petrol, or, if you don't mind about a few % carbon emissions, traditional gas-oil (diesel). All these fuels are expensive, and each brings its own challenges, but the volumes burnt are tiny, so price is not a showstopper, and there is good optionality in the range. Indeed we would suggest using a mix.

Key messages

1. We can get to a 100% decarbonised and 100% self sufficient, more reliable power system than today, with the same renewables and grid as already planned for our 2030 RES-E 80% system, simply by adding LDES of 50-100hr.
2. Large energy user grid and planning policy, as it stands, is disjointed and dysfunctional. The LEU Proposed Decision on connection policy is not compatible with Ireland's carbon budgets. 24/7 corporate PPAs (with 50-100hr LDES) offer a way to connect data centres without impacting Irelands capacity margin, gas imports, carbon budgets or power prices.
3. Co-location/proximate/clustering/valleys is not actually necessary. Network flow studies demonstrate that LDES smooths out power flows, makes better use of existing grid, allowing LEUs, renewables and storage all to select their own optimal locations (at least outside Dublin).
4. Adding LDES at offshore DMAP connection points would create 2-3x grid capacity to accept new offshore wind without building new grid infrastructure. The ambitious new DMAP plan is unlikely to succeed without LDES.
5. The wind capture and dispatch down risks of building offshore wind without flexibility such as LDES will result in spiralling PSO costs, with big political and reputational risks, even if individual investors are shielded by RESS.
6. The gas network may not present an economic or secure solution for fuelling peakers. But 15 days liquid fuel works.
7. It is time for Ireland to set a national target to achieve a 100% renewables system (which is de facto 100% self-sufficiency and 100% decarbonised) by the mid-2030s.

Coffee: Discussion & Reflection

Recommence at 15:20

Members Insight

How technology and collaboration at a new Data Centre can support fault ridethrough capability

Shaping Advisory Council Meeting, Dublin

20th May 2025

Graeme McWilliams
Advisory Council Member

Cormac Nevin
Head of Energy Systems,
Echelon DC's

EirGrid SONI

Thank You - Let's Reflect

Thank You!

A message from our co-Chairs

Liam Ryan & Gerard Carlin

Thank You