

Rialtas na hÉireann Government of Ireland

Decarbonised Electricity System Study Launch

Department of Climate, Energy, and the Environment and

Sustainable Energy Authority of Ireland

Agenda Item	Institute	Time
Welcome and Opening Address: Policy Context	DCEE	14:00
SEAI Research Coordination	SEAI	14:15
DESS Overview and Workplan	SEAI	14:25
DESS Stakeholder Engagement	SEAI	14:45
Q&A		14:55
Break		15:10
Assessment of Power Sector Technologies for Portfolio Building	COWI-RPS	15:25
Q&A		15:55
Closing Remarks	SEAI	16:15
End	16:20	





Rialtas na hÉireann Government of Ireland

Decarbonised Electricity System Study

Philip Newsome
Principal Officer, Renewable Electricity Section, DCEE
30 June 2025

Climate & Energy Policy 2030-2050







Climate Action Plan 2025





EN

The European Green Deal

Carbon Budget Proposal Report	
2024	Number 32 of 2021
Rialtas na hÉireann Government of Ireland	Climate Action and Low Carbon Development (Amendment) Act 2021 ——————————————————————————————————
Sectoral Emissions September 2022	Ceilings

Target	Year
51 % reduction in energy-related Greenhouse Gas Emissions relative to 2018	2030
75 % reduction in electricity-related Greenhouse Gas Emissions relative to 2018	2030
EU 2040 reduction target in net Greenhouse Gas Emissions relative to 1990	2040
Carbon Neutral Economy	2050
Net-Zero Electricity System	2050

Rialtas na hÉireann | Government of Ireland

Electricity Policy Context



Renewable Led System

Reliability

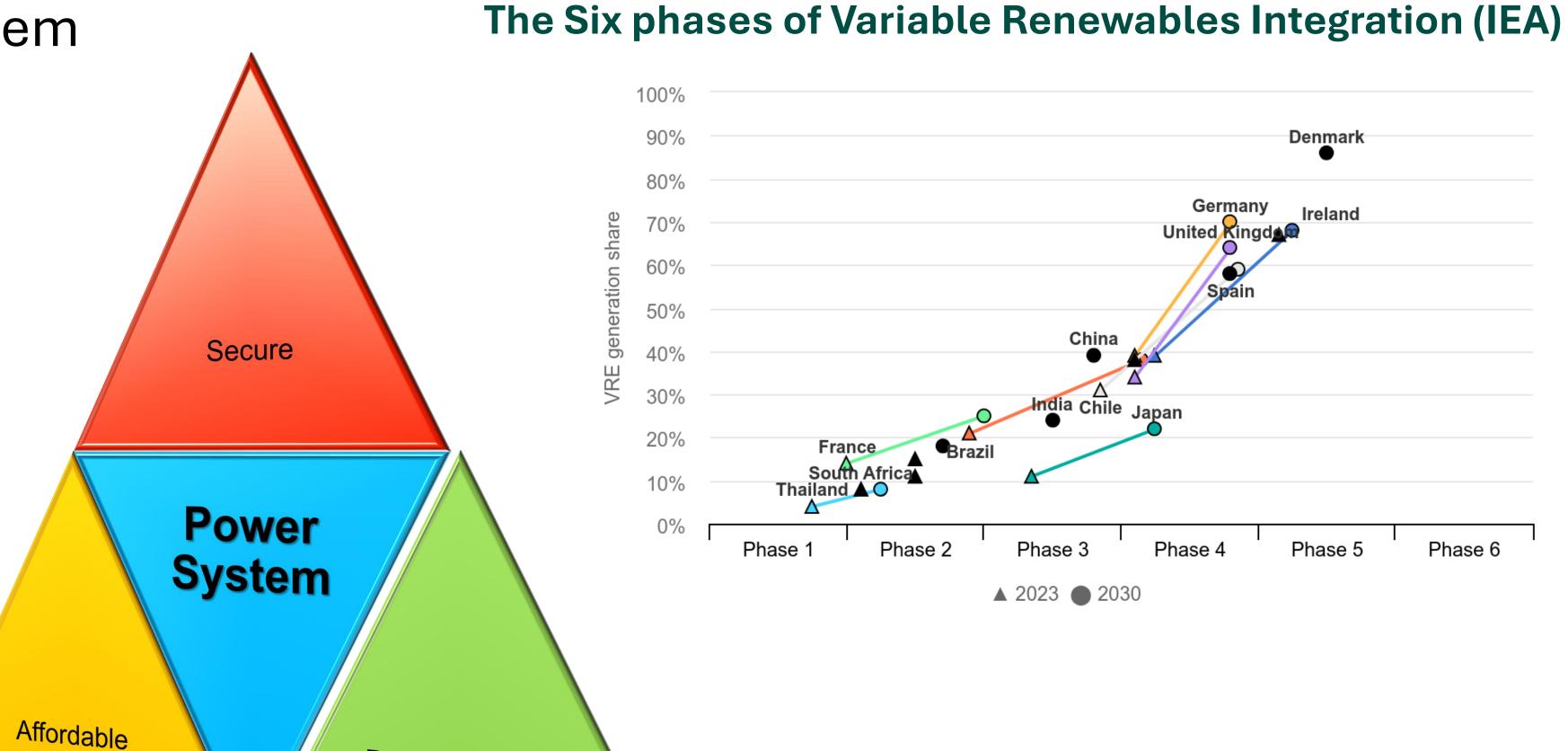
Flexibility

Affordability

Demand Growth

Grid Delivery

Interconnection



Decarbonised

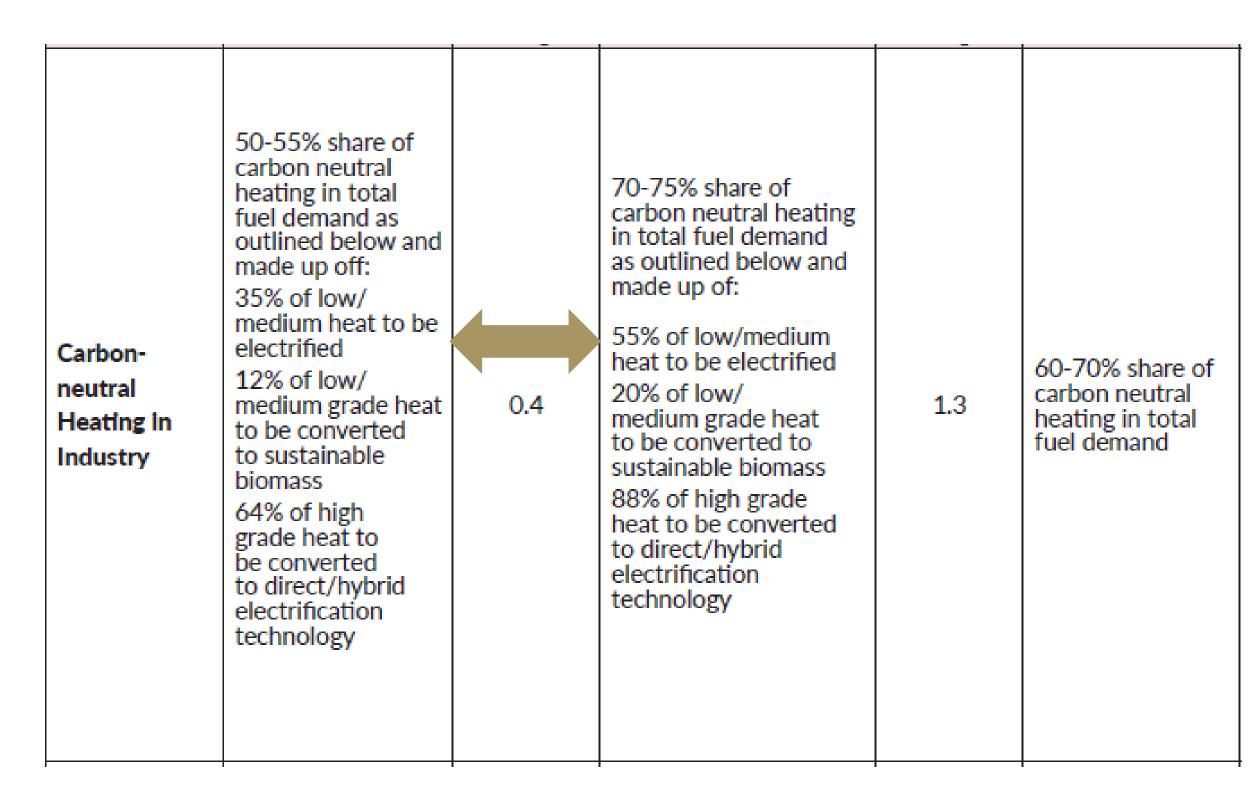
Electricity Sector Supporting Decarbonisation



		Private Car Fleet EV share of total passenger car fleet (30%) EV share of new registrations (100%) 845,000 Private EVs ⁴⁶
Fleet Electrification	 175,000 passenger EVs 20,000 commercial vans 700 low-emission HGV 300 EV buses in PSO bus fleet Expansion of electrified rail services 	Commercial Fleet 20% EV share of total LGV fleet. 95,000 commercial EVs 30% ZE share of new heavy duty vehicle registrations 3,500 HGVs
		PT Services 1,500 EV buses in PSO bus fleet; Expansion of electrified rail services.

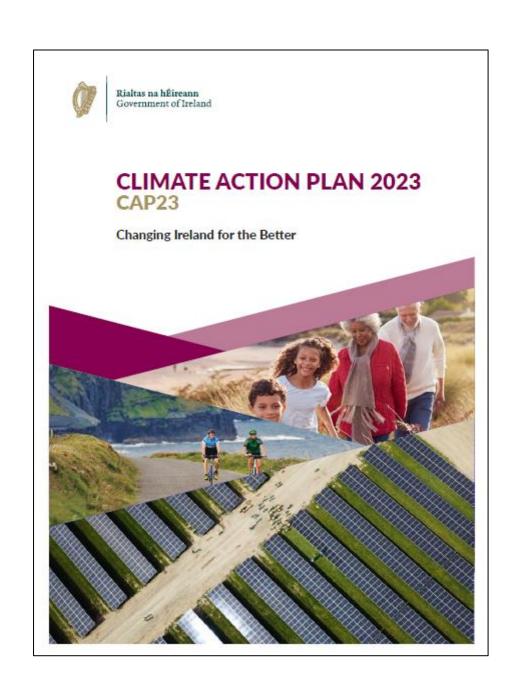
Standards and Regulations	All new dwellings designed and constructed to NZEB standard 170,000 new dwellings using heat pumps	0.338	All new dwellings designed and constructed to ZEB standard 280,000 new dwellings using heat pumps	0.4	Minimum Energy Performance Standards for all dwellings
National Retrofit Plan	120,000 dwellings retrofitted to BER B2 cost optimal or carbon equivalent 45,000 existing dwellings using heat pumps	0.9	500,000 dwellings retrofitted to BER B2 cost optimal or carbon equivalent 400,000 existing dwellings using heat pumps	2	Increased number of dwellings retrofitted and using heat pumps in line with activity by 2030 and minimum energy performance standards for all dwellings

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Decarbonised Electricity System Study



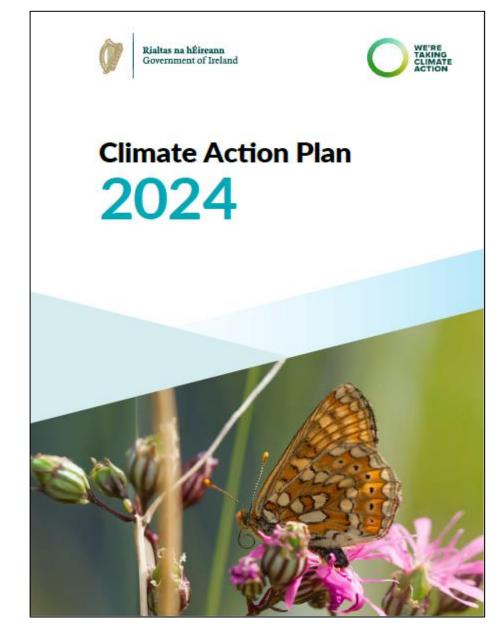


Climate Action Plan 2023 – 12.3.4 Further Measures

The third carbon budget (2031-2035) is expected to require continued electrification of industry, the built environment, and transport, leading to substantial electricity demand growth which will need to be almost fully decarbonised. In that context, **SEAI will report to the Department of the Environment, Climate and Communications ... on an evidence-based decarbonisation pathway for the electricity system to net zero, in order to provide support future iterations of the Climate Action Plan; inform future carbon budgets; and provide a basis for a long-term electricity system development strategy to achieve our 2050 objective.**

Climate Action Plan 2024, Action EL/24/3

Complete a stakeholder consultation for an evidence-based decarbonisation pathway for the electricity system to net-zero and support future iterations of the Climate Action Plan.

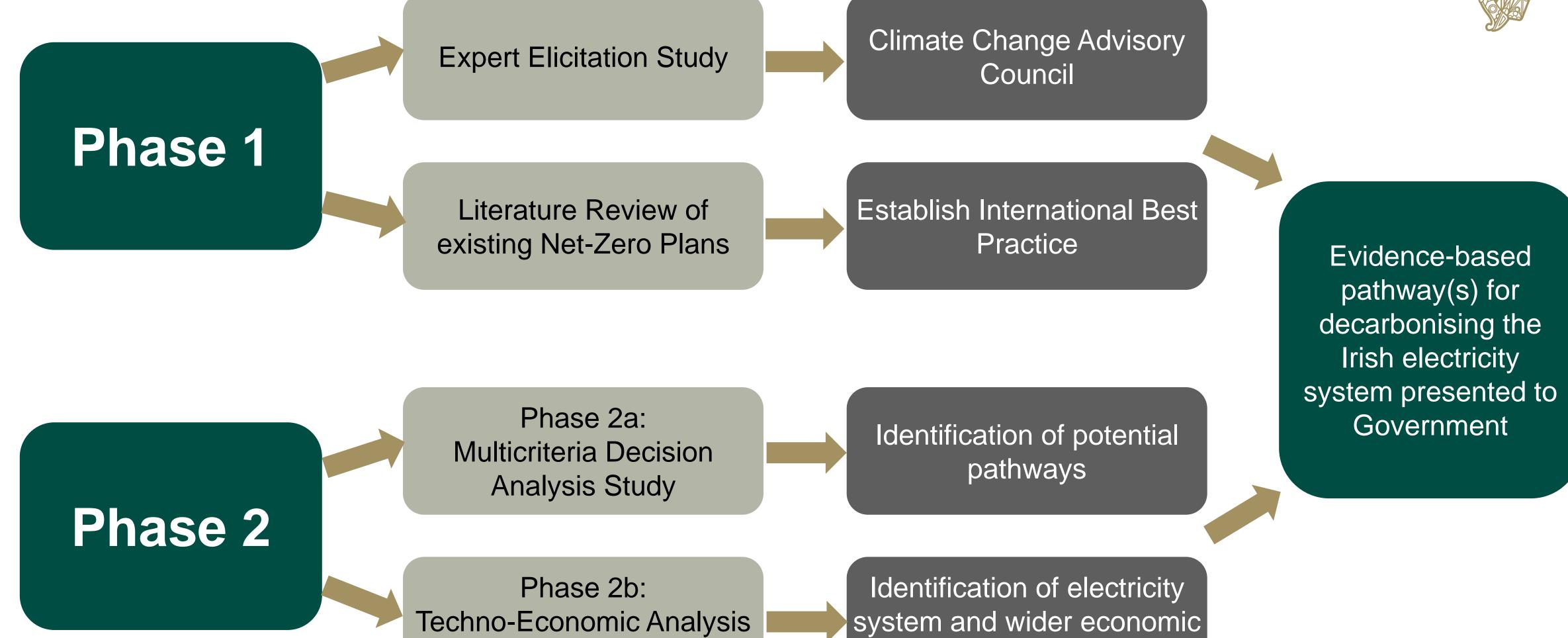


Decarbonised Electricity System Study

Techno-Economic Analysis

Study





impacts

Decarbonised Electricity System Study



Study Launch, 30 June 2025



Overview

Context - Margie McCarthy

DESS approach & workplan - John McCann

Stakeholder engagement – JP Roux

Q&A





Context

Margie McCarthy, Director of Research & Policy Insights



SEAI is Ireland's national sustainable energy authority.

We have supported a significant range of activities across energy users and sectors, from home energy efficiency upgrades to ocean energy research, driving the reduction and replacement of fossil fuel usage.





SUSTAINABLE ENERGY ACT, 2002

Functions of Authority.

6.—(1) The functions of the Authority shall be—

- (a) to promote and assist environmentally and economically sustainable production, supply and use of energy,
- (b) to promote and assist energy efficiency and renewable sources of energy,
- (c) to promote and assist the reduction of greenhouse gas emissions and transboundary air pollutants associated with the production, supply and use of energy,
- (d) to promote and assist the minimising of the impact on the environment of the production, supply and use of energy,
- (e) to promote and assist research, development and demonstration of technologies connected with the foregoing paragraphs of this subsection,
- (f) to provide advice, information and guidance-
 - to the Minister and such other Ministers or bodies as the Minister may direct, and
 - (ii) to energy suppliers and users,
 - relating to the matters specified in the foregoing paragraphs of this subsection.

- (2) The Authority shall have all such powers as are necessary for or are incidental to the performance of its functions under this Act, including—
 - (a) co-operating with the Central Statistics Office and acting as an agent of that Office in relation to matters related to the functions of the Authority,
 - (b) the compilation, extraction and dissemination of information and projections relating to energy production and use (including implications relating to the sourcing, transformation, transmission, distribution and emissions thereof),
 - (c) the licensing, regulation and control of activities related to the functions where directed by the Minister from time to time,
 - (d) the initiation, development, administration, participation in and promotion of schemes and programmes of action,
 - (e) the promotion of and assistance with participation in international programmes,
 - (f) the provision of assistance in the co-ordination of activities carried out in the State related to sustainable energy,
 - (g) the assessment of energy technologies and markets for the purpose of promoting best practice,
 - (h) encouraging the establishment and development of companies involved in the provision of services,
 - (i) the exchange of information with organisations outside the State and participation in international activities,
 - (j) representation of a Minister of the Government at meetings of international bodies where requested to do so by the Minister,

in connection with the matters referred to in subsection (1).

Modus Operandi – Policy support

SEAI, as the authority under the sustainable energy act, 2002, supports DCEE in its policy formulation mandate

National Heat Study (Feb 22)

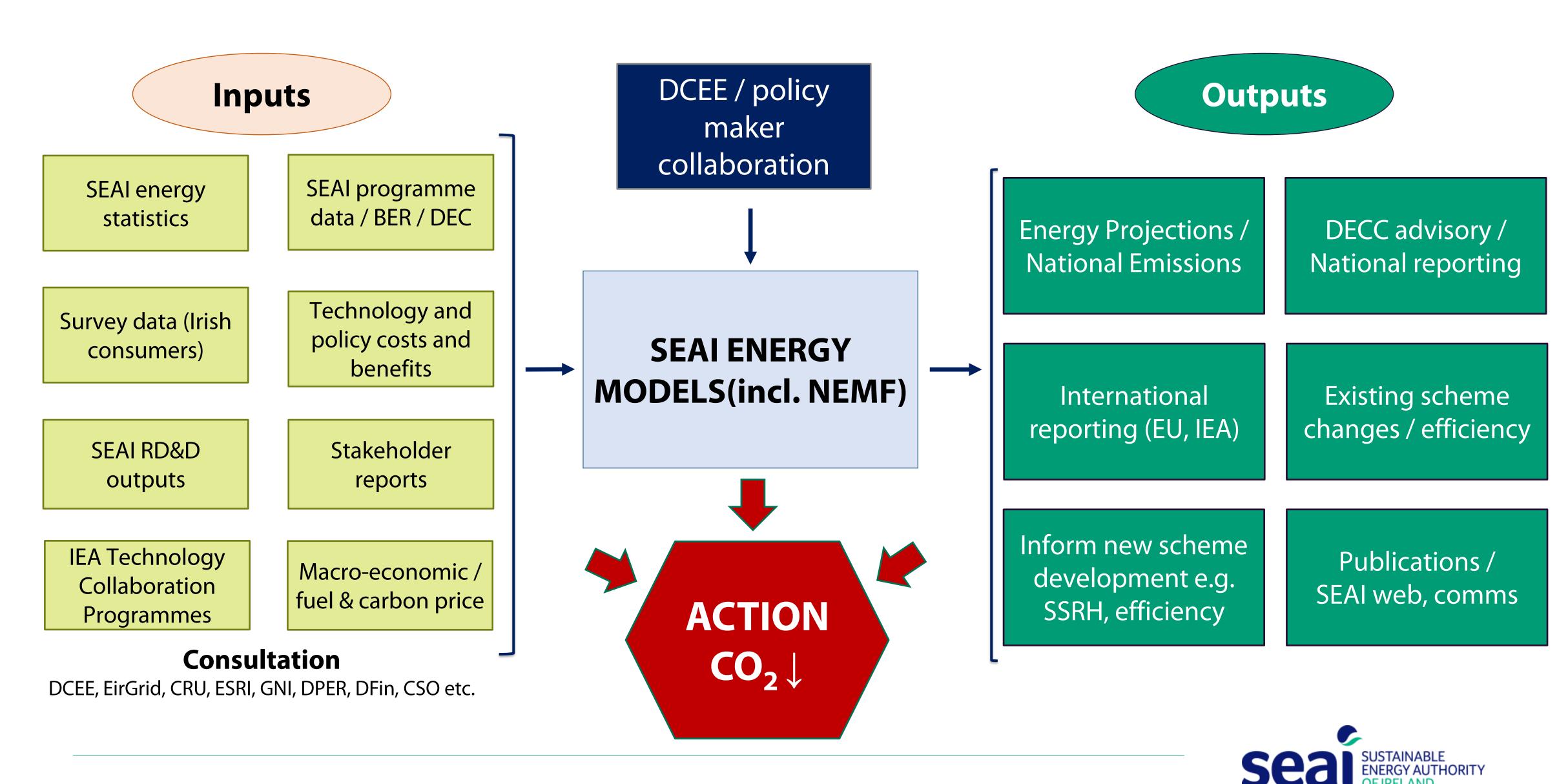




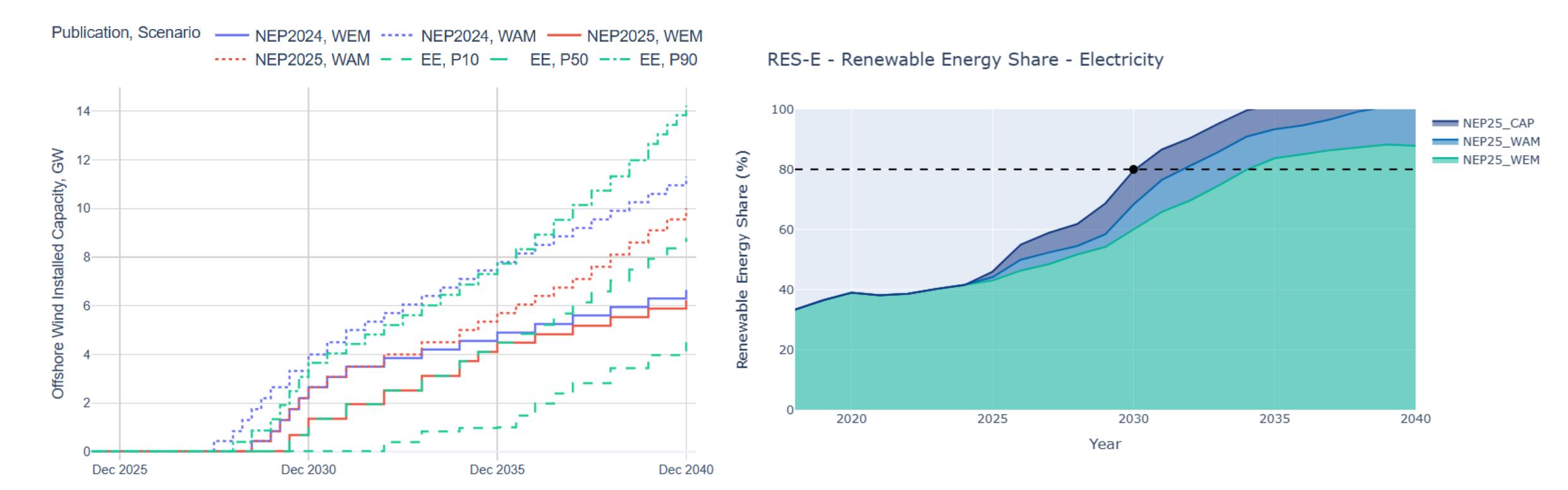
- District Heating National Plan
- Heat & Built Environment Taskforce
- Heat Bill and Heat Policy Statement
- Bioenergy Pathways
- Sectoral analysis including solutions for industry and commercial heat
- SEAI Programme delivery and support



SEAI Energy Modelling - informing policy and action



National Energy Projections (NEP) 2025



- Delay of renewable energy deployment from DESS Expert Elicitation (EE) informed the NEP2025 scenarios, resulting in a reduction in projected RES-E by 2030. DESS will build on evidence and risk-assessed projections for 2030 starting point.
- Demand management critical to progress toward renewable share and emissions targets, energy security and affordability of electrification across sectors

Review of net zero studies

Recommendations:

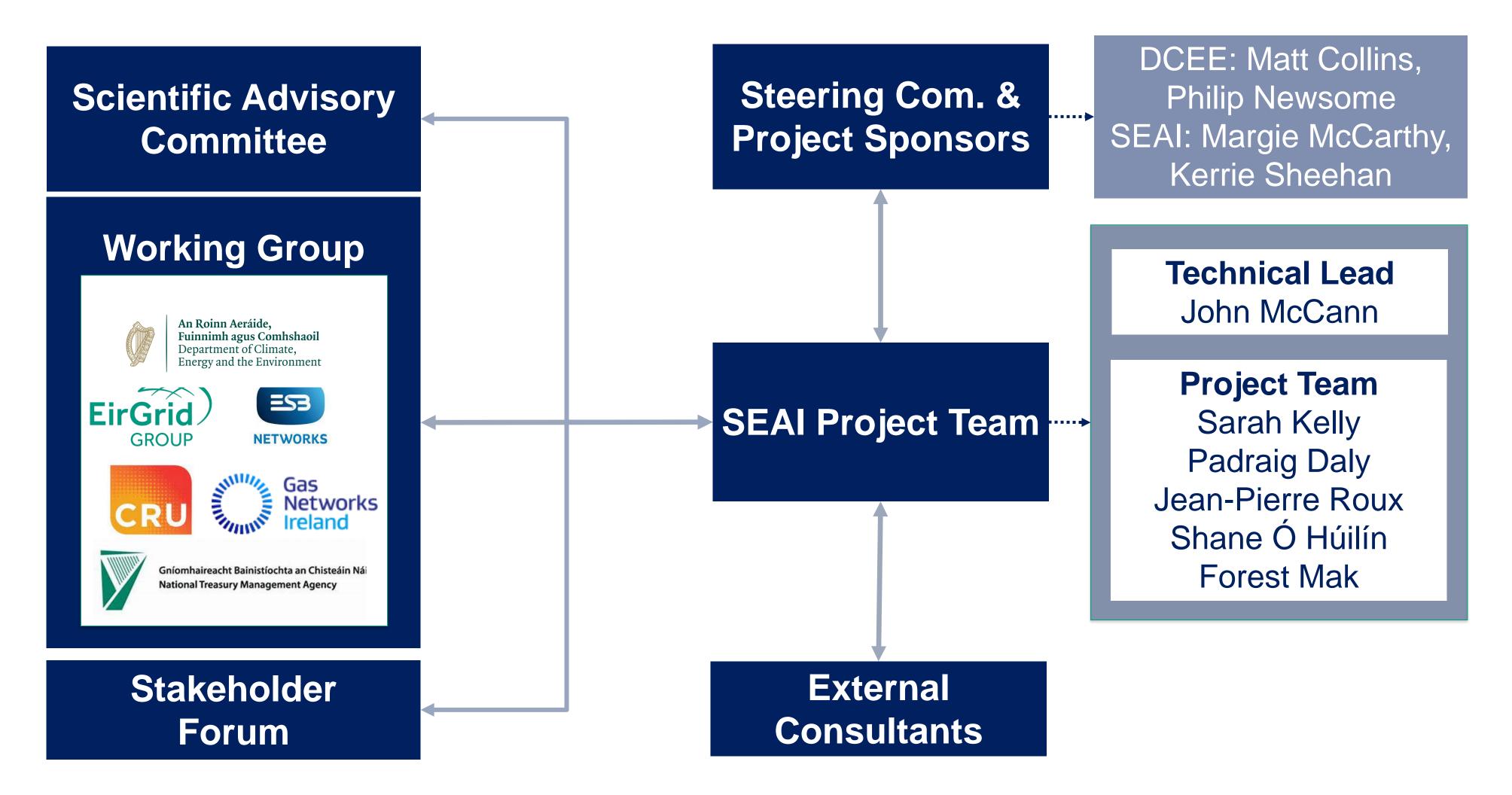
- Energy system integration: Capture interactions between electricity, gas, heat, and transport sectors
- System flexibility needs: Include high temporal resolution in investment models
- Network: Detailed modelling to estimate transition costs accurately
- Security of supply: Comprehensive adequacy assessments over multiple weather years
- System services: Consider stability and ancillary services in future system planning
- Capturing key uncertainties: Scenario development and sensitivity analysis to address uncertainties in technology costs and adoption rates

Institute	Temporal Resolution	Energy System Integrat- ion	Power System Portfolio	Methodol ogical Detail	Seasonal Storage	Short- term Flexibility	Network Detail	Resource Adequacy	Cross Border Flows	Stability	Geographi cal Scope	Temporal Scope
CCC		0		?		?		9			country	2035
CER	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0					套				country	2020
EirGrid*	?	0			***	****		9			country	2035 🗯 2050
Energinet	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0								**** **** ****	country	2030 2035
ENTSO	/ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0									continent	2025 🗯 2050
EPRI	, 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0				?		9			country	2020 🖘 2050
IEA		0			•••	***		9			world	2020 🖘 2050
LBNL*	?	0					套		0	8	country	2020 🗯 2035
NREL		\bigcirc			9-00 -00 -0-0		食		?		country	2020 🗯 2035
OFGEM	00 00 00 00 00 00 00	\bigcirc			?	****	† 食	?	?		country	2020 🗯 2050
PU	00 00 00 00 00 00 00 00 00 00 00 00 00	\bigcirc						0	?		country	2020 🗯 2060
TransnetB W	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0				?				9-90 900 90-90	continent	2020 2050
UCC	?	0			?	?	?	9	0		country	2020 🗯 2050

^{*} These studies have a clean energy target rather than net zero



A partnership model to deliver DESS





The study will answer the following policy questions

- Pathways
 - What are the viable pathways?
- Timelines
 - By when can the viable pathways deliver decarbonisation?
- Cumulative emissions
 - What are the emission trajectories on route to decarbonisation goals?
- Economics
 - Which pathways are affordable? (=> not self-defeating)
- Policies for implementation
 - What are the policy priorities to support implementation of viable pathways?



DESS Approach and work plan

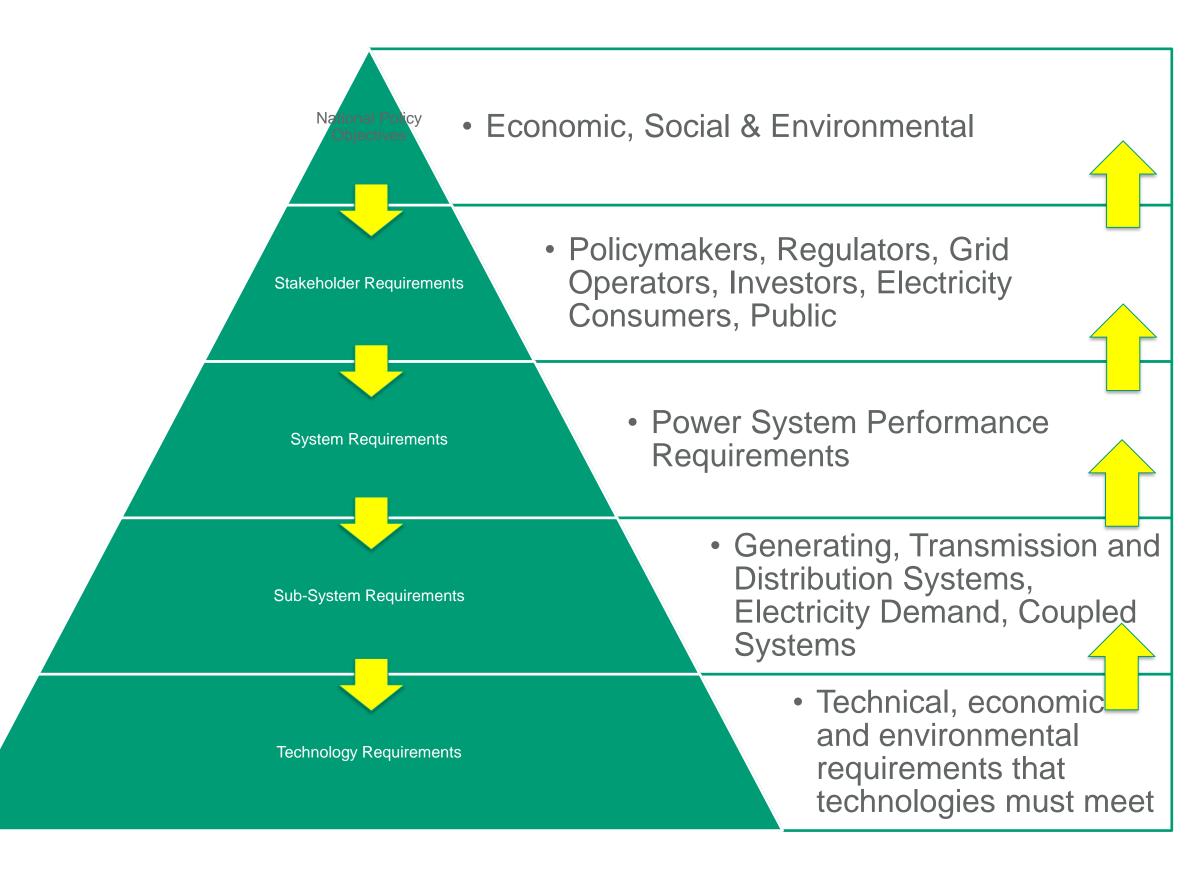
John McCann - Programme Manager, Electricity & Wind



Approach: Problem Framing

- Evidence-based Decarbonisation Pathway for the Electricity System to 2050, that:
 - Provides a basis for a long-term electricity system development strategy to achieve our 2050 objective
 - Supports future iterations of the Climate Action Plan;
 - Informs carbon budgets;
- For each decarbonisation pathway, provide
 - Emissions profiles
 - Plant/technology mixes
 - Policies/legislation/regulations required to support pathway(s)
 - Economic and cost data; e.g. electricity price projections, subsidy costs, cost to exchequer and electricity consumer, distributional impacts
 - Security of supply indicators, investment requirements, import dependency, spatial impacts, enterprise opportunity

Multi-level requirement hierarchy:





Stakeholder Requirements

- Government, ministries, regulators:
 - Emissions trajectory, policy requirements, legislation, regulations, supports, subsidies, market reform, high level spatial planning information, investment requirements, security of supply, price impacts, distributional impacts, (macro-) economic impact, indigenous supply, enterprise opportunities
- TSO, DSO, utilities
 - New infrastructure requirements, location/growth of new generation and demand, generation and demand profiles, proposed new regulation, proposed market reforms, subsidies & supports, cost recovery, impact on system security & reliability, impact on electricity prices and bills, I.T. & other systems requirements, plant exit/repowering, stranded assets
- Investors/Developers
 - Future technology portfolio, investment opportunities, market(s) design, market prices, supports/subsidies, locational opportunities, curtailment and constraint levels, new business models.
- Electricity Consumers
 - Affordable and stable prices, reliability, low GHG emissions, sustainable energy sources, demand side opportunities
 (On- site storage and generation, microgeneration, demand response, co-location, coupling)
- Public (inc. Govt. bodies, NGO's & representative bodies:
 - Climate change addressed, environment conserved, economy supported, negative impacts minimised, engagement on, and input to, future vision, participation in decision making processes



Work to date

Literature review of net-zero studies Phase 1 Qualitative inputs for carbon budget (focussed short term studies) (2024)Building partnership model for delivery with system operators, regulator, DCEE Develop net zero study specification, Procurement of external consultants Commence assessment of technologies and building of Phase 2a portfolios (COWI, RPS) (Q3 2024 – Q2 2025) Commence specifications for high level dispatch modelling to verify portfolios (SEAI) Establishing working group and partnership model for delivery Phase 2b Scoping technical specifications (Q1 2025 – Q2 2025) Detailed scoping of work streams and packages



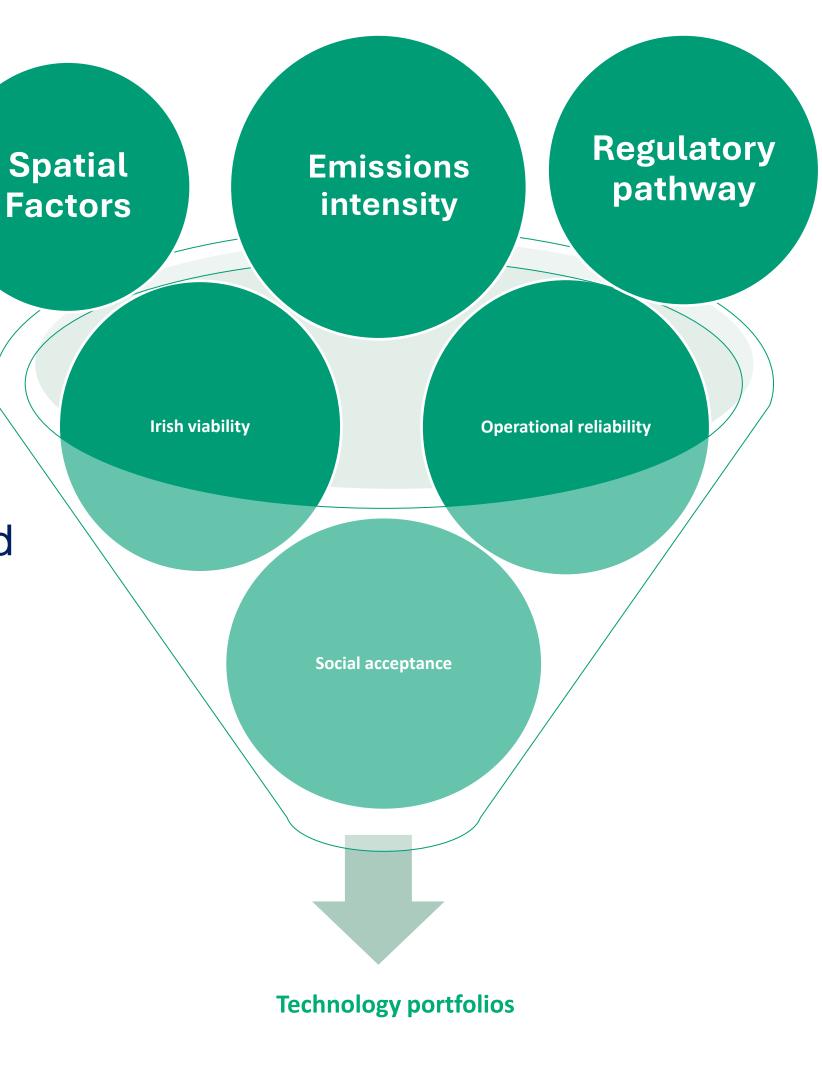
Multi-Criteria Assessment of technologies

MCA (commenced May 2025, completed Q1 2026)

 Assessment of generation, storage and system service technologies to determine viable technology portfolios for subsequent scenario building and modelling

Outputs

- Assessment of technology options against economic, technical, environmental, and socio-political criteria
- Early indication of viable technology portfolios weighted to strategic national interests (competitiveness, sustainability, security)
- Input assumptions to investment and dispatch modelling and scenario building
- Stakeholder review of input assumptions; i.e. technology selection and boundary conditions for scenarios





DESS Phase 2b Overview

WS 2a

WS 2b.3

Multi Criteria Decision Analysis

High Level Study

WS 2b.1

Scenario Development

WS 2b.2

Portfolio Expansion

Distributed Resources

Coupled Systems

Resource Adequacy

Transmission Planning & Security¹

Stability Studies²

Distribution Expansion³

Transm./Distr./Coupled Operation

Work by Others

WS 2b.5

Total System Cost Analysis

Emissions Impact

Economic Impact

Policies/Support Measures

WS 2b.4

Coupled Networks

- ¹ Eirgrid Net Zero Network study
- ² Future work for Eirgrid
- ³ ESB "Networks Networks for Net Zero"& "Capacity Pathways" studies



DESS Stakeholder engagement

Working hypothesis:

Power system change becomes more likely if a critical mass of stakeholders co-produce knowledge that they trust and feel compelled to act upon, even if their self-interest might push against it.

Jean-Pierre Roux – Senior Energy Policy Specialist



Orienting concepts and principles

Post-Normal Science (Funtowicz & Ravetz 1993)

Characteristics of the study context

Uncertain facts: Data and models are incomplete, contested or rapidly evolving

Disputed values: Cultural and political values influence research assumptions and methods

High stakes: Research decisions can have significant consequences

Urgent decisions: Policy makers and stakeholder must act under uncertainty.

Orienting principles

Extend peer community: include a broad range of stakeholders with diverse interests

Participatory quality assurance: test robustness of research through deliberation



Hybrid solutions: find solutions that accommodate trade-offs and expert judgement

Distributed research: conduct trans-disciplinary and application-oriented research

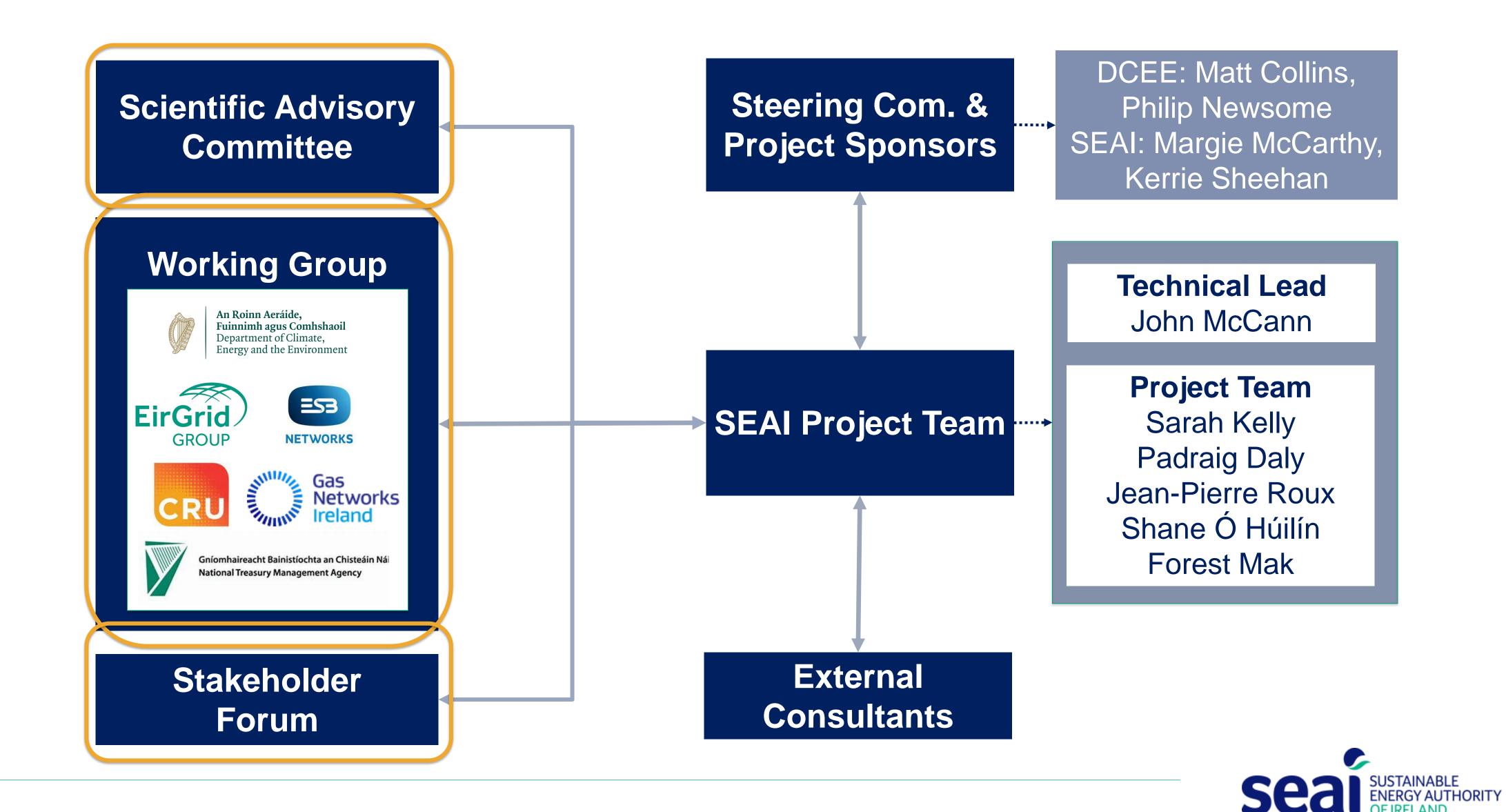


Process design for Post-Normal Science

- Process design: who is 'at the table', when, and why?
- DESS process seeks to internalise knowledge conflicts:
 - data conflicts
 - value conflicts and
 - conflicts of interest
- Process design guides knowledge production
 - Include as many stakeholders as possible who are affected by and implementing sectorial decarbonization plans
 - Stakeholders can:
 - Influence commissioning of research and choice of methods
 - Examine input assumptions, data and draft results
 - Ask for revisions
- The DESS process is time and resource intensive for all involved.
 - Pragmatic solutions to integrate expert opinion/ judgements
 - Discretion of SEAI to open and close deliberation at key 'Decision Gates' based on resource constraints



A partnership model to deliver DESS



Stakeholder Forum Terms of Reference

- A forum for the DESS WG to share study information and discuss stakeholder views on power sector
 decarbonisation pathways after 2030, especially focused on the technical assessment of technologies in
 portfolios, the construction of scenarios, direct power sector impacts, and direct and indirect economic
 impacts of decarbonisation pathways.
- Review and discuss draft research outputs from DESS, including review of methodologies, input assumptions and results.
- Highlight areas of concern that the forum and DESS WG can help to address (related to the general aims of DESS) and inform agenda-setting
- Full TOR and FAQ available here: https://www.seai.ie/renewable-energy/decarbonised-electricity-system-study
- First stage deadline for Expressions of Interest: 7 July



Stakeholder Forum Schedule and Format

- Q3 2025 Q1 2026: focused on Multi-Criteria Analysis (MCA), portfolio building and initial dispatch modelling
- Timing and topics are provisional and time required indicative

Timing	Topic	Format	Time required
September 2025	Criteria weighting workshop: interrogate and weight criteria for assessment	Online	0.5 day preparatory reading0.25 day participation
December 2025	Results Workshop 1: interrogate MCA data and input assumptions	In-person	1 day preparatory reading0.5 day participation
January 2026	Results Workshop 2: interrogate MCA data and input assumptions	In-person	1 day preparatory reading0.5 day participation
January 2026	Results Workshop 3: interrogate portfolios and high-level dispatch modelling results	In-person	0.75 day preparatory reading0.5 day participation
January 2026	Submission of written response to consultation	Online	1 day
		Total	6 days



Thank you. Any Questions?



MCDA overview DESS launch event COVI

Agenda

- 1 Study execution
- 2 Technology catalogue
- 3 Technology selection
- 4 MCDA model
- 5 Criteria
- 6 Portfolio creation



We are COWI and RPS

COWI's expertise:



Buildings and industry

Buildings fit for the future, for people and for the planet.



Renewable energy

Accelerating direct electrification and green fuel production.



Infrastructure

Connecting people through innovation and digitalization.

7,500

COWI have more than 7,500 colleagues working in services related to engineering, architecture, energy and environment.

2022

COWI decided to deselect all new projects exploring fossil energy.

2025

Launch of COWI Ireland

RPS's (Tetra Tech) expertise:



Property



Water



Energy



Defense



Transport



Resources

2023

RPS has been acquired by Tetra Tech, increasing its offering and technical capability

30,000

Tetra Tech has more than 30,000 colleagues.

550

The group consists of 550 offices worldwide.



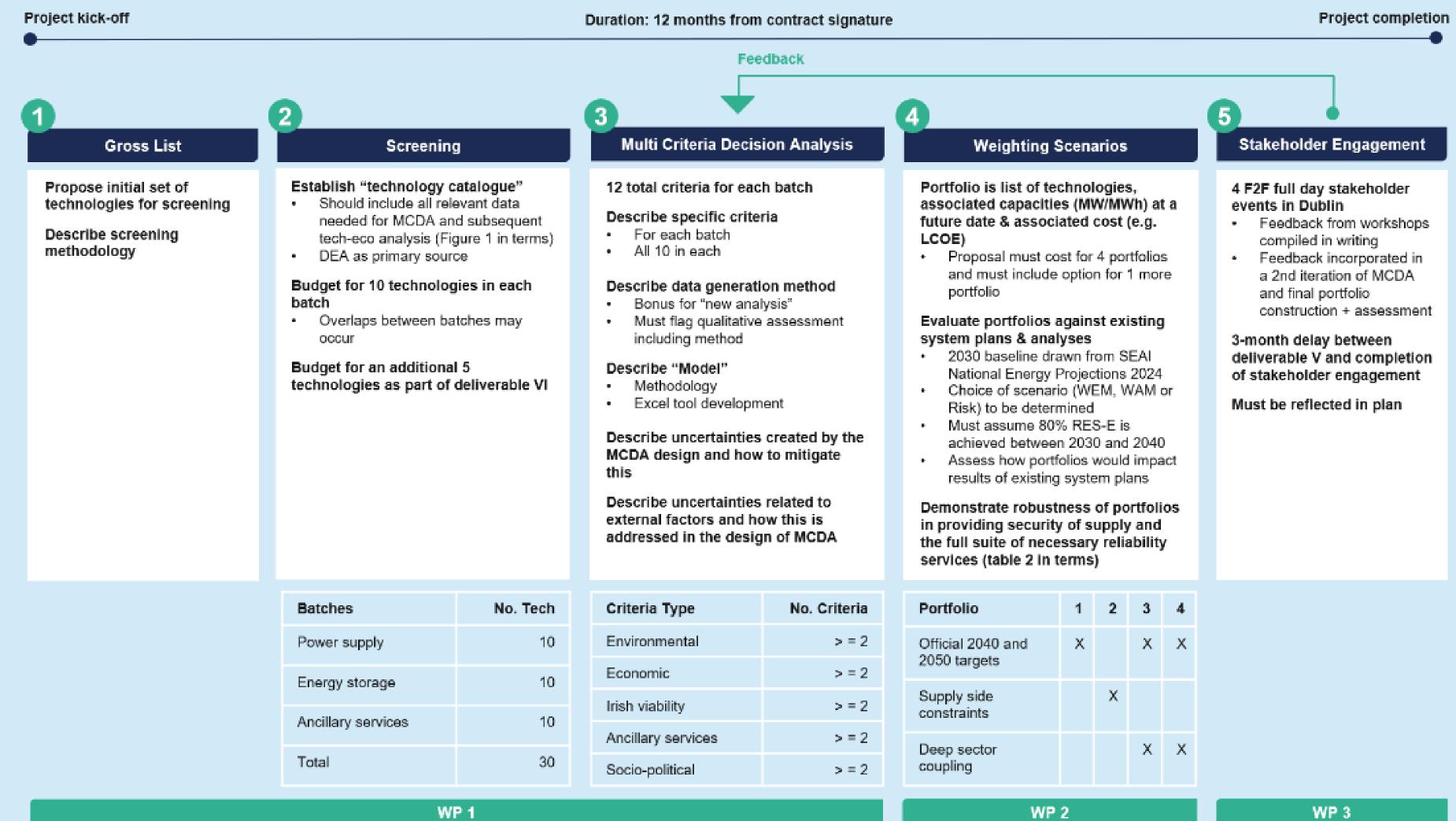
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Study execution



1. Study execution

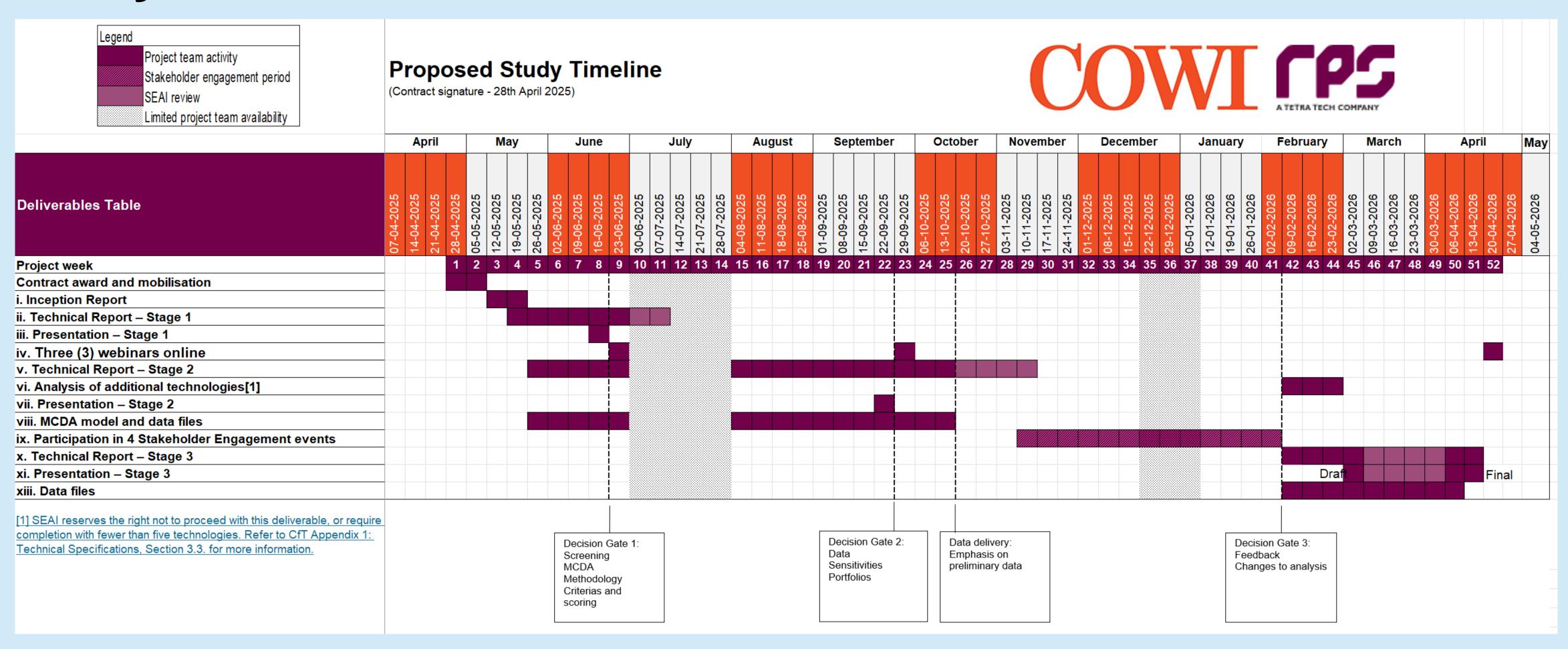
Study design





1. Study execution

Study timeline





Technology catalogue



2. Technology catalogue

Structure of the technology catalogue

Purpose: Comprehensive overview of both technical and non-technical parameters for each technology.

Reference: Based on data, methodologies and data structures from the Danish Energy Agency (DEA) Technology Catalogue.

Key data presented:

- Parameters included for each technology:
 - Technical (e.g., capacity factors)
 - Economic (e.g., CAPEX, OPEX)
 - Environmental (e.g., CO₂ emissions)
 - Social (e.g., social acceptance)
- Clear explanatory notes
- Full references for all data sources

Temporal coverage: Projections for the years 2030, 2040, and 2050.

Key consideration: Focus efforts on generating new data

		2030	2040	2050	2050	2050	Note
Parameter	Unit	central	central	central	lower	upper	-
Energy/technical data							
Generating capacity for one unit	(MWe)	5,0	5,5	6,0	1,5	8,0	A1
Forced outage	(%)	0,02	0,02	0,02	0,01	0,05	В
Planned outage	(%)	0,00	0,00	0,00	0,00	0,01	С
Technical lifetime	(years)	30,0	30,0	30,0	25,0	40,0	D
Construction time	(years)	1,5	1,5	1,5	1,0	3,0	Е
Financial data							
Nominal investment ("total)	(MEUR/MWe)	1,1	1,1	1,1	0,8	1,2	[I, M]
Variable O&M (*total)	(EUR/MWhe)	2,0	1,9	1,8	1,5	2,2	[J, N]
Fixed O&M (*total)	(EUR/MWe/year)	16.662,7	15.965,4	15.602,1	12.481,7	18.722,5	[J, N]
Technology-specific data							
Availability	(%)	1,0	1,0	1,0	1,0	0,9	
Hub height	(m)	100,0	105,0	110,0	85,0	150,0	
Rotor diameter	(m)	145,0	155,0	165,0	100,0	150,0	K
Specific power	(W/m2)	302,8	291,5	280,6	191,0	452,7	
Average capacity factor	(-)	0,4	0,4	0,4	0,2	0,5	
Average annual full-load hours	(MWhe/MWe)	3.600,0	3.700,0	3.800,0	2.000,0	4.500,0	[A, L]
Environmental data							
Emission intensity	(t CO2e/MW)						
Spatial footprint	(1000 m2/MWe)						
lrish context data							
Physical constraint	(area/(m³/MW))						
Deliverability	(-)						
Deployment rate	(MW/year)						

- A1. The capacity is set to 3.5 MW in 2015 and 2020 based on data of current wind turbines and under the anticipation that the maximum height will not exceed 150m before 2020. From 2030 a slight increase in generator size, and hub height is
- A. The full load hours (annual produktion (MWh) per installed power (MW)) depending on the actual location of the wind farm, wake losses and technological characteristics of the individual turbine. The value is an average for the expected locations of the wind farms. FLH also depends on wake losses, noise reduction and technological characteristics of the individual turbine. The level for 2020 is based on expectations from the November 18 auction winners locations and the 2019 prefered
- B. Modern turbines has typically higher forced outage than older smaller turbines had when they were newer due to more complex technology.
- C. Planned outage is typically 1-2 service visits a year, with a maximum duration of one work day, but there can also be planned outage due to shadow flicker stop or sector management (protect turbines at given wind speeds and directions, where
- D. The life time depends on the wind conditions; average annual speed and turbulence, relative to the design class of the turbine
- E. The construction time is the periode from FID to commissioning. But from first "dig" to turbines are in operation less than 1/2 a year is needed for smaller wind farms (clusters), where the similar periode for larger wind farms will be longer. The planning time from idea to construction starts will typically be 2–3 years, but can be essentially more if permitting problems occour.
- F. An area of around 50 m x 50 m is needed for a modern wind turbine. Another way of defining the "area use" could be the noise zone, which ranges up to 600-800 m from the wind turbine in worst case
- G. Wind turbines can be downward regulated within very short time and can therefore (if the wind is blowing) be used in both the primary and secondary downward regulation
- H. 2015 Investment costs are based on a number of prospects for projects published in relation to Køberetsordningen. 2020 investment costs are based on updated data from Køberetsordningen. Note that the investment costs listed here includes 1. The grid connection is sozialized in Denmark and can be subtracted from the given nominal investment seen from the project owner (change with new auction system from 2018).
- J.75% of the total yearly O&M costs are assumed to be fixed cost and 25% are assumed to be variable cost.
- K. Currently only turbines up to 150 m total height is installed commercially in Denmark because of strict demands to higher turbines. No change in the national regulation is assumed until after 2020. Some test sites allow for larger turbines. Aboard L. It is expected that the production (FLH) increase 13% from 2015 to 2020 and 3% from 2020-2030 and 1% per decade from 2030-2050.
- M. It is assumed that the investment cost for on shore turbine projects will be reduced 5% in each decade from 2020
- N. It is assumed that the operation cost for on shore turbines will be reduced 5% in each decade from 2020.
- P. Land costs can be as well purchace as annual rent. Here is chosen to add annual rent x 10 to purchace costs in CAPEX and then remove land rent from OPEX.
- Q. Purchase of neighbour settlements includes only the needed due to noise and distance demands, not the "new" 2022 politically decided "Sales optio

- 1. DTU International Energy Report Perspectives on Wind Energy, DTU, 2021
- 2. Master data register of wind turbines, March 2022, Danish Energy Agency, 2023
- 11. Information from Energinet, dk based on analyses of installed projects (2013–14), published under "Købsretsordningen", 2015 12. Schwabe, P., Lensink, S. & Hand, M., IEA Wind Task 26: Multi-national case study of the financial cost of wind energy, 2011
- 13. Hvor længe holder en mølle, Naturlig Energi, januar 2012
- 18. Nielsen, P. et. al., Vindmøllers økonomi EUDP projekt 33033-0196, 2010
- 19. Når all-inclusive service alligevel ikke dækker alt, Naturlig Energi, nov. 2014
- 20. Analysis of "køberets" projects 2017-2018
- 21. Interviews with project developers and suppliers Dec. 2018 Jan. 2019



Technology selection



Screening logic



Cornerstones of the green transition

- Technologies that are universally recognized as important to reach carbon neutrality.
- Sector coupling technologies direct and indirect electrification.

E.g Solar PV, onshore and offshore wind, sector coupling technologies.



Relevance in an Irish context

- Respect for limitations inherent in an island system.
- Respect for limitations in resource availability in Ireland.

E.g Interconnectors, transmission, storage



Hot topics in the public debate

- Comparison on a like for like basis with more conventional technologies.
- Increase knowledge level in public debate on the green transition.

E.g Nuclear fission power, Hydrogen to power generation.



Distinct technologies

- Potentially infinite possibilities for combining technologies.
- This study is looking at 30 technologies.
- Combinations to be considered in later phases.
- Provide a consistent and expandable approach to technology data.

NB: Hybrid technologies are not considered, aim to provide "modular" data that can be combined later.



MCDA model



Scoring of the technologies



- Data: Numerical values (e.g. spatial footprint, annualized fixed costs).
- **Methodology:** Normalization between 1 and 5 based on the maximum and minimum value of the dataset:

$$Score_x = 1 + 4 \times \frac{x - min_{\Omega}}{max_{\Omega} - min_{\Omega}},$$

with x being the datapoint, and Ω the dataset.



- **Data:** Qualitative data where no numerical values can be extracted (e.g. social acceptance).
- Methodology:
 - Pair-wise comparison: Each technology is compared with every other technology in the dataset, one pair at a time. Binary comparison.
 - Ranking: For each technology, the total number of pairwise wins is used to rank the technologies.
 - Normalization: Normalization between 1 and 5 based on the maximum and minimum value of the dataset.





Score from 1 to 5 to be used in the MDCA model



Weighting



Purpose: reflecting different national strategic priorities

- Not all criteria are equally important to all stakeholders.
- Strategic national priorities (e.g., competitiveness, energy security, sustainability) influence weightings.



Identification of key criteria

- Identification of key criteria relevant for a specific priority.
- Decisions on how to manage non-key criteria, i.e. zero weight or small weight.



Ranking

- Calculation of a weighted score for each technology.
- Technologies are ranked based on the weighted score.
- Different priorities will give different rankings.

Example 1: Fast and cheap

Criteria:

Fixed costs - cheap

Variable costs - cheap

Deliverability – known tech + available supply chain

Physical constraints – no time to change zoning

Regulatory pathway – existing regulation + fast permitting

Example 2: Green and popular

Criteria:

Carbon footprint - green

Spatial footprint – *less invasive* = *green and popular*

Biodiversity impact - green

Physical constraints – protection of conservation areas

Social acceptance - popular



Criteria



Correlation matrix for criteria assessment



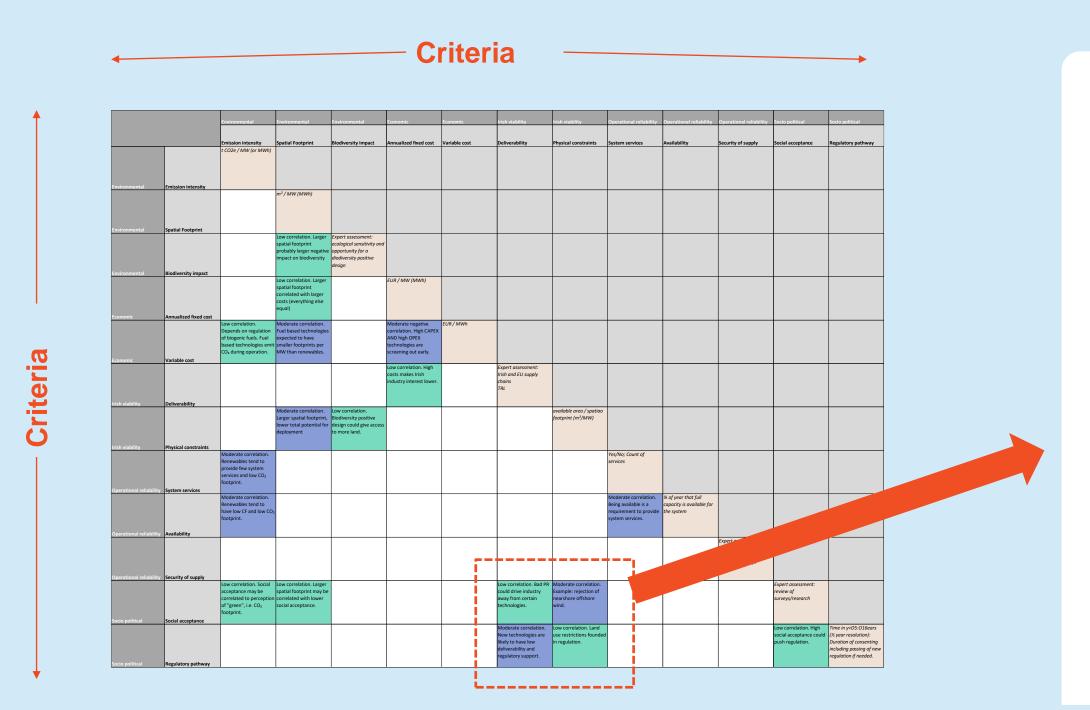
Ensure that the selection of criteria is thorough and complete, while avoiding overlap.

Basis of discussion when new criteria are proposed.

Low correlation

Moderate correlation

High correlation: to avoid as this shows that an overlap is existing.



		Irish viability		
		Deliverability	Physical constraints	
Socio political	Social acceptance	Low correlation. Bad PR could drive industry away from certain technologies.	Moderate correlation. Example: rejection of nearshore offshore wind.	
	Regulatory pathway	Moderate correlation. New technologies are likely to have low deliverability and regulatory support.	Low correlation. Land use restrictions found in regulation.	



Environmental criteria



Estimation method: Literature review for each technology and experience/data collected from past projects, Including material extraction, transport, installation/construction, operation, maintenance and decommissioning, based on life-cycle analyses (LCAs) in peer-reviewed scientific papers and LCAs in reports from the industry and are less than 10 years old.

Source:

- 1. LCA papers
- 2. LCA databases
- 3. EPDs

Output: Direct and indirect emissions in tonnes CO2e per MW (MWh for storage) installed.



Spatial footprint

Estimation method: Literature review of open access resources available for the environment and energy sector in EU and further afield if necessary.

Source hierarchy:

- 1. Danish Technology Catalogue
- Desktop research e.g. LCA of Electricity Energy (UNECE); Land-use intensity of electricity production (PLOS ONE)
- 3. Project examples national, UK, Europe
- 4. Expert advices (COWI and RPS)

Output: Land-used in m2 per MW (MWh for storage) installed or similar defined unit



Estimation method: Literature review of open access resources to determine impact pathways and sensitivities. Literature review for best pratice examples of biodiversity positive design (BPD) at national, EU and if necessary international level.

Source hierarchy:

- 1. Papers, projects and plan assessments for impact pathways
- 2. Article 17 reporting for designated habitats and species status, threats/pressures
- 3. Project examples / papers for BPD opportunities
- 4. Ecological expertise

Output: Expert assessment of the ecological sensitivity and opportunity for BPD.



Economic criteria



Estimation method: Calculation of the annual cost of ownership based on CAPEX and fixed OPEX.

Annualized fixed cost =
$$CAPEX \cdot \frac{(1+i)^n \cdot i}{(1+i)^n - 1} + Fixed OPEX$$

With n technical lifetime and i discount rate of the project.

Source hierarchy:

- 1. Danish Technology Catalogue
- 2. Desk research
- 3. Contact with manufacturers.

Output: Average lifetime cost per installed MW capacity (MWh for storage).



Estimation method: Variable OPEX covers all costs which depend on operation.

Source hierarchy:

- 1. Danish Technology Catalogue
- 2. Desk research
- B. Contact with manufacturers.

Output: Cost per MWh generated/stored



Irish Viability Criteria



Estimation method: Assessment of TRL (1-9) and Irish industry involvement through review of existing projects with interviews to fill gaps. Consideration of the supply chain maturity in Ireland and EU (1-5).

Source hierarchy:

- 1. Review of existing projects in Ireland and EU
- 2. To fill any gaps, interviews with industry manufacturers and
- 3. Assessments from the COWI RPS pool of experts will be utilised.

Output: Normalised integer figure from 1-5 produced from a pairwise comparison of technologies to provide prioritisation of alternatives.



Estimation method: Available area divided by spatial footprint based on consultation with GIS databases. Analogous to work done by RPS on the implementation of Climate Action Plan Action 102 (Spatial Policy Framework).

Potential parameters to consider: CSO Settlements Geodirectory, MyPlan Zoning, Connection Turbines, Overhead Power Cables, Gas Networks, Water Mains, Roads, Railways, Main Rivers, SAC/SPA/Ramsar Sites, Lakes, Transitional Waterbodies, UNESCO World Heritage Sites, Salmonid Rivers, CFRAMS Flood Mapping, Soil Category, Landslide Susceptibility, Groundwater Vulnerability, and Geological Heritage Sites.

Source hierarchy:

- 1. Exisitng data
- 2. GIS database analysis

Output: Total MW installable wrt. Land availability.



Operational reliability criteria





Estimation method: Available full-load hours (FLH) based on existing projects and literature.

Source hierarchy:

of them at first stage.

 Combination of information from the technology catalogues, EU Regulations and Grid Code requirements (generation, demand, etc.).

Estimation method: Yes/No evaluation on

individual service and not as a combination

each item on a list of system services

classified by technology. Considered as

- Desk research on technical documentation of the technologies (literature, manufacturer's catalogues) and
- 3. Expert inputs based on international experiences.

Output: Count of system services provided.

Sources hierarchy:

- The availability will be assessed based on existing project description in Ireland (especially important for wind and solar) and open-source statistics as well as through
- relevant literature, international reports,
 TSOs studies and statistics and
- 3. Expert inputs based on international experiences.

Output: % availability over the year, not including curtailment for non-synchronous generation (wind and solar PV) or demand response (bulk consumers).



Estimation method: Evaluate based on the 3 criteria – fuel supply chain issues, failure/maintenance risks, sabotage/cyber risk

Source hierarchy:

- 1. COWI RPS pool of experts
- 2. Relevant Literature and EU cybersecurity regulations.
- International geo-political reports for main equipment/spares supply chain, fuel extraction and refine and transportation.

Output: Reseach input to pairwise comparisons.



Socio-political criteria



Estimation method:

- Research available information on public attitudes and acceptance, applying a hierarchy of sources.
- Review of 6 case studies on projects in Ireland and internationally with a cross section of technologies.
- Apply a pairwise scoring method to allocate a score on a scale of 1 to 5.

Source hierarchy:

- See following slide.
- Irish and international project case studies.

Output: Comparative scoring of the social attitudes towards and acceptance of technologies.



Estimation method: Review of

- 'system readiness' (i.e. is the regulatory framework in place for this technology?) and
- 'duration' of consenting process that applies to this technology.

These will be combined to enable an estimate of the **overall time** to achieve consent for each technology.

Source hierarchy:

- Irish legal/ regulatory framework (and regard to EU / International where necessary)
- SEAI energy consenting guidance.
- Past project experience (duration of consenting).

Output: Expected duration of successful project consenting, in a number of time bands.



Portfolio creation



Portfolio construction



Four distinct portfolios will be constructed, each corresponding to the subset of technologies that achieve the highest scores in the MCDA, tailored to reflect different national strategic priorities.



An iterative process of validation and revision will be employed to refine these portfolios, ensuring their suitability before progressing to the formal validation phase.

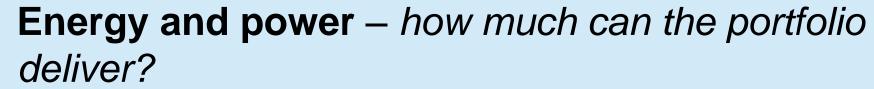


A portfolio will be a **sub-set** of the available technologies. At the outset, it will consist of the 3-4 **highest ranked** technologies in each batch (generation, storage, enabling).

Portfolio validation



Evaluation of the ability of the portfolio to consistently meet demand under various scenarios while complying with Irish regulatory standards.





System stability - is the portfolio sufficient?

Risk – geopolitical, security of supply, mitigations

Themes – policy targets, sector coupling, constraints



Feedback loop incorporated based on the stakeholder engagement phase to ensure a portfolio definition aligned with the expectations.



Thank you

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