



HYreland

Analysis of large-scale green Hydrogen and Synfuels Production in Ireland and their Export to Germany

Christoph Hank – Fraunhofer Institute for Solar Energy Systems ISE, Germany
World Hydrogen Technologies Convention 2025, Dublin



With funding from the:



Hydrogen Technologies at Fraunhofer ISE



Business Area Hydrogen Technologies at Fraunhofer ISE

Defossilisation of transport, industry, chemicals and process heat



Electrolysis and H₂ Infrastructure

Hydrogen production by water electrolysis, hydrogen injection, Power-to-X simulations and techno-economic assessments, technical consulting



Fuel Cell Systems

PEM fuel cell characterization, modelling, and manufacturing, Integration in mobility and drivetrains



Sustainable Synthesis Products

Development of catalysts and processes, techno-economic and life cycle assessments, technical consulting

 **>150 Employees**

 **15 MEUR/a Budget**

 **>30 Years Experience in the field of hydrogen and thermochemical processes**

Department Sustainable Synthesis Products

PtX Products - Production, Transport and Utilisation

Enjoy a virtual tour of
our Syn-labs



From Catalyst to Industrial Reactors / Processes

- Design and evaluation of advanced green chemicals and energy carriers (e.g. DME as promising H₂ carrier)
- Design, test and characterisation of tailor-made catalysts (e.g. HT-NAP-XPS)
- Process development of more efficient, cost optimised processes using CO₂/CO or N₂ and H₂ as feeds
- In-house design, construction, programming and operation of synthesis and reforming miniplants
- Digital Twin Development for innovative applications
- Techno-economic feasibility and LCA studies assessing the potential of PtL processes

About 50 employees work on these topics:



Power-to-Methanol



INDIGO DME
Technology



π-COMET® – Clean
OME Technology



Methanol to Jet fuel
SAFari



DAC Material
and Process
Characterization



PICASO NH₃
Technology



Thermochemical H₂
Production with Electrically
Heated Catalyst Carrier
CatVap®



LOHC as H₂-carrier



The Power-to-X concept for green energy carriers and chemicals

Hydrogen, Methanol, Fischer-Tropsch and Ammonia as Key PtX Products

Sustainable Feedstock

Wind power



Solar power



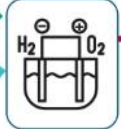
Hydro power



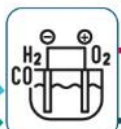
Air



Water electrolysis



Co-electrolysis



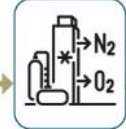
Industry and biomass



Direct air capture



Air separation unit



Efficient Conversion

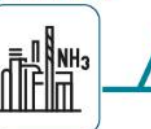
Refineries



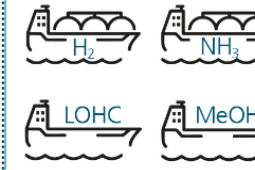
Methanol synthesis



Ammonia synthesis



Efficient and Safe Transport Chain



Advanced Products

Fuels and energy carrier

Fuels

Methanol, DME, OME, gasoline, Fischer-Tropsch products, jet fuel

Chemicals
Solvents, polymers

Fertilizer and energy carrier

H₂ HYreland






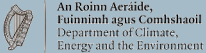


Investigating the technological, economic, and environmental potential for the production of green hydrogen and its synthesis products in Ireland and by taking into account their transport to Germany.

Hard Facts

- **Project duration:** 01.11.2024 – 31.12.2025
- **Funding German Side:** Federal Ministry of Research, Technology and Space - BMFTR

Project Partners

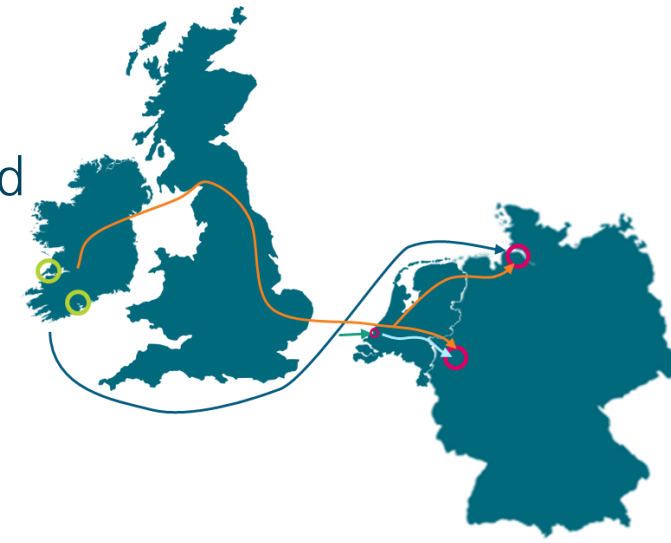
	Electricity Supply Board ESB
	Fraunhofer Institute for Solar Energy Systems ISE
	International Energy Research Centre IERC
<i>Associated Partners:</i>	
	Duisport - Duisburger Hafen AG
	Region Stade
	Department of Climate, Energy and the Environment DCEE

Paul Lennon (ESB), David Gill (German Ambassador to Ireland), Keelan Glennane (ESB) and Charlie Brophy (DECC); Source: RTE



The HYreland Project

General Scope, Approach and Methodology



Technical Scope of the HYreland Scenarios:

- **Renewables locations:**
 - Identified by holistic GIS analysis for onshore wind and solar and offshore wind
- **Power-to-X hub locations:**
 - Focus hubs: **Moneypoint** (Co. Clare) and **Aghada** (Co. Cork)
 - + 3 further regions to be identified as 'promising' based on GIS analysis
- **Time Horizon:** ~2032 - 2037
- **Scale:** Depending on scenarios ~**0.5-1 GW_{eI}** of installed electrolysis capacities
- **Assessed PtX pathways:** **Gaseous & Liquid H₂, Ammonia, Methanol, Dimethylether (DME), eSAF**
- **CO₂ supply:** Capturing from local point-source

HYreland

General Approach



IERC
International Energy Research

Energy Modeling & Irish Market Study

Information on future market development

Fraunhofer ISE

Assessment of Irish RE and PtX Potentials based on GIS Analysis

Location of RE clusters, PtX hubs and LCOE

Fraunhofer ISE

Techno-economic and environmental analysis of the defined PtX scenarios

Hub-specific information on future energy and hydrogen demands as well as transformation roadmaps

Fraunhofer ISE

Development and evaluation of 'Hydrogen Regions' along the German import corridors

ESB

Support with data acquisition and establishing contact with relevant stakeholders

An Roinn Aeráide, Fuinnimh agus Comhshaoil
Department of Climate, Energy and the Environment

duisport

Associated partners in Germany

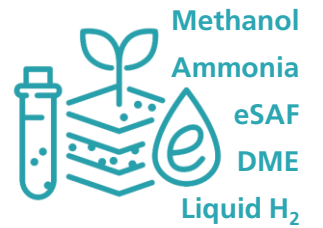
w:f Wirtschaftsförderung Landkreis Stade GmbH

Results for local production cost, product amounts and environmental footprints

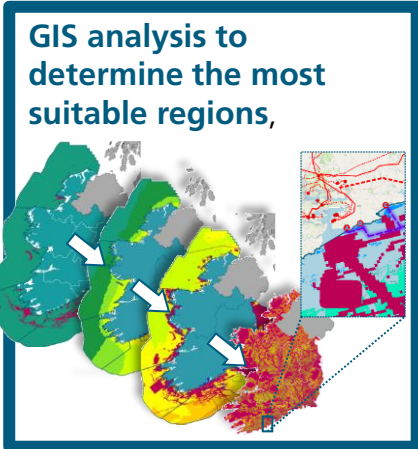
Results for supply cost to German import locations

Techno-economic analysis of the PtX scenarios

Methodology Overview

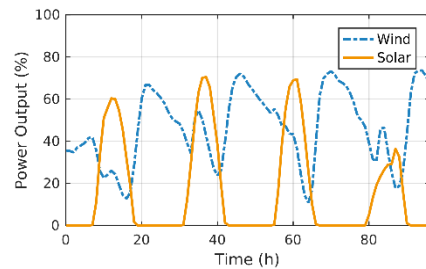


Location Analysis and Data Preparation



Internal data library: containing relevant site-specific techno-economic parameters of the entire PtX value chain (e.g. capital costs, grid electricity costs)

Generation of location specific **wind and solar** timeseries based on satellite data from the past 10 years:



Automatic **Transport route analysis** based on real world shipping routes:



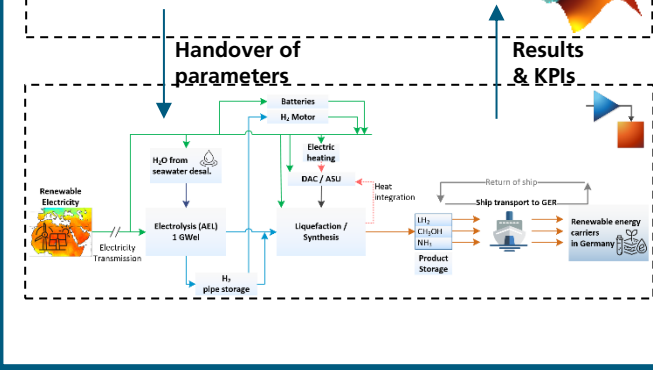
System Simulation & Optimization

Dynamic and **hourly-resolved simulation of complete Renewables and Power-to-X production and supply chains.**

Holistic **system optimization** with the help of a genetic algorithm to minimize costs.

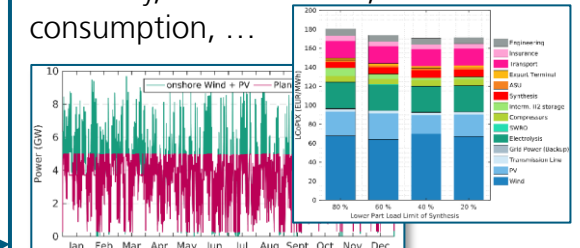
Consideration of **learning curves** for modelling of **future scenarios.**

ISE 'H2ProSim' Optimization Algorithm

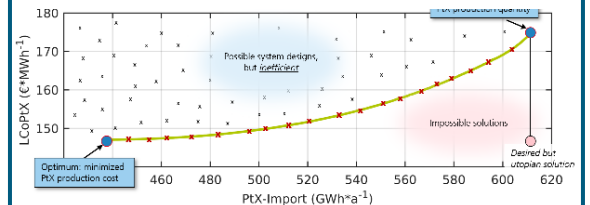


Results Analysis

Key performance indicators: leveled costs of product, production quantity, total investment costs, overall system efficiency, full load hours, water consumption, ...



Plant design in the cost optimum, e.g., optimized ratio of wind/ solar to electrolysis, intermediate hydrogen storage, etc.

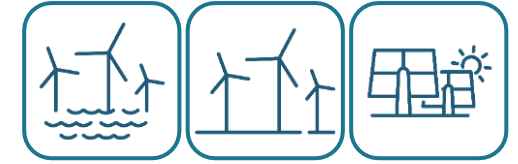


The HYreland Project

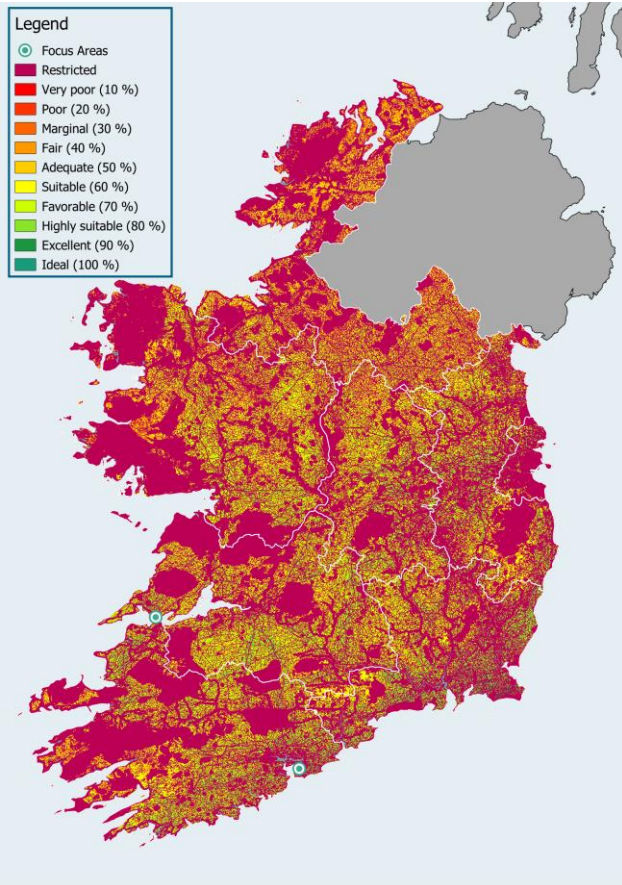
Assessment of Irish Renewables and Ptower-to-X Potentials based on GIS Analysis

Results from HYreland

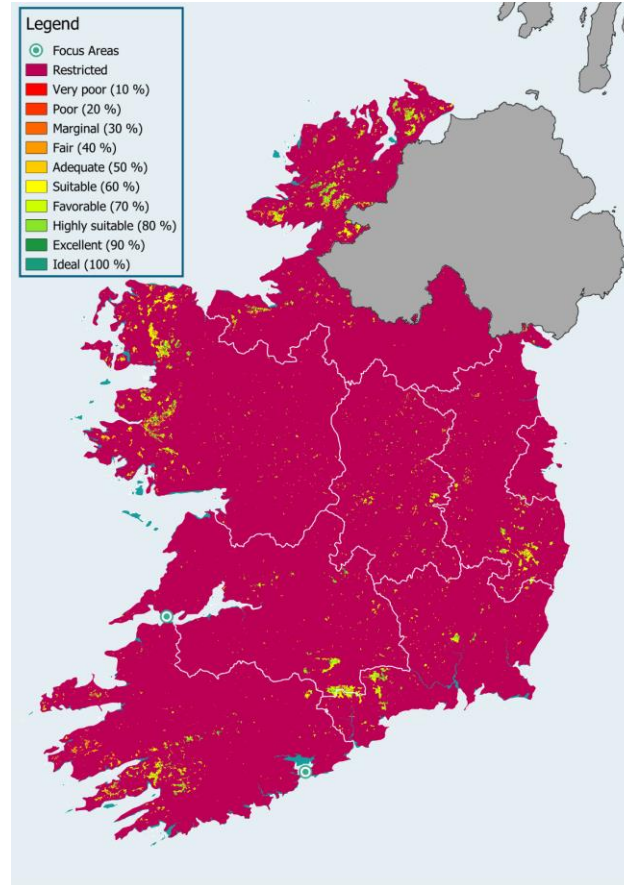
Site suitability for Solar PV, On/Offshore Wind



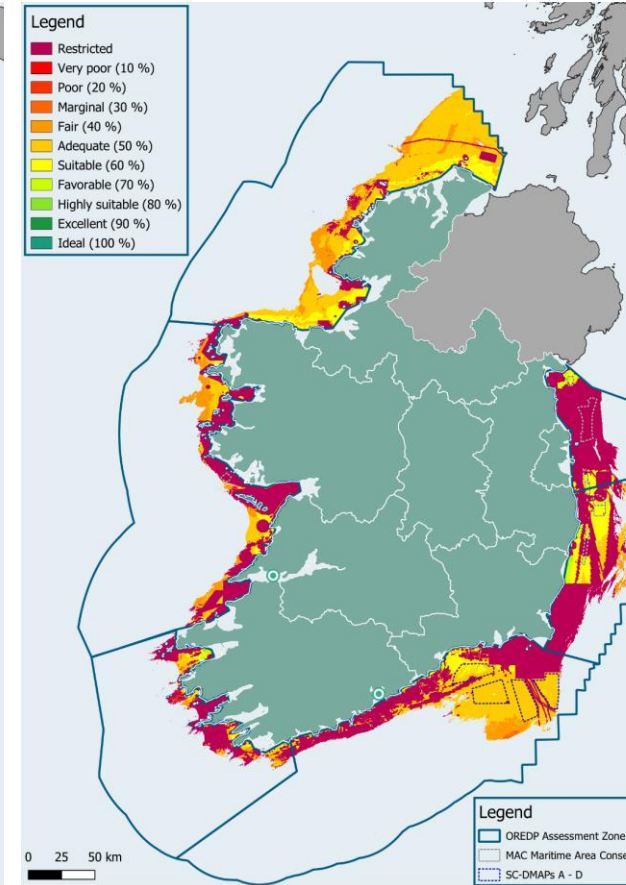
Ground-mounted PV



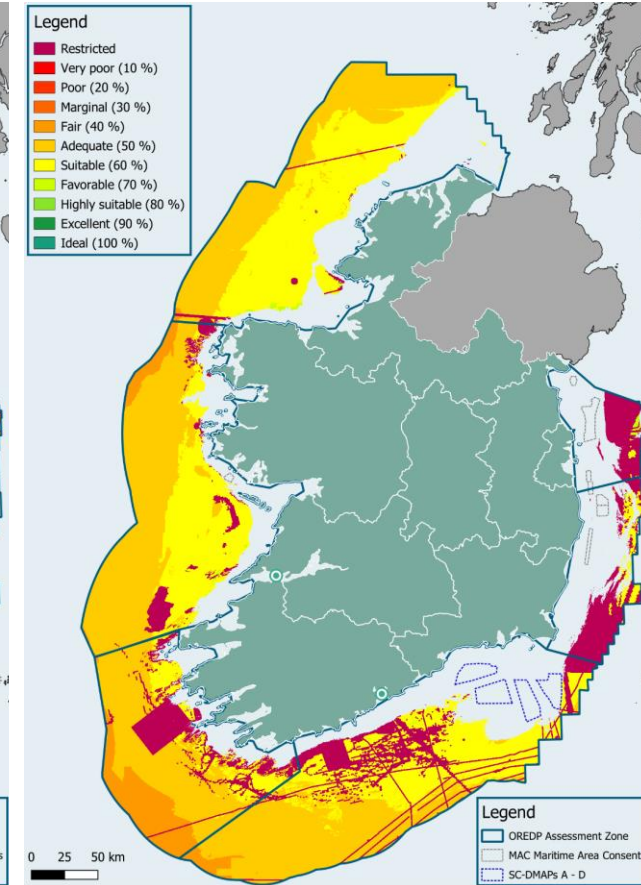
Onshore wind



Offshore wind - Fixed



Offshore wind - Floating

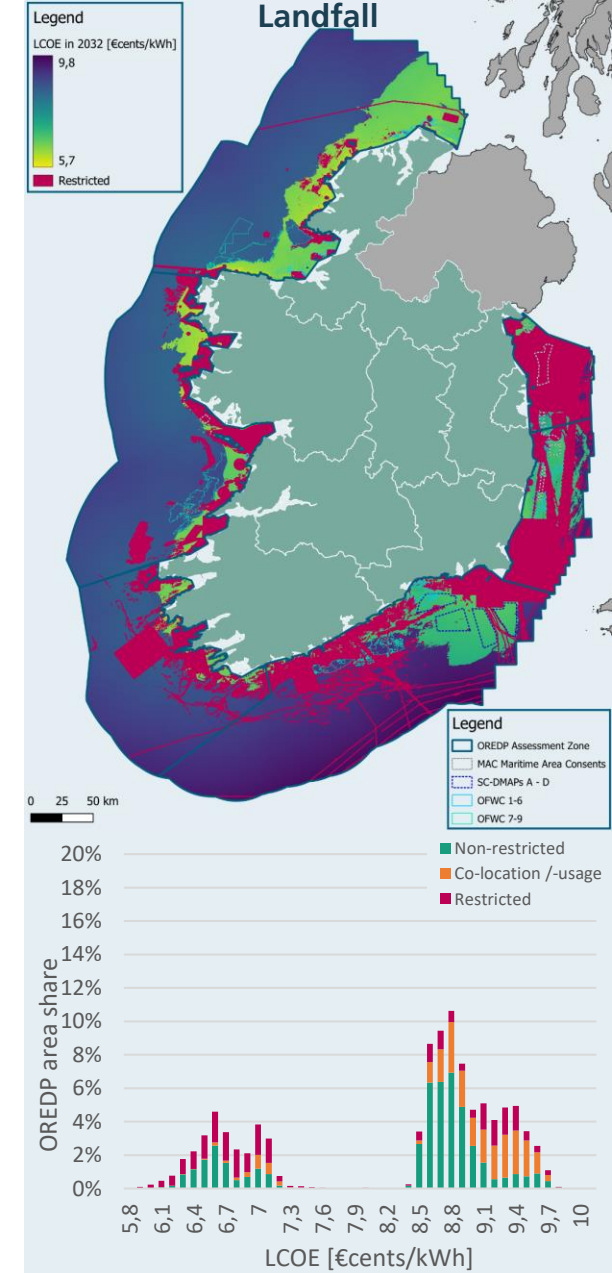
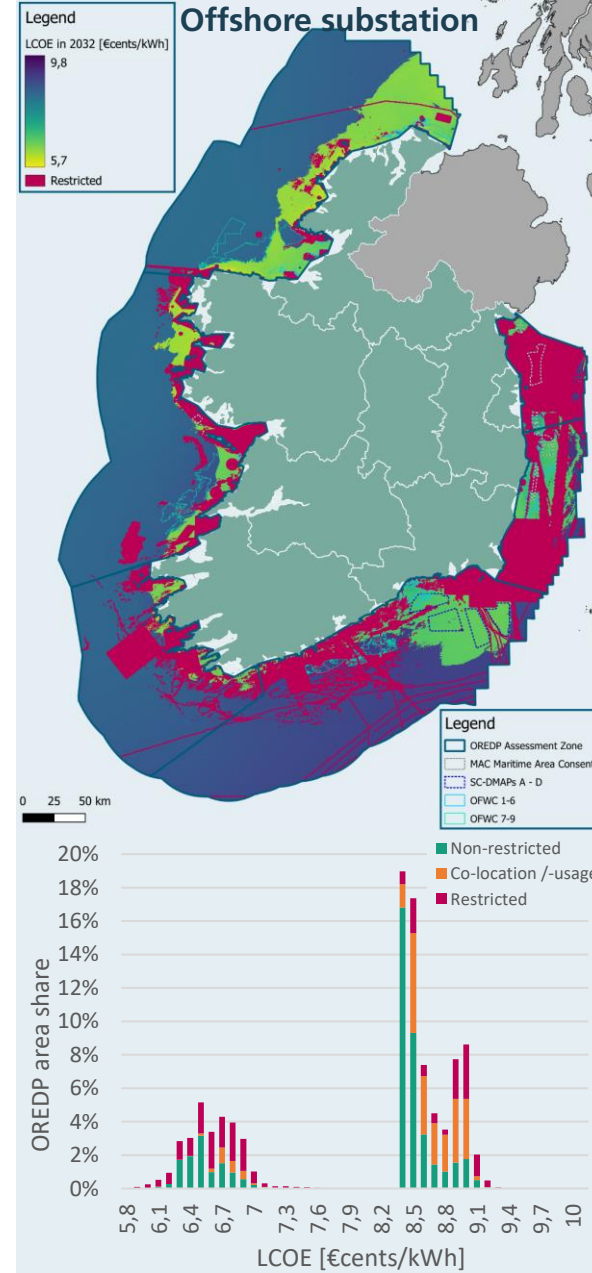


Results from HYreland

Levelized cost of electricity - Offshore wind 2030s

Restriction areas over LCOE

- Lowest LCOE values occur almost exclusively at restricted areas.
- Clear cost gap between fix-bottom and floating in the range of 1.8 – 2.0 €_{cents}/kWh_{el}.
- Considering the connection to landfall broadens the LCOE bandwidth due to the wind clusters varying shore distance.
- Co-location/-usage areas occur at elevated LCOE
- Factor of 1.5 between highest and lowest CAPEX value
- If the assumed learning curves are not realized, the LCOE for the future will increase by ~1.0-1.5 €_{cents}/kWh_{el}



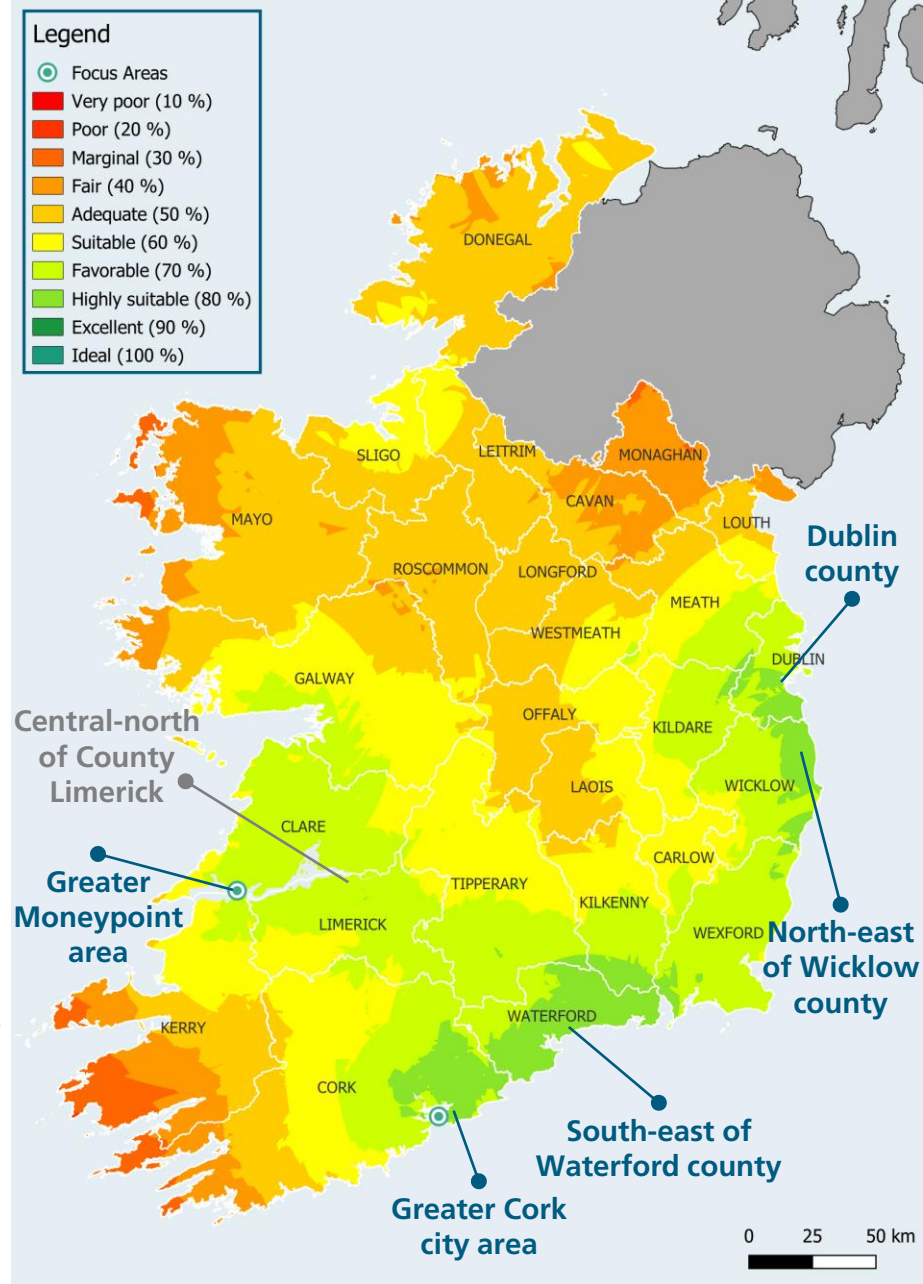
Results from HYreland

Production clusters suitability – Power-to-Hydrogen

Power-to-Hydrogen suitability in Ireland

- Focus on locations suitable for large-scale hydrogen export via pipeline
- Clear identification of regions with a high site suitability score
 - Greater Cork city area (Both)
 - South-east of Waterford county (PtH₂)
 - North-east of Wicklow county (PtH₂)
 - Dublin county (Both)
 - Greater Moneypoint area (Power-to-Ammonia)
 - Central-north of County Limerick (Power-to-SAF)
- Identified Power-to-Hydrogen clusters are located in proximity of fix-bottom offshore wind clusters or SC-DMAPs
- Detailed assessment of focus areas

Criteria	Weight
Offshore wind clusters	30%
Onshore wind clusters	8%
Ground-mounted PV clusters	15%
HV-transmission lines	3%
HV-substations	4%
Electricity interconnectors	2%
Water stress	5%
Underground H ₂ storage	8%
Potential future H ₂ pipelines	10%
Railways	3%
Seaports	6%
Local H ₂ offtake	2%
Local O ₂ offtake	1%
Local heat offtake	2%



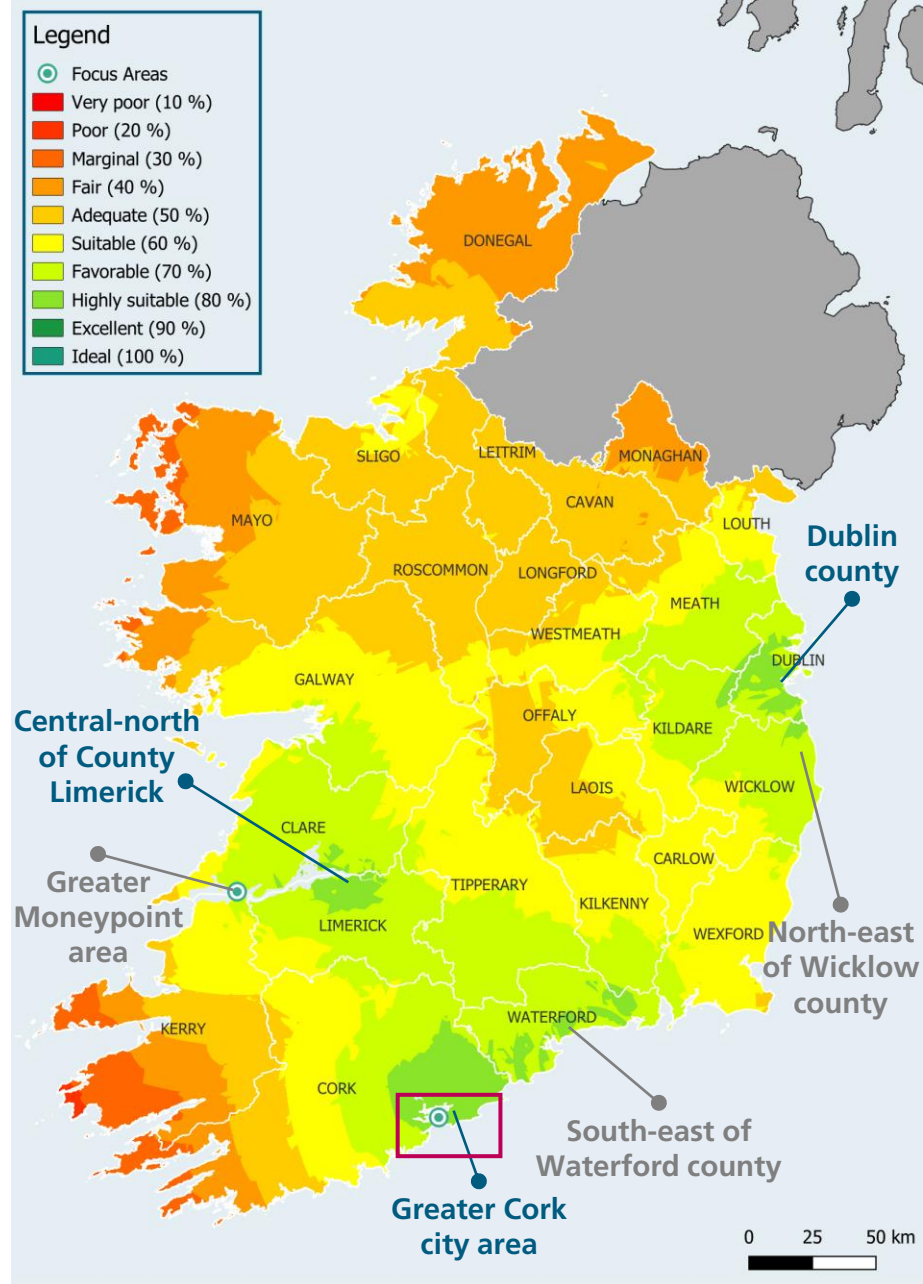
Results from HYreland

Production clusters suitability – Power-to-SAF

Power-to-Hydrogen suitability in Ireland

- Focus on locations suitable for large-scale hydrogen export via pipeline
- Clear identification of regions with a high site suitability score
 - Greater Cork city area (Both)
 - South-east of Waterford county (PtH₂)
 - North-east of Wicklow county (PtH₂)
 - Dublin county (Both)
 - Greater Moneypoint area (Power-to-Ammonia)
 - Central-north of County Limerick (Power-to-SAF)
- Identified Power-to-Hydrogen clusters are located in proximity of fix-bottom offshore wind clusters or SC-DMAPs
- Detailed assessment of focus areas

Criteria	Weight
Offshore wind clusters	22%
Onshore wind clusters	5%
Ground-mounted PV clusters	10%
HV-transmission lines	2%
HV-substations	3%
Electricity interconnectors	2%
Water stress	3%
Underground H2 storage	6%
Carbon point sources	15%
Refinery infrastructure	13%
Potential future H2 pipelines	2%
Railways	4%
Seaports	3%
Local SAFOfftake	9%
Local O ₂ offtake	1%
Local heat offtake	1%

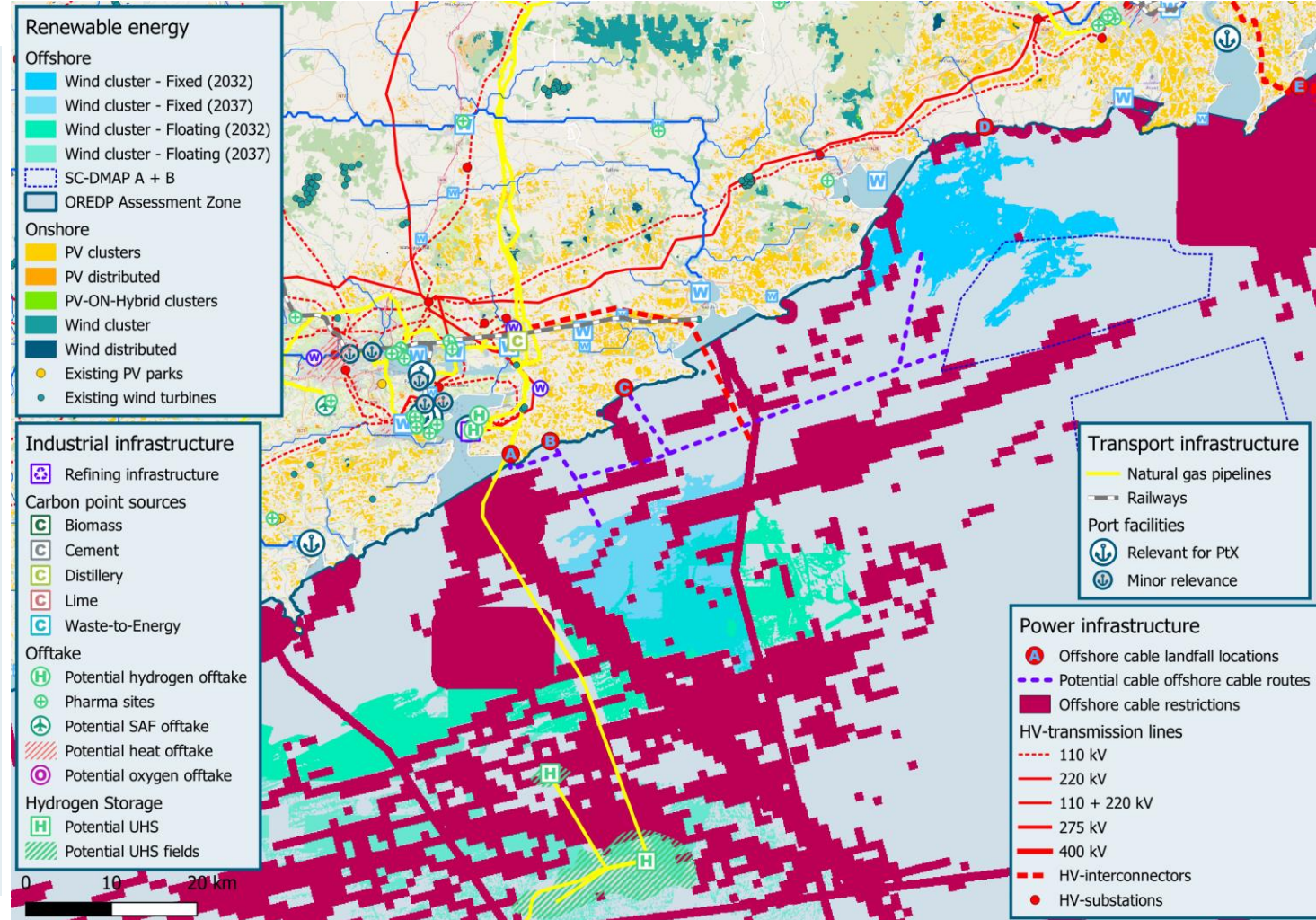


Site evaluation

Aghada

Large-scale Power-to-X

- + **Excellent access to renewable energy**
 - Proximity to large-scale fixed and floating offshore wind clusters, in addition to SC-DMAPs
 - Outstanding availability of future PV clusters
 - Reasonable distance to large-scale onshore wind clusters
- + **Access to potential future H₂ transmission pipeline system & UHS in depleted gas fields**
- + **Access to diverse port facilities & refinery infrastructure**
- + **Potential for local hydrogen and SAF offtake**
- + **Well-developed HV-transmission grid**
- + **Limited availability of industrial carbon point sources, but proximity to medium-scale biogenic source**
- + Water availability from upgraded water treatment plants, treated wastewater and surface water
- + Limited potential options for heat & oxygen offtake
- + Moderate environmental sensitivity might impede the production and export of specific PtX products (e.g. NH₃)
- **Excellent location for first-mover H₂ & SAF-projects**
- **Potential for H₂ scale-up & pipeline export**



The HYreland Project
**Preliminary Results on Capacities and necessary
Investments**

The HYreland Project

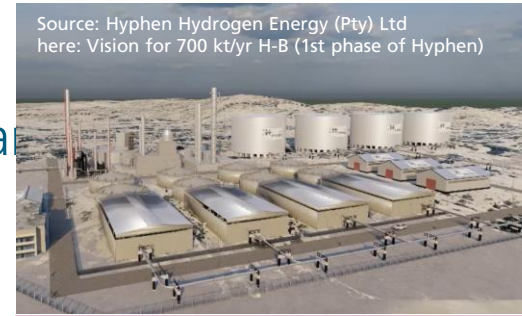
Preliminary Results on the Irish side

Preliminary results for a 2032 Irish-German hydrogen supply via green ammonia:



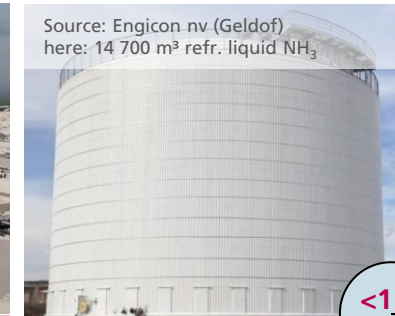
PEM Electrolysis:
 Installed cap.: 500 MW_{el}
 CAPEX : EUR 750M
 Full load hours: 6100 h/yr (69% CF)

25%



Haber-Bosch synthesis:
 Installed cap.: 420 kt/yr
 Output: 330 kt/yr
 CAPEX : EUR 230M

8%

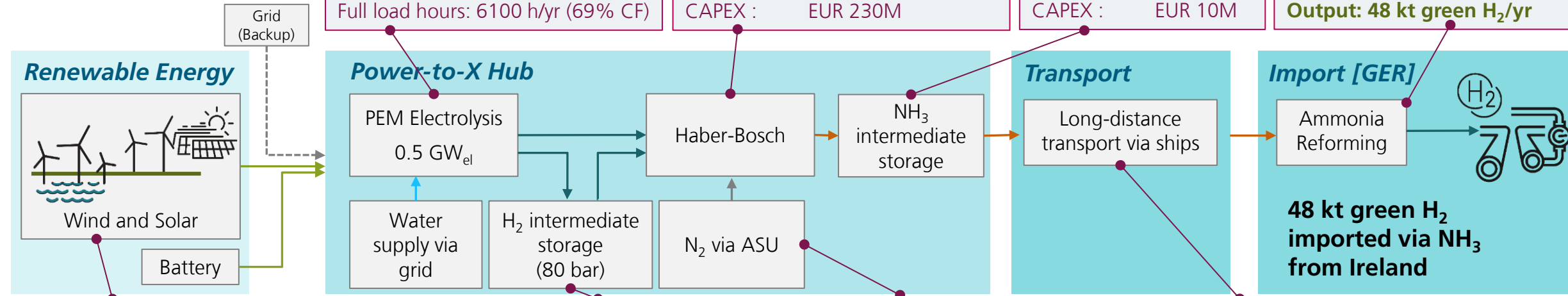


NH₃ storage:
 Size: 19 000 m³
 CAPEX : EUR 10M

<1%



Ammonia Reforming:
 Installed cap.: 48 kt/yr
Output: 48 kt green H₂/yr



Wind and PV:
 Capacities Wind onshore: 600 MW_{el}
 Capacities Wind offshore: 130 MW_{el}
 Capacities PV: 450 MW_{el}
 Total CAPEX RE: EUR 1,737M

57%

H₂ storage:
 Size: 140 000 m³
 CAPEX : EUR 290M

10%



Air Separation Unit:
 Installed cap.: 352 kt/yr
 CAPEX : EUR 45M

2%



Ship transport: LPG Carrier
 Ship size: 3 x 8 600 m³
 CAPEX : EUR 0.08 bn.
 Distance: 1620 km



xx% = Contribution to total Investment on Irish side

The HYreland Project

Next Steps and Outlook

Conclusions (for today)

- **Preliminary results indicate that Ireland has no reason to hide behind other global sweet spots for green hydrogen:**
 - Ireland is geographically well-placed to serve European markets (not just domestic).
 - Top wind conditions; large extent of energy infrastructure already available
 - Agahda and Moneypoint with huge synergies potential
(Brown field, HV grid connection, Proximity to large-scale offshore wind clusters, access to port facilities & refinery infrastructure)
 - Future access to EU Hydrogen Backbone enables clear cost reduction potential.
 - Although, policy gridlock and investment uncertainty has been flagged by some project developers it can be stated that Ireland is setting necessary Institutional frameworks (regulation, infrastructure planning) and shows clear political commitment.

HYreland is providing an important basis for the necessary next steps.



The inquiry deepens, and so does our commitment.

- With penalties looming in the aviation (ReFuelEU Aviation) and shipping (CO₂ pricing) sectors, the necessary off-take will begin to materialize.
 - The task now is to enable base demands by reducing regulatory costs of H₂ production and drive forward infrastructure expansion.
 - Therefore, for a **HYreland Phase II** Fraunhofer ISE could focus on:
 - **Accompanying research within the framework of a demonstration project at scale.**
 - Development and operation of **mini-plants and digital twins for production of e.g. methanol or eSAF.**
 - Analysis of the necessary **economic and regulatory conditions to underpin the business case.**
- A potential scope of a **HYreland Phase II** is under discussion with the relevant partners and stakeholders.

Fh ISE Mini-plant to advance efficient production of eMethanol and eSAF © Fraunhofer ISE 2025.

Thank you for your kind attention

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Holistic Analysis of Regional and Global Hydrogen Supply Chains

We carry out techno-economic analyses for Power-to-X production sites and evaluate the value chain for hydrogen and its derivatives from production to storage, transportation, and use.