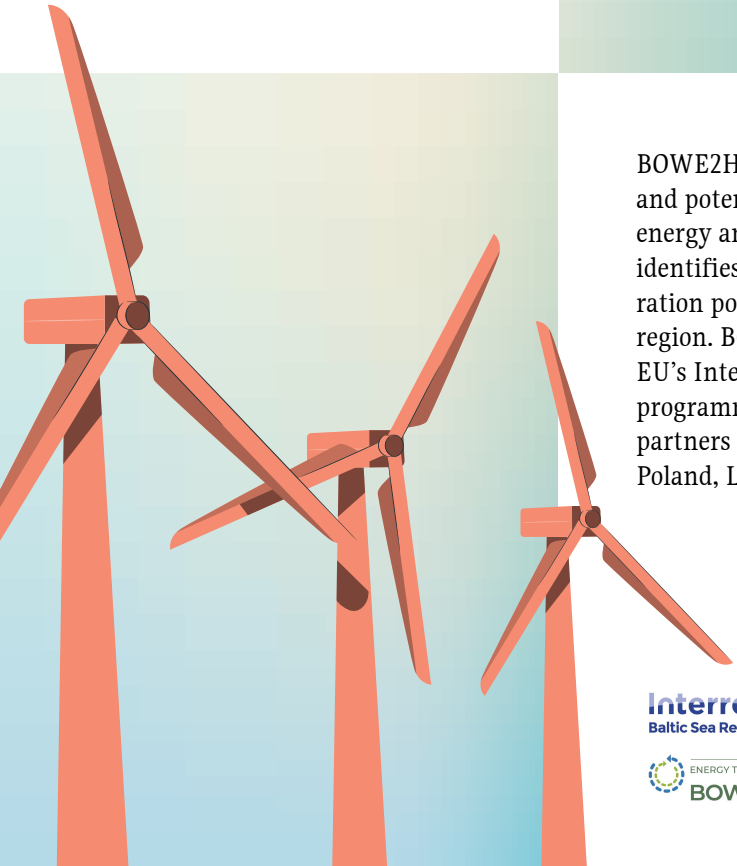
BOWE2H

Baltic Offshore Wind Energy to Hydrogen



BOWE2H takes stock of the state and potential of offshore-wind energy and green hydrogen, and identifies transnational collaboration potential in the Baltic Sea region. BOWE2H is funded by the EU's Interreg Baltic Sea Region programme and implemented by partners from Germany, Sweden, Poland, Lithuania and Latvia.

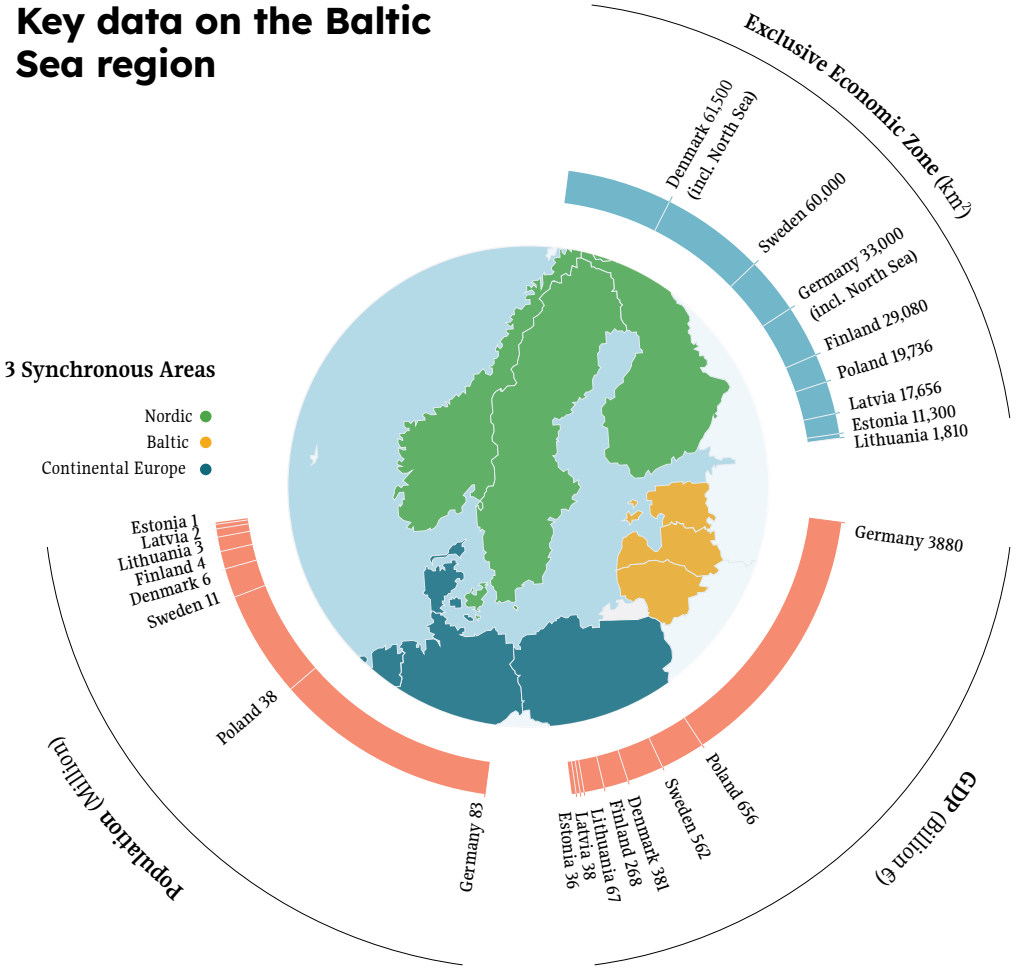
Interreg Baltic Sea Region
Co-funded by the European Union
ENERGY TRANSITION BOWE2H

UNITED IN DIVERSITY

The Baltic Sea countries have a wide range of sizes and populations – Estonia's GDP, for instance, is less than one percent of Germany's. Even smaller countries have significant maritime space, however, offering strong potential for offshore-wind development – and export to more crowded places.

The region's long tradition of cooperation, not least through the EU's BEMIP (Baltic Energy Market Interconnection Plan) since 2008, supports the necessary transnational energy planning.

Key data on the Baltic Sea region



TOWARDS AN INTEGRATED GREEN ENERGY MARKET

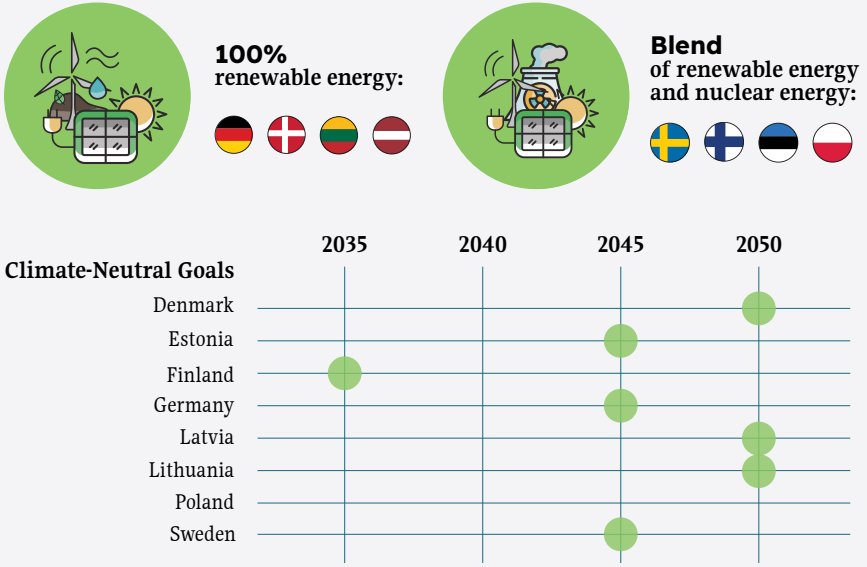
The electricity markets of the eight EU Baltic Sea Region countries are divided into three synchronous areas. The Baltic States' planned disconnection from Russia and integration into the European Continental Grid by February 2025 is geopolitically very significant.

EU countries are aiming to reach climate neutrality by 2050, with some including nuclear energy in their low-carbon strategies. Rapidly ramping up renewables will be key to decarbonising the Baltic energy systems.

"Rapidly ramping up renewables will be key to decarbonising the energy system in the Baltic Sea Region"

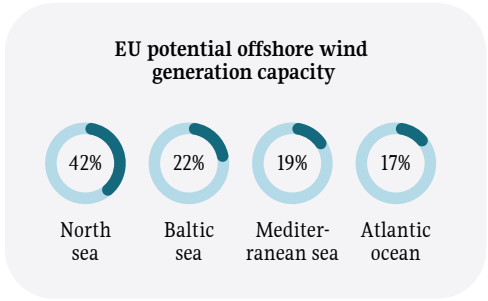
Climate-neutrality goals and technology mixes

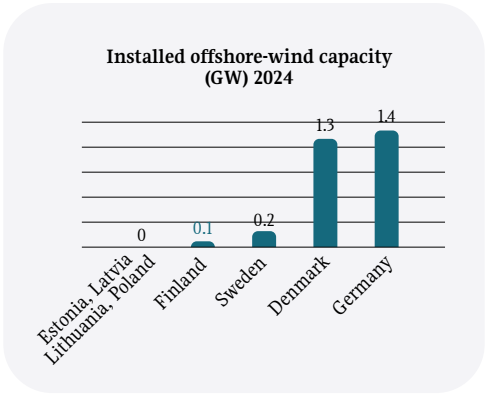
Climate neutrality: Planned technology mixes in the BSR

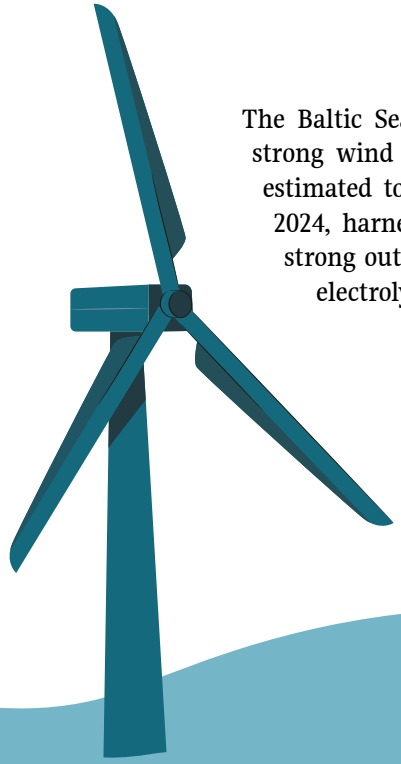


OFFSHORE-WIND ENERGY IN THE BALTIC SEA REGION

For the European Union to reach the goal of climate neutrality by 2050, offshore-wind energy must grow from a capacity of 15 GW today to 300 GW by 2050, with 22% of that capacity located in the Baltic Sea!







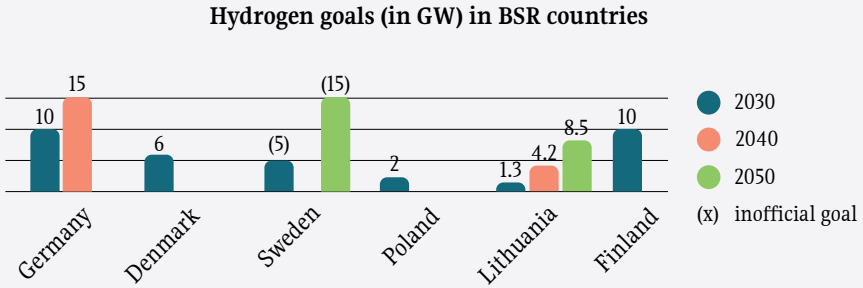
The Baltic Sea has shallow waters, short distances to shore, and strong wind speeds, enabling an offshore wind-energy potential estimated to 83-100 GW by 2050. Only 3.1 GW is installed as of 2024, harnessing just 3% of this potential. With its stable and strong output, offshore-wind energy is ideal to power hydrogen electrolysers across the Baltic Sea Region.

"With 3.1 GW installed as of 2024, only 3% of the Baltic Sea's offshore wind potential is currently being harnessed."

HELLO, HYDROGEN!

Decarbonising energy means electrifying everything possible, and using green hydrogen in hard-to-abate sectors - like shipping, aviation, and heavy industry. RePowerEU targets 10 million tonnes of clean hydrogen by 2030, with up to 45% potentially from the Baltic Sea Region. Ambitious pilot projects and national strategies are paving the way for a regional hydrogen economy.

Countries with H2 goals expressed in GW



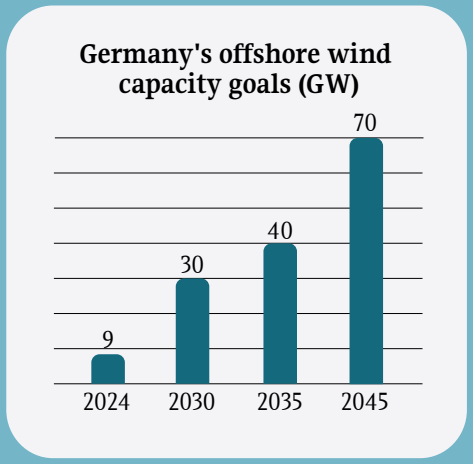
The high costs of producing green hydrogen and uncertain demand often slow rollout and hinder ambitious 2050 targets. However, electrolysers are swiftly becoming much cheaper. To tap into the socio-economic benefits of this new green industry, developing local skills and equipment in the Baltic Sea Region should be a priority.

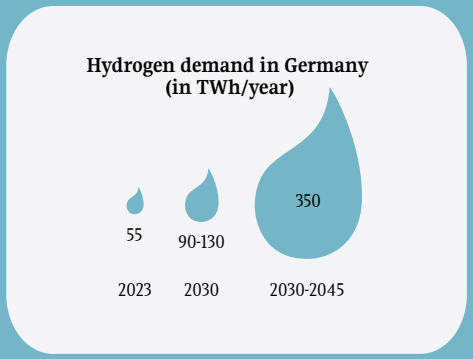
BOWE2H - COUNTRY HIGHLIGHTS

Germany

In 2022, in response to Russia's war of aggression in Ukraine, Germany boosted its Energiewende, or energy transition, with new ambitious offshore-wind targets of 30 GW in 2030, followed by 40 (or 50, pending approval) GW in 2035 and 70 GW by 2045, in close cooperation with their Danish and Dutch neighbours.

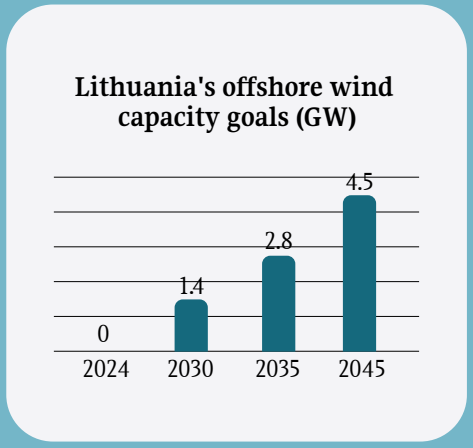
In the field of hydrogen, Germany has great ambitions too, anticipating an increase in demand of up to 350 TWh per year by 2050! Germany's high energy consumption means regional collaboration will be key in securing sufficient green energy in the future.





Lithuania

Lithuania held its first offshore wind auction in 2023, with a second planned for late 2024, alongside the adoption of a National Hydrogen Strategy. The country prioritises energy independence, aiming for 4.5 GW of offshore wind and 8.5 GW of electrolyser capacity by 2050. After implementing all planned projects, Lithuania could produce all its necessary electricity from renewables by 2030 and potentially become an exporter'. The government's proactive efforts have established a strong regulatory framework and investment conditions.



Sweden

Sweden's long coastline offers vast offshore wind potential, with 68 GW of projects in planning but few realised. Heavy industries see hydrogen as key to replacing fossil fuels, driving Sweden to double its electricity use from 135 TWh to 300 TWh by 2045, with offshore wind playing a crucial role. Nuclear power and carbon capture will also contribute to achieving net-zero by 2045.

Poland

Poland sees great potential in offshore-wind energy, with 33 GW available in its maritime areas. While no offshore-wind farms are yet operational, 8.4 GW are under construction, with the first expected by 2026. Poland aims to use offshore growth to boost green hydrogen production. Despite modest government targets (2 GW by 2030), demand for green and blue hydrogen is expected to rise from zero to 450,000-510,000 tonnes by 2030.

Hurdles to overcome

Countries around the Baltic Sea may have varying energy mixes, offshore wind and hydrogen targets, but many of the obstacles they face on the path to reaching those climate goals are similar:

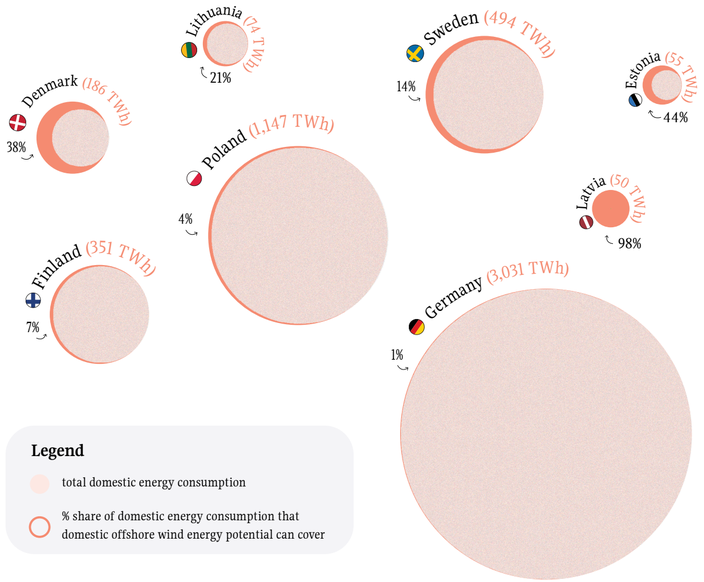
- Investors and industry see the lack of clear, binding political targets as a risk in the development of capital-intensive projects
- Supply-chain shortages, affecting materials and equipment, increase costs, risks and delays further; this is compounded by global inflation
- Lengthy and complex planning and permitting processes increase uncertainty, risks and possible delays
- The many stakeholders can create acceptance issues over innovative projects involving offshore-wind energy and/or hydrogen
- A lack of expertise and skilled labour makes the timely implementation of projects challenging
- Hydrogen in particular suffers from uncertainties surrounding demand and uptake, as well as the cost of green electricity for electrolysis

Transnational cooperation towards 2050

Regional offshore-wind and green-hydrogen infrastructure in the Baltic Sea Region

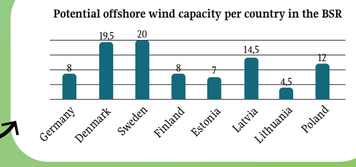
Destined to work together

The Baltic Sea Region countries differ greatly in offshore wind potential and energy consumption. Germany accounts for half the region's energy use, and the total potential offshore-wind output of 326 TWh across the Baltic Sea would only cover a tenth of its 2022 needs. In contrast, Latvia's offshore wind capacity could nearly meet its entire domestic demand! The region's onshore wind and hydropower potential also means that many countries are even more suited to becoming green energy exporters.



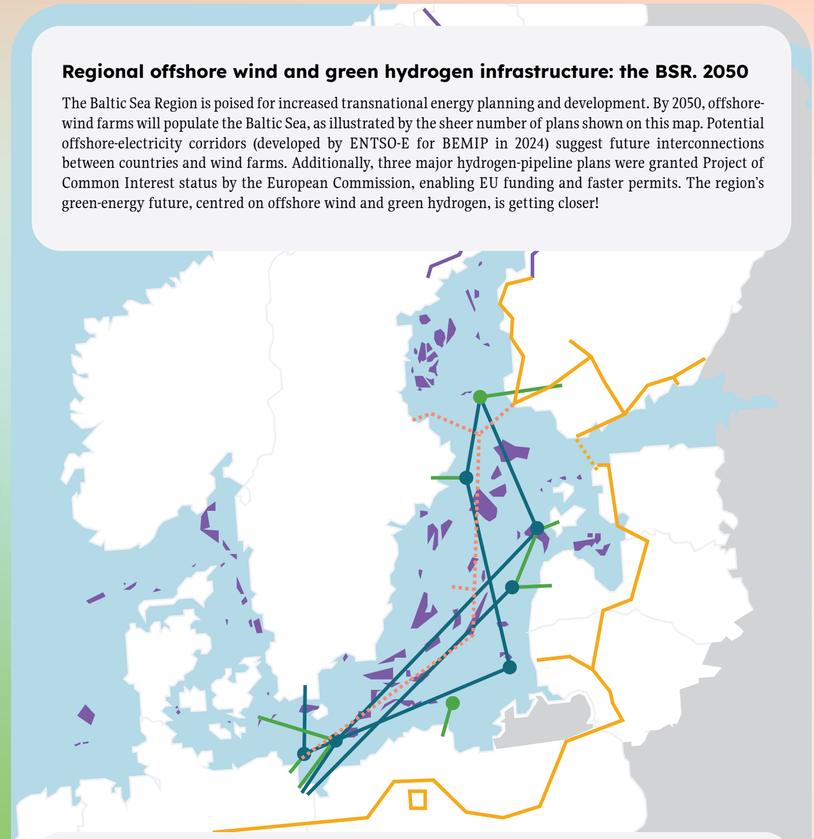
A bright – and windy – future

The Baltic Sea Region could host 93 GW of offshore wind capacity by 2050! While countries differ in the size of their maritime space, even smaller areas can generate significant green electricity. This chart highlights each country's offshore wind development potential in gigawatts.



Regional offshore wind and green hydrogen infrastructure: the BSR. 2050

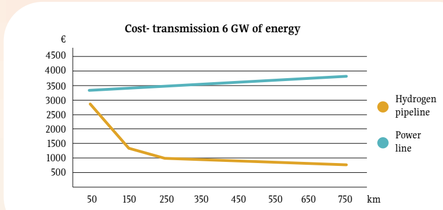
The Baltic Sea Region is poised for increased transnational energy planning and development. By 2050, offshore-wind farms will populate the Baltic Sea, as illustrated by the sheer number of plans shown on this map. Potential offshore-electricity corridors (developed by ENTSO-E for BEMIP in 2024) suggest future interconnections between countries and wind farms. Additionally, three major hydrogen-pipeline plans were granted Project of Common Interest status by the European Commission, enabling EU funding and faster permits. The region's green-energy future, centred on offshore wind and green hydrogen, is getting closer!



Green hydrogen regional cooperation

While green hydrogen is growing at national and local levels in the Baltic Sea Region, regional cooperation is key to unlocking its full potential. Initiatives include cross-sector consortia for hydrogen pipeline plans with PCI status and gas-transmission operators signing a Memorandum of Understanding for transnational hydrogen cooperation.

Beyond its benefits to the climate and energy security, green hydrogen offers financial advantages: medium to long-distance pipelines are cheaper and require less space than electricity grids, a crucial factor in the densely used Baltic Sea.



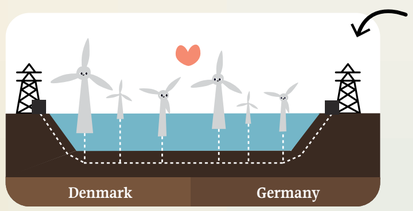
Pylons or pipelines? Comparing land use for transmission of 42 GW

14 high-voltage pylons
= 1000 meters wide

An underground 1,2 meter-wide pipeline
=20 meters wide

The future is now

The path to a transnational energy system is being forged through cross-border projects. Innovative initiatives like energy islands, which serve as transnational hubs for offshore wind and green hydrogen, are emerging across the Baltic Sea, from Estonia's Saaremaa to Sweden's Gotland. Bornholm in Denmark leads the way, with a connection permit for its 3 GW offshore wind development already secured.



Kriegers Flak CGS

The Kriegers Flak Combined Grid Solution is the world's first hybrid grid system, linking Denmark's Kriegers Flak and Germany's Baltic 1 and 2 offshore wind farms. Together, they can power over a million households and provide an additional 400 MW of transfer capacity for electricity between east Denmark and Germany.

ELWIND

ELWIND is a joint Estonian-Latvian offshore wind project in the Baltic Sea. It will meet 20% of Estonia's and Latvia's combined annual electricity consumption, replacing fossil fuels and saving around 3 million tonnes of CO2 emissions yearly. This project aims to boost energy independence, security, and affordability while reducing costs and creating new business opportunities.

Recommendations

Why transnational cooperation is key

Innovative green technologies like offshore-wind energy and power-to-hydrogen can be greatly optimised through transnational, region-wide planning. This helps to ensure that:

1. Best practices and lessons learnt in new domains like green hydrogen are widely shared
2. Supply chains and labour are coordinated and developed in accordance with the planned project pipeline in the region
3. Power production can meet demand (both within Member States and across borders, and for power-to hydrogen projects)
4. Maritime space is used efficiently, as regional offshore-wind grids, and hydrogen pipelines, require less space and resources than radial connections
5. Resources in skill and infrastructure-building are pooled to maintain a leading position for the Baltic Sea Region and the EU in green technologies

What is the best way to tap into these multi-disciplinary benefits? Below is a list of recommendations for each of the key target groups of the BOWE2H project.

Energy industry

Choose project sites compatible with current and future transmission systems. Form public-private partnerships and consortia to share costs and expertise. Strengthen supply chains and provide career opportunities in offshore wind and hydrogen sectors.

Research

Create a hydrogen valley for large-scale training and practical experience. Research energy-system costs, identify bottlenecks, and study socio-economic effects of renewable projects. Develop innovative financing models to support green-energy initiatives.

Local authorities

Engage communities early in project planning to build trust and minimise opposition. Maintain transparent communication and support dialogue between developers and civil society. Offer economic incentives to local communities and promote education to raise awareness about renewable-energy benefits.

Grid operators

Develop cross-border electricity and hydrogen infrastructure. Draft funding strategies for transmission infrastructure and increase grid capacity for renewable energy. Implement smart grid technologies, seek partnerships, and establish national hydrogen TSOs for a coordinated hydrogen grid.

Policy

Develop consistent long-term policies for green transitions, focusing on offshore wind, hydrogen, and interconnected power and gas grids. Harmonise national strategies to boost offshore-wind power and hydrogen efficiency. Adapt tender rules, provide financial incentives, and establish grid access points to encourage investments. Simplify permitting processes to reduce delays. Embed security in energy planning on a regional level. Foster acceptance measures in project planning. Create a framework for transnational exchange between advanced offshore & hydrogen countries, and starters. Collaborate with other governments in the BSR and form a regional training program to boost skilled labor.

Credits: Content: Anika Nicolaas Ponder, Dàmir Belltheus Avdic, Devon Petrecca, Pierre Ståhl, Indré Gecaité, Roman Bykov, Kamila Tarnacka, Julia Lange, Zane Kaufelde **Design**: Julie Hertel, Odile Stabon

Sources: European Commision, 2023; Kupetz, GASCADE (ed.), 2024; Green Hydrogen Organisation; State of green, Reglobal (ed.), 2023; VEO, 2023; Edwardes-Evans, S&P Global (ed.), 2021; BloombergNEF, 2020; Federal Ministry for Economic Affairs and Climate Action, 2023; PWEA Konferncja-offshore, 2022; Tomaszewski, 2023; Norris, RenewableUK (ed.), 2024; Government Offices of Sweden (ed.), 2024; Entsoe (ed.), 2022; Entsoe (ed.), 2024; BotH2nia (ed.), 2023.

BOWE2H

Between 2022 and 2024, BOWE2H implemented a metastudy, original research, an event series, and qualitative interviews with private and public stakeholders in Latvia, Lithuania, Poland, Germany, and Sweden to identify key obstacles and drivers for offshore wind-energy and hydrogen development.

Consortium

IKEM

POLISH WIND ENERGY ASSOCIATION

LITHUANIAN ENERGY AGENCY

LATVIAN ASSOCIATION OF LOCAL AND REGIONAL GOVERNMENTS

ENERGIKONTOR SYD

FOUNDATION OFFSHORE WIND ENERGY

For access to the BOWE2H metastudy, final report, digital poster, and stakeholder interviews

BOWE2H is inspired by the unique regional energy collaboration efforts of BEMIP - the Baltic Energy Market Interconnection Plan.

“Through BEMIP, the Baltic Sea region has been a stronghold of regional cooperation in the field of energy that has delivered the integration of all Member States in the region into our energy market. We have now the opportunity to use this tradition and momentum to work together on reaching our climate targets and ambitions while maintaining energy security in the region.”

Catharina Sikow-Magny
Director of Green Transition and Energy System Integration,
DG Energy, European Commission