Ea Energy Analyses

Value of Offshore Development for Baltic Countries

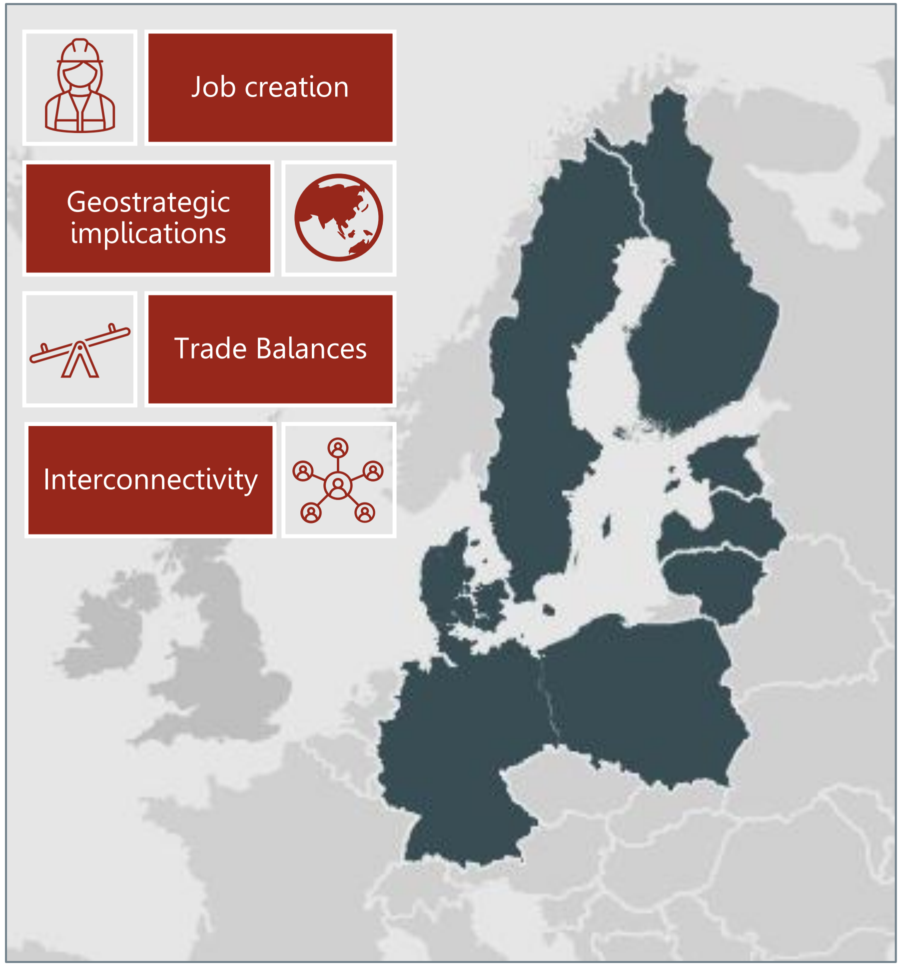
Final Report – December 2024

Disclaimer

The study was commissioned by 50Hertz to create new knowledge about the broader economic benefits and geostrategic advantages of offshore wind development, (hybrid) interconnectors and cooperation in the Baltic Sea region with the aim to enhance classical socio-economic cost-benefit analysis and to foster stakeholder dialogue. As the analysis is based on the offshore wind development scenarios published as part of the ENTSO-E Sea-Basin ONDP Report 2024 for the Baltic Sea, the results and numbers presented in the report should be taken as potentials rather than actual numbers.

Contents

Purpose of the study



This study aims at:

- highlighting the **broader economic benefits and geostrategic advantages** of offshore wind development and cooperation in the Baltic Sea region;
- based on **quantitative** and **qualitative** insights and
- to foster **stakeholder dialog** about the broader benefits of offshore wind development

Geographically, the study focuses on Denmark, Germany, Sweden, Finland, Latvia, Lithuania, Estonia and Poland.

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Executive Summary

Baltic Sea Region: key characteristics

- The Baltic Sea region includes eight countries with about **152 million people** and an estimated workforce of approximately **70 million people employed*.**

- The **combined GDP of the regions is of approximately EUR 5.5 trillion**, representing approximately 32% of the total EU-27 GDP **.

- **The Baltic Sea region has set non-binding targets of 70.2 GW by 2050 (ONDP 2024).** Wind speeds are in the range of 7.9 – 9.6 m/s (as measured at 100m above sea level).

Source: EUROSTAT

** Estimated as total people employed in the Baltic Region on a full-time basis (avg. work week of 39,3 hours) in 2023*
*** Estimated as the GDP at market prices of countries in the Baltic Region in 2023*

What secondary benefits does the offshore wind buildout bring for the Baltic Sea countries?

Job creation

Communities will **benefit from direct job creation and spillover effects**, especially in port regions.

Creation of jobs and **added value** includes **spill over into other industries**, such as green steel and Power-to-X, fuel-shifting and improvement in energy-related trade balances.

Potential of the entire value chain

The Baltic Region has capabilities to support the **development** of the entire **offshore value chain**, thus enabling even higher job creation.

But regional cooperation is needed to establish a common long-term **commitment to attract investors**.

Interconnectivity

Interconnectors, including hybrid infrastructure, are essential for the Baltic Region **to utilise the full offshore wind potential** to achieve net-zero emissions.

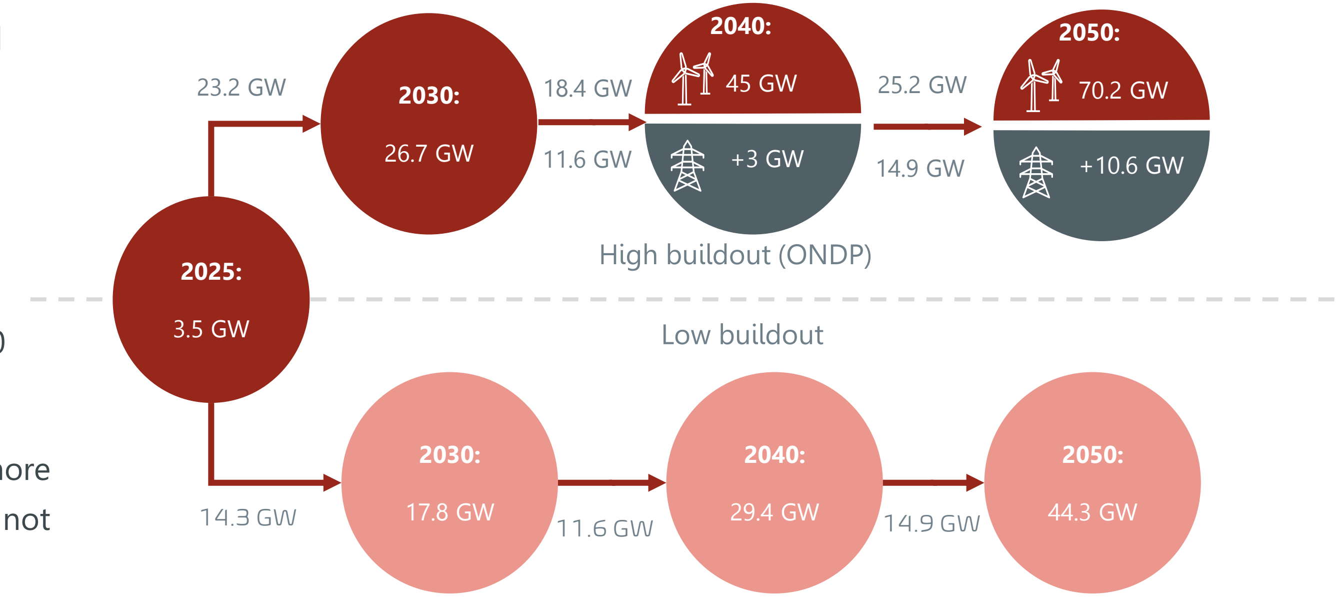
Interconnected offshore wind can **support energy sovereignty and resilience** through: i) a more integrated electricity market and ii) deepening European energy alliances.

Quantitative foundations for the analysis

The study builds on quantitative assumptions about **offshore wind generation**, **transmission** infrastructure and **offshore-induced electrolyzers.**

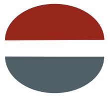
Two alternative scenarios:

- **High:** based on non-binding targets expressed by Baltic Sea countries, including hybrid expansions by 2040 (3 GW) and 2050 (10.6 GW).
- **Low:** non-binding targets are only partially realized, offshore transmission buildout is lower, and hybrid expansions do not materialize.



Offshore wind generation & transmission: The figure above shows the buildout (arrows) and the cumulative offshore wind generation and transmission infrastructure capacity (bubbles)

Legend:



stands for offshore generation capacity
stands for hybrid transmission capacity

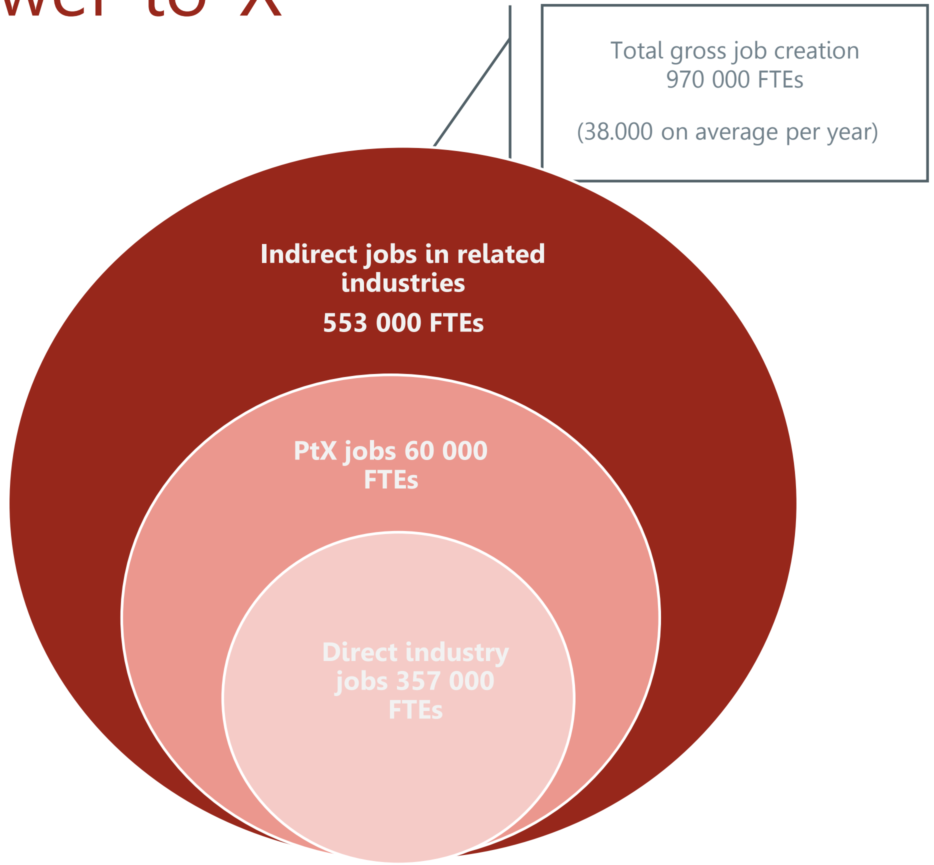
Notes:

- *Low scenario: For DE, DK and PL buildout is 30% lower than the high buildout in 2030, 20% lower in 2040 and 10% lower in 2050. For all remaining countries, buildout is halved in all years.*
- *The main quantitative source for the study is the Offshore Network Development Plan (ONDP 2024) developed by (ENTSO-E).*

Creation of jobs and **added value** includes spillover effects into other industries, such as green steel and Power-to-X

If the high buildout scenario materializes for the years considered in the study (2030, 2040, 2050):

- **Direct industry job creation** is estimated at 357 000 FTEs, created throughout the lifetime of an offshore wind project: design, wind turbine manufacturing, balance of plant, installation, operation and maintenance and decommissioning. Transmission infrastructure-related jobs are included.
- **PtX jobs** are estimated at 60 000 FTEs, including spillover effects from electrolysers to related industries.
- **Gross job creation** is estimated at 970 000 FTEs, including both direct and indirect jobs, as well as estimated employment effects on other sectors of the economy.

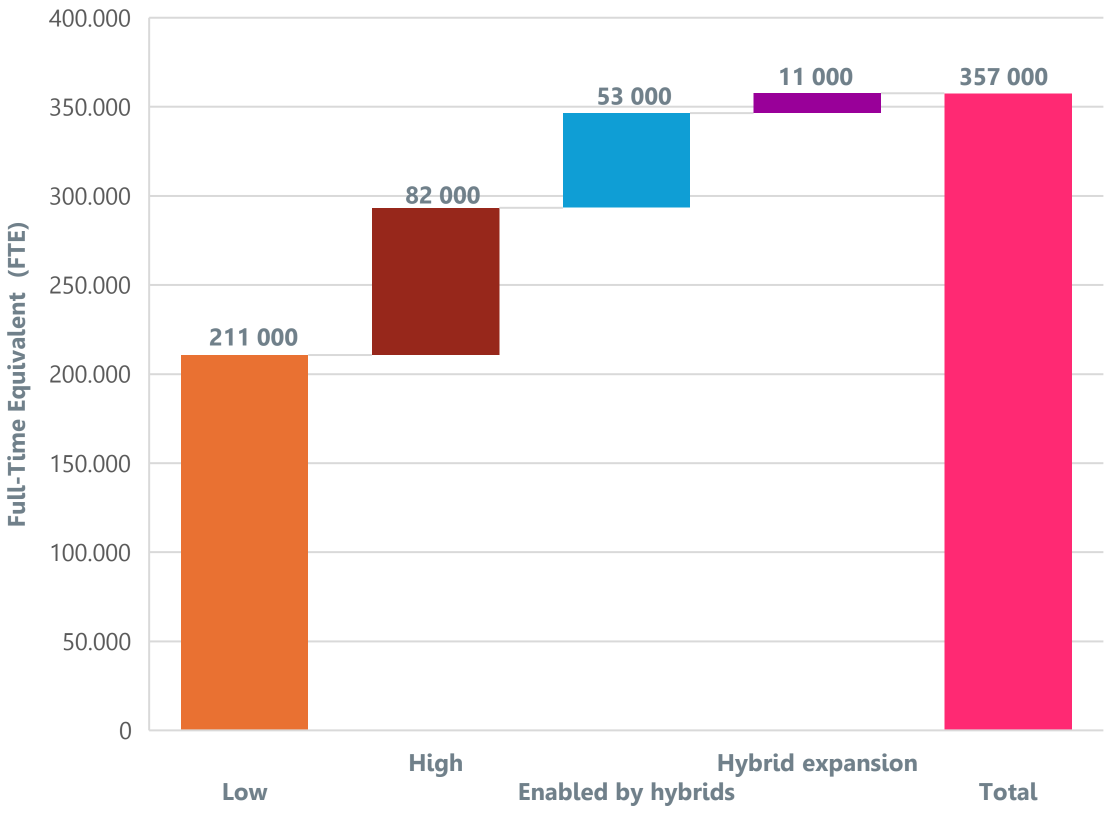


Job creation in the high build out scenario in the Baltic Sea Region over the years 2025-2050

Offshore potential (70 GW) in the Baltic Sea region could create 357.000 direct jobs - if we start now

Direct industry jobs in the Baltic Sea region

- Potential for the creation of approx. 357.000 direct industry jobs (FTEs) from the buildout between 2025-2050 (on average 14.250/year).
- This includes the complete life cycle of a connected offshore wind project and necessary transmission infrastructure, including the development of hybrid interconnectors.
- Additional hybrid interconnector projects result in a total of approx. 64 000 jobs (FTEs) (18% of all direct jobs created):
  - — 53 000 FTEs based on the offshore wind farms and.
  - — 11 000 FTEs based on hybrid transmission infrastructure.

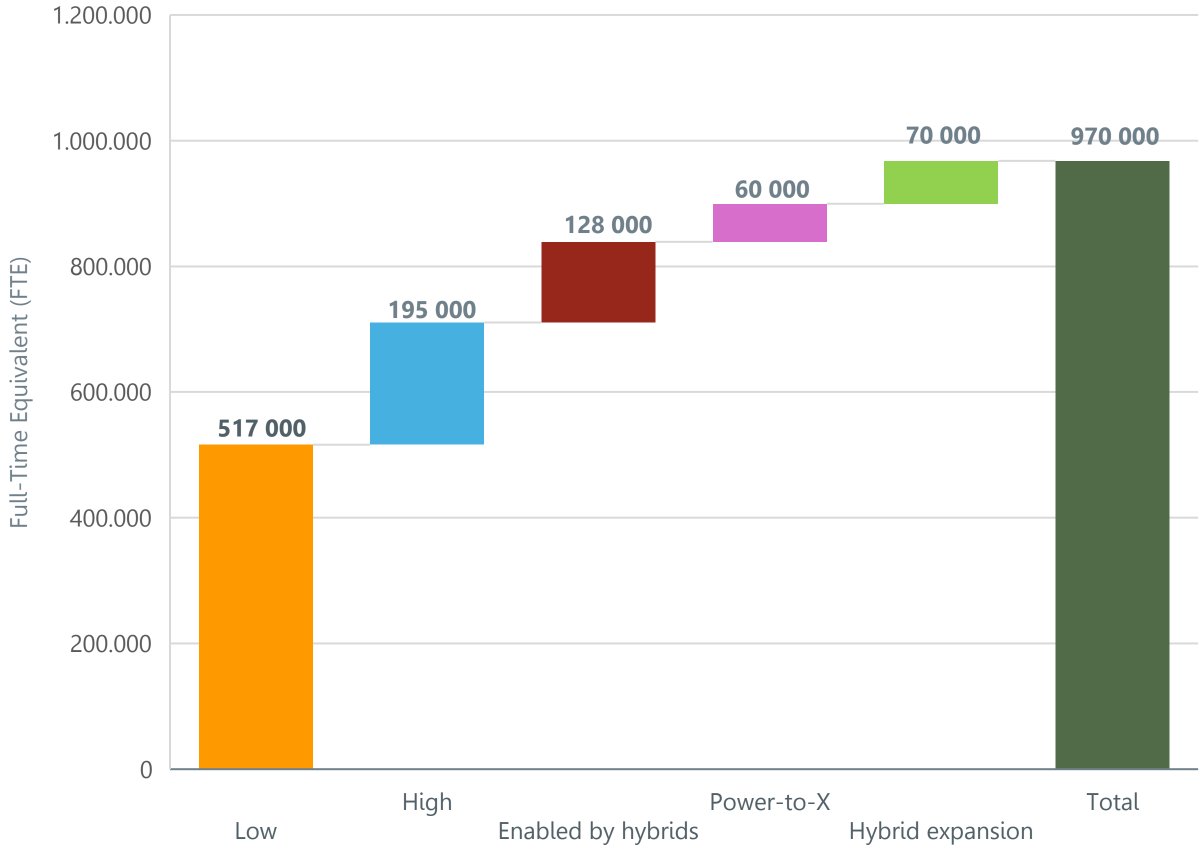


Note: *"Enabled by hybrids" are jobs in offshore wind generation that can be attributed to hybrid infrastructure development, while "hybrid expansion" jobs are associated with expanding the hybrid transmission infrastructure itself.*

Realizing the Baltic region's offshore potential (70 GW) supports gross job creation of approx. 970.000 FTEs

Gross job creation in the Baltic Sea region

- Spillover effects from offshore wind into other industries increase the potential to 970 000 jobs (FTEs) in the period 2025 – 2050 (38 000 FTEs on average/year).
- Especially communities and near port areas benefit from new jobs, supporting local employment in engineering, logistics and maritime services.
- Gross job creation includes increased workforce required to support industrial growth in several sectors, such as steel production and Power-to-X.
- Gross job creation based on additional hybrid interconnectors amount to 198 000 FTEs over the whole period (on average 7 920 FTEs/year).



The Baltic Region has capabilities to support the **development** of the entire **offshore value chain**, thus enabling even higher job creation.

- **Strategic Port Locations and maritime tradition:** Ports are the first necessary step to support the installation, operation and maintenance of offshore wind power plants.
- **Existing manufacturing base:** Germany, Denmark and Poland have strong manufacturing facilities for the main components of wind turbines. The Baltic countries can further develop their already solid manufacturing foundation and competitive workforce in this sector, with significant job creation within the sub-component industry.
- **Skilled Workforce:** Educational institutions like universities and training centres offer already specialized training programs to ensure a talent pool ready to support the entire offshore wind value chain.

Regional cooperation and a common long-term strategy is key to attracting investors and maximizing the region's potential.

Note: *This information is based on semi-structured interviews with stakeholders from all eight Baltic Sea countries and a global supplier.*

Interconnectors **are essential for the Baltic Region** to utilize the full offshore wind potential

The analysis has identified three effects resulting from increased interconnectivity:

1. **Immediate market benefits**: increased producer and consumer surplus, congestion rents.

   „Classic“ socio-economic results from project evaluation:
   Together with interconnector flows, net position of countries, curtailment an overall picture of the project's effect on the energy system can be generated.

2. **Unlocking the full offshore potential** by connecting surplus generation regions to demand centers.

   Offshore wind development beyond national demand
   Additional direct and indirect job creation through more solid supply chain incentives, state income from auctioning revenues, industry tax payments.

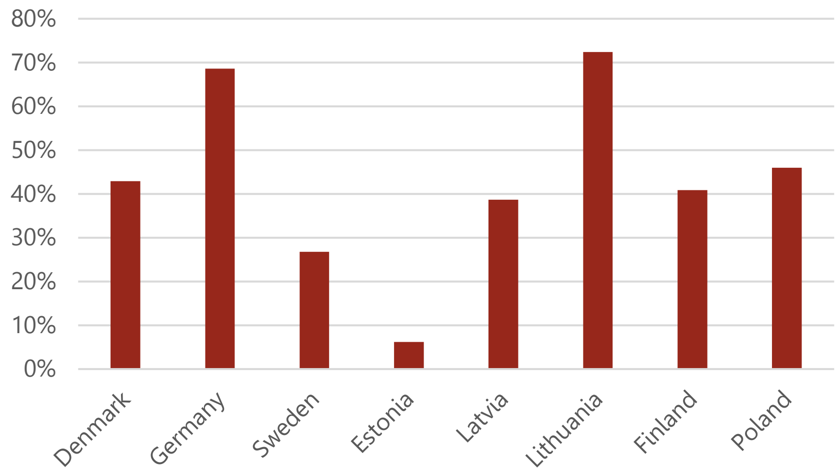
3. **Increasing efficiency and security of supply** by further integrating the EU internal energy market.

   Cheaper electricity and cheaper hydrogen
   Interconnectivity is the key element in attracting offshore wind and electrolyser investors that ensure energy independence and resilience

Interconnected offshore wind can **support energy security** through a more integrated electricity market, and deepening European energy alliances

- **Market integration**: An integrated electricity market with hybrid interconnectors improves energy security by enhancing market efficiency, enabling cross-border flows to manage peak loads, and reducing price volatility, as shown during the 2022 energy crisis.
- **Energy Alliances:** Offshore wind and interconnectors in the Baltic Sea are fostering stronger European energy alliances by boosting energy independence, cutting reliance on imports, and enhancing regional security through greater market integration.

Energy imports dependency rate
2022, based on terajoules



Source: Eurostat: Shedding light on energy in Europe - 2024 edition
**Estonia has a notable low dependency rate due to domestic oil shale which is used to produce oil products*

Outlook for Offshore Wind in the Baltic Sea

The ONDP 2024 as the quantitative foundation for the study

The **main quantitative source** for the study is the Offshore Network Development Plan (ONDP), which is a new component of the Ten-Year Network Development Plan (TYNDP) developed biennially by the European Network of Transmission System Operators for Electricity (ENTSO-E).

The first edition of the ONDP for the Baltic Sea region (2024) delivers:

- A high-level outlook on the **offshore generation capacities potential** for the region, which reflect non-binding targets expressed by involved Member States
- The resulting **offshore network transmission needs**

The ONDP 2024 Outlook for Offshore Wind in the Baltic Sea provides the quantitative foundation for the study

The ONDP 2024 has three offshore **transmission capacity categories**:

- **Radial connections**: these are expected to be the most common kind of connections until 2040.
- **Existing and planned hybrids:** this category refers to either already existing hybrids (e.g., Kriegers Flak) or projects that have been announced as hybrids and are currently under development (e.g., Energy Island Bornholm, Elwind).
- **Hybrid expansions:** these are model-optimized hybrid expansions identified through ONDP modeling work and are realized in the high scenario.

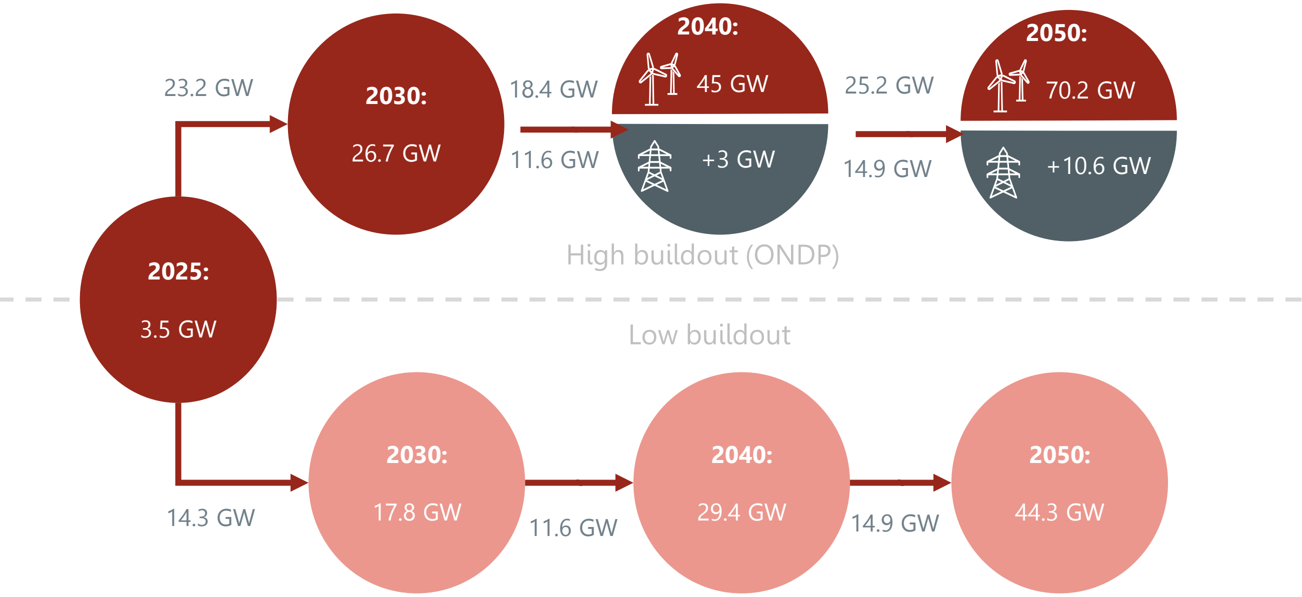
Taking the ONDP as starting point, the present study considers:

- Two alternative offshore wind buildout scenarios: **high** and **low.**
- Offshore transmission infrastructure development: **radial** connections and **hybrid** infrastructure.
- **Power-to-X** development (electrolyser buildout).

High scenario: Baltic Sea countries achieve 70 GW offshore wind potential

The estimated potential for offshore wind in the Baltic Region is 70.2 GW. This allows defining two main scenarios:

- **High:** under this scenario, the non-binding targets expressed by Baltic Sea Region countries materialize. Hybrid expansions by 2040 (3 GW) and 2050 (10.6 GW) as modeled in the ONDP 2024 also materialize.
- **Low:** this is an alternative scenario, in which a lower offshore wind buildout takes place. Accordingly, offshore transmission buildout is also lower. In this case, hybrid expansions do not materialize.



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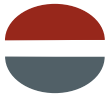


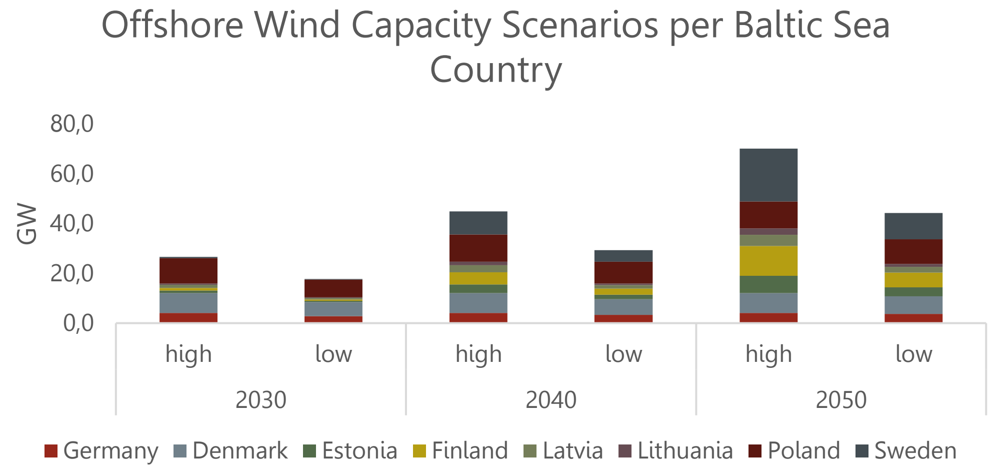
stands for offshore generation capacity
stands for hybrid transmission capacity

Notes: *Low scenario: for DE, DK and PL buildout is 30% lower than the high buildout in 2030, 20% lower in 2040 and 10% lower in 2050. For all remaining countries, buildout is halved in all years.*

Hybrid expansions do not materialize under the low buildout scenario

Takeaways:

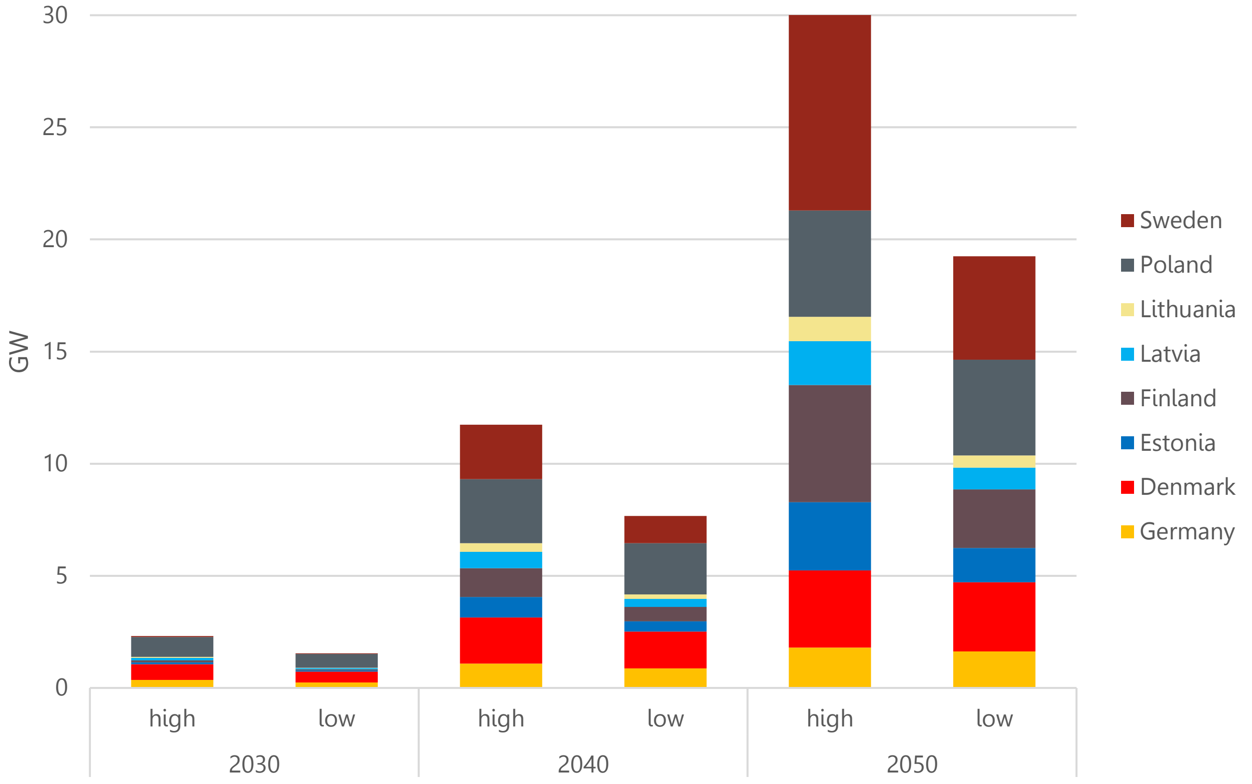
- Radial connections and the "existing and planned hybrids" are equal to offshore wind capacity in both high and low scenarios.
- In the low scenario, hybrid expansions are not included, and radial connections are reduced.
- In the outlook, all offshore development is connected to shore and part of transmission costs are counted in the offshore wind development cost.



Electrolyser capacity is modelled as a share of offshore wind installed capacity

To account for the secondary benefits of Power-to-X development in the Baltic Region, the outlook models **offshore-wind induced electrolyser development**:

- Electrolyser capacity included in the outlook is limited to the deployment resulting from offshore wind expansion.
- Other country targets on Power-to-X development are not included.
- The broader Power-to-X supply chain, including the conversion of H2 to more advanced green fuels, is not part of the outlook.



Note: *This study assumes that by 2030, 9% of offshore wind generation will be used for hydrogen production, rising to 26% by 2040, and reaching 50% by 2050.*

Direct Economic impacts of offshore wind

Direct costs and benefits in project assessment are affected by external factors

Costs and Benefits categories for project assessment

- CAPEX
- OPEX
- Socio-Economic Welfare
- CO_2 variation
- RES Integration
- Non-CO_2 emissions
- Grid losses
- System Adequacy
- System Security
- Reduction of necessary reserves for redispatch

Main project assessment categories according to the ENTSO-E CBA Guideline (2023).

Factors affecting the business case

- Willingness to pay for green transition (CfDs, PPAs, ETS,...)
- Competing Technologies (conditions for low OPEX technologies, permitting, alternatives to green hydrogen)
- Enabling Technologies (Demand Response, flexibility)
- Geopolitics and price assumptions
- CAPEX and OPEX related risks
- Power Market Structure (bidding zones)
- Regulatory Framework for Cross-Border Cooperation

Direct benefits from offshore wind (radially connected)

1. Fuel and carbon cost savings

2. Reduced Generation Costs

3. Displaced Investments

4. Improved trade balance with neighbouring countries

5. Lower average electricity prices

6. Stakeholder effects, such as consumer surplus, producer surplus

Further direct benefits from integrated offshore wind (hybrid interconnectors)

1. Cost Efficiency through Regional Cooperation

2. Further reduction in Generation Costs (in addition to what is achieved radially)

3. Enhanced Market Value by allowing power to flow where it is most needed

4. Optimised Grid Infrastructure, reducing congestions

5. Cross-Border Support Mechanisms enabling deployment of wind power in optimal locations

6. Increased Renewable Integration by improved grid flexibility and capacity

7. Scalability and Flexibility through advanced hub configurations

8. Long-Term Cost Reduction by focusing on the most profitable and strategically timed projects

Secondary benefits are usually not included in Cost-Benefit analysis

Job creation

Geostrategic implications

Trade Balances

Interconnectivity

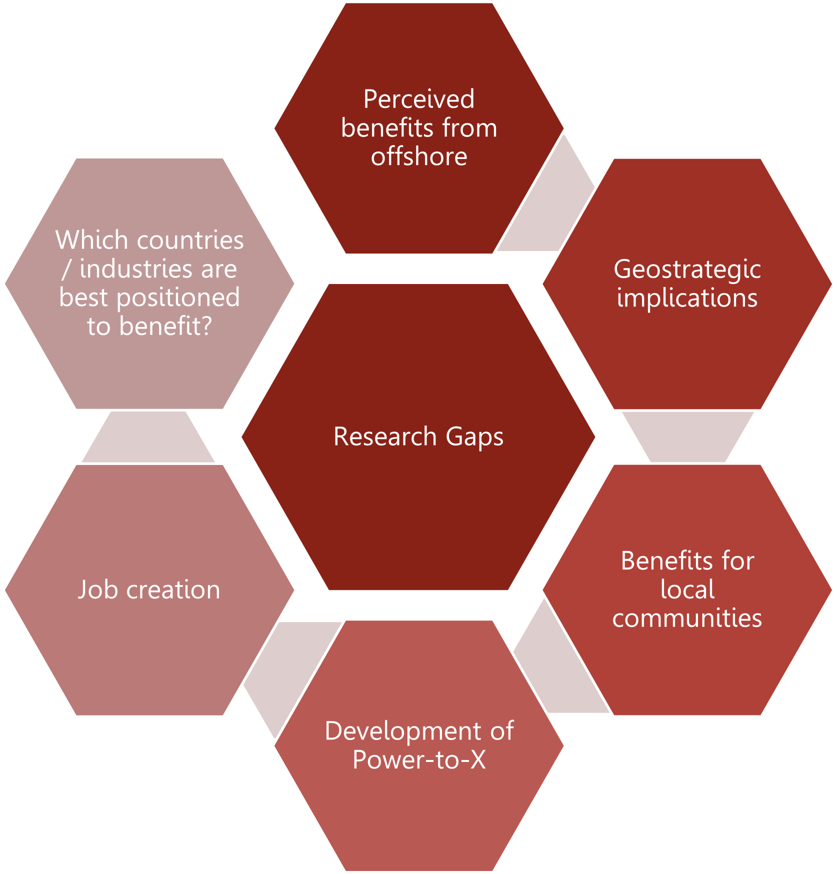
- Secondary benefits like job creation, geostrategic implications and a change in trade balances are usually not included in the project assessment of direct benefits.
- A target literature survey based on web search sources (Google Scholar, libraries, journals) focused specifically on the indirect economic effects of offshore wind in the Baltics, excluding traditional cost-benefit analyzes related to the electricity market. A total of 45 studies were identified and categorized into three main areas:

  1.Employment Effects

  2.Geostrategic Implications

  3.Other Community Benefits and Costs

Identified research gaps served as the foundation for further analyzes



- Identified research gaps were converted into questions.
- These questions were explored further through qualitative interviews.
- Where possible, they were quantitatively assessed in later analyzes.

Broader Benefits of offshore wind

What secondary benefits does the offshore wind buildout bring for the Baltic Sea countries?

Job creation

Communities will **benefit from direct job creation and spillover effects**, especially in port regions.

Creation of jobs and **added value** includes **spill over into other industries**, such as green steel and Power-to-X, fuel-shifting and improvement in energy-related trade balances.

Potential of the entire value chain

The Baltic Region has capabilities to support the **development** of the entire **offshore value chain**, thus enabling even higher job creation.

But regional cooperation is needed to establish a common long-term **commitment to attract investors**.

Interconnectivity

Interconnectors, including hybrid infrastructure, are essential for the Baltic Region **to utilise the full offshore wind potential** to achieve net-zero emissions.

Interconnected offshore wind can **support energy sovereignty and resilience** through: i) a more integrated electricity market and ii) deepening European energy alliances.

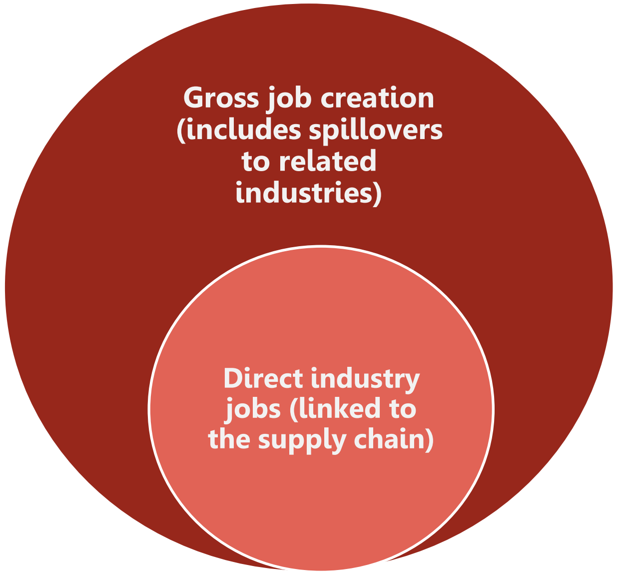
4.1

Job Creation

Job creation – two approaches

To understand job creation in the Baltic Region, the present study has estimated two different but complementary kinds of jobs:

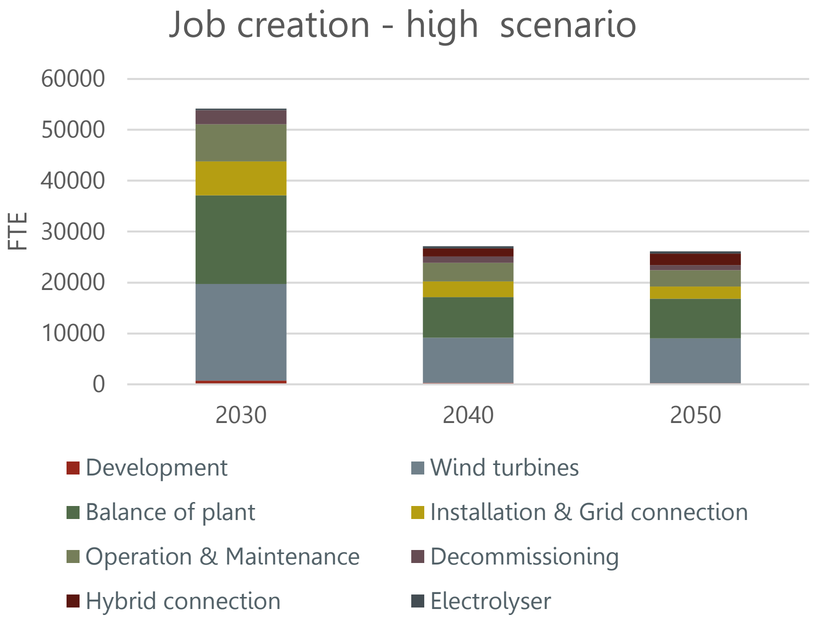
- **Direct Industry Jobs:** These are jobs directly associated to the offshore wind industry. Its estimation is based on a bottom-up approach, in which an analysis of the supply chain is conducted to identify the direct workforce required to establish and operate an offshore wind farm.
- **Gross Job Creation:** This includes both direct and indirect jobs associated to selected industries closely related to the offshore wind industry. Its estimation is based on an Input-Output (IO) analysis in which an increase in total final use (i.e., a demand-side "shock") requires output expansion which translates into an increase in employment. Gross job creation includes workforce employed both in a specific country and industry related to offshore wind and in other industries outside the relevant country, which may or may not be related to offshore wind.



Note: *Jobs are measured in Full Time Equivalents (FTEs), which represents the work of one full time employee in a year. We use the term "jobs" and FTEs interchangeably.*

Job creation – indicators: Lifetime jobs vs. yearly jobs

- **Lifetime jobs:** It refers to the total number of jobs associated with a buildout regardless of the moment in which employment occurs.
- According to this indicator, all jobs created from capacity installed a given year are assigned to that year, assuming installation only happens in the impact years 2030, 2040, or 2050.
- This total includes all jobs created throughout the project's lifetime, although job creation occurs before 2030 or after 2050. For example, jobs from capacity installed in 2030 are allocated to that year, even if they begin earlier (e.g., 2026) or continue well beyond (e.g., OPEX-related jobs).
- Lifetime jobs are measured in FTE.

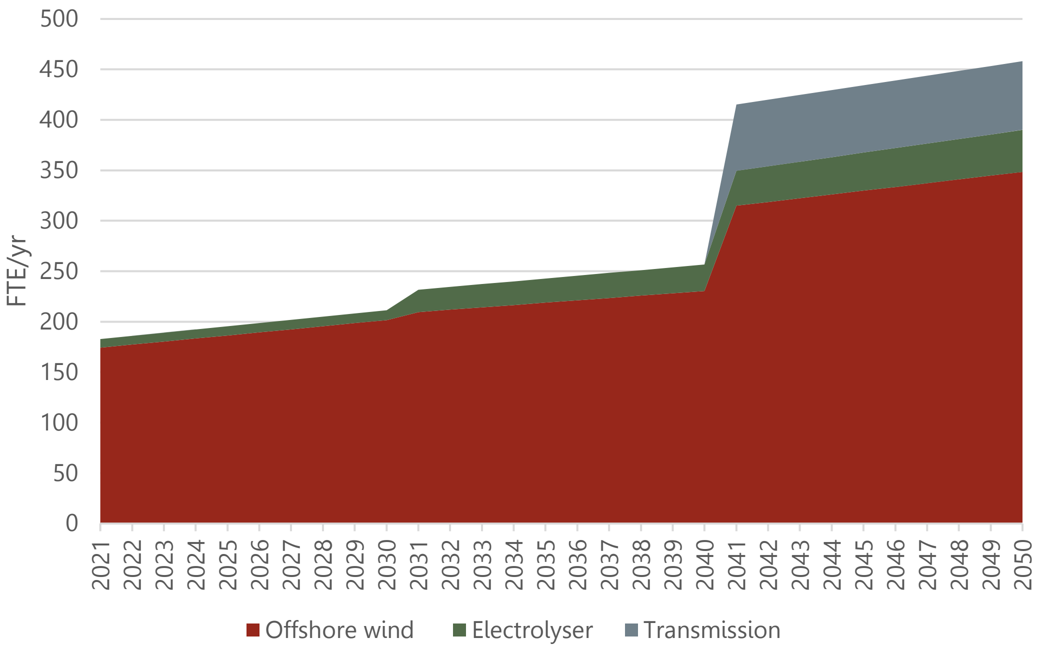


For illustrative purposes only, the figure illustrates lifetime jobs, i.e. jobs associated with the buildout and corresponding phase in the supply chain.

Note: *Jobs are measured in Full Time Equivalents (FTEs), which represents the work of one full time employee in a year. We use the term "jobs" and FTEs interchangeably.*

Job creation – indicators: Lifetime jobs vs. yearly jobs

- **Yearly jobs:** For the yearly jobs the capacity installation is spread over 10 years as a simplified assumption. Thus, for the 2030 goal, capacity is assumed to be evenly built from 2021 to 2030, and for the 2040 and 2050 commitments, it's equally split evenly over 10 years. CAPEX-jobs are calculated from the yearly buildout. OPEX-jobs last for 25 years, starting when capacity is installed, some beginning in 2026 and the last ones continuing until 2075. OPEX-jobs increase yearly until 2050, as new jobs are added each year. Yearly jobs are measured in FTE/year.

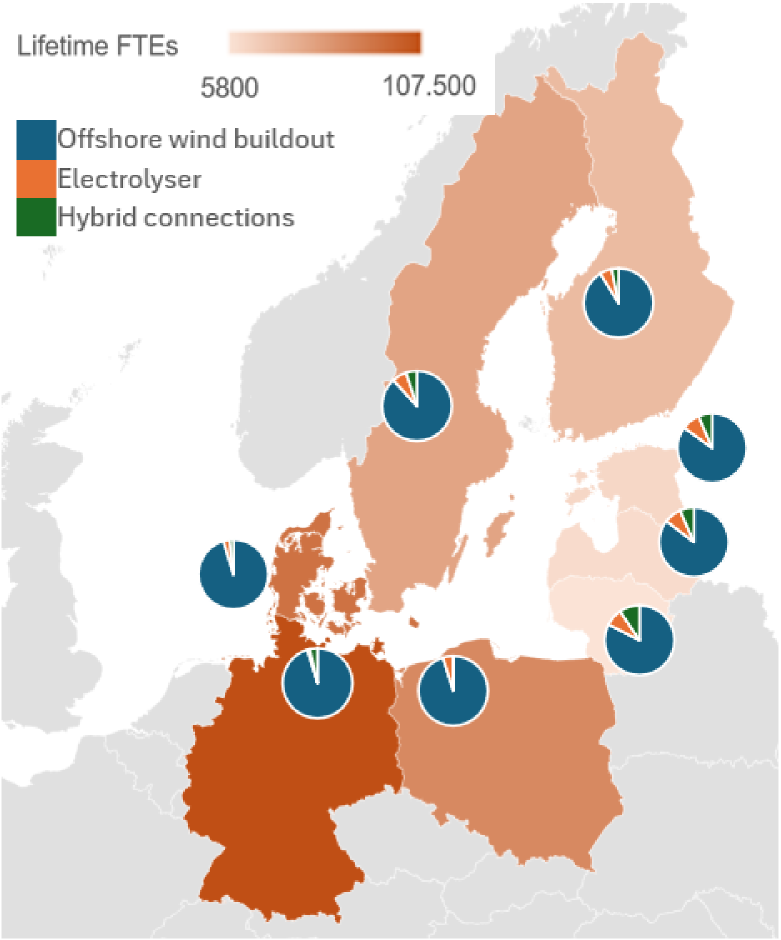


For illustrative purposes only, the figure illustrates jobs per year, i.e. jobs spread out the lifetime of the project. In this specific case, it can be seen that the country will have approximately 500 jobs per year in 2040.
The dip shown in job development is due to the distribution of non-binding policy targets for GW expansion outlined in the ONDP. In reality, a smoother distribution of jobs can be assumed.

***Note**: Jobs are measured in Full Time Equivalents (FTEs), which represents the work of one full time employee in a year. We use the term "jobs" and FTEs interchangeably.*

Communities will benefit from direct job creation and spillover effects, **especially in port regions**.

- **Direct job creation:** Communities, particularly those near port regions, will benefit from new jobs in offshore wind farm construction, operation, and maintenance, supporting local employment in engineering, logistics, and vessel services.
- **Spillover effects:** The offshore wind buildout will boost local economies through secondary industries, such as manufacturing, supply chain services, and hospitality, which will experience increased demand from the growing workforce and business activity.
- **Long-term infrastructure development:** Ports and surrounding areas will see investments in infrastructure, leading to sustained economic growth and better regional connectivity.



Direct job creation in the Baltic Region

Creation of jobs and **added value** includes spillover effects into other industries, such as green steel and Power-to-X

If the high buildout scenario materializes for the years considered in the study (2030, 2040, 2050):

- **Direct industry job creation** is estimated at 357 000 FTEs, created throughout the lifetime of an offshore wind project: design, wind turbine manufacturing, balance of plant, installation, operation and maintenance and decommissioning. Transmission infrastructure-related jobs are included.
- **PtX jobs** are estimated at 60 000 FTEs, including spillover effects from electrolysers to related industries
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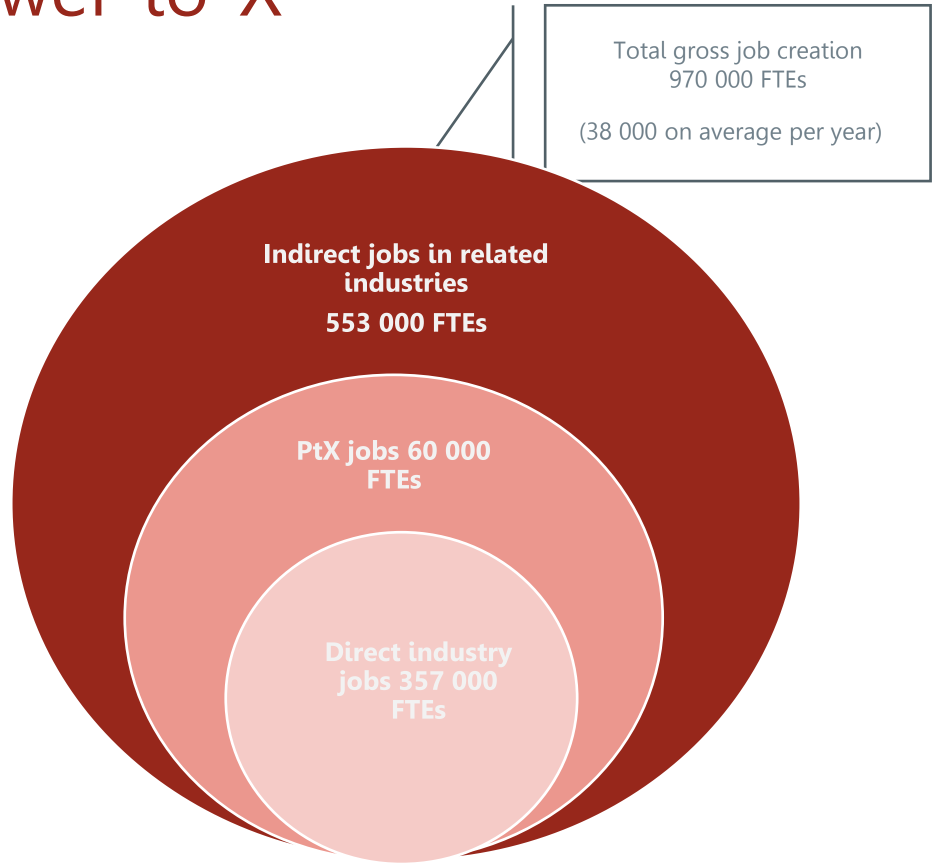
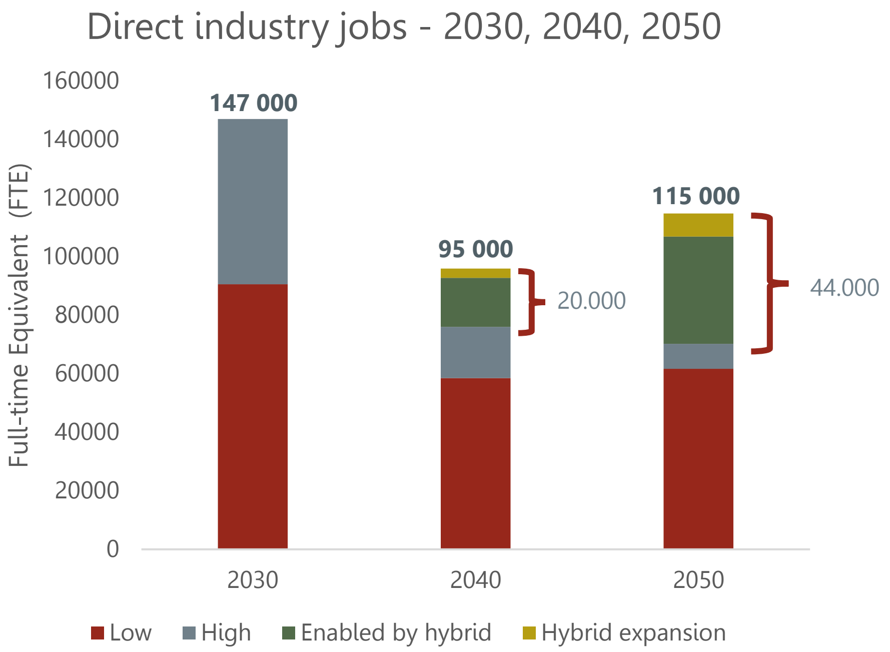


Job creation in the high build out scenario in the Baltic Sea Region over the years 2025-2050

Note: *Job creation is calculated as FTEs, e.g. full-time equivalents, meaning 1 FTE = one person being full time employed for <u>one</u> year.*

Approximately 357 000 direct industry jobs (FTEs) in the Baltic Region, if the high buildout materializes



Hybrid transmission expansion can translate into approximately 64.000 direct industry jobs (18% of all direct industry jobs in the period)

- **2030 buildout:** approximately 20 000 FTEs
- **2050 buildout:** around 44 000 FTEs

For an estimated lifetime cost of approximately 230 billion EUR - which includes offshore wind buildout and hybrid expansion – up to 357 000 direct industry jobs can be created in the Baltic Region.

- **2030 buildout**: between 90 000 and 145 000 FTEs are associated with estimated lifetime costs in the range of 53 - 86 billion EUR.
- **2040 buildout:** between 58 000 and 95 000 FTEs can be created, depending on the realized lifetime cost (35 -60 billion EUR)
- **2050 buildout:** yet an additional 60 000- 115 000 industry jobs can be created, depending on lifetime costs in the range 40 – 80 billion EUR).

Note:

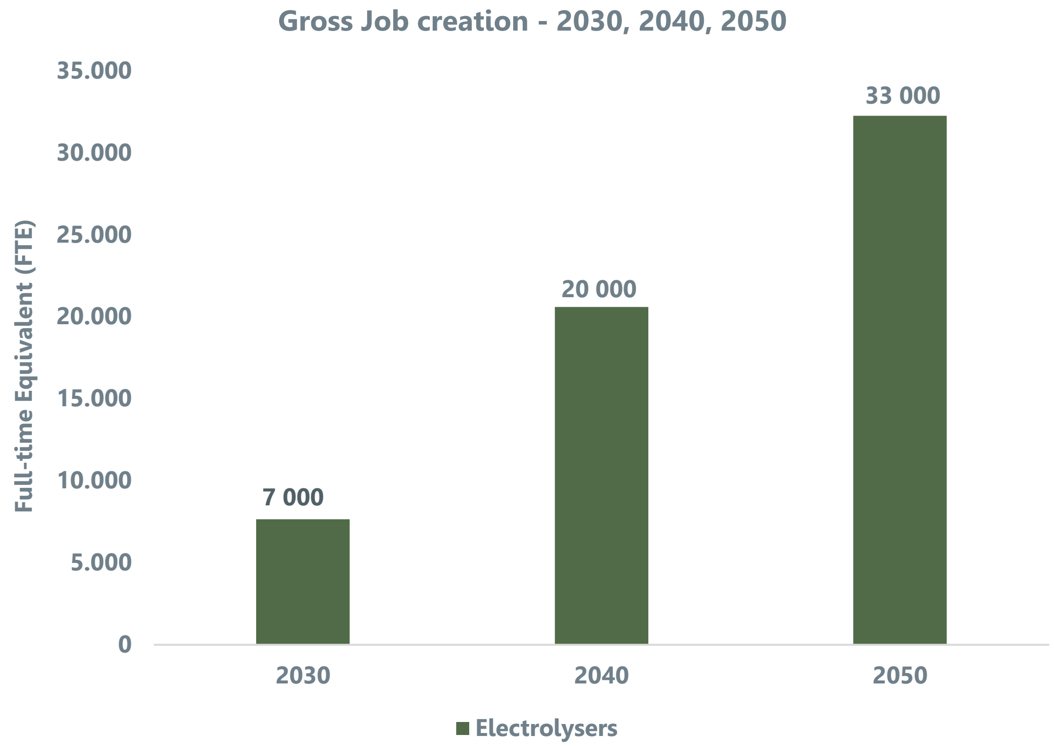
- *"Enabled by hybrids" are jobs in offshore wind generation, while "hybrid expansion" jobs are associated with expanding hybrid infrastructure only*
- *These jobs are lifetime jobs, i.e. jobs associated with a given buildout regardless of the moment in which employment actually occurs*
- *Lifetime costs include all costs in all phases of offshore wind: development, wind turbine production, balance of plant, installation and grid connection, OPEX, and decommissioning (DEPEX)*

Power-to-X – Gross job creation

For an estimated lifetime cost of EUR 20 billion, up to 60 000 jobs can be created in connection with Power-to-X development in the Baltic Sea Region.

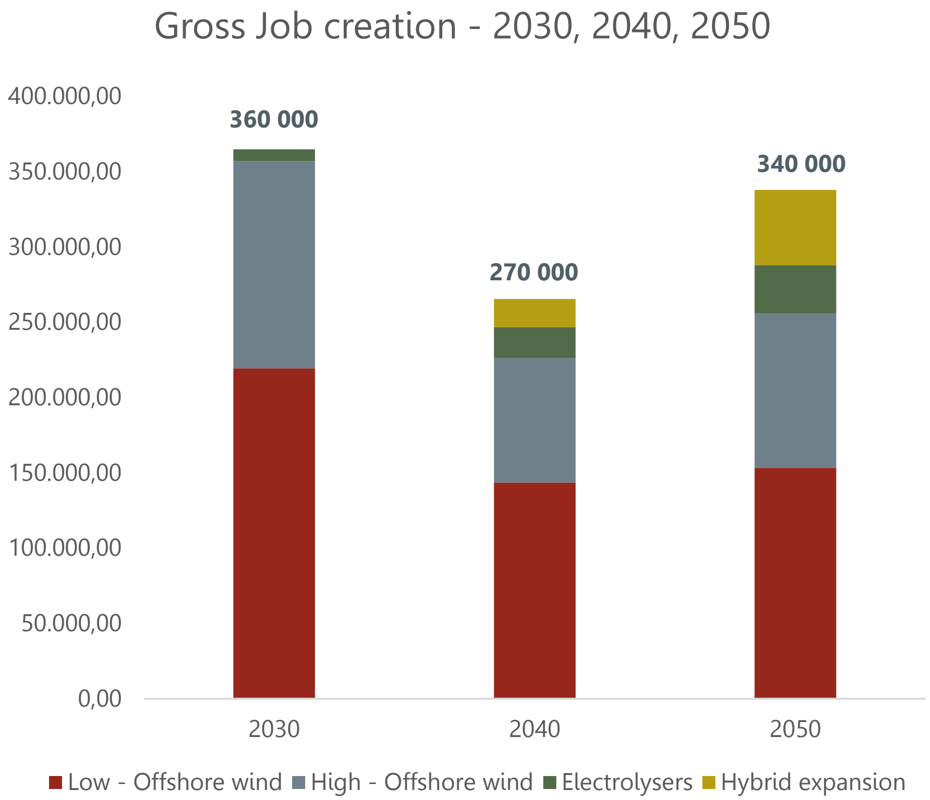
This estimate includes electrolyser development, and spillover effects into sustainable industrial growth, such as green steel and production of sustainable fuels and petrochemicals.

- **2030 buildout**: approximately 7 000 jobs can be created, as a result of total lifetime costs of EUR 2 billion.
- **2040 buildout:** between 20 000 jobs can be created, based on lifetime costs of approximately EUR 6 billion.
- **2050 buildout:** yet an additional 33 000 jobs can be created, in connection with lifetime costs of around EUR 12 billion.



Note: *These jobs are lifetime jobs, i.e. jobs associated with a given buildout regardless of the moment in which employment actually occurs.*

Gross job creation in the Baltic Region could reach 970 000 FTEs under high buildout



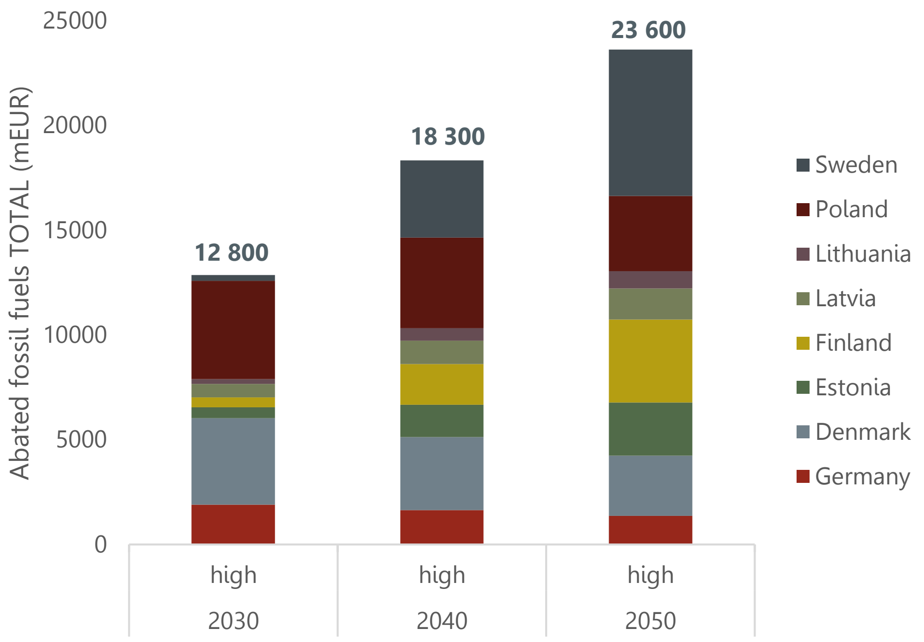
Focusing on gross job creation – which includes both direct and indirect jobs – the estimated lifetime cost of approximately 250 billion EUR associated with the high scenario buildout has the potential of creating 970 000 FTE **in total** in the Baltic Region:

- 360 000 FTE are linked to the estimated lifetime cost for the 2030 buildout (89 billion EUR)
- An additional 270 000 jobs based on 2040 buildout (70 billion EUR), including both the development of electrolysis and hybrid expansions.
- Further 340 000 gross jobs can be created, in connection with the estimated lifetime cost of the 2050 buildout (90 billion EUR).

Notes: *1) Gross job creation mentioned here are also "lifetime jobs", which are created throughout the lifetime of a project; 2) the estimated lifetime costs support jobs outside the Baltic Region as well.*

Offshore wind may markedly improve the fuel trade balance in the Baltic Sea region

- Offshore wind has the potential to **significantly improve the fuel trade balance** in the Baltic Sea region by reducing dependency on costly fossil fuel imports, keeping more capital within the region.
- Accumulated spending on fossil fuel imports in the Baltic Sea Region as of today: EUR 126 billion, contributing to trade deficits and capital outflows.
- Offshore wind deployment could offset fossil fuel imports by EUR 13 billion by 2030 and EUR 24 billion by 2050 (high scenario), improving the trade balances of the region's countries by reducing energy import costs and fostering local energy production.



***Note**: The figure shows the current and projected annual savings on fuel imports from offshore wind deployment in the Baltic Sea, based on 2021 energy balances and 2030 forward prices.*

4.2

Potential of the entire value chain

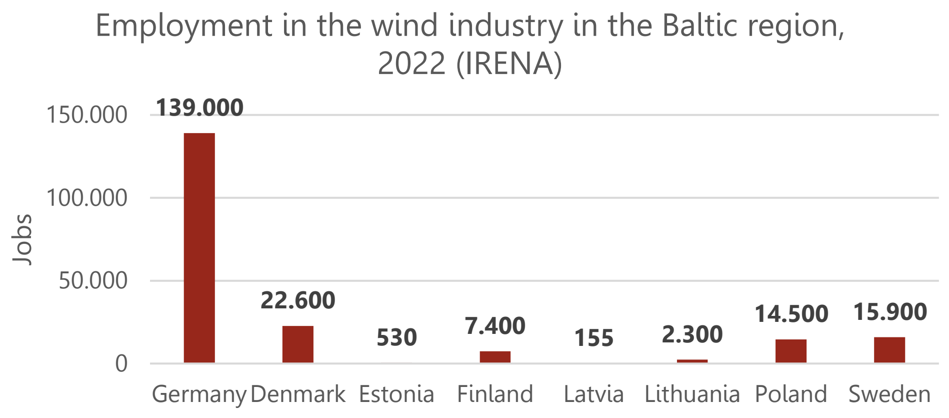
Narratives about job distribution in the Baltics

Static scenario:

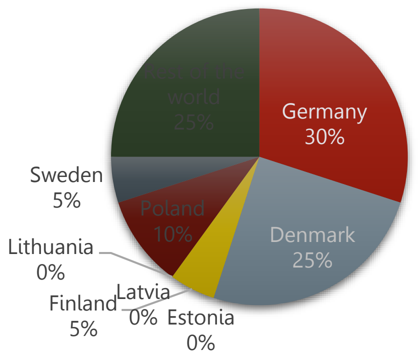
- Offshore wind is a global industry, and locational decisions are therefore based on competitiveness considerations. Ease of access to components, availability of labor and established supply chains determine job creation. The industry is characterized by first-mover advantages, which have made of countries like Germany and Denmark major players. These countries are the main beneficiaries and will continue to be in the future.

Dynamic scenario:

- Emerging countries with offshore wind potential will be able to attract investments to the country. These investments will translate into local jobs, because cooperation in the Baltic region will be fruitful and specific efforts on upskilling and re-skilling will be fruitful.



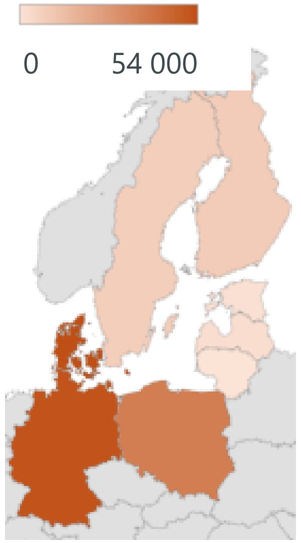
Study assumption on current distribution of offshore wind industry



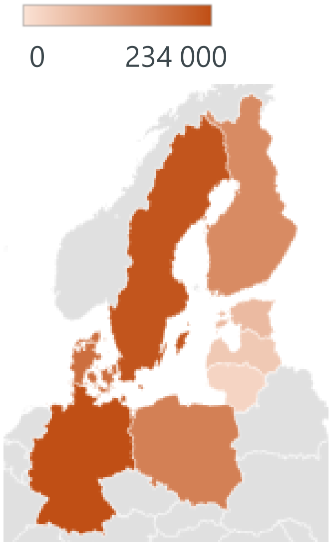
Job distribution – Theory of change (Narrative) 1/2

Reality will be in between the static and dynamic scenarios

- **Competition in a globalized industry**: global players will continue dominating the offshore wind supply chain and competition will largely determine job creation and locational decisions. First movers will keep their advantage.
- **Efforts are fruitful:** cooperation in the Baltic Region will trigger changes that will strengthen the position of countries in the region. Some countries, each based on their strengths, will manage to participate in parts of the offshore wind supply chain, rather than being mere receivers of investments.



Distribution of offshore wind jobs by 2030

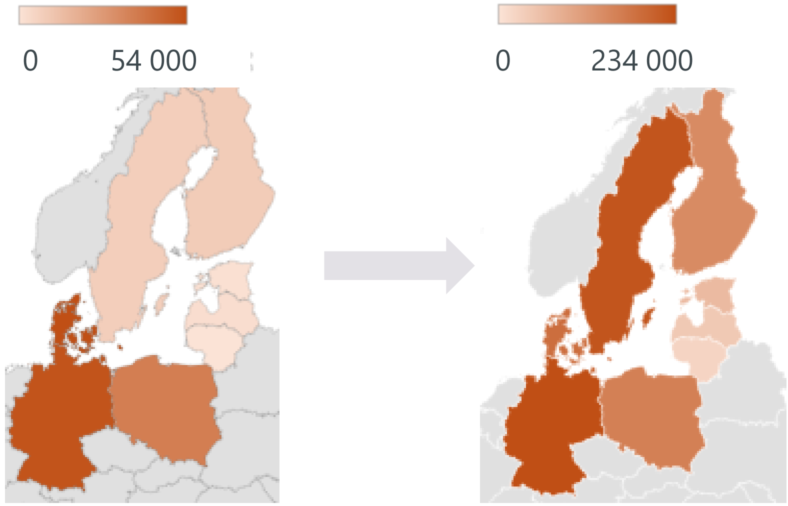


Distribution of offshore wind jobs by 2050

Job distribution – Theory of change (Narrative) 2/2

Theory of change – how we model it

- Job distribution is a weighted average of:
  - **Market share:** the relative strength of some of the main players in the Baltic region determines the location of the job
  - **Location of the wind investment:** jobs partially follow deployment, i.e., the job partly goes to where the generation is located, especially jobs related to planning and maintenance
- Some jobs are created beyond the Baltic region, acknowledging the global nature of the offshore wind industry.
- The map illustrates the evolution of jobs under the high buildout, using the bottom-up approach.
  - Over time, countries outside Denmark and Germany are expected to obtain a greater portion of total jobs created.
  - The change is progressive.



Distribution of offshore wind jobs by 2030

Distribution of offshore wind jobs by 2050

The Baltic Region has capabilities to support the **development** of the **entire offshore value chain**, thus enabling even higher job creation.

- **Strategic Port Locations and maritime tradition:** Ports are the first necessary step to support the installation, operation and maintenance of offshore wind power plants.
- **Existing manufacturing base:** Germany, Denmark and Poland have strong manufacturing facilities for the main components of wind turbines. The Baltic countries can further develop their already solid manufacturing foundation and competitive workforce in this sector, with significant job within the sub-component industry.
- **Skilled Workforce:** Educational institutions like universities and training centres offer already specialized training programs to ensure a talent pool ready to support the entire offshore wind value chain.

Regional cooperation and a common long-term strategy is key to attracting investors and maximizing the region's potential.

***Note:** This information is based on semi-structured interviews with stakeholders from all eight Baltic Sea countries and a global supplier.*

But regional cooperation is needed to establish a common **long-term commitment to attract investors**.

- **Ensuring a stable framework:** Collaboration among Baltic countries should go beyond technical grid development to establish a common long-term strategy supported by stable policies and infrastructure.
- **Avoiding Stranded Assets:** A common Baltic strategy will prevent stranded assets and ensure more equitable benefits across participating countries.
- **Unlocking the Baltic Sea potential:** A common long-term strategy for the Baltic Sea boosts investor interest, as the region's combined potential is much greater than that of individual countries.

Example: Port Development for Offshore Wind buildout

Developing ports is the first step in offshore wind projects; cooperation and knowledge exchange among Baltic countries can enhance regional potential and prevent stranded assets.

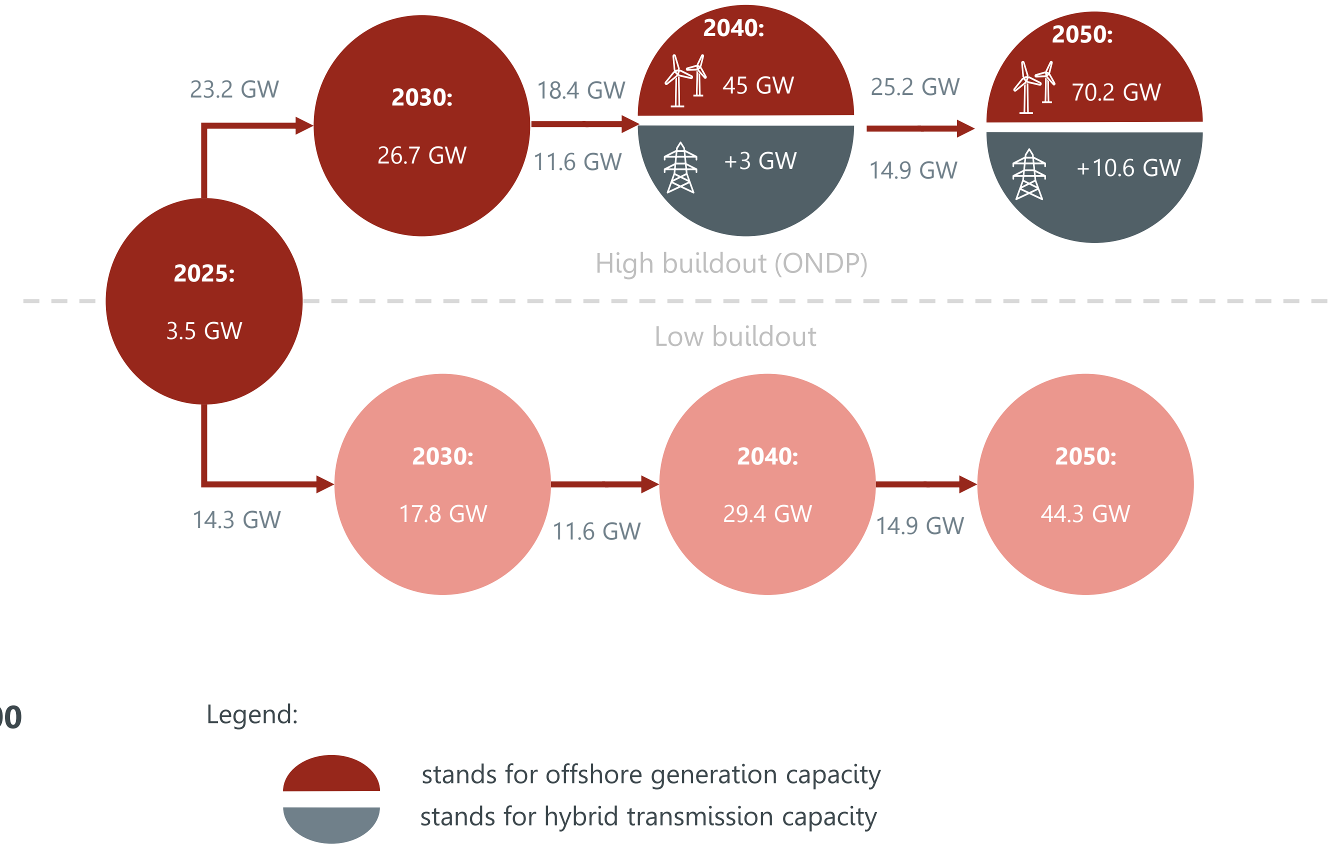
Interconnectivity

Hybrid offshore interconnectors are essential for the Baltic Region **to utilize its full offshore wind potential** to achieve net-zero emissions.

- **Essential for Net Zero Goals:** Offshore wind is essential for achieving net zero emissions, leveraging the Baltic Sea's vast potential to generate substantial amounts of green electricity.
- **Mature and Scalable Industry:** Offshore wind has become a mature industry, capable of scaling up rapidly to meet the growing demand for green electricity. EU Strategy on Offshore Wind proposes to increase Europe’s offshore wind capacity from its current level of 20 GW (2023) to at least 60 GW by 2030 and to 300 GW by 2050
- **Limitations of Other Energy Sources:** Onshore wind and solar face planning constraints, biomass potential is largely exhausted, and nuclear power struggles with cost uncertainties, long timelines, and public acceptance.
- ***Example:*** The Swedish Energy Association projects that onshore wind can meet the growing electricity demand until 2035, after which offshore wind is expected to take over and supply the continued demand growth.

Hybrid offshore interconnectors are essential for the Baltic Region **to utilize its full offshore wind potential** to achieve net-zero emissions.

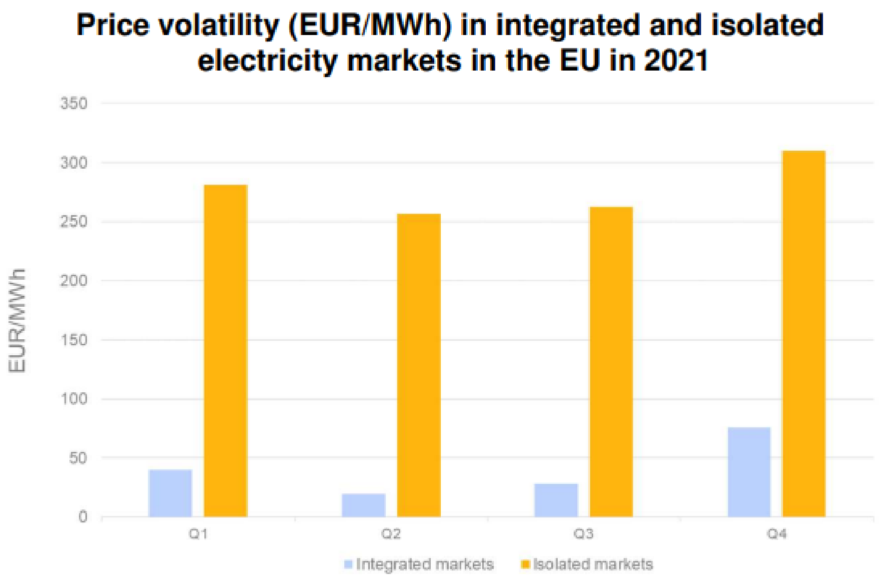
- Achieving the Baltic Region's full offshore wind ambitions by 2050 requires a yearly average buildout of 2.7 GW/year over 25 years – taking existing installed offshore wind capacity (3.5 GW) as point of departure.
- This highly ambitious offshore wind buildout will become a reality, only if hybrid interconnectors are built.
- Under the high scenario, an estimated 6% of all available transmission capacity is expected to be hybrid by 2040 and 13% by 2050.



In total, an estimated additional 10 GW can be enabled by hybrid interconnectors. This supports the creation of approximately 70 000 direct industry jobs.

Interconnected offshore wind can **support energy sovereignty and resilience** through: i) a more integrated electricity market

- **Strengthening Market Functionality:** Developing hybrid interconnectors will enhance market efficiency and improve overall energy security.
- **Importance of Cross-Border Flows:** Cross-border electricity flows are crucial for strengthening supply security, enabling countries to rely less on domestic generation while effectively managing peak loads and extreme weather events.
- **Reduced Price Volatility:** According to ACER (2022), countries integrated into the European electricity market experienced significantly less price volatility during the 2021 energy crisis compared to isolated markets, highlighting the benefits of market integration.

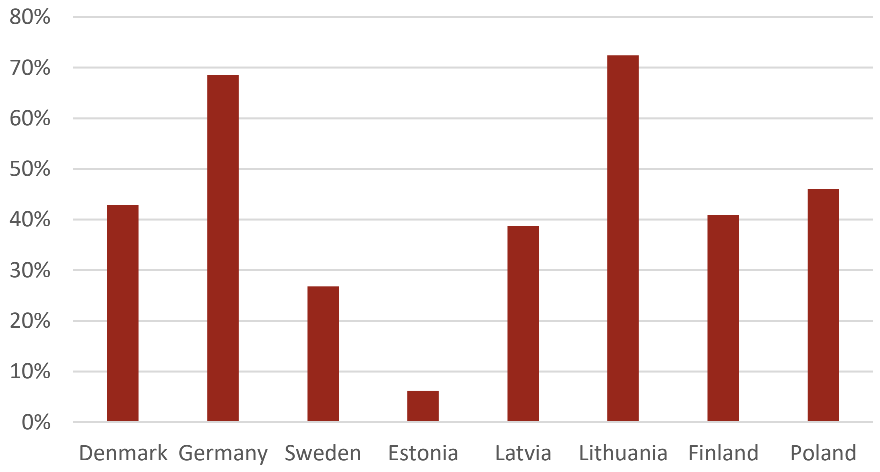


Price volatility (EUR/MWh) in integrated and isolated electricity markets in the EU in 2021. Source: ACER (2022).

Interconnected offshore wind can **support energy sovereignty and resilience** through: ii) deepening European energy alliances.

- **Enhanced energy independence:** Expanding offshore wind capacity in the Baltic Sea reduces the region's reliance on energy imports, fostering greater self-sufficiency and insulating it from geopolitical energy disruptions.
- **Strengthening European energy alliances:** By investing in offshore wind and interconnectors, Baltic countries can deepen their energy cooperation with other EU nations, creating a more resilient and integrated energy market that enhances regional security.

Energy imports dependency rate
2022, based on terajoules

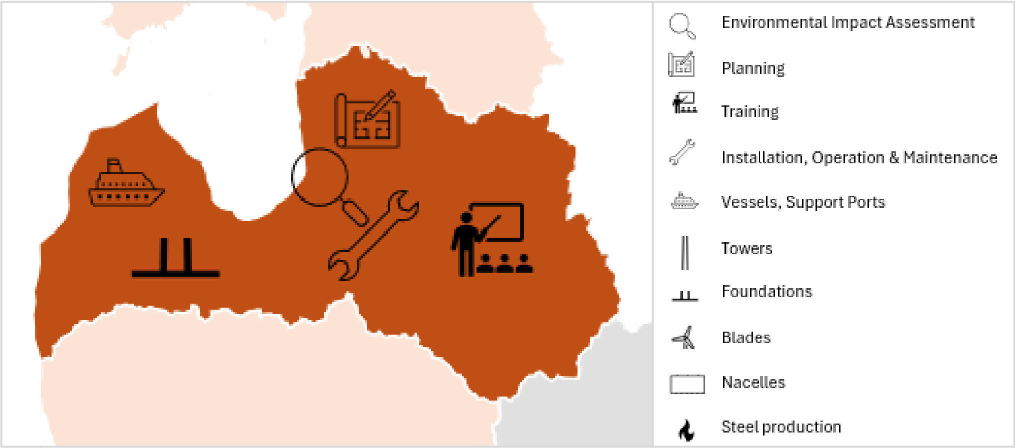


Source: Eurostat: Shedding light on energy in Europe - 2024 edition
**Estonia has a notable low dependency rate due to domestic oil shale which is used to produce oil products*

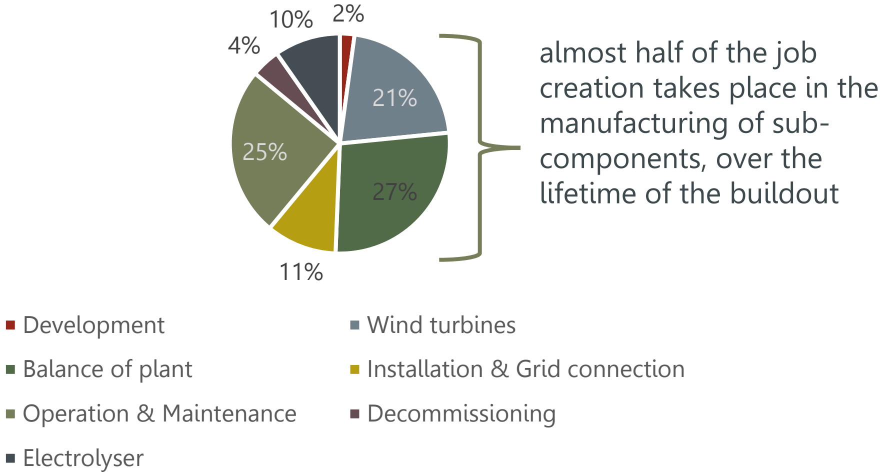
Country reports

Latvia – Ports, innovation and upskilling

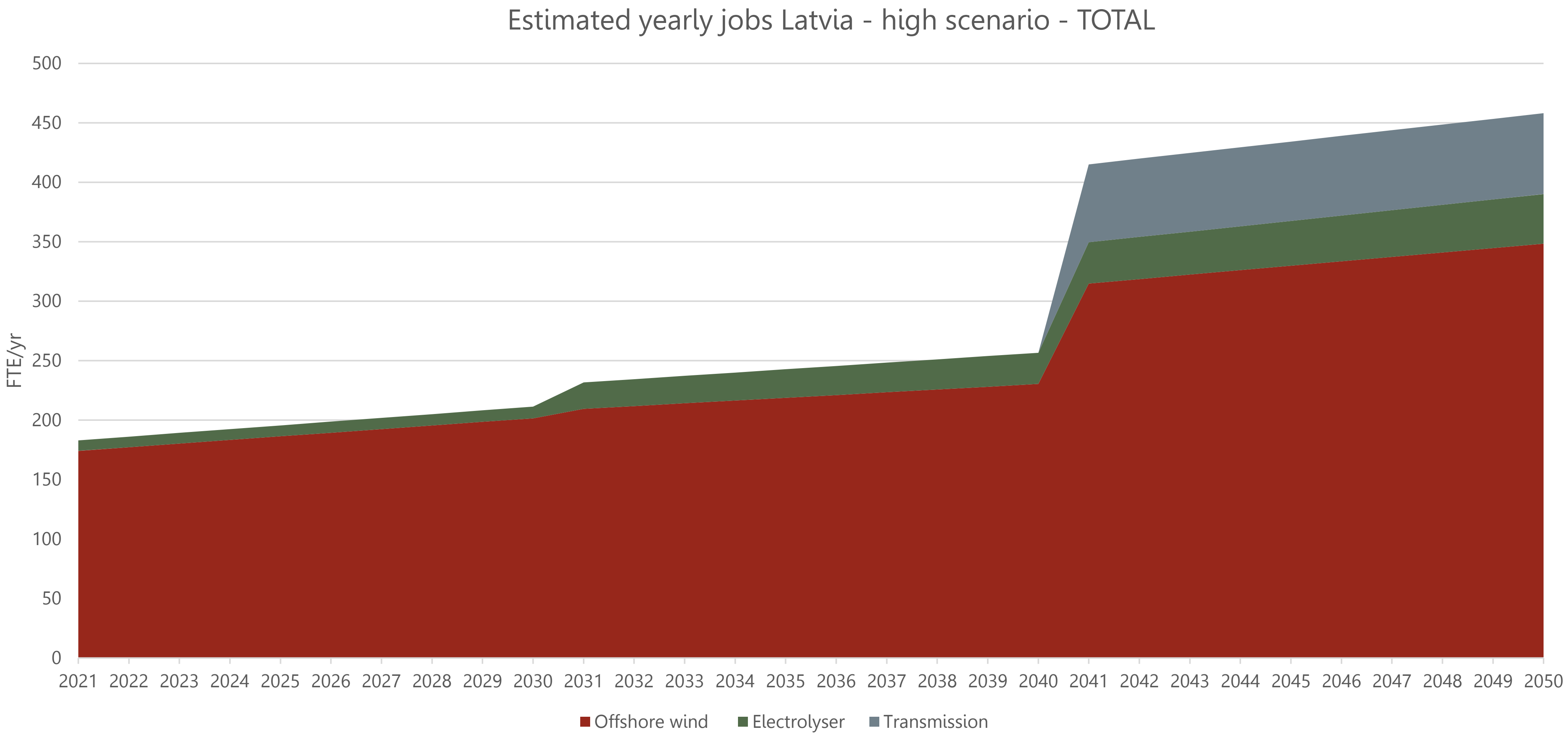
- **Under the ONDP buildout, there is a potential for the creation of around 10 000 direct lifetime FTEs in Latvia's offshore wind industry until 2050.** Offshore wind buildout creates jobs in foundation building, installation, and maintenance. The BOTC Training Center provides training for the whole region.
- **Strategically located in the center of the Baltics, Latvia serves as a vital hub for wind energy solutions.** Liepaja: Van Oord's offshore wind support base starting in 2026. Riga: Engaged in discussions with suppliers for offshore wind services.
- **With the hydrogen strategy under development, Latvia could become a leader in green hydrogen. About 10% of the jobs over the lifetime are expected to come from electrolysers.** Two major hydrogen projects:
  - CIS Liepaja: Power-to-X terminal in the Port of Liepaja.
  - Ventspils: Large-scale green hydrogen and green ammonia production plant. Potential for startups and new technologies.



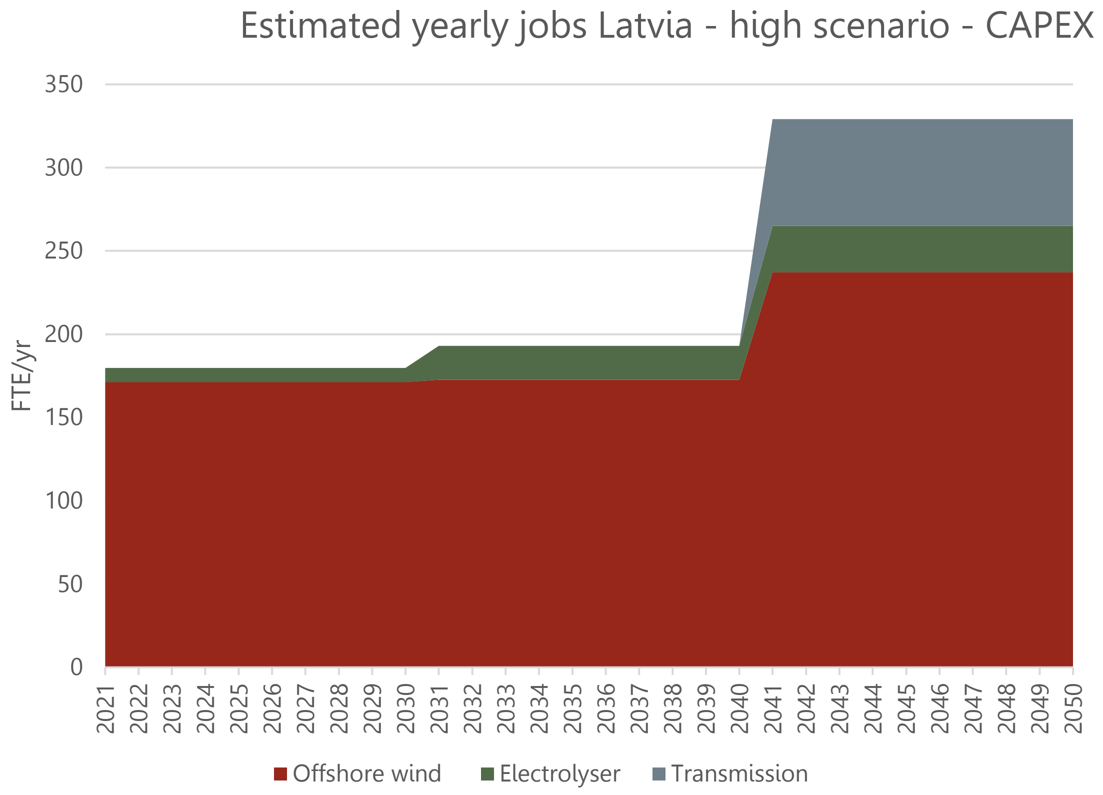
Job creation by supply chain phase
Latvia – high scenario

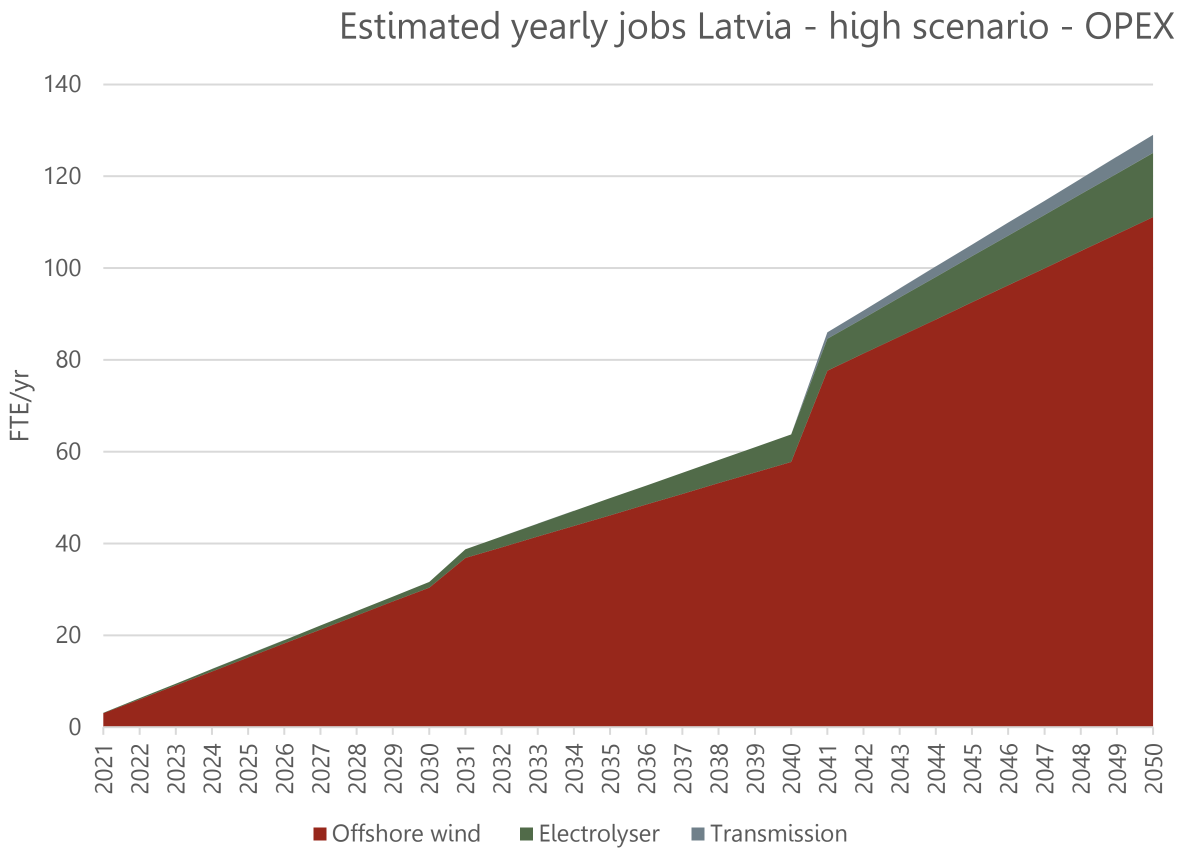


Latvia – Estimated yearly jobs (direct industry jobs)



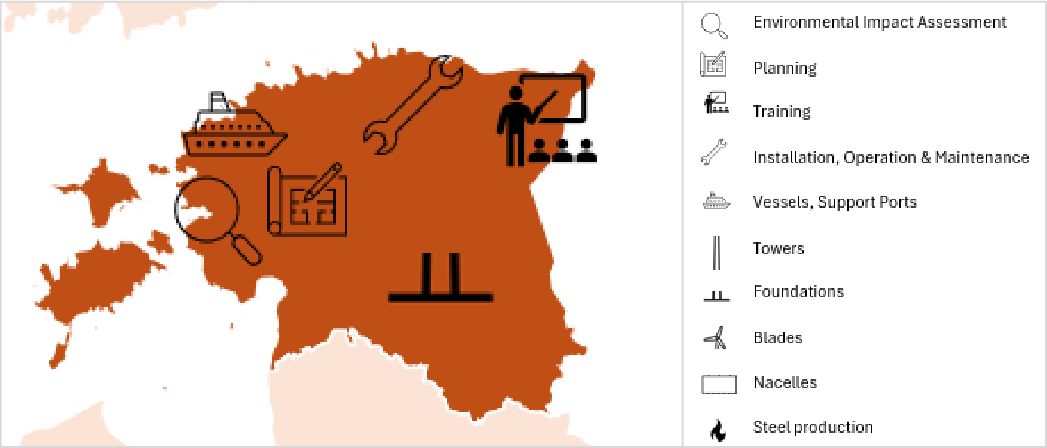
Latvia - yearly jobs – CAPEX- jobs and OPEX- jobs (direct industry jobs)



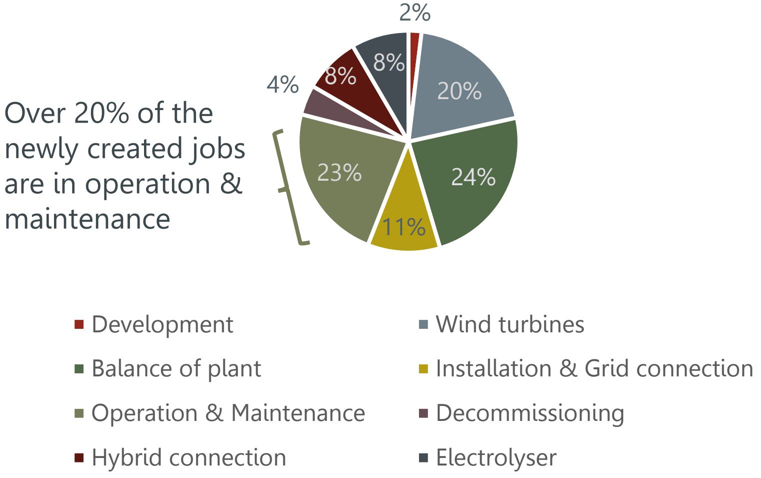


Estonia - Ports, PtX, and Regional Development

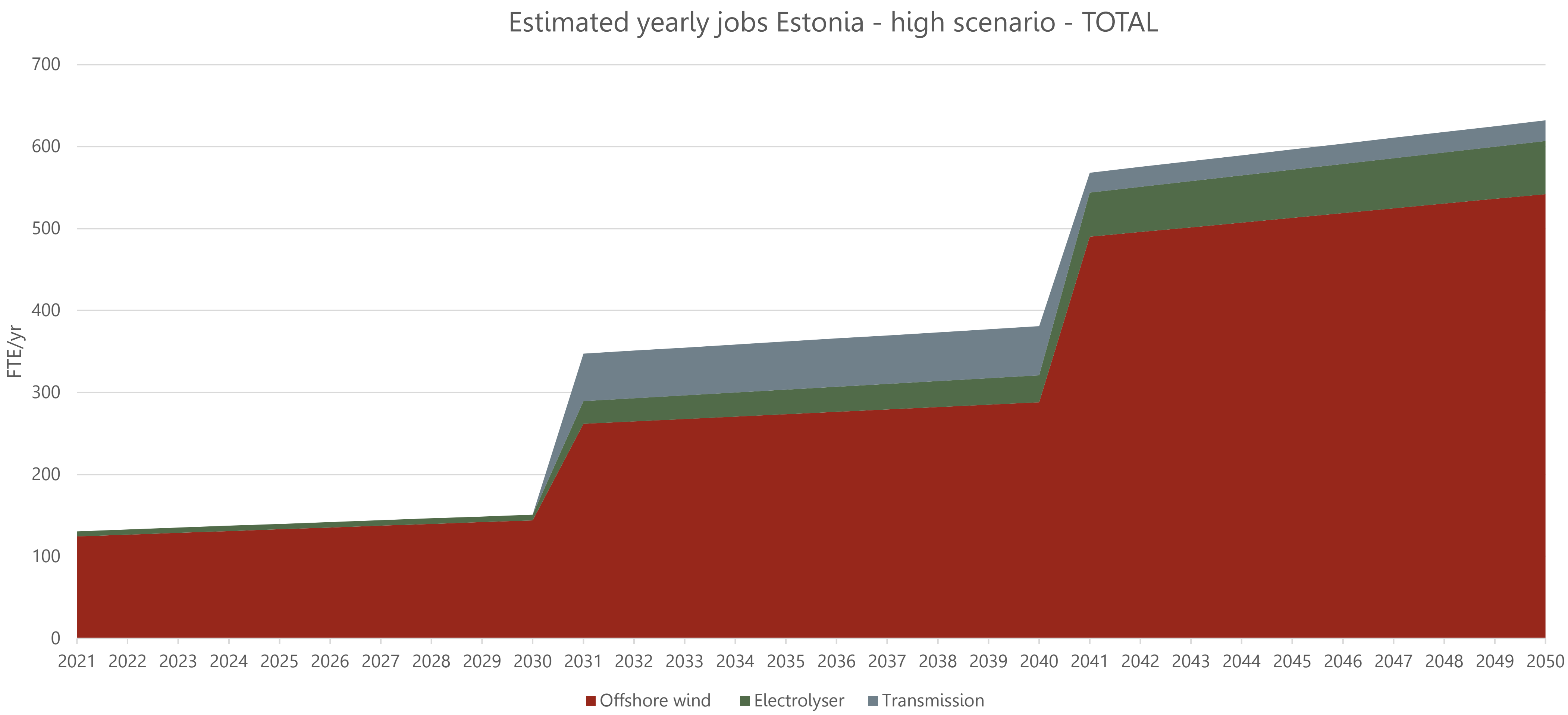
- Offshore wind development is capable to create **12 000 direct lifetime jobs (FTE)** under the ONDP buildout until 2050. With a focus on construction, foundation building, concrete work, and technical services.
- **New Economic and Tourism Development in Western Estonia:** Offshore wind projects bring new tourism opportunities to western Estonia. Regional economic development fueled by increased investment in energy and infrastructure. Growth in related sectors such as local tourism and services due to offshore wind activity.
- **Paving the Way for Green Methanol: Around 8% of the jobs are created by electrolysers and even more jobs could be created through the green hydrogen economy:** Dutch company Power2X plans to build a methanol plant in Pärnu, with an annual capacity of 500 000 tons. Future methanol production will be powered by green hydrogen from Estonia's offshore wind plants.



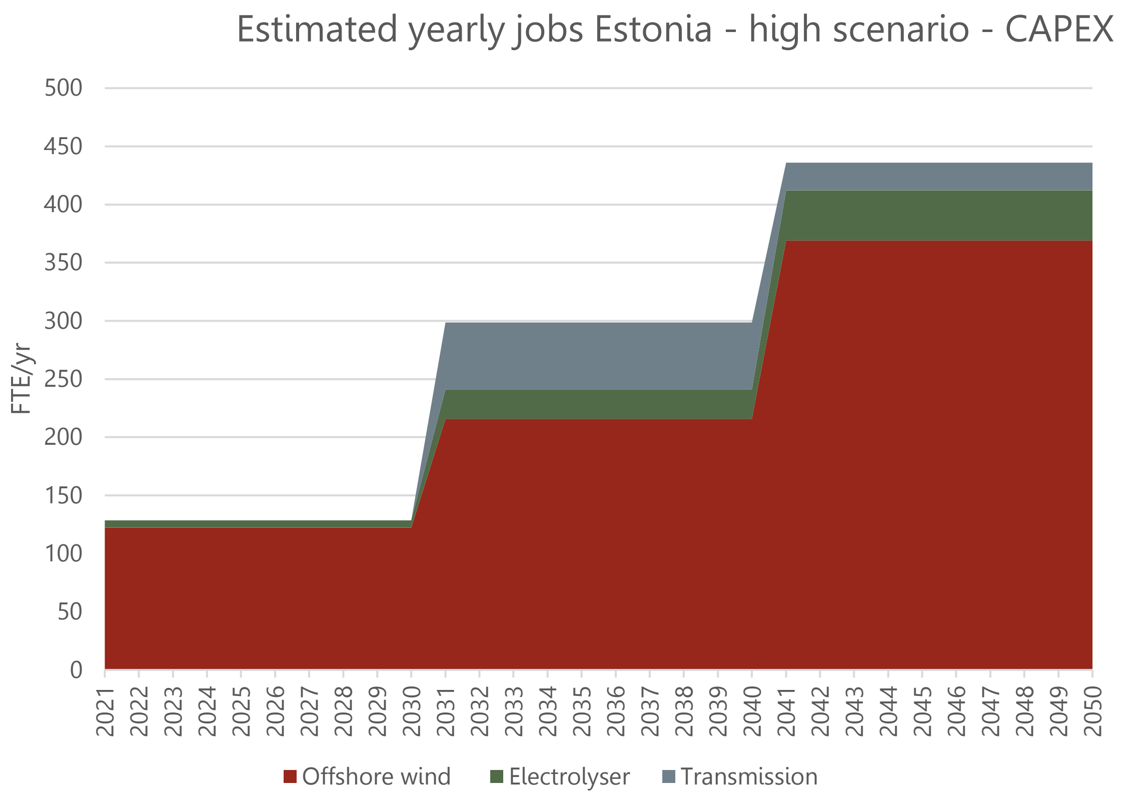
Job creation by supply chain phase
Estonia - high scenario

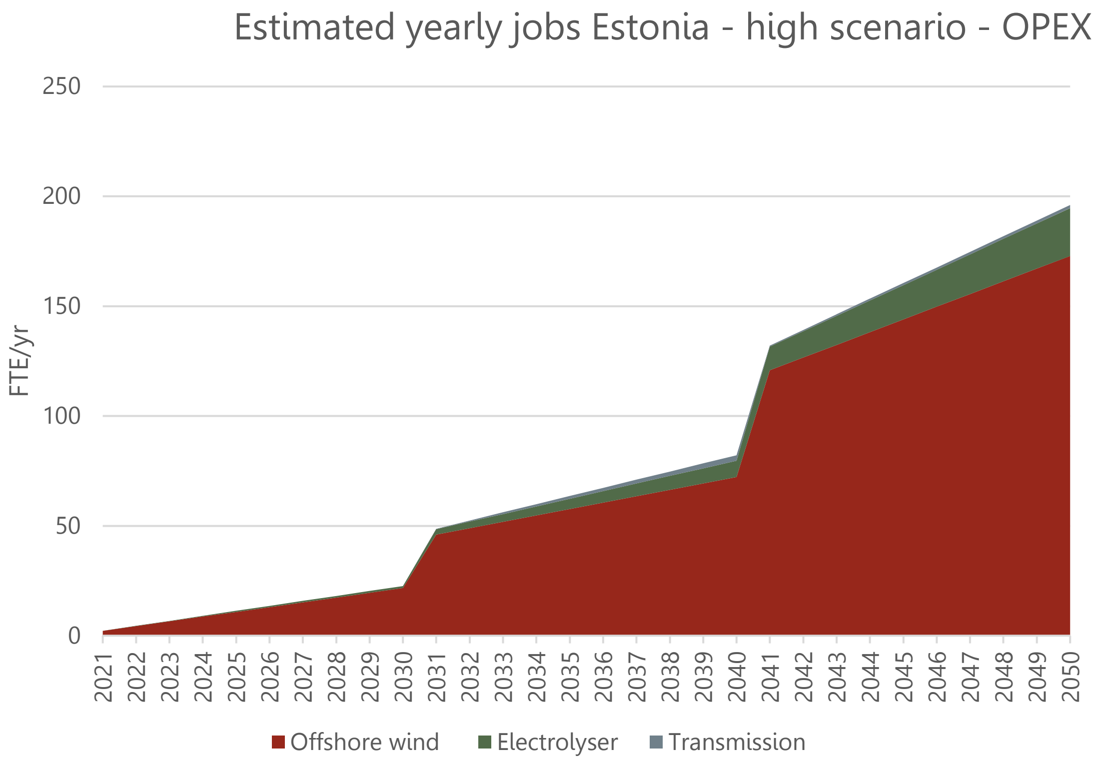


Estonia - Estimated yearly jobs (direct industry jobs)



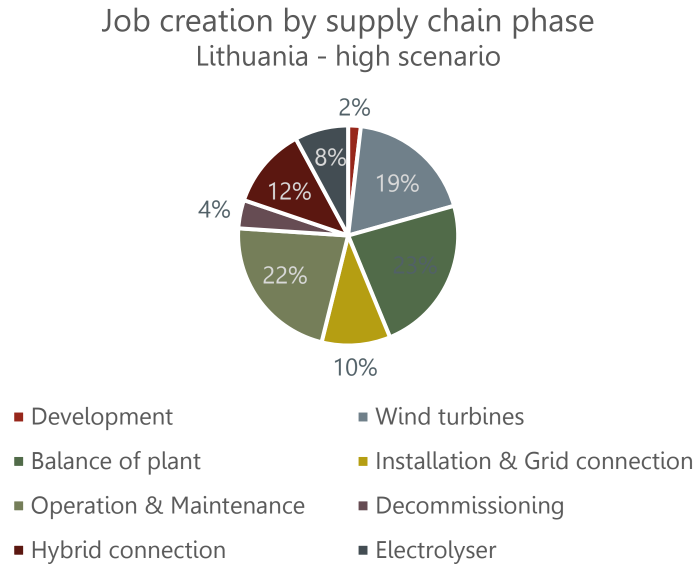
Estonia yearly jobs – CAPEX- jobs and OPEX- jobs (direct industry jobs)



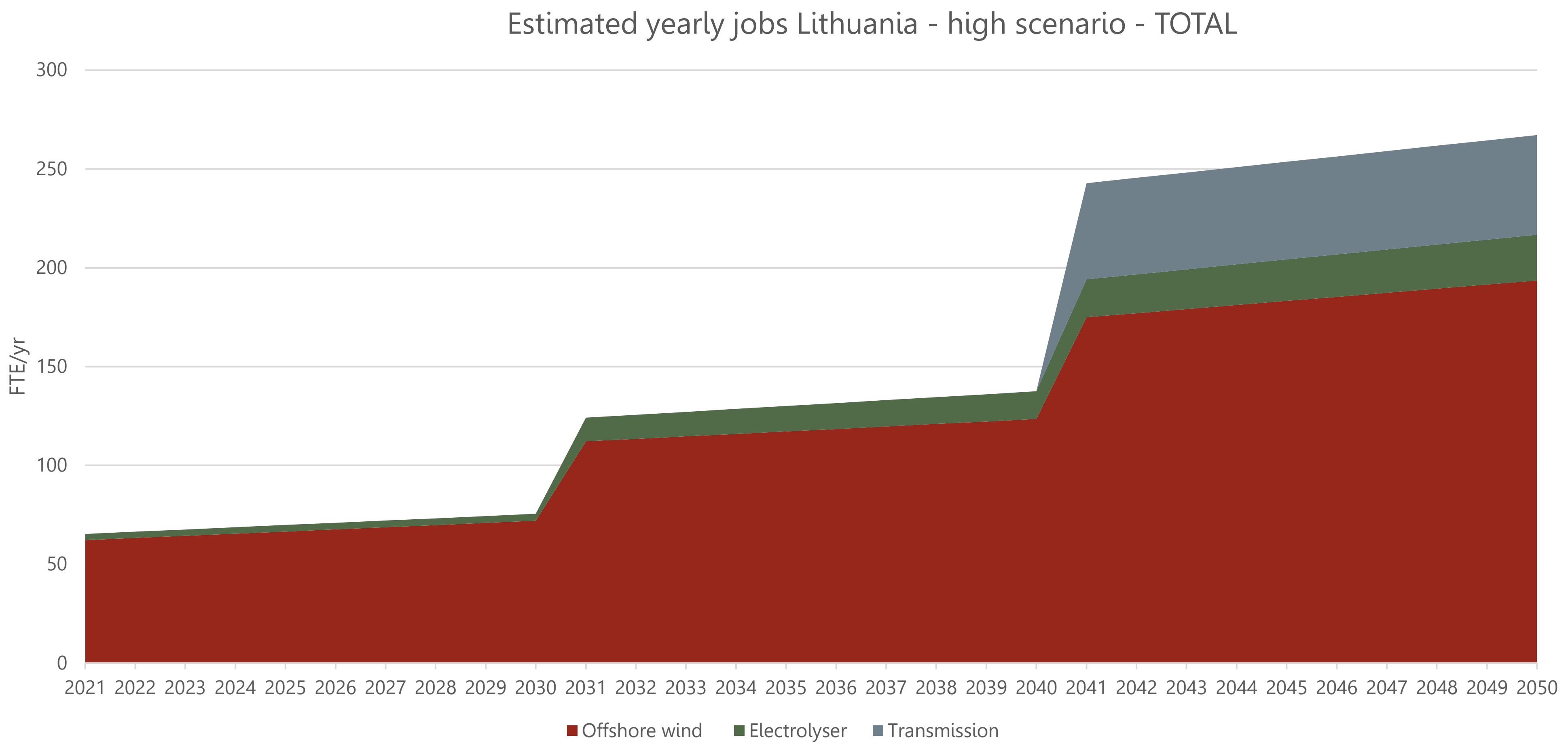


Lithuania - Energy Independence and Economic Growth

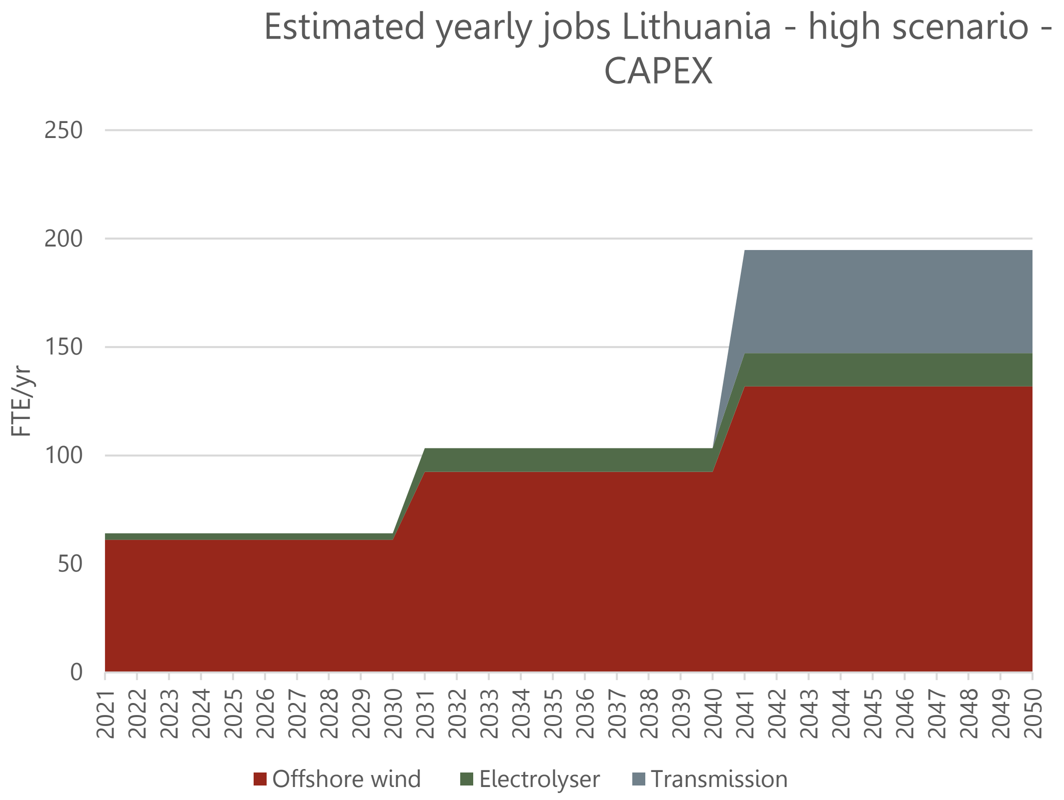
- **With the offshore wind buildout under the ONDP, there is a potential for around 5 000 direct lifetime FTEs in Lithuania until 2050. The majority of the job creation in Lithuania could take place in specialized manufacturing across the country.** Lithuania is set to play a key role in manufacturing smaller components for offshore wind turbines. Proximity to Poland allows for knowledge exchange and cooperation. Growth of supporting industries like logistics, maintenance, and accommodation for offshore workers.
- **Local energy generation strengthens national security.** Offshore wind will cover a crucial portion of Lithuania's energy demand, aligning with Lithuania's energy independence strategy, reducing reliance on imported energy. Lithuania shifts from a net-importer to a net-energy exporter.

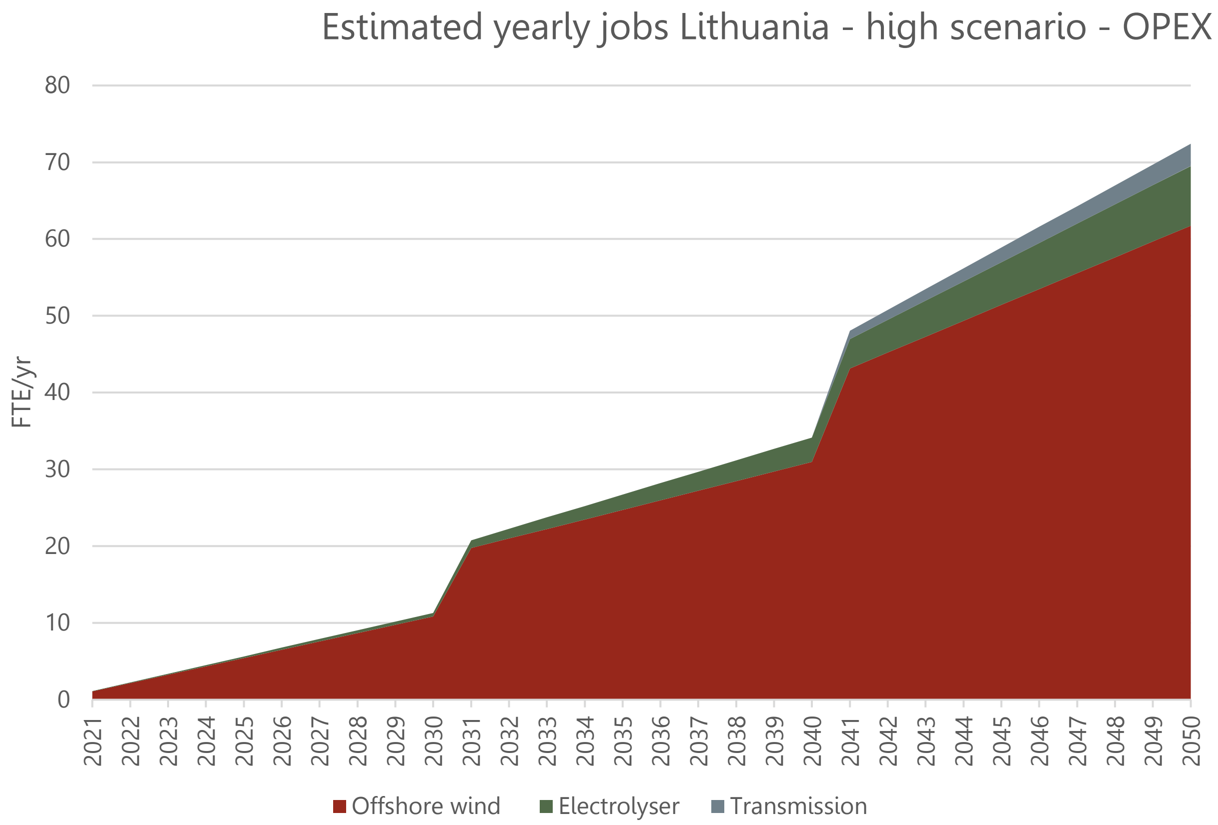


Lithuania - Estimated yearly jobs (direct industry jobs)



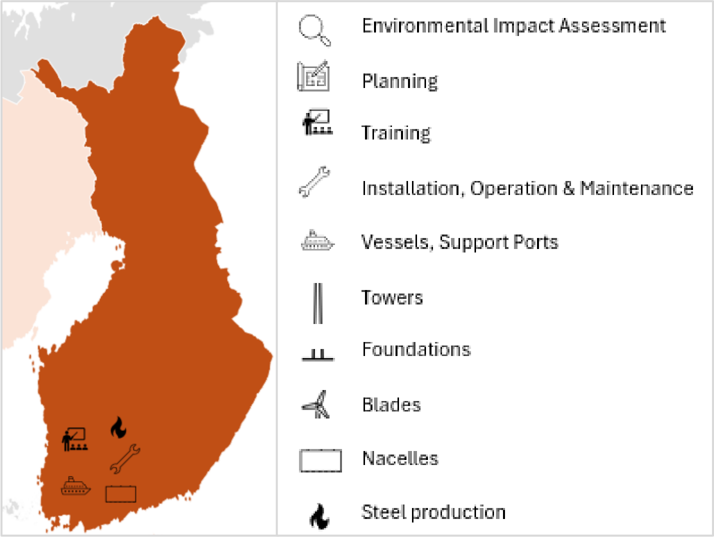
Lithuania yearly jobs split into CAPEX-jobs and OPEX-jobs

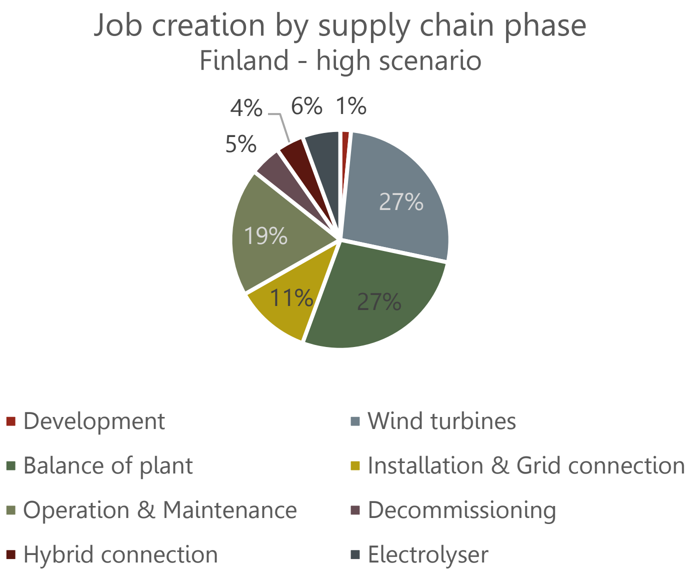




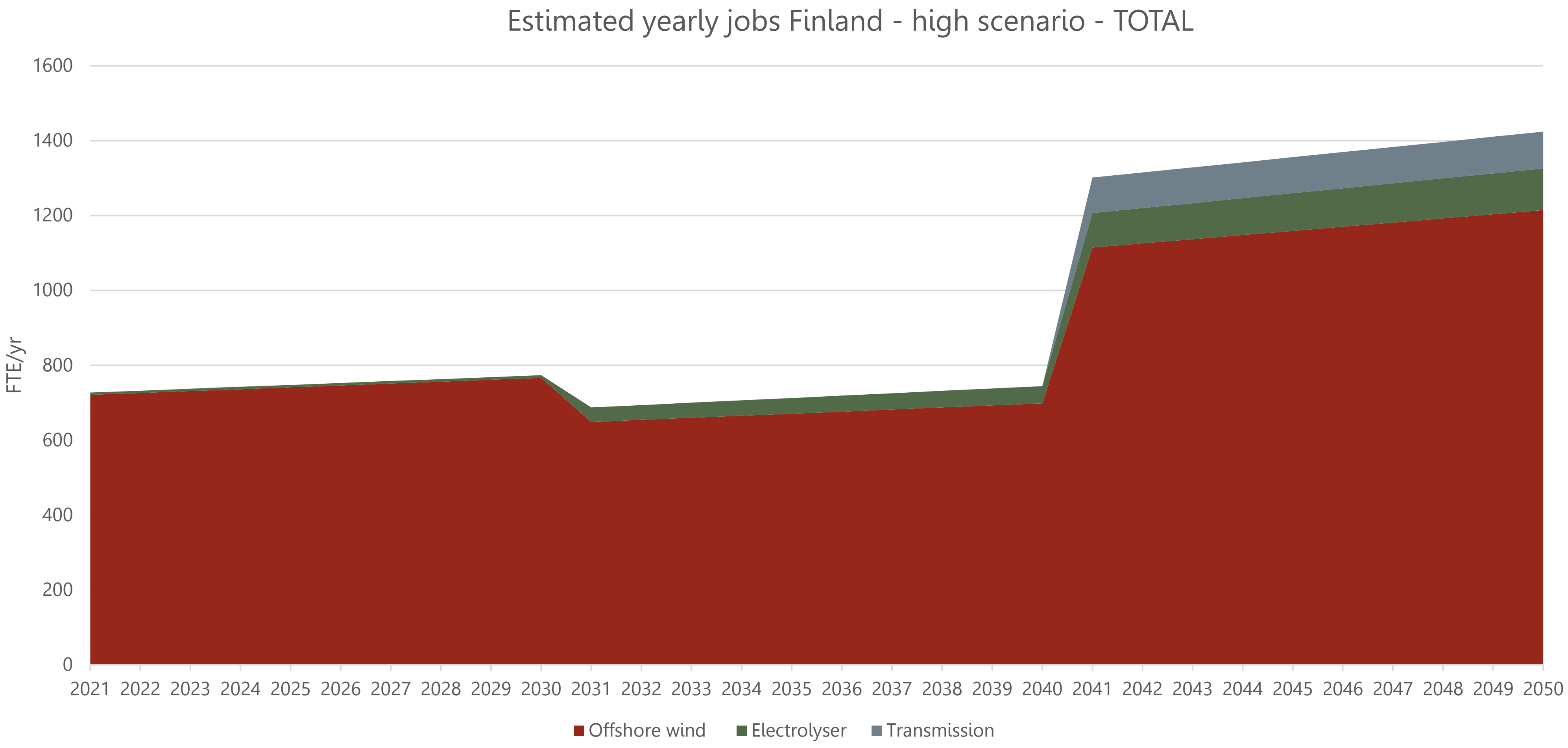
Finland – Vessel construction and port logistics

- **Finland's maritime sector will see increased collaboration with energy firms.** Finland's experience in shipbuilding and marine engineering will be crucial in constructing specialized vessels for offshore wind projects.
- **Employment opportunities: There is a potential for the creation of over 30 000 jobs (lifetime FTEs) in Finland through the offshore wind buildout until 2050.** Port logistics jobs will grow during the construction phase of offshore wind projects. As the projects progress, employment will shift to the service sector, including maintenance, operations, and technical support. Finland's expertise in vessel construction and engineering will support the efficient deployment and maintenance of wind farms.

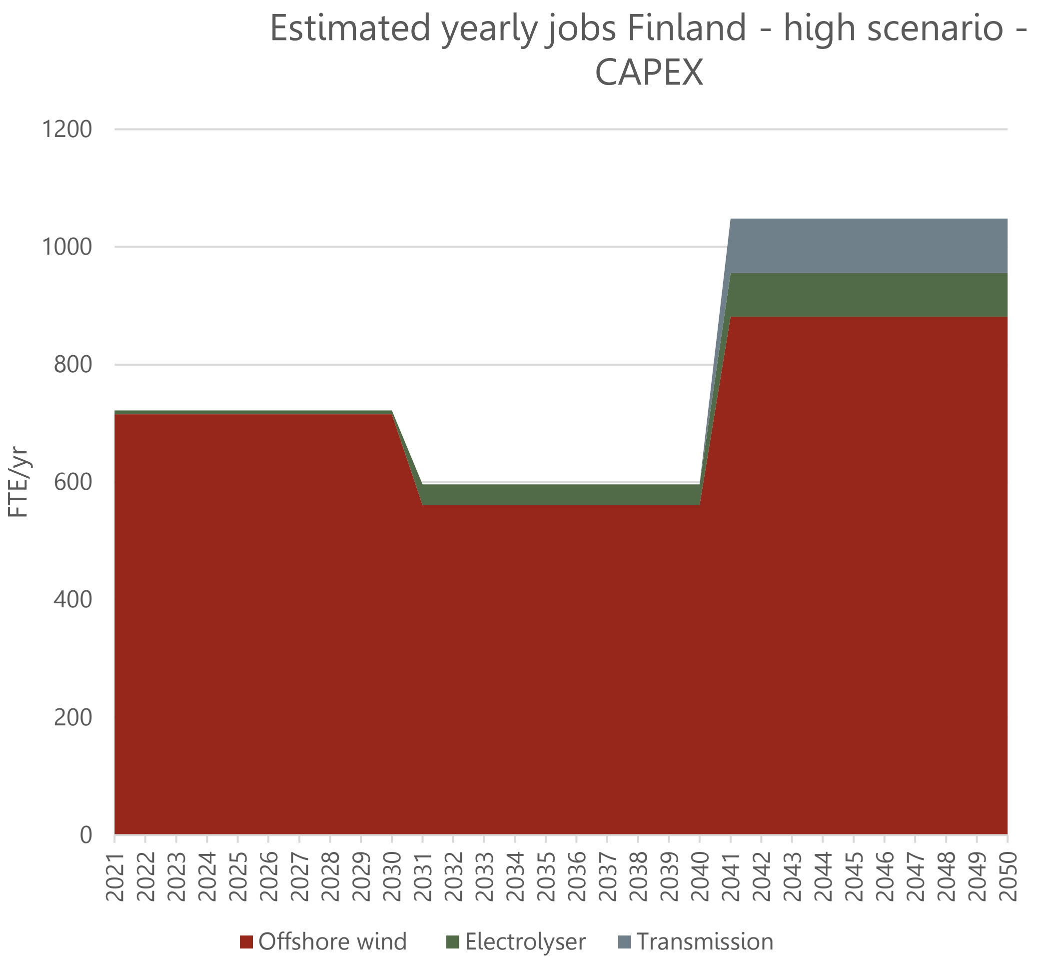


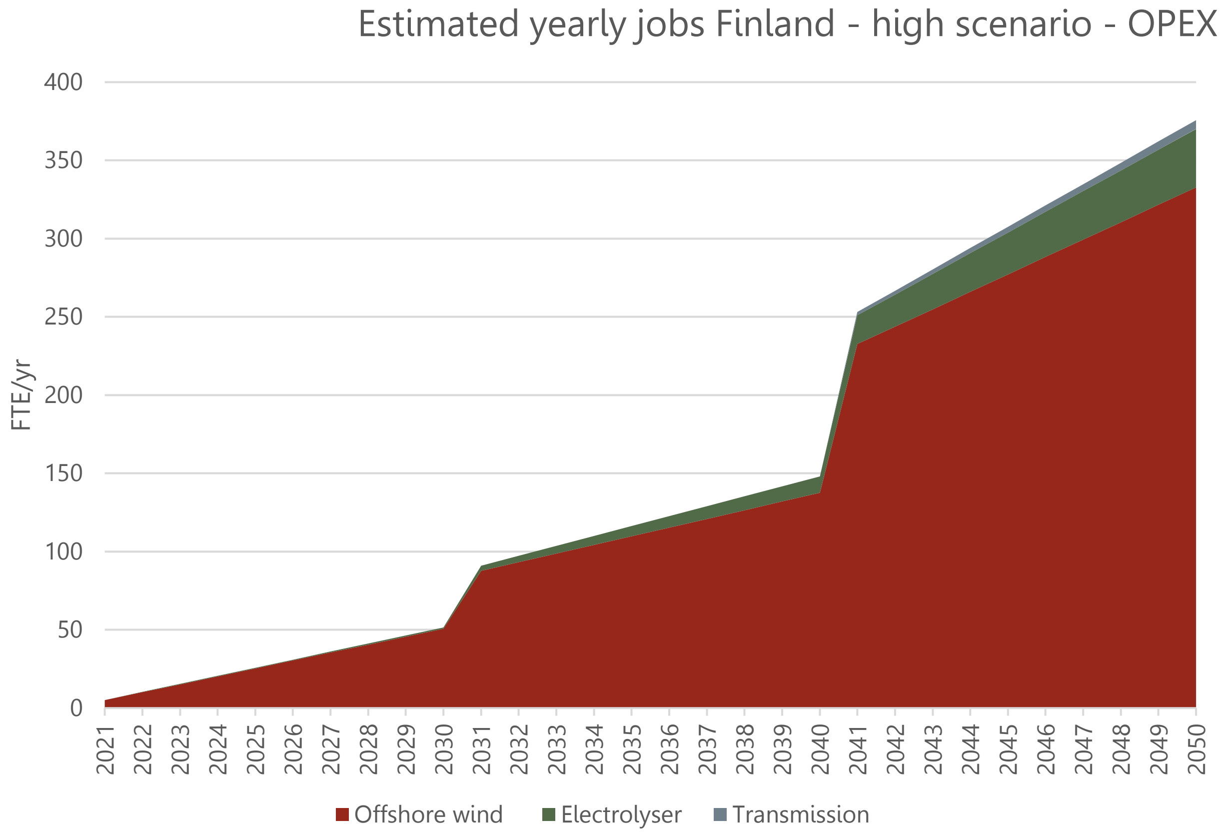


Finland - Estimated yearly jobs (direct industry jobs)



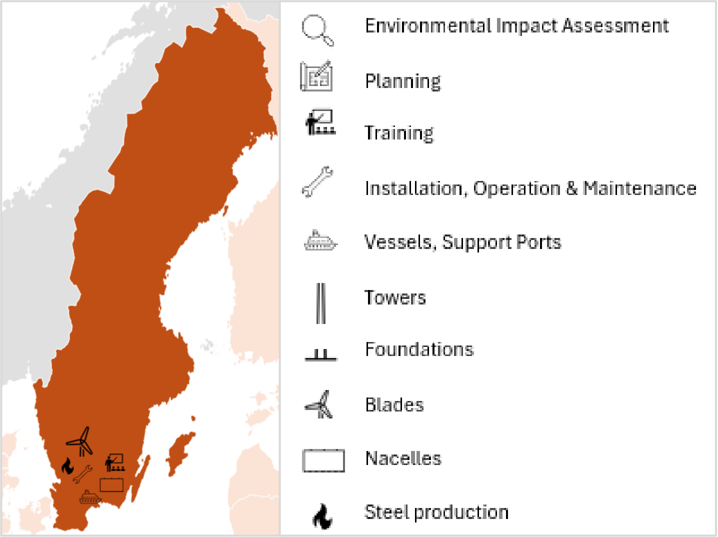
Finland - CAPEX- jobs and OPEX- jobs (direct industry jobs)

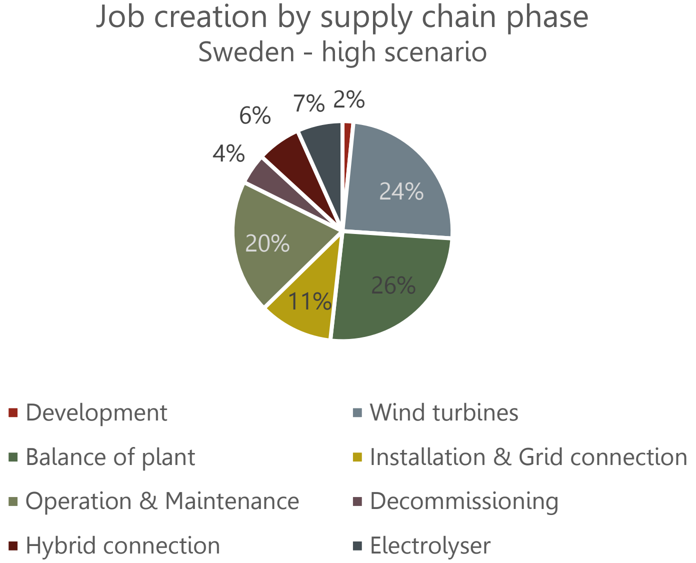




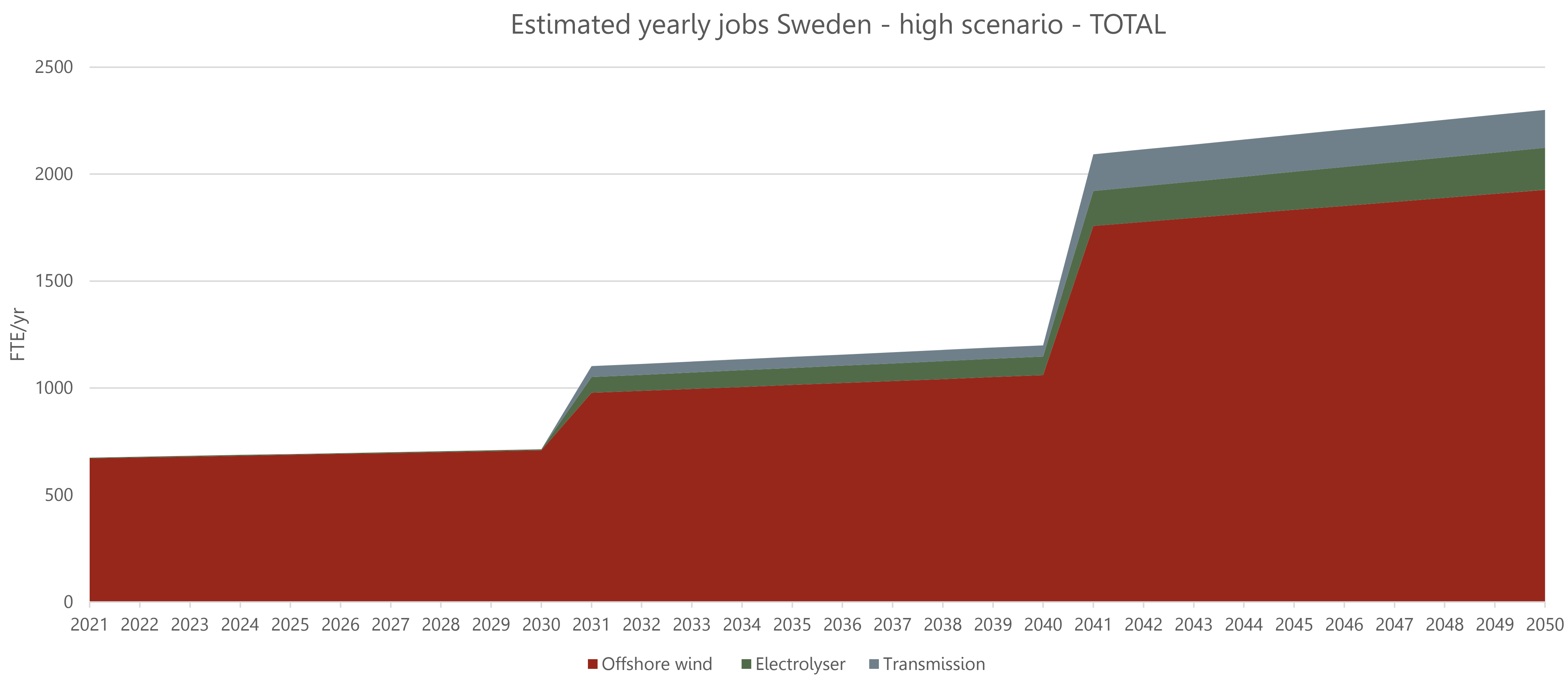
Sweden – Sustainable turbine components

- **Addressing increasing power demand**: With power demand expected to double by 2045, offshore wind can provide the necessary new generation capacity, especially as onshore wind faces planning constraints and nuclear energy remains uncertain in terms of cost and timelines. Southern Sweden, particularly Skåne, is facing an electricity deficit. Offshore wind could help alleviate this by providing a local source of renewable energy.
- **Sustainable turbine components:** Swedish green steel manufacturers and innovative companies, like a start-up producing wood-based wind towers, could benefit from supplying materials for offshore wind turbines, especially with favorable EU regulations. There is a potential for the creation of over 43 000 jobs (lifetime FTEs) in Sweden through the offshore wind buildout until 2050.
- **Regional Cooperation**: Offshore wind projects could strengthen Sweden's diplomatic and geopolitical relations with Baltic Sea neighbors, such as Estonia, Latvia, and Lithuania, by enhancing cross-border infrastructure and energy security.
- **Long-term Strategic Importance**: Though these investments may not be immediately profitable, they support regional collaboration, energy security, sustainability, and Sweden's broader geopolitical objectives.

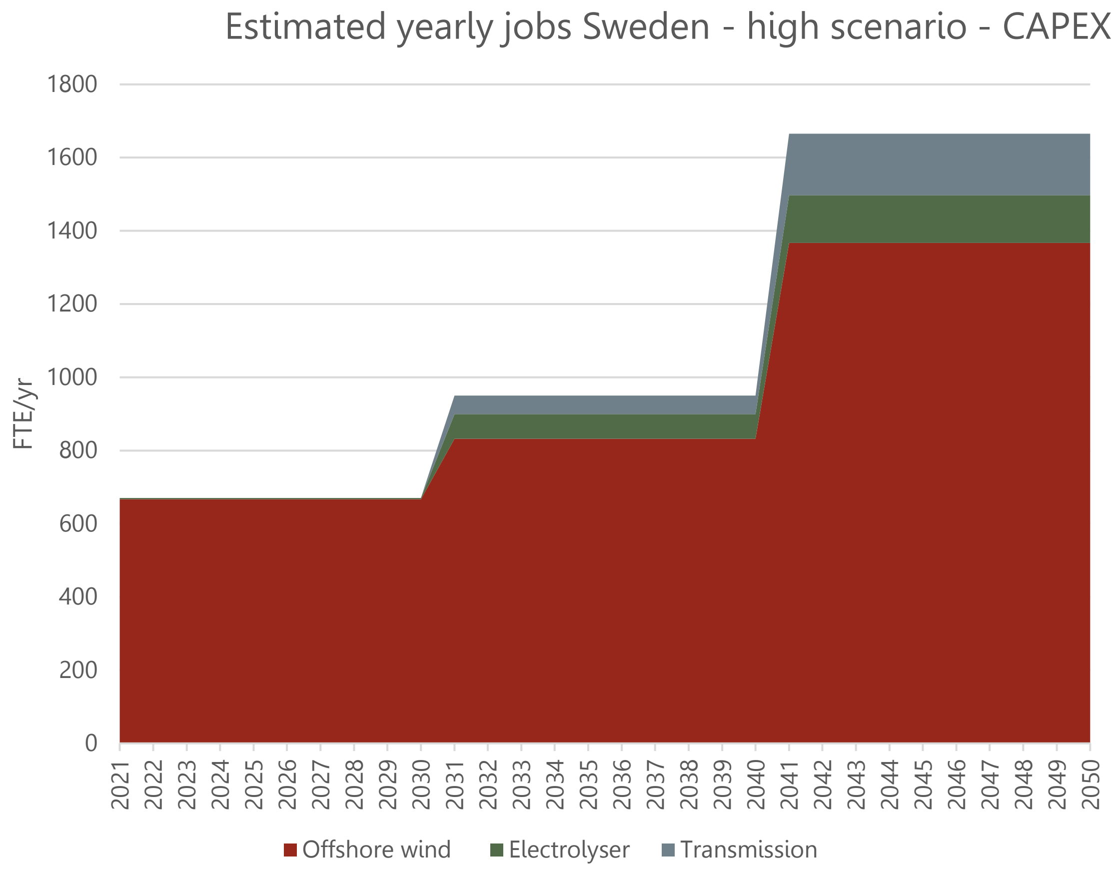


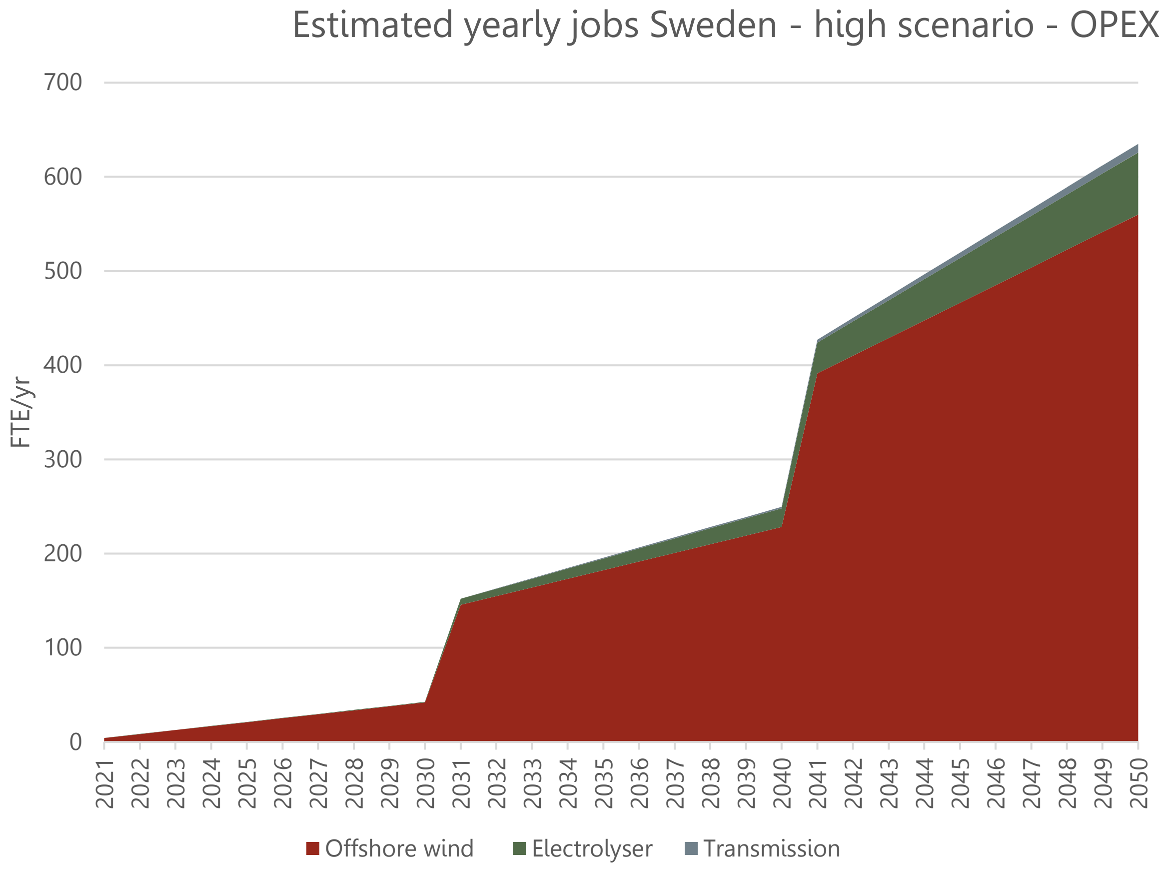


Sweden - Estimated yearly jobs (direct industry jobs)



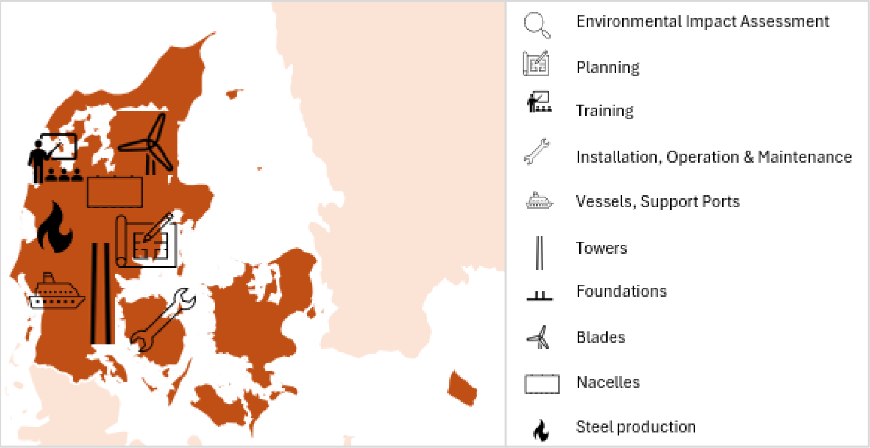
Sweden - CAPEX- jobs and OPEX- jobs (direct industry jobs)

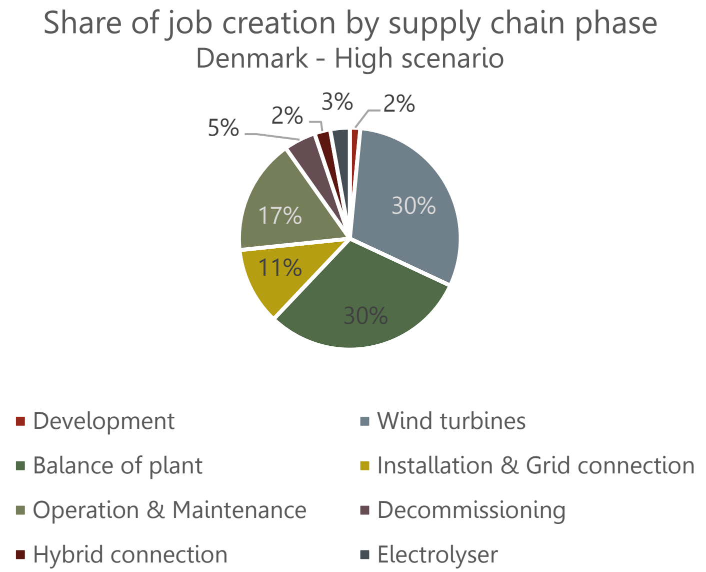




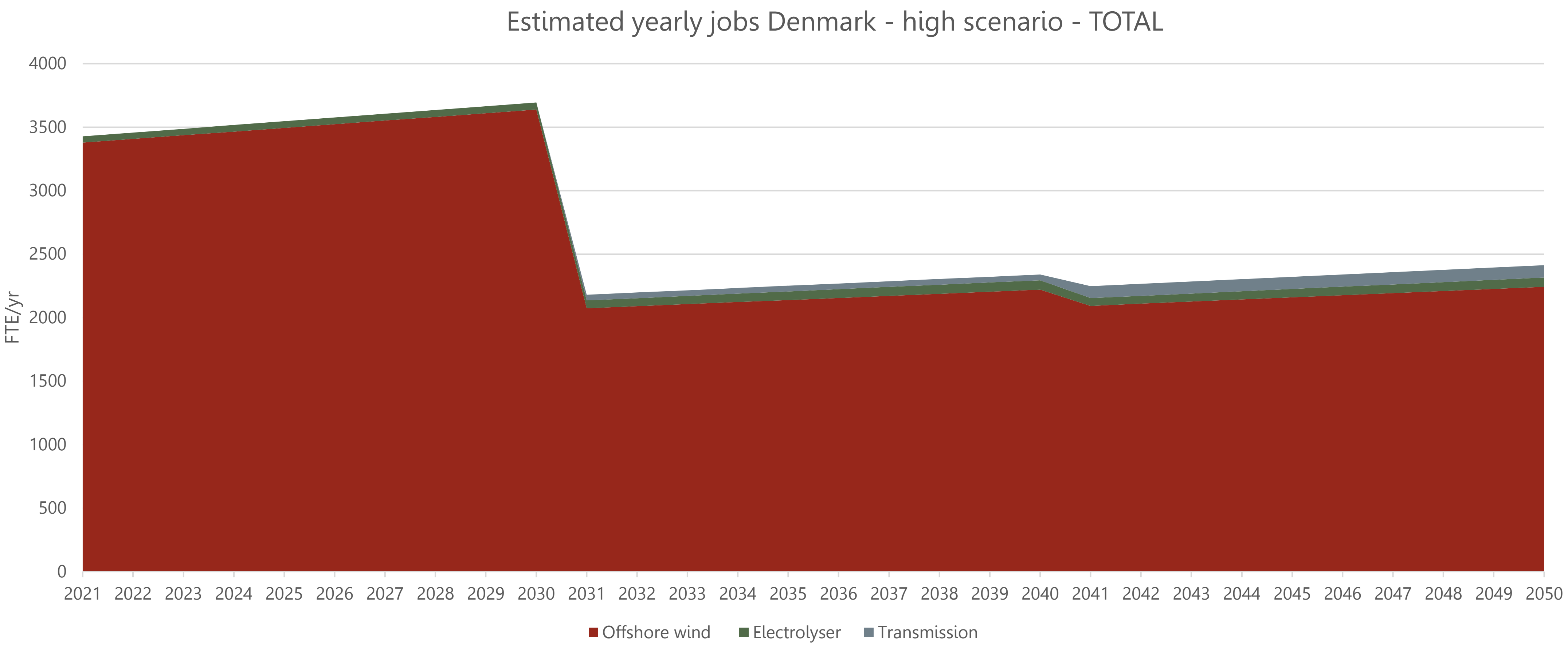
Denmark: First mover strengthening European supply chain

- **First-mover advantage:** Offshore wind development in the Baltic Sea will allow Denmark to strengthen its global position by exporting key wind components and sharing technological expertise, while enhancing the Baltic Sea and European value chain to compete with global players.
- **Job creation and green hydrogen economy:** The spillover effect from offshore wind projects could generate almost 80 000 direct lifetime FTEs in the offshore industry and further jobs across various sectors until 2050. Overplanting wind farms can support Power-to-X development in Denmark and the whole region.

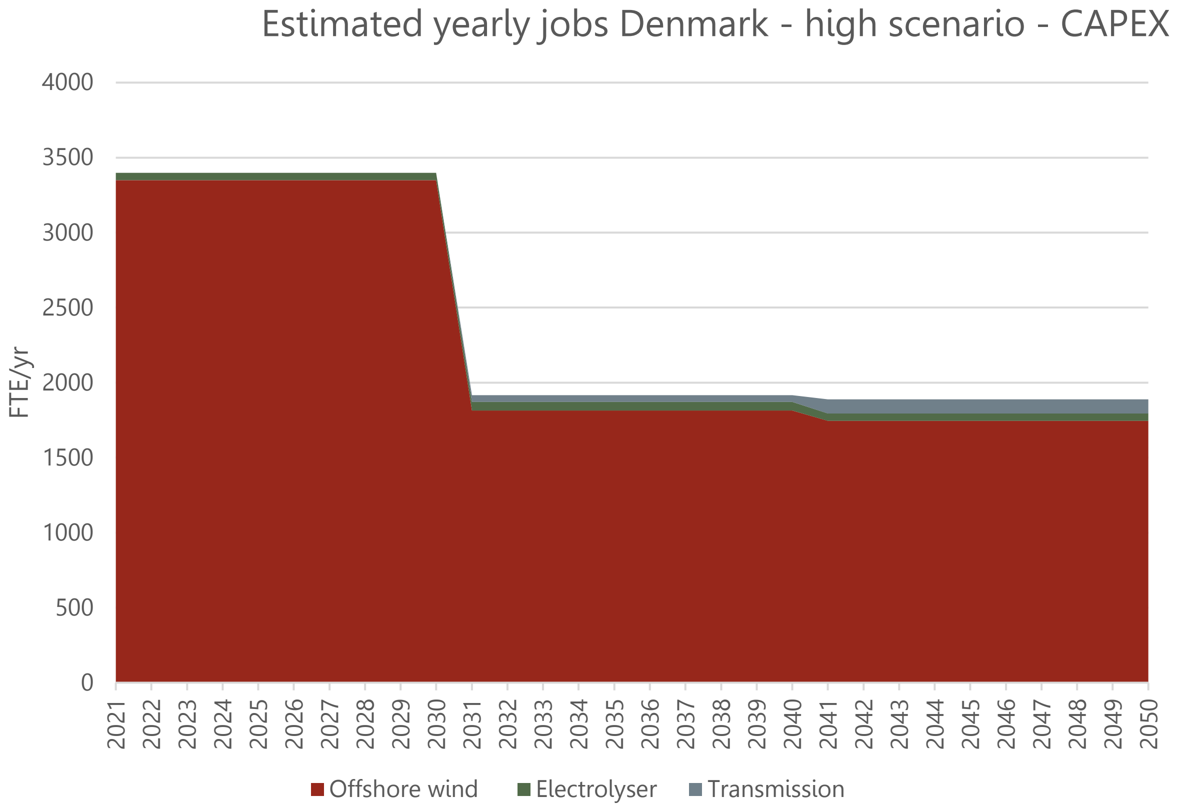


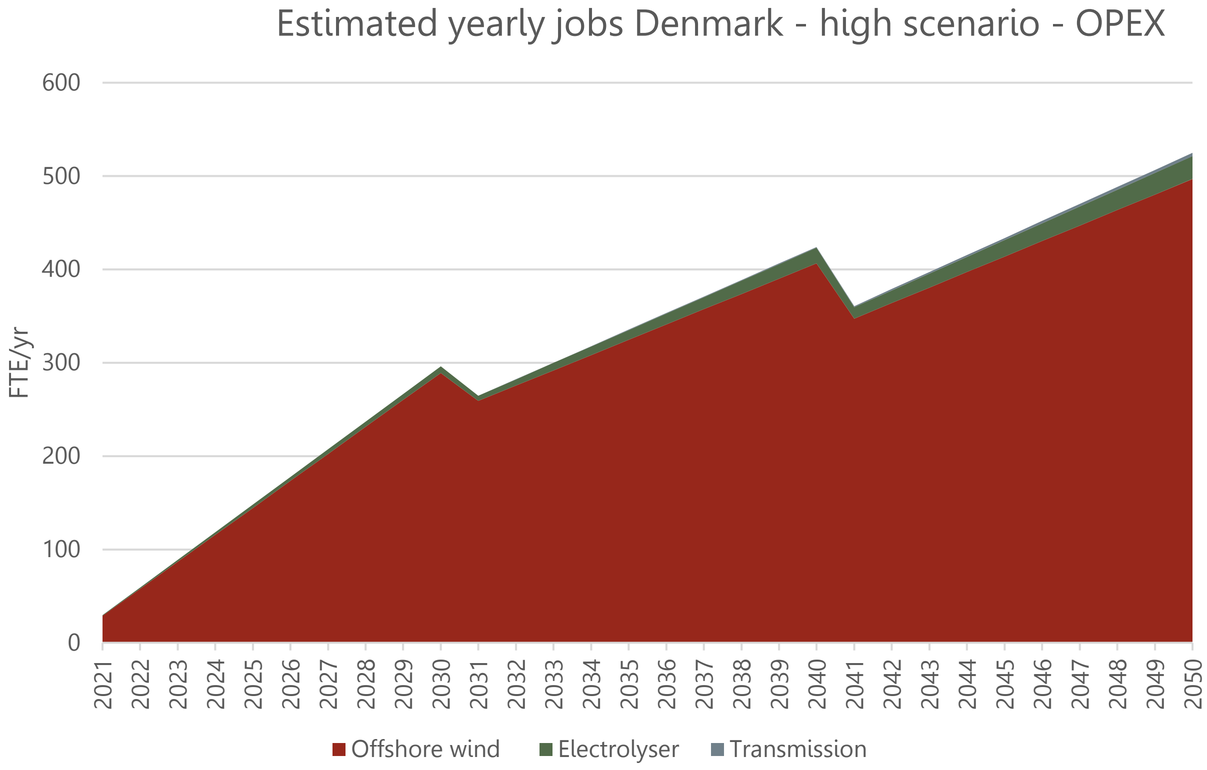


Denmark - Estimated yearly jobs (direct industry jobs)



Denmark - CAPEX- jobs and OPEX- jobs (direct industry jobs)





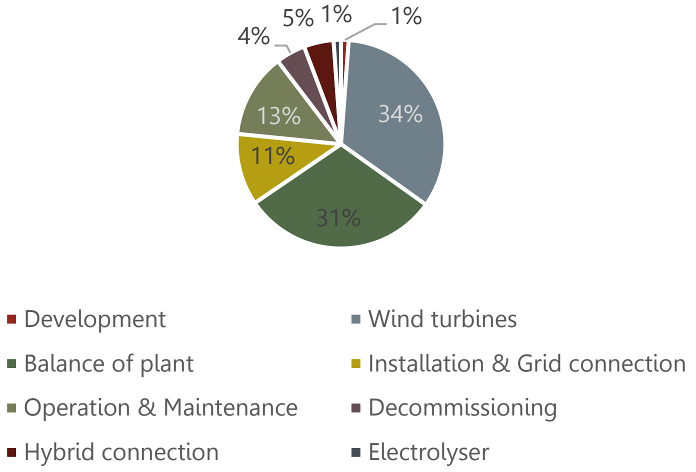
**This figure shows significant spikes, as efficiency improvements (reduction of FTE per GW) are assumed for the years 2030, 2040, and 2050.*

Germany - Expertise and existing Infrastructure

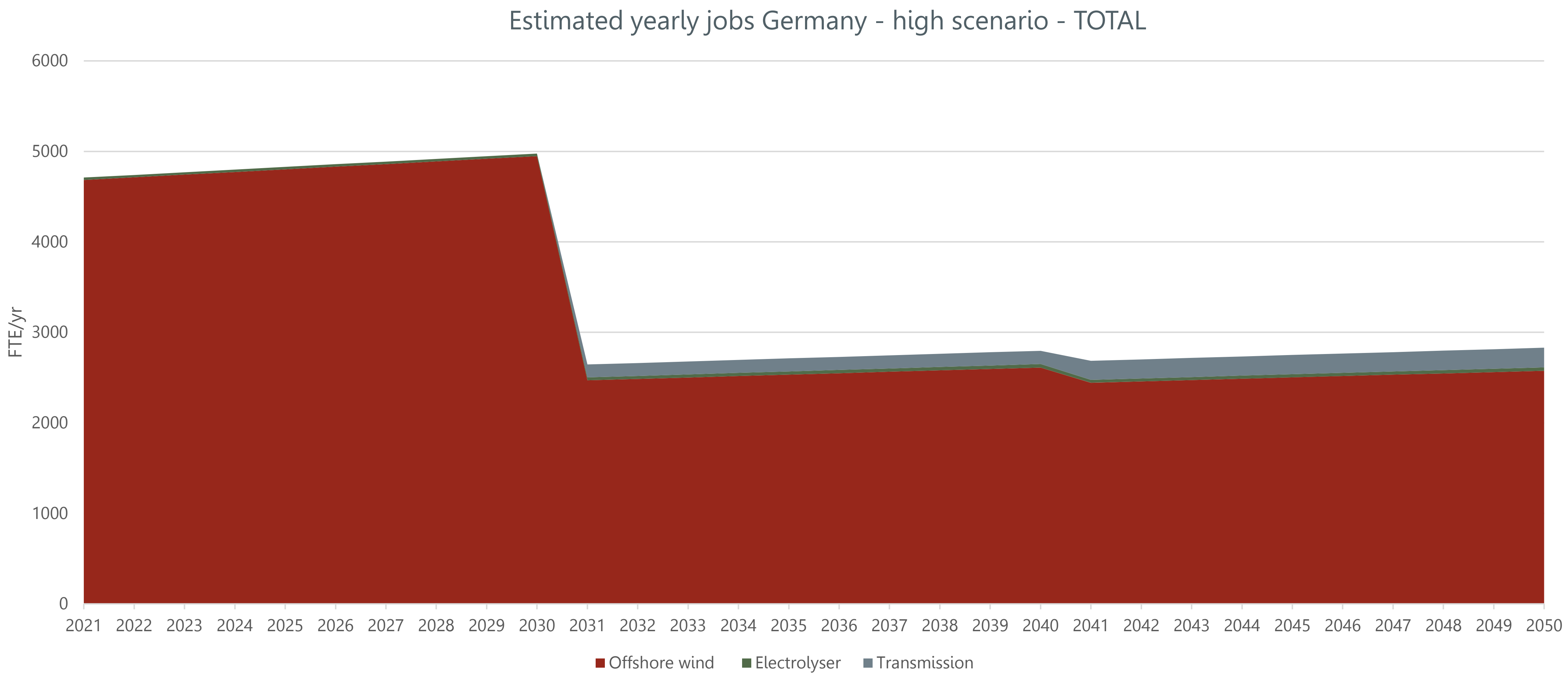
- **Germany's Offshore Wind Expertise Across the Value Chain**: Germany excels in various aspects of the offshore wind value chain, from manufacturing turbines and components to building and maintaining offshore wind farms. Its advanced port infrastructure supports large-scale installations, and its R&D capabilities drive innovation in rotor blade technology, floating turbines, and offshore electrolysis. There is a potential for the creation of around 100 000 jobs (lifetime FTEs) in Germany through the offshore wind buildout until 2050.
- **PtX & Hydrogen Development**: Mecklenburg-Vorpommern is planning hydrogen projects linked to offshore wind resources and pipeline infrastructure. However, securing biogenic CO_2 for methanol production remains a challenge, which may lead to a focus on ammonia production.
- **Business interests:** There is strong demand for green energy from companies dependent on a high availability of power/"baseload", i.e., data centres, PtX, battery production, with a focus on securing long-term power purchase agreements (PPAs)

Share of job creation by supply chain phase

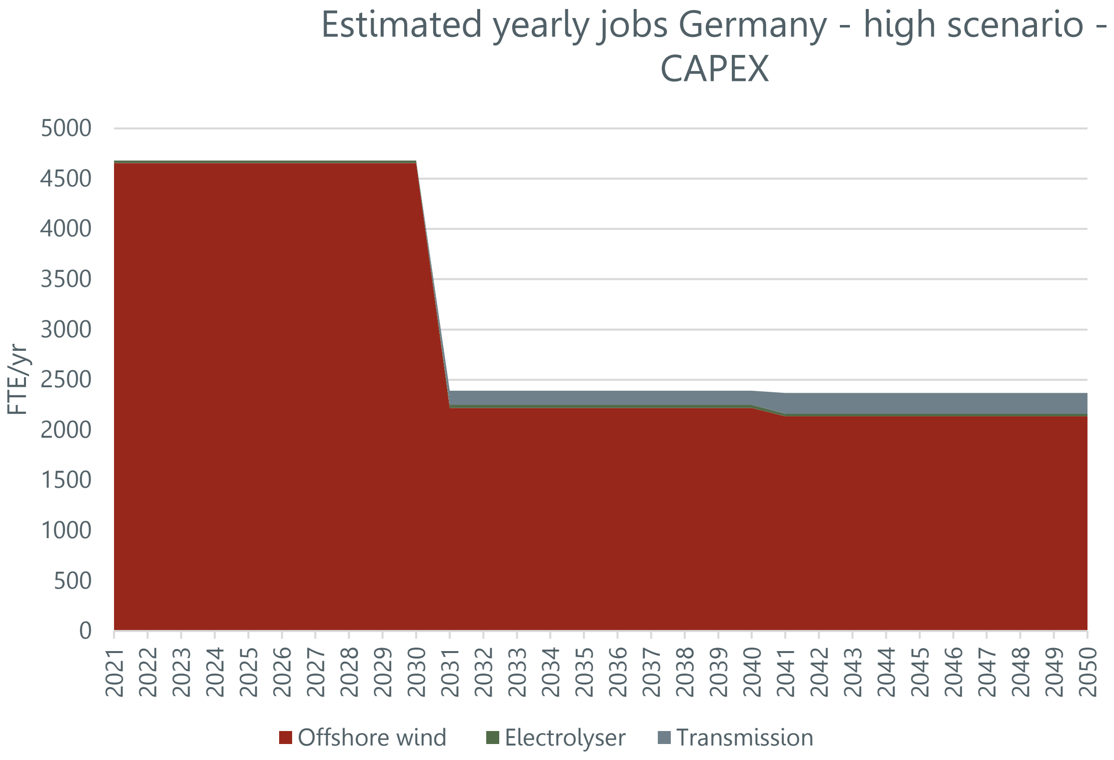
Germany - high scenario

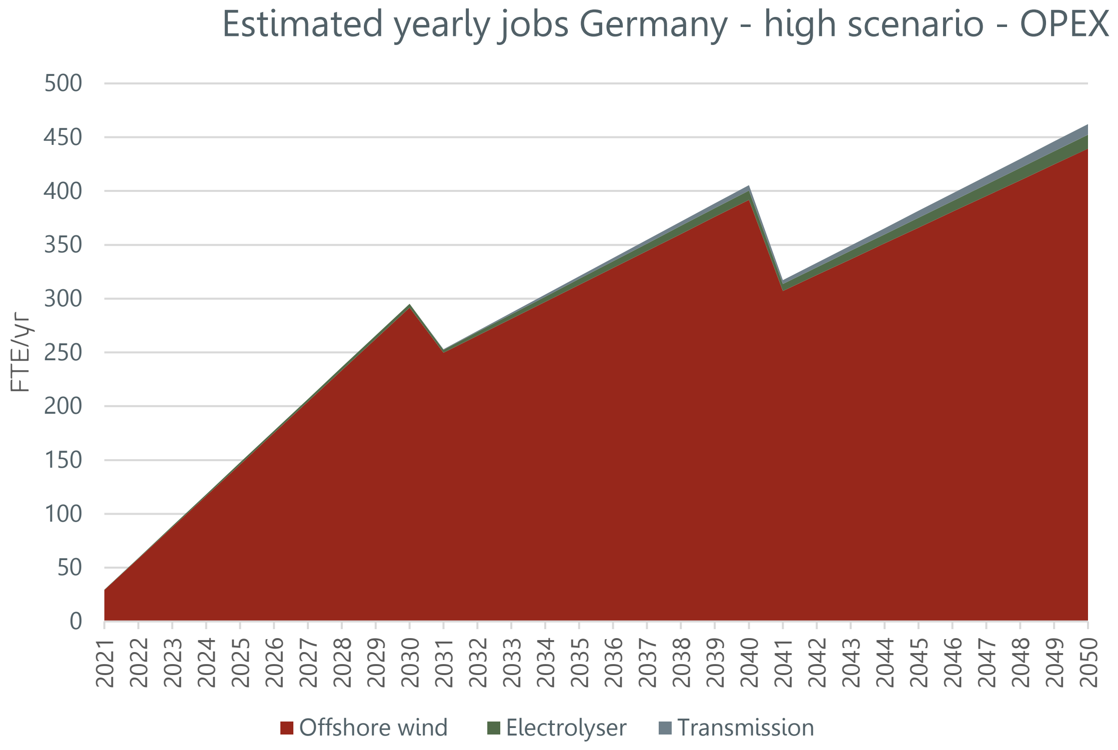


Germany - Estimated yearly jobs (direct industry jobs)



Germany - CAPEX- jobs and OPEX- jobs (direct industry jobs)

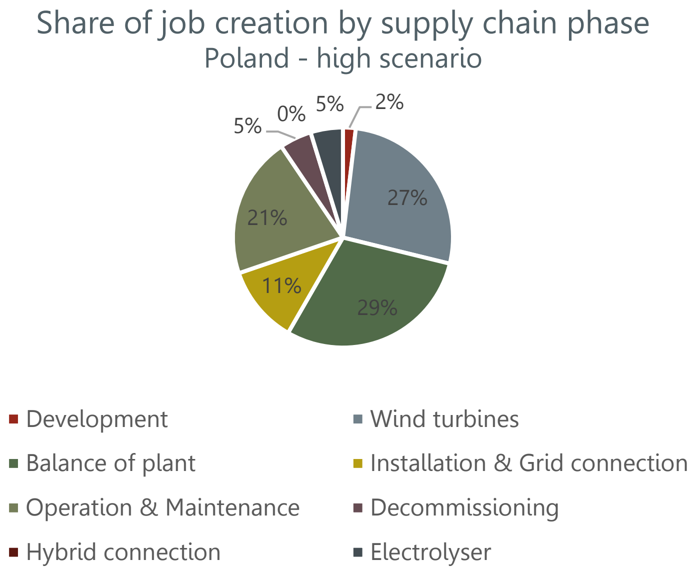




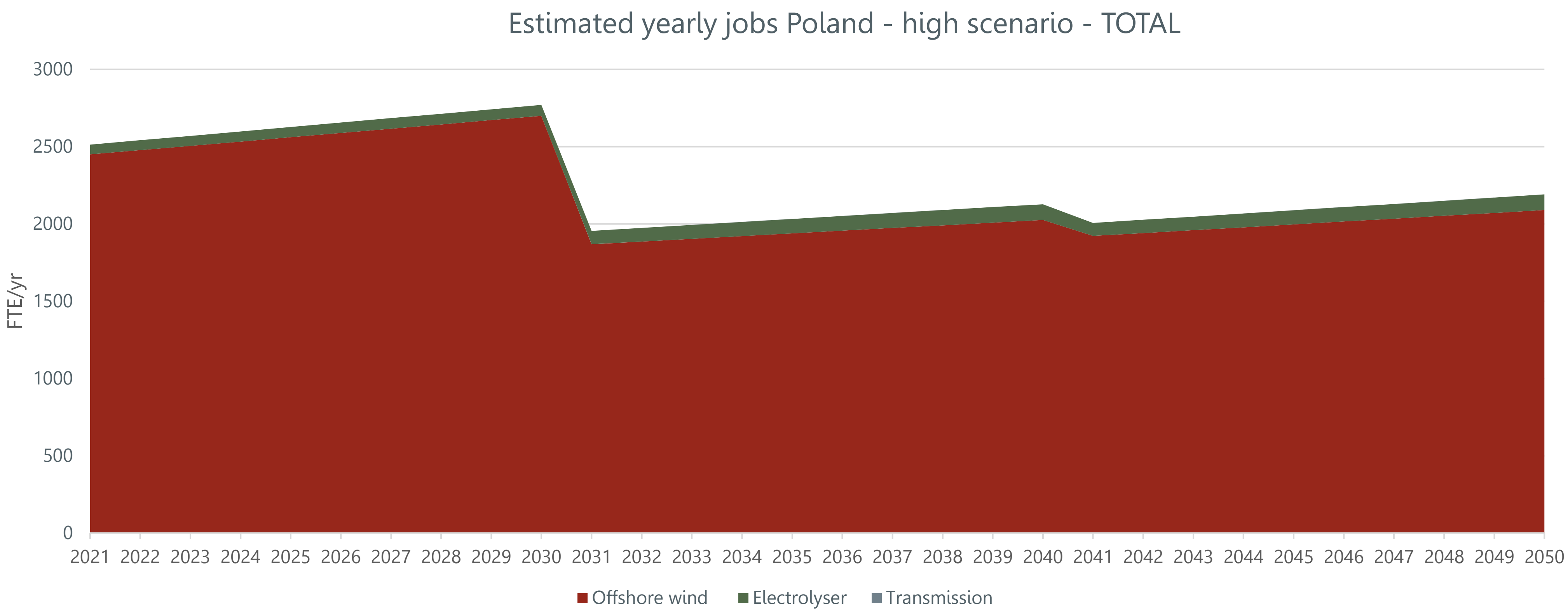
**This figure shows significant spikes, as efficiency improvements (reduction of FTE per GW) are assumed for the years 2030, 2040, and 2050.*

Poland – incentivising investments through streamlined processes

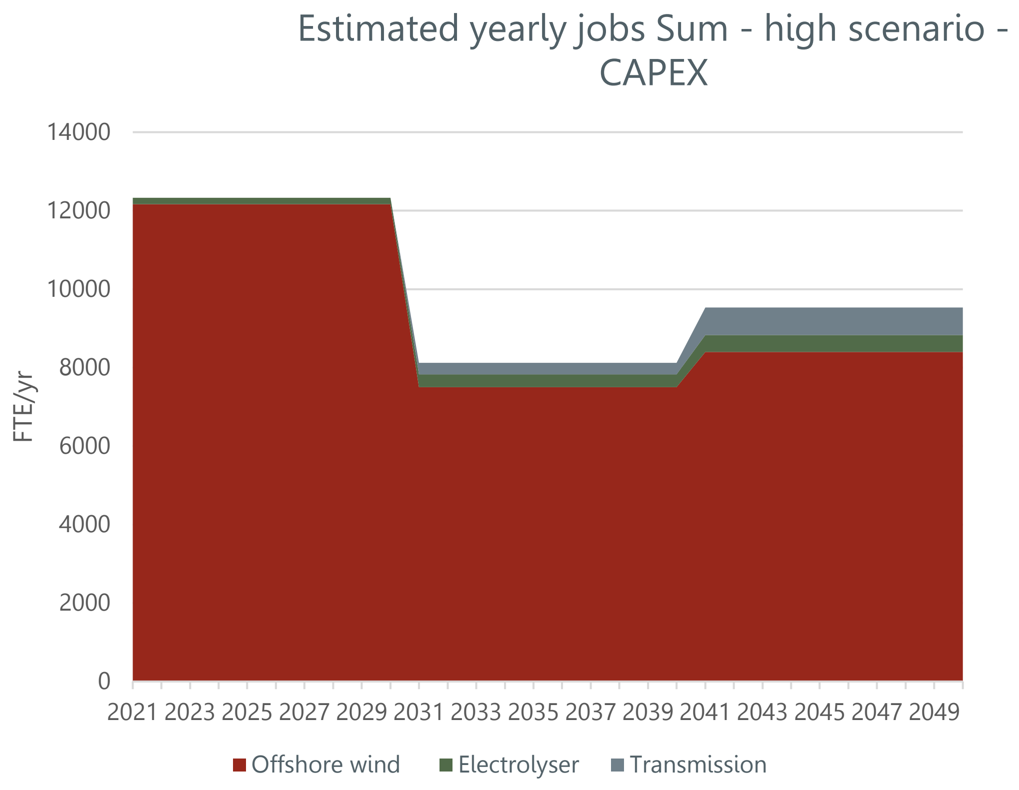
- **Boost in manufacturing jobs:** Poland can leverage its established manufacturing base and competitive labor market to become a hub for producing offshore wind components like turbines, blades, and steel structures, leading to increased employment in industrial sectors and strengthening its export potential. **There is a potential for around 65 000 jobs (lifetime FTEs) through offshore wind buildout in Poland until 2050** and further jobs in related industries.
- **Economic growth through streamlined processes:** Poland's relatively smooth bureaucratic processes for wind energy projects attract investments, generating indirect benefits such as supply chain expansion, skills development, and enhanced local infrastructure in coastal regions.

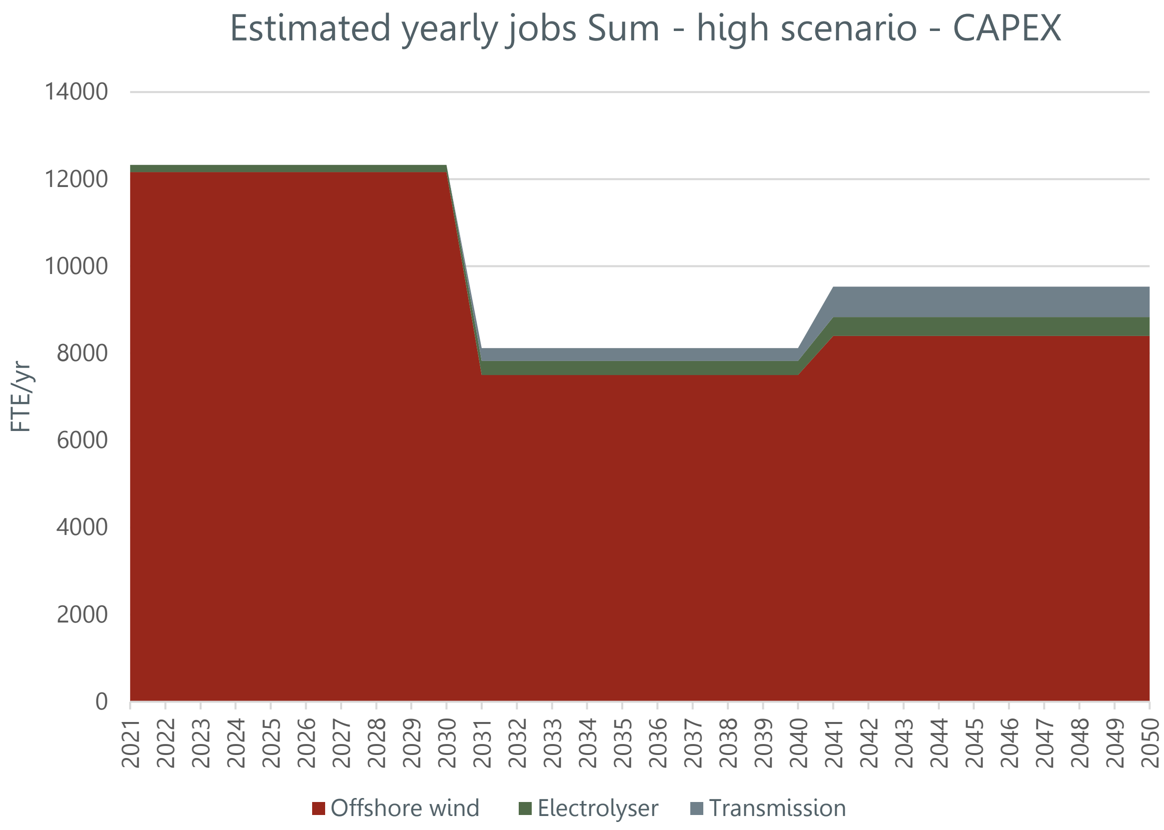


Poland - Estimated yearly jobs (direct industry jobs)



Poland - CAPEX- jobs and OPEX- jobs (direct industry jobs)





**This figure shows significant spikes, as efficiency improvements (reduction of FTE per GW) are assumed for the years 2030, 2040, and 2050.*

Conclusions

What secondary benefits does the offshore wind buildout bring for the Baltic Sea countries?

Job creation

Communities will **benefit from direct job creation and spillover effects**, especially in port regions.

Creation of jobs and **added value** includes **spill over into other industries**, such as green steel and Power-to-X, fuel-shifting and improvement in energy-related trade balances.

Potential of the entire value chain

The Baltic Region has capabilities to support the **development** of the entire **offshore value chain**, thus enabling even higher job creation.

But regional cooperation is needed to establish a common long-term **commitment to attract investors**.

Interconnectivity

Interconnectors, including hybrid infrastructure, are essential for the Baltic Region **to utilise the full offshore wind potential** to achieve net-zero emissions.

Interconnected offshore wind can **support energy sovereignty and resilience** through: i) a more integrated electricity market and ii) deepening European energy alliances.

Appendices

Quantitative Foundations

Methodologies: How to measure job creation?

Employment Factor (EF) Approach

- Estimates direct jobs by combining installed capacities and power generation data with employment factors.
- Focuses on direct jobs in manufacturing, installation, and maintenance.
- Does not account for indirect employment in upstream industries.

Gross Input-Output (IO) Model

- A comprehensive method estimating both direct and indirect employment.
- Combines expenditure data with an input-output model to capture economic interdependencies across industries.
- Includes jobs in both the renewable energy sector and related upstream industries.

Comprehensive Model

- Goes beyond gross job counts by factoring in the investments made, job displacement, and other shifts in the economy

⇒ Use of models is not part of this analysis

Bottom-up

Top-down

Combining bottom-up and top-down approaches provides a robust estimate of job creation from offshore wind deployment.

Main assumptions of the analysis

Technological efficiency will continue to characterise the offshore wind industry:

- **Lower technology costs**: the offshore wind industry will continue its efficiency trend in terms of cost reductions (EUR/MW) – bigger capacities, lower costs.
- **Labor efficiency gains**: the offshore wind industry will continue experiencing increasing capital-labor ratios, i.e., less labor input per unit of capital

Direct job creation		FTE/GW	mEUR/GW	FTE/mEUR
2030	Offshore Wind	7778	3719	2.09
	Electrolysis	1476	877	1.68
2040	Offshore Wind	5857	3018	1.94
	Electrolysis	825	665	1.24
	Transmission	1839	2424	0.76
2050	Offshore Wind	4794	2648	1.81
	Electrolysis	605	589	1.03
	Transmission	1176	1634	0.72

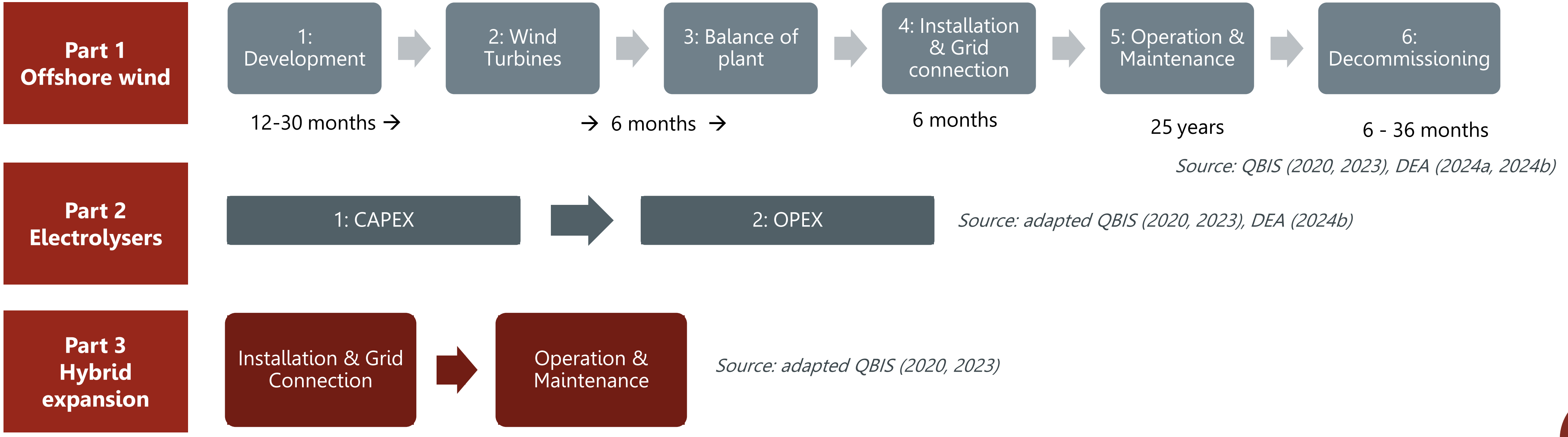
Source: own calculations based on direct job estimations

Note*: the table shows key metrics for the direct job estimation based on our own analysis.*

Bottom-up approach (direct industry jobs)

Direct job creation:

- From capacity (MW) lifetime costs (EUR/MW) to jobs (full time equivalents, FTEs)
- Assumption: decreasing cost (EUR/MW) and increasing labor efficiency (less labor per unit of capital).
- Divide the supply chain into three parts with different phases of construction and operation



Bottom-Up Methodology - Estimating Job Creation from Offshore Wind Deployment in the Baltic Sea

- The methodology for analyzing job creations is grounded in a bottom-up approach aimed at estimating job creation, as quantified in Full Time Equivalents (FTEs) per gigawatt (GW) of offshore wind capacity across various phases of offshore projects constructed in the Baltic Sea.
- The estimation of FTE/GW is based on QBIS (elaborated on the following slide) with adjustments tailored to its application in future projects and with specific insights into the Baltic region.
- The expected increase in capacity (GW) is based on The Offshore Network Development Plan (ONDP) for the Baltic Sea and a second less ambitious scenario.

Combining bottom-up and top-down approaches provides a robust estimate of job creation from offshore wind deployment.

Step-wise description of Bottom-Up methodology (Offshore Wind)

Step 1 (estimate lifetime costs) which comprehend the following five phases: 1) development, 2A) wind turbines, 2B) balance of plant*, 3) installation & grid connection, 4) operation & maintenance, 5) decommissioning

- EA's in-house cost estimation is calibrated to the cost distribution suggested by QBIS, as Ea's in-house cost does not include development, and decommissioning costs
- However, EA's in-house cost estimation has been adjusted to assumptions used by developers (costs in 2025 are 125% of formerly assumed costs due to supply chain bottlenecks) but takes the Danish Energy Agency's Technology figures as starting point (DEA, 2024)

Cost shares and total lifetime costs

Year	P1 - Design & PM	P2A - Wind turbine	P2B - Balance of Plant	P3 - Installation	P4 - O&M	P5- DEPEX	Total m EUR /GW
2030	4%	35%	22%	12%	17%	11%	3719
2040	4%	34%	22%	11%	19%	10%	3018
2050	4%	33%	21%	11%	21%	10%	2648

** Balance of plant: All the supporting components and auxiliary systems of a wind farm, excluding the wind turbines themselves.*

Step-wise description of Bottom-Up methodology (Offshore Wind)

Step 2 (obtain FTE/GW): each phase is associated with an estimated number of FTE/GW. The main source for this estimate is QBIS.

- Capital-labor ratio adjustment: at this stage, we adjust for the capital-labour ratio and introduce a declining rate in the years to be modelled

Estimated FTE/GW

Year	P1 - Design & PM	P2A - Wind turbine	P2B - Balance of Plant	P3 - Installation	P4 - O&M	P5- DEPEX	Total FTE/GW	FTE / m EUR
2030	125	2555	2500	955	1249	394	7778	2.1
2040	91	1876	1835	701	1065	289	5857	1.9
2050	73	1498	1466	560	967	231	4794	1.8

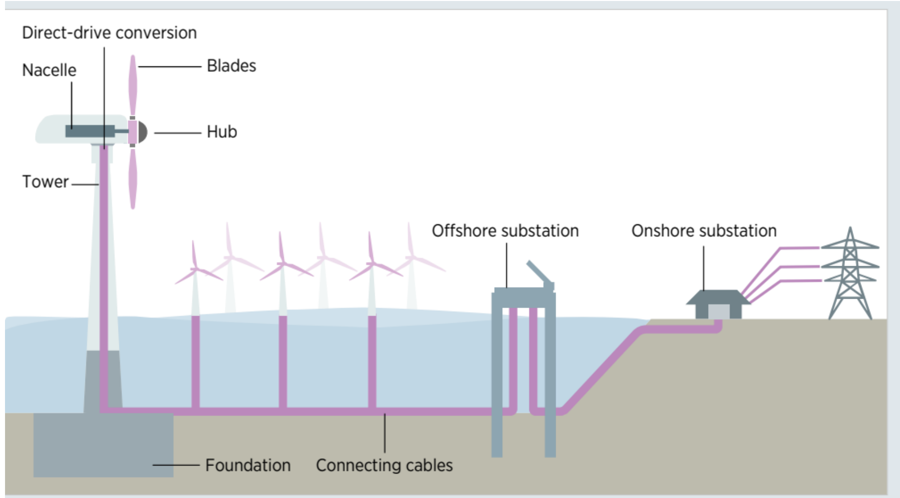
Step 3 (from GW to jobs): based on these assumptions, we utilize the outlook to estimate:

- Lifetime costs
- Direct jobs

Offshore wind Supply Chain

In the distribution of costs considered in the present study, we consider the following phases:

1. **Design and Project Management:** this phase includes site selection, environmental impact assessments, technical feasibility studies (e.g., coastal, wind and seabed assessments), financial feasibility studies, engineering design and project development.
2. **Manufacturing:** the second phase can be broadly categorized as the manufacturing of components and further subdivided into two subphases: **2A: Wind Turbines** (rotor, nacelle, tower, cabling, blades)**, 2B: Balance of Plant** (supply of connecting cables, foundations, and offshore and onshore substations).
3. **Installation and grid connection:** during this phase foundations, substations and export cables are placed. Turbines are set on the foundations, electric connections are completed, and the grid connection of the offshore wind farm is finalized.
4. **Operation and Maintenance:** contract management, operations management, management of onshore facilities, wind turbine planned maintenance and unplanned service, balance of plant planned maintenance and unplanned service, and offshore logistics.
5. **Decommissioning:** dismantling the project, recycling and disposing of the equipment, and clearing the site.



Source: Siemens, n.d.

Source: IRENA (2018) which is cited by QBIS (2020, 2023)

Top-down approach – IO analysis (Gross job creation, output, income)

Regional Input-Output table (Durán & Banacloche, 2022)

	Intermediate consumption				Final demand				
	Country A	Country B	Country C	RoW	Country A	Country B	Country C	RoW	Output total
Country A	$Z^{A,A}$	$Z^{A,B}$	$Z^{A,C}$		$Y^{A,A}$	$Y^{A,B}$	$Y^{A,C}$	$R^{A, RoW}$	Output ^{A}
Country B	$Z^{B,A}$	$Z^{B,B}$	$Z^{B,C}$		$Y^{B,A}$	$Y^{B,B}$	$Y^{B,C}$	$R^{B, RoW}$	Output ^{B}
Country C	$Z^{C,A}$	$Z^{C,B}$	$Z^{C,C}$		$Y^{C,A}$	$Y^{C,B}$	$Y^{C,C}$	$R^{C, RoW}$	Output ^{C}
Rest of World (RoW)	$Z^{RoW,A}$	$Z^{RoW,B}$	$Z^{RoW,C}$						
Freight and insurance	FI^{A}	FI^{B}	FI^{C}						
Total intermediate consumption	TI^{A}	TI^{B}	TI^{C}						
Value added (basic prices)	VA^{A}	VA^{B}	VA^{C}						
Output total	Output ^{A}	Output ^{B}	Output ^{C}						

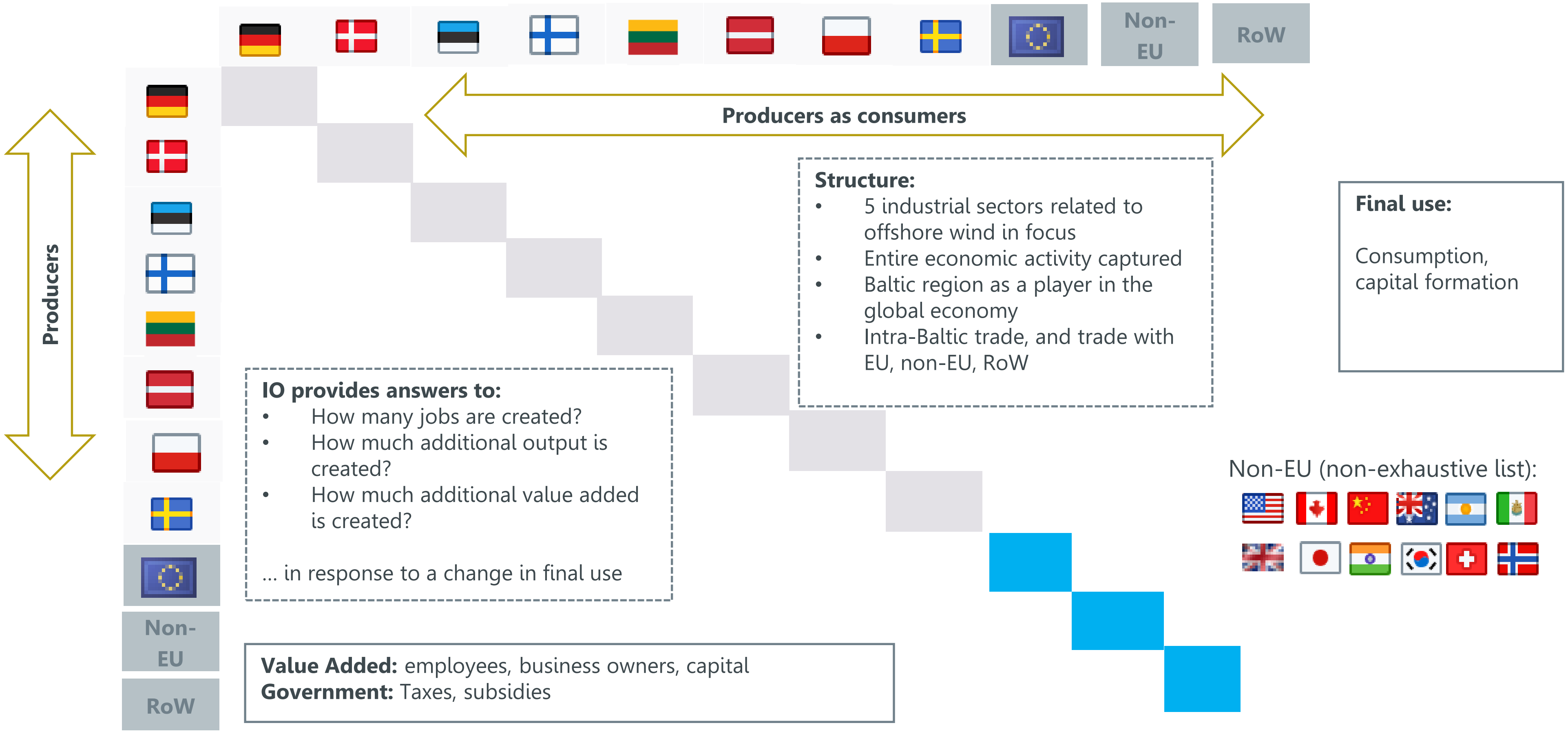
Satellite accounts	s^{A}	s^{B}	s^{C}

Statistical source: FIGARO tables (EUROSTAT)

- We construct an Input-Output table of the Baltic region (8 economies) with specific focus on 5 industries that "proxy" offshore wind
- We estimate **direct** and **indirect** multipliers:
- **Direct** multipliers: measure impact of a demand "shock" on output, employment, income in the same industry
- **Indirect** multiplier: measure impact of a demand "shock" on output, employment, income in the rest of the economy
- Caveats:
  - Static analysis, no technological change
  - Reflects present, not future
- Main strength: based on real data of the economy

***Note**: FIGARO stands for 'Full International and Global Accounts for Research in input-Output analysis' and it is the result of a cooperation project between Eurostat and the Joint Research Center of the European Commission*

IO model for the economies of the Baltic Region (Gross Job creation)



Statistical source: FIGARO tables (EUROSTAT)

Selected industries and links to offshore wind supply chain

Selected industries (NACE classification)

Industries	Proxy for
C25: Manufacture of fabricated metal products, except machinery and equipment	Towers
C27: Manufacture of electrical equipment	Internal grid
C28: Manufacture of machinery and equipment n.e.c.	Turbines, nacelles
C33: Repair and installation of machinery and equipment	Operation & Maintenance
F: Construction	Engineering works
Rest of the economy	All other activities in the economy (59 industries)

Notes:

- *NACE is the statistical classification of economic activities in the European Community*
- *EUROSTAT aggregates 64 industrial activities in National Account presentations*

Source: NACE documentation

***Note**: NACE is the European Classification of Economic Activities*

Matching between offshore wind phases and industries

Offshore wind:

	P1	P2A	P2B	P3	P4	P5
C25	-	-	50%	-	-	-
C27	-	-	50%	-	-	-
C28	-	100%	-	-	-	-
C33	-	-	-	100%	100%	100%
F	100%	-	-	-	-	-

P1: Development, **P2A:** wind turbines, **P2B:** Balance of plant, **P3:** Installation & Grid connection, **P4:** Operation & Maintenance, **P5:** Decommissioning

IO model for the economies of the Baltic Region

		DE C25	DE C27	DE C28	DE C33	DE F	DE Rest	DK C25	DK C27	DK C28	DK C33	DK F	DK Rest
DE	C33	0,05	0,04	0,05	3,50	0,01	0,02	0,00	0,00	0,00	0,00	0,00	0,00
DE	F	0,09	0,07	0,08	0,08	4,42	0,14	0,01	0,01	0,01	0,01	0,01	0,00
DE	Rest	2,30	2,26	2,41	2,69	2,78	6,81	0,42	0,40	0,39	0,39	0,28	0,19
DK	C25	0,00	0,00	0,00	0,00	0,00	0,00	3,01	0,07	0,13	0,17	0,12	0,01
DK	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,01	2,10	0,05	0,02	0,01	0,00
DK	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,06	0,08	1,63	0,09	0,05	0,01
DK	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	2,88	0,01	0,01
DK	F	0,00	0,00	0,00	0,00	0,00	0,00	0,04	0,04	0,04	0,04	2,74	0,07
DK	Rest	0,01	0,02	0,02	0,01	0,01	0,01	1,14	0,88	1,08	1,20	1,64	4,29
EE	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	Rest	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,04	0,01
FI	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,00	0,00
FI	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00
FI	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00
FI	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FI	F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FI	Rest	0,06	0,04	0,04	0,04	0,03	0,03	0,16	0,13	0,11	0,11	0,09	0,06
LT	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LT	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LT	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LT	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LT	F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LT	Rest	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,03	0,03	0,03
LV	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	Rest	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
PL	C25	0,03	0,02	0,02	0,02	0,02	0,01	0,05	0,03	0,04	0,03	0,02	0,01
PL	C27	0,00	0,04	0,01	0,01	0,01	0,00	0,00	0,03	0,02	0,01	0,00	0,00
PL	C28	0,00	0,00	0,02	0,01	0,00	0,00	0,01	0,01	0,02	0,01	0,01	0,00
PL	C33	0,00	0,01	0,00	0,01	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,00
PL	F	0,02	0,02	0,02	0,02	0,02	0,01	0,03	0,03	0,03	0,02	0,08	0,01
PL	Rest	0,37	0,36	0,32	0,31	0,28	0,23	0,52	0,54	0,46	0,51	0,48	0,27
SE	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,02	0,01	0,02	0,02	0,01	0,00
SE	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,04	0,02	0,01	0,01	0,00
SE	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,03	0,01	0,01	0,00

		EE C25	EE C27	EE C28	EE C33	EE F	EE Rest	FI C25	FI C27	FI C28	FI C33	FI F	FI Rest	LT C25	LT C27	LT C28	LT C33	LT F	LT Rest
DE	C33	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00
DE	F	0,01	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,02	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
DE	Rest	0,34	0,37	0,38	0,27	0,19	0,21	0,54	0,56	0,62	0,52	0,47	0,44	0,37	0,45	0,44	0,44	0,24	0,23
DK	C25	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DK	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DK	C28	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DK	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DK	F	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
DK	Rest	0,04	0,04	0,04	0,04	0,02	0,03	0,13	0,12	0,14	0,14	0,11	0,13	0,03	0,04	0,04	0,09	0,03	0,03
EE	C25	6,21	0,23	0,62	0,26	0,36	0,06	0,04	0,04	0,03	0,03	0,05	0,01	0,02	0,00	0,00	0,00	0,01	0,00
EE	C27	0,01	5,81	0,01	0,01	0,01	0,01	0,01	0,09	0,02	0,03	0,02	0,01	0,01	0,04	0,00	0,01	0,00	0,00
EE	C28	0,01	0,00	3,33	0,00	0,00	0,00	0,00	0,00	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	C33	0,05	0,02	0,03	5,05	0,04	0,04	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EE	F	0,06	0,07	0,06	0,06	6,53	0,14	0,02	0,02	0,02	0,03	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,00
EE	Rest	1,80	1,31	1,92	2,33	3,27	8,83	0,15	0,18	0,14	0,17	0,21	0,15	0,07	0,10	0,09	0,11	0,07	0,08
FI	C25	0,06	0,07	0,05	0,04	0,02	0,01	4,82	0,34	0,57	0,42	0,44	0,14	0,01	0,01	0,00	0,00	0,00	0,00
FI	C27	0,00	0,08	0,01	0,01	0,01	0,00	0,03	2,77	0,07	0,11	0,06	0,03	0,00	0,01	0,00	0,00	0,00	0,00
FI	C28	0,02	0,04	0,05	0,04	0,01	0,01	0,11	0,12	3,13	0,34	0,16	0,09	0,00	0,01	0,01	0,00	0,00	0,00
FI	C33	0,01	0,02	0,01	0,07	0,01	0,01	0,14	0,10	0,18	7,00	0,16	0,14	0,00	0,00	0,00	0,00	0,00	0,00
FI	F	0,02	0,02	0,02	0,02	0,01	0,01	0,17	0,12	0,14	0,19	6,11	0,29	0,00	0,00	0,00	0,00	0,00	0,00
FI	Rest	1,12	0,87	0,81	1,13	0,57	0,45	7,86	5,12	6,03	6,26	9,14	14,12	0,16	0,18	0,19	0,10	0,13	0,15
LT	C25	0,03	0,02	0,02	0,01	0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,00	6,21	0,09	0,12	0,10	0,26	0,04
LT	C27	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03	4,98	0,01	0,02	0,03	0,01
LT	C28	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,04	0,02	7,44	0,14	0,05	0,02
LT	C33	0,00	0,00	0,00	0,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,03	0,03	7,75	0,08	0,05
LT	F	0,01	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,15	0,07	0,17	0,08	7,84	0,16
LT	Rest	0,12	0,13	0,14	0,13	0,24	0,21	0,04	0,04	0,04	0,05	0,06	0,05	2,13	1,95	2,33	2,13	2,76	10,36
LV	C25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	C27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00
LV	C28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	C33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LV	Rest	0,01	0,01	0,01	0,01	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,02	0,02	0,01	0,01
PL	C25	0,10	0,08	0,07	0,03	0,03	0,01	0,04	0,04	0,04	0,03	0,04	0,02	0,17	0,08	0,08	0,02	0,06	0,02
PL	C27	0,01	0,05	0,00	0,00	0,01	0,00	0,00	0,05	0,01	0,01	0,01	0,00	0,03	0,10	0,01	0,01	0,01	0,00
PL	C28	0,01	0,01	0,01	0,01	0,00	0,00	0,01	0,01	0,03	0,01	0,01	0,00	0,01	0,01	0,03	0,01	0,01	0,00
PL	C33	0,01	0,01	0,01	0,04	0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,03	0,02	0,02	0,02	0,01	0,01
PL	F	0,09	0,05	0,05	0,03	0,04	0,02	0,04	0,04	0,03	0,04	0,03	0,03	0,09	0,09	0,07	0,03	0,06	0,04
PL	Rest	1,56	1,04	1,07	0,56	0,55	0,42	0,65	0,74	0,64	0,68	0,66	0,58	2,07	2,04	1,74	0,70	1,25	0,89
SE	C25	0,02	0,02	0,02	0,01	0,01	0,00	0,02	0,02	0,02	0,01	0,02	0,01	0,01	0,00	0,00	0,00	0,00	0,00
SE	C27	0,00	0,03	0,00	0,00	0,00	0,00	0,00	0,03	0,01	0,01	0,01	0,00	0,01	0,02	0,00	0,00	0,00	0,00
SE	C28	0,00	0,01	0,02	0,01	0,00	0,00	0,01	0,01	0,05	0,02	0,01	0,01	0,00	0,00	0,01	0,00	0,00	0,00

→ Heat map showing employment multipliers, red indicates low impact, green indicates high impact.

Statistical source: FIGARO tables (EUROSTAT)

Selected industries and links to offshore wind supply chain

Matching between offshore wind phases and industries (continued):

Electrolysers:

	CAPEX	OPEX
C25	-	-
C27	85%	-
C28	-	100%
C33	-	-
F	15%	-

Transmission:

	CAPEX	OPEX
C25	-	-
C27	85%	-
C28	-	100%
C33	-	-
F	15%	-

Key points:

- Estimated lifetime costs are distributed according to the indicated matching between phases and industries
- These costs and their distribution are used to create a “shock” in the final use of the IO table – IO analysis are demand-driven
- Estimated lifetime costs are:
  - A result from the bottom-up analysis
  - An input to the IO analysis
  - Therefore, link between bottom-up and top-down approaches
- Estimated multipliers were adjusted downwards to reflect:
  - Cost evolution over time (-7% every 10 years)
  - The fact that NACE industries are merely proxies to the wind industry (adjustment to reflect labor productivity in the Renewable Industry of countries in the Baltic Region)

Multipliers resulting from the Input-Output (IO) analysis

The following slides show the employment multipliers obtained from the IO analysis. These are calculated according to the following steps:

- **Shock**: each country in the Baltic Region receives a "shock" equal to the estimated **lifetime costs** used in the bottom-up approach. The shock reflects the amount by which demand faced by the industries increase. This reflects the output (O) side of the analysis
  - **Distribution of lifetime costs:** to create consistency between the assumptions in the bottom-up and IO analyzes, the shock received by each country follows the same distribution as **jobs** in the bottom-up approach. Both the bottom-up and IO analyzes reflect the "Theory of Change" in which the Baltic region increasingly benefit from the offshore wind supply chain.
  - Sheets "Shock_High" and "Shock_Low" in the IO_client_version Excel sheet contain the same **distribution** as "Job Distribution" in the Outlook Excel sheet.
- **Jobs:** once each country receives a demand-side shock, the IO table indicates the number of jobs required to meet the increase in demand. This reflects the input (I) side of the analysis.
- **Multipliers** are equal to the ratio of Input to Output to, i.e., the ratio of Jobs (measured in FTE) required to meet the demand-side shock (measured in mEUR) [FTE/m EUR]
  - However, other indicators, such as FTE/GW and m EUR/GW can also be estimated

Multiplier and Key Metrics resulting from the Input-Output (IO) analysis

Baltic Region

Direct & indirect job creation (IO)	Baltic region	FTE/GW	mEUR/GW	FTE/mEUR
2030	**Offshore Wind**	15407	3038	5.07
	Electrolysis	3297	570	5.79
2040	**Offshore Wind**	12325	2606	4.73
	Electrolysis	2189	432	5.07
	Transmission	6228	1430	4.36
2050	**Offshore Wind**	10147	2351	4.32
	Electrolysis	1718	383	4.48
	Transmission	4701	1126	4.18

Note*: 1) FTE/ mEUR is the estimated employment multiplier for each year based on the buildout and total amount invested in the region, i.e., the "shock" perceived by the region; 2) Multipliers have been adjusted to reflect labor productivity in the renewable energy industry of the countries in the region*

Source: FIGARO tables for the Baltic Region

Short Summary of WP1 (Task 1A) – 1/2

Year	Buildout	DE	DK	PL	EE	FI	LV	LI	SE	Total
2030	**high**	**4.1**	**8.0**	**10.1**	**1.0**	**1.0**	**1.4**	**0.5**	**0.6**	**26.7**
	low	2.9	5.6	7.1	0.5	0.5	0.7	0.3	0.3	17.8
2040	**high**	**4.2**	**7.9**	**10.9**	**3.5**	**4.9**	**2.8**	**1.5**	**9.3**	**45.0**
	low	3.3	6.3	8.7	1.8	2.5	1.4	0.8	4.7	29.4
2050	**high**	**4.2**	**7.9**	**10.9**	**7.0**	**12.0**	**4.5**	**2.5**	**21.2**	**70.2**
	low	3.7	7.1	9.8	3.5	6.0	2.3	1.3	10.6	44.3

Low buildout in DE, DK, PL: 2030: reduced by 30%, 2040: reduced by 20%, 2050: reduced by 10%

Low buildout in all other countries:
- 2030, 2040, 2050: reduced by 50%

Rationale behind low scenario:

- DE, DK, PL have robust policy support and well-defined national targets for offshore wind. Their governments have established ambitious offshore wind goals and consistent, long-term subsidies or incentives, providing the market with confidence and stability for investment. Regulatory frameworks in these countries are also more mature, allowing for faster permitting processes and reduced project uncertainty.
- In contrast, SE, FI, and the Baltic countries lack similarly defined targets and incentives, leading to less certainty around support. This regulatory gap makes large-scale investment in offshore wind less predictable in these regions.
- For that reason, we subtract 50% from the ONDP to reach the low scenarios for FI, SE, and the Baltic countries whereas for DE, DK, and PL we only reduce by 30% in 2030, by 20% in 2040 and by 10% in 2050.

Short Summary of WP1 (Task 1A) – 1/2

Electrolyser capacity (GW)

Year	Buildout	DE	DK	PL	EE	FI	LV	LI	SE	Total
2030	**high**	**0.36**	**0.69**	**0.88**	**0.09**	**0.09**	**0.12**	**0.04**	**0.05**	**2.3**
	low	0.25	0.49	0.62	0.04	0.04	0.06	0.02	0.03	1.5
2040	**high**	**1.08**	**2.06**	**2.84**	**0.91**	**1.28**	**0.73**	**0.39**	**2.43**	**11.7**
	low	0.87	1.65	2.28	0.46	0.64	0.37	0.20	1.21	7.7
2050	**high**	**1.81**	**3.44**	**4.74**	**3.05**	**5.22**	**1.96**	**1.09**	**9.22**	**30.5**
	low	1.62	3.09	4.27	1.52	2.61	0.98	0.54	4.61	19.3

The deployment of offshore wind in the Baltic Sea Region will play a crucial role in the electricity system by achieving three main objectives:

1. Displacing fossil fuel generation,
2. Enabling direct electrification and serving new demands, such as those from data centers, and
3. Facilitating investments in indirect electrification, particularly through the expansion of electrolyser capacity.

Looking ahead to 2050, as the power system becomes more decarbonized, a significant portion of offshore wind power is expected to be directed toward hydrogen production via electrolysers.

This study assumes that by 2030, 9% of offshore wind generation will be used for hydrogen production, rising to 26% by 2040, and reaching 50% by 2050. A similar assumption was made in the North Sea Wind Power Hub (NSWPH) Pathway Study 2.0 to which Ea Energy Analyzes contributed. Hydrogen production in this study is thus not modeled, but simply an assumption on the share of electrolyser capacity induced by offshore wind generation is made.

These projections apply uniformly to all offshore wind generation, regardless of location. However, in reality, these percentages are likely to vary between countries, depending on factors such as the composition of each nation's power sector, competition from other forms of energy demand, and export opportunities.

Short Summary of WP1 (Task 1A) – 1/2

Transmission (GW)

Year	Buildout	DE	DK	PL	EE	FI	LV	LI	SE	Total
2030	**high**	**4.1**	**8.0**	**1.0**	**1.0**	**1.4**	**0.5**	**10.1**	**0.6**	**26.7**
	low	2.9	5.6	0.5	0.5	0.7	0.3	7.1	0.3	17.8
2040	**high**	**5.7**	**7.9**	**4.5**	**4.9**	**2.8**	**1.5**	**10.9**	**9.8**	**48.0**
	low	3.3	6.3	1.8	2.5	1.4	0.8	8.7	4.7	29.4
2050	**high**	**8.2**	**8.4**	**8.5**	**14.0**	**5.9**	**3.5**	**10.9**	**24.5**	**83.8**
	low	3.7	7.1	3.5	6.0	2.3	1.3	9.8	10.6	44.3

- Low buildout in DE, DK, PL: 2030: reduced by 30%, 2040: reduced by 20%, 2050: reduced by 10%
- No hybrid expansion in Low scenario

Low buildout in all other countries:

- 2030, 2040, 2050: reduced by 50%
- No hybrid expansion

Hybrid expansion buildout (GW)

Year	Buildout	DE	DK	PL	EE	FI	LV	LI	SE	Total
2030	**high**	0	0	0	0	0	0	0	0	0
	low	0	0	0	0	0	0	0	0	0
2040	**high**	**1.5**	**0**	**1**	**0**	**0**	**0**	**0**	**0.5**	**3**
	low	0	0	0	0	0	0	0	0	0
2050	**high**	**4**	**0.5**	**1.5**	**1.95**	**1.35**	**1**	**0**	**3.3**	**13.6**
	low	0	0	0	0	0	0	0	0	0

Source: BEMIP ONDP (2024)

Methodology – (Hybrid)-Transmission Jobs*

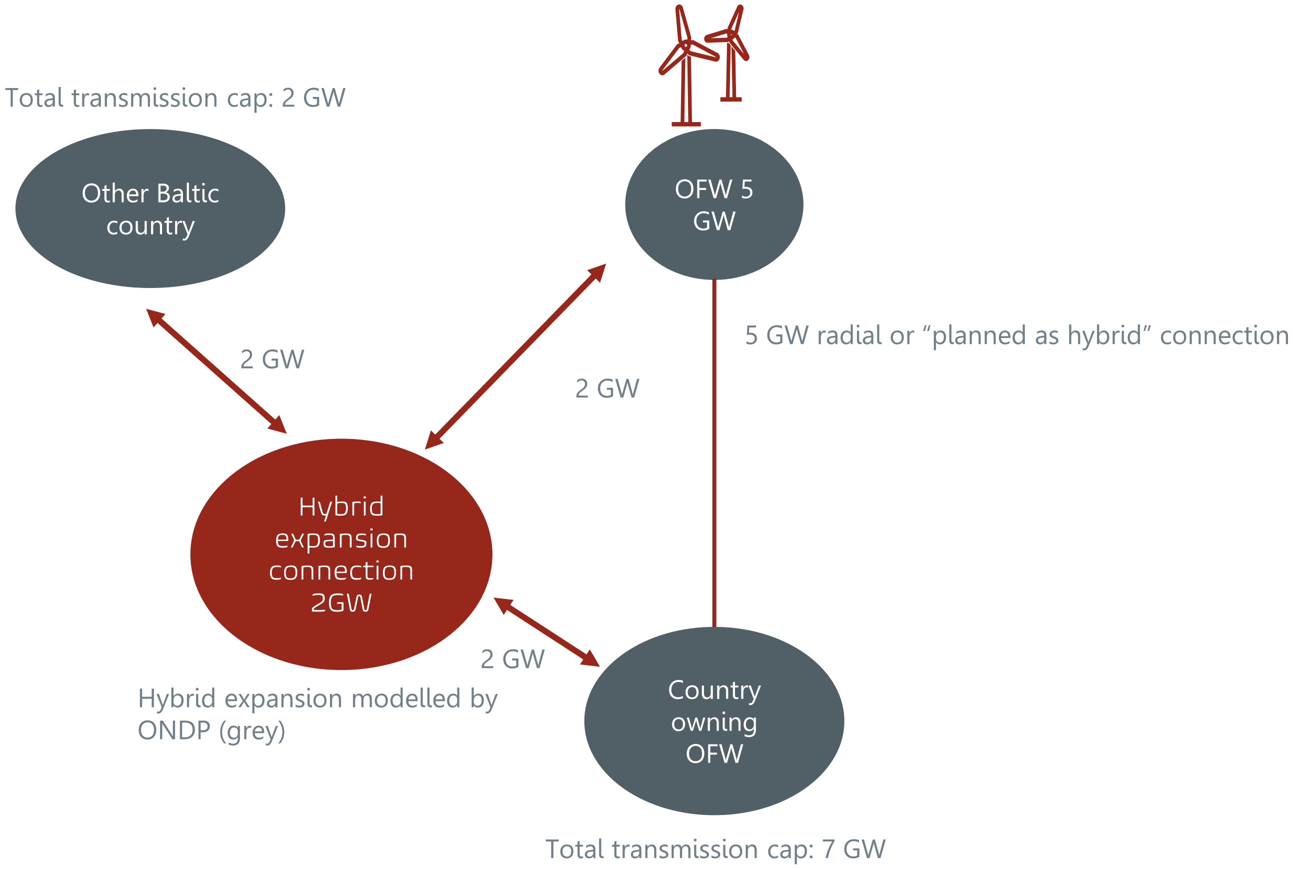
- **Step 0:** Only the additional hybrid connections are considered in this approach.
  - The methodology from offshore wind already includes the jobs from radially connecting the windfarms, as well as from the category "Planned hybrids" (hybrids that have been announced and planned, see ONDP (2024).
- **Step 1 (extract transmission element of QBIS estimate):** For each of the phases, the job creation share related to transmission is found based on costs distribution in each phase of offshore buildout (from QBIS)
- **Step 2:** ONDP hybrid expansion costs are divided equally out between countries sharing a hybrid connection.
- **Step 3:** Cost are multiplied by a factor to include OPEX and divided onto phases per country and year
- **Step 4:** Transmission share are multiplied with the FTE/mEUR factor for each phase and then multiplied by the associated cost/investment for each phase.
- **Step 5:** This result is FTE per phase for the additional hybrid expansion connections.

**In order to calculate the direct jobs created by the hybrid expansions modeled in the ONDP (2024) – transmission related only.*

Estimating (hybrid)-transmission-related jobs

As an example, the slide shows a schematic representation of a 5 GW offshore wind farm with 2 GW hybrid expansion

- Total transmission capacity: 5 GW Radial/ "planned as hybrid" + 2 GW Hybrid = 7 GW
- Jobs associated to hybrid transmission include only the "hybrid expansion" category
- Jobs associated with a radially connected or "planned as hybrid" connection are counted as part of the offshore wind farm itself
- This approach avoids double counting jobs, which would otherwise overestimate the amount of jobs created.



Radial connections, planned hybrids and hybrid expansions

This table shows graphically the three categories considered of transmission considered in the ONDP

- Radial connections (dark green lines)
- Existing and planned hybrid interconnections (light green lines)
- ONDP expanded hybrid corridors (yellow lines)

2030: no ONDP expansion

2040: 3 GW ONDP hybrid expansion

2050: 13,6 GW ONDP hybrid Expansion

Source: BEMIP ONDP (2024)

Methodology – Enabled by hybrids

To provide a quantitative assessment of the impact on job creation of developing hybrid interconnections, this study has used the following method.

- **Step 1 [share of hybrid expansions in total transmission capacity]:** we estimate the share of hybrid expansions in total transmission capacity. In 2040, this is 6%, i.e., 6% of total transmission capacity is a hybrid expansion [3 GW/48 GW = 0.06]. In 2050, this is 13%, i.e., 13% of total transmission capacity is a hybrid expansion [10.6/83.8 GW = 0.13]
- **Step 2 [assumption on generation enabled by hybrids]:** we assume that the share estimated in step 1 (6% in 2040 and 13% in 2050) corresponds to the total installed generation capacity in the High scenario (6% * 45 GW = 2.81 GW in 2040 and 13% * 70.2 GW = 8.87 GW in 2050) is enabled by a hybrid expansion.
- **Step 3 [difference between scenarios]**: the enabled generation capacity (2.81 GW in 2040 and 8.87 GW in 2050) is respectively 18% and 34% of the difference in total installed capacity between the high and low scenarios. Note that 2.81 GW is 18% of the difference between total installed generation capacity between high and low (45 – 29.4 GW =15.6 GW) in 2040 and 34% of the difference between high and low (70.2 – 44.3 GW = 25.9 GW) in 2050.
- **Conclusion**: we conclude that respectively 18% and 34% of the jobs created in the high scenario are “enabled by hybrids” in the years 2040 and 2050.

OPEX yearly FTE – Explanation of graph "jumps"

- The total OPEX-jobs follow the expected trend, increasing annually. Small jumps in 2031 and 2041 occur due to higher yearly installation rates.
- The OPEX-jobs in Germany show spikes due to a shift in share of total OPEX-jobs : from 25% in 2030 to 19% in 2031, and a similar trend from 2040 to 2041.
- In other countries, like Estonia, the share of total OPEX-jobs increases, contributing to the observed jumps.
- In general: The "jumps" in OPEX-jobs for individual countries occur because 'country shares' are defined per decade rather than annually.

Germany's share of OPEX jobs:

2021-2030: 25%

2031-2040: 19%

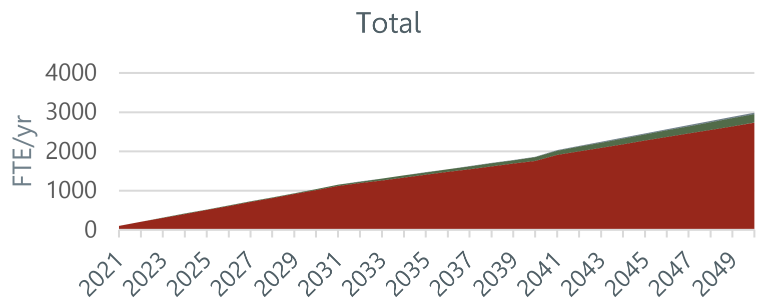
2041-2050: 13%

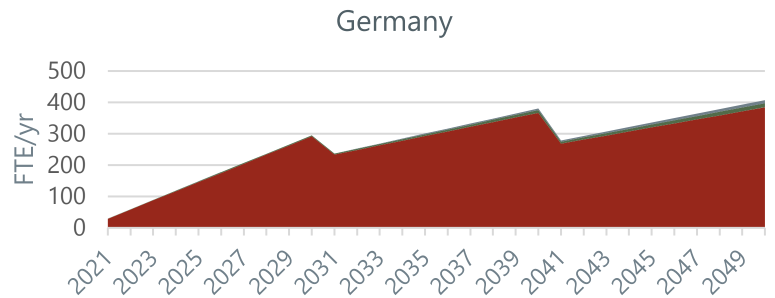
Estonia's share of OPEX jobs:

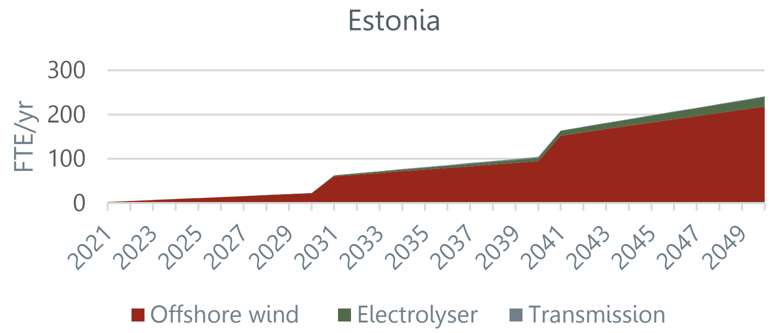
2021-2030: 2%

2031-2040: 5%

2041-2050: 7%







Different job metrics

- **FTE lifetime** [FTE]: here all the jobs created by the buildout in the impact year through the whole lifetime (assuming that the buildouts only happens in 2030, 2040 and 2050) are assigned to this year. This would also mean that the whole lifetime of OPEX-jobs are assign to this year. (See sheet: Direct jobs)
- **FTE per impact year** [FTE/yr]: Here the Capex-jobs are assumed to happen over 10 years; this means that only a 10^{th} of the buildout happens every year. The OPEX-jobs is divided into 25 years. This means that this value for e.g., 2030 is only the jobs that exist in 2030. The sum of the three years Capex-jobs are not equal to the lifetime jobs – this is equal to a 10^{th} of the lifetime jobs. While the OPEX-jobs will not match up because the OPEX-jobs that exists after 2050 are not counted in this metric. (See sheet: Direct jobs)
- **FTE for every year per country** [FTE/yr]: This shows the yearly direct jobs for every year between 2021-2050. Which means that summing the Capex-jobs would be equal to the lifetime jobs. However, this is not entirely accurate, as we only consider jobs created in the Baltic Sea region, meaning the difference in the total from lifetime jobs reflects jobs allocated to the rest of the world. The OPEX-jobs does not add up to the lifetime because we don't consider the jobs that exists after 2050. (See sheet: Jobs Distribution every year)

Electrolyser direct jobs

- **Jobs per wind cost**: The number of full time equivalent (FTE) jobs created per euro spent on wind energy is calculated. It is derived by dividing the total jobs associated with wind energy CAPEX or OPEX (FTE per GW of wind capacity) by the cost per gigawatt of wind energy. Essentially, it shows the labor intensity of wind energy investments relative to their cost. Here all the phases that are under the Capex are calculated as a total for every year.
- **Electrolyser jobs**: This formula extrapolates the job-cost relationship to electrolysers (we use wind as a proxy for electrolysis). By multiplying the jobs per euro for wind energy with the cost of installing one GW of electrolyser capacity, it estimates the FTE jobs created per GW of electrolyser capacity. This approach assumes the labor intensity (jobs per cost) for wind energy projects can be used as a proxy for electrolyser projects. Here it is again divided out on phases as the electrolyser cost is per phase.
- The electrolyser job values are applied similarly to those for the wind farm. Each project phase and impact year has a specific job value for electrolysers.

$$\text{Jobs per wind cost}\left[\frac{FTE}{EUR}\right] = \frac{\text{Wind jobs}\left[\frac{FTE}{\text{GW}_{\text{wind}}}\right]}{\text{Wind cost}\left[\frac{\text{EUR}}{\text{GW}_{\text{wind}}}\right]}$$

Sources: QBIS (2020, 2023)

$$\text{Electrolyser jobs}\left[\frac{FTE}{GW_{elec}}\right] = \text{Wind jobs per cost}\left[\frac{FTE}{EUR}\right] \cdot \text{Electrolyser cost}\left[\frac{EUR}{GW_{elec}}\right]$$

Source: DEA 2024b

Assumptions and calculations of direct electrolyser jobs

Key references – Quantitative Foundations

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Qualitative foundations

Literature Review on Direct and Indirect Benefits: Identifying Research Gaps

The literature review was structured in two main parts:

1. The first part focused on the discussion of the **direct economic effects** of offshore wind in the Baltic Sea by examining cost-benefit analysis (CBA) studies related to offshore wind projects. It included comprehensive desktop research to identify various sensitivities impacting the economic assessments and outcomes of these projects.
2. The second part aimed to identify research gaps by exploring web search sources (Google Scholar, libraries, journals) focused specifically on the **indirect economic effects** of offshore wind in the Baltics, excluding traditional cost-benefit analyzes related to the electricity market. A total of 45 studies were identified and categorized into three main areas:
    1. Employment Effects
    2. Geostrategic Implications
    3. Other Community Benefits and Costs

Literature Review – Direct Benefits

- 15 studies from authoritative sources as well as Ea's own modeling were identified and reviewed.
- The review focused on direct economic effects within the electricity market, such as consumer surplus, producer surplus, and congestion rent.
- Not all studies directly reported such distributional metrics but instead reported total system costs and revenues which allow estimating net benefits for the electricity market participants.
- Two studies were identified as particularly relevant due to their **focus on the Baltic region's economic dynamics related to offshore wind**, while two additional studies were noted for their comprehensive insights, despite not being Baltic-specific.

Literature Review – Indirect Benefits: Employment

– A total of 28 studies on employment were reviewed, of which 12 specifically addressed offshore wind. Three of these studies referenced the Baltic countries.

	Title	Author	Specific mention of OWF	Specific mention of Baltic countries
1	Klima og grønne job	3F and Rådet for Grøn Omstilling		
2	The characteristics of energy employment in a system-wide context	Grant J. Allan and Andrew G. Ross		
3	Beskæftigelses effekter af investeringerne i den grønne omstilling	Dansk Energi		
4	Comparative analysis of direct employment generated by renewable and non-renewable power plants	Juan Jose Cartelle Barros et al.	x	
5	Direct employment in the wind energy sector: An EU study	Maria Isabel Blanco and Gloria I	x	x
6	Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion	Christoph Böhringer, Andreas Keller and Edwin van der Werf		
7	Guidelines for employment impact assessment of renewable energy deployment – general aspects and net employment studies	Barbara Breitschopf, Carsten Nathani and Gustav Resch		
8	Dansk klimapolitik frem mod 2030	De Økonomiske Råd		
9	Estimation of the potential effects of offshore wind on the Spanish economy	Pedro Varela-Vazquez and María del Carmen Sanchez-Carreira	x	
10	Employment in the Energy Sector: Status report 2020	JRC	x	
11	The Possible Implications of the Green Transition for the EU Labour M	European Commission		
12	Employment impact assessment of renewable energy targets for electricity generation by 2020—An IO LCA approach	Carla O. Henriques et al.		
13	Klog klimaomstilling vil skabe jobs til alle faggrupper	IDA		
14	Skills Development and Inclusivity for Clean Energy Transitions	IEA	x	
	Title	Author	Specific mention of OWF	Specific mention of Baltic countries
15	World Energy Employment	IEA	x	
16	Renewable Energy and Jobs Annual Review 2023	IRENA and ILO	x	
17	Abandoning fossil fuel production: What can be learned from the Danish phase-out of oil and gas?	Poul Thøis Madsen et al.		
18	Towards a green energy economy? Tracking the employment effects of low-carbon technologies in the European Union	Anil Markandya et al.		x
19	Employment effects of renewable electricity deployment. A novel m	Margarita Ortega et al.	x	
20	Macroeconomic analysis of the employment impacts of future EU climate policies	H. Pollitt et al.		
21	The social face of renewables: Econometric analysis of the relationship between renewables and employment	Sara Proença and Patricia Fortes		
22	Job creation during a climate compliant global energy transition across the power, heat, transport, and desalination sectors by 2050	Manish Ram et al.		
23	Green Jobs—A Literature Review	M.R. Stanef-Puică et al.		
24	Socio-economic impact study of offshore wind	QBIS	x	
25	Study on Baltic offshore wind energy cooperation under BEMIP Final Report	European Commission DG Energy	x	x
26	Lithuania Energy System Transfromation to 2050	EPSO-G		x
27	The regional economic impacts of offshore wind energy developmer	Kevin Connolly	x	
28	Challenges for the Polish energy policy in the field of offshore wind energy development	Wojciech Drożdż and Oliwia Joanna Mróz-Malik	x	
		Total	**12**	**4**

Literature Review –Indirect Benefits: Geostrategic implications

- Twelve studies on geostrategic implications were identified. Although most of these studies demonstrated direct relevance to geostrategic issues, only five mentioned offshore wind explicitly, and just four of those focused on the Baltic countries.

	Title	Author	Specific mention of OWF	Specific mention of Baltic countries	Direct relevance for geostrategic implications
1	Offshore Wind farms & Defence implications	NATO Energy Security Centre of Excellence	x	x	
2	Maritime Security and the Wind: Threats and Risks to Offshore Renewable Energy Infrastructure	Christian Bueger and Timothy Edmunds	x	x	x
3	Baltic States' Synchronisation with Continental European Network: Navigating the Hybrid Threat Landscape	Justinas Juozaitis		x	x
4	Energy Highlights	NATO Energy Security Ce	x		
5	Evaluating the competitiveness and uncertainty of offshore wind-to-hydrogen production: A case study of Poland	Aleksandra Komorowska	x	x	
6	Ammonia Production as Alternative Energy for the Baltic Sea Region	Gunnar Prause et al.		x	x
7	Invisible but not indivisible: Russia, the European Union, and the importance of "Hidden Governance	Morena Skalamera			
8	The new oil? The geopolitics and international governance of hydrogen	Thijs Van de Graaf et al.			x
9	A New World The Geopolitics of the Energy Transformatio	IRENA			x
10	The Geopolitics of Hydrogen: Technologies, Actors, and Scenarios until 2040	Jacopo Maria Pepe et al.			
11	Baltic Offshore Wind Energy Development—Poland's Public Policy Tools Analysis and the Geostrategic Implications	Kamila Prонińska and Krzysztof Księżopolski	x	x	x
12	Policy and political (in)coherence, security and Nordic–Baltic energy transitions	Paula Kivimaa			
		Total	5	6	6

Literature Review – Indirect Benefits: Other Community Benefits

- Five studies on other community benefits were identified and reviewed. While all these studies focused on offshore wind development, only one specifically examined the Baltic Sea region.

Title	Author	Specific mention of OWF	Specific mention of Baltic countries	Direct relevance local community costs/benefits
The local socio-economic impacts of offshore wind farms	John Glasson et al.	x		x
Implications of offshore wind energy developments in coastal and maritime tourism and recreation areas: An analytical overview	Júlia Terra M. Machado and Maria de Andres	x		x
Energy Transition in the Baltic Sea Region: Understanding Stakeholder engagement and community acceptance	Farid Karimi and Michael Rodi	x	x	
Deep waters: Lessons from community meetings about offshore wind resource development in the U.S.	Damon M. Hall and Eli D. Lazarus	x		x
Germany's policy practices for improving community acceptance of wind farms	Pia Kerres et al.	x		x
	Total	5	1	4

Main results from literature study - methodology

There are several studies on job creation for different countries, such as Denmark, Poland and the BEMIP region but there is **no common framework for the measurement of job impacts**.

- Several methodologies to estimate job creation exist, both top-bottom and bottom-up. There is a **trade-off between the level of technological detail (bottom-up assessments) and the estimation of overall economic impacts** (top-down).
- Some studies analysed **beyond the scope of traditional CBAs** (e.g. Lithuania energy transformation study).
- Some studies lacked a solid methodological foundation in their assessment of employment or other effects (e.g., Lithuania energy transformation study).

Main results from literature study

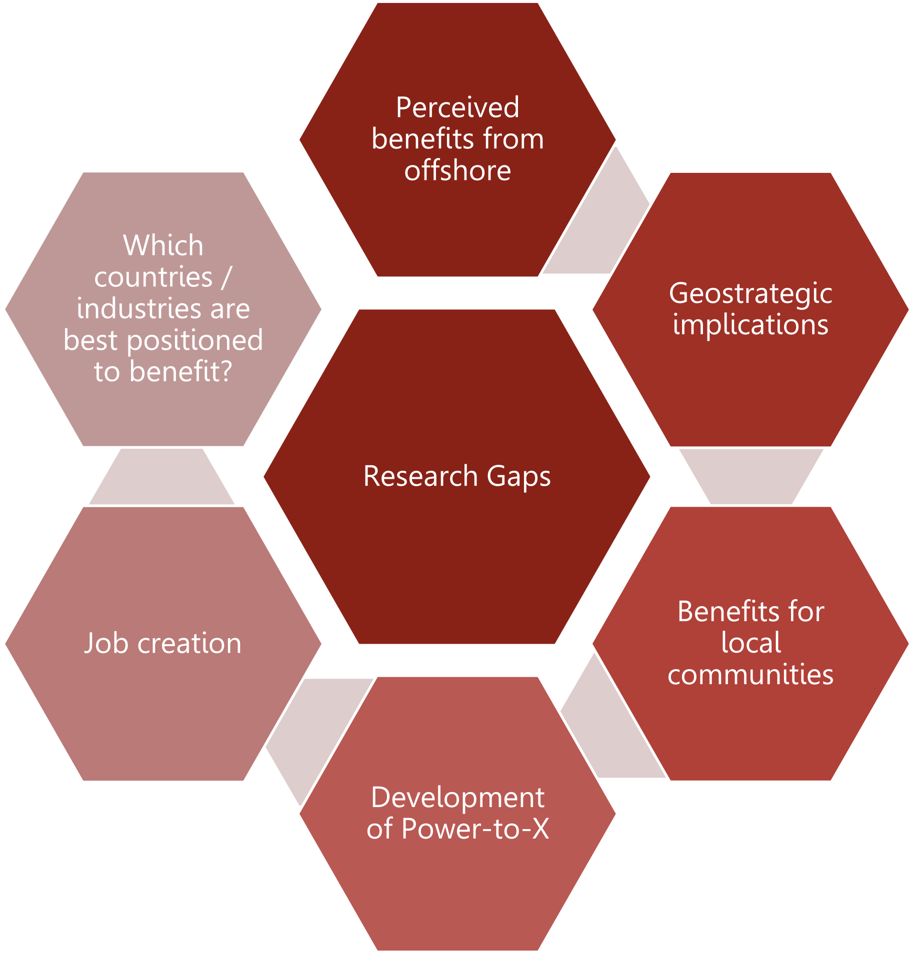
Regarding geopolitics, the analysed literature revealed several ways in which renewable energy development (including offshore wind development) can result in benefits:

- **Electricity trade:** additional interconnections enhance grid stability and resilience and bring about efficiency gains, however, they can also lead to higher prices in the exporting regions, which affects political acceptability.
- **Trade in renewable energy fuels** may also grow significantly, e.g., hydrogen and other derived fuels can strengthen the position of the Baltic regions
- **Efficiency gains**: In the longer run, the offshore wind industry is becoming more efficient both in terms of CAPEX and job creation, meaning that less employment (per GW) can be expected in the future than in the present.
- **Uneven CAPEX distribution**: CAPEX expenditure in the offshore wind supply chain tends to be unequally distributed: countries with comparative advantages and technological expertise benefit from job creation during the CAPEX phase.

Main results from literature study

- Predictions can also substantially overestimate impacts, with **major leakage of benefits to established international contractors**. There is increasing concern that the industry should take the **delivery of national and local content** and economic success much more seriously.
- There is a need to strengthen not only initial cost benefit analyses but monitoring the results continuously.
- Regarding the **practice of cost-benefit analyses**, the literature survey revealed a need to broaden the scope of the benefits:
  - The consideration of jobs and wider economic impacts via the supply chain is understandable, and **easier to quantify** than social impacts. This calls for a more holistic approach, which is more qualitative and includes demographic, housing, local services and wellbeing impacts

Identified research gaps served as the foundation for further analyses



— Identified research gaps were converted into questions.
— These questions were explored further through qualitative interviews.
— Where possible, they were quantitatively assessed in later analyses.

Semi-structured interviews to support hypotheses

Organization	*Country*
Litgrid	**Lithuania**
Ministry of Energy of the Republic of Lithuania*	**Lithuania**
AST	**Latvia**
Investment and Development Agency of Latvia (LIAA)	**Latvia**
Environmental Investment Center (KIK)	**Estonia**
Business Finland – Cleantech Unit	**Finland**
Polish Wind Power Association (PWEA)	**Poland**
Royal Danish Embassy Riga	**Denmark**
WindEnergy Network e.V. Mecklenburg-Vorpommern	**Germany**
Energi Företagen - Energy Systems Unit	**Sweden**
Siemens Gamesa	**n.a.**

** The Ministry of Energy of the Republic of Lithuania replied to our questions in written form.*

- Semi-structured interviews with 19 participants from 11 organizations across 8 Baltic Sea countries
- Mix of predetermined open-ended questions and adaptive follow-up questions
- Interviews were recorded with consent
- Notes were analyzed thematically to identify key patterns and insights

For any inquiry, contact:
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or find us on LinkedIn