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THE WIND ENERGY INDUSTRY IN ESTONIA: THE AVAILABILITY AND NEEDS OF THE WORKFORCE

Master Thesis

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Annotation

Estonia is a small country located in the Baltic region of Northern Europe and is exploring the potential for developing wind power in its waters and on land. The Estonian government has set a goal of producing 100% of its electricity from renewable energy sources by 2030, and wind farms power is expected to play an important role in achieving this goal. (Tatomir, 2022) However, the shortage of workforce in this sector has been highlighted as one of the major problems for Estonia as well as for many other countries.

The study includes an analysis of the current and future demand for workers with specific skills and an evaluation of the current supply of workers in the industry. The result is to find solutions for how the wind energy industry can improve its recruitment and retention efforts, and what preparations must be made for the first stage of development in the Estonian Wind industry. To achieve a more objective result, the author uses a combined research strategy or case study. To study this topic, a survey was conducted among the participants of the Estonian Wind Energy Association and an interview with the project manager of a Kuressaare Regional Training Centre, Saaremaa Island, Estonia. The author also collected a database of workers in the wind sector with the support of Tschudi Ship Management company. Directly 5 years of experience of the author in the shipping company as a recruiter became the basis for providing conclusions and achieving the aim of the work.

Estonia has set ambitious goals for the advancement of wind power and is taking measures to support the expansion of this sector. As the industry continues to grow and evolve, there is a projected increase in demand for professionals with specialized skills in wind energy. Individuals proficient in electrical and mechanical engineering, data analytics and artificial intelligence, project management, and coordination, as well as environmental science and sustainability, are expected to be highly sought after, with various opportunities available across the wind energy sector. In conclusion, although the wind energy industry faces challenges in recruiting and retaining talent, there are strategies that can be employed to overcome these obstacles.

Introduction

Since 2010, there has been a steady growth in wind power worldwide, with the amount of power generated by wind increasing by almost 30% every year. Countries around the world need to rapidly scale up renewable energy supplies to meet growing demand and quickly cut emissions. Europe and the North Sea have been the driving force behind the international expansion of wind energy. (Gourvenec, 2020)

In recent years, wind farms have emerged as a crucial renewable energy source. However, the operation and maintenance of these farms pose significant challenges. Several factors, such as weather conditions, logistics, and turbine design, can impact the effectiveness of the maintenance process. Concurrently, the efficiency of wind farm work and maintenance strongly influences the shortage of skilled workers.

A dearth of proficient workers can result in work delays, heightened equipment failure risks, and an overall negative impact on wind farm performance. As the wind energy industry continues its growth, there will likely be an increasing demand for qualified personnel. Thus, the availability of a skilled workforce becomes a vital factor for the successful operation and maintenance of wind farms. Stakeholders involved must prepare recruitment and retention strategies and implement them proactively.

This thesis uses data and market analysis to forecast the future labor needs of the Estonian wind energy industry and make recommendations for how to meet these needs. The study includes an analysis of the current and future demand for workers with specific skills and an evaluation of the current supply of workers in the industry. The result is to find solutions for how the wind energy industry can improve its recruitment and retention efforts, and what preparations must be made for the first stage of development in the Estonian Wind industry. To achieve a more objective result, the author uses a combined research strategy or case study. Data collection is mainly based on the Tschudi Ship Management company's database and interviews with various experts related to Estonian wind energy development.

Hypothesis: The wind energy industry in Estonia faces challenges related to the availability and needs of the workforce, which impact the sector's growth and development. The hypothesis proposes that the growth and investment in the wind energy sector in Estonia are influenced by

the availability and needs of the workforce. If the industry faces challenges in accessing a skilled workforce, it may hinder the expansion of wind energy projects and the realization of Estonia's renewable energy targets. The hypothesis suggests that addressing workforce-related issues is crucial for the sustainable development of the wind energy industry.

The master's thesis consists of three chapters. The first part presents an overview of the Wind Energy Industry in Estonia, describes about government support, and provides the interview with interested parties, and this analysis. The second part describes the qualifications of the workforce and requirements for standards, and education in this field in Estonia. Also, the author gives a comparison of the industry with neighboring countries. The last chapter presents the labor market analysis and forecasting and results from the case studies performed as a part of the thesis. The author suggests recommendations in recruitment branch in wind industry based on the results of the research work. Also, the final chapter describes the author's experience as a recruiter in the wind industry. Directly 5 years of experience of the author in the shipping company as a recruiter became the basis for providing conclusions and achieving the aim of the work.

1 Wind Energy Industry in Estonia

Estonia, a small Baltic country in Northern Europe, is actively exploring the potential for wind power development both offshore and on land. Although offshore wind farms are not yet operational, Estonia has presented various initiatives and plans to advance the wind energy industry. Currently, the country has an installed wind energy capacity of nearly 600 MW, distributed across multiple wind farms throughout Estonia. (Tatomir, 2022)

Since the establishment of its first wind farm in 2001, Estonia has made significant investments in wind energy development. Most of the wind farms are situated on the western coast and islands, where wind resources are abundant. Notably, the highest-capacity wind farm is located on Hiiumaa Island, with a total capacity of 150 MW. (Kärmas, 2023)

Estonia's wind energy sector is experiencing rapid growth, with the country aspiring to become the world's leading per capita wind energy producer. To achieve this, Estonia is expediting offshore wind farm projects, which will contribute to meeting renewable energy targets and reducing reliance on fossil fuels. The designated area for offshore wind farms will be divided into three to four parts and auctioned in September 2023, with the auction winners playing a crucial role in shaping Estonia's energy future. Currently, there have been 44 building permit applications for an approximate area of 1,800 square kilometers in the south and west of Saaremaa. (Liive, 2022)

Multiple developers are competing for available land, with each claiming their share of square meters. To determine which developers will proceed, the government has devised a straightforward formula: the construction permit will be granted to the company that offers the highest payment. The deadline for submitting proposals is set for October 1st as mandated by the law. The Economic Commission's minutes mention a recurring message that the outcome of the building permit auction might be announced before the summer. According to the minutes of the Economic Commission, there is also a repeated message that the results of the building permits auction could be known before the summer. (Kärmas, 2023) (De Brouwer, 2022)

One of the most significant developments is the plan to build a 1-gigawatt offshore wind farm in the Gulf of Riga. This project is expected to provide a significant increase in Estonia's wind power capacity and help the country achieve its renewable energy goals and start to import electricity. (Tatomir, 2022)

Globally, offshore-based renewable energy generation, including offshore wind, is gaining traction, and approaching increased deployment. The country aims to be a place where new technological solutions for offshore wind farms are developed, tested, and manufactured. For this purpose, a unique laboratory on the sea will be created near Estonia's largest island, Saaremaa. This offshore wind technologies innovation area can be used by companies from all around the world to test floating wind turbines, subsea stations and robots, service and maintenance drones, autonomous ships. (EU Comission, 2023) This trend is expected to continue, providing new opportunities for the wind energy industry in Estonia and other countries around the world.

In addition to offshore wind projects, Estonia is also investing in onshore wind technology research and development. (IEA, 2023) This includes efforts to reduce investment costs and increase efficiency, which will make wind energy even more cost-competitive with traditional energy sources. This year was begun the construction of the largest wind farm in the Baltics- in Tootsi, North Pärnumaa municipality. The works of the Enefit Green wind farm are carried out by Verston OÜ and Nordecon Betoon. 38 wind turbines will be erected in the Sopi-Toots wind park, the total capacity of the park is 255 megawatts, and it will start operating at the end of 2024. The construction of the park will cost 305 million euros. The wind turbines are installed by Nordex, one of the world's leading wind turbine manufacturers. The production of this park covers 8.5% of the electricity consumption of the entire country and 40% of the electricity needs of domestic consumers. (Erilaid, 2022) Overall, the Wind Energy Industry in Estonia is poised for continued growth, with a focus on offshore wind projects and onshore technology research and development.

1.1 The lifecycle of an onshore and offshore wind farm

The lifetime of a wind farm can be more than 25-30 years, from the initial design work to the final decommissioning of a farm. There are different stages to this work:

1. Site selection and assessment: In this stage, potential locations for the wind farm are identified and assessed for their wind resources, access to the grid, and other factors that may affect the project's feasibility. Environmental studies are also conducted to identify potential impacts on wildlife, habitats, and local communities.

2. Development and permitting: Once a suitable site has been identified, the developer will submit a permit application to the relevant authorities. This may involve obtaining permits for land use, environmental impact assessments, and zoning and planning approvals.

3. Construction: The construction phase involves building the wind turbines, installing the infrastructure needed to connect the turbines to the grid, and constructing any necessary on-site buildings or infrastructure.

4. Commissioning: Once the turbines are installed and the infrastructure is in place, the wind farm is commissioned. This involves testing and verifying that all systems are working as intended and that the turbines are generating electricity at the expected levels.

5. Operation and maintenance: The wind farm enters its operational phase once it has been commissioned. During this stage, the turbines generate electricity, which is fed into the grid. Regular maintenance is also required to keep the turbines functioning properly, and repairs may be needed if any components fail.

6. Decommissioning: At the end of the wind farm's lifespan, the turbines are decommissioned and removed from the site. This involves dismantling the turbines, removing the infrastructure, and restoring the site to its original condition. (Chipindula, 2018)

Recent studies on the life cycle assessment (LCA) of offshore wind farms have shown that the material used in installing the foundations contributes significantly to the environmental impact. Onshore wind farms, on the other hand, have a smaller environmental impact due to the lower number of materials needed for their construction. (Lundtang Petersen, 2004)

The life cycle of a wind farm includes several stages, such as raw material extraction, manufacturing, transportation, installation, operation, and decommissioning. The environmental impacts of each stage must be considered in the LCA. For example, the manufacturing of wind turbines requires significant amounts of energy and raw materials, which can result in greenhouse gas emissions and other environmental impacts. (Chipindula, 2018)

Offshore wind farms also have additional environmental impacts due to their location in marine environments. The installation of foundations and turbines can disturb the seabed and affect marine life. However, these impacts can be mitigated through proper planning and management.

Overall, the life cycle of onshore and offshore wind farms has significant environmental impacts that must be carefully considered and managed. LCA studies can help identify areas for improvement and guide the adoption of more sustainable practices in the wind energy industry. (Bonou, 2016)

1.2 Development plans for wind energy in Estonia

Wind energy has become an increasingly important source of renewable energy in Estonia in recent years. Estonia has set a goal of producing 100% of its electricity from renewable energy sources by 2030, and wind power is expected to play an important role in achieving this goal. The Estonian government is actively exploring the potential for wind power development in the country and has set several targets for increasing wind power capacity in the coming years. Estonia is adopting an integrated planning permit for offshore wind farms. To meet all the goals, the government is simplifying permit granting processes and shortening deadlines – projects of societal importance should be completed within three years. Integrated planning permits give developers an opportunity to launch their projects more quickly. (Tatomir, 2022) Also, potential foreign investors have noted Estonia's preferable wind conditions and efficient business environment.

The development of offshore wind energy in Estonia has been driven by several factors, including the country's ambitious renewable energy targets, the availability of favorable wind resources, and the increasing demand for electricity. In particular, the war in Ukraine and its consequences had an additional impact on the development of the renewable energy industry.

To facilitate wind energy development, the Estonian government has implemented several policies and incentives to encourage investment in the sector. For example, there are subsidies available for renewable energy projects, as well as tax breaks and other financial incentives for companies that invest in wind energy.

On April 10, representatives of the Reform Party, Estonia 200, and the Social Democratic Party signed a coalition agreement. The goal of the coalition is to increase the competitiveness of the economy through the expansion of green energy production with green reform.

For this purpose:

1. The government will increase the security of the energy supply and will formulate a long view of energy.
2. plans to develop modern and weather-proof networks and start managing energy use wisely.

3. The government promises to speed up the planning, construction, and access to the network of renewable capacities. (Oidermaa, 15)

It is important to note that Estonia is planning to actively support the establishment of an electricity network of offshore wind farms in the Baltic Sea and its inclusion in European projects. The aim is to make the country a renewable energy exporting country that is rapidly adopting various green technologies and thereby increasing the competitiveness of its economy. To this end, the government is reorganizing the work structure and responsibilities of the current public administration.

The Port of Tallinn has taken a keen interest in the ambitious offshore wind farm tender initiated by the state. As the largest port authority in Estonia and an active player in the Baltic Sea region, the Port of Tallinn has recognized the significance of the emerging offshore wind industry and is already preparing to support its development. Currently, the port is in the process of constructing a new quay in the Paldiski South Harbor, specifically designed to cater to the needs of wind farms.

The upcoming development is a 310-meter quay, covering an expansive area of 10 hectares. The estimated cost for this substantial project is approximately 53 million euros. The primary objective behind the construction of this new quay is to enhance the port's capacity to accommodate high-draft special-purpose vessels, which will be utilized for the construction of offshore wind farms and the transportation of vital wind turbine components. By providing the necessary infrastructure, the Port of Tallinn aims to position itself as a crucial hub for the emerging offshore wind energy sector.

The Port of Tallinn has already taken significant strides in fostering partnerships and collaborations within industry. A Memorandum of Understanding has been signed between the port and three prominent European wind farm builders. This agreement serves as a foundation for establishing a dedicated construction and maintenance port for offshore wind farms in the neighboring region, specifically the North-West of Estonia. The chosen location for this facility is the Paldiski South Harbor, strategically positioned to cater to the needs of the planned wind farms in the area.

The wind farms in question are slated to commence production in 2028, following an anticipated three-year construction period. This timeline underscores the long-term commitment and

investment required for the successful establishment of offshore wind energy infrastructure. The Port of Tallinn's proactive approach in preparing for the arrival of wind farm projects highlights its dedication to facilitating the growth and success of the renewable energy sector in Estonia.

By providing a specialized port facility tailored to the unique requirements of offshore wind farms, the Port of Tallinn is positioning itself as a crucial enabler of the country's renewable energy ambitions. The construction of the new quay signifies a significant commitment to fostering sustainable development and supporting the transition towards clean energy sources. The Port of Tallinn's proactive engagement and collaboration with industry stakeholders demonstrate its determination to play a pivotal role in the establishment and operation of offshore wind farms in the Baltic Sea region. (Liive, 2022)

In general, Estonia has ambitious plans for the development of wind energy, and the country is taking steps to support the growth of this industry. With its strong commitment to renewable energy and its favorable location for wind power generation, Estonia has the potential to become an important player in the wind energy sector in the coming years.

1.3 Interested parties related to the wind farm and their roles

In Estonia, the interested parties related to a wind farm project are:

1. Developers: The developers are the companies or organizations that plan and finance wind farm projects. They may conduct site surveys, secure permits, purchase wind turbines and equipment, and oversee the construction and operation of the wind farm. Such companies as RWE, Vestas Wind Systems A/S, Siemens Gamesa, Nordex SE, Saare Wind Energy, Enefit Green, and Utilitas Wind. (Vatsfeld, 2023)

2. Landowners: The landowners are individuals or organizations who own the land where the wind farm will be constructed. They may lease the land to the developers for the wind farm project. The names of the joint ventures between landowners – Multiland OÜ, OÜ Metsakohin, Osaühing Traperii, Osaühing Metsagrupp, and Sunly Land AS are accordingly SW Multituul OÜ, SW Tuulekohin OÜ, SW Tuulerii OÜ, and SW Metsatuul OÜ. (Lepasepp, 2021)

3. Government Agencies: The government agencies are responsible for regulating the wind farm project, issuing permits and licenses, and ensuring compliance with environmental and other regulations. For example, the Ministry of Climate and Living Environment which is responsible for the comprehensive implementation of the green reform.

4. Energy Consumers: The energy consumers are individuals, businesses, or municipalities that purchase the electricity generated by the wind farm. They can be local governments and foreign states. Estonia's vision is to cooperate with the countries in the Baltic region to create an energy network that would enable offshore wind farms to interconnect and thereby strengthen the connections between states. (Strenga, 2022)

5. Environmental Organizations: Environmental organizations may be interested in the wind farm project due to its potential impact on the environment, including wildlife, habitats, and natural resources. For example, Regional Ministry.

6. Local Communities: Local communities may be impacted by the wind farm project, both positively and negatively. They may be interested in the economic benefits of the project,

such as job creation and increased revenue for local businesses, as well as potential negative impacts such as noise, visual pollution, and decreased property values.

7. Contractors and Suppliers: Contractors and suppliers provide the equipment, labor, and services needed to construct and operate the wind farm. They may include construction companies, wind turbine manufacturers, and maintenance and repair companies. (Erik Lundtang Petersen, Peter Hauge Madsen, 2004) They are Saare Wind Energy, Enefit Green, and Utilitas Wind, RWE Renewables, Enersense AS, TotalEnergies. (Vatsfeld, 2023)

There is established a wind energy association to support the development of this sector in Estonia. The Estonian Wind Energy Association is a non-profit organization that promotes the development and use of wind energy in Estonia. Established in 2007, the association aims to increase public awareness of wind energy and its benefits, as well as to support wind energy businesses in Estonia. The association works closely with government agencies, energy companies, and other stakeholders to advocate for policies and regulations that support the growth of wind energy in Estonia. The association also provides information and resources to its members, including industry research, networking opportunities, and professional development. Through its efforts, the Estonian Wind Energy Association is helping to establish Estonia as a leader in renewable energy and sustainability. (Kärmas, 2023)

1.4. Interview with interest-related parties. Analysis

The purpose of the research is to understand how far Estonia can get closer to meeting the 2030 EU directives on renewable energy and analyze if Estonia has enough funds to train and provide specialists for this industry. To achieve the aim of the master thesis the author carried out research between interested parties. In the first step, the questionnaire was sent to twenty participants of the Estonian Wind Energy Association (hereinafter EWPA) be e-mail. EWPA is an independent non-profit organization of people who have joined on a voluntary basis, and which operates in the public interest. Members of EWPA are domestic or foreign companies and organizations acting within or interested in wind energy development in Estonia. A total is 30 companies are members of EWPA. The questionnaire was created in Google documents. The survey period was October 2022.

The statistics of the received answers can be found below and presented as a diagram (Figure 1). This was created in Excel by the author of the thesis.

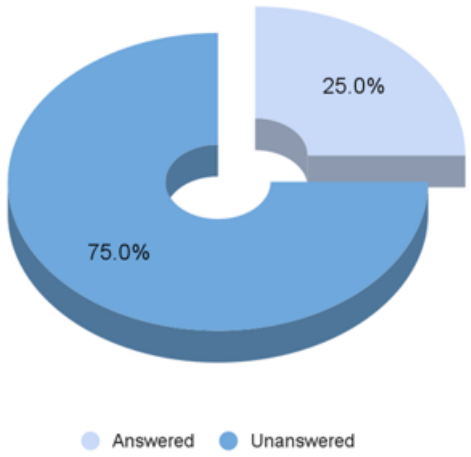

Figure 1 The statistics of the research received answers.
(Source: The diagram was made by the author of the work on the collected data)

As we see, some limitations and challenges were faced by the author during the research process. Unfortunately, the sector of the industry is new, and the companies see each other more as competitors, not as one team. At the same time, the author is not an independent person but is a representative of an interesting company. The results of the survey are used anonymously as summarizing in the completion of the master's thesis.

For an overview of the survey conducted by the author, below are represented charts with the results:

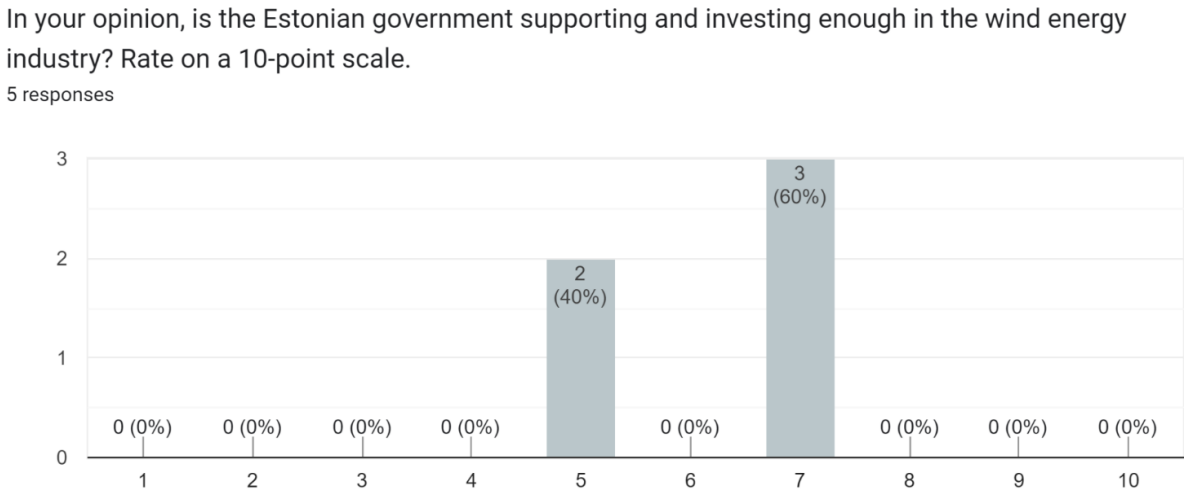

Figure 2 Chart of answers to the question about government support for wind energy.
(Source: The diagram was made by the author of the work on the collected data)

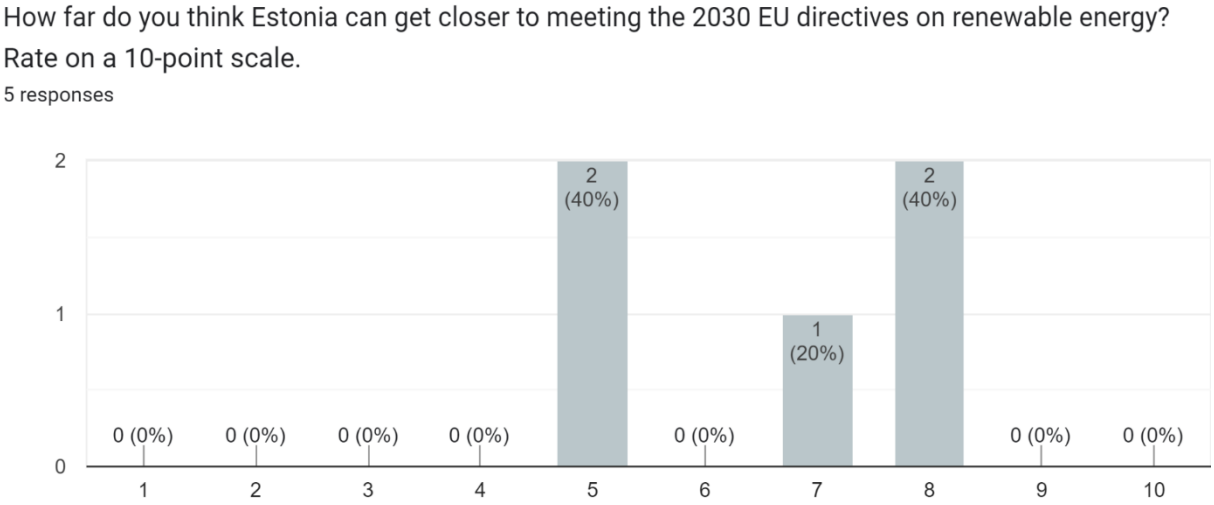

Figure 3 Statistics of responses to the question about Estonia's ability to achieve the EU directives in renewable energy.
(Source: The diagram was made by the author of the work on the collected data)

As we see, the result of the survey is more positive. The interviewees are confident that Estonia can be closer to meeting the 2030 EU directives on renewable energy. The main problem that the author and survey participants see is time and a quick start. Now, Estonia does not have time for

discussions. Now is the time for movements and real action. To reach the EU directive and even exceed the plan Estonia needs only one-two offshore wind farms and some hundred new/additional MW onshore. It is still possible before 2030. However, we still see some obstacles on the way to achieving the goal. They have described below:

1. The high possibility that authorities will continue endless meetings and not much is happening.
2. Even if Estonia will do the right decisions (successfully permitting), the European/ global supply chain is full, and Estonia will wait in a queue. In that case, 2030 targets will not be met.
3. Technical obstacles on that road like grid connection, availability of installation/service vessels, availability of turbine components, etc. have long lead times on a market but orders will not be placed before a final investment decision has been made.
4. The planning process and environmental monitoring are not as fluent as necessary.

Estonian businesses and governments have experience with onshore wind farms. At the same time, the participants of the survey consider that the Estonian maritime cluster is very young and has enough experience to develop and service the offshore wind farms independently with Estonian resources, but what we see is that there have been foreign partners brought on board such as Van Oord, and Orsted got on board as joint venture partners to compensate for the lack of experience. There are very few companies in a supply chain with relevant experience.

However, local content is essential and needs to be utilized as much as practically possible without compromising safety and quality. The potential is there, but if there is no real offshore wind farm in Estonia, the practical capability will not develop. It is impossible to do it only on paper and in the classroom. Today, without the offshore wind farm, the gap with developed countries in know-how is increasing.

Today, Estonia does not have enough resources in the entire spectrum. Apparently, there is capacity in some areas (more general maritime areas, e.g., "ordinary" logistics) but there is no capacity in specialized fields such as recruitment of wind turbine maintenance technicians or other specific specialties. Also, there was raised a question of how universities and companies can collaborate to create mutually beneficial outcomes and increase the interest of students in engineering. Engineering is a field that offers a wealth of opportunities for innovation and

problem-solving. However, despite the potential benefits of a career in engineering, many students struggle to find the motivation to pursue this field. One of the most effective ways to increase student interest in engineering is to offer more hands-on, project-based learning opportunities. By providing students with the opportunity to apply their knowledge in a practical setting, they are more likely to develop a passion for engineering and see its real-world applications.

Another strategy for increasing student interest in engineering is to expose them to a wide variety of engineering disciplines. Many students are not aware of the breadth of fields within engineering and may not realize that there are opportunities to specialize in areas such as renewable energy, environmental engineering, or robotics. By providing students with exposure to different areas of engineering, they can better understand the range of opportunities available to them and may find a niche that they are passionate about.

It is also important to address the perception that engineering is a field that is only for a select few. Many students may feel intimidated by the math and science requirements of engineering or may believe that they do not have the necessary skills to succeed in the field. To combat these misconceptions, educators can focus on making engineering more accessible and approachable. This can include providing extra support for students who struggle with math and science, highlighting the diverse range of backgrounds and experiences that engineers come from, and emphasizing the importance of creativity and problem-solving in engineering.

The number of jobs for specialists doing more complex work will increase and the number of routine jobs will decrease. In the future, the Estonian labor market needs smart workers who know how to implement, develop, maintain, and manage technology in different fields. The growth is expected in more personal services. The number of vacancies that require data analysis skills but also empathy and creativity will increase. Thus, universities and interested parties should think about this topic in advance, invest in young professionals, engage young people in this industry, as well as provide competitive and promising conditions. Also, one of the opportunities that Tschudi Ship Company sees is to retrain and additionally educate the seafarers as they have real experience, skills, understanding of offshore work including long business trips, and all needed qualifications to work in the wind energy industry.

2 The winds farming chain of command, different operational positions, and activities

The chain of command for the Operation and Maintenance (O&M) of a wind farm typically involves several key stakeholders and decision-makers, each responsible for different aspects of the wind farm's operations. Here's a general outline of the typical O&M chain of command in a wind farm. The table is created by the author of the thesis in excel using open resources related to wind energy job descriptions and offers.

Position	Education	Skills	Job description
Owner and Operator	N/A	N/A	The owner of the wind farm is responsible for ensuring the overall performance and financial success of the project. The operator is responsible for the day-to-day operation and maintenance of the wind farm.
Electrical engineer	Degree in engineering, a background in wind energy	The planning of the electrical components of the transformer platform and the high and medium voltage distribution in the wind farm.	Responsible for systems that use electricity to control turbine systems or signal processes. Whereas electrical engineers work primarily with power generation and distribution.
Civil engineer	Bachelor's degree in engineering	Producing calculations, drawings, project reports for civil and structural engineering works associated with all aspects of structural engineering.	Civil engineers design and supervise the construction of many parts of wind farms, including roads, support buildings, and other structures.
Environmental engineer	Bachelor's degree Engineering	Work in Environmental Engineering related subject or Chemical Engineering with an Environmental focus.	Environmental engineers deal with the potential environmental impacts of wind turbines.
Health and safety engineer	Bachelor's degree in civil, Mechanical, or Marine Engineering	Responsible for providing support and guidance on all aspects of compliance with the Safety, Health, and Environmental processes.	Health and safety engineers identify and measure potential hazards of wind turbines and implement systems that ensure safe manufacture and operation.

Mechanical/ Industrial / engineer	Bachelor's degree in engineering	Procurement & construction activities related to complex structures track record related to offshore substations.	They research, develop, and test tools and devices. Industrial engineers determine the most effective ways to use the basic factors of production to make components of wind turbines.
Welder/ Assembler	A mechanical educational or a relevant industry background	Welding/ Assembling requirements for offshore tower construction.	In the wind industry, welders work on many diverse components; for example, they weld together cylinders of rolled steel to form turbine tower segments. Assemblers are responsible for putting the components together into a larger product
SHEQ manager (Safety, Health, Environmental, Quality)	A degree or similar in QHSE, or similar engineering discipline	Assessing procedures and policies and making changes where necessary to improve safety for staff and customers. discovering and integrating safer ways to handle materials.	Enhancing QHSE culture and awareness across the Offshore footprint, providing training, support, guidance, and QHSE campaigns.
Industrial production manager	A mechanical/ electrical education	Industrial engineers find ways to eliminate wastefulness in the wind turbine production processes.	Industrial production managers plan, direct, and coordinate the work on the factory floor.
Logistician	A logistician education	Manage a product's life cycle from design to disposal.	Logisticians are responsible for keeping transportation as efficient as possible.
Construction workers	A mechanical/ electrical educational or relevant industry background	Construction workers in the wind industry are responsible for building local access roads and the foundations that support wind turbines.	Construction workers employed by companies that specialize in developing wind farms are sometimes in supervisory roles.
Wind technician	A mechanical/ electrical or relevant industry background	Wind technicians can diagnose and fixing any problem that could cause the turbine to shut down unexpectedly or fail to operate properly.	Assure that all operation and maintenance activities are performed in a safe manner consistent with policies and procedures established for the wind farm site.
Wind turbine service technician	Degree in Electrical Engineering, or equivalent;	Electrical and hydraulic technical knowledge in these areas which are essential to the proper performance of the position.	Verify electrical connections and schematics; Perform commissioning and maintenance procedures; Install turbine control software.

Table 1 The chain of command for the Operation and Maintenance

(Source: The diagram was made by the author of the work on the collected data)

The exact structure of the O&M chain of command in a wind farm may vary depending on the size and complexity of the project, as well as the specific needs and requirements of the owner and operator. However, the roles and responsibilities described above are typical of most offshore wind farm O&M operations. (Estate, 2019)

It is important to note that education and experience of specialists for such industries as wind energy play a key role in quality of operational and maintenance works. Hiring qualified employees for O&M work in a wind farm is essential for ensuring safety, efficiency, cost-effectiveness, compliance, and expertise. It is an investment that can pay dividends in the form of increased energy output, reduced downtime, and lower overall maintenance costs.

2.1 Workforce qualification and requirements

The wind energy industry offers employment opportunities to a wide range of workers, including construction, manufacturing, professional, and trade workers. The educational requirements for wind energy jobs can vary depending on the specific position but typically range from high school diplomas to advanced degrees.

For technical positions such as wind turbine engineers, a bachelor's degree in engineering is usually required. Wind engineers typically have a Bachelor of Science in an engineering specialty, such as electrical, civil, environmental, industrial, materials, or mechanical engineering. (Hamilton, 2010)

For non-technical positions such as construction workers, a high school diploma or equivalent is typically required. However, some positions may require additional training or certification in areas such as construction safety or specialized equipment operation. (Keyser, 2019)

Overall, the wind energy industry offers a range of employment opportunities with varying educational requirements. Technical positions such as wind turbine engineers typically require a bachelor's degree in engineering, while non-technical positions such as construction workers typically require a high school diploma or equivalent.

Some of the key workforce qualifications and requirements for the offshore wind industry include:

1. Engineering and Technical Skills: A range of engineering and technical skills are required to design, build, and maintain offshore wind farms. These skills can include electrical, civil, and mechanical engineering, as well as knowledge of geotechnical, oceanographic, and meteorological conditions.

2. Health and Safety: Working offshore can be hazardous, so workers in the offshore wind industry must have an awareness of safety protocols, as well as training and certification in areas such as first aid, personal safety, and survival techniques.

3. Marine and Nautical Skills: Offshore wind farms are in marine environments, so workers must have a range of nautical skills, including navigation, seamanship, and vessel handling.

4. Project Management and Logistics: Offshore wind farms are complex projects that require careful planning and management, so expertise in project management and logistics is essential.

5. Environmental and Sustainability: The offshore wind industry is committed to reducing its environmental impact, and workers must understand environmental and sustainability issues, as well as the ability to implement sustainable practices.

6. Communication and Teamwork: Offshore wind farms require a high level of collaboration and teamwork, so workers must have strong communication and interpersonal skills to work effectively with colleagues, contractors, and stakeholders. (Hamilton, 2010)

Training and certification programs are available to help workers acquire the necessary skills and qualifications for the offshore wind industry. These programs can include university and vocational training, as well as on-the-job training and certification from industry organizations.

2.2 Standards

OPITO, the Offshore Petroleum Industry Training Organization, has developed Global Qualifications and a qualifications framework to support the development of skills and competence in operations and maintenance activities within the industry. The framework offers recognized qualifications that can be compared to national and regional standards. (McDonald, 2023)

Qualification standards in wind energy vary depending on the specific job role and industry sector. However, there are some general qualifications that are commonly required in the wind energy industry, including:

1. Electrical and mechanical engineering qualifications: Many jobs in the wind energy industry require a background in electrical or mechanical engineering, as these skills are critical for operating, maintaining, and repairing wind turbines.

2. Relevant industry certifications: Certifications such as the Global Wind Organization (GWO) Basic Safety Training and Working at Heights can be required for many wind energy jobs. Other certifications, such as the Certified Energy Manager credential, may also be helpful for certain job roles. (Brun, 2021) (Holst, 2023)

3. Education: A degree in engineering, physics, or a related field can be helpful for many wind energy jobs, particularly those in research and development or management.

4. Relevant work experience: Employers may look for candidates with relevant work experience, such as in the electrical or mechanical trades, or in a related industry such as oil and gas.

5. Physical fitness: Many jobs in the wind energy industry require physical fitness and the ability to work at heights, so candidates may need to undergo a medical assessment to ensure they are fit for the job.

The (GWO) has developed training standards for professionals working in the wind turbine industry. These courses cover a range of safety topics, including risk reduction and safety hazards associated with working at height. (Holst, 2023)

Specifically, the GWO offers a Basic Safety Training program, which includes modules on First Aid, Fire Awareness, Manual Handling, and Working at Heights. The organization also offers advanced modules on topics such as Enhanced First Aid and Advanced Rescue Training. (Waghorn, 2023)

In addition to GWO training standards, some positions in the wind industry may require specific certifications or licenses. For example, wind turbine technicians may need to be certified by the American Wind Energy Association.

Overall, the wind industry has established training and certification standards to ensure that professionals working in the industry have the necessary skills and knowledge to work safely and effectively. These standards include GWO training courses, as well as certifications and licenses specific to certain positions. (Waghorn, 2023)

Furthermore, to solve maintenance challenges in the offshore oil and gas industry, was formed the UK in the late 1980s - IRATA. It is an acronym for the Industrial Rope Access Trade Association. Created in response to a specific need in the inspection and maintenance of offshore oil platforms, IRATA International spent the following 29 years providing operational solutions to the work-at-height and confined access sectors and, in doing so, has constantly shown its procedures to be more effective and efficient than many of the mechanized access systems available to the market. IRATA International's rope access system is a safe method of working at height where ropes and associated equipment are used to gain access to and from the work position and to be supported there. (Capper, 2023)

The advantage of using rope access methods mainly lies in the safety and speed with which workers can get to or from difficult locations in order to carry out their work, often with minimal impact on other operations, surrounding areas, and the environment. Another major benefit is the reduction of the combination of the total man-hours and perceived level of risk for a particular task (man-at-risk hours) when compared with other means of access and their associated risks and costs. (Capper, 2023)

The primary objective when using rope access methods is to carry out the work efficiently, with minimal accidents, incidents, or dangerous occurrences. To ensure a safe system of work is always

maintained, whilst avoiding damage to property or harm to the environment, careful planning and documented risk assessments are undertaken for each operation.
(Capper, 2023)

IRATA began its life by providing teams to inspect, maintain, repair, and renovate the offshore platform. This was in answer to the companies operating these rigs who had found other means of access to be of limited use in the offshore environment, with their structures and machinery taking up too much of the limited space available; and at times prejudicing the whole safety regime of the rig, including emergency evacuation. (Capper, 2023)

In addition to these qualifications, wind energy employers may also look for candidates with strong problem-solving skills, a commitment to safety, and a willingness to learn new skills and technologies. By meeting these qualification standards and demonstrating these skills, candidates can increase their chances of success in the wind energy industry.

2.3 Education in Estonia

Wind power is rapidly developing as a source of renewable energy around the world. Estonia is no exception and as noted in the World Energy Outlook 2021 analysis, renewable sources such as wind continue to grow rapidly in the country. To support this growth, Estonia offers several educational opportunities in wind energy. (Brun, 2021)

One of the leading universities in Estonia, Tallinn University of Technology, offers a master's program in wind energy. (Tatomir, 2022) This program focuses on wind resource assessment, turbine technology, and wind farm design, providing students with the skills and knowledge required to work in the wind industry.

In the author's opinion, is important that universities develop and integrate new educational programs. Necessary to state that the Estonian Maritime Academy introduces the one-year study program "Maritime Digital Solutions" which will improve knowledge and skills on the possibilities and trends of digitalization in the maritime sector and work in a digitizing environment, planning sustainable and environmentally friendly strategies.

As well, on April 1, 2023, the first 16 maintenance technicians of electric wind turbines trained in the Baltics received their certificates at the Pärnumaa Vocational Education Center. This suggests that Estonia is one step closer to fulfilling its plans in the renewable energy sector and will be ready to provide a skilled workforce at all stages.

Also, there is begun to develop a new education program at Kuressaare Regional Training Centre - wind blade service technicians, maintenance technicians, and electricians for the wind sector. According to Mairold Vaik, Project manager of Kuressaare Regional Training Centre, the most companies require that service technicians obtain a vocational education, but only training courses. Therefore, Estonia is preparing to release qualified workers into the labor market. Kuressaare Training center is participating in an EU scholarship project "Attractive regional business and living environment" to rebuild the school building. The plans are to make the school more innovative, as well as prepare everything to attract more students, as well as be ready to introduce new training programs. The project deadline is August 2023, the decision will be announced in December 2023. The school was also promised support by the state. Based on all the data, the

school plans to introduce new programs to train various specialists for the wind industry by 2025. Consequently, the first graduates and new employees will be ready to work starting in 2028.

According to the author of the work, this is a positive factor for the development of the industry and Estonia's readiness to meet the market's needs. But it had to start at least 3-4 years earlier. The author began his research back in 2019-2020, at the same time he contacted various educational institutions in Estonia on the topic of cooperation between the Tschudi Ship Management company and vocational schools. The goal was for the schools to notify their best graduates - electricians, mechanics, and energy workers of the possibility of receiving GWO, and IRATA courses from the company in the future to be employed in Tschudi Ship Management for wind projects. Unfortunately, there was no impressive result. There is an opinion that covid played a role and educational institutions faced other problems at that time, such as quarantine and online learning, and simply did not have enough time to implement this.

In addition to the education in universities and schools, there are various educational institutions that provide training for wind energy workers. These are Reval Offshore and Marine Training School, Skyproff, and Albon Group. Schools provide GWO and IRATA training for professionals.

Estonia pays attention to the education and training of the workforce, as indicated in the article “Estonian Climate Policy: Challenges and Opportunities” (Tatomir, 2022) Through expanded education, training, and active labor market policies, Estonia is preparing its workforce for the transition to a low-carbon economy. This includes training opportunities in areas such as wind energy and the supply of skilled workers to meet the growing demand for renewable energy.

Although Estonia's focus on wind energy education is not widely reported in the media, as evidenced by limited search results, the country is taking steps to support the industry's growth in the region. By offering educational opportunities and training programs, Estonia is preparing its workforce to meet the growing demand for renewable energy, especially in the wind energy sector. Despite all the steps taken, there is still a lot of work to be done, so it is time to act.

2.4 Compression with neighboring countries - Latvia, Lithuania, Poland

The wind energy industry in Latvia, Lithuania, and Poland is growing, as mentioned in "Overview and key findings – World Energy Investment 2022" (Daume, 2022). The table of global energy investments can be found below. Investment in renewables, including wind energy, has been the main boost for the power sector in recent years. According to the article "Lithuania speeds green transition, expects 10 billion euros" (Sytas, 2021), Lithuania alone will see investments of up to 10 billion euros in green energy by 2030, highlighting the growing importance of the sector in the region.

To support the growth of the wind energy industry in Latvia, Lithuania, and Poland, governments in the region have adopted public policies to promote the transition towards a low-carbon economy, as discussed in the source "Renewable energy project development in the Baltics". (Strenga, 2022) This includes incentives for the development of renewable energy sources, such as wind energy, and support for the implementation of new energy technologies.

In terms of wind energy education, there are several universities in the region that offer programs related to renewable energy, including wind energy. For example, the Warsaw University of Technology in Poland offers a master's program in Energy Technologies with a specialization in renewable energy. (Strenga, 2022) Similarly, the Riga Technical University in Latvia offers a bachelor's program in Renewable Energy Engineering. (Sytas, 2021)

Moreover, RWE has collaborated with leading Lithuanian educational institutions to accelerate the development of offshore wind energy in the Baltic region. RWE AG is a German multinational energy company headquartered in Essen. It generates and trades electricity in Asia-Pacific, Europe, and the United States. The company is the world's number two in offshore wind power and Europe's third largest company in renewable energy. (Knauber, 2022)

It is planned to share knowledge and expertise and to identify opportunities for joint research in the field of offshore wind energy. Educational programs are being developed to prepare the workforce for the growing industry. (Knauber, 2022)

Over and above that, these countries have a several training service providers for the wind energy industry. Training service providers in Latvia, Lithuania and Poland offer courses and

certifications for the wind sector, including international certification bodies such as GWO and IRATA. These training providers collaborate with wind energy companies and other organizations to provide comprehensive training programs that meet the industry's needs.

The wind energy industry in Latvia, Lithuania, and Poland is growing rapidly, supported by government policies and investments in renewable energy. The region also offers educational programs to prepare the workforce for the transition towards a low-carbon economy, with a focus on renewable energy sources such as wind energy. These countries have a huge resource in the form of education. There are many training centers, which also positively affects their competition and the pricing of courses.

Wind energy development in Estonia, Latvia, Lithuania, and Poland has progressed at different rates and with different policies and challenges. Here's a brief comparison of the current situation in each country:

1. Estonia:

Estonia has been one of the leading countries in the Baltic region in terms of wind energy development. As of 2021, the country has a total installed wind energy capacity of nearly 600 MW, with several wind farms located throughout the country. The Estonian government has set a target of producing 100% of the country's electricity from renewable sources by 2030, and wind energy is expected to play a significant role in meeting this goal. (Srdan Tatomir, OECD, 2022)

2. Latvia:

Latvia has a relatively small wind energy market compared to Estonia, Lithuania, and Poland. As of 2021, Latvia has a total installed wind capacity of around 69 MW, which accounts for around 4% of its electricity generation. The government of Latvia has set a goal to increase the share of renewable energy to 50% of the country's final energy consumption by 2030, and wind energy is expected to play a significant role in achieving this goal. However, the slow permitting process and lack of investor confidence have hindered the development of wind energy in Latvia. (Strenga, 2022)

3. Lithuania:

Lithuania has been actively developing its wind energy sector in recent years. As of 2021, Lithuania has a total installed wind capacity of around 494 MW, which accounts for around 16% of its electricity generation. Lithuania has set a target of producing 45% of the country's electricity from renewable sources by 2030, and wind energy is expected to be the main contributor towards this goal. The country has also introduced a feed-in tariff scheme to incentivize the development of wind energy projects. (Strenga, 2022)

4. Poland:

Poland has the largest wind energy market in the region, with a total installed wind capacity of around 6.7 GW as of 2021, accounting for around 17% of its electricity generation. The Polish government has set a target of producing 23% of the country's electricity from renewable sources by 2025 and 32% by 2030. However, the government has also been criticized for its recent changes in regulations that have slowed the development of new wind energy projects.

All-inclusive, while wind energy development in the region varies, Estonia, Lithuania, and Poland have been more successful in developing their wind energy markets than Latvia. The development of wind energy in each country is expected to continue to play an important role in meeting their respective renewable energy targets. (EU Union, 2023)

3 Labor market analysis and forecasting

Overall, labor market analysis and forecasting are important tools for understanding the current and future demand for workers in the wind industry in Estonia. By identifying areas of potential labor shortages or surpluses, policymakers and industry leaders can develop strategies to ensure a strong and sustainable workforce for this growing sector.

The author sees that it will be a big problem for the world including Estonia to train and find qualified employers for the wind energy industry. Also, the Covid pandemic has greatly influenced the choice of professions. And now the war in Ukraine is making huge adjustments. More than half a million wind technicians are needed by 2026 for wind energy construction and maintenance:

1. 33% rise in recruitment and training needs for wind turbine technicians over the next five years if the world is to deliver the wind energy capacity required to meet net-zero goals (Savage, 2022)
2. Industry calls for more investment in standardized training to attract new talent, ensure workforce safety and build sustainable careers. The rapid growth in the onshore and offshore wind capacity is generating huge demand for a skilled workforce, a new report reveals today. New figures from Global Wind Organization (GWO) and Global Wind Energy Council show that 569,000 technicians will be needed to build and maintain a global onshore and offshore wind fleet that will increase in size by 67% by 2026. (Savage, 2022)

With the rapid growth of the wind energy capacity at the heart of the world's plans to achieve net zero by 2050, governments must enact policies that support this expanding workforce. New capacity, modern grids, and a just transition all require a strong and sustainable workforce at their foundation. This skilled, modern workforce will be a great reward for countries advancing with their energy transition plans. (Savage, 2022)

Almost 30,000 new technicians are expected to join the global wind workforce every year. But the Global Wind Workforce Outlook 2022-2026 highlights an urgent need for faster growth in industry-standard safety and technical training capacity to meet the forecast gaps in worker supply.

With 119,000 wind technicians holding a valid industry standard GWO training certificate by the end of 2021, the report demonstrates a substantial opportunity for up to 450,000 technicians to complete safety and technical training during the next five years. (Savage, 2022) According to the report «Wind energy and economic recovery in Europe» more than 7,000 jobs related to wind farms will be created in Estonia by 2040. (Europe, 2020)

The wind energy industry in Europe has been experiencing a significant lack of workforce in recent years. This shortage of skilled professionals is a major challenge for the industry, which is striving to meet the growing demand for renewable energy. There are several reasons behind this shortage of workforce, including the lack of training and education programs, the aging workforce, and the competition from other industries. (Daume, 2022)

One of the main reasons for the shortage of workforce in the wind energy industry is the lack of training and education programs. There are few universities and technical schools that offer specialized training in wind energy, which makes it difficult for companies to find qualified employees. Additionally, the existing programs are often limited in scope and may not cover all the necessary skills and knowledge required for a career in wind energy.

Another factor contributing to the shortage of the workforce is the aging workforce. Many of the professionals who have been working in the wind energy industry for several years are approaching retirement age, and there are not enough young professionals entering the field to replace them. This trend is expected to continue in the coming years, which will exacerbate the workforce shortage even further.

The competition from other industries is also a significant challenge for the wind energy industry. Many highly skilled professionals are drawn to other industries, such as the oil and gas industry, which offer higher salaries and more job security. This makes it difficult for the wind energy industry to attract and retain talented employees. (Daume, 2022)

To address the workforce shortage in the wind energy industry, several strategies can be implemented. One approach is to invest in education and training programs to attract more young professionals to the field. This includes expanding the curriculum of technical schools and universities to cover all the necessary skills and knowledge required for a career in wind energy.

Another approach is to provide incentives for professionals to switch to the wind energy industry. This could include offering competitive salaries and benefits packages, as well as opportunities for career advancement and professional development.

In conclusion, the shortage of workforce in the wind energy industry in Estonia and in Europe is a significant challenge that needs to be addressed. By investing in education and training programs and providing incentives for professionals to switch to the industry, it is possible to attract and retain a skilled workforce that can meet the growing demand for renewable energy.

3.1 Challenges of recruiting and retaining workers in the wind energy industry

The wind energy industry, like many other industries, faces difficulties in recruiting and retaining workers. According to the article “The Challenges of talent retention in the energy industry” (Denham, 2021) one of the main issues is talent retention. This means that companies need to focus on a work environment and providing opportunities for career growth and development to retain their employees.

Attracting the right talent is also crucial for the wind energy industry. (Boyle, 2020) Companies need to focus on capacity building for new projects and research, as well as retraining existing employees to ensure they have the necessary skills to succeed in the industry. Mobility programs can also be implemented to attract talent from other regions or countries. Analyzing the experience of the author of the thesis, human resource companies are already prepared to invest in the training of new specialists. But this requires guarantees that jobs will be provided by developers. And it also takes time and opportunity for the practice of young workers.

To overcome the issue of finding the right talent at affordable salaries, companies in the wind energy industry need to rethink their HR and recruitment strategies and processes, as mentioned in the article “Renewable-energy development in a net-zero world: Overcoming talent gaps” (Daume, 2022). This may involve offering competitive salaries and benefits packages, as well as providing opportunities for professional development and career advancement.

The transition towards a low-carbon economy in Estonia presents an opportunity for wind energy companies to attract workers who are passionate about environmental sustainability. (Liive, 2022) These workers may be more motivated to work in the wind energy industry and may be more likely to stay with a company that aligns with their values.

As well, according to the author of the thesis, educational institutions and interested organizations should invest more in industry advertising to attract new specialists. It should show how engaging this sector is, and information about the benefits - an interesting job that helps the whole world, and with a gainful salary and bonuses. After all, it happens that if a person does not have acquaintances who work in this or a similar industry, then he does not even know about this opportunity. For example, in Estonia there are a lot of advertisements about education for a policeman, bus driver, broker, and other professions, but nowhere is there any information about

working in the wind industry. Should not miss such moments that at first glance may seem not so important. In fact, this is a great contribution to the development of the future generation.

In summary, the wind energy industry faces difficulties in recruiting and retaining workers, but there are strategies that can be implemented to overcome these dares. To address the challenges of recruiting and retaining workers in the wind energy industry in Estonia, companies need to focus on creating a positive work environment that supports employee growth and development. This includes offering competitive salaries and benefits packages, providing opportunities for professional development and career advancement, and promoting a culture of sustainability and environmental responsibility. By addressing these issues, the wind energy industry in Estonia can attract and retain the skilled workforce it needs to meet the growing demand for renewable energy.

3.2 Analysis of the current and future demand for workers with specific skills

The demand for workers with specific skills in the wind energy industry has been increasing in recent years and is expected to continue to grow in the future as more countries transition to renewable energy sources. (Denham, 2021)

One of the most in-demand skills in the wind energy industry is technical expertise in electrical and mechanical engineering, as these skills are critical for operating, maintaining, and repairing wind turbines. This demand is likely to continue in the future as more wind turbines are installed and the need for maintenance and repair services increases (Lord, 2023).

In addition to technical skills, there is also a growing demand for workers with skills in data analytics and artificial intelligence, as these technologies are being used to optimize wind turbine performance and reduce costs. This trend is expected to continue in the future as the industry becomes more reliant on technology to improve efficiency and reduce downtime. (Lord, 2023)

Another area of increasing demand is project management and coordination, as the wind energy industry requires a range of specialized skills to plan, execute, and manage wind farm projects. This includes skills in logistics, procurement, and supply chain management, as well as the ability to coordinate with contractors and suppliers.

There is a growing need for workers with skills in environmental science and sustainability, as the wind energy industry seeks to minimize its impact on the environment and ensure that wind farms are constructed and operated sustainably. This includes skills in environmental impact assessment, habitat restoration, and biodiversity conservation.

Although, Estonia has a huge potential in the wind energy sector and has all opportunities to provide a high level of the workforce. However, right now the industry has been experiencing a significant lack of workforce. The author of the thesis has made a data analysis of wind energy workers. The aim of the analysis was to create a database of resumes of such employees as wind turbine technicians, rope access technicians, electricians, riggers, and blade technicians. Out of the 105 candidates who sent their CVs, only 3 were from Estonia. All the rest were from Poland, Latvia, and Lithuania. Below is a chart with the percentage of candidates on a civil basis. The chart

was created by the author according to the collected data via using LinkedIn (https://www.linkedin.com/) and direct communication with workers from the wind energy sector.

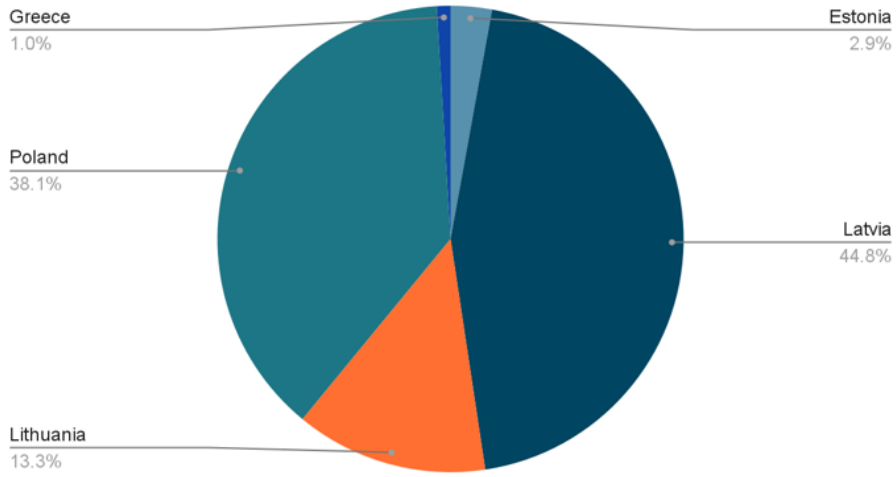

Figure 4 Statistics of workers in the wind sector by place of residence
(Source: The diagram was made by the author of the work on the collected data)

Moreover, for the onshore wind farm maintenance projects in Purtse and Paldiski, companies are searching for employees in the Baltic states as cannot find enough specialists in Estonia. According to the candidate's words, they are recruiting via Polish companies. Put in the picture that there are omissions in the cooperation of companies located in Estonia. From this, it should be concluded that despite all the advantages, there is still a lot of work to be done. As mentioned earlier, it's worth starting by actively attracting young people to the wind industry and starting to hold events, introductory programs, and hackathons, so that the sector becomes more recognizable and popular.

Overall, the shortage of workforce in this sector has been highlighted as one of the major problems for Estonia as well as for many other countries. (Meriküll, 2012) It is more likely that Estonian companies will have to look for labor in other countries to start, and in parallel gain experience in this sector and train their local specialists. According to the report «Wind energy and economic recovery in Europe» more than 7,000 jobs related to wind farms will be created in Estonia by 2040. (Europe, 2020) This is an impressive number for Estonia, it will be necessary to find professionals in their field to ensure that all plans for wind energy are implemented. It will be necessary to attract people who already have a job, therefore more expenses will be spent on recruiting. To do this, initially, companies need to rely on a larger budget.

It becomes clear that at the initial stage, Estonian enterprises will have to look for employees in neighboring countries, in priority in Latvia and Poland. The best way would be to contact human resource companies dealing with personnel in the wind industry. There are also companies that provide service by a trained team for wind turbines. These options will help reduce the risks at the initial stage.

Looking toward the future, the demand for workers in the wind industry is expected to continue to grow in Estonia. The country has a relatively small wind energy sector compared to some of its European neighbors, but it has the potential to expand significantly in the coming years. The Estonian government has identified wind energy as a key priority in its national energy and climate plans, and it has set targets for increasing the share of wind energy in the country's electricity mix.

To support the growth of the wind industry in Estonia, it will be important to develop a skilled workforce and attract investment in wind energy infrastructure. This will require a focus on training programs and education in the relevant skills, as well as policies and incentives to encourage investment in wind energy projects. Overall, the wind industry represents a significant opportunity for job creation and economic growth in Estonia, particularly in the areas of engineering, construction, and maintenance. Issues related to the labor force cannot be left for the future, they need to be addressed now along with other important questions.

3.3 Recommendations for how the wind energy industry can improve its recruitment and retention efforts

Estonia must make fast decisions as business is ready, and today authorities and grid make decisions and act too slowly to construct at least one Offshore Wine Farm operational before 2030. Real OWF provides a base for the practical active cluster. Recruiting and retaining talent in the wind energy industry can be challenging due to the highly specialized and technical nature of the work, as well as the constantly evolving technology and regulations. Here are some recommendations for how the wind energy industry can improve its recruitment and retention efforts.

Government can support legislative acts and policies, and investing will be done by the private sector if the background is supportive.

Universities and interested parties should think about the education of the new workforce in advance, invest in junior professionals, engage young people in this industry, as well as provide competitive and promising conditions. Partner with the government and private organizations to develop training programs and internships that can help build a pipeline of future talent. Attracting new employees to the wind industry in Estonia can be a challenge, particularly as the sector is still in its early stages of development and may not yet be well-known to job seekers.
However, there are several strategies that can be used to attract more new employees to the wind industry in Estonia:

1. Promoting the benefits of working in the wind industry: Highlight the opportunities for career growth, the potential to work on innovative projects, and the chance to contribute to the transition to a more sustainable energy system. Emphasize the positive impact that working in the wind industry can have on the environment and the local community.
2. Developing training programs: Develop training programs that provide job seekers with the skills they need to work in the wind industry. This could include technical training, as well as soft skills training in areas such as communication and teamwork.
3. Partnering with educational institutions: Partner with universities, colleges, and vocational schools to promote careers in the wind industry and provide opportunities for students to gain practical experience through internships and apprenticeships.

4. Offering competitive salaries and benefits: Offer competitive salaries and benefits packages to attract top talent. This could include flexible work arrangements, health insurance, and retirement plans.
5. Investing in diversity and inclusion: Create a workplace culture that values diversity and inclusion. This can help attract a broader range of job seekers and improve retention rates.
6. Engaging with the community: Engage with the local community to promote the benefits of the wind industry and build support for wind energy projects. This can help attract new employees who are passionate about sustainability and environmental issues.

One of the opportunities that Tschudi Ship Management company sees is to retrain and additionally educate the seafarers as they have real experience, skills, understanding of offshore work including long business trips, and all needed qualifications to work in the wind energy industry.

The government can adopt new tax regulations for renewable energy industry workers. For example, apply the same taxation system as for seafarers. The remuneration paid to a crew member is subject to income tax at 0% if the compensation was due for employment on a ship. The same scheme can be implemented for wind farm/ offshore workers.

Finally, the industry can improve recruitment and retention efforts by addressing concerns about the environmental impact of wind turbines and engaging with local communities to promote understanding and awareness of the benefits of renewable energy. By taking these steps, the wind energy industry can attract and retain the skilled workforce it needs to meet the growing demand for renewable energy.

3.4 Tschudi Ship Management example and personal accomplishment

Tschudi Ship Management AS (TSM), based in Tallinn, is a wholly owned subsidiary of the Tschudi Shipping Company, a privately owned Norwegian holding company for the Tschudi Group. The Tschudi Group has a long history in conventional and non-conventional shipping worldwide, dating back to 1883. In 2001, the Tschudi Shipping Company acquired the Estonian Shipping Company, which was then renamed Tschudi Ship Management AS to oversee the technical department.

TSM offers comprehensive ship management services to clients globally, with its main office in Tallinn, Estonia, and crewing subsidiaries in Holland and Ukraine. They have a portfolio of 28 vessels under partial or full management, employ approximately 180 seafarers, and have established partnerships with various companies worldwide (Saar, 2022).

The company provides technical and crew management for various types of vessels and offers additional services. TSM Crewing is certified according to the Maritime Labor Convention 2006 and operates as a maritime manning agent. They specialize in specific nature projects and provide international headhunting services (Saar, 2022).

Over the past decade, TSM has actively participated in offshore wind projects. Since 2013, they have operated service operation vessels and have been selected by Chevalier Floatels BV to manage these vessels. TSM's involvement starts with the conversion phase, transforming passenger vessels into Dynamic Positioning (DP) 2 service support vessels. They now provide project-specific methodology, consultancy services, and solutions for standard and customized activities related to offshore wind projects, such as deploying and retrieving wind turbine blade maintenance baskets from service operation vessels. In 2021, TSM became a member of the Estonian Wind Energy Association. They have also collaborated with Bridgemans Services Group, successfully providing vessel services for Vestas Offshore Wind in Belgian wind farms. These services include vessel conversion, accommodation services, personnel and cargo transfers, and assistance in planning and executing offshore operations (Saar, 2022).

In April and May 2021, TSM supported EAGLE-ACCESS B.V. during the sea trials of their innovative offshore access system. TSM assisted in sourcing and chartering a suitable vessel, and the Vroon Offshore-operated vessel "VOS Star" was chosen as the installation platform for the trials. TSM also provided two offshore wind technicians from their pool of offshore personnel through their sister company, Tschudi Personnel Services. The sea trials involved testing the access system and conducting numerous personnel and equipment transfers between the vessel and a wind turbine. The participating technicians praised the system for its speed, comfort, and ease of handling cargo, tools, and equipment (Saar, 2022).

Figure 5 A Tschudi technician hooking up cargo.
(Saar, 2022)

Figure 6 Personnel transfer by EAGLE from w2w*
(Saar, 2022)

W2W - walk to work vessel. These ships are intended to give safe access to offshore structures and to increase access during bad weather to platforms both in the wind and oil and gas industry. (Hunt, 2022)

TSM offers a range of professionals to support the renewable energy sector, including electricians, technical workers, service technicians, riggers, supervisors, engineers, welders, assemblers, wind turbine service technicians, and seafarers for offshore vessels. In collaboration with local training and certification facilities, TSM facilitates additional training and certification programs to enhance the skills and qualifications of its workforce, providing comprehensive and industry-specific training (Saar, 2022).

In terms of offshore wind experience, TSM has primarily been involved in service operational vessel duties, construction and installation phases, operational and maintenance support, risk management and contingency assistance, provision of offshore accommodation solutions, ice-breaking services, logistics and site clearance support, cable pull-in and termination support, ocean towage, and regular reporting on project aspects (Saar, 2022).

To address the labor force situation, one potential opportunity is to retrain and further educate seafarers who already possess valuable experience, skills, and understanding of offshore work, including extended business trips, and hold relevant qualifications. Estonia, being a maritime country, has a reputation for producing responsible, capable, and highly educated seafarers who are sought after worldwide. The Baltic countries, including Estonia, are known for producing top officers in the shipping industry. This indicates that the educational institutions in Estonia are capable of training qualified workers. Therefore, Estonia has the potential to produce highly skilled specialists for the renewable energy sector, including marine engineers, electricians, sailors, welders, assemblers, and even officers for the wind industry. Retraining seafarers would require less time than training individuals from scratch.

4 Conclusion

The wind industry in Estonia is currently in its nascent stage of development, but its potential to contribute significantly to the country's energy mix and help achieve its climate goals cannot be overlooked. The Estonian government has set an ambitious target of producing 100% of the nation's electricity from renewable sources by the year 2030, and it is expected that wind energy will play a pivotal role in realizing this objective (Tatomir, 2022).

However, operating and maintaining wind farms presents their own set of challenges, with one major obstacle being the shortage of skilled workforce in this sector. This issue is not unique to Estonia but is prevalent in many other countries as well (Meriküll, 2012). The development of wind energy in Estonia has been driven by a combination of factors, including the country's ambitious renewable energy targets, the presence of favorable wind resources, and the growing demand and prices for electricity.

Research indicates that Estonia has the potential to come closer to meeting the 2030 EU directives on renewable energy. However, the pressing concern lies in the limited time available and the need for immediate action. Deliberations and discussions may no longer be sufficient; it is imperative for Estonia to take decisive steps and make tangible progress. To achieve the EU directive and even surpass the set targets, Estonia would require the establishment of only one or two offshore wind farms and the addition of several hundred wind turbines onshore. With concerted efforts, it is still possible to accomplish this before the specified deadline (Tatomir, 2022).

To address the shortage of skilled workers in the wind energy industry, various strategies can be implemented. As previously mentioned, one approach involves investing in education and training programs that aim to attract more young professionals to this field. This includes expanding the curriculum offered by technical schools and universities to cover all the necessary skills and knowledge required for a successful career in wind energy. Another strategy entails providing incentives for professionals to transition to the wind energy industry.

To tackle the challenges associated with recruitment and retention, companies operating in the wind energy sector in Estonia should prioritize the creation of a positive work environment that fosters employee growth and development. This can be achieved by offering competitive salaries and attractive benefits packages, providing ample opportunities for professional development and career advancement, and cultivating a culture of sustainability and environmental responsibility.

As the wind energy industry continues to expand and mature, the demand for skilled workers with specialized expertise is expected to persistently increase in the future.

In conclusion, this study provides compelling evidence to support the fulfillment of the hypothesis that the wind energy industry in Estonia faces challenges related to the availability and needs of the workforce. The findings underscore the importance of addressing the skills and training gap, understanding labor market dynamics, shaping favorable policy and regulatory frameworks, and attracting investment for sustainable industry growth. The insights gained from this research contribute to the body of knowledge surrounding the wind energy industry in Estonia. They can serve as a foundation for future research and policy initiatives.

Finally, the industry can improve recruitment and retention efforts by addressing concerns about the environmental impact of wind turbines and engaging with local communities to promote understanding and awareness of the benefits of renewable energy. By taking these steps, the wind energy industry can attract and retain the skilled workforce it needs to meet the growing demand for renewable energy.

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Addendum 1 Commonly used abbreviations

DP	Dynamic Positioning vessel
EWPA	The Estonian Wind Energy Association
EU	European Union
GW	Gigawatt
GWO	The Global Wind Organization
IRATA	The Industrial Rope Access Trade Association
LCA	Life cycle assessment
MLC	The Maritime Labour Convention
MW	Megawatt
O&M	Operation and Maintenance
OPTIO	Offshore Petroleum Industry Training Organization
OWF	Offshore wind farm
TSM	Tschudi Ship Management
SHEQ/QHSE	Safety, Health, Envorimental, Quality
W2W	Walk to work vessel

Addendum 2 License

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