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Optimizing Green Energy Deployment: Project Management Strategies in Wind Farms in Finland

School of Technology and Innovations

Master's Thesis

Industrial System Analytics

Vaasa 2024

UNIVERSITY OF VAASA
School of Technology and Innovations
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Title of the thesis: Optimizing Green Energy Deployment: Project Management Strategies in Wind Farms in Finland
Degree: Master of Sciences in Technology
Discipline: Industrial System Analytics
Supervisor: Petri Helo
Year: 2024 **Pages:** 119

ABSTRACT :

My Thesis Focuses on Optimizing Project Management Practices In the Wind Farm Construction Industry to Align With EU Net Zero 2050 Goals, where emphasis has been given on the Finnish Wind Energy Sector. My main theme is How Wind Farm Project Management Practices can be improved while suggesting better Policy Modifications that also goes with Sustainability.

The Problems that I have worked in this thesis are the Price Indexation and Negative Electricity Prices, Inflation, Regulatory and Legislative Hurdles, Labor Shortages and Skills Gap, Geopolitical Instability, Integration of New Technologies, Lack of Standardized Process, Flexibility and Adaptibility in the Project Management Process as well as there is Competition from Other Renewable Energy Sources.

Existing literature, interviews and information on Wind Energy Project Management has highlighted some of the key challenges associated with this domain. But these existing studies has been lacking solutions that is particularly addressed towards wind Energy. Additionally, this thesis has been built upon Prior Academic literature that identifies the need for more sustainable regulatory frameworks across European Union states to facilitate the timely completion of wind farm Construction projects.

This study consists of a qualitative research Methodology which consists of Literature Review, Case Studies and interviews from the Project Professional of One of the Lead Wind Turbine Manufacturing Company Vestas. The data have been collected from the Project Professional, literatures and Websites which are focused on understanding the Challenges and Best Practices of the Project Management in Wind Farms in Finland and across Europe.

Key findings consist of solutions for Regulatory and Permitting Delay, Inflation, Labor Shortage and Skills Gaps and other policy recommendation for Policy Modifications and Project Management Improvement Crucial for Accelerating the Wind Energy Sector.

The findings of this study have put Valuable insights both for Industry professionals and Policymakers and Proposing Strategies for Efficient and optimize Wind Farm Project Management Aligned with European Union Net Zero 2050

KEYWORDS: Project Management, Wind Farm, Wind Farm Policy, Renewable Energy, Efficiency

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Abbreviations:

WBS Work Breakdown Structure

SDG Sustainable Development Goals

SPMM Sustainable Project Management Model

LCA Life Cycle Assessment

CP Comprehensive Plan

EVM Earned Value Management

NRW North Rhine-Westphalia

1. Introduction

The global shift towards Renewable Energy has accelerated significantly in recent years as countries aim to reduce their dependence on fossil fuels, to combat climate change as well as to reduce the Carbon Footprint and the European Union and its countries are not different than that. As European Union has committed to achieve Net Zero Emissions by 2050, Renewable Energy sources such as Wind Power, Nuclear Energy, Solar Power and Hydropower have become critical pillars of Energy Strategies across the European Continent. And among these, Wind Power is regarded as the game changer for European Union to achieve its carbon Neutrality.

Finland has been making good Progress to its transition to the Green Sustainable Energy as the country is committed to increase its Share of Renewable Energy in the overall Energy Mix in aligned with the European Union's Green Deal and Net Zero Emissions target by 2050. Wind Energy has been significant part of this strategy as Finland location, neck for innovation and the Finnish Governments Support for the onshore and offshore has been pivotal in achieving EU Net Zero Goals.

1.1 Theoretical Background of the Problem

Renewable Energies are those that are derived from the Natural Resources and restored at a faster rate than they are consumed. Wind Energy is one of the most valuable form of Wind Energy that converts the Kinetic Energy into the Electricity through the use of Wind Turbines. This process of Converting does not Involve any Greenhouse Gas Emissions, which makes it clean and sustainable energy option compared to the traditional fossil fuel-based Energy Sources such as Coal and Natural Gas or the dangerous substance like Nuclear Energy.

The Net Zero Goal of 2050 is a key plan to Eliminate the Green House gas Emissions and this Goal is critical not only for the Europe but also for the Whole World. Gaining the Net Zero 2050 objective will reduce Significantly the Effects of Global Warming and limit the Rise in Global Temperatures to 1.5 Degree Celsius above Pre-Industrial Levels.

Net Zero 2050 target is significant for Europe for various other reasons. This Net Zero 2050 and European Green Deal reflects the Europe’s target of ensuring Energy Security, Promoting of Sustainable Economic Growth and lessen the dependencies on Fossil Fuel imports. This will also act as a shield for Europe to Protect them from Geopolitical Instability such as Russia-Ukraine War and thus Energy Independence can be achieved.

1.2 Research Questions and Objectives

There are two main Research Objectives of this thesis:

(1) Finding out how can Current Project Management practices in the Wind Farm Industry be optimized to align with the EU's sustainability goals. This can be done by analysing Current Project Management Frameworks which has been being used in Wind Farm Projects on the Planning, Execution and Handover Phases especially in terms of Regulatory Compliance, Permitting processes as well as Resource Management. And, to propose optimization Strategies that reflects sustainability into the Project Cycle.

(2) To Identify existing Project Management Practices, to analyse their effectiveness, and propose optimization strategies as well as policy modifications. This can be done by Reviewing Existing Project Management practices in Wind Farm projects, both in Finland and across Europe. Specific attention will be given to facts such as Permitting, Resource Allocation, Subcontractor Coordination, New Technologies integration Management in the Wind Energy such as Offshore Wind Farms as well as there will be policy modifications find out regarding Government steps in the Various stages of Wind Farm Construction which will cover not only Finland but also the other parts of the Great Europe. The Assessing will be done by company Case Studies and interviews with industry professionals. Suggesting Policy Modifications could further increase Efficiency in Project approvals and reduce delays, providing clearer guidelines for Offshore and Onshore wind projects, Improving Government support for Wind energy developments as well as how to establish the Wind Energy robustly for Net Zero 2050 to compete with other Renewable Energy Sources.

2. Literature Review

2.1 Overview of Wind Energy in the EU and Finland

The European Green Deal aims to make Europe climate neutral by 2050, with increase the economy with green technology, create sustainable industry and transport and reduce pollution, (European Commission, 2022). This aims to turn climate and

environmental challenges into opportunities for all. Finland wants to achieve that target even faster, by 2035, (IEA, 2021). As per ‘Fit for 55’, (Consilium, 2023), the transition to a Green Economy requires a comprehensive transformation of the energy sector, with a focus on Renewable Energy Technologies as well as Reducing Reliance on oil and gas.
While Wind Energy is an essential part of the clean energy mix required to achieve Net Zero emissions by 2050, it plays a critical role in the Sustainability also, (IEA, 2021). In the European Union, Wind is a secure, abundant, and sustainable source of Energy. It is essential to achieving the Europe’s decarbonization goals and providing our homes, businesses, and eventually the transportation sector with safe, cheap, and clean power. As a result, the Energy security is expected to be improved and high number of employments will be created by the European Unions Wind sector and Energy growth (COMMISSION, 2023)
The predictions for Europe and global deployment of wind firms are positive. The Europe target of getting 42.5% of renewables by 2030 will need the already installed capacity to grow from 204 GW, which is the statistics from 2022, to more than 500 GW in 2030 (COMMISSION, 2023)

Relander (2024) asserts that In Finland, the fastest-growing electricity source in recent years has been wind power. From the statistics, 18.2% of Finland’s electricity consumption has come from the Wind Power Wind production has been increased by 25% and wind capacity increased by 1.3 GW over the previous years, which contrasts with the EU's average wind power share of 19% (O’Sullivan, 2024).

The Finnish government has established an ambitious target for full stream Offshore Wind Power generation by the year 2035 (Association, 2023). The Finnish government’s objective is to facilitate the installation and operation of wind farms within their territorial waters to position Finland as a leading destination for large-scale wind energy projects in the Baltic Sea region. In order to make sure a smooth and efficient implementation process, the Finnish Government is willing to provide Wind Farm developers with clear and uncomplicated laws. They will also make sure that other sea users, including fishermen and commercial boats, are not negatively impacted by the construction of Wind Farms and thus the environmental challenges remain secure which will be supervised by the Ministry of Employment and the Economy, (Association, 2023). The execution of these plans will make Finland significantly more towards the Wind Energy and sustainability. In Finland, Project Management practices for Wind farms emphasizes on rigorous planning and regulatory compliance to ensure that these projects contribute effectively to the country's visionary renewable energy goals, (IEA, 2021). Effective project management is essential in coordinating various stages of wind farm development, from Site selection and Environmental assessment to Construction and Operational management. These Project Management practices in Finland and European Union are constantly being upgraded to optimize efficiency, to minimize environmental impact, and to ensure that projects align with both National and European Union directives for renewable energy expansion and carbon neutrality. (Council, 2019)

2.2 Current Project Management Practices in Renewable Energy

Current Project Management Practices in Renewable Energy emphasize the importance of aligning project outcomes with organizational goals. The five phases of project management, as defined by the Project Management Institute (2013):

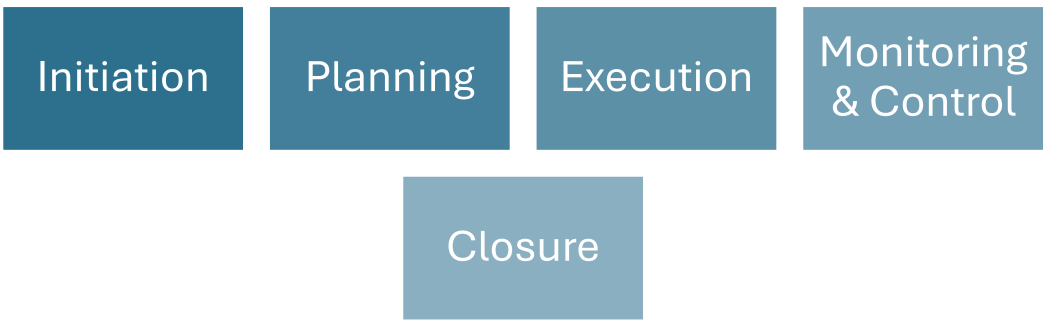


Figure 1: The five phases of project management (Project Management Institute, 2013)

Effective Project Planning, especially in the Renewable Energy involves identifying specific Community issues, developing a work plan, describing the project's positive impacts, and estimating funding requirements. Project controls include activities related to managing project costs and schedules. These projects involve aligning with organizational goals, developing a Work Breakdown Structure (WBS), Budgeting, Forecasting, Monitoring costs, and asking for feedbacks. Project Controls facilitate efficient Project Management by identifying potential concerns and enabling necessary adjustments (Kibet & Senaji, 2024)

Consistent and integrated application of Project Controls is essential for any project to be effective. Now a days, Work Breakdown Structure is being implemented in the project management, especially in the renewable energy. The Work Breakdown Structure or WBS is a Visual representation of the Project Scope and deliverables which is being used by companies these days. The WBS divides the project scope into smaller, manageable outcomes. The WBS provides clarity in the hierarchy of activities and facilitates the structure interdependence between operational procedures of different sectors and project goals. Effective coordination, communication, and clearly defined objectives are crucial for timely project completion. By using the framework is a simple way to implement the Project Management Process. It involves setting up definite stages, which results in a clear comprehension of the necessary tasks for a specific project. In order to facilitate Resource Allocation, Milestone Identification, and project completion assessment, the WBS offers individuals and teams working on a project in an organized plan, which is essential for current Project Management practices. Companies like to adhere to the WBS because it supports management, organization, and performance control of forecasts and provides supplementary measures for quality performance management and the attainment of project management unit objectives. Now organizations take some common Mitigation Strategies for Risks in Renewable Energy Projects (Kibet & Senaji, 2024).

Figure 2: Mitigation Strategies for Risks in Renewable Energy Projects (Kibet & Senaji, 2024)

Organizations proactively identify potential risks through risk analysis, evaluate risk likelihood and impact, and they usually develop mitigation strategies. Companies practice Effective stakeholder management which involves regular communication, Collaboration, and involvement in risk identification and mitigation planning. Companies usually try to do realistic project scheduling that takes into account potential delays and uncertainties. And now also it is important to have contingency plans to address unforeseen challenges. Effective management of project teams involves careful selection and allocation of skilled personnel with relevant expertise, specially in the sensitive Renewable Energy Sector. Accident plans for handling unexpected absences or turnover and fostering a collaborative and supportive team environment is also crucial for successful project execution these days. Another key components of successful risk management in renewable industry include establishing a risk monitoring system, holding regular risk review meetings, and taking prompt action to address emerging risks.

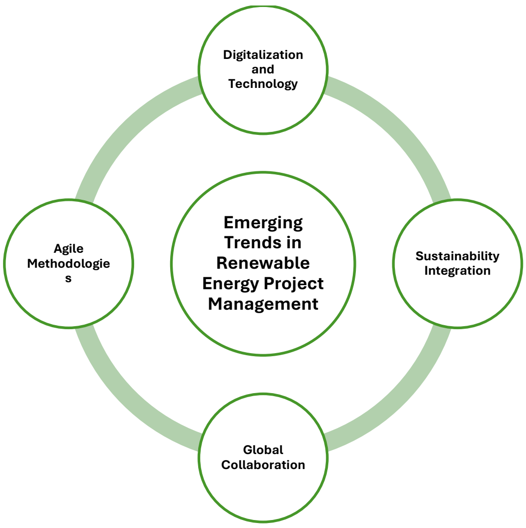


Figure 3: Emerging Trends in Renewable Energy Project Management (Kibet & Senaji, 2024).

According to Kibet & Senaji (2024), the use of digital tools and technologies for Project planning, monitoring, and communication, as well as data analytics to identify risks and optimize project outcomes, are two of the key trends in Project Management. Secondly Organizations, adopt Agile project management approaches to changing requirements and uncertainties. These approaches are necessary for continuous learning and iterative development. Integrating sustainability principles into project management is crucial for minimizing environmental impacts and maximizing social benefits. Considering lifecycle impacts and Applying Circular Economy principles is also crucial to ensure resource efficiency in Renewable Energy. Another good practice is Increased collaboration among nations and organizations for sharing knowledge, best practices, and resources for renewable energy projects is a key aspect of global collaboration. The multidisciplinary teams involved in this process usually have diverse expertise and skills.

The project management triangle is a crucial concept in managing the balance among Scope, Schedule, and Cost. Any alteration in one aspect necessitates adjustments in the others to maintain project equilibrium. This is especially important in renewable energy projects where scope changes are frequent due to technological advancements or regulatory updates (Project, M. I. 2021).

2.2.1 Cost Management Methodology:

According to Project, M. I. (2021), this is a significant tool for the estimation of Costs, Cost Budgeting, Cost Control, and optimization. In order to manage the significant upfront expenses and maximize investments over the course of the project lifespan, renewable energy projects require effective cost management, Another important technique that helps project managers monitor and forecast project performance is called Earned Value Management (EVM), which combines scope, schedule, and cost measures. Usually it provides information on budget overruns and timetable delays. As a component of risk management, Management Reserves take into consideration unforeseen circumstances including scope modifications, outside alterations, inaccurate estimations, and variations in cost levels.

A common practice for companies is Contingency Reserves which is an account for unforeseen events. These costs can be calculated based on historical data, risk assessment, or as a percentage of the total cost. Unexpected events like machinery breakdowns, consulting expenses, scope changes, material delivery delays, and weather conditions require contingency reserves. Contingency reserves help Project Managers plan for the unexpected and maintain budget compliance in the renewable energy sector.

Quality management in Renewable Energy projects is crucial to ensure the reliability and efficiency of technological components. The quality management usually is defined by continuous monitoring and improvement to meet project specifications and stakeholder expectations. This is essential to achieve sustainability objectives by ensuring that projects are delivered on time, within budget, and to the required quality standards. Effective project management practices usually come through quality management methodologies, which are instrumental in attaining long-term project success of renewable energy plants. (Project, M. I.,2021)

Like the project management in different sectors, quality management systems in renewable energy sector comes with different components, mainly they are

Figure 4: International Organization for Standardization (ISO 9001:2015 Quality management systems — Requirements. Geneva, Switzerland, ISO, 2015)

There are some Quality Management Tools mainly used in project management, which are as below:

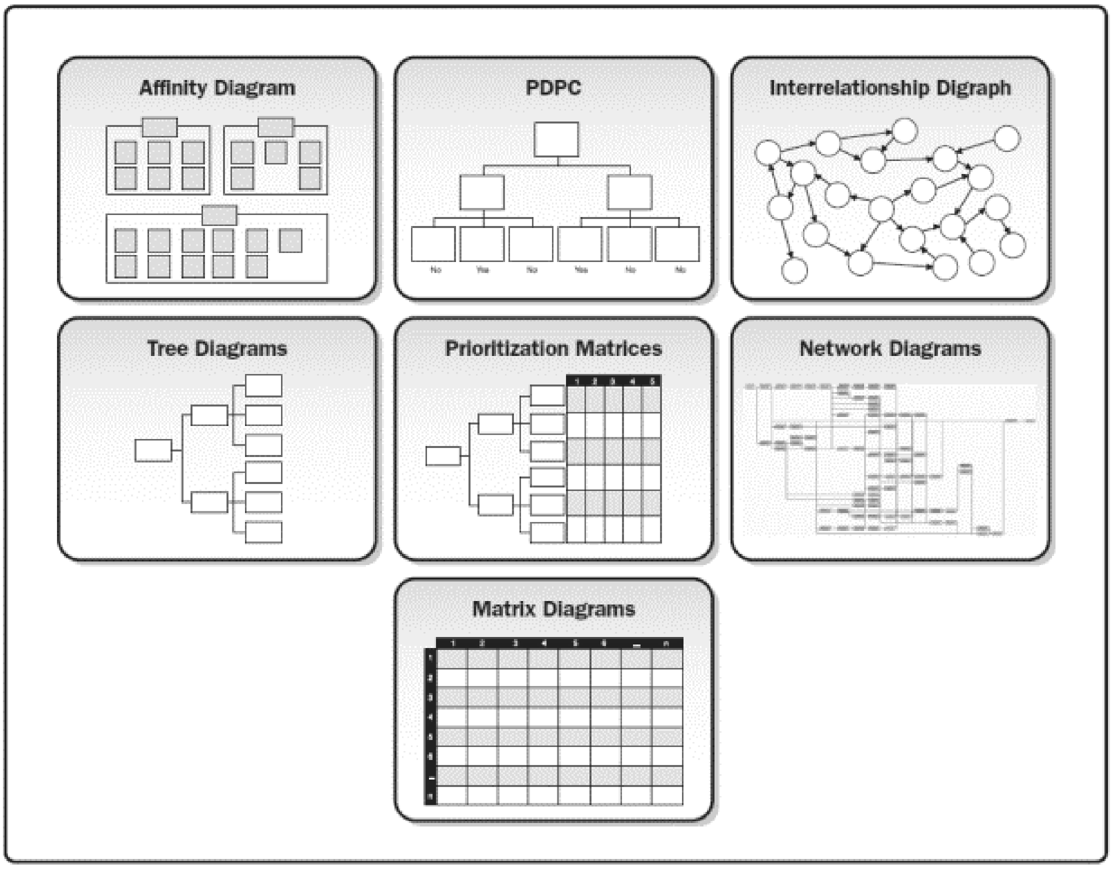


Figure 5. Main Quality management tools in project, (ISO, 2015)

Several techniques are being used in Ensuring the Project Quality Goal. One of such technique is Self-assessment. This is a key tool for quality control that facilitates reflection and the discovery of areas that require improvement. It highlights areas of Agreement and Disagreement, Assesses Commitment, and Outlines the project managers what needs to be improved. In addition to assessing organizational changes, self-assessment can track procedures and gauge the success Of Quality Improvement Initiatives needed to take.

There are many quality management models exist for project management, providing frameworks to guide organizations in their quality pursuits. The EFQM or European Foundation for Quality Management Model focuses on customer orientation, leadership, and continuous improvement. The ISO 21500 which is International Organization for Standardization, offers a comprehensive set of quality management principles and guidelines specifically tailored for project environments. The Lean Six Sigma combines lean manufacturing principles with Six Sigma statistical methods to drive efficiency and reduce defects. Total Quality Management or TQM model specializes on the importance of continuous improvement, customer focus, and employee involvement to achieve organizational excellence.

The practise of PMS in renewable energy projects has led to significant enhancements in project management and efficiency in the Renewable Energy Projects. A wide range of essential functions such as planning and scheduling, assigning tasks and allocating resources, collaborating and communicating, monitoring progress, and reporting, are being supported by these systems.

2.3 Sustainable Project Management Theories Relevant to Wind Farms

In this chapter of thesis, I am going to discuss about the Sustainable Project Management practices, and which can also be applied to the Wind firms. All the topics which are going to be discussed here will all be a part of the Sustainability.

Sustainability in project management aims to balance environmental, social, and economic aspects of project-based work to meet current stakeholder needs without compromising our future generations. This is something that involves individual and organizational responsibility to ensure sustainable outputs, outcomes, and benefits throughout the Project Lifecycle (APM, 2021)

So, Sustainability should be something that needs to be planned from the start to in all phases of project management. To maintain sustainability can be hard but project managers should work towards it on how to deliver the Sustainable Project Management methods.

If we want to go towards a more specific definition, then, Sustainable Project Management is a holistic approach to project planning, monitoring, and control. Sustainable practices consider variable aspects such as project's effects on the environment, the economy, and society at every stage of its existence, from inception to completion. This strategy includes stakeholders and provide benefits in a transparent, equitable, and ethical manner. Sustainable Project Management helps to ensure that projects are aligned with an organization's long term Sustainability goals and contribute positively to the environment and society as a whole (Silvius & Schipper, 2014).

Sustainable project management involves identifying and managing risks associated with Renewable energy and Climate change. Though the risks of Renewable Energy to the environment and the risks of climate change to Renewable Energy are relatively smaller compared to fossil fuels but they cannot be overlooked. And so, for ensuring the successful deployment of Renewable Energy Solutions, it is important to analyse these risks thoroughly, to understand the legal framework of governing agencies, and to apply Energy Laws effectively throughout the lifecycle of Renewable Energy Projects, (Girgibo, 2022).

The world is facing challenges and the main reason for this is the growing population and expanding cities, which results in resource depletion and environmental damage. We need to understand what sustainability means actually. The Aim of Sustainability is to meet the present's needs without compromising future generations' ability to do the same. Sustainability encompasses environmental, demographic, social, and economic aspects, and emphasize future orientation and balance among these dimensions. (Salama, M.,2018). The United Nations has set 17 Sustainable Development

Goals or SDGs for countries to work on, which includes ending poverty, reducing inequality, and protecting the environment. Businesses are now focusing on Social Sustainability, emphasizing fair treatment of workers and workforce diversity. While sustainability presents certain challenges, it also offers opportunities for businesses to become more innovative and competitive and opens up new career paths for individuals interested in sustainability especially in the renewable energy sector. We need collaboration among business, Government and Individuals to achieve sustainable development, (GetSmarter, 2021)

For the Sustainable Project Management, the Offshore Wind Industry places a strong emphasis on Safety Management, with all offshore wind companies implementing thorough Safety Management Systems or SMS to not only comply with regulatory requirements but also it is essential to maintain their brand reputation. Though there are many definitions of "safety management" exist in academia, in a broad sense, safety management consists of organizational procedures for Identifying, Assessing, and Mitigating Risks associated with specific tasks or organizational activities which includes near misses, incidents, accidents, occupational injuries and environmental damage, (Ahsan et al., 2019)

To ensure sustainability, working in a high-risk environment like Offshore Wind Farm Projects demands a stringent safety management system to prevent accidents during operations. A robust Health, Safety and Environment (HSE) management system is of paramount Necessity. Not only for adhering to national and international regulations but also from a business standpoint. Any accident can have long term negative consequences for the environment and company reputation, which can lead to financial penalties and legal prosecutions, (Ahsan et al., 2019)

There can be multiple reasons for organizations to adopt, sustainable practices. According to (Carboni et al., 2018). Sustainability plays a vital role in corporate risk management and brand reputation. Sustainability practice helps companies through crisis management, regulatory compliance, resource optimization, and purpose driven initiatives. Crisis Management involves responding to sustainability related situations such as oil spills or human rights concerns. Regulatory Compliance ensures adherence to laws, regulations, and guidelines. Finally, Resource optimization focuses on efficient resource utilization for cost reduction or improved efficiency.

Purpose Driven approaches helps to organize staff and resources responsibly for value creation and sustainable growth for the organizations. An organization might start incorporating better sustainability practices after encountering a crisis, such as an environmental disaster caused by its actions while another organization might adopt Sustainable practices to adhere to relevant regulations. But in both events, the underlying motivations for their decisions involve risk mitigation and maintaining brand reputation. While what Mature organizations would do, they still prioritize Risk Mitigation and Brand Protection, and they would perceive Sustainability as a source of future investments. For the sustainable development, as the businesses grow, Sustainable Companies put their focus shifts from Resource Optimization to balance sustainability, that offers enhanced productivity, competitive advantages in the market as well as newly opened opportunities.

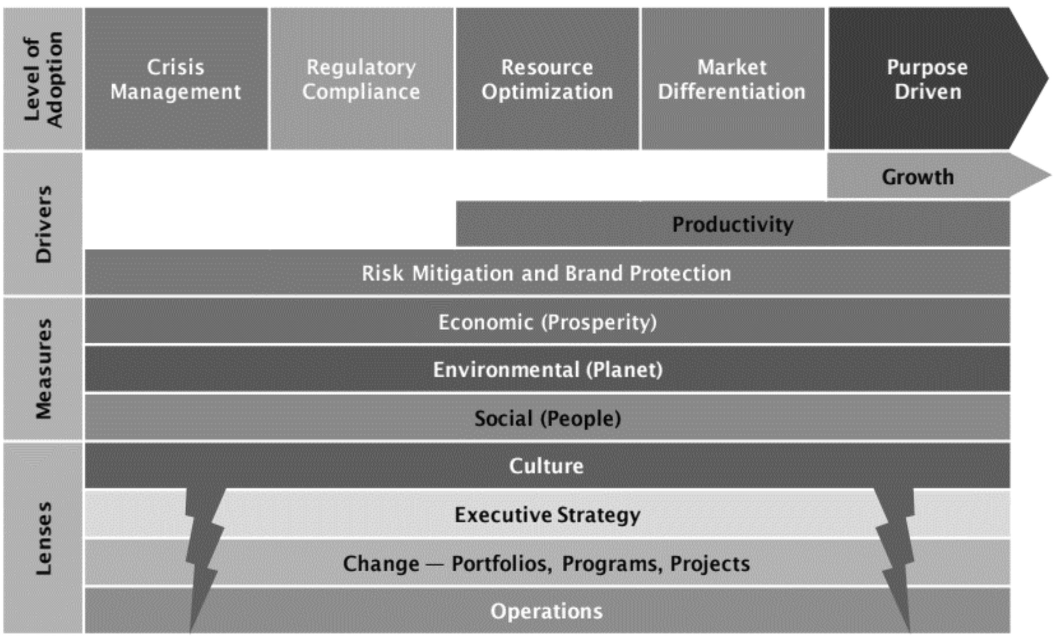


Figure 6. Levels, Drivers and Measures of Sustainability Adoption, (Carboni et al., 2018)

An important factor for Project success is engaging stakeholders during the planning and implementation phases of renewable energy projects. Role of local communities' support and active involvement in the initiatives, especially in the Wind Farms Projects is very important. It is important to share the benefits of such projects among all stakeholders, which creates a sense of ownership and acceptance within the community which works towards Sustainability (Katarzyna Piwowar-Sulej et al., 2023)

According to the research of Katarzyna Piwowar-Sulej et al. (2023), there is a need for research in benchmarking specifications for Wind Power Projects, an exploration of the limitations and challenges of Green Electricity Markets, and to have a deeper understanding of the Socio Institutional Complexities surrounding renewable energy projects to further bridge the gap between future research and sustainable project management.

According to Salama, M. (2018), the Sustainable Project Management Model or SPMM is a proposed standard shift in project management that supports the inclusion of sustainable innovation and technological advancements. This model aims to ensure projects address their environmental, social, cultural, and economic impacts. According, in the SPMM model, modern project management needs to expand beyond traditional metrics which are scope, time, cost to include considerations for long-term sustainability goals also.

Salama, M. (2018) points out the challenges in integrating sustainability, such as the need for new competencies and innovative approaches. Salama, M. (2018) stated that Sustainable innovation is crucial for wind farm projects, as it enables the development of technologies and practices that minimize environmental impact while maximizing economic benefits. Stakeholder engagement is equally important, as it involves consulting with local communities and relevant stakeholders to identify their concerns and incorporate their input into project planning and implementation phase.

Furthermore, according to Salama, M. (2018), Wind Farm Projects should consider their long term for sustainability that includes the potential effects on local ecosystems, communities, and local economies. And for this, companies require a forward-looking approach that could anticipates and mitigates any negative consequences.

Salama, M. (2018) also mentioned, Adaptability is another key factor for the long-term sustainability of Wind Firm projects. As policies, technologies, and community needs to evolve over time, the projects need to remain flexible and responsive to changing circumstances. The main key factors for the adaptability are being up to date with the latest technological advancements, adapting to evolving regulations, and addressing the changing needs of local stakeholders as well as prioritize them.

Some of the key components in Sustainable Project Management Practices by Salama, M. (2018)

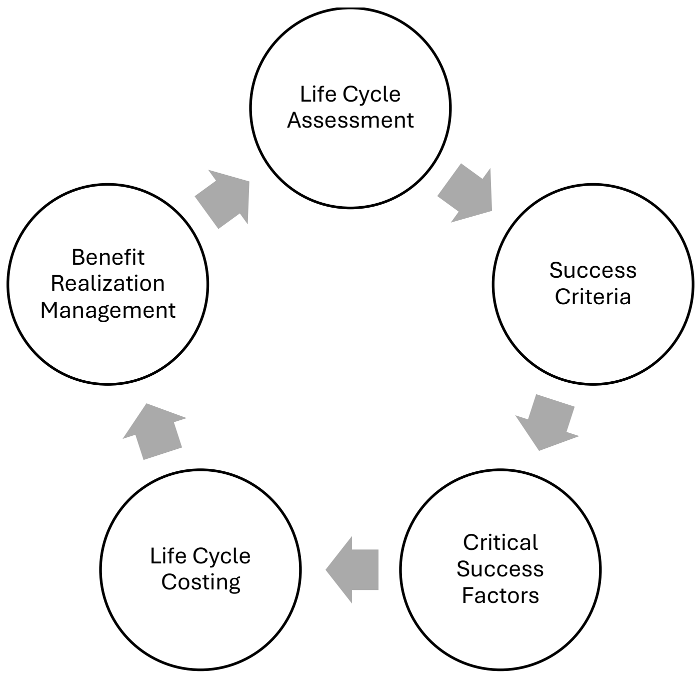


Figure 7: Key Components of Sustainable Project Management Practices

Life Cycle Assessment or LCA was created in 1990, associated with the term 'cradle-to-grave' which covers all important steps in a product's life cycle. Success criteria determine the successful delivery of the project, while success factors ensure the smooth and enhanced delivery process. The success criteria must include the full life cycle of the project. Next the Critical Success Factors or CSF make easier the achievement of the success criteria, with consideration of the entire project life cycle. Life cycle costing includes all phases of the project, and thus the most sustainably viable options are chosen. With Benefit Realization Management, sustainable project managers should consider the full life cycle and should ensure that projects deliver actual benefits.

2.3.1 Sustainable Energy Sources in Finland

A percentage of Total Energy Supply of the Sustainable Energy Sources from different Energy Sources in Finland are given below:

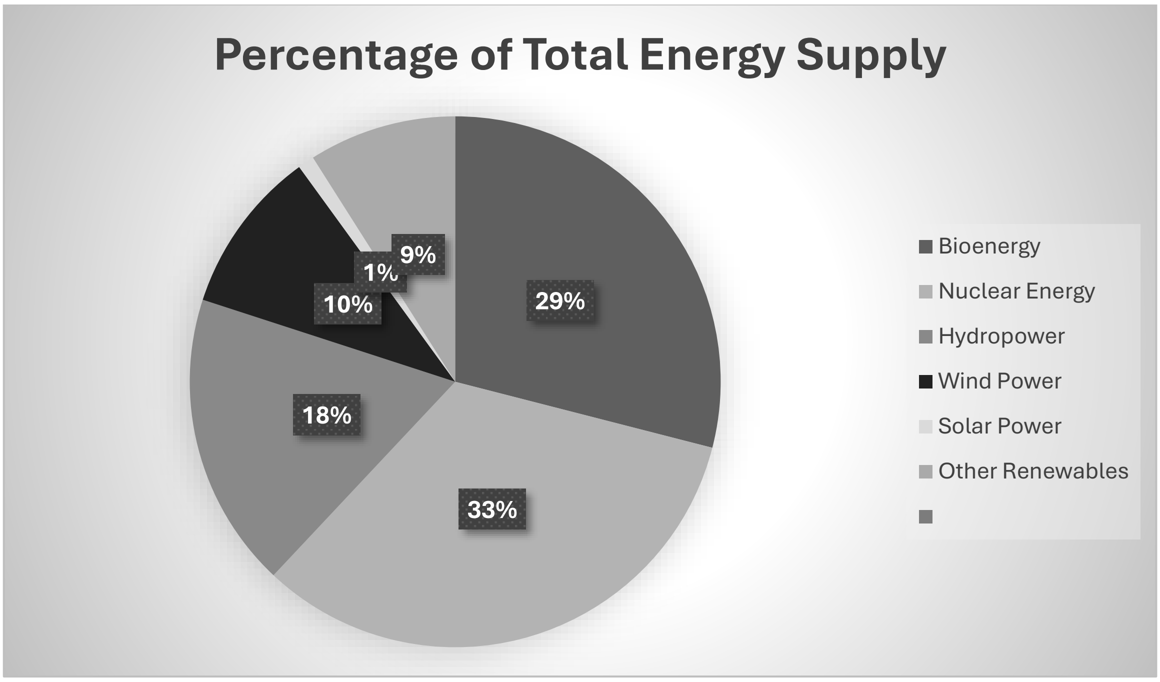


Figure 8: Sustainable Energy Sources in Finland

From the chart, we can see that**,** in Finland, the industries heavily rely on Bioenergy that comes particularly from forest industry side streams and other wood based fuels (Fleming, 2021). This energy source supplies 29% of the Finnish Energy Source. After that comes Nuclear Energy with 33% share. A significant portion of Finland's electricity comes from nuclear power as the Olkiluoto 3 reactor is expected to put more contribution in this portion, (Oyj, 2024). After that, the Hydropower is a stable and significant part of Finland's renewable energy mix, which is accountable for the 18% of the Energy Share. Wind Energy is now one of the fastest energy growing sectors in Finnish Energy industry which is contributing now and fulfilling targets of 10%. Although currently a small part of the energy concentration, Solar Power is gradually increasing and now at 1% of the supply (International Energy Agency, 2021). The rest of the energy supply comes from other Renewables which includes Geothermal Energy and other minor renewable sources (International Trade Administration, 2022).

2.4 Challenges in Wind Firm Development:

Though European Union is trying their best to fulfil their Net Zero 2050 goal, there are certain complicacies that make constructing Wind Farms big of a challenge still.

According to Agarwal et al. (2016), the construction of wind farms requires thorough assessment of the availability of land and any conflicts with current and future land use. Due to the abundance of land, the lack of obstructions that might slow down wind speeds, and the possibility of coexisting with Agricultural Activities such as farming and livestock operations, rural locations are frequently chosen for Wind Energy projects. This require develoers need to obtain long-term leases or ownership of property rights in rural areas.

Wind energy has both positive and negative effects on the environment which can be add up to the challenges for constructing the Wind Farm. Wind farms can cause wildlife impacts, Noise impacts, and Visual impacts. Wildlife impacts can include direct mortality from collisions with Wind turbines and indirect impacts such as habitat disruption. Moreover, Noise impacts can lead to reduced property values and can be hazardous to human health. This is the reason many landlords and Government do not want to give lands to wind firm companies. Additionally, Wind energy requires a high capital investment, which can be as high as 80 percent of the initial cost estimation (Agarwal et al., 2016).

According to the Research of Teschner & Alterman, (2018), now Governments worldwide are committed to increasing renewable energy production. However, obtaining permission for large-scale renewable energy installations is becoming increasingly difficult due to land use conflicts. Consequently, countries are looking to tap into the potential of smaller-scale facilities in urban areas to meet their renewable energy targets

So, addressing these challenges has been crucial for countries to meet the EU Net Zero 2050 goal. The successful deployment of wind energy projects is significantly influenced by the prevailing legislative and regulatory landscape. Barriers within existing legal frameworks can create significant hurdles for Project Development that often leading to Delays, Increased costs, or Even Project Cancellation incidents (Inês et al., 2020; Teschner & Alterman, 2018)

Complex and lengthy permitting processes frequently emerge as a key concern. Acquiring the necessary land use permits and environmental approvals for Wind Farms can be a time consuming and bureaucratic process. Additionally, inconsistencies in regulations across different regions or even within a single country can create confusion and uncertainty for Wind Farm Contractors (Inês et al., 2020; Teschner & Alterman, 2018).

Energy systems in the Europe and especially in Finland, are slowly transitioning to renewables, with Onshore Wind Power becoming economically viable in Finland for the first time. According to, S. Pradip, personal interview, (27.03.2024) the energy transition from fossil fuels to renewables is ongoing, and the law governing Energy Systems faces two challenges which are

- Transformative capacity to trigger change
- Adaptive capacity to allow past decisions to be changed.

The transformative and adaptive capacities of law play out differently in the context of renewable technologies in Finland. As, the Offshore Wind power is gaining momentum and should be supported by law, Hydropower raises questions whether existing legal protection allows the Electricity System to adapt to the new way of Sustainability (Similä et al., 2021).

According to Kibet & Senaji (2024), the Current Project Management practices, Types of Risks in Renewable Energy Projects,

End Product Risks	Project Contents Risks	Project Size Risks	Resource Risk	External Risks:
• Potential hazards or dangers associated with renewable energy systems • Misalignment between project results and stakeholder requirements.	• Unclear or evolving project requirements • Technical uncertainties and challenges in implementing • Hidden complexities or unforeseen challenges	• Organizations tend to underestimation the project scope and complexity • Companies tend to have Overly optimistic project schedules to satisfy the clients	• Skills gaps or inadequate expertise among • Unforeseen absences or illnesses • Internal conflicts or lack of teamwork	• Financial instability or shifting priorities • External factors such as regulatory changes or market fluctuations

Figure 9: Types of Risks in Renewable Energy Projects, (Kibet & Senaji, 2024)

The problems that are being faced to integrate New Technologies such as Offshore Wind Firms are visualized below:

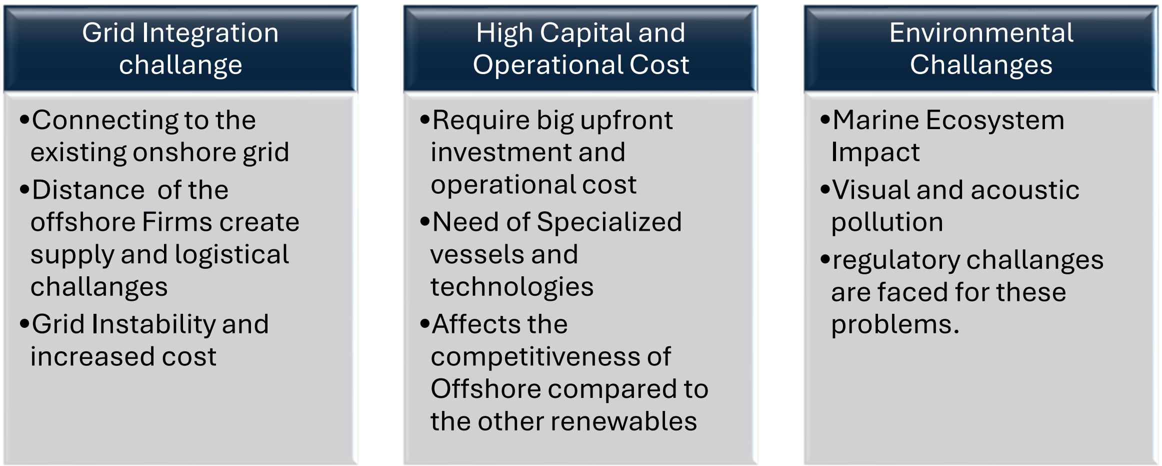


Figure 10. New technology integration challenges, (Snyder & Kaiser, 2009; Europe, 2017; IEA, 2021)

2.5 Comparative Analysis of European Green Initiatives

To talk about the Green Initiatives here in Europe, first comes European green Deal which is a comprehensive strategy adopted by the European Commission in 2019, aiming for a sustainable transformation of the EU's economy, (European Commission, 2022). The main key points of the Green Deal are:

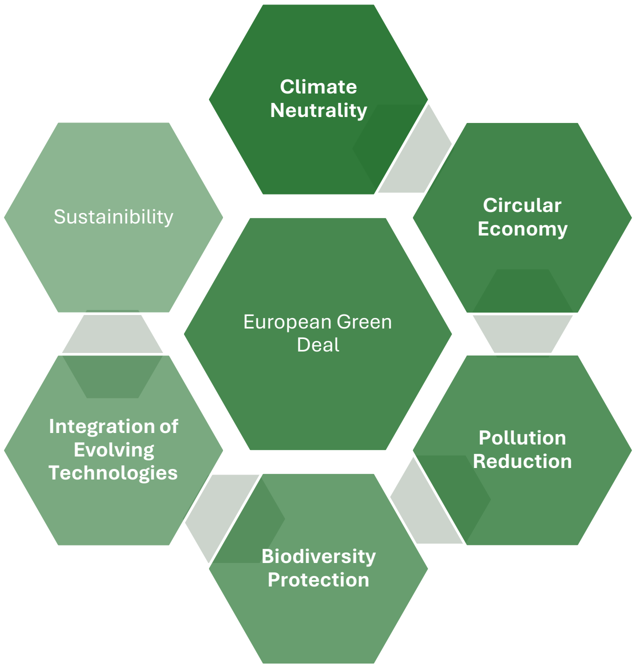


Figure 11: Key Points of the Green Deal in Europe, (European Commission, 2022)

The Green Deal has set a target for the EU to achieve net-zero greenhouse gas emissions by 2050. This goal requires significant reductions of gas emissions across all sectors, such as energy, transportation, and agriculture industry with promoting a shift towards a Circular Economy, where resources are kept in use for as long as possible. This initiative minimizes waste generation, promotes product design for recyclability, and develops efficient recycling and reuse systems.

The Green Deal aims to significantly Reduce Pollution of all kinds elements which includes Air, Water, and Soil pollution. This has introduced stricter regulations on emissions, promoting cleaner technologies, and the polluted environments will be restored. With The Green Deal, the crucial role of Biodiversity for a Healthy planet and thriving societies is recognised. It sets out measures to protect ecosystems, to restore degraded habitats, and to halt biodiversity loss.

The European Union's ambitious goal of achieving Net-zero Greenhouse Gas emissions by 2050 places Offshore Wind at the front of European Unions Energy transition policies. Though there is not a single document for the Offshore wind farm's Net Zero 2050 guidelines, the various European Union policies and strategies give a clear direction towards this sector.

The key policies EU has taken to integrate emerging technologies such as Offshore wind Farms into Net Zero 2050 Goal are as follows, (COMMISSION, 2023):

2.5.1 European Green Deal:

This European Union strategy establishes a comprehensive framework for achieving Climate Neutrality by the year 2050. It underscores the pivotal role of renewable Energy Sources, that include Offshore Wind Power as a big catalyst for the climate neutrality target.

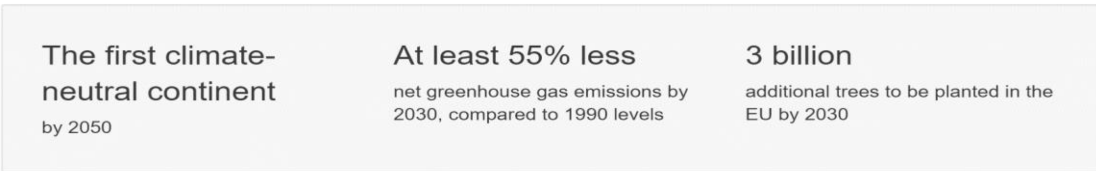


Figure 12: Key Figures of the European Green Deal, (COMMISSION, 2023).

The Highlighted Points of the Policies Towards offshore Wind Farms are:

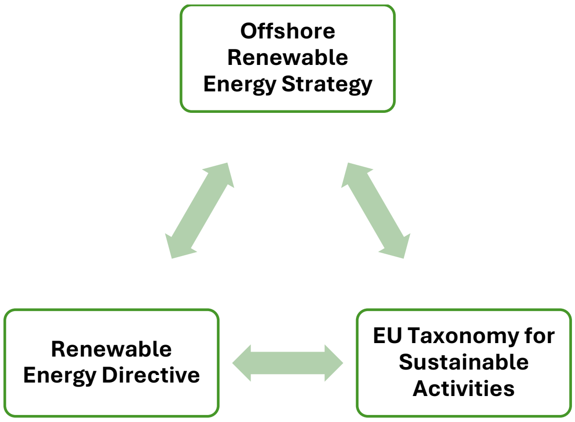


Figure 13: Key Points of the Policies Towards offshore Wind Farms

Offshore Renewable Energy Strategy was adopted in 2020, to set ambitious targets for offshore wind capacity by 2030 and 2050, (Union, 2020) which also describes key actions to support the sector's development including Grid infrastructure Development, Grid permitting, as well as research and innovation.

Renewable Energy Directive includes the increased use of Renewable Energy in the EU, including Offshore Wind. It sets specific targets for the member states of EU and provides a framework for supporting the development of the sector, (Renewable energy directive, 2023)

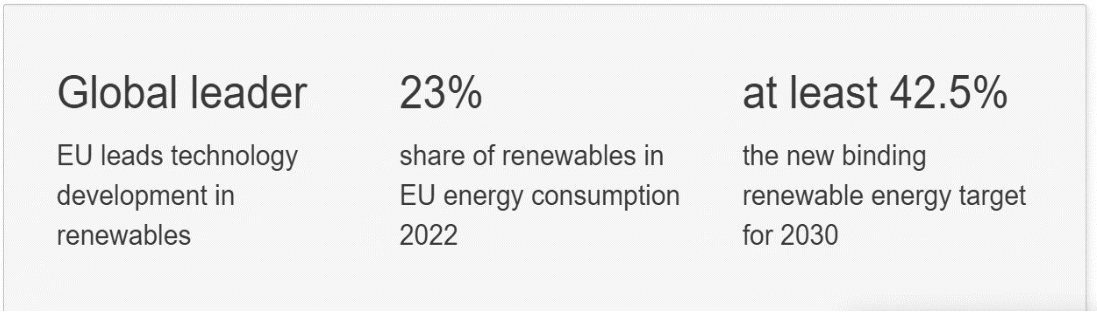


Figure 14. Renewable Energy Directive, (Renewable energy directive, 2023)

The EU taxonomy allows Financial and non-financial companies to share a common definition of economic activities that can be considered environmentally sustainable.

The EU taxonomy is a vital tool that helps the EU to increase its sustainable investment. This provides security for investors, helps them from Greenwashing, encourages companies to become more environmentally conscious and sustainable, as well as increases market coordination in a Sustainable finance, (Renewable energy directive, 2023)

2.5.2 Distinguishing Between Onshore and Offshore Wind Farms

Offshore wind farms differ from onshore wind farms in several keyways, some of the key differences are given below:

Feature	Onshore Wind	Offshore Wind
Location	Land	Ocean waters (coastal or further out to sea)
Wind Speed	Lower and more variable	Stronger and steadier
Turbine Size	Smaller (due to land restrictions)	Larger (deeper water allows for larger structures)
Upfront Costs	Lower	Higher (construction in ocean environment)
Installation & Maintenance	Faster and easier (ground-based access)	Slower and more complex (harsh sea conditions)
Technology	Mature and established	Requires specialized expertise
Visual Impact	More noticeable on land	Less visible from shore
Community Involvement	Easier for local communities to develop and manage	Limited community involvement
Land Use	Requires significant land area	Less land use impact
Impact on Wildlife	Bird and bat collisions a concern	Potential impact on marine life
Intermittency	Wind variability leads to inconsistent power generation	Steadier winds provide more consistent power generation
Grid Connection	Easier to connect to existing grid	May require grid upgrades in some regions
Potential Lifetime Cost	Lower	Potentially lower due to higher efficiency, despite higher upfront costs

Figure 15. Distinguishing Between Onshore and Offshore Wind Farms, (Blackridgeresearch, 2024).

2.5.3 Factors Finland is Taking to Boost Onshore Wind:

Finland has taken several Energy and climate strategies which are committed to expanding the use of the Onshore Wind Power in the countries electrical grid. The Finnish government has taken ambitious targets for Renewable Energy generation, which include significant contributions from Onshore Wind farms such as by 2030 the Onshore Wind energy will be 11-15 GW and by 2050 Offshore wind energy will be a key factor to achieve carbon neutrality for Finland, (WindEurope, 2022). Given below some of the initiatives taken by the Finnish Government that is actually a step towards boosting onshore Wind in Finland:

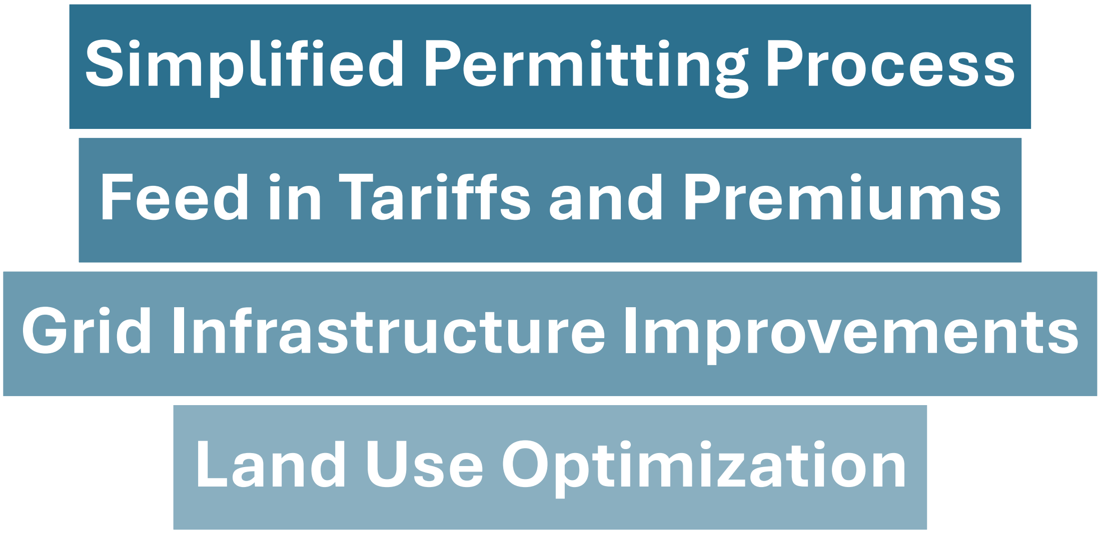


Figure 16: Initiatives thats been Taken By Finnish Regualtory Authoratives

The Finnish government has Simplified the Permitting Process for onshore Wind Energy Projects and this has accelerated the construction process of new Wind Farms. This involves streamlining the Administrative Procedures and aligning Regulations across local, regional, and national levels (Valtioneuvosto, 2022).

The Finnish government's financial support through different schemes such as Feed in Tariffs and Premiums has made Onshore Wind Energy projects more financially viable, which has been proved to be crucial in driving the rapid growth of the country's onshore wind capacity, (Valtioneuvosto, 2022)

According to Huttunen et al. (2022), Finland is investing in Grid infrastructure to ensure that the increasing amounts of Wind Generated electricity can be efficiently integrated into the National Grid which includes improvements to Power Transmission networks and the implementation of Advanced Sustainable Smart Grid systems to accommodate the variable nature of Renewable Energy Sources like Wind Power. The government is providing support for grid connection costs which is making it easier for wind farm developers to link their projects to the National Electricity Network.

For the Land Use Optimization policy Finland's planning policies have designated specific areas that are optimal for Onshore Wind Energy projects and these areas have been chosen based on Wind Resource Assessments, Environmental Considerations, and Proximity to the Grid.

2.5.4 Environmental Impact Assessments or EIA:

According to Wilson et al. (2010), the Environmental Impact Assessment or EIA is one of the most important factors to establish a Wind Farm regarding the Environmental aspects. The Finnish government requires extensive Environmental Impact Evaluations for all Wind energy projects to mitigate the environmental impact and address concerns regarding Noise, Impacts on wildlife, and Conflicts over land use which has been pivotal for the meaningful expansion of Onshore Wind capacity in the past decades.

The EU's renewable energy targets consist of both Binding and Informative targets. While the EU sets an overall target, individual countries have been flexible in their approach. Some countries have been following the EU's ambition through Binding national targets, while others use Informative targets to outline their goals. Recognizing varying starting points with existing Renewable Energy Infrastructure and resources, the

EU allows some variation in national targets. Such as countries with lower Renewable Energy sage having modestly less ambitious targets compared to those countries which have established renewable energy sectors.

Many European countries incentivize Renewable energy production by the Feed in Tariffs, which is a fixed price per unit of Electricity produced from Renewable sources. This helps to guarantee a stable income for the Energy producers. An alternative system to Feed in Traiifs are the auctions which allow producers to compete for contracts to sell renewable energy at a certain price. This approach promotes cost effectiveness, (IEA, 2021)

2.6 Process across Different Countries and Finland:

Germany is Known for its significant "Energiewende" (energy transition) plan, Germany utilizes Feed in Tariffs, Auctions, and a strong focus on solar energy, (Action, 2024). Among European countries, Germany boasts the most extensive installed Wind Energy capacity which is closely followed by Spain. Both of these countries possess significant Wind Resources, onshore and offshore. Denmark is a frontrunner in wind energy, Denmark practices auctions and Offshore Wind farm development to achieve its high renewable energy targets, (Agency, 2018)

According to Intelligence (2022), France relies heavily on Nuclear Power but also has a growing Renewable Energy Sector, primarily focusing on solar and wind energy, supported by Feed in Tariffs and Public Investment. These incentives are part of France’s broader strategy to increase the share of renewables in the country’s energy mix. Currently they are aiming for at least 33% of total energy consumption and 40% of electricity production by 2030

According to Agency, (2018), the policies taken for Wind Farm Projects can be categorised into two sectors:

- **Policy Mechanisms.**
- **Ownership Model**

Germany, Denmark, Spain, the Netherlands, and Finland have implemented strategic shifts in their Renewable Energy policies. Germany and Denmark transitioned from Feed-in Tariffs to Auctions in order to enhance Cost Competitiveness And Resource Allocation while Spain and Netherland promotes Competitive Bidding and Innovation. Finland employs a hybrid system, that combines feed in tariffs for small-scale projects with a premium based system for larger projects for balancing Predictability and cost-effectiveness. These shifts only reflect the Europe's good will towards Sustainability.

For Ownership Model, different countries in Europe have varying approaches to Wind Energy development. Denmark emphasizes Community Ownership and Cooperative Models which could enhance social acceptance and local economic benefits. Germany, Spain, and the Netherlands focus on large-scale projects developed by major Energy Companies. But as in Finland, Community Ownership is less prevalent, where Utilities and International developers plays a significant role in project development.

The Swedish energy agency (EM) has identified 8 important points to work on while working for Wind Power, (Energimyndigheten, 2016):

1. To achieve a full Renewable Energy Grid, Wind power needs to be strategically planned.
2. Implement Wind Energy initiatives in the Municipal Comprehensive Plan or CP, so that Municipalities may learn more about how to make the greatest use of the existing land and water by incorporating wind power into the CP.
3. It needs to be clear that how does the comprehensive plan address national interests. So, clear explanations of the municipality's priorities and the way it has balanced various interests in relation to "areas of significant national interest" needs to be provided.

4. The municipality is required to state in the CP which public interests are served and how to describe localization, delimitations, and any other public interests that could conflict with this as well.

5. There needs to be Standards which needs to be applied to determine the planned area.
6. Municipalities should avoid imposing height limits since Wind Power is an industry that is rapidly advancing technologically.
7. Need to Steer clear of policies that need approval from other agencies. The procedure can be accelerated, and planning times can be reduced by avoiding needlessly contacting other entities.
8. Need to Choose areas with good Wind Conditions.

In the below figure, the Wind Firm buildup factors are given, according to (Leiren et al., 2020)

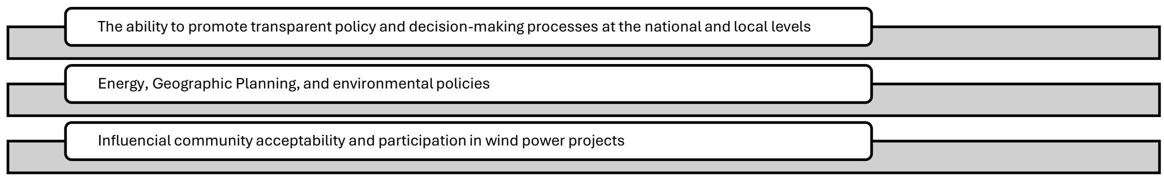


Figure 17. Key Factors for Wind Farm buildup, (Leiren et al., 2020).

If we look at some of the countries that made significant progress according to the EU net zero 2050 guidelines, the trend towards Sustainability among countries can be classified in three main categories

Figure 18: The Main Pillars Towards Sustainability

2.6.1 Netherlands

(1) Policy and Regulatory Framework:

Wind Farm development in Netherland faced challenges due to initially supportive but later inconsistent policies. According to the research of, Agterbosch et al. (2004), the Government was focused on large-scale wind power technologies and promoted growth through favourable regulations like the National Environmental Policy Plan (1989). However, corporate interests gradually weakened these environmental policies, which lead to instability in support for renewable energies highlight how these shifting priorities have hindered the wind energy sector's long-term growth and sustainability.

(2) **Planning and Implementations:**

According to Agterbosch et al. (2004), the Wind Farms faced significant local opposition due to the top to down planning approaches. And this caused the hampering of project execution. But later on, the new rules favoured local ownership which boosted the renewable energy capacity.

(3) **Challenges:**

As Agterbosch et al. (2004) discussed, main challenges have been the frequent changes in the policy which created uncertainties for the investors and the developers. There have been difficulties for the securing planning permissions for local opposition and bureaucracies.

2.6.2 England

(1) Policy and Regulatory Framework:

According to (IEA,2013), Early liberalization of the energy sector took place in 1989, and that was followed by the Non Fossil Fuel Obligation (NFFO). The Renewables Obligation (RO) is a UK government scheme which was introduced in 2002 and was designed to encourage the generation of electricity from Renewable sources. It was criticized for cost ineffectiveness.

(2) Planning and Implementation:

The competitive bidding processes under the Non-Fossil Fuel Obligation or NFFO led to low-cost wind projects but limited local involvement. While national planning policies supported renewable energy, they lacked mechanisms to effectively address local conflicts. This caused slowing project implementation and increasing resistance.

(3) Challenges:

According to the research of McLaren Loring (2007), Wind Farm Projects faced strong opposition which mainly came from the landscape and the nature preservation groups. As a result, the local planning authorities often denied the approval of Wind Farm constructions due to the ecological effects.

2.6.3 Germany

(1) Policy and Regulatory Framework:

According to the research of Steinbach (2013), there was early support through programs like the Federal 100/250MW Wind Programme and the Electricity Feed-in Act (1991). Similarly, the policies have been stable and focused on encouraging a diversity of investors and local ownership.

(2) Planning and Implementation:

In the early stages of a Wind Power Project, local and participatory planning techniques were proved to be effective. In Germany, Wind power has always enjoyed special treatment, which made project approval a simple process (Steinbach, 2013)

(3) Challenges:

As per Steinbach (2013), With the progression of Wind Farm Projects, resistance from local towns and environmental organizations is growing. This opposition is partly driven by the shift from locally owned initiatives to larger, investor-led developments, which has led to decreased local involvement and support.

To summarize, we can characterize the process of these three different countries into the below comparisons.

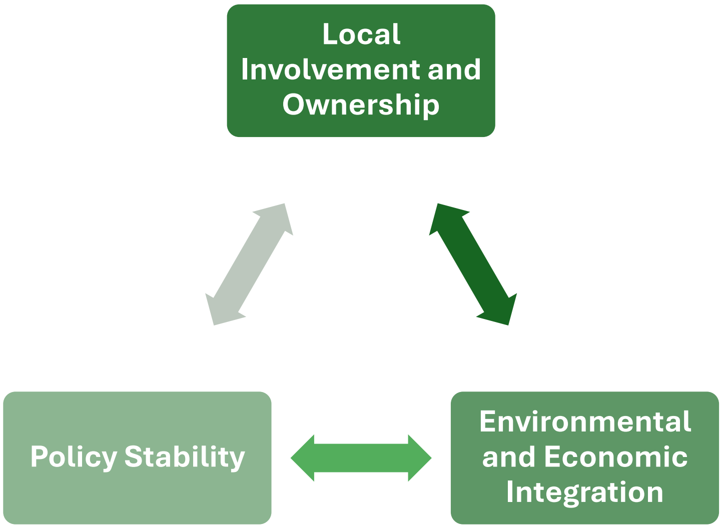


Figure 19: Main Comparison Metrics

Early local engagement in the Wind farms and ownership have helped North Rhine-Westphalia or (NRW) to gain societal acceptability and support. The Netherlands and England were hit with local opposition as a result of top to down strategy and a lack of local participation.

Stable and supportive policies in Germany have resulted in large increases in wind power capacity. Unstable regulations in the Netherlands and Competitive systems in England have been the main culprit for stifled consistent growth.

Germany's Ecological Modernization policies have integrated environmental concerns with economic development, supporting wind power growth. While, England and the Netherlands have faced challenges in balancing Environmental and Economic goals.

2.6.4 Offshore Wind Energy Project Management Scenario in Europe:

Offshore wind energy has grown significantly in Europe, whereas the United States remains has still not advanced much in the operating and resource assessment stage of the offshore wind firms (Firestone et al., 2015). Some of the patterns and development of offshore wind energy in Europe is given below:

The first offshore wind farm began operating in Denmark in 1991.Major developers who has been playing a pivotal role in making Offshore Wind Firm possible include Vattenfall (Sweden), Shell (Netherlands), DONG (Denmark), Nuon (Denmark), Vestas (Denmark), E.ON (Germany), and Centrica (UK).

This industry now providing around 210,000 jobs in Europe, accounting for more than half of all wind energy employment, with more growth expected as investment increases. Furthermore, hybrid projects that combine offshore wind are being expanded through hydrogen generation and battery storage which are some of the main agenda for European Commission and installed offshore wind capacity must reach 500 GW in order to fulfill the EU's revised objective of 42.5% renewable energy consumption by 2030 (Benjamin et al., 2020). So, The EU has responded to sector concerns with amended rules and frameworks, such as the Renewable Energy Directive, TEN-E framework, Energy Market Reform, grids action plan, net-zero industry act, and vital raw materials act. These initiatives highlight the importance of offshore wind farms in attaining the EU's net zero 2050 goals.

Some of the key trends that Europe has Undergone for Offshore Development according to Snyder & Kaiser (2009), the Size of the Wind Farms have increased by moving from the small projects from 10-50 MW to larger ones which are around 400-1,000 MW; There has been development in the deeper waters which are away from the shore and simultaneously the capacity has been increased.

If we look at the Offshore Wind Development by Country, we can see the below picture

(1) Denmark:

According to Europe (2024a), Denmark has been the Early leader in the Offshore Wind and Denmark has taken unique steps such as competitive bidding for the lowest feed in price.

(2) **Germany:**

Germany has a significant projected capacity, but few operating farms. As of mid-2024, Germany has around 1,602 offshore wind turbines with a total capacity under 8.9 GW, (Windguard, 2024). Offshore Wind farms are approved without discretion in Germany where developers have the right to build unless there is a severe hazard to transportation, the environment or in the biodiversity (Schwanitz & Wierling, 2016)

(3) United Kingdom:

The United Kingdom has one of the largest shares of operational offshore capacity. Here the Crown Estate organizes lease rounds, which allows for a faster approval process for Offshore Wind Farms (Thomas, 2021).

(4) United States:

Though in the United States, the number of offshore wind firms are less than the number in Europe, but it is increasing. The USA offshore wind energy infrastructure is predicted to have a capacity of 52,687 MW. This capacity comprises of installed projects, projects under construction, projects approved for construction as well as projects going through different state and federal approval processes, which includes existing leasing areas (EERE, 2019)

Some of the notable Key Offshore Projects in the United States are Cape Wind situated in Massachusetts which was proposed as the nation's first offshore wind farm but faced delays due to local opposition and regulatory processes. The Galveston Offshore Wind situated in Texas, is being built by a Luisiana Based Company is going to face fewer federal regulatory hurdles because of the different laws in the different state. So the main challenges in the USA firms are notably higher costs, regulatory burdens, and limited financial subsidies which are being given in state (Firestone et al., 2015)

Table 1: Differences between Europe and USA Wind Firm Project Management

Aspect	Europe	US
Financial Incentives	Feed-in tariffs, tax exemptions, renewable energy credits, and government grants available	Production Tax Credit (PTC), Renewable Portfolio Standards (RPS), and state level incentives, which are generally lower and less stable than European subsidies
Regulatory Framework	Fast and supportive regulatory frameworks, such as Denmark's tenders and UK's Crown Estate leasing	Lack of a final regulatory system, slower development due to legal challenges and detailed planning requirements
Wind Resources	Higher wind speeds and more economically and environmentally suitable sites	Suitable sites exist but are generally less economically favorable compared to Europe
Conclusion	The development of offshore wind power in Europe is driven by stable and supportive policies, larger financial incentives, and a more favourable regulatory environment	The US faces significant challenges because of less supportive financial incentives, a complex regulatory environment, and less favourable wind resources

2.6.5 Core Guidelines and Objectives For Offshore Wind

Based on these policies and strategies, the EU's guidelines for Offshore Wind Farms can be summarized as follows, (Commission, 2020):

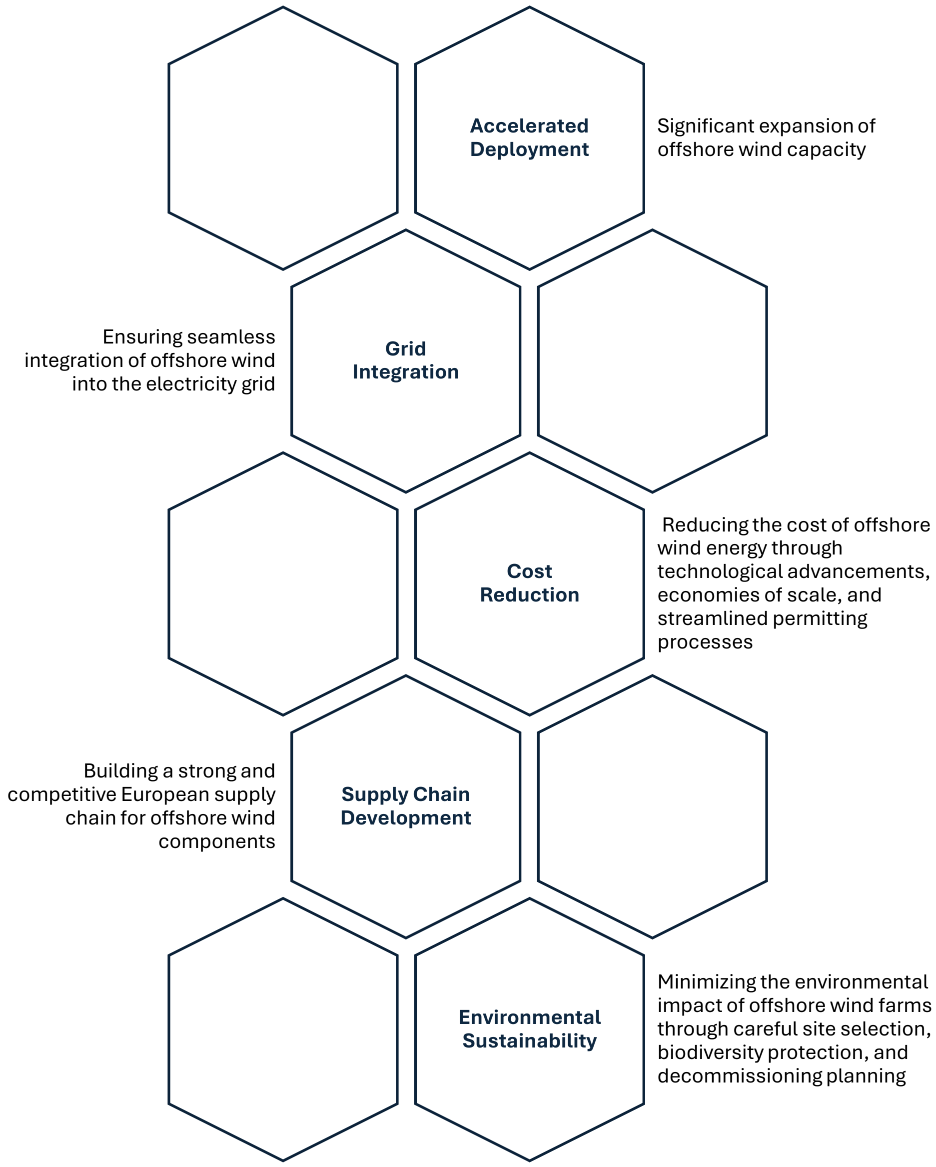


Figure 20. Core Guidelines for Offshore Wind Farms

2.6.6 SWOT Analysis of Wind Energy in Finland and other Leading European Countries:

Below is the SWOT analysis chart where I tried to highlight the strengths, weaknesses, opportunities, and threats related to wind energy development in Finland and other leading European countries:

Table 2: Swot Analysis of Wind Energy in Europe

Strengths	**Weaknesses**
• Plenty Wind Resources	• Initial High Capital Cost
• Pioneering Technical Advancement	• Intermittency and grid integration complexities
• Strong and Friendly Policy Frameworks	• Environmental and social concerns
• Environmental and economic benefits	
Opportunities	**Threats**
• Expansion of Offshore Wind	• Geopolitical and Economic Crisis
• Technological advancement and Cost Reduction	• Environmental Regulations and Permitting Bureaucracy
• Regional Connectivity and Export opportunities	• Competition from Other Renewable Energies

Strengths

(1) Plenty of Wind Resources:

Finland: Finland gets benefitted from its strong wind resources, especially in the Baltic Sea, which provide significant potential for both onshore and offshore wind farms. Finland is capitalizing its great wind resources to decarbonize the power sector and achieve its renewable energy targets (Europe, 2024c).

Europe: Denmark, the United Kingdom, and Germany have established themselves as leaders in the Wind Energy Sector for an extended period and the favourable wind conditions in the North Sea and coastal regions, has played a significant role in the high efficiency of their wind farms also offshore wind is especially strong in these countries for this reason (Europe, 2024c).

(2) Pioneering Technical Advancement:

Finland: Finland's ongoing development of ice resistant wind turbine technologies and energy storage solutions presents opportunities to address the country's net zero 2030 carbon target and lower the costs associated with wind power projects (Huttunen et al. ,2022).

Europe: Top wind power resourced countries such as Denmark and Uk has been leading the Wind Energy industry with floating wind turbines as well as hybrid renewable energy systems which combine wind with other renewable resources like solar and energy storage (Darwish & AL-Dabbagh, 2020).

(3) Strong and Friendly Policy Frameworks

Finland: Finland's National Energy and Climate Strategy supports the growth of wind energy with clear renewable energy targets for carbon neutrality which includes the streamlining of regulatory procedures for onshore and offshore projects and friendly investment incentives (Darwish & AL-Dabbagh, 2020).

Europe: The European Green Deal and policies such as the Contracts for Difference, (European Commission, 2022), Early liberalization of the energy sector in 1989, which was followed by the Non Fossil Fuel Obligation (NFFO) in the UK and the Energiewende in Germany have established strong regulatory support for renewable energy, ensuring long-term stability and encouraging investment.

(4) Environmental and Economic Benefits:

Finland & Europe:

Wind energy is a crucial component in assisting countries in reaching their Net Zero 2050 Carbon Neutrality objectives. It helps reduce greenhouse gas emissions, lessen dependence on imported fossil fuels, and enhance energy security. Furthermore, the wind energy industry has generated a significant number of jobs across Europe. According to Agency (2023), as of 2022, the wind energy sector in Europe employed approximately 402,000 people. And from these, around 319,000 jobs were in the 27 EU Member States (EU-27). The wind energy industry in the EU is expected to grow significantly projecting that employment could reach between 760,000 and 940,000 jobs by 2030, (Statistia, 2024)

Weaknesses:

(1) Initial High Capital Cost

Finland: Offshore wind projects in Finland often demand considerable initial capital expenditure as there is a requirement for technology that can withstand ice buildup and the challenging climatic conditions. So this high cost of infrastructure especially the grid connection is a barrier for wind energy expansion, (International Renewable Energy Agency IRENA, 2020)

Europe: In Europe, Offshore and Onshore wind energy still requires a large amount of capital investment. Even though costs are decreasing, the number of financial resources required can demotivate small countries or companies to set up new wind farms.

According to International Energy Agency (2021), the average cost of installing a wind turbine in Europe cost around 1.23 million euro per megawatt (MW). This includes the cost of the turbine itself, which accounts for about 76% of the total cost, and there are also other costs such as installation, grid connection, market conditions and foundation.

(2) Intermittency and grid integration complexities:

Finland & Europe: Wind energy's inherent intermittency (fluctuating power generation depending on wind conditions) presents challenges for grid stability and energy storage. According to Ayodele and Ogunjuyigbe (2015), The inherent variability of wind energy presents obstacles for maintaining grid stability and managing energy storage requirements. Efficient grid integration requires significant infrastructure investments and technological advancements in for the energy storage which is a big problem.

(3) **Environmental and Social Opposition**:

Finland: There is a local opposition against constructing the wind firms due to visual aspects, noise pollution, and impacts on local biodiversity in Finland (Nysten-Haarala et al., 2021).

Europe: Similarly, in other European countries, local communities have occasionally opposed the development of Onshore Wind Farms due to concerns about the perceived harmful effects of the wind firms on the surrounding landscape and property values (Maleki-Dizaji et al., 2020).

Opportunities:

(1) Expansion of Offshore Wind

Finland: Finland has significant untapped offshore wind potential which is particularly in the Baltic Sea. Advancements in floating offshore wind farm technology and ice-resistant turbines could significantly expand Finland's renewable energy capacity, (Europe, 2024c)

Europe: The European Union aims to increase offshore wind capacity to 111 GW by 2030, which presents massive opportunities for further investment and innovation in the wind energy section, (Europe, 2024c)

(2) Technological advancement and Cost Reduction

Finland: Finland has Continued innovation in ice resistant turbines which can be shown in Tahkoluoto Offshore Wind Firms, as well as advancements in energy storage solutions, notebebly GigaVaasa, (EnergyVaasa, n.d.), are presenting opportunities for Finland to overcome its unique environmental challenges and reduce and reduction of Costs.

(3) Regional Connectivity and Export opportunities

Finland: Finland's strategic location in the Baltic Sea region enables opportunities for cross border collaboration on offshore wind initiatives with other countries in the Baltic Sea area. Additionally, Finland can leverage its technological expertise to export its specialized ice resistant wind turbine solutions to other cold climate regions (Paweł Wróbel, 2024)

Europe: Countries in Europe can cooperate on large-scale offshore wind projects, such as the North Sea Wind Power Hub, which is a collaborative effort from the Netherlands, Germany, and Denmark to construct a giant offshore wind hub that can serve as a gateway for the integration of offshore wind power across Northern Europe (Investu 2018). Moreover, this is an opportunity to tap into export markets for wind energy technology and expertise.

Threats

(1) Geopolitical and Economic Risks:

Finland & Europe:

Geopolitical instabilities, trade disputes, and supply chain disruptions impact the accessibility and pricing of vital materials like steel and rare earth elements that are essential for Wind Turbine Manufacturing projects. Recent war between Russia and Ukraine has significantly amplified these risks for European nations (International Energy Agency, 2022).

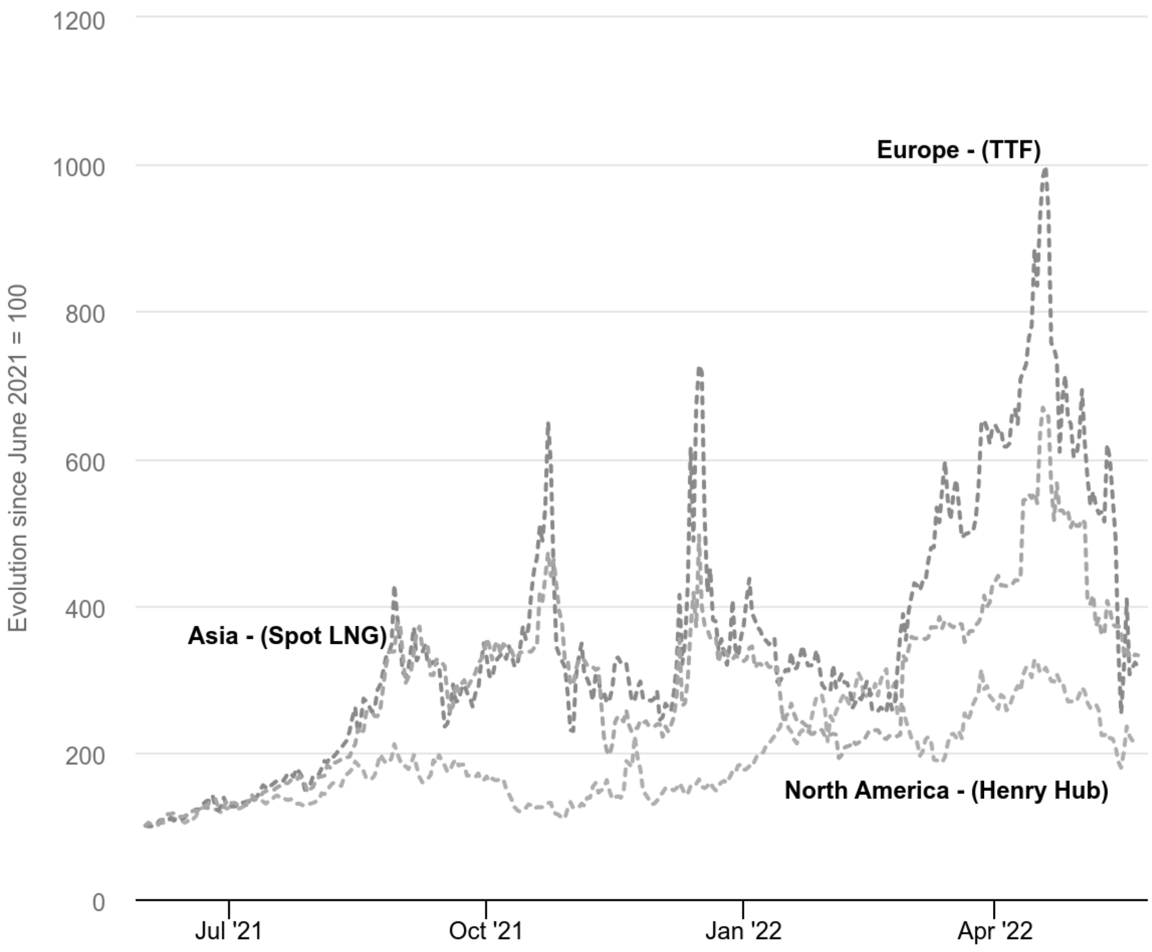


Figure 21. Evolution of key regional natural gas prices, June 2021-October 2022, (*Evolution of Key Regional Natural Gas Prices, June 2021-October 2022 – Charts – Data & Statistics*, 2022)

(2) Environmental Regulations and Permitting Bureaucracy

Finland & Europe:

The hard and stringent environmental regulations as well as the delayed permitting process both pose barriers for the rapid expansion of wind energy in Finland and Europe. These Bureaucratic hurdles can stall the development of both new Onshore and Offshore projects and can increase the overall project costs.

(3) Competition from Other Renewable Energies

Finland & Europe:

The growing focus and investment in other form of renewable energy sources, such as solar, bioenergy, and hydroelectricity are presenting tough competition for wind energy.Though wind energy is dominant in certain areas, it faces competition for resources and political attention from other clean energy technologies (IRENA, 2020).

2.6.7 Finland’s Nuclear Energy Scenario:

Finland recently has inaugurated its largest nuclear power plant, Olkiluoto 3, which is one of the most advanced nuclear reactors in Europe. The plant began regular electricity production in April 2023 after several years of delays (Oyj, 2024).

The Olkiluoto 3, also known as (OL3) Nuclear Plant is a significant milestone in Finland’s energy landscape. Located on Olkiluoto Island in western Finland, OL3 is the third reactor at the Olkiluoto Nuclear Power Plant and is operated by Teollisuuden Voima Oyj (TVO) and it gives the electrical output of approximately 1,600 MW (Oyj, 2024).

This nuclear power plant is anticipated to generate approximately 14% of Finland's total electricity supply, which will significantly bolster the country's energy security and decrease its dependence on fossil fuels. This nuclear facility is a critical component of Finland's strategy to achieve carbon neutrality by 2035 (Oyj, 2024).

2.6.8 EU’s Nuclear Energy Stance:

According to Nuclear Power and Secure Energy Transitions – Analysis - IEA, (2023), the European Union does not have a unified policy on Nuclear Energy, and decisions about the use of nuclear power are made at the national level by member states. While some countries such as Germany, have decided not to pursue nuclear power by 2022, some other countries such as France and Finland have continued to invest in nuclear energy as a key component of their low carbon energy strategies.

2.7 Summary:

In this literature review, methodically work has been done at previous studies on Project Management Techniques and Policies in Renewable Energy industry, especially the wind firm, keeping in mind the European unions larger goals for renewable energy and its Net Zero 2050 aim, where Finland has set ambitious targets for Wind Energy.

Current project management practices in Renewable Energy Emphasize aligning project outcomes with organizational goals. The five phases of Project Management include initiation, planning, execution, monitoring and control, and closure. From the literatures we have found that Effective Project Planning involves identifying community issues, developing a work plan, and estimating funding requirements. Project controls usually mean managing Project Costs and Schedules.

Organizations can mitigate risks in Renewable energy projects in sustainable ways which are risk identification and assessment, stakeholder engagement, project planning and scheduling, Rsource Management, and Risk Monitoring as well as control. Some of the emerging trends in Renewable Energy Project Management include digitalization and technology, Agile methodologies, Sustainability integration, and Global Collaboration.

The Project Management Triangle balances scope, schedule, and cost. Effective cost management is essential in renewable energy projects due to high upfront costs. Furthermore, Earned Value Management or EVM helps evaluate and predict project performance. Quality management is crucial to ensure the reliability and efficiency of technological components. Quality management systems in renewable energy include ISO 9001:2015 and various quality management tools.

The literatures that have been discussed challenges related to the legislative frameworks governing wind energy projects. These challenges often hinder the swift implementation of projects, especially the wind firm projects and affect overall efficiency and compliance with EU directives.

The review includes a comparative analysis of EU guidelines and best practices in Wind Energy Project Management. This analysis provides insights into how Finnish practices align with or diverge from broader EU standards and expectations.

The review also discusses the policy implications of sustainable findings, suggesting potential areas for Legislative and Procedural Improvement to support the growth and effectiveness of the wind energy sector in alignment with EU objectives.

This literature review establishes a solid foundation for understanding the complexities of wind farm project management in Finland. It highlights the gaps in current practices and offers a primary overview of areas where significant improvements can be made to meet the EU's sustainability targets. The insights gained from this review will guide the empirical research phase of the thesis, focusing on identifying and implementing optimal and Efficienct Project Execution strategies and policy modifications in the context of Finnish Wind Farms.

3 Methodology

This chapter of my thesis describes the research technique and methodologies used to conduct this study. The purpose of the research is to look at the ongoing issues of Project Management in Wind farm development in light of the European Union's Net Zero 2050 targets, as well as explore ways to improve the efficiency of these Project Management Processes. Especially the thesis is aiming to identify the critical areas of project management and regulatory hurdles that are critical for the successful execution of Wind Farm projects in Finland, as well as finding immediate improvements that should be made to improve both internal and external processes of Project Management in Wind Firms.

3.1 Research Approach and Strategy:

In this study qualitative research methodologies has been utilized to acquire a thorough knowledge of Project Management processes policies in wind farm building in light of the European Unions Net Zero 2050 ambitions. The thesis approach includes a literature review, interviews with project managers and coordinators, and observations to gather comprehensive data

3.4Qualitative Research

Though Qualitative Research have practical focus, will always have the theoretical part. Firstly, The deductive approach in qualitative research require researchers develop theories based on known concept, seeking empirical responses. After that the findings are compared to the theory to see whether they are aligned. However, qualitative research often takes an inductive strategy which is starting with an individual observation and then gradually progresses into bigger results (Jamshed, 2014).

The inductive process in qualitative research starts with individual observations and progresses to bigger generalizations and hypotheses. It is different from the deductive technique, which begins with a theory and attempts to verify it but the inductive method allows patterns, themes, and insights to emerge organically from the data acquired (Törrönen, 2002). In this study, mainly the Inductive research methodology has been used.

In the qualitative research method, below qualities should be maintained, Denzin and Lincoln (1994: 2)

Table 3. Evaluation Criteria of Qualitative Research

Evaluation of Quality Research:
• Purpose, Context, and Alignment: We need to check the specific purpose, context, aims, questions, design, theoretical concepts, and alignment of the actual study.
• Sampling and Saturation Strategies: We need to evaluate the sampling and saturation strategies, and the representativeness and diversity of the participants.
• Data Collection and Analysis Methods: We need to examine the data collection and data analysis methods, and how the data was reduced or transformed for analysis.
• Interpretation and Presentation of Findings: We need to aassess the interpretation and presentation of the findings, and how they address the research questions and contribute to the existing knowledge.

3.4.1 Literature Review:

The literature study gave an overview of existing studies and works on Wind Farm Project Management, Sustainability Practices, and regulations. By studying academic articles, industry reports, and governmental documents, the study has identified major topics, gaps in current knowledge, and best practices that will drive my paper's later stages.

3.4.2 Case Study:

"A strategy for doing research which involves an empirical investigation of the particular contemporary phenomenon within its real-life context using multiple sources of evidence.", this is the definition of Case Study given by (Robson,1993). The Classification of case studies have been defined by, (Yin,2014), which are Holistic case, Embedded case, Multiple case, and Single case. Because this research focuses on the way of project management in the target company, a single case study of how things are done at Vestas are appropriate and good to go.

3.2.3 Interviews:

The empirical data of the thesis is gathered mainly with interviews. Usually, the nonnumeric data, observations or interviews are considered as qualitative data. All interviewed persons are working Within Project Management in Vestas. To get an extensive view of the maturity of project management, the interviews are aiming to answer the empirical research question: "How can current project management practices in the wind farm industry be optimized to align with the EU's sustainability goals??" and identify existing project management practices, analyse their effectiveness, and propose optimization strategies.

On the other hand, unstructured interviews, lack a defined framework or approach. The unstructured type of interviews usually meanders freely between subjects which requires an interviewer's interpersonal abilities to take interviews. As a result, this strategy was also not used in this thesis.

Semi-structured interviews allow the interviewer to ask extra questions and respond to answers. Semi-structured interviews are formed in such a way that supports the Quantitative analysis. For these reasons, the semi-structured interview approach has been used in this thesis to collect the primary empirical data. (Erikson et al., 2008)

Semi-structured interviews were taken with Vestas project managers and coordinators. The interviews were designed to provide in-depth insights into the practical issues of

Wind Firms, techniques, and experiences of experts regarding the hurdles they have been facing in the sector. The open ended nature of the questions encouraged those who took part in the interview session to portray on the issues, resulting in important qualitative data on project management methods and their alignment with sustainability goals of EU net zero 2050.

3.5Data collection & Process

As written in the previous chapter, empirical data was gathered through interviews with Vestas. The information is gathered from live semi-structured interviews. Eriksson and Kovalainen (2008) describe three types of interviews which are structured interviews, semi-structured interviews, and unstructured, informal, and open interviews. In a structured interview, a framework for organized interviews is carefully developed, and questions are properly established. The questions in each interview session are same, and the purpose is to compare replies. But this thesis does not compare data and is instead looking for responses to questions. So the structured interviews cannot be deemed the best strategy to utilize in interviews.

All interviews have been taken in 2024 and all interviews at the target firm has been done in both live and online. The interviewees from Vestas are from Europe and Finland and included project managers and coordinators. Furthermore, the environment of interviewing scenarios was kept pleasant and open-minded, while interviewers encouraged to provide constructive comments on many topics related to their everyday struggles and problems they have been facing while doing the project management work.

The first step after the interview was to categorize the transcript of the interview with problems identified in the Wind Farm Construction. Every interview transcript has been read through, with an emphasis on the key problems highlighted.

Below are some key highlights of the insights from the interview with Professionals, Rest of the Data will be mentioned in the Findings and Analysis Part

3.5.1 Interview One:

The Experience and background of First Interviewee form Vestas is Presented at the table Below:

Table 4: Designation and Experience of Mr. Pradip Saha

Title	Name	Work experience in Vestas (<1, 1-2, 2-3, 3> Years)	Date Of the Interview
Project Coordinator	Prodip Saha	2-3 Years	27.03.2024

Mr. Pradip, who is currently has more than 2 years of Experience working as a Project Coordinator in Vestas, Vaasa, has given data regarding Price Indexation, Labour and Skills Gap, the supply chain Problem where Vestas is having a hard time while competing with cheaper Competition while keeping the Quality Up and the complexity of Permitting and Legislative process in Finland and other European countries. He has discussed about the supply chain problem for bringing the components from Overseas as there are not enough local manufacturers around Europe which creates price escalations and delays in project execution.

The questions were asked also about the current Geopolitical Crisis, Policy recommendations Vestas and other Finnish Wind Farm Companies would like to see, his take on the Emerging Technologies and possible hurdles to integrate those technologies, personal Experiences that he has faced during the Project Completion as well as their Company take on Futuristic Technology such as Offshore Wind Farms in Finland.

When I asked him about the Vestas Vision on Aligning with Europe’s Goal of Utilizing the Sea Basins, he Replied

"Vestas is very much looking forward to the opportunities presented by this goal. That's why, as I mentioned, we have recently started an offshore manufacturing plant in Poland. This new facility will play a critical role in supporting the production and deployment of offshore wind turbines across Europe."

3.5.2 Interview Two:

The Experience and background of Second Interviewee form Vestas is Presented at the table Below:

Table 5: Designation and Experience of Anders Ahlqvist

Title	Name	Work experience in Vestas (<1, 1-2, 2-3, 3> Years)	Date Of the Interview
Associate Project Manager	Anders Ahlqvist	3> Years	28.05.2024

Anders Ahlqvist, who is currently working as a associate Project Manager at Vestas Vaasa and his expertise mainly lies in the Onshore Wind. He has shared his experience Regarding Supply Chain issue, the Grid Infrastructure Issues, the Need for Friendly Governmental Policy, Project Lifecycle steps from Vestas

He also Reflected Upon the other Various Aspects of the Wind Farm Projects which are the Environmental Concerns, Waste Management and Stakeholder Management.

Anders Reflected the commitment towards Sustainibility of Wind Farms by mentioning

“And I I think sometimes people don't realize that if we build a wind farm, we are replacing maybe coal as as an alternative”

3.5.3 Interview Three

The Experience and background of third Interviewee form Vestas is Presented at the table Below:

Table 6: Designation and Experience of Nicolás Oviedo

Title	Name	Work experience in Vestas (<1, 1-2, 2-3, 3> Years)	Date Of the Interview
Project Manager	Nicolás Oviedo	3> Years	19.07.2024

Nicolás Oviedo, who is a Project Manager for Vestas based on Germany, but he reports to Finland and Sweden Region Mainly.

In the Interview, he mainly focused on the topics of Land Use Permit in Germany, the Gnatt Chart System of Vestas for Project Management, Stage Gate and also the Exceptional Growth of Wind Energy which is Creating a need for standardized Project Management Frameworks.

The question topic was also on the Risk Management and Efficient Project Management Practices. While Asking what could be the best Project Management Advice he Could give as a Project Manager, he mentioned

“Basically, they key point for the project management position or pushing management role is secure communication, defined expectations, define a framework, define what needs to be done, communicated properly and keep the communication. Ongoing throughout the project, I yeah, I'm passionate about communication to be honest, and I think that is the key point”

3.6 Data analysis

Data analysis is the step in which the intended data is gathered. The goal of data analysis is to observe acquired evidence in the appropriate manner while avoiding bias. To properly Analyse Data, Complete Impartiality in the analysis step is essential. Data reduction in a data analysis is the term that refers to the process of sorting, reorganizing, and concentrating data. There are no hard and fast rules for selecting analytic methodologies. Analyses should be performed not only in one phase, but also in numerous stages during qualitative research, as data is usually collected in multiple phases and simultaneously utilizing diverse methodologies. So, data is collected and analyzed continuously (Yu et al., 2014).

This thesis followed the standard approach, and the analysis has been performed simultaneously. The main data gathering was conducted methodically. Although the interviews are done sequentially, the process has been developing such as the results of the first interview were considered for the second and so forth. The Data for the Gnatt Chart was done from the Sample model given by Vestas and from the literatures. For the Gnatt Chart Analysis and Outline, Excel Software was used.

3.7 Reliability and Validity:

Qualitative research is one of the best technique for investigating processes when professionals are strongly involved in their everyday working. According to Yin (2016), it is easy for the researchers with qualitative research to see what professionals are facing everyday. Conversely, validity refers to an indicator's or research method's ability to measure exactly what it was designed to measure.

All respondent was experienced in are of project management and each one had an educational background from project management and respondent were answering questions related to their personal experience and observations. To guarantee authenticity and credibility, all the literature cited was gathered from official academic publications, published books by well-known authority, magazines, websites and newspapers. As the cited materials are from some globally recognized publications and authors, so it can be trusted. Interview questions were different in the each interview, and the interviewee's knowledge was guaranteed, there have been always some additional questions and extra explanation have been provided if the question was not properly understood by the interviewee.

3.8 Observations

Observations have been carried out through the interviews and the documentation regarding the various stages of wind firm project management so that there can be a through idea regarding the process and challenges of wind firm project management efficiency and policies in the implementation of project management practices, how team members work as well as how external factors affect the wind firm project management.

4 Research Findings and analysis

4.1 Case Company

The case company, Vestas, is presented in this chapter, and its overall project management structure is outlined. Following the introduction, the key results from interviews with Vestas Project Managers and Coordinators are given. Direct quotations from the interviews are presented to increase openness and provide a fuller understanding of the respondents' opinions regarding the project management. At the end of this chapter, the findings are examined and compared to existing literature in order to draw significant conclusions regarding wind Firm Project Management in Vestas

Vestas Wind Systems A/S is a multinational firm which is currently operating in 87 countries. Since its inception in 1945, Vestas has emerged as the world's leader in sustainable energy solutions. The fact that they have installed more wind firms in countries than any other firm, just backs up their commitment EU net Zero 2050. According to the Vestas Wind Systems A/S (2023), The firm is situated in Denmark, with its main headquarters in Aarhus. Vestas Wind Systems A/S employs around 28,000 people worldwide, which allows them to focus on its core business of Wind Turbine Design, Project Development, Production, Installation, and Operation.

As of 2024 the company has installed more than 179 GW of wind power in a total of 87 countries fulfilling the stated purpose of Vestas, “to make the world a better a better place and to contribute to a sustainable future” (Vestas, 2023).

“I think the best is being the global leader in this industry. Vestas is playing a vital role in supplying more and more wind turbines than any other company is supplying basically”,

Project Coordinator from Vestas mentioned in the interview.

Similarly in Finland, though their Footsteps are comparatively new in this country, they are working closely with the local stakeholders such as Vestas received a 135 MW order from Ilmatar Energy Oy for Four projects in Finland which includes the supply, commissioning and servicing of the wind turbines to ensure their performance over the time. With their experience in Cold Weather Technology and Advanced Construction Techniques such as Automatic Positioning System, Vestas has played a crucial role in Overcoming many Challenges faced by the Wind Energy development in Finland to achieve the Carbon Neutral Target (Vestas, 2022).

Sustainability strategy and performance

Our sustainability strategy, titled "Sustainability in Everything We Do", consists of four key pillars and is based on a materiality assessment of issues critical to our stakeholders.

Carbon neutral in own operations and 45% reduction in supply chain emissions intensity by 2030	Production of zero waste wind turbines by 2040	The safest, most inclusive, and socially responsible company in the energy industry	Leading the transition to a world powered by renewable energy
Emissions from own operations (scope 1 and 2) (k tonnes): 109 (2023), 100 (2022)	Material efficiency (tonnes of waste excl. recycled per MW produced and shipped): 1.2 (2023), 1.6 (2022)	Injury rate (Total Recordable Injuries per million working hours): 3.0 (2023), 3.3 (2022)	Green energy R&D (EURm): 500 (2023), 514 (2022)
Emissions from supply chain (scope 3) (kg/MWh generated): 6.30 (2023), 6.46 (2022)	Refurbished component utilisation (%): 17 (2023), 17 (2022)	Women in leadership positions (%): 24 (2023), 23 (2022)	Installed turbines (GW): 13 (2023), 13 (2022)
Expected emissions avoided (turbines produced and shipped) (m tonnes): 396 (2023), 408 (2022)	Materials recycled (%): 68 (2023), 55 (2022)	Community beneficiaries reached (thousand): 9.8 (2023), 7.6 (2022)	Political engagement: Helped boost a sustainable wind industry with enactment of the EU Wind Power Package
For initiatives linked to reducing greenhouse gas emissions, see pages 15-22. For further information on calculating emissions avoided, see page 21.	For initiatives linked to design for circularity, see pages 27-31. For initiatives linked to operational circularity, see page 30. For initiatives linked to material recovery, see page 31.	For initiatives linked to health and safety, see pages 35-36. For initiatives linked to diversity, equity, inclusion, and belonging, see pages 41-42. For initiatives linked to social responsibility, see pages 43-53.	For initiatives linked to political engagement, see pages 54-55.

Vestas Sustainability Report 2023 7

Figure 22: Vestas Sustainibility Reports 2023, (Vestas, 2023a)

4.4 Findings:

This chapter provides the analysis and conclusions of two research questions on project management methods From Wind farm Projects in Finland and. This study is based on data acquired using Qualitative Approaches, which are mainly Literature Review, Interviews With Project Managers and Coordinators from Vestas, and observations. The goal is to identify Project Management issues and possibilities as well as increase the efficiency in the wind farm business, which are necessary to obtain Euro Net Zero 2050 goal

The Project management Issues that this thesis will talk about are as below:

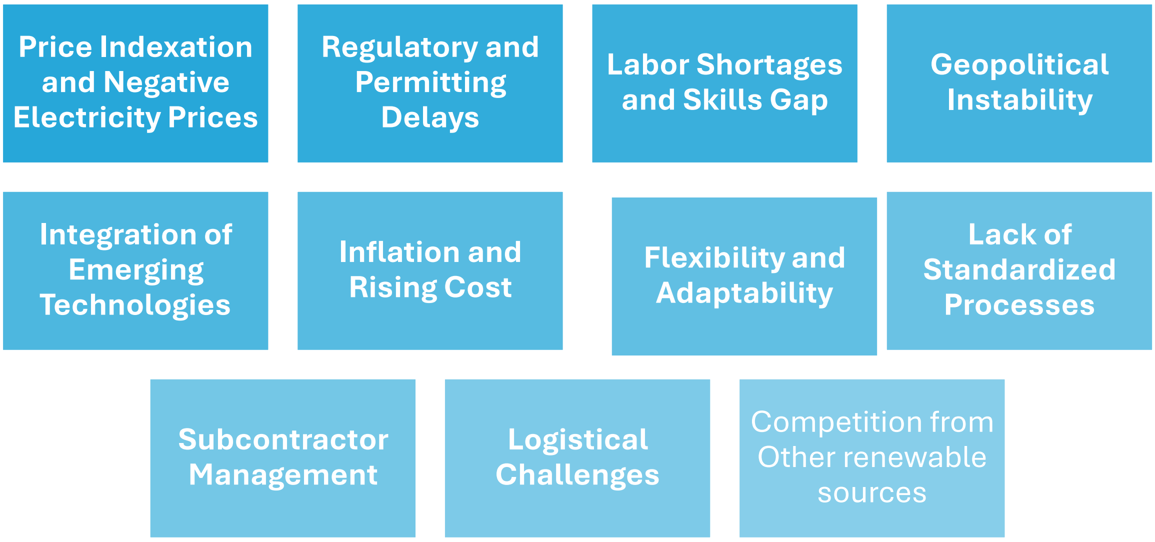


Figure 23: Wind Farm Project Management Challanges

4.4.1 Regulatory and Permitting Delays

Delays in regulatory and permitting processes pose significant challenges to the Wind Energy industry in Europe and Finland (Wind Power Construction, n.d.). These delays are sometimes caused by complicated and variable criteria across many countries, making it difficult for Wind Firm Construction companies like as Vestas to secure the appropriate licenses on time. One Associate Project Manager from Vestas Mentioned, "*In Scotland, there is a traffic permit that needs to be applied for special transports for carrying wind turbine components. The difference is that in Scotland, they need police transport for the special transports, so the police needs to be involved and they need to have resources allocated*."

In Finland, the legal framework necessitates receiving approval from several agencies, that includes municipalities, transportation authorities, and tax offices. Each of these Authorities has their own standards and approval timeline that varies greatly and create challenges for Wind Firms.

These delays can have a profound impact on Project timelines and costs. For instance, a project scheduled to start in Spring might be pushed to Late Summer or even the next year if permits are not secured on time. This not only increases costs but also affects the project's financial viability and alignment with strategic goals.

"Last year, when we applied for two site managers for a site, one site manager was rejected, and we had to replace him with another site manager. This required us to reassign from one project to another.", Project coordinator from Vestas, Vaasa noted. He also motioned whenever Vestas or some other company have to apply for a site manager coming from outside Finland, there is a tax liability and reporting requirement. This tax process is very difficult and often complex. So if some company want to take someone from a nearby country to Finland, they need to have a Finnish tax number because the employee needs to be tax compliant, and of course, Vestas or the company who is hiring, needs to be tax compliant for that specific worker", Project Coordinator of Vestas Noted at the Interview.

During the interview, the project Coordinator of Vestas mentioned, *"The permitting process in Germany can take up to 18 months, which significantly delays our project timelines. We have had to reallocate resources multiple times due to these uncertainties."*

This problem can be tackled with the below measures

(1) Proactive Engagement with Regulatory Bodies: According to (Kibet & Senaji, 2024), engaging regulatory authorities early and continuously is crucial to understanding the Necessary Requirements and expediting the approval process,. This usually involves regular communication with municipalities, transport authorities, and tax offices to ensure all necessary documentation is prepared and submitted well in advance to avoid any kind of delays.

(2) Centralized Database Especially for Permit Tracking: Establishing a centralized database to track permit applications and regulatory requirements can facilitate the management and monitoring of diverse permits for different nationals while ensuring timely follow-ups and mitigating the risk of missed deadlines for important permits, (Project Management Institute, 2020)

(3) Automation Tools: Using Project management software with automation features to send reminders and track application statuses, and many of the companies using latest project management tools such as Microsoft Project, Microsoft Teams to automate the permitting process.

(4) Dedicated Regulatory Compliance Teams: Organizations should establish dedicated teams responsible for managing regulatory compliance and permit applications which would be according to the need of different countries. These teams should be trained and should be lead by people who know how to navigate the regulatory landscape efficiently and address any issues as soon as possible (Renewable Energy World, 2019).

(5) Resource Allocation: Organizations need to distribute sufficient resources to these teams to ensure they can handle the workload and maintain good relationships through the process with regulatory bodies in the respective countries.

(6) Standardized Documentation and Templates: The development and implementation of standardized documentation and permit application templates can promote consistency and thoroughness in permit submission materials and increasing the transparency, (*WindEurope - the Voice of the Wind Energy Industry*, 2016)

(7) Sharing Best Practices: Another solution would be sharing best practices and standardized procedures across projects and countries to improve efficiency.

For example, one Associate Project Manager from the Vestas, Vaasa has quoted *"I have a hard time finding examples of permission and policies that are actually out challenge for us"*

4.4.2 Price Indexation and Negative Electricity Prices:

When Low Electricity demand occurs, especially in the summer, when the demand is low, electricity prices can drop significantly which can lead to electricity price become negative. This happens when the supply of Electricity exceeds the demand and leads to situations where producers have to pay consumers to take the excess electricity.

This scenario introduces Financial Instability for wind energy companies such as Vestas as they continue to bear maintenance and operational costs without receiving compensation from their Electricity sales.

The occurrence of Negative or Significantly reduced electricity prices can severely affect the financial stability of wind energy companies. These Market occurrences constrain the ability of these organizations to regain their expenditures, thereby Adversely affecting their revenue streams and overall financial well being of the company as they still have to cover the costs of Maintaining and Operating wind turbines, and when they cannot sell Electricity at a profitable rate, it creates economic challenges. Additionally, the increasing cost of wind turbine components further Exacerbates this issue which leads to higher operational costs that the Electricity Sales cannot cover.

During the interview, the project coordinator noted,

"During the summer times, when the electricity demand is not too high compared to the winter times, then the price of the electricity goes really, really low. Sometimes it is minus. So if you have been using any electricity from some company, for example, you will see that the electricity prices are really minus, which means that the company is not really charging any electricity price to you at all."

Another important point he mentioned was, *"When the company who are buying the electricity from the companies who are constructing the wind farms, that is a problem because if you are in a business selling electricity and you are not getting any price for a couple of months, it is a big issue."*

In the Interview, another important issue was highlighted which is the rising costs of wind turbine components, *"Wind turbine is getting more and more expensive than it used to be before. This is also another thing that customers will suffer from by paying high costs of the electricity."*

To Tackle this problem, below solutions can be implemented

Figure 24: Solution Model for Price Indexation and Negative Electricity Prices

Flexible Power Purchase Agreement or PPAs can be developed that can align Electricity prices with market demand which can stabilize the Revenue Flow when Low Demand occurs. Long term contracts can be secured with fixed prices to ensure stable income streams despite the Electricity Market Fluctuations (Renewable Energy World, 2019a).

For the Energy Storage Solutions, implementing Battery Storage Systems can enable the capture and storage of Surplus Energy Produced during periods of Low Demand. This

Stored Energy can be sold during the period of High Demand when Energy Prices are on Rise.

Grid Storage Solutions can be used to balance supply and demand, so that the Excess Energy for Renewables can be stored and released as needed.

The Giga Vaasa industrial project in Vaasa, Finland, is emerging as a significant hub for Energy Storage Solutions, which is not only playing a crucial role in the transition to Renewable Energy in Europe. The Gigaavasa project is mainly focused On Advanced Battery Energy Storage System so that Finland can be the energy leader implementing Euro Net Zero 2050 target

"In Vaasa we aim to be a carbon neutral city by 202x.", (*Gigavaasa*, n.d.)

One of the leading companies in the Gigavaasa is FREYR Battery, which focuses on producing Sustainable Battery Cells with a low carbon footprint to store this Excess Electricity supply that is being generated by the Wind Turbines (*Decarbonizing Transportation and Energy Systems...*, n.d.). Also, The University of Vaasa, (*Vaasan Yliopisto*, n.d.) and VTT Technical Research Centre of Finland, (*Welcome to VTT | VTT*, n.d.) are involved in several joint projects aimed at improving battery performance and developing New Storage Technologies.

4.4.3 Inflation and Rising Costs:

The rising costs of materials and construction due to inflation significantly affect the overall budget of Wind Farm Projects.

Inflation is one of the main reasons for the increased costs of Wind Firms due to the rising cost of materials and construction. According to recent reports, inflation has increased the costs of Wind Farm Projects by 20-30% (Seetharaman et al., 2019)

This issue is Exacerbated by Price Competition, where some companies can offer turbines at lower prices which makes it challenging for companies like Vestas to Compete while maintaining Quality Standards.

In the interview, the Project Coordinator from Vestas explained,

“And you know, we have a lot of competitors now. There are Chinese wind turbines that's in the market”

Higher Costs may lead to more expensive projects, which can rise the rate of and decrease the rate of new wind farm installations. Customers may opt for Cheaper Alternatives, even if they are of Lower Quality because of the Budget Constraints. This adversely impacts both the Financial Sustainability of Project Marketing and the competitive advantage of companies like Vestas in the market. *"So they are selling the turbines at a much cheaper price than Vestas. But for Vestas, we are not really in a position to sell our turbines at a cheaper price because we do sell quality products, and this is also a challenge we are facing in Finland and around Europe."* (S. Pradip, personal interview, 03.05.2024)

He further added, *"Customers sometimes prefer other investors because they think Vestas is expensive. We believe we are selling a quality product that results in fewer problems and a very strong service support system. From that point of view, the customer will have fewer loss production hours (LPH) and higher efficiency."*

This inflation Problem can be tackled following the below strategies

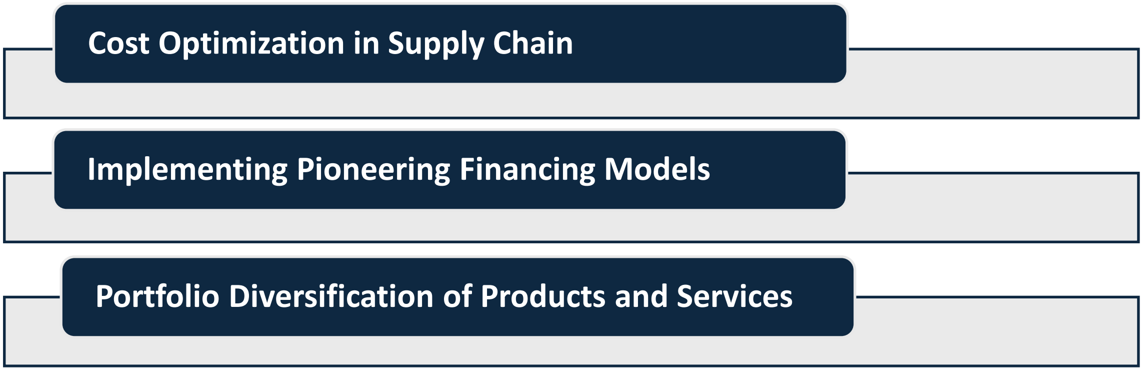


Figure 25: Solutions for Inflation Problem

For making a Cost Optimization in Supply Chain, a strategic collaboration with suppliers can enable the negotiation of more favourable pricing terms for the Wind Firm components and secure a consistent supply of required materials. This may involve the implementation of long-term contractual agreements and the bulk purchasing agreements can be arranged.

Another important step of Lean Manufacturing can be Lean Manufacturing. Companie can Implement Lean Manufacturing Principles to reduce Waste and increase Efficiency in Production Processes which could turn down the cost a lot (Kumar et al., 2013).

In the Finance Models, the use of Green Bonds and other sustainable financing ways to can be a good way to secure capital for Wind Farm Development Projects (Lee & Zhong, 2015). Moreover, European Unions can give subsidy to this sector to implement Net Zero 2050 targets. Engaging in Public-Private Partnerships to share the financial burden of Wind Farm Projects could compensate Public Funds and Incentives (Zhao et al., 2022).

For Diversifying the Portfolio of Products and Services for Wind Farm Construction Companies such as Vestas, they can offer comprehensive service packages such as maintenance, monitoring, and optimization services which can add value and differentiates companies such as Vestas from competitors.

Another great solution can be Modification of the Products where Companies can Develop customized turbine offerings that could cater to the specific requirements of each customer which would enable the validation of Premium Pricing based on the tailored advantages provided (*Clean Energy Wire*, n.d.).

4.4.4 Labor Shortages and Skills Gap

In Finland, there is a shortage of Skilled labours especially in the fields of Wind Farm Constructions, installations and maintenance. According to the Vestas Project Coordinator*, "We always need more technicians on site, and we struggle a lot to find them locally."*

And this is a problem as the Wind Farm construction companies need to hire them from outside Finland which adds to the time and cost (Wind energy and employment, 2023)

Another big problem is that the requirement for Finnish language skills which limits the pool of talents even further. Most of the energy courses in Finland are conducted in Finnish language which further exacerbates the problem.

This reliance on foreign labour and expertise is significantly increasing project costs due to higher recruitment and logistics expenses. The need for Finnish language proficiency among technicians and engineers is also limiting the available talent pool, making it more challenging to find qualified professionals. This issue delays in project timelines and increases operational complexity to obtain Net Zero 2050.

The main initiatives can be taken in this regard are

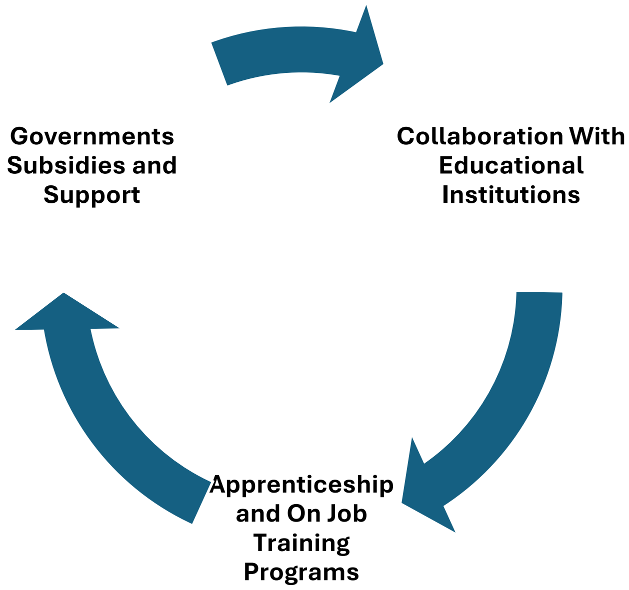


Figure 26: A roadmap for the Labor Shortages and Skill Gap Problem Solution

Companies such as Vestas can collaborate with Educational Institutions to develop Specialized Training Programs in Wind Energy and Renewable Energy Technologies, that could focus on wind farm construction and maintenance.

For this Companies need to Establish partnerships with Universities, Polytechnic Institutes, and Vocational Schools to create Degree Programs and Certifications that are specifically tailored to the needs of the wind energy sector which should be offered in both Finnish and English to attract students from different diversities.

For internships and On Job Training Program Wind Energy Farms can arrange paid internships and training that would allow the students and the young professionals to gain practical hands on experiences (Goh et al., 2014).

Wind firm organizations can Establish Structured Apprenticeship Initiatives that would enable young students and trainees to get direct Practical Training in Wind Farm or other renewable projects under the guidance of Seasoned Industry Experts. This approach will empower them to acquire practical expertise while addressing the pressing Labour and Expert requirements of the industry.

The Governments Subsidies and Support is crucial to promote the development and employment of skilled workers in the renewable energy field especially in the Wind firm Construction Field that supports the EU net Zero 2050 goals.

The government could offer Tax Incentives for companies that invest in Training And Development programs related to renewable energy. Governments can make a fund for the students who is pursuing studies in this field as well as can patronize specific training or certification programs (White et al., 2013).

During the interview, the Project Coordinator mentioned, *"Most of the courses are in Finnish, and when wind farm companies ask for a technician, they most often require Finnish language skills. This restricts the pool of available candidates significantly."*

The Project Coordinator further added, *"There are not many specific degree programs focused on wind turbines and renewables at the university level, especially not in English. This gap in education and training makes it harder to find local and qualified experts for wind farm projects."*

The Finnish Government has already taken policies such as Incentives and Support for Renewable Energy Workforce Development that could be a role model for other countries in pursuing the Net Zero Goal

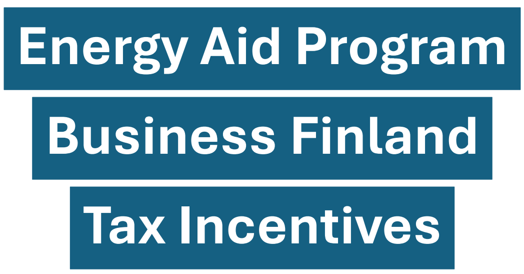


Figure 27: Initiative of The Finnish Government to Improve Labour Shortages and Skill Gap

For the case study, The Project Coordinator mentioned that the Finnish government and rules are very supportive and encouraging towards the growth of wind power sector.

The Finnish government has taken initiative through the Energy Aid Program to companies investing in Energy Efficiency and Renewable Energy Projects which includes support for training programs and the development of a skilled workforce in the Renewable Energy Sector.

The Energy Aid Program allows renewable energy companies to receive financial assistance of up to 30% of the costs for training programs that are specifically focused on improving energy efficiency and transitioning to renewable energy technologies (Energy and Investment Aid - Ministry of Economic Affairs and Employment, n.d.)

Innovation Funding through Business Finland, a Public Organization under the Finnish Ministry of Employment and the Economy, provides funding and support for innovation in renewable energy. which includes grants and loans for projects focusing on training, research, and development in the wind energy sector, Companies involved in renewable energy can apply for funding to develop new technologies and training programs that could enhance Workforce Skills. Additionally Business Finland also support the collaboration between the Universities and Wind Energy companies for Research and Development, (Mörk, 2021)

Finnish companies that invest in training and upskilling their employees In Renewable Energy Technologies, including Wind Energy, may be eligible for tax incentives. These tax subsides are designed in a way that could compensate the training cost for the companies, (*Finnish Tax Administration's Year 2021*, n.d.)

In the process, companies can claim deductions for expenses related to employee training and development, particularly in areas that contribute to the transition to renewable energy.

4.4.5 Integration of Emerging Technologies

Offshore wind Energy is one of the most important emerging renewable energy technologies that can contribute significantly to the EU's net zero emissions goal by 2050. As in the literature section, I have already discussed about the guidelines and policies the EU has put in place to support the offshore wind sector and the challenges.

And the Offshore Wind is important for Several reasons. Notably High Energy Potential. As Offshore wind has the potential to generate vast amounts of Clean Energy due to the Higher and more Consistent Wind Speeds available at sea compared to onshore locations. The coastline of Europe is very big with coastline that can generate excellent wind resources such as in the North Sea, Baltic Sea, and the Atlantic Ocean Bilgili et al. (2011).

According to Europe (2017), Offshore wind farms can be built on a much larger scale than onshore ones which can enable a large portion of EU electricity demand. This scalability is important for the transition to renewable energy system by 2050. The EU's Net Zero 2050 target requires a drastic reduction in greenhouse gas emissions across in all sectors including the energy Sector. Offshore wind energy is estimated to have an emissions intensity of 10-11 g CO_2/kWh, compared to around 500 to 1000 g CO_2/kWh for fossil fuel generation (COMMISSION, 2023).

Offshore wind has the ability to supply energy in aligned with the other type of Energy sources such as solar and the onshore wind. and this diversity helps to ensure a reliable and continuous energy supply which is a must for decarbonizing the energy sector (Fernández-Guillamón et al., 2019).

The offshore wind business creates jobs for locals such as in Construction, building the wind farms, Running the equipment, and in maintenance, which contributes to the Eu green Deal and its goal of creating local green jobs.

Moreover, The placement of Offshore Wind Farms near coastal population helps to reduce energy transmission losses and supports the establishment of a Decentralized and Resilient electricity grid (Feltes et al., 2012). Furthermore, these wind farms can be integrated into cross border grid energy networks which is aligned with the EU's objectives for a Connected and Flexible energy system. As Significant investment In Grid Infrastructure, such as subsea cables and interconnectors are necessary to facilitate the deployment of Offshore wind farms, the investment not only supports the Construction of Offshore Wind but also enhances the overall Flexibility and Capacity of the European Electricity Grid.

Advancing in the Offshore Wind Energy Initiatives enables the EU to claim position as a global leader in Renewable Energy Technologies. The total amount of offshore wind power in EU, as of 2023, was approximately 30 GW, which is spread across several countries, with the United Kingdom, Germany, and the Netherlands being the largest contributor. This allowed the EU to establish industry standards and catalyse international climate action efforts (Europe, 2024b)

As Project Coordinator from Vestas Mentioned:

"that's the futuristic goal of European Commission that they have a vision for the accelerated deployment of offshore wind funds. They want to the Commission, want to deploy more and more in the whole, you know, whole Europe and five European biggest sea basins"

Finland is Relatively Newcomer to Offshore Wind Energy compared to other European countries such as the UK, Germany, and Denmark which have been leading the offshore wind industry in Europe for years. But now Finland is taking steps to be in the development of the offshore wind sector. Below is a comparison between offshore wind power among the European Countries:

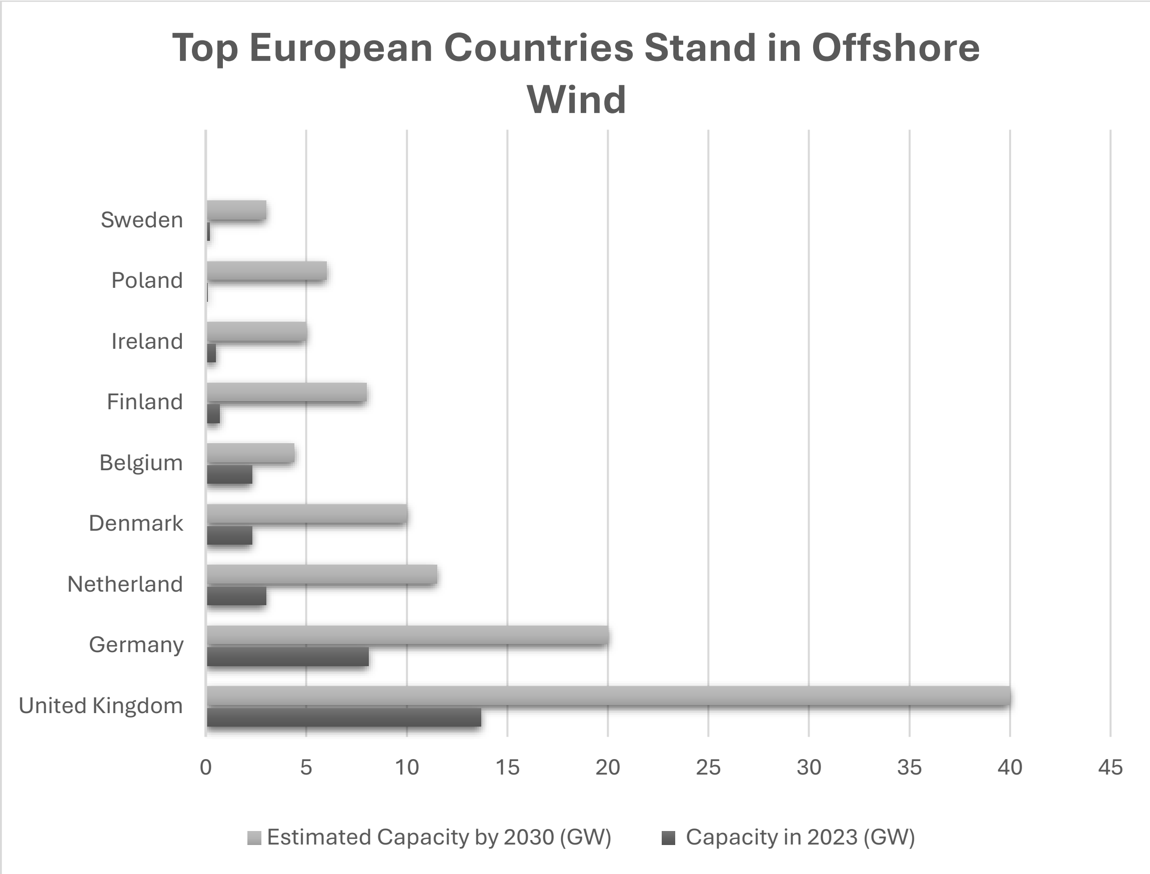


Figure 28. Offshore Wind Scenario in European Countries, (Europe, 2024c)

Though the Finnish Wind Capacity is smaller comparatively to the other European countries, Finland has also started its journey in the offshore wind with the Tahkoluoto wind farm and plans to significantly increase its offshore wind capacity in the coming years to contribute in the Renewable Energy Goals.

Finland has taken ambitious plans to expand its Offshore Wind Capacity Projects. The Finnish government has set targets to significantly increase offshore wind installations, with several large-scale projects in the pipeline by 2030 which can be a role model for other Countries for Integration of Technologies such as Offshore Wind. Such two notable Finnish Supremacy in Offshore Technology are

(1) **Ice-Resistant Technology**:

Finland has proved itself a pioneer in developing offshore wind technology in the cold and icy conditions of the Baltic Sea with Tahkoluoto wind Firm. According to Aslani et al. (2013), Finland has long been at the forefront of adopting various alternative energy technologies, especially in Biomass and Hydropower.

Finland is also exploring the potential of Floating Offshore Wind Farms Projects that can be significant for the country's Offshore wind capacity in deeper waters of the Baltic Sea (*FLOATING OFFSHORE WIND ENERGY -A POLICY BLUEPRINT for EUROPE FLOATING OFFSHORE WIND ENERGY,* 2019).

(2) **Environmental and Geographical Considerations**

Finland's position in the Baltic Sea, with its Shallow Waters and Consistent Wind Conditions, is beneficial for the advancement of offshore wind firms. But the presence of Ice During the winter months possess unique challenges but technological advancement making a big role for that. Finland places a strong emphasis on researches that have been conducted on minimizing the environmental impact of Offshore Wind Projects. This includes consideration regarding Marine Biodiversity, Residential Property Prices, and coordination with other Maritime Activities like shipping and fishing as well as regarding the Health Problems (Jenkins et al., 2022).

Companies Such as Vestas are concerned Regarding this issue, as during the interview, Associate Project Manager from Vestas Vaasa Mentioned

" So we have a lot of metal and also some wood waste actually because we get a lot of these wooden crates with the parts shipped to site.So there's a lot of carboard lot of wood and some metal waste. We need to expose of and we usually hire that the local waste management companies, but we need to need to report to the authorities what kind of waste is produced from the site"

For the Case study of the Integration of Offshore Wind Farms, we can consider the Pioneer the only Finnish Wind Farm Tahkoluoto. This Unique Offshore Wind Farm Faced Several Challenges but emerged as a successful Project.

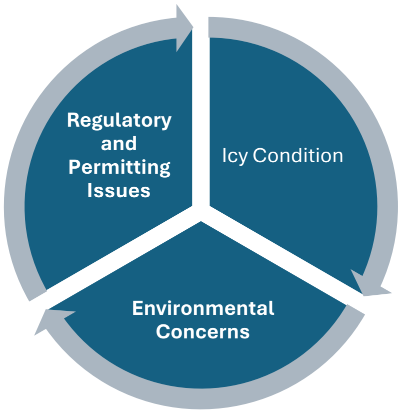


Figure 29: Challenges Tahkoluoto Offshore Windfarm Faced During Construction

The Tahkoluoto Offshore Wind Farm which is located off the coast of Pori, Finland, is notable for being the World's First Offshore Wind Farm designed for Icy Conditions.

The Tahkoluoto offshore wind farm, developed by Suomen Hyötytuuli, Pilot operations began in 2010, and the wind farm became fully operational in 2017. Recently, an extension project has been approved that would add Forty wind turbines exceeding 15 megawatts each, will be located Northeast of the current wind farm. This extension is expected to be completed by 2027 and produce an estimated annual output of 2000 gigawatt hours.

The most significant challenge during the construction of Tahkoluoto was dealing with the Harsh Icy conditions in the Baltic Sea. In this region Ice flow and the Sub Zero temperature was very common which required a Specialized design and Construction methods to ensure the wind turbines can withstand these harsh conditions.

The solution came as Wind turbines of this project used a Jacket Type foundation equipped with robust pieces to counter the ice loads. Also the creation of Monopile

Foundations capable of Resisting ice was a vital development that allowed the turbines to tolerate the Physical Pressures exerted by floating ice (Panfilov, 2018).

Protecting the Marine Environment during construction was a major concern. This project had to be careful about many important aspects of the environment which include birds, marine life and natural landscapes.

Widespread environmental impact analyses were performed prior to the construction, and mitigation strategies were employed to reduce the offshore project's influence on marine habitats, which included close monitoring of wildlife during construction and operation phases, (Hyötytuuli, 2023)

Securing the Necessary Permits and Navigating Through the regulatory landscape presented challenges, particularly due to the novel nature of the project. As this Tahkoluoto Offshore Wind Firm was the first of its kind, it required a through review process that met the Finnish and EU standards.

But the Solution was smooth and Hassel free as project team closely collaborated with Finnish authorities and strictly adhered to Environmental And Safety Regulations and these proved to be pivotal in addressing these challenges. Furthermore, this project established a role model for the future Offshore Wind developments in the Similar environments, (Hyötytuuli, 2023)

Another Technological Problem came out while Interview is the Wind Sensitivity in Blade Installation**.** Wind turbine blades are highly sensitive to wind conditions, especially when the lifting and installation phase happens. The big wind turbine blades are highly vulnerable to powerful wind forces during the lifting and installation process. Keeping these blades stable and properly aligned with the turbine hub while putting them in place presents a significant challenge for the construction companies. This issue becomes even more problematic in the winter months when wind conditions are often unpredictable. Wind movements can result in blade misalignment, cause delays in the installation work, and can pose safety risks to the technicians working on site (Afzal & Virk, 2018)

Anders Matias Ahlqvist, Project Coordinator at Vestas, explained,

" The blades are, of course very, very keen to take, let's say they it's a lot of wind impacting the blades. So when we are actually lifting the blades, they are very sensitive to to wins and it's it's greater challenge to actually install the blades to the to the wind turbine as they are moving about and it's difficult to exactly attach the bolts to the knots."

For solving this challenge, Vestas has introduced a new system called Automatic Positioning System. This consists of two rotors which are attached to each end of the Wind Turbine blades. And technicians will be able to adjust the speed of these rotors which will enable the blades to counter react the wind forces impacting the blade.

Ahlqvist highlighted the innovation beautifully

"We use a system called Automatic Positioning System, which places two large fans on each end of the blade. These fans are controlled wirelessly, allowing us to counteract the wind and stabilize the blade much more effectively than before."

4.4.6 Analysis of Flexibility, Adaptability, and Lack of Standardized Processes in Wind Farm Project Management:

In the Interview with Vestas Project Managers and Coordinators, several problems were identified in the versatile efficiency and effectiveness of the Project management Sector. The Conversation Highlights the below Problems going on in the Wind Farm Project Management:

Figure 30: Currently Ongoing Project management Problems

(1) Flexibility and Adaptibility:

As the Wind Energy industry is experiencing rapid growth over the last few decades, there has been an increasing demand for flexible Project Management Strategies. Flexibility is crucial in addressing the challenges posed by new technologies, Different Regulatory Body In Different Countries and Changing Environmental Regulations.

(2) Lack Of Standardized Process:

During the Interview, the Project Coordinator highlighted a challange of having lack of a Clear, Standardized Process for managing Wind Farm Projects, as this is a rapidly growing and evolving industry. And also, there is no specific guidelines for the Offshore Wind Farm Project Management.

(3) Dependencies On Subcontractors:

The Wind Farm Construction Companies depend on subcontractors to a large extent in the different phases of Wind Farm. Important tasks such As Transporting Materials to Handling Installation are usually done by Subcontractors.

As the Vestas Project Manager Mentioned, "*We start engaging with the subcontractors during the planning phase. Subcontractors are a huge part of Vestas structure for projects. as best as we are, we have a lot of own factories. We have, of course, own research and development. We have our own factories, but from the point that we have completed the production of wind turbine blade or a Tower, or such a main component, there are basically only subcontractors supporting us thereafter.”*

(4) Project Lifestyle and Communication:

The development of Wind Farm Projects usually follows a four-stage lifecycle which are Initiation, Planning, Execution, and Commissioning. However, these stages are often highly structured, aligned and process oriented that disturbances or alterations in one phase can substantially impact the others. This frequently results in Delays, cost Overflows, and Reduction of Operational Efficiency.

As described in the Gnatt Chart of my thesis, during the Planning Phase**,** Wind Farm developers often face challenges in coordinating with various subcontractors responsible for key tasks such as Component delivery, Installation, and Commissioning. As most of the Companies such as Vestas depend on the subcontractors for different tasks, lack of clear communication and alignment between the different teams who are handling the supply chain as well as logistics, can lead to delays in starting the execution phase. And this is even more problematic when companies have to work in the remote Ice areas such as in Finland.

From the literature part and Interview analysis, below solutions can be taken to solve these

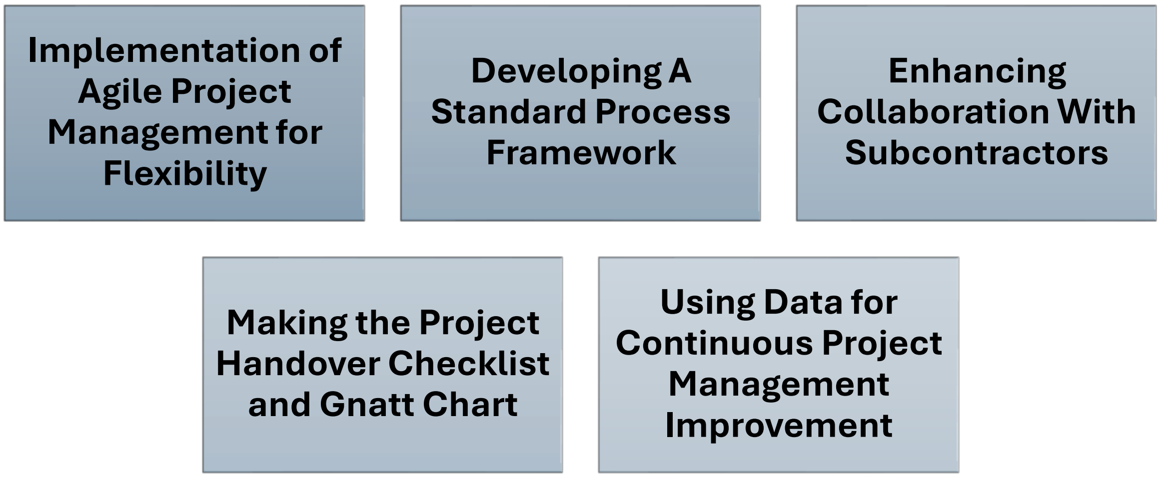


Figure 31: Solution Models for Enhanced Efficiency in Project Management

Agile Project Management methodologies should be integrated into the existing Project Lifecycle at Wind Farm Companies Such as Vestas. Agile methodologies can be used for greater flexibility, where project teams can quickly adapt to changes, especially when New Products, Technologies, or Environmental regulations come into play. Scrum or Kanban frameworks can help manage ongoing tasks and respond to evolving project requirements. Agile's iterative approach enables project teams to work in short cycles, to deliver project components gradually and to make necessary adjustments based on real-time feedback and changing project requirements, (Zasa et al., 2021). This approach could be very important for Wind Farm Project Management and Sustainiility.

Wind Energy Companies should work on developing a Standardized Project Management Framework or Gnatt Chart for Wind Farm Projects. As wind Energy Sector now a dynamic and rapidly growing industry, having a standardized process can bring Consistency and Predictability to projects.

A good approach can be using Standard Operating Procedures or SOPs for logistics, Contracting with subcontractors, and installation processes which can be developed to mitigate delays and communication gaps. Another important approach should be lessons learned from Previous Projects and these should be documented and used to Update and Refine these processes over time, (Project Management Institute, 2021)

As I have discussed, in wind energy projects, one of the major challenges is the effective collaboration and coordination with subcontractors because companies such as Vestas depend heavily on the various task for Subcontractors. As delays in resource mobilization, or misalignment between subcontractors schedules and project demands is the root cause of bottlenecks in the installation of wind turbines and other tasks that the contractors have been given responsibility of. So to solve these issues, Wind Energy developers such as Vestas should integrate subcontractors right from the beginning in the project planning process and should establish a long term relationship keeping in mind about their Carbon Footprints. Clear contracts with well defined responsibilities and pricing models are essential to prevent delays and maintaining consistent project timelines which ensures Effective collaboration, reduces project risks, enhances the efficiency of the overall construction process, and ensures that subcontractors are aligned with the companies and clients values and objectivity for Sustainability. Associate Project Mangager from Vestas has highlighted their Priority for Sustainability in a very specific way

“we are not working with subcontractors that have a very low score in sustainability, but we are also choosing a partner and supplier who are also focused in the same role of being a Sustainable Company in their field”

In the wind Farm Project Management, the Hand Over Phase is important between Different Departments, especially between Sales and Project Management. A well documented and structured checklist can improve communication as well as ensure that the Project Management team has all the information they need to move forward efficiently including Timelines, Project Scope, Key Stakeholders, and Risks.

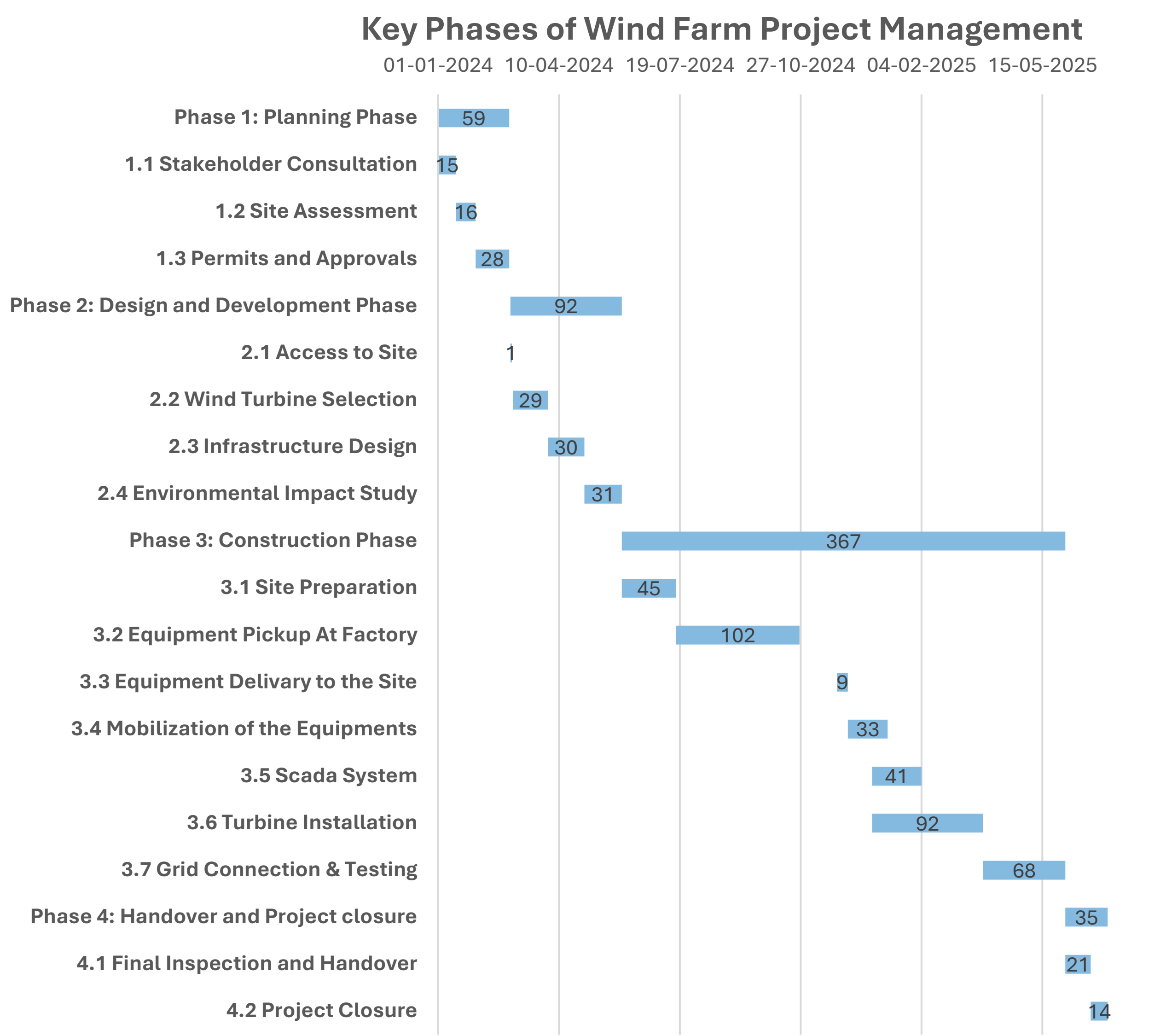
A Gnatt chart can also help and do wonders in this regard, and an example of these have been shown on the later part of this thesis. A Gantt chart provides a Visual Representation of all the Project Tasks and Phases in chronological order. For example, in wind energy projects, a chart can include the Phases Of Planning, Component Transportation, Design, Development, Installation, Commissioning, as well as Handover. By Mapping Out the timeline for each task, it can help project managers and co-ordinators to see the overall progress and could be used to identify potential Bottlenecks or Delays.

Now the wind industry’s rapid growth and the introduction of new range of products highlight the need for data driven decisions and the use of AI or Artificial Intelligence in Project Management. By gathering data on Project Performance such as time taken at each stage, cost overruns, project issues encountered, companies such Vestas can improve future projects and this can be done by Automated System Using Artificial Intelligence. By Using Project Management software with Data Analytics Features can help identify bottlenecks and inefficiencies in real time. Softwares such as SAP and Trello can be highly recommended.

Wind Farm Construction companies can benefit greatly from using Trello due to its integrated Visual Task Management System, which helps teams to easily track progress across different Project Phases (Trello, 2023). It enables Efficient Communication between different teams, contractors, and stakeholders, streamlining project updates and task assignments. Trello support Agile Project Management helps teams remain Adaptable, particularly when changes are needed during construction due to external factors like weather or regulatory updates which can help Wind Farm companies to improve efficiency and coordination.

Wind Farm Companied can be benefitted by Using SAP ERP Project System (PS) modules. This software has integrated tool such as Work Breakdown Structures**.** SAP can helps Project Managers break down complex Wind Farm Projects into manageable tasks and track progress through key milestones. The integration of resource management and cost control modules ensures that resources such as labor and materials are efficiently allocated, and project budgets can be maintained with milestones.

The Gantt Chart has been presented below shows a comprehensive Project Management Timeline for the Wind Farm Construction which has been designed to align with the European Unions Net Zero 2050 goals, in the context of Finland so that the Wind Farm Companies can Follow this Guideline. I have structured the timeline around critical phases of Wind Farm Development such as from the Initial Planning phase to Design and Development, Construction to Project Closure Phase. This Gantt chart serves as a roadmap for Wind Farm Projects in Finland, demonstrating how these projects can be effectively managed to meet both national and European Sustainability objectives. This has been done by the data provided by Vestas and By following this Structured Timeline, Project Managers can ensure that wind farms are Constructed in time to contribute to Finland's Renewable Energy targets and the EU Net Zero 2050 ambitions.

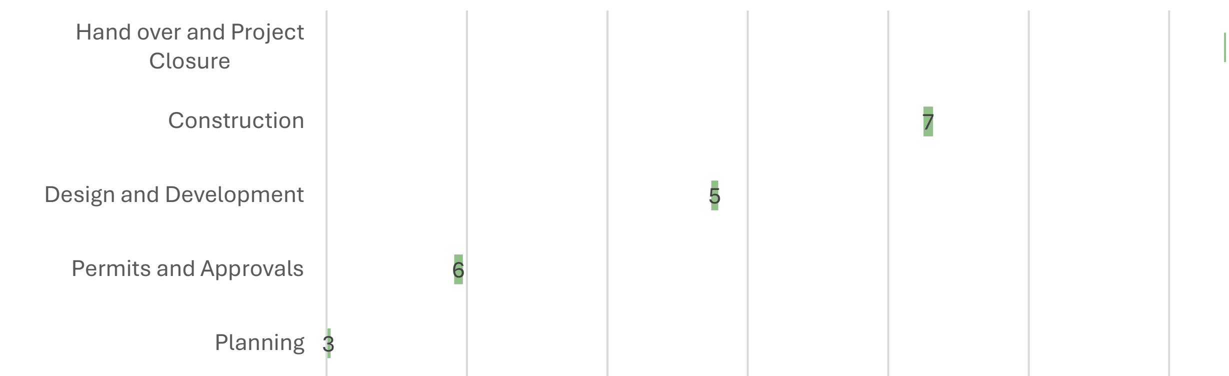


	4.2 Project Closure	4.1 Final Inspection and Handover	Phase 4: Handover and Project closure	3.7 Grid Connection & Testing	3.6 Turbine Installation	3.5 Scada System	3.4 Mobilization of the Equipments	3.3 Equipment Delivary to the Site	3.2 Equipment Pick up At Factory	3.1 Site Preparation	Phase 3: Construction Phase	2.4 Environmental Impact Study	2.3 Infrastructure Design	2.2 Wind Turbine Selection	2.1 Access to Site	Phase 2: Design and Development Phase	1.3 Permits and Approvals	1.2 Site Assessment	1.1 Stakeholder Consultation	Phase 1: Planning Phase
Start Date	24-0	03-0	03-0	27-0	25-1	25-1	05-1	26-1	16-0	01-0	01-0	01-0	01-0	03-0	01-0	01-0	01-0	16-0	01-0	01-0
Duration	14	21	35	68	92	41	33	9	102	45	367	31	30	29	1	92	28	16	15	59

Figure 32: An Ideal Timeline for Successful Wind Farm Construction

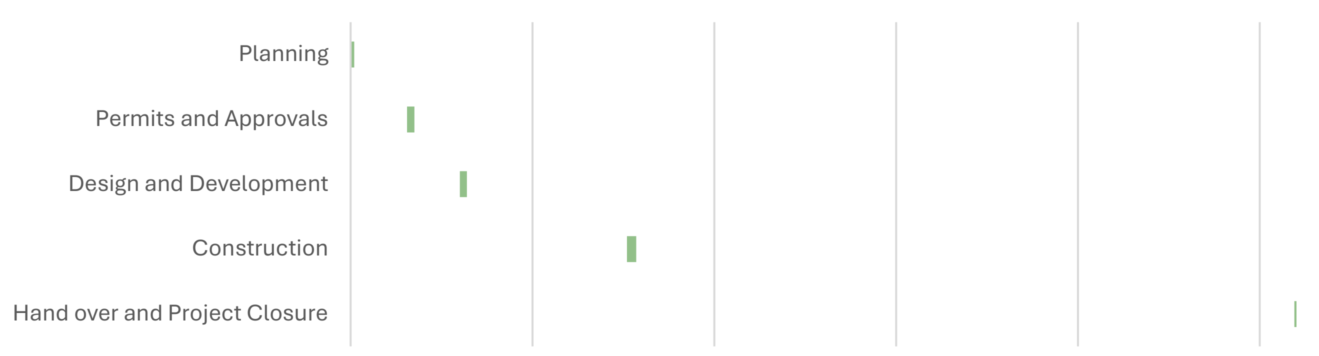
From this chart, we can see that in the Finland Context, the Wind Farm Constructions can be done in Around 24 months from Initial Planning Phase to Project Closure. Additionally, Finland's government has rationalised several processes such as Easy permitting to promote renewable energy projects in alignment with the EU Green Deal and the Net Zero 2050 goals.

Now We can have a look of Gnatt Charts regarding the timeline Differences of Project Lifecycle around Pioneering Wind Energy Implemented Countries around Europe:



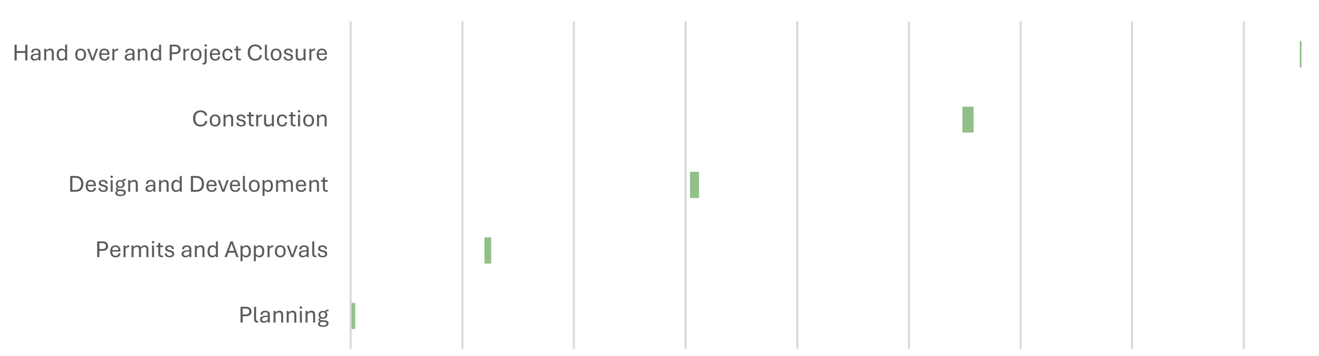
	Planning	Permits and Approvals	Design and Development	Construction	Hand over and Project Closure
Germany start	01-01-2024	01-04-2024	01-10-2024	01-03-2025	01-10-2025
Germany Duration (Month)	3	6	5	7	3

Figure 33: Construction Project Lifecycle Timeline in Germany



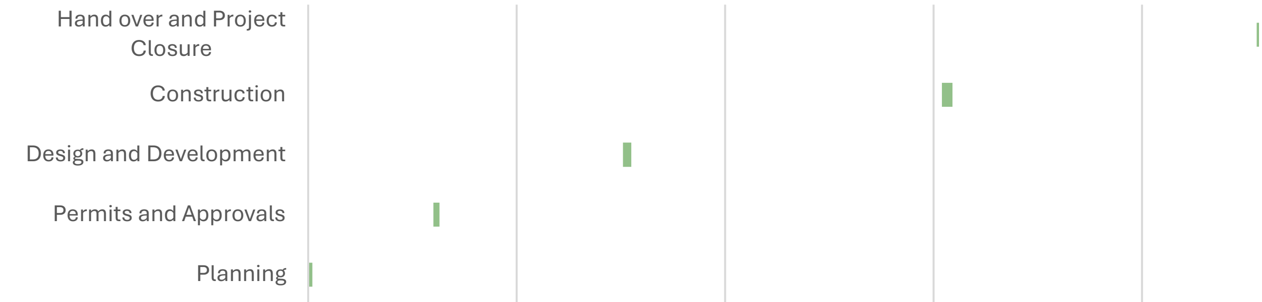
	Hand over and Project Closure	Construction	Design and Development	Permits and Approvals	Planning
Finland start	03-06-2025	01-06-2024	01-03-2024	01-02-2024	01-01-2024
Finland Duration (Month)	2	5	4	4	2

Figure 34: Construction Project Lifecycle Timeline in Finland



	Planning	Permits and Approvals	Design and Development	Construction	Hand over and Project Closure
UK start	01-01-2024	01-03-2024	01-06-2024	01-10-2024	01-03-2025
UK Duration (Month)	2	3	4	5	3

Figure 35: Construction Project Lifecycle Timeline in UK



	Planning	Permits and Approvals	Design and Development	Construction	Hand over and Project Closure
Denmark Start	01-02-2024	01-04-2024	01-07-2024	01-12-2024	01-05-2025
Denmark Duration (Month)	2	3	4	5	2

Figure 36: Construction Project Lifecycle Timeline in Denmark

In Germany the Planning Phase can start from January. And it usually consists of 3 months. As mentioned in the literature, Germany requires extensive initial planning, particularly in conducting environmental and community impact assessments, which extends the period of this phase.

In Finland, the planning process can start from the February. And as we have discussed, Finland has more organized process for initial Planning, which specifically focuses on the challenges by cold weather, the planning process of Finland is shorter than Germany.

As United Kingdom is known for Vast Renewable Energy Resources, we put the planning phase for United Kingdom two months only and as we have discussed earlier in the literature, Contracts for Difference or CFD mechanism also contribute to quicker planning

We have kept the planning phase 2 months for Denmark also as Denmark's government strongly supports Renewable Energy Projects, allowing for quicker planning through existing infrastructure and policy incentives as well as pioneer in Wind Energy Company such as Vestas has also its origin in Denmark.

As from the discussion above, we can see the Planning Phase is influenced by how well prepared a country is in terms of Infrastructure, Regulatory Hurdle, and experience in renewable energy, especially in Wind. While Germany's longer duration reflects its thorough processes countries like Finland, the UK, and Denmark benefit from more efficient policies in terms of Renewables.

In the Permits and Approvals Phase, for Germany, they have strict environmental regulations and the involvement of multiple regulatory bodies as I have discussed in the literature section. On the other hand, the UK, Finland and Denmark have more supportive and relaxing Energy framework that results in a shorter approval time than Germany.

The design and development phase is mainly influenced by local engineering standards and environmental considerations in the countries mentioned. In Germany the there is collaboration with the local contractors extensive safety regulations are taken for Wind Turbines. design and development in Finland focus are mainly focused of if wind turbines can withstand extreme cold and icy conditions as we discussed, and this takes lesser time than Germany for lesser bureaucratic hurdles. In the UK and Denmark has experienced contractors and Wind Farm Construction companies like Vestas, so this mature market takes lesser time.

The construction process is impacted by the country's labour availability, weather conditions, and regulatory requirements. As discussed, Germanys more stringent safety standards which lengthen this stage. On the other hand, Denmark, the UK, and Finland have construction timelines that are more time efficient as we can see from the Chart.

Germany's Hand Over and Project Closure phase is constructed of detailed safety checks and grid integration processes, which usually lengthen the timeline. On the contrary, the UK, Denmark, and Finland have efficient Grid Integration, Mature Wind Energy and focusing specifically in the cold weather technologies.

Now from the below table we can figure out the below trends which is given below:

Table 7: Key Differences Based on the Analysis

Phases	Germany	Finland	United Kingdom	Denmark
Planning	Starts in January Extended planning period for Environmental and Community impact assessments.	Usually Starts in February. More organized and specific to cold weather challenges.	Usually Starts in January Faster due to Contracts for Difference	Starts in January for 2 months usually. Very Friendly and Supported Government Policy
Permits and Approvals	Long Period due to strict environmental regulations and involvement of multiple regulatory bodies.	Short due to more structured and supportive energy framework	Shorter due to supportive regulatory frameworks.	Shorter due to Government incentives and rationalised regulations.
Design and Development Phase	Extended duration due to collaboration with local contractors and safety regulations.	Focusing on Wind turbines resilience to cold conditions as well as Lesser bureaucratic hurdles.	Shorter duration due to Experienced contractors and Mature market.	Efficient processes due to Wind Experience and Government Support.

Construction	Longer duration due to stringent safety standards and regulatory requirements.	More time efficient with streamlined processes for weather-related challenges.	More time efficient with experienced contractors.	Quicker process due to mature wind energy market and experienced labor availability.
Handover and Project Closure	Lengthened due to detailed safety checks and Grid Integration Processes.	Efficient Grid integration Process with focus on cold weather technologies	Efficient and mature wind energy market, quicker handover.	Quicker handover due to mature grid infrastructure and local expertise such as Vestas.

4.4.7 Geopolitical Instability:

The war between Russia and Ukraine has significantly impacted Europe's supply of energy. As I have discussed in the literature section, Europe has faced challenges in securing stable energy supplies, particularly fossil fuels, given because it has been depending on Russian gas. This instability has accelerated the need to transition for the renewable energy sources, mainly Wind Power for the alternative source.

So the Europe's response to this Crisis should be to Reduce energy dependencies on Unstable Russia and to Increase investment on the Wind Energy. Unlike fossil fuels, Wind

Energy is domestically produced and doesn't rely on imports, which makes it more robust to geopolitical shocks. And to ensure that there should be specific laws at work. One of such law is The European Commission's REPowerEU Plan, (REPowerEU, 2022). This plan has already been successful at cutting the EU's reliance on Russian fossil fuels and significantly increasing renewable energy targets, with Wind Energy playing a focused role.

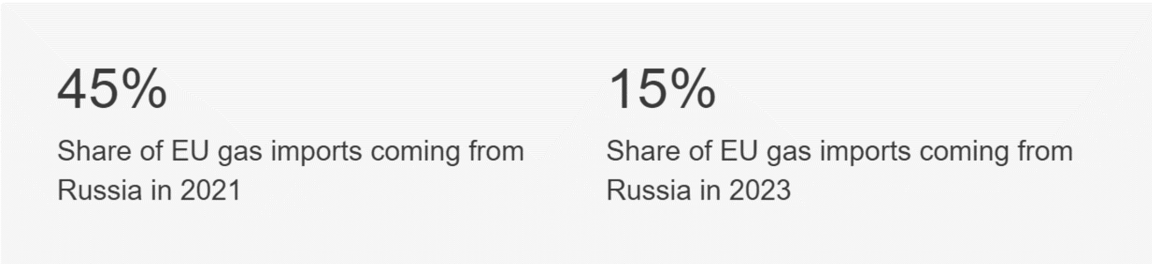


Figure 37: Diversifying energy supplies, (REPowerEU, 2022)

Another most important step will be accelerating Offshore Wind Development, which statistics has been discussed earlier. Finland in particular has identified the Baltic Sea as a key area for Offshore Wind Development, where it has the huge potential For Offshore Wind Farm, and also Finland has been rapidly expanding its Onshore Wind Capacity.

Work on Strengthen Geopolitical Supply chain should be done also. One of the key Impacts of Geopolitical Instability, such as the Russia-Ukraine War, we have seen is the Disruption of Supply Chains for Critical Materials.

A solution to this can be to ensure that wind turbine components are sourced domestically or from stable trade partners. This reduces the dependency on external suppliers that might be affected by geopolitical instability.

In the interview the Project Manager of Vestas Mentioned, *"We basically are dependent on the vessel for transporting the components from one place to another and our components are coming from China, from Vietnam, if let's say there is a supply chain issue and we don't get components when planned in April and we need to start only in September, then the project in line would of course be massively infected, just not only by the supply chain factor but also that the installation phase would take much longer than expected"*

So initiatives for localizing the Supply chain could not only solve the Geopolitical Instability problem but also could manage the Carbon Footprint.

"Suggestion would be to use as a material to project in Finland from low nearby factories, preferably only from Europe, because then we can limit the transport emissions and costs.
Uh, for example. They Vestas has a lot of factories set up in Denmark already. We also have other suppliers for for main components and materials from Turkey, Spain, uh Belgium, Germany", He added

4.4.8 Competition from Other renewable sources and Winning Strategy:

Europe and Finland need more investors in the Wind Energy for meeting the growing demand for the Renewable Energy and achieving the carbon neutrality through the EU net zero 2050 target. As I have mentioned in the literature section, Wind is currently facing strong competition from the Nuclear, Solar, hydro and biomass energy. So both the Europe and Finland must implement policies that emphasize the advantages of wind energy, enhance investment attractiveness, efficient project management and policies that ensure the industry remains competitive with other renewables.

So the Policy Recommendations can be taken as below:

Figure 38: Policy Recommendations for Winning

Wind Farms both Offshore and Onshore requires a huge capital investment. To attract investors, Europe and Finland need to ensure that the financial returns are attractive and stable over the long term periods. So, Governments need to work on that bigger investments come on the way of Wind Energy. One such policy is Power Purchase Agreements which have been discussed already. Europe has introduced that guarantee fixed electricity prices for Wind Energy over extended periods and stabilizes the Risk of Indexation. This policy can be a game changer towards Net Zero 2050. Countries can offer subsidies and tax incentive as both Europe and Finland are offering to attract investment in wind energy. These include feed in tariffs, Green Bonds and production tax credits that I have discussed in the literature section. These ensure that Wind Energy producers receive financial support during the early stages of project development. So these incentives can make Wind competitive investment compared to other renewable energy sources for Net Zero 2050

A Fast and Easy permitting process for both Onshore and Offshore wind projects will reduce barriers to entry and accelerate the time for Investors to return on their investments. In this regard, the Repower EU Plan introduced by the European

Commission aims to fast track permitting for Renewable Energy Projects, including Wind Energy. This ensures that wind projects can move from planning to execution in shorter timeline to make them more attractive to investors who want to minimize project delays and risk. And Currently Finland is working on a clear Offshore Wind Project and they can already follow the permitting of Big players such as UK, Germany and Denmark to attract international investors who prefer stable and predictable regulatory environments. As the project Coordinator from the Vestas highlighted

“This is usually an issue, so to say, because if we fly in an expert from let's say from Germany and they have never been in Finland before for work, then they don't have a tax number, so they fly in on Monday, they go to the tax office, they fill in the application and maybe on Thursday, Friday they get actually the the tax number issued so they can start working. So that's 3-4 days that they just wait for to be allowed to work. This is of course, a tax legislation and a topic that is limiting us for starting the works or starting the investigation or whatever this expert would be doing on the site but this is something that we from Vestas would like to see get smoother and quicker to get the tax number issued”

Governments have huge responsibilities in regards both infrastructure improvements and attracting the investors. Offering the Government Backed loan guarantees or insurance policies can lower the apparent risk of investing in large scale wind projects. Infrastructure improvements such as Grid infrastructure is a must to ensure that investors get their quick returns. Another important initiative that Governments can take is to make investors understand abut the credibility of Wind Energy such as unlike solar, wind energy is less affected by Seasonal Variations and can provide stable electricity generation even during winter months. And this is very important for Countries such as Finland where darkness persists in most of the times of the year. Another important steps Governments need to take is Grid Infrastructure Improvement. Expanding and modernizing the grid to accommodate more Wind Power will ensure that wind energy can be fully utilized without bottlenecks, and investors would be willing to

Invest more when they will see that the Grid Capacity is well balanced to accommodate the Wind Power.

5 Conclusion:

In this chapter, the conclusions of Research and Findings will be presented. And there will be suggestions regarding further research and development opportunities will also be presented. Through the Analysis, Literature Review and Interviews with the Company Representatives of Project management from Vestas, it is apparent that while Wind Energy is essential in achieving the EU net Zero 2050 target, there are opportunities to improve Project Management Practices to ensure better alignment with sustainability goals.

The first Research Question was Finding out how Current Project Management practices in the Wind Farm Industry can be optimized to align with the EU's sustainability goals. And My second Research Question was to Identify existing Project Management Practices, to analyse their effectiveness, and propose optimization strategies as well as policy modifications.

My research highlights that the current Project Management Practices in the Wind Farm Construction often Face challenges in the domain of Regulatory and Legislative Hurdles, integration of the new technologies, Flexibility and Adaptability of the Project Management Process, Lack of Standardized guidelines for Wind Farm Project across different Geographies and Collaboration with Subcontractors, and Supply Chain Issues.

So in this Project Management issues, I found solutions from the literatures and Vestas Interviews where the Project Managers and Coordinators have shared their insights and Recommendations as well as the problems they have been facing from their personal experiences. Based on these findings I have suggested some ways to improve the way of Managing Wind Farm Projects in a more Effective, Efficient, and Sustainable manner. For Regulatory and Permitting delays, it is hard for Companies like Vestas to secure the

Necessary Permits and Licenses on time, which always delays the project start and Project Handover. So the proposed solutions for this are Proactive Engagement with Regulatory Bodies, Centralized Database for Permit Tracking, Automation Tools, Dedicated Regulatory Compliance Teams, Resource Allocation, Standardized Documentation and Templates as well as Sharing Best Practices. The integration of New Technologies face problems especially when it comes to installing new technologies such as offshore Wind Farms in the Ice conditions in Finland, which comes with the Environmental Concern, Regulatory and Permitting issues and proposed solutions have been discussed such as using a new type of Foundation system, Widespread Environmental Analysis and Securing necessary permitting with the concerned authority. This issues of integrating new technologies have been discussed as a case study of the First offshore Wind Farm of Finland, Tahkoluoto Wind Farm Project. In addition to that innovative solution for a significant issue of Wind Sensitivity in the Blade Installation problem has been discussed which is a solution by Vestas which is using the Innovative Idea of Automatic Positioning System.

The Gantt charts I developed during this research serve as a critical tool for visualizing and structuring the Wind Farm Project Management Process in both a general model and in the context of Different Countries. In the Gnatt Chart, I have tried to show outlines in different steps of Project Management from Planning and Permitting to the Handover phase with a proposed timeline for each phase. By utilizing these Gantt charts which I have done in Collaboration with Vestas, wind farm developers can establish clear project milestones and timelines.

Then Wind Farm construction companies suffer from Flexibility and Adaptibility as well as often there is a Lack of Standard Guidelines for Global Wind Farm Projects as the Wind Farm locations are very diverse geographically. With these there are added problems of Dependencies on Subcontractors as companies Such as Vestas need to collaborate tightly with various Subcontractors, suppliers, and Logistic providers for Small to big issues. In the Project Lifecycle, companies face problems as these steps are very much process intense. So, the solutions will be implementing the Agile Project Management, developing a standard process framework with the better collaboration with subcontractors and using the use of data analytics to identify and mitigate bottlenecks.

And finally, in my thesis I have tackled the Geopolitical Instability and the competition from other Renewable Energy Sources such as Nuclear Energy Source which already has big footing in the electricity market in Europe. For the Geopolitical Instability such as for the current Russia and Ukraine situation going, Europe and Finland should focus on the diverse renewable Energy sources with keeping the Wind Energy in Focus as one of the main players to achieve carbon Neutrality Goals. The wind turbine components need to be sourced domestically or from stable partners preferably from Europe which would decrease the carbon footprint also.

For investors to invest more in the wind energy and to make it more competetive against the other source of Renewable energies and fossil fuels, policies such as Power Purchase Agreements, Green bonds needs to be taken, which will enable the guarantee of a fixed electricity price and protect companies against the price indexation. Also a easy permitting process is needed.

Attracting investors is also Very important to win against other renewable energy sources such as solar and nuclear and Fossil fuels so that the Euro Net Zero 2050 can be achieved. As for the winning strategy, three most important factors need to be done. Which are, Granting Financial incentive for the Investors, making the permits fast and Easy as well as Guranteed Government Support system.

In summary, the Research findings have shown that while Wind Energy is a Promising and Essential for the European Decarbonization Goals and Sustainability, there are some crucial aspects of Project Management and Operational challenges that need to be addressed to ensure the Strategies for overcoming legislative and management hurdles in Wind farm construction Project as well as making Project management in wind farm more efficient with the European Union Net Zero 2050 target with Sustainability in Mind.

5.4 Further Research and Development

As the Renewable Energy Sector is Expanding in light of the EU Net Zero 2050, continuous innovation and adaptation are significant. Companies such as Vestas should look into integrating more sophisticated technologies such as Automatic Positioning System and trending technologies such as Artificial Intelligence and Machine learning to their armada.

In my thesis, I have discussed about the Offshore Wind Farms and Cold-Climate Adaptations for the Finnish and Baltic region, as how Finland has positioned itself as a pioneer in developing specialized offshore wind technologies that can withstand the harsh conditions of the Baltic Sea, including ice, cold temperatures, and high wind speeds. But further research are needed to analyse the long term performance of these wind farms, maintenance challenges in Ice Conditions as well as decommissioning

for the Wind turbines as companies such as Vestas has still yet to develop a complete sustainable recycling process for the entire wind turbine component. Another key area can be the exploration of the Use of Drones and Remote Monitoring of the Wind Turbines.

As I have discussed, there is a growing need for skilled labour to support the Wind Energy Sector as the demand increases and countries such as Finland have been falling behind as most of the technical courses are still in Finnish language. So Analyzing the education gap could provide insights into how education systems need to evolve for supporting a more international and diverse workforce in the renewable energy sector for Sustainability.

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