Strategic Approach to Expanding Wind Energy Operation and Management Business to Finland

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SAVONIA UNIVERSITY OF APPLIED SCIENCES **THESIS Abstract**

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Abstract

The aim of this final thesis was to find out whether it is reasonable for ABO Wind AG (ABO Wind) to open Operation & management (O&M) department office in Finland. The main topics in the thesis are O&M departmental tasks, how the teams of O&M department handle them usually and which teams are involved. The results were gathered to this thesis. Thesis also includes background information of wind energy in general, relocation and centralization factors and the situation of wind energy in Finland.

The results of the study on which tasks should be handled either locally or centralized were gathered by interviewing each team of O&M department. After the interviews a list of advantages and disadvantages concerning the location of the current team was established. Cost calculations of the yearly inspections of wind turbines (WTs) was also made to evaluate the total costs of the inspections. In the final follow-up meeting with the management of the O&M department the decisions were made on which teams should be placed to Finland.

The outcome of the final thesis was that it is currently reasonable to localize the accounting team. Yearly inspections of WTs are also topical, because of the increasing number of wind farm projects the company will have in Finland. ABO Wind considers handling its Finland’s WTs yearly inspections from Germany and in the future these inspections could be taken care of by an international service technician team that handles other countries as well. Another significant matter that was discovered during the follow-up meetings was a need for a local sales person in Finland.

The thesis process was successful and useful for ABO Wind in evaluating the demand of which teams of the O&M department are reasonable to be placed to the local country. The thesis would be used for other countries as well when ABO Wind deals with the same questions. The thesis will save time in the future when evaluating the needed tools and processes for a new localization process.

Keywords
Energy O&M Operation Management Finland Wind Turbine Localization Centralization Wind Farm

CONTENTS

APPENDICES (All the appendices are for the client's use and they are not part of this public version of thesis)

LIST OF ABBREVIATIONS

MW	Megawatt
TWh	Terawatt hours
ABO Wind	ABO Wind AG
O&M	Operation and management
WT	Wind turbine
CS	Commercial specialist
RMS	Remote monitoring staff
n.d.	No date
DN	Distribution network
B.C.	Before Christ
KAM	Key account manager
TPM	Technical park manager
e.g.	For example
HAWT	Horizontal-axis wind turbine
WF	Wind farm

1 INTRODUCTION

Wind energy is a fast growing field globally and also in Finland and it has a huge potential. Finland has a lots of unused space to use for wind energy and also because the country is so sparsely populated, there is plenty of space for wind energy. The EU's targets to produce more energy with renewable energies are also topical at the moment and it is important for Finland to achieve these targets as well.

For now it seems that at end of 2017 ABO Wind AG, which is the client of this final thesis, would have five wind farms (WFs) in operation in Finland. Still the company is expanding more and more its business and developing more wind farms in Finland and therefore it is important to evaluate the need to open a new local office for ABO Wind in Finland.

The aim of this final thesis is to gather the results on whether it is reasonable and cost-effective for ABO Wind's Operation & Management (O&M) department to open an office in Finland. The thesis includes a brief look into wind energy basics, history of wind energy in general and current situation of wind energy in Finland.
Main focus is on the O&M department and the tasks that the teams of O&M department are responsible for. The outcomes of the thesis are needed documents and further actions of how ABO Wind should proceed in the above mentioned matters.

2 OBJECTIVES AND METHODS OF THESIS

The main objective of this thesis was to discover whether it is profitable for ABO Wind to open an O&M department in Finland. An important objective is to study important processes and which of them should be placed in Finland and which of them should be centralized to Germany. In the thesis the local country is Finland and the central location is Germany.

The method of this thesis was development research. In the first meeting with my supervisor from ABO Wind we came to the conclusion that the thesis research method is more development than just research, because decisions are made during the process. ABO Wind wants to expand its business and with development research it will achieve the results better than just by research. By using development research we will learn about the process itself at the same time while developing it. Development research work is done closely with related teams of O&M department. ABO Wind has already experience about the relocation and centralization process, because it has opened O&M offices in other countries.

The material and the data is mainly from ABO Wind. ABO Wind material consists of documents and interviews. Secondary sources are related literature and reliable sources from internet. Previous researches or material closely related to this specific topic were not found.

Thesis is focused more on the contents relevant to engineering field. Contents include a specific look at O&M department's processes, how they are usually handled and how they could be handled if they were either localized or centralized. Results should give for ABO Wind a clearer view on how to proceed with these questions mentioned above. This is a fairly topical issue at the moment for the O&M department, because in the near future workload will be much higher from new wind farms in Finland.

2.1 ABO Wind AG

ABO Wind was founded in 1996 by Dr. Jochen Ahn and Matthias Bockholt. ABO Wind is one of Europe's most experienced developers of renewable energy. Originating in Germany, ABO Wind now has subsidiaries in Argentina, Finland, Iran, the Netherlands, France, Ireland, the United Kingdom and Spain. ABO Wind AG has successfully developed, constructed and maintained wind farms for more than 20 years now. (ABO Wind AG. 2017). Company's core business is wind energy.

FIGURE 1. Locations of ABO Wind AG offices (ABO Wind AG 2017).

The ABO Wind consists of about 400 professionals with expertise covering all phases of wind farm development: from site selection and land acquisition to assessing the specific wind yield for a project, technical wind farm design, planning and environmental impact assessment, bank financing, and wind farm construction (ABO Wind AG. 2017). ABO Wind also provides long-term operational management, maintenance and services such as inspections, repairs, gearbox endoscopies or technical assessments. The company has so far installed wind farms with a total capacity of over 1100 Megawatt (MW). At the end of 2017 the company should have about 100 MW in operation in Finland.

3 WIND ENERGY

Wind energy is a renewable energy source and basically it produces electricity from wind. The wind itself is basically moving air. Wind comes from atmospheric changes; changes in temperature and pressure make the air move around the surface of the earth; all of which is triggered by the sun. So in a way, wind energy is another form of solar power. A wind turbine captures the wind to produce energy. (Energy matters).

Usually large wind turbines for electricity production to the grid are at the moment up to 100 meters tall. Most common wind turbine type is horizontal-axis wind turbine (HAWT) consisting of three blades as in FIGURE 3. Less common type is vertical-axis wind turbine e.g. the Savonius and the Darrieus.

3.1 History of wind energy

Wind energy propelled boats along the Nile River as early as 5000 B.C. By 200 B.C., simple windmills in China were pumping water. (Wind Energy Foundation 2016).

American colonists used windmills to grind grain, to pump water, and to cut wood at sawmills. Homesteaders and ranchers installed thousands of wind pumps as they settled the western United States. In the late 1800s and early 1900s, small wind-electric generators (turbines) were also widely used. (U.S. Energy Information Administration).

The first automatically operating wind turbine for electricity generation was built by Charles F. Brush during the years 1887-1888 in Cleveland, Ohio, the United States. At the time it was the world’s largest wind turbine with a rotor diameter of 17 meters.

In 1940-1950 a Danish engineering company called F.L. Smidth built two bladed and three-bladed wind turbines and the turbines generated direct current. Oil crises in 1970 changed the energy industry and made the wind energy production more effective. From 1980 to 1990 the wind industry began to expand and wind farms were built to onshore and offshore.

Nowadays wind industry is a remarkable business in the energy field. New wind farms are built more and more, because of the need to provide alternative ways to produce energy even in a more environmentally friendly way.

3.2 How does a wind turbine work

The basics of how a wind turbine works are explained in this chapter.

The available power from the wind is proportional to the cube of the current wind speed. If you get more wind speed then you get more power generation and usually the faster the blades are rotating the higher is the wind speed, that's why wind turbines are usually located on higher spots like mountains or hilltops in case of an onshore wind turbine.

First touch to the wind are blades that are designed aerodynamically to achieve the best efficiency out of them in the current circumstances. The blades will start to rotate when the wind creates lift, because of the aerodynamic profile of the blades. The rotating blades rotate the hub and that rotates turbine's rotor shaft. Next part is the gearbox where the relatively low rotational speed from the blades is increased to generate electricity more easily. When the speed from the gearbox is increased it rotates the generator. The generator's primary task is to transform mechanical energy into electrical energy.

After the generator, the electricity is transformed by power cables to the transformer. The transformer transforms the electricity to meet the requirements of distribution network and also for more efficient transfer. After this process the energy could be supplied to the distribution network (switchyard).

These above mentioned components are inside the housing called nacelle. Nacelle can be focused towards the wind with a yaw system. There is also a focusing system for the blades that can maximise the benefit from the wind, the system is called a pitch system.

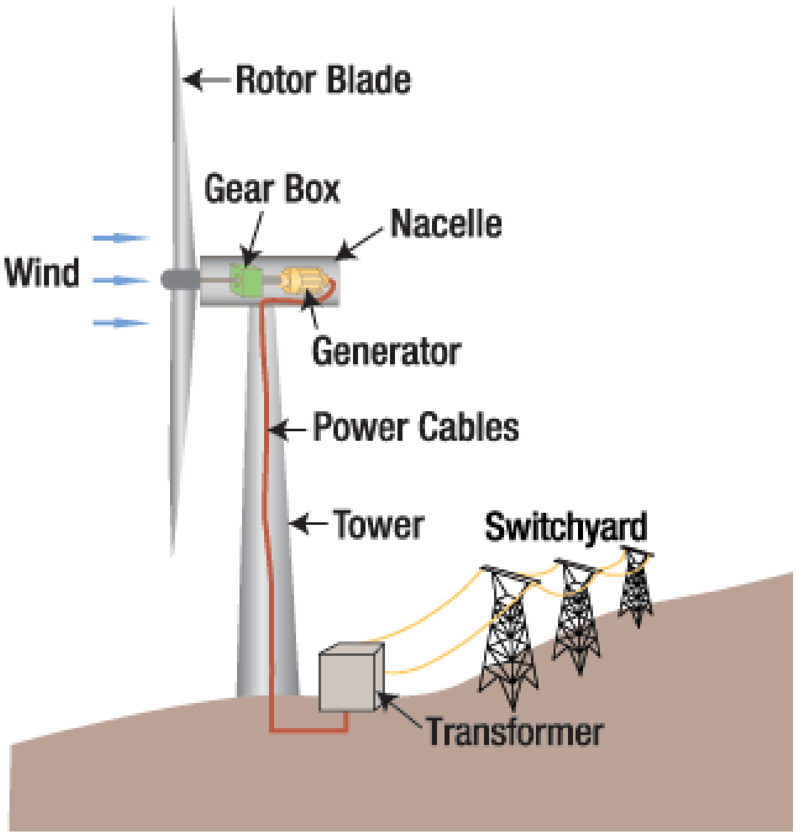

FIGURE 2. HAWT structure. (Energy Informative. 2013)

3.3 Wind farms

Wind turbines can be grouped together and then the system is usually called a wind farm. It is therefore more cost-effective to do all the tasks and duties for multiple wind turbines at the same time this also guarantees easier and cheaper energy production. Wind farm provides power to distribution network and the turbines are situated for example in the field as in FIGURE 3.

There are onshore and offshore wind farms when we are dealing with HAWT. Onshore wind farms are built near the coast, in the interior or on the higher ground (e.g., hills). Currently the onshore wind farms have lower investment costs than the offshore wind farms and it is also easier to supply the generated electricity to distribution network (DN), because it’s usually closer than the nearest DN close to an offshore wind farm.

Offshore wind farms are built in seas and lakes usually near the coast. Offshore wind farms are by technical and operating conditions more demanding than the onshore wind farms, mostly because of complicated foundations and connection to the DN. Offshore wind farms are expected to become more common if the investment cost would be lower and when the technology will develop to make it possible in the future. There are higher wind speeds, lower visual landscape effect than in onshore wind farms and also higher availability rates in offshore wind farms. Therefore offshore wind farms might be more productive and more recommended by some factors, but they require special knowledge and larger investments.

FIGURE 3. Onshore wind farm constructed by ABO Wind. (ABO Wind AG. 2017)

4 WIND ENERGY IN FINLAND

Wind power is a relatively new mode of electricity generation in Finland and it developed well in the last few years. As with other forms of renewable energy, wind power receives government subsidies. Finland introduced a wind power feed-in tariff in 2011, whose level was calculated by the ministerial working group to attract the investments needed to meet the 6 Terawatt hour (TWh) annual production target. (Finnish Wind Power Association). Of course with any energy project, wind power interests investors only if it’s profitable. Interest in wind power investments grows as project’s uncertainty decreases and expected returns increase.

4.1 Goals to achieve in Finland

The EU's Renewable energy directive sets a binding target according to which 20% of final energy consumption should be from renewable sources by 2020 (European Commission. 2017). Because of that Finland also has commitments regarding to it. The Finnish Ministry for Employment and the Economy feed-in tariff proposal set the target to provide 6 TWh of annual electricity production by building enough wind power to Finland. The target of 6 TWh equates approximately to 2000-2500 MW of capacity and on the other hand it’s almost 1000 new wind turbines.

However, if the wind power market is allowed to develop after 2020, and if cost-effective methods are used to promote development, wind energy will become competitive in the electricity market without subsidies (Finnish Wind Power Association).

4.2 Potential of wind energy in Finland

Finnish wind conditions for wind energy are good. The population of Finland is also relatively low compared to unused land areas that Finland has. Therefore wind energy is a very considerable way to produce the needed energy in Finland.

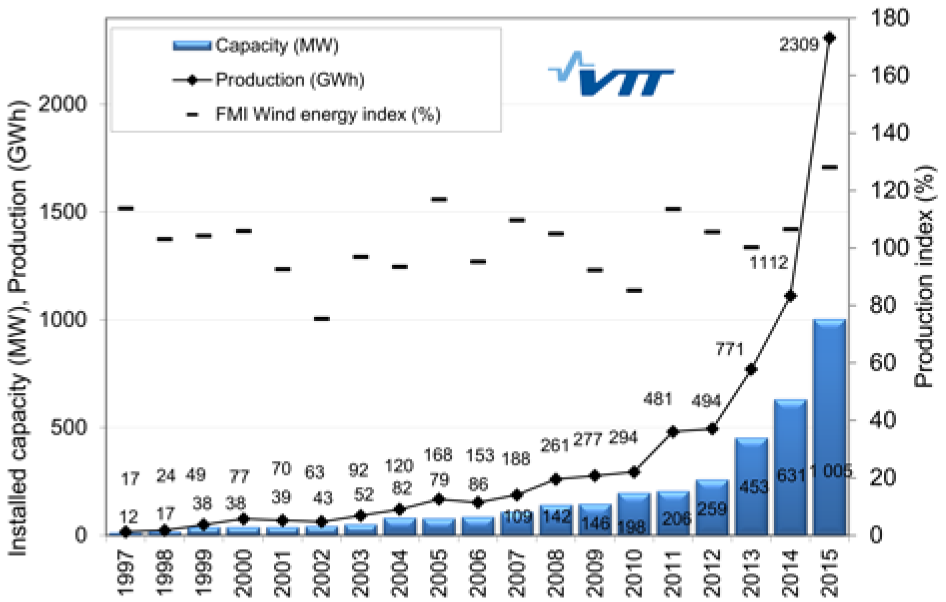

FIGURE 4. Wind power production and capacity in Finland (year level) (VTT).

There is also potential to increase wind power capacity in Finland. As we can see from FIGURE 4 the installed wind turbine capacity has increased radically within a few years in Finland. At the end of 2015 there were 387 installed wind turbines with capacity of 1005 MW. In total wind power production in 2015 was 2.3 TWh and that is 2.8 % of the whole electricity consumption in Finland.

4.2.1 Equipment

The special environment of Finland creates opportunities. Because of the cold climate Finland requires special skills in wind energy field. One of the opportunities is to increase serviceability and reliability of wind farms and its equipment and Finland has the necessary technological know-how.

Another field where to succeed is the manufacturing of wind turbine parts such as transmissions, generators, power shaping circuits, radar technology and steel structures. Finnish companies have been quite successful in international markets with their wind energy products and services. In the future there are still a lot of markets for smaller wind turbine equipment manufacturers who are specialized in a specific field.

4.2.2 Services and management

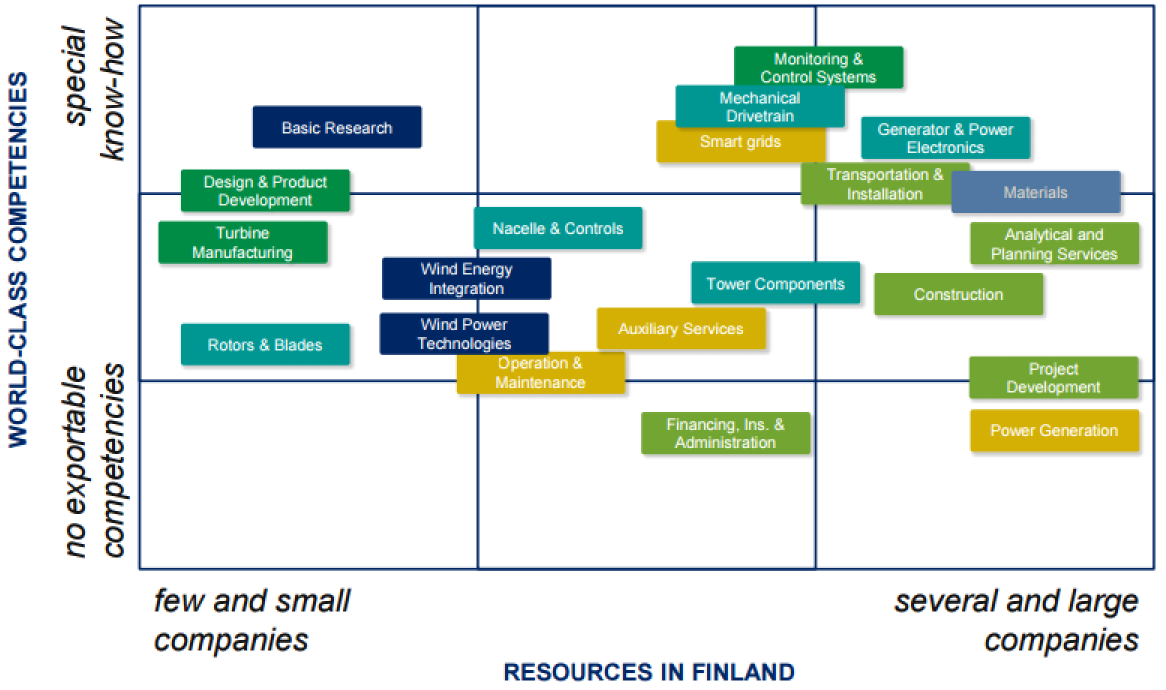

FIGURE 5. Special know-how resources in wind energy field in Finland (The wind power technology group 2014).

Operation and maintenance field is closely related to operation and management. As we can see from the FIGURE 5 special competence in Finland in the field of operation & maintenance is rated rather low. The FIGURE 5 shows also that there would be potential to companies from abroad in Finland's O&M markets.

5 OPERATION AND MANAGEMENT OF WIND FARM

Operation & management is an important part of a wind farm investment. The main objective of O&M is to minimize the cost of generated energy during the life time of the wind farm. Wind turbines are usually designed to operate for 20 years and the O&M of the wind farms is also done for the period. Main fields of O&M are technical and commercial control of the wind farm.

The duties and services that the wind farm O&M has vary. If the owner views the wind farm asset purely as an investment, it may wish to see no more than a monthly production and a budget statement. Owners who have a more substantial portfolio of generation facilities may take on the day to day management themselves, and engage assistance for specialized services only. (Knill & Oakey 2006).

What does a wind farm owner expect from his operational manager? (Wetter 2015, 3.)
Technical Controlling: high revenues

- Long operating time of his WT and high availability
- Few breakdowns, cost-effectiveness and quick remedy of defects
- Controlling of all technical service providers (example, provider of maintenance and service, provider of expert studies)

Commercial controlling: low costs

- Commercial handling (example, invoice management or accounting)
- Efficient planning of liquidity and revenues
- Controlling of all commercial service providers (example, electricity trader)
- Current check of contracts and possible savings (example, maintenance, loans)

5.1 Technical and commercial teams of O&M department

5.1.1 Remote monitoring (Control room)

With remote monitoring the availability of WT will be maximized. In remote control room staff is monitoring WT's performance, weather conditions and technical conditions. Communication to remote monitoring staff is necessary during maintenance or an inspection of the WT. Because of the communication to remote monitoring staff (RMS), there are not going be any extra alarms in WT. It is also important to guarantee the safety of on-site workers, in case the WT is turned on from the remote monitoring, because of a possible fault or because RMS doesn't know of the on-site work. Electronic logbook is held for every single action that occurs in WT. Logbook helps to analyze and optimize the possible issues of WT.

5.1.2 Technical park management

Technical park manager (TPM) is usually the first contact if a customer has a technical issue. Tasks of technical park managers are for example, calculation of the availability rates, taking care of the fault elimination, keeping an eye on all deadlines, managing the correction to faults, advising customers and preparing of monthly reports of the wind farm.

Preparing a monthly report is one of the main tasks of TPM. The report usually includes data like:

- Production rates (MWh)
- Scheduled and unscheduled services
- Availability rates of WTs
- Alarms and failures
- Downtime analysis
- Yields
- Wind speed analysis
- Other relevant information that is important for the owner of the wind farm.

Monthly report is an important document for the owner of the wind farm and also for other departments to see how the wind farm is producing, how profitable it is and what were the main reasons for possible downtimes.

5.1.3 Engineering and expert studies

The field of engineering and expert studies requires high technical knowledge from wind turbines and the team deals with:

- Wind turbine technical calculations
- Condition assessments
- Warranty claims

- Examining and evaluating large components of the turbine like foundations, tower, gearbox and rotor blades.
- Gearbox endoscopy checks and Condition Monitoring Systems
- Retrofittings

Examinations and evaluations of large components are explained more specifically in the following subchapters.

5.1.3.1 Gearbox

Gearbox damages are the main cause for prolonged downtime in the life of a wind turbine (ABO Wind AG 2017). Condition-based technical assessments are made to plan and optimize any other needed repairs. This minimizes additional damage or downtime and reduces repair costs and yield loss (ABO Wind AG 2017).

5.1.3.2 Concrete (Foundations)

The backbone of WT is the foundation and the tower. Examining concrete tower, inspecting damages and testing the concrete for stability are needed to prevent damages. Services include also viewing of WT's infrastructure and crane pads.

5.1.3.3 Rotor blades

The rotor blade is crucial for high yields: Exposed to wind and weather, it must function reliably over the course of 20 years. Only when the rotor blade is in perfect condition will the turbine deliver the desired yield. Repairs that are not completed at the optimal time increase the cost of repairs and the yield loss many times over. (ABO Wind AG 2017). Inspections and evaluation of rotor blades are necessary to make a proper time plan for possible repairs.

5.1.4 Environmental Compliance

The team deals with environmental compliances. Bats, birds and other protected species often result in certain conditions of planning permits that have a significant impact on yields (ABO Wind AG 2017). Additional restrictions regarding noise, shadow flicker and ice throw require competent expertise during the entire operational life of a wind turbine (ABO Wind AG 2017). The team also negotiates with relevant authorities that are linked to environmental requirements and monitoring campaigns e.g., protecting species and noise measurement.

5.1.5 Service technicians

The team provides maintenance, safety checks, fault clearance, optimisations and spare parts. Regular inspections are also held usually twice a year per WT. Inspections include checking of damages and wear of the wind turbines. With these preventive actions the unnecessary downtimes can be prevented.

Maintenance

- Semiannual and annual maintenance of the wind turbine
- 5-year maintenance
- Converter maintenance
- Lubrication/greasing works
- Winch and Blockstop maintenance
- Maintenance of on-board crane and chain hoists
- Oil change and taking of oil samples
- Maintenance of transformer and transmission station
- Condition-based blade inspection including lightning protection testing
- Gearbox endoscopies and transformer endoscopies

Safety checks

- Periodic inspections and testing of electrical installations of wind turbines, transformers and transmission stations
- Renew certification of personal protective equipment
- Renew certification of climbing protection system
- Cooperation with licensed inspection organisations
- Renew certification of abseiling equipment
- Renew certification of first aid kits, fire extinguishers
- Condition-based blade testing including lightning protection
- Renew certification of fire fighting systems
- Lightning protection measurements

Fault clearance

- Repairs of wind turbines
- Fault clearance of subsystems (bats, CMS etc.)
- Remedial measures from reports and inspections
- Replacement of main components
- Repairs of instruments such as climbing protection system and on-board crane

Optimisations

- Retrofits
- Oil additives
- Drive train alignment
- Retrofitting of protective equipment
- Upgrading of communications equipment
- Retrofitting of subsystems (fire alarm system etc.)

TABLE 1. Onsite related services for wind turbines. ABO Wind AG (2017).

5.1.6 Key account manager

Key account manager’s (KAM) main areas are sales and advising the client for additional needs or further optimisations of the wind farm. Basically KAM is dealing with customers and makes sure that all the necessary tasks are handled according to customer and contracts.

5.1.7 Accountant (commercial)

The duties of accountant are in connection to financial matters like:

- Tax returns and tax payments
- Maintaining bank accounts
- Invoices
- Claims management
- Land lease payments
- Insurance premiums
- Interest payments.

5.1.8 Commercial Specialist

The special tasks of commercial department are part of Commercial Specialist's duties. The tasks include:

- Monitoring of ongoing feed-in volumes and tariffs
- Ongoing liquidity planning
- Supporting with asserting claims
- Preparing new contracts for direct marketer

Negotiations are also possible with various contractors like for example, with third-party lenders. Commercial Specialist (CS) also supports client with matters that are related to financial banking.

When the commissioning of the wind farm is finished, CS also checks that the rates of remuneration coming either from the distribution network or the direct marketer are correct and that they match up with legislation and the contract.

6 LOCALIZATION AND CENTRALIZATION

Localization becomes a topical question when companies reappraise their business and try to find out whether localization is a more sensible way to handle it. If localization does not suit all processes or none of the processes, then they are centralized to manage the processes more effectively from the same place. Localization process takes time and effort from companies and usually there's a deadline for the localization process. After the deadline decisions have to be made on should a company localize some of its processes or not.

6.1 Listing of advantages and disadvantages

A list of advantages and disadvantages helps to see the overall view of the current need to localize or centralize the examined team. *Pros cons local central* (Appendix 1) includes the advantages and disadvantages for different teams.

6.2 Factors

This part of the thesis lists factors that are the most effective when considering whether to localize or centralize teams of ABO Wind's O&M department. The following factors are emerged in the *Pros cons local central* (Appendix 1).

6.2.1 Local language

Local language is an important factor when contacting local service providers or authorities. Contacting service providers would be also easier in the local language and would save time. Some service providers or authorities might not even be able to speak English like for example, requesting a written offer for service work. Another thing with local language is that the applications and notifications might also be available only in local language.

6.2.2 Experience and knowledge

Most of the ABO Wind's experience and knowledge of wind energy is centralized to Germany, so there is no need to localize all of them and it's not even profitable for by financial factors. Tasks that require special studies are normally not so common and there is usually already knowledge of them, those tasks can often be handled from the centralized location in a reasonable way. For example, the special tasks of teams not worth of to localication would be, changing of main components of the wind turbine like blades or gearboxes. Those kind of tasks are usually not so common and they require high knowledge and previous experience from the current process by practical and theoretical aspects. In this case the current team is easier to be placed in central location in order to handle the above mentioned tasks and travel from there to the site if needed.

Experience and knowledge can also be gained from colleagues. If all departments would be centralized, then gaining the experience from the colleagues would be maximized. But because there are some other factors why centralization might not be the best option it's therefore likely impossible or not ideal to handle everything from the central location.

If the tasks require consulting of colleagues it would be easier at the same workplace than by phone or email when it's slower and not so effective.

6.2.3 Cost-effectiveness

Because of the localization the companies usually want something in reward. Companies have to think economically so that they could succeed. Of course the costs of localization are higher at the beginning but they will stabilize in time. Most of the costs originate from facilities, labor, authority/legal payments, proper equipment, systems and tools. Some costs could also be caused when using outsourcing for a better success of the localization process.

6.2.4 Customers and markets

Mainly it would be easier to contact existing customers from a centralized location, if the knowledge and the network is based there. In case of ABO Wind's wind farms annual reports for customers are given in meetings which the customer is usually hosting, therefore Germany offers a more central location for them.
However, localization may have a few advantages like:

- Possible new customers
- New markets
- Ability to get an overall view of the current markets.

6.2.5 Outsourcing

Outsourcing is necessary for some tasks that require special knowledge for example, local language. It can sometimes be a more effective way to handle some tasks with subcontractors and also to gain experience from the subcontractor. Outsourcing is also relevant if we have a lot of work that is simple, we don't have enough employees for the work or the work doesn't require special knowledge, then it could be reasonable to outsource at least a part of the work.

It is also important for companies to have a good relationship between the contractual partner e.g., if some task needs to be handled quickly, then the good relationship usually helps between the company and the contractual partner.

From Pros cons local central (Appendix 1) we can see that outsourcing is a topical question for some teams. It is clear that not all possible subcontractors will be able to handle all the required tasks in English, therefore it would be highly recommended to have someone who is able to communicate in the local language and who is able to instruct the subcontractors if needed.

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