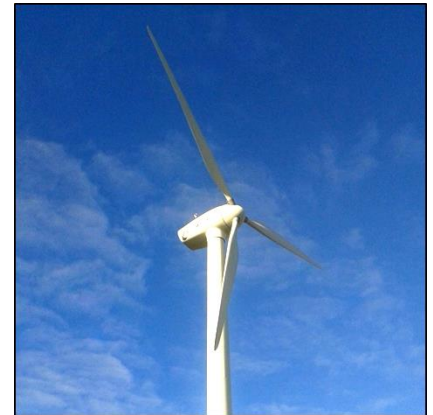


# SmallWind - Market Analysis and Prospects

## Final report

September 2016



DTU Wind Energy  
Department of Wind Energy



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## *Abbreviations*

SWT	Small Wind Turbine (includes turbines and blade manufacturers)
DK	Denmark
DTU	Danish Technical University
WP	Work Package
EGV	Energistyrelsens Godkendelsessekretariat for Vindmøller
FIT	Feed in Tariff
PBT	Pay Back Time in years
ROI	Return on Investment
IECRE	International Electrotechnical commission for Renewable Energy
IEA	International Energy Agency
LCOE	Levelized Cost of Energy
DA Toronto	Danish Consulate General in Toronto
B2B	Business to Business
SWOT	Strengths, Weaknesses, Opportunities, and Threats
DKK	Danish kroner

## 1. Project details

<b>Project title</b>	SmallWind - Market Analysis and Prospects
<b>Project identification (program abbrev. and file)</b>	Projekt nr. 64014-0161
<b>Name of the programme which has funded the project</b>	EUDP
<b>Project managing company/institution (name and address)</b>	DTU Wind Energy, Frederiksborgvej 399, 4000 Roskilde
<b>Project partners</b>	<p><b>DTU Wind Energy:</b> Peggy Friis, Davide Conti</p> <p><b>Brinch Management:</b> Michael B. Pedersen</p> <p><b>Ecology Management:</b> Svend W. Enevoldsen</p> <p><b>Olsen Wings:</b> Karl-Kristian Bro, Troels Agerskov</p> <p><b>HSWind:</b> Ulrich Høgenhaven</p> <p><b>Solid Wind Power:</b> Carsten Lauridsen, Honey Arora, Julius Vilovas,</p> <p><b>Thy Møllen:</b> Leif Pinholdt</p>
<b>CVR (central business register)</b>	30060946
<b>Date for submission</b>	September 1, 2016
<b>Web-site project documents</b>	<a href="http://www.vindenergi.dtu.dk/english/Research/Projects">http://www.vindenergi.dtu.dk/english/Research/Projects</a>

## 2. Short description of project objective and results

The project consists of four main objectives that all have led to distinctive results. The SWT **Market potential** has been studied and created a significantly improved insight of market potentials for SWT in DK and internationally; **Industrial business plans** for manufacturing and marketing have been identified, including options for inclusion of export; **A roadmap to SWT export** has been developed including a market penetration model and several essential tools for improving export readiness; An **Export campaign** has been conducted, which successfully has demonstrated how to prepare and realize an export campaign in an international setting. Hence, all barriers and challenges that the project has strived to overcome have been removed.

*Projektet består af fire overordnede mål, som alle har ført til markante resultater. Et SWT **Markedspotentialet** er blevet undersøgt og skabt en markant forbedret indsigt i markedets potentialer for SWT i DK og internationalt; **Industrielle forretningsplaner** for fremstilling og markedsføring er blevet identificeret, herunder mulighederne for inddragelse af eksport; En **køreplan for SWT eksport** er blevet udviklet, herunder en markedspenetrationsmodel og flere vigtige værktøjer til forbedring af eksportparathed; Et **Eksportfremstød** er blevet gennemført, som med succes har vist, hvordan man kan forberede og realisere et eksportfremstød i et internationalt miljø. Derfor synes alle barrierer og udfordringer, som projektet har bestræbt sig på at overvinde, at være fjernet.*

### 3. Executive summary

Danish manufacturers of Small Wind Turbines (<200m<sup>2</sup> swept rotor area) including components, and blade manufacturers (SWTs) have increasingly been looking for various ways to penetrate global markets to pursue export opportunities. The halt of the Danish small wind market in spring 2014 due to insecurity of the Feed-in-Tariff (FIT) actualized the need to look for new markets and revenue streams. During summer 2014 the Danish small wind industry lost more than 60% of its employment. Hence a Market analysis and prospects was of essence to the industry.

This report outlines the activities, results and conclusions of a project where 6 partners have joined forces to conduct a thorough analysis of markets and prospect in Denmark and internationally. The marked analysis [2] shows that the Danish market has potential of 40.000 SWT installations with a baseline of 3.400 installations by 2024. The international markets are difficult to quantify due to insecurity of data sources and estimation methods. Thus, the international export market potential has been qualified based on best available data sources, which shows that the most promising export markets are Italy, Japan and US, as well as emerging off-grid coupled wind-diesel (e.g. in Canada). For some of these countries estimates of potential installation capacity are available.

The market force of the Danish SWT technology was mapped during the partners' joint market delegation to Canada in October 2015. In the eye of potential customers, agents and other stakeholder the Danish SWT technology shows much competitive strength, where Origin, Durability and Economy are the dominant selling points. The joint delegation turned out to be important for testing international marketing materials, approaching potential customers face-to-face, and participating in B2B meetings in English.

The ways forward for the Danish SWT technology and potential international export markets are three-fold. Firstly, an Export handbook and a roadmap to export have been developed to support manufacturers in handling operational and practical issues in building export business. Secondly, a number of findings in the manufacturers business models shows that export can be integrated and stimulate more sustainable business models and plans. The analysis also showed that home market presence in Denmark is imperative for R&D and export. Finally, a combined Danish and Export Market prospect of a potential market value of 1 Billion DKK within the next 4 years, corresponding to 1.000 jobs, should be a strong driver for the manufacturers to pursue and invest in market penetration.

Based on the results and conclusions of this project it is evident that the future of the Danish Small Wind Industry will depend of a variety of internal and external factors. These have been outlined in three different scenarios of which the most promising - "Boosting R&D", can kick-start an export adventure and create access to the largest customer base.

## 4. Project objectives

The project is built around four objectives and structured through six Work Packages (WPs) as described in Table 1. A full project overview and hierarchy including tasks, and deliverables and reports is presented in Figure 8.

Main Objectives	Supporting Work Packages
1. Market potential: Improve insight of market potential for SWT in DK and internationally	WP 2. Danish Market Forecast and Barriers
	WP 5. International Market Description
2. Industrial business plan: Identify industrial business plans for manufacturing and marketing.	WP 3. Danish Manufacturers Business Model
3. A roadmap to SWT export: Provide insight and raise the knowledge on export	WP 1. Export and Market Initiative
	WP 4. Workshop
4. Export campaign: Demonstration and realization of an export campaign	WP 6.7 Market Approach

Table 1: Project Objectives and Work Packages

The project took place from December 2014 till May 2016. Overall, the planned Tasks, Work packages, deliverables, milestones and objectives were successfully fulfilled by the project partners.

Task force meetings were held periodically by DTU Wind Energy, Brinch Management and Ecology Management, and served as cooperation tool to lead the project. Meetings were held on the following dates: 18<sup>th</sup> February 2015, 11<sup>th</sup> June 2015, 12<sup>th</sup> November; 17<sup>th</sup> December 2015; 03<sup>rd</sup> May 2016.

The project's milestones were also successfully achieved. All the project's partners took part at the following Milestones (M):

- M1: Kick-off meeting in Vejle on February 11, 2015: The meeting was organized as wanted by EUDP in order to set up project and include an additional milestone (M6)
- M2: Companies visit + survey
- M3: Workshop in Silkeborg on June 4-5, 2015
- M4: One week delegation in Canada
- M5: Workshop in Odder on 30<sup>th</sup> January 2016
- M6: Final paper. See section 7. Is there a future role for Danish SWTs?

The deliverables and reports were submitted and distributed among partners through Dropbox. Summaries of each WP are presented in report [1] appendix B, which describes the main results, conclusions related documents and inputs to M6.

The documents listed in Bibliography are available at [www.vindenergi.dtu.dk/english/Research/Projects](http://www.vindenergi.dtu.dk/english/Research/Projects).



## 5. Project results and dissemination of results

### 5.1 Market potential (Objective 1)

#### 5.1.1 Danish Market (WP 2)

An extensive study of Danish market, including drivers and barriers, facts and statistics was conducted and is described in detail in [2] and [3] (WP2, Task 2.1). The **key-results** are here shortly presented:

Denmark is an ideal market-place to support a robust national SWT industry development:

- Technical Certification Scheme for SWT and entry barriers for competitors
- 1.631 SWTs installed by end of 2015 (560 turbines in 2015), corresponding to approx. 15 MW
- Danish SWTs are solid leaders in DK and hold a 72% market share
- The leading imported SWT is a certified design from 1990s with Danish origin
- Danish SWTs have increased market shares by +16% compared to 2012
- Chinese imported turbines accounted for less than 1.5% in 2015
- "Stop-go" incentive programs caused reduction of sales in 2013-2014 and again an increase of in 2015, figure 1
- Unstable market conditions threaten the industry development
- Potential Market demand is estimated to ca. 40.000 SWT installations
- Base scenarios: estimates 3.400 installations by 2024 , (8.5% of market potential) [2]
- Danish Industry, supply chain, service and R&D hub, are all in place
- Testing sites are available for research and manufacturers
- National market stability is needed to finance export market investments
- Pay Back Time (PBT) is 7.5-10 years with FIT as of august 2015. Thus SWTs is a competitive investment compared to Photovoltaic, Heat Pump or shares in large wind turbine
- SWTs can be more optimally and cost-efficiently designed, the unstable and short-term support strategies does not create incentives for design-optimizing investments.

The Danish technical certification scheme [BEK73](#), defines requirements for SWTs, including design, tests, certification and service. The certification scheme guarantees that only safe, reliable and durable wind turbines (and components) gain access to the market. Noise measurements in compliance with [BEK 1284](#), and grid codes in compliance with [TF 3.2.1 or TF 3.2.5](#) to be fulfilled as well. The Danish BEK73 for SWT, it is seen by the International Standard community, as a role certification scheme, and Denmark is a key stakeholder active in supporting and developing the [IECRE](#) Group Certification for small wind [SG 554](#).

In 2015 the Danish manufacturers account for 5 out of 10 type-certified SWT in Denmark, technical specifications can be found at EGV's website ([here](#)).

Since 2010, the Danish market has experienced unstable trends, demonstrating the high dependency of the industry on appropriate incentives programs. However due to "stop-go", short term (1-year) and different (6kW-10kW-25 kW) subsidies strategies adopted by the Government within the last 6 years, the industry development is highly threaded, with significant impacts on sales volume and market players.

In 2010, the Danish legislation established an incentive program (Net Metering) for household supply with solar, wind and biomass with up to 6kW installed capacity. This support scheme was phased out in 2012, contributing to a shocking decrease of sale's trend by 2014. New legislation was established

February 2015, as a Feed in Tariff (FIT) program with a significant positive support to the market trends (see Figure 1).

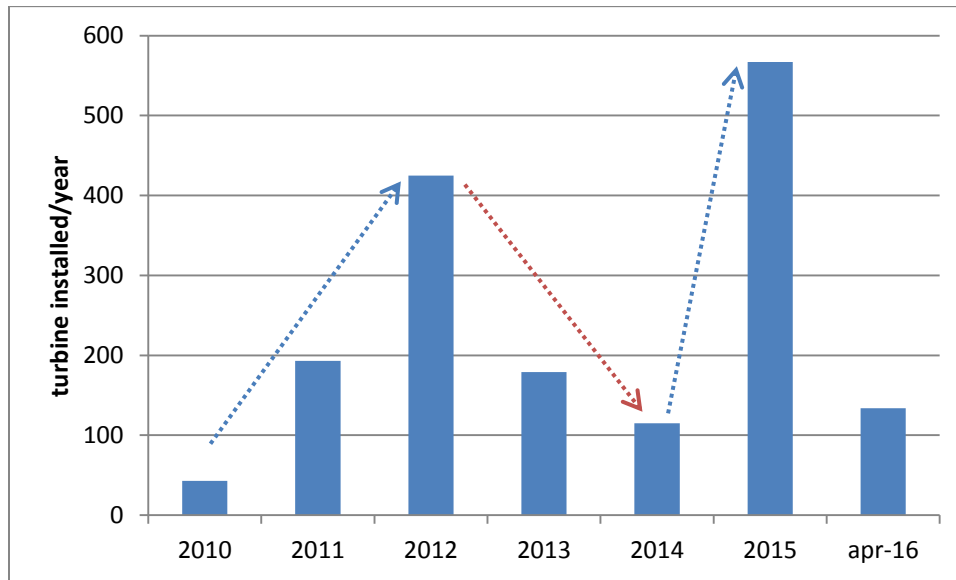


Figure 1: Market statistics in Denmark, annual installed SWTs and sales trends 2010-2015.

Moreover unstable subsidy programs have impacted the key market players. Leading manufacturers in 2012, producing 6 kW turbines, were completely cut-out of the market three years later, with no sales registered in 2015. An overview of policy market influence is given in Figure 2, hence in 2012 the number of installed turbines with rated power 6kW and 10kW respectively accounted for 354 and 0, whereas in 2015 accounted for 1 and 501.

In 2014, a new Danish manufacturer came on the market with a newly designed turbine, reaching a significant sales volume in 2015. This evidence demonstrates the high competitive role and market strength of Danish manufacturers compared to imported turbines. The Danish SWTs including Solid Wind Power, HS Wind, Thy Møllen and KVA Vind account for 72% of current market share in Denmark (see Figure 2). This corresponds to an increase by 16% market share in 2015 compared to 2012. Chinese imported turbines account for less 1.5%, whereas the bulk share of the EU imported turbines are produced by Gaia Wind Ltd, a former Danish company, with a Danish design certified for the first time 20 years ago.

Danish turbines are solid market leaders and synonymous of tradition, reliability, quality and durability.

The analysis of future market potential is well-described in the [Report on Forecast and Barriers \(WP Task 2.1\)](#) [2]. In this study, 40.000 potentially sites for SWT installation are found. Installation sites are identified as farms, rural houses etc. Statistics are collected from BBR register, Naturstyrelsen and Danmarks Statistik at table BYGB12. Data are adequately corrected accounting for disused properties, zones permitting, presence of obstacles and low wind resources. It is found that 85% of realizable potential lies within Nordjylland, Vestjylland, Sydjylland and Vest-Sydsjælland. The 42 municipalities with the highest potential are listed in [2].

Based on estimated potentials, three future scenarios are formulated within the next 10 years (see

Figure 3). Market status and development after 2016 is predicted by assuming different market conditions, e.g. incentive programs and ability of the industry to deal with tighter financial conditions. Assumptions, calculations and sensitivity analysis are presented in [2].

The SWTs economy is calculated by analyzing data provided by partners and other manufacturers. Four general SWTs models, representing the current available technology in the market are defined and the relative costs estimated (see Table 2). In addition a competition analysis is conducted with other investment alternatives including investing in shares in large wind turbine projects, solar PV and heat pumps [2].

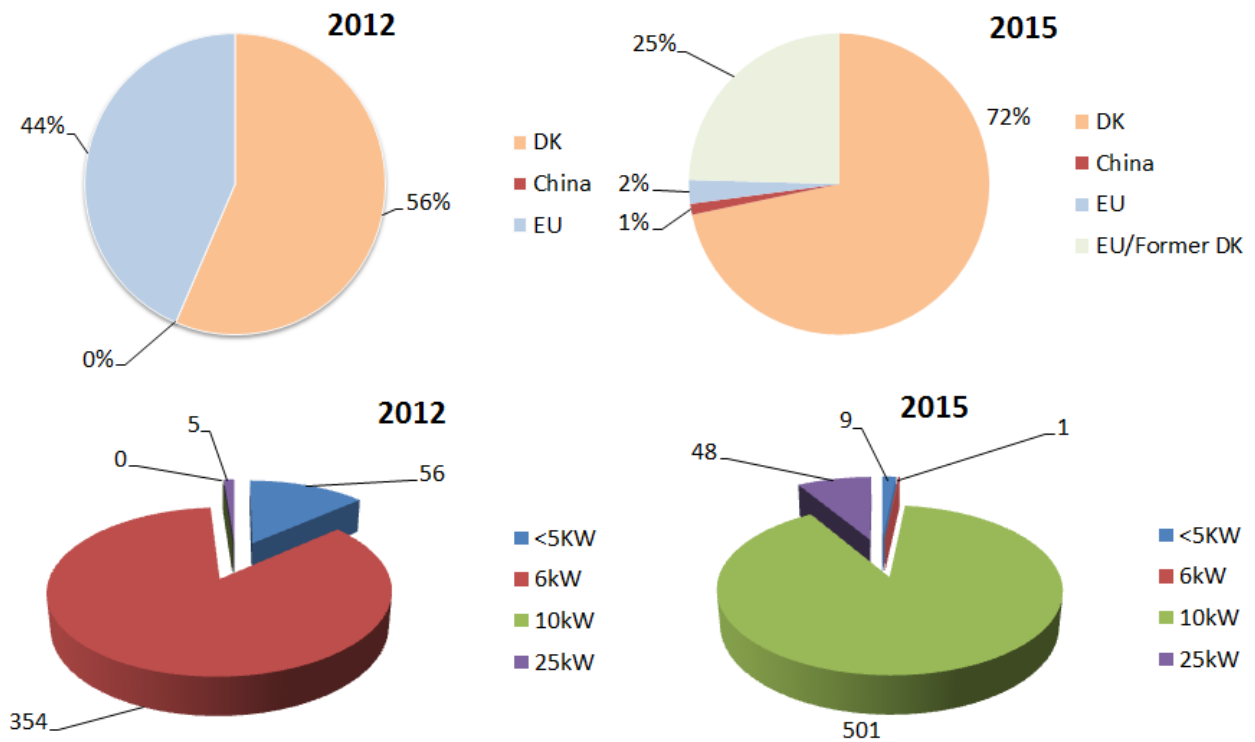


Figure 2: Market share according to turbine size and manufacturers nationality. Source: EGV

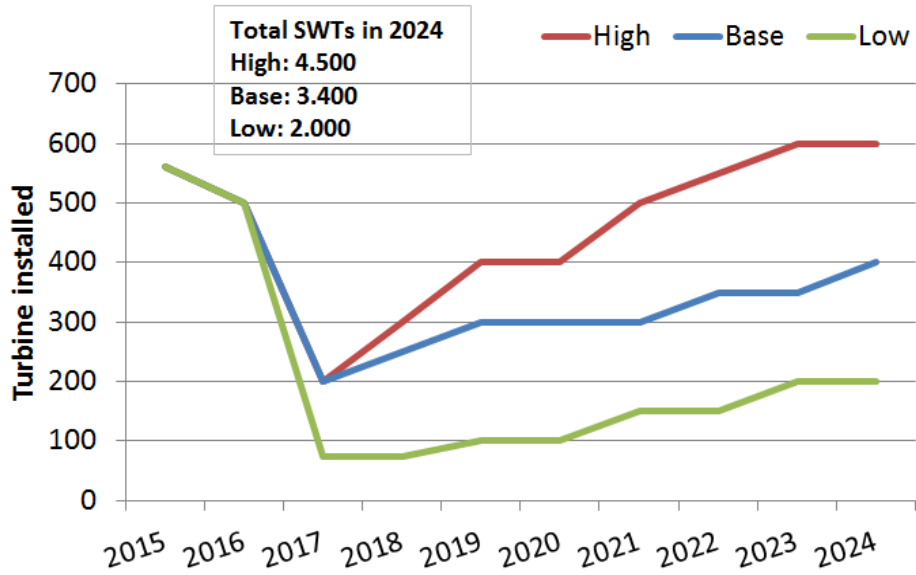


Figure 3: Future scenarios and annual installations forecast for the next 10 years [2]

Turbine size: (kW & rotor area)	Income from production [DKK/yr]	Cost-O&M and insurance [DKK/yr]	Total income [DKK/Yr]	Incl. VAT			Excl. VAT		
				Fixed investment [DKK]	PBT	ROI [%]	Fixed Investment [DKK]	PBT	ROI [%]
<b>Small Wind 1</b> 6kW/40 m <sup>2</sup>	48.500	4,300	44.200	371,200	<b>8.4</b>	<b>11.9%</b>	297,000	6.7	<b>14.8%</b>
<b>Small Wind 2</b> 10kW/40 m <sup>2</sup>	58.200	4,300	53.900	421.250	<b>7.8</b>	<b>12.8%</b>	337.000	6.2	<b>16.0%</b>
<b>Small Wind 3</b> 10kW/133 m <sup>2</sup>	84.875	10,000	74.875	687.500	<b>10.9</b>	<b>10.9%</b>	550,000	7.3	<b>13.6%</b>
<b>Small Wind 4</b> 25kW/154 m <sup>2</sup>	100.500	11,000	89.500	850,000	<b>10.5</b>	<b>10.5%</b>	680,000	7.5	<b>13.2%</b>

Table 2: SWTs economy of current technology in the Danish market in 2015 [2]

### 5.1.2 International Markets (WP 5)

The **key-findings** for international markets are hereafter presented (WP5); a major focus was on most promising markets including North America, Canada, China (WP Task 5.2), Europe (WP Task 5.3), Japan and Brazil as well as emerging markets for hybrid systems coupled wind-diesel (W5 Task 5.4). Project partners have gained knowledge of the above markets regarding:

- Certification schemes and technical entry barriers
- Subsidies and Government support strategies
- Grid codes and building codes
- Stakeholder analysis including supply chain, service sectors and developers
- First contacts with key stakeholders in US, Canada, Italy and Japan
- Customer analysis
- Competition analysis
- Market statistics, facts and trends.

Regarding the International Markets Analysis as a whole (WP Task 5.1–5-4) the **key-results** are extensively described in [4], [5] and summarized below:

- It was not possible to validate and find reliable sources estimating accurately and extensively worldwide market potential
- Incentive programs are active in 24 countries in Europe, North America (US, Canada) and Asia (Japan)
- Most promising export markets are Italy, Japan and US and emerging off-grid coupled wind-diesel (e.g. in Canada)
- Limited and lower competition in regulated markets (e.g. DK, UK, US, Japan), where certification is a requirement. There are 59 out of 320 turbine models which are certified worldwide (in 2015) according to [6], than can gain access to these markets
- To our knowledge, there are 7 SWTs above 20 kW and 14 SWTs between 5-10 kW that are certified (in 2015) see Figure 4
- Unregulated markets with no entry technical barriers, have seen installations of unreliable, low quality and not durable SWTs
- Italy, France, Germany, China, Canada and more, have registered several bankruptcies due to failures in turbine design and inability to meet technical requirements
- Lack of solid market leaders in promising markets
- Danish SWTs have several competitive advantages in foreign markets (see Section 5.4.25.4.2 Danish SWTs in foreign markets: strengths, opportunities and Unique Selling Point)
- Emerging markets as hybrid and off-grid systems coupled wind-diesel are economically attractive even without incentives, LCOE between 2-5 kWh per litre diesel [4]
- World market expected to rise by 19-35% annually
- Market drivers are supporting policies and ecological profile
- Italy potential of 870 MW installation including SWTs, by 2017
- US potential for 30GW new installations including SWTs, by 2030 [7]
- Japan has the highest FIT worldwide for SWT.

The most promising markets are identified with regard to active incentive programs, certification scheme and technical entry requirements, lack of solid market leaders, low competition, established customers, and technical and economic feasibility for export of Danish SWTs. Separate market reports for the United States,

Brazil, Canada and Japan were prepared by DA Toronto [5]. Analysis of European countries is described in [4]. The certification schemes and specific technical requirements, together with building codes and grid codes are addressed in [8].

A competitor analysis is also conducted and a database of worldwide certified turbines combined with technical specifications is developed and reported in [4]. Data were collected through mutual collaboration with international certification authorities.

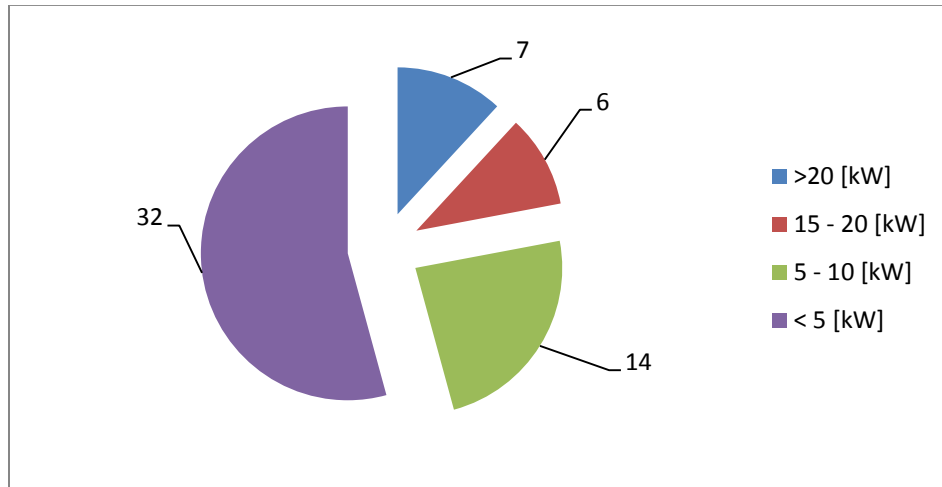


Figure 4: Worldwide Certified (59) turbines classified accordingly to rated power (in 2015).

## 5.2 Industrial Business Plans (Objective 2; WP 3)

The following **key-findings** can stimulate more sustainable business models and plans for SWT and component manufacturers in Denmark:

- Home market presence is imperative for R&D
- Pursue markets with stable FIT and established customers
- Increased turnover through exports can stabilize the underlying volatile business in the Danish "stop-go" FIT environment.
- A market penetration strategy must fit with the business plan, where "Time-to-market" and Return on Investment (ROI) is of essence to develop a successful SWT export business.
- Using the export strategy "Test once, certify everywhere" will keep the exporter agile and flexible in global markets.

An Interview Framework (Task 3.1) was prepared in the Task Force and initially used for a WEB Survey targeting the four manufacturers. The WEB survey provided valuable input for preparing site-visits and interviews, and substantial data for the SWOT analysis [9].

The subsequent SWOT Analysis (Task 3.2), based on both the WEB Survey and the site visits and interviews, is presented in the internal report *Danish Manufacturers Business Model* [10].

The analysis highlights the main Strengths, Weaknesses, Opportunities and Threats of integrating export into the manufacturer's business model, and is described in detail in the report. The reports main results are three-fold:

- The manufacturers run their businesses in the cross-field between a craftsman workshop and an industrial company, which creates dilemmas and paradoxes.
- The manufacturers face challenges in pursuing export, and four recommendations for preparations for the CanWEA Delegation, October 2015 is given.
- Three critical points of attention is outlined for the Manufacturers to focus on.

A detailed resume of the results of the WEB Survey, the site visits and interviews, and the SWOT analysis is given in relation to four business model drivers: Organisation (sales organisation, logistics, key-personnel etc.), Product & production (Product quality, R&D, Production Capacity etc.), Economy (Cost & profitability, Markets & Sales Forecast), and Market & Competition (International Type Approval and Certification, Fit-in-tariffs, new Chinese low-cost type approved SWTs)

A Model for Market Penetration, (Task 3.3) for Danish manufacturers going to international markets, has been developed, based on substantial input from, and in discussion with, the four manufacturers, invited experts at the Workshop (Objective 3), and during the Market Delegation (Objective 4).

The 3-step model describes a market penetration approach through 1. Market Analysis, 2. Market Introduction and 3. Market Maturing. Examples of market penetration and lessons learned can be found in [4].

Discussion during and post-Market Delegation in Canada, clearly demonstrated that the model is a valid source of guidance for the manufacturers. One aspect that cannot be captured in a normative step-wise model was found to be "Time-to-Market", which became apparent when assessing opportunities for penetrating the Canadian Market. However, the manufacturers have become increasingly aware of how a market penetration strategy most fit with their business model and provide an adequate return on investment (ROI) to their business plan.



Figure 5: A 3-step Model for Market Penetration, source [4].

The Product Portfolio Alignment Guide (Task 3.4) has been developed, based on the work undertaken in the national and international certification schemes such as IECRE and IEA Task 27, Type Certificate Process and Formats, and a global certified turbine database. Driven by the export strategy “Test once, certify everywhere” a number of detailed technical specifications and demands have been listed for the manufacturers consideration. The different national markets have different certification rules; building codes and grid codes. It follows that there is not one standardized and unique definition for small wind turbines, which is recognized worldwide. The report [8] provides an overview of the requirements needed for Danish manufactures to access foreign markets.

### 5.3 A road map to SWT Export (objective 3)

The following **key-findings** provide insight and raise the knowledge of doing export among the Danish SWT manufacturers:

- Home market presence is imperative for R&D
- The internal and external challenges identified through SWOT should be used to integrate export into the business model.
- The individual export model/strategy identified as well as options for promotion of export encountered should be used to further develop the business plan.
- The Export Handbook serves as a practical tool with access to template forms, operational guidelines and checklist for self-assessing export readiness.
- The knowledge and experience gained and exchanged during site visits and Workshop represent important building blocks in the manufacturers' individual road maps for profitable domestic - and export markets

#### 5.3.1 Export market incentives (WP 1)

The Export model/strategy (Task 1.1), presently applied by the manufacturers, was individually described through a WEB Survey and with follow-up interviews 6<sup>th</sup>-7<sup>th</sup> May 2015 at four different production locations; SWP in Ringkøbing, Thy Møllen in Hurup, Olsen Wings in Odder, and HS Wind in Randers. The questionnaire applied in the WEB Survey and the interview framework applied in the on-site interviews, are presented in [10] as appendices A and B respectively.

The results show that three of four manufacturers have export experience, and all four finds it imperative to define its own export model strategy. Due to the difference in their individual business models, they also see different challenges when it comes to how to integrate export into their business models. On the other hand, the manufacturers also pointed out some generic opportunities and threats, which a summarized in Table 3.



Opportunities (O)	Threats (T)
<ul style="list-style-type: none"> <li>- Export potential expected to be large</li> <li>- Export can stabilize underlying business</li> <li>- Production Capacity in place and available</li> <li>- "Made in Denmark" gives competitive advantage</li> <li>- The SWT export market is blooming/expanding from recovery</li> </ul>	<ul style="list-style-type: none"> <li>- Stop-Go FIT rules and tariffs</li> <li>- Lacks sales organizations/-channels</li> <li>- Lacks service organization with a "License to Operate"</li> <li>- Product Liability Rules – High cost and high uncertainty</li> <li>- Not-established customers are "time-bandits"</li> <li>- Certification not in place for export</li> <li>- Higher price competition expected</li> </ul>

Table 3: Excerpt from the SWOT analysis, focusing on external opportunities and threats stemming from the export market. Translated from Brinch-Pedersen 2015 workshop presentation.

Various relevant Options for Export Promotion (Task 1.2) have been presented by experienced experts with substantial knowledge in export of similar technology complexity. This has been done as part of Task 1.1 where relevant green-tech model/strategy examples originating from DTU, EC Horizon 2020 (environment, energy, materials) a.o. were discussed with relevance to the manufacturers present export model/strategy. Other relevant options have also been presented as part of WP Task 4.1 and 4.3 (see below), and as part of WP Task 6.7 (see Section 5.4).

The presentations have mainly been intended to be a source of inspiration and a way to create knowledge transfer, rather than reproduce other technologies export model / strategy in a systemic way. This was done by carefully weighing up of the producers' needs and insight into their own business model to ensure that the presented options provide relevant for the development of Danish SWT export.

The Export handbook via Væksthus (Task 1.3) has successfully been developed in an iterative process with Væksthus Midtjylland, combined with frequent amendments, adjustments and consolidations based on input from the four manufacturers and experts. The final report is available as [11].

The handbook is a practical tool that provides guidelines for implementing export into the business plan. It gives access to template forms for agreements and templates for other legal paperwork and explanation to their use and limitations. Sources for template forms and practical guidelines and experiences have been compiled from various sources such as Væksthus Midtjylland, Danish Industry's Export Handbook and The Danish Ministry of Foreign Affairs Exportguide.

Also contained in the Handbook is a checklist for self-assessing export readiness, and supplementary options for export promotion, including Export channel by Agent, Sales Office etc., and sales and marketing from cost- practicality- legal perspective.

### 5.3.2 Workshop (WP 4)

In order to support the design of a roadmap to SWT export, a Workshop in June 2015 was planned to focus the project and exchange of experience and discussion of ways for market penetration.

The Programme/Workgroup Areas (Task 4.1) were organised in three sessions over two days to ensure maximum progression in relation building, exchange of experience, and out-put. The objective and content of the three sessions is shown in Table 4.

Session 1 (Internal)	Markets & Business Models	WP 2, 3 and 5 Status and discussions Key-milestone introduction
Session 2 (open)	Market Penetration	WP 1 Status and discussion External expert presentations Options for export promotion Individual consultations (expert-manufacturer) Product Portfolio Alignment
Session 3 (Internal)	Get ready	WP 6.7 Status and preparations Key-milestone wrap-up Roundtable discussion Conclusions and follow-up

*Table 4: Sessions and Content of SmallWind Workshop, 4th- 5th June, 2015*

Prior to the workshop, a draft programme was discussed bilaterally with each manufacturer to ensure maximum buy-in and facilitation of the manufacturer's needs and wishes. The final workshop programme can be found here [12].

The Workshop Logistics (WP Task 4.2) were handled by the Projects Task Force. The Venue was decided to be at Hotel Scandic in Silkeborg, due to the city's central location for all four manufacturers. The hotel provided all necessary AV-equipment needed by internal and external speakers.

The Conclusions and Recommendations from Workshop (WP Task 4.3) is presented in the Report on Outcome of Workshop [13], and has been summarized (and translated) as follows:

"Based on the workshop's objectives and expectations for output, it was concluded at the end of the Workshop that the participants have:

- Delivered clear and substantive input to the Projects Key-milestone and Question: Is there role for Danish suppliers of components and small wind turbines on the Danish and international market? Who are the customers? And why?
- Discussed market potentials and opportunities for inclusion of export in the business model.
- Actively exchanged experiences based on presentations and prospects.
- Achieved enhanced motivation for trade delegation and increased awareness of what preparations should be done before."

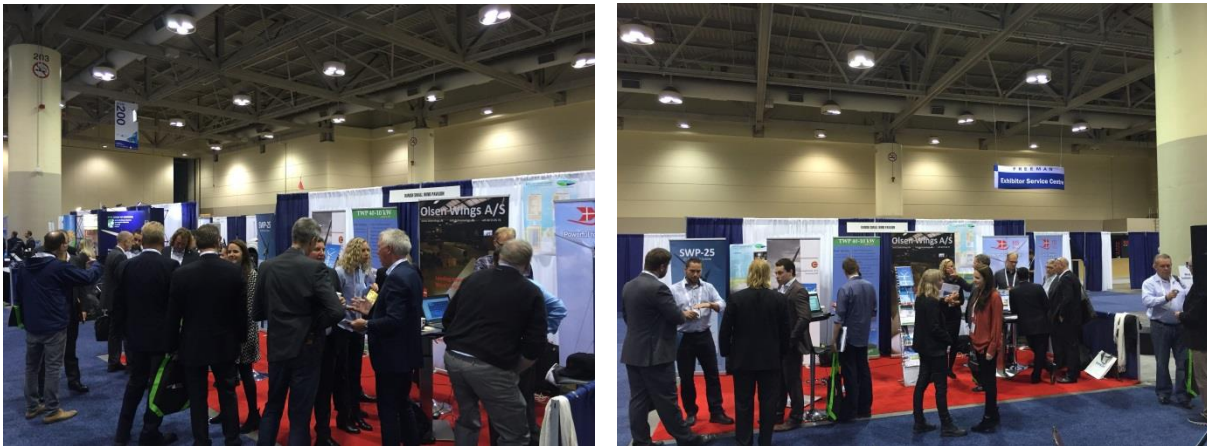
Minutes of presentations, conclusions and recommendations, including reference to the presentations, can be found under the individual agenda items in the workshop report.

## 5.4 Export Campaign (Objective 4; WP 6)

### 5.4.1 Market approach in Canada: A successful experience

All project partners took part at the export campaign in Canada (WP6 Task 6.7). A Danish delegation pavilion was organized at the Canadian Wind Energy Conference, [CanWEA 2015](#), lasting for three days. Project

partners shared equally space, time and resources at the CanWEA, setting a milestone for the Danish Industry into this co-organized and shared export adventure. The Canadian delegation was planned and orchestrated by the precious collaboration of the Danish Consulate General in Toronto (DA Toronto), under the Royal Danish Embassy of Canada, which delivered an excellent work for project partners.



*Figure 6: Danish Delegation pavilion at CanWEA 2015*

The scope of the delegation was to clarify export opportunities for Danish SWT in Canada and North America, through a first-hand export experience. The DA Toronto organized several business-related activities and facilitated networking with key Canadian stakeholders, including:

- Meeting with representatives of Wind Energy Institute of Canada ([WEICan](#))
- Danish Small Wind Pavilion at CanWEA
- Companies presentation and visibility at CanWEA [14]
- B2B meetings opportunities:
  - o WWF-Canada headquarter in Toronto
  - o Thunder Bay representatives
  - o Individual B2B meetings, overall more than 32 stakeholders at CanWEA
- Meeting with VIP stakeholders; including the Danish Ambassador to Canada
- Visit to [Kortright Centre](#) – Test facility for SWTs.

The B2B meetings were planned in advance, in cooperation with individual project partners, thus key stakeholders were identified and invited, which matched specific company needs and strategies. Canadian and North American stakeholders included developers and distributors, service companies, NGOs, manufacturers, refurbishment businesses, financiers, economic developers, education/training specialists, politicians etc. Among VIP stakeholders, high political, economic and ministerial representatives were invited to networking with Danish partners in a private event hold for the occasion. A list of key contacts and the agenda are presented in [15].

The Danish SWT Pavilion was placed visible and appropriate at CanWEA. The location opposite the lecture area "Learning Centres" was instrumental in generating traffic and attention. Danish delegation was also invited to give a well-attended lecture entitled "Growth of the Small Wind Market – A Danish Perspective" [16]. Considering that CanWEA in 2010 had massive focus on small wind industry, the Danish delegation was the only SWT exhibitors at CanWEA 2015, which provides the delegation unique and exclusive attention.

#### 5.4.2 Danish SWTs in foreign markets: strengths, opportunities and Unique Selling Point

At CanWEA exhibition, the market power of Danish SWT was examined by interviewing two target groups. One group consisted of stakeholders (n=12) representing market participants, researchers, politicians, NGOs and the DA Toronto. The second group consists of Danish delegation (n=7), which is the interview on the last day of CanWEA, to get maximum compendium. Moreover marketing strategies were examined through daily targeted observations.

The procedures used, list of contacts interviewed and the key findings are extensively documented in [15]. The purpose of investigating the market power through the interview is to get different stakeholders views on the future role of SWT on the Canadian/North American market, and their perspectives on Danish-produced small wind turbines strengths and opportunities.

The key strengths are listed below:

- "Made in Denmark" as a quality hallmark and a trade mark
- Denmark, story of self-sufficiency as a strong appeal for other markets;
- Danish wind culture, as "basin of competences", Risø/DTU Wind Energy renown
- Danish Small Wind Market as a role model for industry development
- Certified and tested SWTs, leading quality, reliability and durability
- LCOE of Danish SWTs is competitive with local manufacturers
- Origin, Durability and Economy as the dominant selling points.

Denmark is worldwide perceived as the cradle of wind energy, and there is high respect for Danish wind energy related businesses, especially manufactures and blade producers.

Danish SWT's economy calculated over the 20 years lifetime is competitive with North American, Canadian and Chinese manufacturers. Therefore Danish SWTs shall market the competitive advantages of better productivity, lower maintenance cost, and longer lifetime. The North American and Canadian key stakeholders have shown high interest and availability to work with Danish SWT and clearly declared the huge interest in Danish wind businesses. The key opportunities are listed below:

- Danish SWT has high market strength and a large export potential in Canada/North America
- Market power of Danish SWT can be further improved by focusing on the customer's ROI (Return On Investment)
- Improving the industry's product branding in order to consolidate the Danish SWT
- Elaborate a well-defined business plan, which document the cost-competitive advantage over 20 years lifetime
- Development of hybrid solutions e.g. off-grid coupled wind-diesel systems to enhance market power of Danish SWT
- "Wind turbine/Blade export" vs "System export".

The large export potential is supported by market forecasts studied and promoted by CanWEA in 2010 ([here](#)) and DWEA in 2014 ([here](#)), respectively for Canada and North America. The CanWEA delegation also provides a deep insight on customer segments and market opportunities regarding Oxford County, The Ontario Dairy Farmer Community and the Ontario FIT system, Aboriginal communities and Wind-diesel systems, WWF and Thunder Bay off-grid, and emerging renovation-refurbishment markets, which are detailed described in [15].

Marketing strategy shall emphasise competitive advantages, such as “Reliable-low cost alternative” of Danish SWTs, over the technical lifetime of 20 years. Even though the fixed cost of Danish SWTs is higher than direct competitors, the LCOE is competitive and the overall investment should be marketed promoting reliability, durability and performance to corresponding costs and revenues.

Product branding and customer development are processes that require presence in the foreign markets, establishing and strengthening partners relationships, face-2-face visits, attending conferences and seminar, etc. The use of social media is also widely recommended for branding purposes.

A technical challenge and a business opportunity lies in developing appropriate partnership for designing hybrid solutions e.g. wind-diesel systems. Danish SWT has opportunity to market on corporate social responsibility (CSR) level, and offer reliable and sustainable renewable energy solutions contributing to the development of small remote communities.

### 5.4.3 Post Canada, market and observations

The post-Canada workshop was organized in Odder on 28<sup>th</sup> January, three months after the delegation to Canada. The workshop served as an opportunity to elaborate lessons learned and follows-ups from each specific project partner. It was found:

- Danish industry is seen by Canadian/North American stakeholders, as great potential to deliver solutions for the market demand in Canada
- A project partner has extended commercial agreement with a Canadian customer
- First contacts with North America customers/partners are established
- Off-grid wind-diesel coupled system as a concrete and ongoing opportunity for Canadian market
- Lack of government’s long term strategies in most Canadian provinces induced uncertainty and high risk for market penetration
- Danish SWTs will prioritize resources in lesser risky markets with more attractive incentives program
- Ongoing cooperation among Danish SWTs to investigate wind-diesel system solutions for Canadian market
- Setup, methodologies and approaches applied in Canada are all valuable and replicable for future export campaigns.

The Danish industry's vast experience and ability to adapt technology and other services to the market is highlighted by several stakeholders and validated by follow-ups after CanWEA.

A regressive policy strategy in Canada is the main barrier for Danish SWT market penetration. Current incentives programs are being phased out, e.g. the FIT in Nova Scotia in 2015. Current government strategies largely differ from the policy agenda of 2010, for which CanWEA has estimated a prominent market growth [5] and [17].

Structure of exports to the Canadian/North American market is complex, costly and requires focus and commitment from the Danish partners. There are different terms and ways that can lead to an export business, but experience shows that there are some factors that must be in place and important to be evaluated for future export campaign:

- It is essential to ensure the quality of the product. This can be done by establishing facilities for service, maintain and repair along with/at the same time with a sales organization, combined with training of local to the remedying of defects and faults

- It is also essential to participate in conferences/fairs and to network e.g. "face-time" is irreplaceable. There are no short cuts. This requires visits to contacts and consistent follow-up, as well as to be there for his contact/customer

### 5.5 Prospects

In 2015, sales in the Danish market gave a turnover of ca. 284 million DKK. Data are calculated from total number of installations (560), and weighted for prices as given in Table 2. The calculation accounts for differentiation of Small Wind models (see Table 2), accordingly to market statistic presented in [3].

It is also estimated a factor of 50 man-years required for each 1MW installed. This is an approximation as a result of survey conducted with project partners and other statistics previously estimated e.g. in [17]. This employment rate accounts for man-power needed in manufacturing, sales, installations, O&M and services, and supply chain. In 2015, 6MW additional capacity was installed, corresponding to an estimated number of 316 full man-year jobs involved.

The prospects in term of turnover and jobs are estimated for the future scenarios formulated in Figure 3. An additional export scenario is defined by assuming a stabilized sales volume of 600 units/year, which corresponds nearly to the market volume solely in Denmark in 2015, hence it is a conservative estimate.

Results show a potential to reach a market value of 1 Billion DKK within the next 4 years, corresponding to 1.000 jobs (see Table 5). The worst and best case scenarios, respectively estimate a market size of ca. 1 Billion DKK and 2 Billion DKK, and ca. 2.000 and 3.360 jobs by 2024.

	Sales, in Million DKK				Employment, in Man-years			
2015	284				316			
	Base (DK)	Low (DK)	High (DK)	Export	Base (DK)	Low (DK)	High (DK)	Export
2018	766	614	791	1.197	852	682	880	1.331
2020	1.071	715	1.197	1.807	1.190	795	1.331	2.009
2024	1.781	1.071	2.340	3.025	1.980	1.190	2.601	3.363

Table 5: Prospects in term of Sales and Employment rates within the next 10 years



## 5.6 Dissemination strategies

A mix of joint partner strategies and partners individual efforts has been applied for dissemination. Joint partner strategies included activities aimed at primarily technology- and market-oriented audiences:

- A lecture entitled "*Growth of the Small Wind Market – A Danish Perspective*" was given at the CanWEA Conference in Canada [16]
- Presentation of project scope and draft results at the "Temadag for Hustrandsmøller" in 18<sup>th</sup> September 2015
- Presentation of the projects final results at "Temadag for Hustrandsmøller" to be held 9<sup>th</sup> September 2016
- Market introduction is supported by [myWindTurbine.com](http://myWindTurbine.com) that is an easy tool for calculation the feasibility of small and medium sized turbines
- Finally, the main reports and outcomes will be made available on the web by DTU Wind Energy, [www.vindenergi.dtu.dk/english/Research/Projects](http://www.vindenergi.dtu.dk/english/Research/Projects).

Partner's individual efforts included dissemination of findings and prospect to various stakeholders, ranging from industry associations, supply-chain/commercial partners to local politicians.

## 6. Utilization of project results

### 6.1 Business model integration

Through this project, the partners have recognized that integration of export into the manufacturers business model is essential to creating a sustainable business. The reason is the Danish domestic market is too small and volatile with fluctuating market conditions; consequently export is needed to stabilize their underlying business.

Following discussions at their production locations, the Workshop in Silkeborg, during CanWEA in Toronto, Canada, and at the Network Meeting in Odder, the Manufacturers expects three business drivers will be essential to their business planning to realise the export potential:

- Costs will be in focus in order to maintain and if possible strengthen competitiveness against foreign produced SWT from e.g. China. In this context, the cost concept has two dimensions: To reduce the production cost of adjusting the selling price to the level of the export market, and to document the product's overall cost/kW during the life-cycle of the product (LCOE).
- The SWT must be based on a scalable design; a standard that can flexibly be adapted by changing the power regulator to maximum production capacity in the most favourable FIT area, both in terms of geographical market and power span.

The off-grid market has traditionally focused on wind-diesel solutions to remote areas. With recent developments in new storage technologies and renewable forms of energy, such as hybrid technologies, the ability to develop new stand-alone energy platforms where SWT is a key component has increased. This can be pursued as systems export and through development of such solution in R&D partnerships.

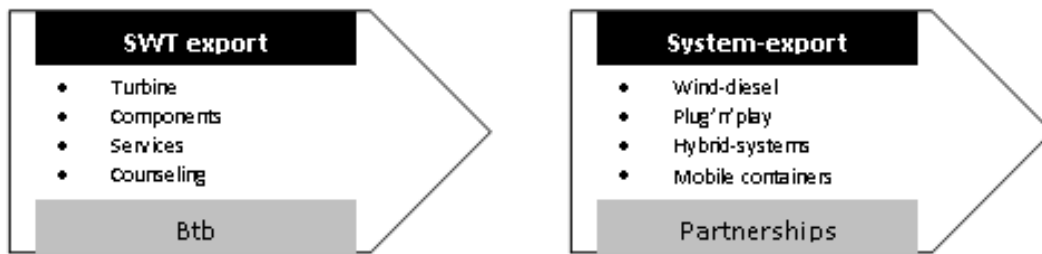


Figure 7: Two export models [15]

## 6.2 Export readiness and focus

Through the project the partners have gained understanding and experience on how to build and focus marketing and export efforts. In particular, the following results and areas of effort have already been adopted and utilized by the partners:

- **Networking**; all partners have established new contacts and informal relationship to share experiences and assist in further networking and collaborative actions.
- **Sales and Marketing materials**; the manufacturers are now further developing the strategies and materials applied and tested during the CanWEA delegation to Canada, including company profiles, flyers, roll-ups, web-sites in additional languages e.g. English and French. These materials are now being used in sales pitches and export campaigns.
- **Market selection and penetration**; inspired by the projects results, some partners have simultaneously undertaken self-organized export campaigns and made their first market approaches in Italy, US and Japan.
- **Sales and Services organisation**; currently, manufacturers are gaining hands-on experience in extending their outbound infrastructure. The Export handbook has shown to be of vital importance to provide guidance at the practical level. In some cases networking has enabled even more tailor-made solutions.
- **Technology alignment to new market demands**; some manufacturers have invested revenues from domestic sales in 2015, into technological development and adopting scalable and flexible design for compliances with foreign markets regulations. New turbines models are currently under certification process and testing, through IEC standards, for final market access.
- **New business areas**; some manufacturers are currently cooperating to pursue new innovative system export opportunities. Some partners are testing if they can transfer the knowledge from this project towards other areas of complex technological export.

This utilization is now enabling the manufacturers to move from step 1. Market Analysis towards step 2. Market Introduction, according to the 3-step Model for Market Penetration, cf. Figure 5

## 6.3 Contributions to energy policy objectives

The project results contribute to realize energy policy objectives related to five general policy areas:

- Transformation from fossil fuels to renewable energy
- Availability of energy in remote/off grid areas
- Decentralized small scale energy production at household level
- Development and innovation of a renewable energy technology



- Enforcement of Danish Energy Technology export.

Since the main project results are aimed at export markets, the Danish SWT Industry has a prominent Global role to play in the contribution to UN’s Sustainable Development Goals [18] agreed in 2015 in the Resolution “Transforming our world: the 2030 Agenda for Sustainable Development”. Contributions will be made directly through two out of 17 goals; all related to sustainable energy objectives:

- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 12: Ensure sustainable consumption and production patterns

### 6.4 Overcoming barriers and challenges

In the original description of project EUDP Smallwind 64014-0161 the Barriers and Challenges for the Danish Small wind industry were listed, together with the goals of the SmallWind project, see table 1 in [19]. The status of achievement of the SmallWind goals and thus the fulfilment of the projects objectives has been attached to the original Table below. Due to the partner’s utilization of the project results, the manufacturers are now significantly better equipped to meet the challenges on the export markets and to expand the Danish industry for SWT to new markets.

Area	Barrier(s)/Challenge(s)	SmallWind	Status
<b>Market selection</b>	Knowledge to the market, Language, Legal issues, Distance, Technical Approvals, Grid Codes.	Comprehensive knowledge to what markets are hot, and what the obstacles are.	Fulfilled
<b>Documentation</b>	Manuals and Technical Information material lacks international level.	Roadmap to required information level needed in product documentation.	Fulfilled
<b>Readiness</b>	Insufficient experience and skills.	Workshop + Export campaign that highlights the actual process of exporting a long life product.	Fulfilled
<b>Capacity</b>	Lack of understanding customers’ expectations on delivery time and quantity, payment terms etc.	Roadmap to how distribution is made in the best way in consideration of market and own resources.	Roadmap done - To be fulfilled with increasing export

Table 6: Barriers and Challenges from Project description with status completed

## 7. Project conclusion and perspective

### 7.1 Is there a future role for Danish SWT manufacturers?

At the projects kick-off meeting in February 2015 in Vejle, EUDP challenged the project partners by asking an important key-question on which the successful outcome of the project will depend: **Is there a future role for Danish SWT?, Who are the customers? And Why?**

Hence, the conclusions are two-fold; 1) on basis of the project objectives and 2) as a response to EUDP's key-question.

Firstly, the overall conclusions from the Danish SmallWind project are clear:

- **The Global export market potential is huge:**
  - o Prospects for installed capacity is rising
  - o DK SWT is world class – reliable and cost effective
  - o Global customers recognize DK SWT technology to be a preferred choice
- **The willingness among Danish manufacturers to pursue export is strong:**
  - o The partners have gained important experience to enter export markets
  - o Partners recognize that export will stabilize the underlying business
- **The readiness among the Danish manufacturers to pursue export has matured significantly:**
  - o The main obstacles/barriers for Danish WST to penetrate export markets have been identified and partly eradicated.
  - o The Technological history/pool of competence to drive future market penetrations appears to be world-wide acknowledged
- **Danish Small Wind Technology is an attractive and cheap alternative**
  - o Levelized Cost of Energy (LCOE) that includes life-time cost
  - o Reliable technology
  - o Brand value

Secondly, the response to EUDP's question is more nuanced, because the role of Danish SmallWind depends on the future. What will the future bring?

Three different scenarios, "Stop-go Industry", "Stable Markets" and "Boosting R&D" is sketched in the next chapter and the EUDP question will be answered accordingly in Table 8.

### 7.2 Perspective/ Future scenarios

Based on the results and conclusions of project EUDP SmallWind 64014-0161 it has become evident that the future of the Danish Small Wind Industry will depend of a variety of internal and external factors. The future perspective is determined by the importance and certainty, which is attached to the forces that will drive the Small wind industry in General and the Danish SWT manufacturers in particular.

Some of the key-driving forces, which have been identified in the project, can be used to build some plausible future scenarios and thereby illustrate what efforts are needed from the various stakeholders, in order to achieve the vision for the desirable scenario.

Scenario	Stop-go industry		Stable Markets		Boosting R&D	
<b>Vision</b>	Consolidation - Number of manufacturers at home market adapts to short-term demand		Sustainable growth - Manufacturers gain competitiveness by reducing cost and/or gain access to new markets		Export adventure - Manufacturers take first-mover position in global markets with new generation of SWT solutions from industrialized line-production	
Driving Force	Importance	Certainty	Importance	Certainty	Importance	Certainty
Political drivers <sup>1)</sup>	High	Low	Low	Low	Low	High
Industry drivers <sup>2)</sup>	High	Low	High	High	High	High
Technology drivers <sup>3)</sup>	High	High	High	High	High	High
Innovation drivers <sup>4)</sup>	Low	Low	Low	Low	High	High
Market Drivers <sup>5)</sup>	Low	Low	High	Low	High	High
Customer Drivers <sup>6)</sup>	High	High	High	High	High	High

Table 7: Three future scenarios for the Danish Smallwind Industry.:

<sup>1)</sup> Feed-in-Tariff levels, Total production volume and deadlines.

<sup>2)</sup> Business model integration; Reduction of cost/lifecycle-cost; Export-organisation; Customer base.

<sup>3)</sup> Certification, Type approval, Scalable design.

<sup>4)</sup> Design optimization, Cost reduction, New hybrid off-grid solutions, home market presence for testing

<sup>5)</sup> Changed demand, short time-to-market

<sup>6)</sup> Reliable technology, favourable Return-of-Investment

Of these three scenarios, “Boosting R&D” represents a vision, which hold the potential to become a real export adventure for the Danish Small wind industry?

Contrary to the first two scenarios, where the main stakeholders are the manufacturers themselves, the “Boosting R&D” scenario call upon several stakeholders to come together. Here the Innovation drivers constitute the key component with high importance and certainty, compared to the other two scenarios. Therefore, stakeholders from research, testing facilities, and business modelling and market commercialisation must be involved

<b>1. IS THERE A FUTURE FOR DANISH SWT?</b>		
NO	MAYBE	YES
<i>Scenario</i>		
STOP-GO	STABLE MARKETS	BOOSTING R&D
<i>Time perspective</i>		
0-2 years	0-2 years	2-5 years
<i>Market focus</i>		
DK	DK + INT.	(dk) INT.
<b>2. WHO ARE THE CUSTOMERS?</b>		
<ul style="list-style-type: none"> <li>- Households on-grid</li> <li>- Households off-grid</li> </ul>	<ul style="list-style-type: none"> <li>- B2B export customers</li> <li>- Households on-grid</li> <li>- Households off-grid</li> </ul>	<ul style="list-style-type: none"> <li>- Private label</li> <li>- Agents</li> <li>- Retail chains</li> <li>- Rural communities</li> <li>- Export households on-grid</li> <li>- Export households off-grid</li> <li>- B2B export customers</li> <li>- Households on-grid</li> <li>- Households off-grid</li> <li>-</li> </ul>
<b>3. WHY?</b>		
<ul style="list-style-type: none"> <li>- Few turbines sold at domestic market</li> <li>- Some SWT producers will be stopped out due to lack of home-market demand.</li> <li>- Some SWT producers will maybe survive through export.</li> <li>- Domestic market will become marginal for component-suppliers.</li> </ul>	<ul style="list-style-type: none"> <li>- SWT producers who can adapt costs to international competition face growth through export.</li> <li>- Export may increase revenues to re-invest in R&amp;D and Marketing.</li> <li>- Component-suppliers benefit from increased export and access to international SWT customer base.</li> </ul>	<ul style="list-style-type: none"> <li>- Main turnover and revenue from export.</li> <li>- Ability to reinvest in SWT R&amp;D in Denmark and to scale-up industrial line-production.</li> <li>- Partnerships, strong market power and position, makes Danish SWTs more competitive.</li> <li>- High-end competitive position provides a sustainable future with great prospects for Danish SWT manufacturers and component-suppliers.</li> </ul>

Table 8: A response to the EUDP key-question according to three scenarios

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## Appendix A: Project structure and hierarchy

Main Objectives	Supporting Work Packages	Tasks	Deliverables and Reports
<b>1.</b> Market potential: Improve insight of market potential for SWT in DK and internationally	<b>WP 2.</b> Danish Market Forecast and Barriers	<b>T 2.1</b> Denmark/Report on Forecast and Barriers	<b>D2.1</b> Small Wind DK markedsrapport WP2. Birger T Madsen [2] <b>D5.1</b> Market approach 1-week delegation [15] <b>D5.2a</b> Markedsanalyse Europa [4] <b>D5.2b</b> SWT Report by DA Toronto [5]
	<b>WP 5.</b> International Market Description	<b>T 5.1</b> Canada <b>T 5.2</b> China <b>T 5.3</b> Europe <b>T 5.4</b> Emerging markets	
<b>2.</b> Industrial business plan: Identify industrial business plans for manufacturing and marketing.	<b>WP 3.</b> Danish Manufacturers Business Model	<b>T 3.1</b> Prepare interview framework <b>T 3.2</b> SWOT Analysis <b>T 3.3</b> Model for Market Penetration <b>T 3.4</b> Product Portfolio Alignment	<b>D3.1</b> Danish Manufacturers Business Model [10] <b>D3.2</b> Product Portfolio [8]
<b>3.</b> A roadmap to SWT export: Provide insight and raise the knowledge on export	<b>WP 1.</b> Export and Market Initiative	<b>T 1.1</b> Export model/strategy <b>T 1.2</b> Options for Export Promotion <b>T 1.3</b> Export handbook via Væksthus	<b>D1.1</b> Eksporthåndbog for Small Wind [11] <b>D1.2</b> Eksport med væksthushuset midtjylland <b>D4.1</b> Workshop 4-5 juni 2015 Silkeborg - final report [13]
	<b>WP 4.</b> Workshop		
<b>4.</b> Export campaign: Demonstration and realization of an export campaign	<b>WP 6.7</b> Market Approach	<b>T 6.1</b> Project economics and book keeping <b>T 6.2</b> Task Force <b>T 6.3</b> Consortium Agreements <b>T 6.4</b> Records of Meeting <b>T 6.5</b> Liaison with EUDP Project Officer <b>T 6.6</b> Management periodic status reports <b>T 6.7</b> Market Approach 1 week delegation <b>T 6.8</b> Paper presentation	<b>D6.1</b> Final paper for the project

Figure 8: Project structure and hierarchy

