Task 3.4 Product Portfolio Alignment

November 2015

Summary

The different national markets have different certification rules; building codes and grid-codes. It follows that there is not a standardized and unique definition for small wind turbines, which is recognized worldwide. This report provides an overview of the requirements needed for Danish manufactures to access foreign markets.

1. Certification scheme

We have identified four regulated markets which have implemented certification scheme for small wind turbines (see UK, U.S., Japan and Denmark). The certification schemes are based on IEC standards with specific national requirements or exemptions. There are "only" 52 models out of >320 turbines that are certified worldwide and therefore have access to authorizations and financial support in these regulated markets. Danish small wind turbines (with rotor area >40m^2) own a competitive advantage in foreign markets, as they are certified in compliance with the Danish certification scheme BEK 73. Other un-regulated markets (e.g. China, Netherlands, Germany, Italy, etc.) are now recommending installation of certified turbines and are also considering the implementation of a National certification scheme.

2. Building codes

The building codes including tower height, rotor area and noise level, in the major markets, are envisioned. The building codes and authorization procedure differ from country to country, provinces to provinces and case to case. This procedure complexity may be overcome by locally partnership with distributors/agents with expertise in handling local regulations. Danish small wind turbines are designed considering the maximum height set by the National law to 25m height (including tip blade) and a rotor area below 200 m^2. It is found that there are not restrictions to adapt the current design of Danish turbines in foreign markets (e.g. U.S., UK, Germany, and Italy etc.). Besides the noise emission of Danish turbines are tested and documented in compliance with IEC 61400-11 which is recognized and applicable also in foreign markets.

3. Grid codes

Currently, requirements for connecting small wind systems to the electricity grid vary widely. But all power providers face a common set of issues in connecting small renewable energy systems to the grid, so regulations usually have to do with safety and power quality, contracts (which may require liability insurance), and metering and rates. Moreover national policies are supporting small wind turbines integration into the grid thought different incentives. The prices pay in relation to the rated power is not standardized but differ from country to country. Danish turbines may require power regulation solutions to access foreign markets and be eligible for local incentives.

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T3.4 -1 Certification rules and International standards IEC 61400 series

The IEC 61400-2 standard defines a small wind turbine by having a rotor area less than 200m^2. The IEC standards ensure safety, reliability, performance and noise level of wind turbines. To our knowledge, today there are four countries implementing certification schemes for small wind turbine worldwide (see table 1). The IEC 61400 series is the foundation for all four schemes, where requirements are mostly similar but yet not the same. Generally the following standards are required for certification scope of small wind turbines:

- Load modelling and structural analysis — IEC 61400-2
- Safety and Function test — IEC 61400-2
- Duration test — IEC 61400-2
- Static blade test — IEC 61400-2
- Power performance — IEC 61400-12-1
- Acoustic test — IEC 61400-11

Country	Certification scheme / standards	More info
UK	BWEA	http://smallwindcertification.org/wp-content/uploads/2014/08/RUK-Small-Wind-Turbine-Standard3.pdf
US	AWEA	http://www.smallwindcertification.org/wp-content/uploads/2011/05/AWEA_2009-Small_Turbine_Standard1.pdf
Japan	JSWTA0001	http://www.jab.or.jp/en/system/service/product/accreditation/detail/453/
Denmark	BEK 73	http://www.wt-certification.dk/UK/Rules.htm

Table 1: Certification scheme adopted by individual country (source: Brent Summerville SWCC)

In these regulated market, there are several certifying bodies which are approved or accredited to conduct tests and measurements and to emit certifications for small wind (<200m^2). Figure 1 illustrates an overview, though not exhaustive, of certification bodies operating in four regulated countries. The number of certified turbines from each body is listed in table 2, whereas a complete database of certified turbines, including technical specifications and manufactures are provided in Appendix T3.4-A.

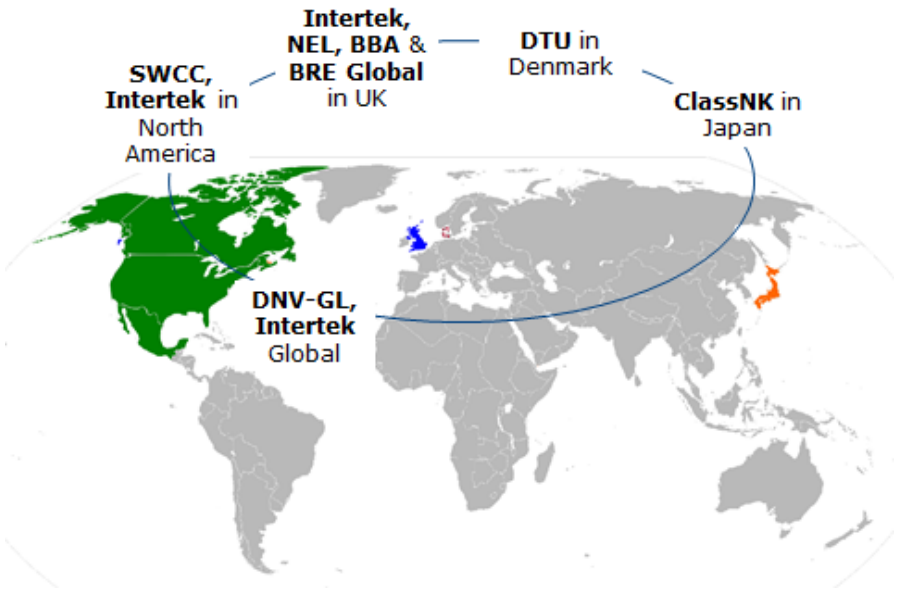

Figure 1: Certification bodies worldwide, (source: Brent Summerville SWCC)

Global certification bodies of Small Wind turbines	N^ of turbines certified	More info
SWCC	7	http://smallwindcertification.org/certified-small-turbines/
Intertek	31	http://www.intertek.com/wind/directory/ http://www.microgenerationcertification.org
ClassNK	7	https://www.classnk.or.jp/hp/pdf/activities/windmill_attestation/en/reg_wind_e.pdf
DTU	13	http://www.vindmoellegodkendelse.dk/DK/Godkendte_small_WT.htm
BBA	1	http://www.microgenerationcertification.org
DNV-GL	5	http://www.gl-group.com/pdf/Wind_Turbines.pdf
BRE Global	4	http://www.microgenerationcertification.org/
TUV-NEL	6	http://www.microgenerationcertification.org/

Table 2: Certification bodies and number of small wind turbines certified (source: Brent Summerville SWCC)

In these regulated markets (e.g. U.S., UK, Japan and Denmark), only certified turbines can be installed and are eligible for national support scheme (e.g. Feed in Tariff, Tax Credit, Net Metering programs etc.). The Small Wind Certification Council (SWCC) has identified 52 “unique” models of small wind turbines currently certified worldwide (see Appendix T3.4-A).

The Small wind turbines catalogue edited by the Nordic Folkecenter, Wind World Energy Association (WWEA) and Chinese Wind Energy Association (CWEA), (here) has identified an overall number of 320 models of small wind turbines (<50kW) worldwide in 2014. This means that approx. 84% of current manufactured small wind turbines have not access to regulated markets above described, as they are not certified accordingly to IEC standards. This represents a competitive advantage for Danish small wind turbine manufactures. Figure 2 shows the number of certified small wind turbines worldwide, classified accordingly to rated power.

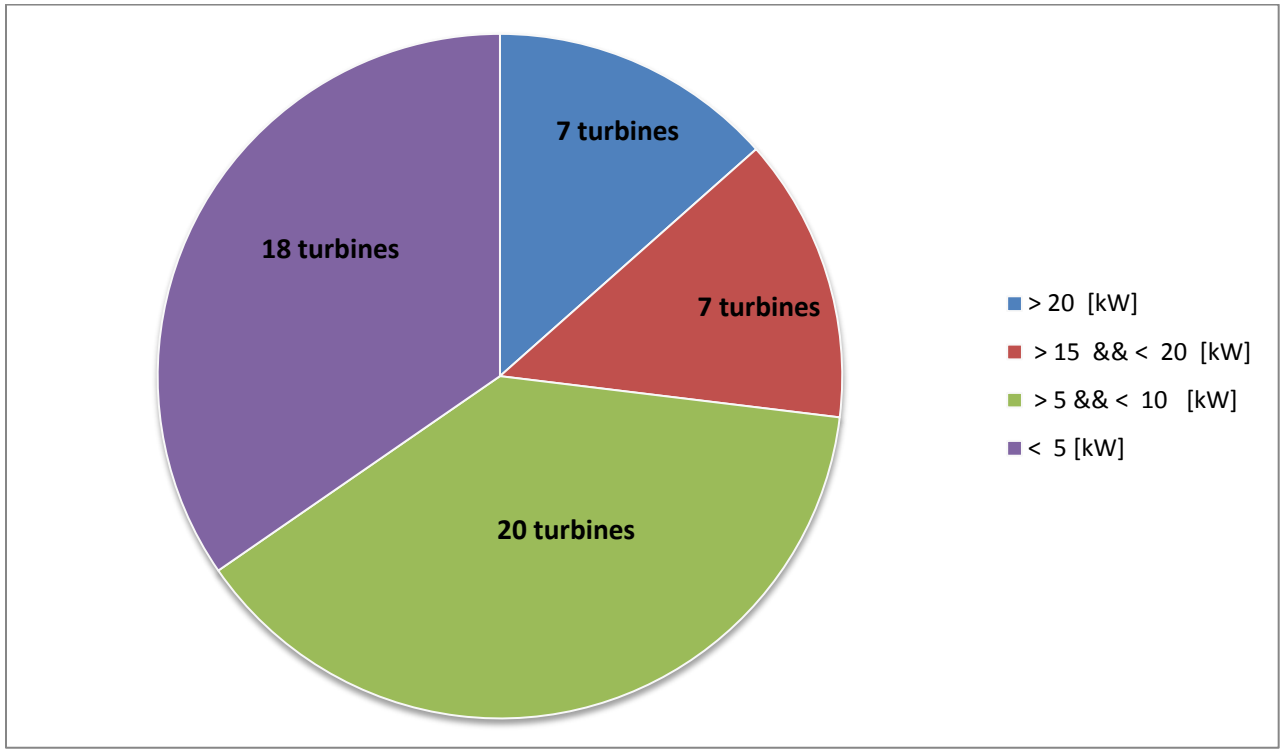

Figure 2: Number of unique model of small wind turbines (only certified), classified accordingly to rated power

Past experiences in the other unregulated markets (e.g. Italy, Germany, France, Netherlands, China, Canada etc.), have demonstrated the importance of adopting a certification scheme to promote only safe and reliable turbines. In Canada, within the last 5 years, the market experienced the advent of new manufactures which went bankruptcy as turbines were not designed to withstand local wind climate conditions at the operating sites. Today the Canadian Wind Energy Association (CanWEA) is recommending to manufactures to design turbines accordingly to IEC standards and also recommending end-users to purchase only certified turbines.

In Italy, beforehand 2011, the small wind industry was nearly inexistence. It is with the advent of the Feed In Tariff-FIT in 2012 that boosted the creation of national small wind industry. Not only local development, but also an extensive import of foreign un-certified turbines characterized the current market trends in Italy. Even though the market is at its early stage, there have been registered cases of at least 40 foreign small wind turbine installed, which do not operate yet (2- 3 years after) due to fails in the design. Today Italian

retailers/distributors of small wind are looking for establishing new partnerships with Danish certified turbines, as demonstration of reliable, safe and quality products.

In China the Chinese Wind Energy Association (CWEA) identified as a major threads for the small wind industry development, the lack of a certification scheme ensuring quality and reliability of turbines. With a low pricing comes a low competition, and often low quality products approaches the market (CWEA). Main representatives from CWEA are now strengthening partnership with Danish representative of the BEK 73 (Danish certification scheme) for possibility to adopt a similar certification scheme in China.

Also the Dutch delegation is working to implement a certification scheme for small wind turbines.

Eventually the implementation of certification scheme in more countries will support the development of the wind industry by ensuring reliable, safe and performant turbines to be installed and operated. On the other hand the certification scheme will also cut out from the market a substantial number of manufactures which do not have resources to design, test and certified turbines in compliance with IEC standards.

T3.4 – 2 National grid-codes and building codes

T3.4 – 2.1 Italy

In Italy is not required any structural evaluation of the turbine, but only compliance with the Machinery Directive and CE marking. The authorization procedure to install a turbine includes an in depth study, conducted by local civil engineering authority, of the specific site. Italy is a seismic land and therefore tower and foundation have to be designed to withstand extreme events. As a rule of thumb 7-10 m^2 of concrete is used to build the foundation, whereas the tower shall be in compliance with the UNI 1090, EN-1090-1.

The technical rules regarding the grid codes are described in CEI 0-21 directive and also connection guidelines are provided by ENEL (national power distributor) (here). The GSE (national authority managing power services) has established a directive for which generators in compliance with CEI 0-21 cannot exceed with a fixed tolerance, the specified rated power, penalty the revocation of the incentives. To adopt solutions such as the “dump load” commonly used in Denmark is not legally adaptable in Italy. Therefore this may require installation of different generators on Danish turbines. There are not limitations on the top height of turbines.

The installation generally necessity only of the simplified application at Denuncia di Inizio Attivita’ (DIA) or also named (S.C.I.A.) Segnalazione Certificata Inizio Attività, law: 244/2007, for turbines with rated power up to 60 kW. However different regions may enforce different regulations and permitting (there are 20 regions).

- The ***Basilicata*** Region, with Law no. 31 of 24 December 2008 (art. 10), extended the application of (DIA), referred to in art. 22 and 23 of the Consolidated Presidential Decree June 6, 2001 n. 380, as amended, to wind farms with total installed power rating of not more than 1 MW and a maximum of

five wind turbines; with the exception of: SCI / SPA, national and regional parks, restricted areas under Excerpt Basin Plans drawn up pursuant to Legislative Decree. n. 152/2006. Moreover, on October 20, 2009 was adopted the Regional Council Resolution n. 1816 to approve the PIEAR (Regional Environmental Energy Plan), where it confirms the application of the procedure (DIA) to wind farms of rated power up to 200 kW.

- The ***Calabria*** Region, with L.R. n. 42 of 29 December 2008 (published on BURC of December 30, 2008 No. 24 Sup. Extr. N. 3), subsections 2.2 Art. 2 attached sub 1, applied the (DIA), and referred to in art. 22 and 23 of the Consolidated Presidential Decree June 6, 2001 n. 380, as amended, wind power plants with a generating capacity of less than 60 kW

- The Region of ***Molise***, with L.R. n. 15 of 21 May 2008 (published on the GR 31 May 2008 no. 12), defined as systems of "small wind" those having maximum power of 35 kW and support posts with a maximum height of 20 meters, installed by individual farms or associated companies and production falling in trade or industrial areas.¨

- The ***Sardinia*** Region with Regional Law no. 3 of 7 August 2009 established art. 5 paragraph 23 that the wind turbines with total capacity of less than or equal to 60 kW are not subject to the procedures of environmental impact assessment, in accordance with Law 244/2007 art. 158 paragraph 2 letters g), which in fact provides for such power plant application of (DIA).

- The Region of ***Tuscany***, with L.R. n. 71/2009 amended Article. 16 of L.R. 39/2005, introducing the procedure (DIA), for the construction and operation of wind turbines up to 100 kW

- The ***Puglia*** region, with the Regional Regulation No. 24 of 30 December 2010, issued the Guidelines for the authorization of plants powered by renewable sources, which identifies areas and sites unsuitable to installation of plants powered by renewable sources in the Region of Puglia. For wind farms with capacity of 20 to 60 kW it is expected to apply the system of authorization SCIA, or DIA (for areas with environmental restrictions, landscape and cultural).

T3.4 – 2.2 Germany

Notes from http://www.klein-windkraftanlagen.com/ administrated by Patrick Jüttemann.

In Germany there is not a uniform regulation for the approval of small wind turbines. The maximum height is set to 50 meters (including tip blade) and small wind below < 50m height, comply with a simplify authorization procedure. The procedure is regulated by the respective provincial law, in particular the country's building regulations must be observed.

The approval for the construction of small wind turbines in residential areas is typically more complex than in commercial areas or in rural areas. Small wind turbines on mobile platform, such as sailing boats or RVs do not require approval. Small wind turbines in rural areas, including agricultural and industrial firms, which use the small wind turbine primarily for own needs coverage (e.g. over 50% of energy usage), have authorization privileges in accordance with § 35 of the Building Code (BauGB).

In general small wind turbines over 10 meters in height must be approved. In recent years, an increasing number of provinces have started to allow small wind turbines up to 10 meters in height without permission. Today permitting requirements for small wind turbines up to 10 m height can be classified as following:

- *Exemption*: the small wind turbine can be erected without notifying the Building Authority
- *Permit required*: the building authority must be informed of the installation of small wind turbine.

Permitting requirements from the lists of provinces can be found here:

Baden-Wurttemberg
Bavaria
Berlin
Brandenburg
Bremen
Hamburg
Hesse
Mecklenburg-Vorpommern
Lower Saxony
NRW
Rheinland-Pfalz
Saarland
Saxony
Saxony-Anhalt
Schleswig-Holstein
Thuringia

The provincial building regulations also set minimum requirements regarding zoning of small wind installations. The distance between turbines and buildings is described In the Musterbauordnung (building-code), where a minimum distance of 0.4*H (H refers to total height of wind turbine) is required or at least 3 m clearance. In Bavaria, the building code requires a distance of at least 1*H.

Noise emissions from operating turbines are regulated by the State guidelines from *TA Lärm (Technische Anleitung zum Schutz gegen Lärm - technical instruction for the protection against noise)*. Noise level specified by the manufacture of the small wind turbine shall be lower than the maximum allowable noise level of the TA *Lärm.*

T3.4 – 2.3 US

In US the maximum height of small wind turbine, including tip blade, varies from 18 m to 45 m accordingly to state regulations. There are about 25.000 local jurisdictions for planning and zoning of small wind. These regulations in some counties and cities represent a significant barrier, as do not provide special exemptions for individually owned wind turbines.

The ubiquitous 10 m height restriction has its origins in the fire safety of inhabited structures over a century ago, but its persisting impact on small and medium wind turbine permitting cannot be overstated. Besides the approval process for small wind turbines fails into the same zoning processes used for larger infrastructure projects, which set complexity (Distributed Wind Energy Association, DWEA).

Grid-connection requirements vary accordingly to power providers (here). In general the following equipment is required for connecting the small wind system to the grid (link):

•Power conditioning equipment

•Safety equipment

•Meters and instrumentation.

Power providers require that the small wind system includes safety and power quality components. These components include switches to disconnect the system from the grid in the event of a power surge or power failure and power conditioning equipment to ensure that the power exactly matches the voltage and frequency of the electricity flowing through the grid (here).

In an attempt to address safety and power quality issues, several organizations are developing national guidelines for equipment manufacture, operation, and installation:

- •The Institute of Electrical and Electronics Engineers (IEEE) has written a standard that addresses all grid-connected distributed generation including renewable energy systems. IEEE 1547-2003 provides technical requirements and tests for grid-connected operation. See here for more information.
- •Underwriters Laboratories (UL) has developed UL 1741 to certify inverters, converters, charge controllers, and output controllers for power-producing stand-alone and grid-connected renewable energy systems. UL 1741 verifies that inverters comply with IEEE 1547 for grid-connected applications.
- •The National Electrical Code (NEC), a product of the National Fire Protection Association, deals with electrical equipment and wiring safety.

Although states and power providers are not federally mandated to adopt these codes and standards, a number of utility commissions and legislatures now require regulations for distributed generation systems to be based on the IEEE, UL, and NEC standards.

When connecting a small renewable energy system to the grid, it will be probably needed to sign an interconnection agreement with the local power provider. In the agreement, power providers may require you to do the following:

- Carry liability insurance -- Liability insurance protects the power provider in the event of accidents resulting from the operation of your system.

- Pay fees and other charges -- including permitting fees, engineering/inspection fees, metering charges (if a second meter is installed), and stand-by charges (to defray the power provider's cost of maintaining your system as a backup power supply).

In addition to insurance and fees, you may find that your power provider requires a great deal of paperwork before you can move ahead with your system. However, power providers in several states are now moving to streamline the contracting process by simplifying agreements, establishing time limits for processing paper work, and appointing representatives to handle grid-connection inquiries.

T3.4 – 2.4 UK

RenewableUK describes the planning policy for England, Wales, Scotland and North Ireland in the Small and Medium Wind UK Market Export 2015 (here). Moreover he building codes, including maximum heights, noise emission and zones for installation of small wind turbines can be found at the online portal of the local planning authority (here).

To install a grid-connected system, permission from the local Distribution Network Operator (DNO) is needed. This is the company who operates the distribution network in the local areas. DNOs have different policies when it comes connecting small scale renewable generation systems to their networks.

The Distribution Code of Licensed Network Operators: www.dcode.org.uk. The guide for the distribution code - *Issue 26 – 01 September 2015*, can be found here.

Generally it is needed an inverter to transform the low-voltage DC power produced by a wind turbine into high-voltage AC power that meets the quality requirements of the electricity network.

It is recommended to use inverters that meet the *Engineering Recommendations G83/1 - 'connection of small-scale embedded generators in parallel with public low-voltage distribution networks*', which sets out technical requirements that small-scale generators need to meet in order to connect to the mains network. These are only recommendations, but as they have been agreed by the DNOs, applications that conform are usually processed more quickly.

T3.4 – 3 Financial Incentives – Worldwide

The Wind World Energy Association (WWEA) yearly releases a small wind world report and it can be found here. Figure 3 is extracted from this report and shows the current FIT program in different countries. It is seen that incentives largely differ both in term of rates and rated power. It follows that Danish small wind turbines require power regulation solutions or different generators to approach foreign markets and being eligible for local incentives.

Country/ Region	Size Limit	EUR/kWh	Country/ Region	Size Limit	EUR/kWh
Canada			**Japan**	< 20kW	0,418
Nova Scotia	< 50kW	0,350		≥ 20kW	0,167
China (off-grid)	0,2–3kW	0,140	**Lithuania**	< 10kW	0,081
(on-grid)	5-20kW	0,110		11-350kW	0,075
Chinese Taipei	1-10kW	0,185		> 351kW	0,064
Denmark	< 10kW	0,330	**Portugal**	< 3,68kW	0,432
	10-25kW	0,200	**Slovenia**	< 1 MW	0,095
Greece	< 50kW	0,250	**Switzerland**	< 10MW	0,179
Italy	< 1MW	0,300	**UK**	< 100kW	0,207
Israel	< 15kW	0,250	**USA**		
	15-50kW	0,320	**Hawaii**	< 100kW	0,110
			Vermont	< 15kW	0,200

Figure 3: Small Wind Feed-in Tariff Pricing Worldwide (source. WWEA)