WP2-TRAINING COURSES COMPARATION

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1. INTRODUCTION

In order to evaluate the transverse skills needed to qualify the wind energy sector stall and normalize the training at European level it is necessary to analyze the skills that this sector work market is demanding in the different countries that form part of this consortium.

Having in mind the standardization, a research has been done focusing in the European Market to analyze the wind industry sector and its prospective growth in the future years which could affect employment requiring a very high number of qualified personnel. As is later mentioned the trend is an increasing of the number of people to be employed in the sector due mainly to two factors: first the progressive ageing of the existing wind farms and second, the growth of the sector at world wide level.

The structure of the contents of the Skillwind Serious-Game manuals have evaluated and compared with the main European training programs for the purpose of obtaining a training material in wind energy that includes the wider variety of skills as possible.

In Europe, there is a wide variety of general training programs related to wind industry focusing on different, to pursue the evaluation task the Reference training organizations in Europe in wind energy training have been chosen: BZEE Academy and the Danish Wind Power Academy and the GWO basic technical training.

A. BZEE is a German academy was founded in 2000 and it has become a European model in wind energy training. From the beginning its aim was to fill the qualification gasp within the wind energy sector. Nowadays BZEE is present in 29 different locations offering wide programs in wind energy training oriented to the development of skills needed in the wind energy industry in order to provide with qualified technicians for the production, installations, commissioning as well as maintenance and operation of wind turbines.

B. The Danish Wind Power Academy provides with training and services for the main wind turbine owners and manufactures across the globe. It was founded in 2004 and offers a wide variety of training courses to qualify technicians from the main wind turbine owners and operations as well as service providers.

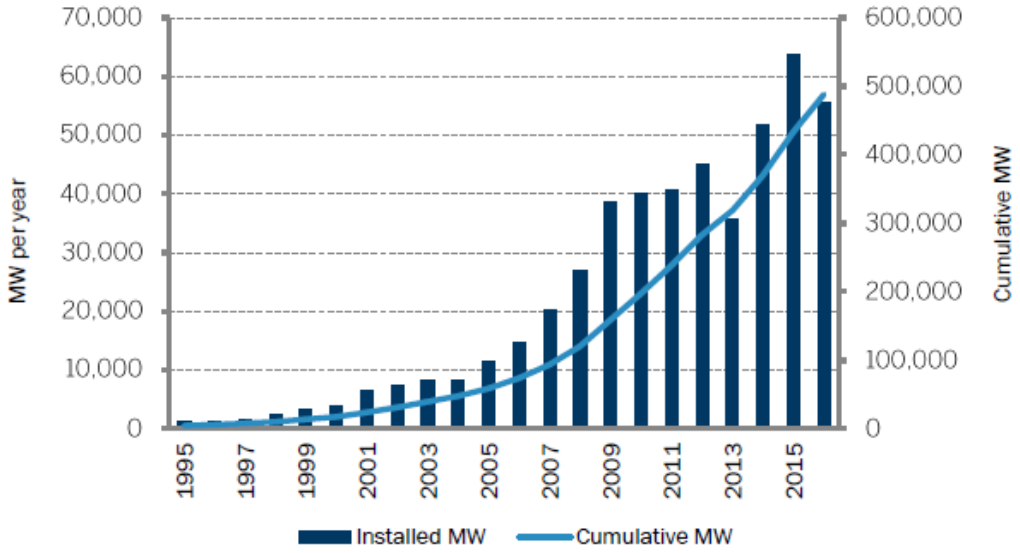
C. GWO is a not-for-profit association of wind turbine manufacturers and wind farm owners with the aim to strive towards and injury-free work environment in the wind industry through cooperation among the members and other stakeholders in setting common standards for safety training.

The main aim of this parallel analysis is to obtain a summary of the wind industry situation in order to develop solid content structure for the Skillwind training modules that would fill the gap of current training requirements in the wind industry.

It is important to keep in mind that manufacturers and ISP (Independent Services Providers), who are independent of OEMs and producers, have their own training cours which follows the approach of the SKILWIND project: general concepts, training course on specific turbines and special training for some components (in our case, blades and converters). The basic approach is that people involved in for instance general maintenance is different of those devoted to the blades reparation.

2. WIND SECTOR EMPLOYMENT

To understand the European wind industry and its potential as employment source it has to be considered the growth that this sector has experienced during its life, having just 13 GW of wind power installed in 2000 and reaching 154 GW at the end of 2016, as is presented in the following figure.

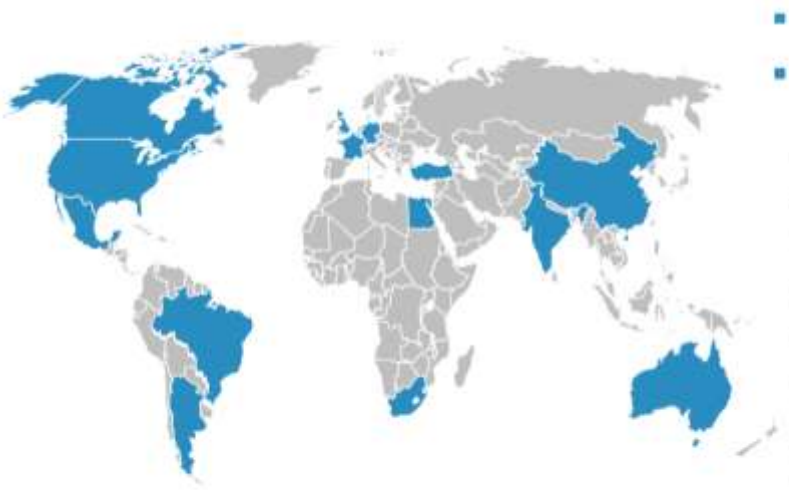


Year	Installed MW	Increase %	Cumulative MW	Increase %
2007	20,286	38%	93,911	27%
2008	26,952	33%	120,725	29%
2009	38,478	43%	159,089	32%
2010	39,989	4%	197,953	24%
2011	40,637	2%	238,139	20%
2012	45,161	11%	283,068	19%
2013	35,655	-21%	318,596	13%
2014	51,716	45%	369,677	16%
2015	63,792	23%	433,118	17%
2016	55,492	-13%	488,259	13%
Compound Average Annual Growth – 10 Years		20.1%		

Figure 1: Wind power growth at worldwide level (Source: FTI Intelligence)

In practice, wind energy is a very young industry with around 20 year of history and where workload is more concentrated in equipment manufacture and operation and maintenance. The great advantage of this last phase of the supply is that is more sustainable and less affected by regulatory changes and moreover, with a vegetative trend of growth thanks to the fact that existing wind farms are getting older.

About the future, in the following figure is presented the markets with more potential for the future, being only a first approach because that potential is conditioned by political decisions and also, by the cost of the main competitors, mainly photovoltaic and shale gas.



- The top 15 wind markets are expected to install 515.6 GW, accounting for 83.5% of the new capacity added worldwide in 2017–2026.
- Among the top 15, China is going to add 258 GW of new capacity in 2017–2026, followed by the U.S., Germany, India and France.

Country	Total Installations 2017–2026 (Added MW)
China	258,000
U.S.	65,000
Germany	40,755
India	37,900
France	20,065
Brazil	16,100
UK	14,050
Mexico	11,450
Turkey	11,400
Netherlands	7,750
Canada	7,500
South Africa	7,436
Egypt	6,500
Australia	5,950
Argentina	5,773
Total	515,629

Figure 2: Largest Wind Markets in Terms of New Added Capacity 2017-2016 (Source: FIT Intelligence)

For the period between 2017 -2021 the forecast is based in a combination of bottom-up analysis and a top-down approach is used. Factors taken into account are mainly those that have an immediate impact on market growth:

- Near-term national energy plans, such as China's 13th Five- Year Plan (for the period 2016-2020)
- Current renewable energy support incentives
- Proposed changes to the market structure, such as the EU’s state aid guidelines
- Total projects under construction by the end of 2016
- Total projects either approved by the relevant national authorities or with a signed PPA
- Competitive bidding (auctions) for projects under construction in the near term

- Project pipelines or near term investment plans of utilities and large energy generation companies
- Infrastructure to support near-term growth, including the electricity grid and road transport
- Deployment of the latest commercial turbine technologies
- Wind turbine pricing and availability of project finance
- New types of wind project investor and owners
- Competitiveness of wind energy compared with other forms of generation, including other renewables , particularly Solar PV.
- Oil/coal/gas prices
- (Financial) ability of project developers and/or contractors to complete specific projects
- Availability of finance (investor appetite)
- Availability of grid capacity/grid connection

Medium-term forecast period (2022-2026), due to the additional uncertainty associated with a longer-term prediction, a top-down approach is deployed for the medium-term forecast period. Factors taken into account are those that impact the medium to long-term market growth.

- Medium or long-term national (renewable) energy plans/targets
- Regional renewable energy binding/non-binding targets
- Positive outcomes from the latest UN Framework Convention on Climate Change and commitments for CO2 emissions reduction made by the world's biggest emitters
- Level of concern about energy security
- Expected global electricity demand as forecast by the International Energy Agency
- Availability of wind resources and technology breakthroughs for wind turbines and balance of plant
- Infrastructure improvement and a market's ability to integrate wind — for example, a fully integrated European electricity transmission system and sufficient investment in the power grid in China, the U.S. and other developing markets
- Previous market growth patterns for markets with similar conditions

- Cost of onshore and offshore wind energy and its expected ability to be cost-competitive with conventional energy sources, especially, coal and gas.
- Forecasted penetration rate of wind power electricity in the global electricity supply
- The size of the repowering market
- Carbon pricing in Europe and the recently announced carbon emissions trading system in China
- Oil/coal/gas prices
- Population growth and GDP per capita
- Wind turbine pricing and availability of project finance

In the following figure is presented the Annual Growth Rate and in can be observed a continuous growth even in some years there is a certain stabilization related to the decrease of the German market among other things the fulfillment of the EU Directive.

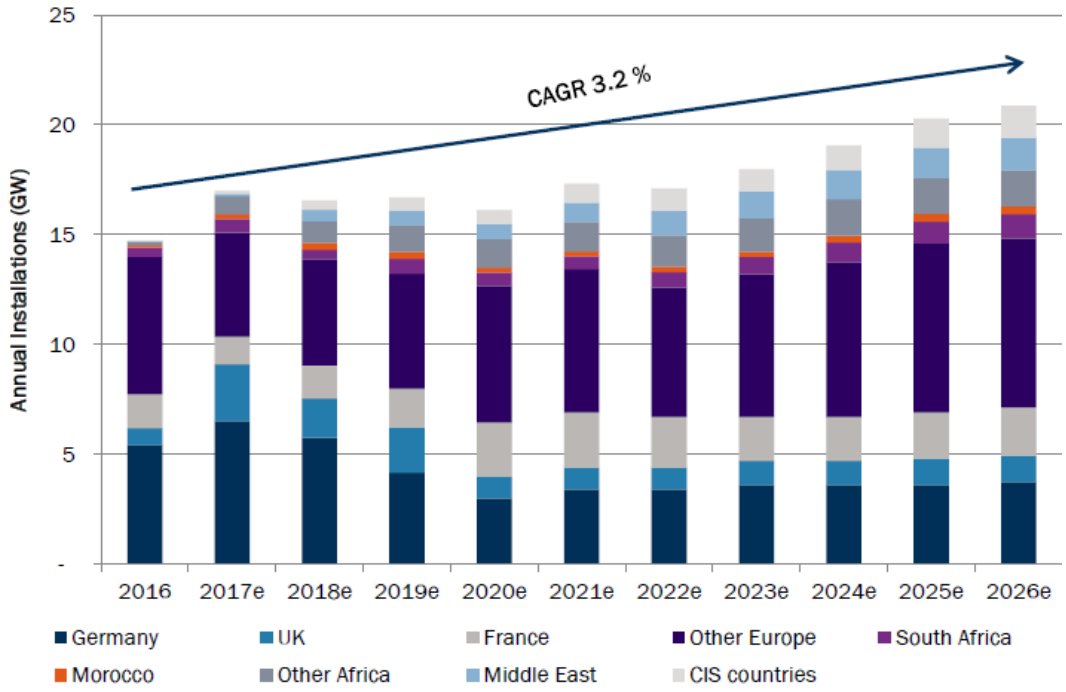


Figure 3: Forecast of wind growth 2016-2026 (Fuente: IT Intelligence)

Following this trend of market evolution as well as the progressive ageing of the existing wind farms the increase of jobs in O&M is presented in the following figure.

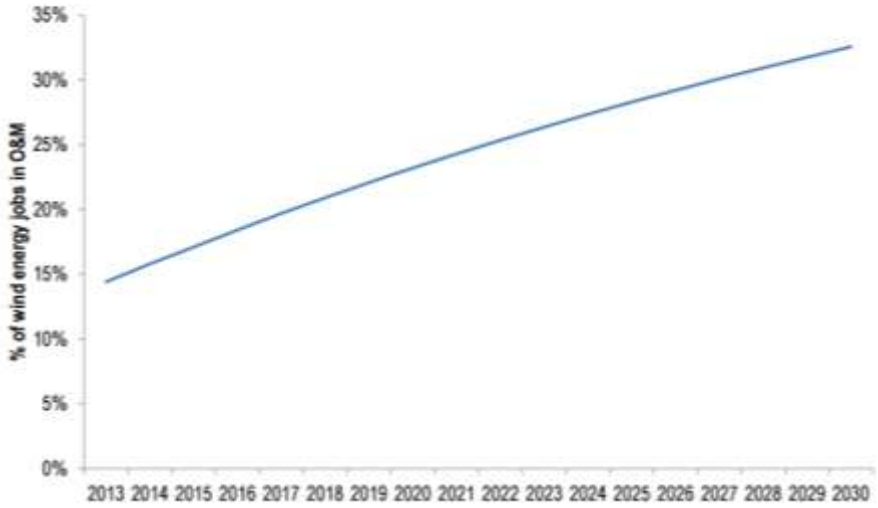


Figure 4. Operation and Maintenance jobs evolution (Source: TPWind Report)

As it can be observed in the figure above almost a linear growth rate in Operation and Maintenance jobs have happened since 2013 and it is expected to keep that progression to fulfill the horizon 2020 and 2030 goals.

It is the activity of Operation and maintenance that would be requiring the higher amount of trained personnel and would experience the higher growth rate. The figure below shows the expected employment increase structured by the main activities in the wind industry. And as it can be observed the Operation and maintenance personnel is expected to double from 2020 to 2030.

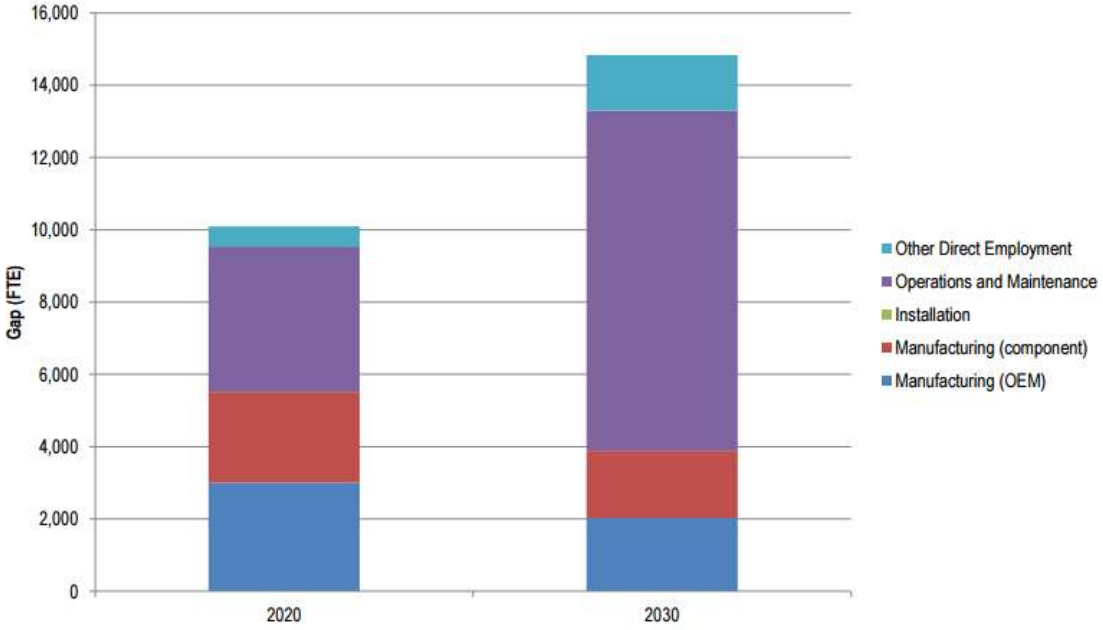


Figure 5. Wind industry estimated employment growth (Source: Wind Europe)

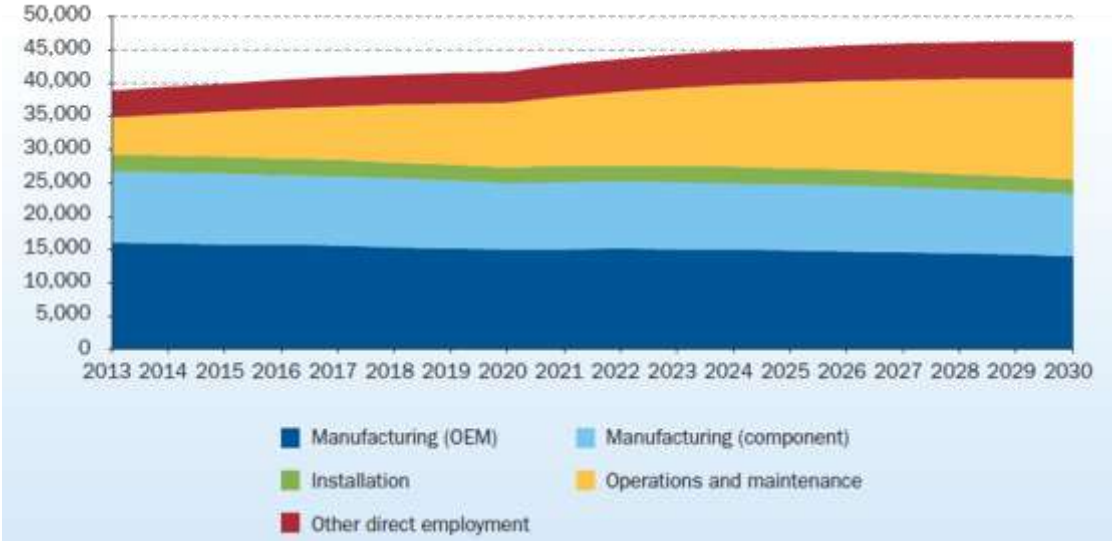


Figure 6. Job creation rate in the Wind energy sector (Source: TPWind survey)

In the following image it can be observed the current employment number related to the renewable energies and its division per technology. As it can be seen more than one million personnel work for the wind industry globally.

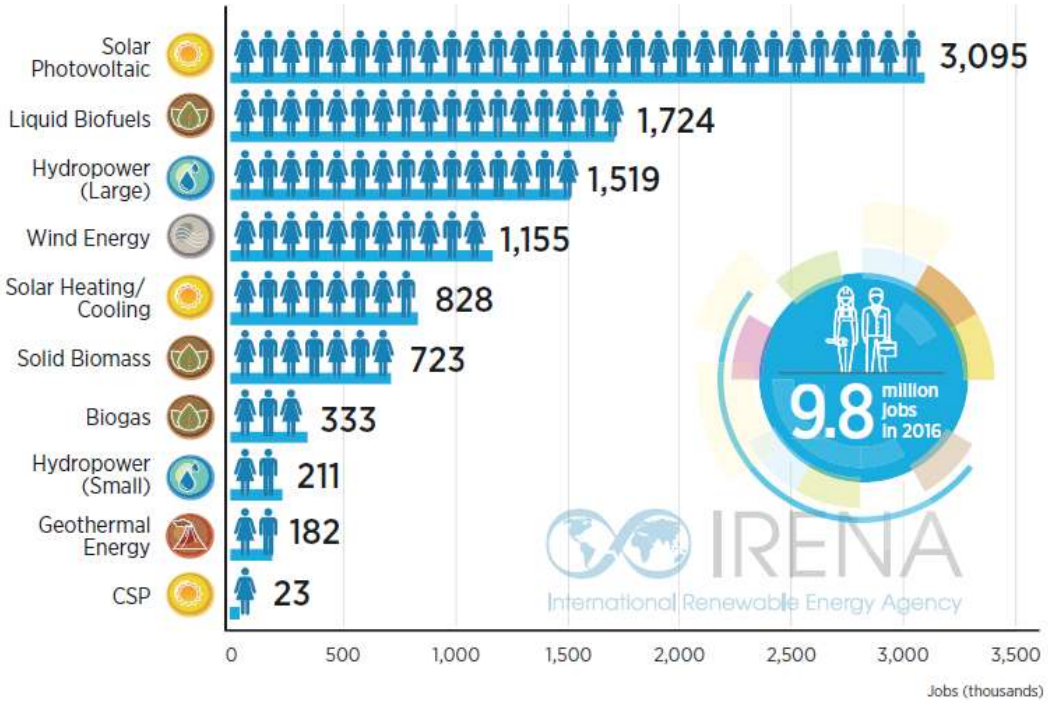


Figure 7. Renewable energy global workforce (Source: IRENA)

As it can also be seen in the figure 8, which shows the Renewable energy workforce evolution, there has been a continuous growth in renewable energies employment. In 2016 this sector employed 9.8 million people which represent a 1.1% increase over 2015. In the wind energy sector, the latest new wind installations in the United States, Germany, India and Brazil contributed to a 7% increase in global wind employment, which reached 1.2 million jobs.

In Europe, during 2016 there was a slight increase in power installation. This fact helped a 10% job increase in offshore employment in Germany, but total wind employment decreased by 4% due to reduced activity in the onshore sector. Wind energy employment is likely to increase with continuous deployment in line with global climate imperatives which can lead to around 3 million jobs in the sector by 2030.

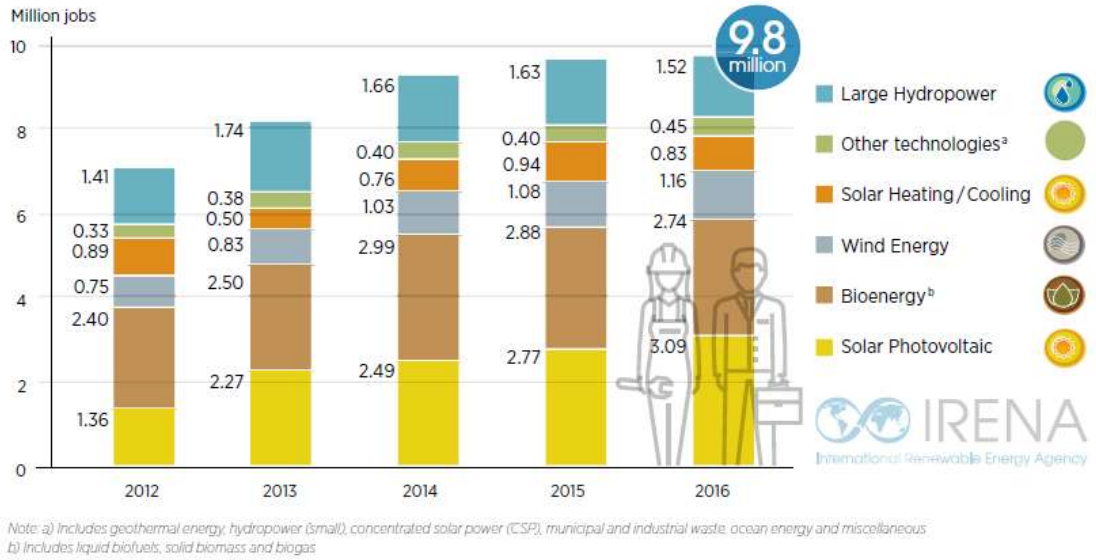


Figure 8. Global renewable energy employment, 2012-2016 (Source: IRENA)

The total power installed in the EU at the year of 2015 was of 145.000 MW and according to the SP and DE standards the number of employees in the maintenance and operation activities is of around 1 person per 6 MW that it means that a total of 25.000 people are employed in these activities. Taking the total power installed at worldwide level will be of 70.000 persons. In these figures are not included labour force manufacturing and repairing components. Furthermore, it is also important to keep in mind that the progressive ageing of maintenance workers who over 45 years have difficulties to work in the harmful and narrow conditions of the old turbines what could be an opportunity for new professionals.

In the EU, there are at least 15.000 Wind farms and some of them are owned by small and medium size companies, mainly in the northern countries, then it is a clear opportunity the methods to evaluate the different options to extend the life of the wind farms and to compare different alternatives, including the replacement of existing WTGs.

This future need of staff answers the wind power to be installed all over Europe in order to achieve the horizon 2030 goal in renewable energies in addition to the increase in operation and maintenance not only for the wind power increase but for the aging of the wind farms already installed.

In this sense, there is currently a shortage in qualified personnel required by the European wind energy sector each year, reaching 15,000 staff shortage by 2030 if there is not a rise in the number of graduates taking relevant courses. It is an increasing economic concern the lowering numbers of graduates from schools and universities that choose a major in science, technology or engineering. This situation concerns the wind industry where as it was stated the need in adequately trained staff.

In addition, high education programmers normally are focused on academic rather than practical and problem solving skills which is leading the industry to ask for an EU standardized curricula.

Besides this group of companies, the staff and operators of the wind farms as a whole can also learn from the experiences in different parts of the world.

Additional renewable energy support policies are needed in order to help deployment and to create a local workforce that can both increase technology reliability and reduce the need of importing talent. Considering the number of workers in the fossil fuels sectors, training in wind and renewable energy would be the key for transition. Fossil fuel energy sectors will suffer of significant job losses of qualified staff that with appropriate training will be able to shift to the decarbonized energy sector providing this sector of experienced personnel in energy.

3. EUROPEAN TRAINING PROGRAMS IN WIND ENERGY

Considering the total wind power installed all over Europe it is understandable the existence of several training programs coordinated by independent bodies and focusing on different professional levels having in mind the current shortage of engineers and technicians with specialized skills in wind energy. This shortage could be blamed on the rapid growth of the wind industry added to the wind turbines aging that consequence in a higher demand of operation and maintenance technicians.

As it was stated before a grave shortage of qualified staff in the wind industry has been estimated for the future years to come in order to succeed in achieving the Renewable energy share that Europe has fixed for 2020 and 2030 horizons.

The professionals needed in the industry and in particular in the wind industry require a specific skills and qualifications that are not easy to find and although there has been an enormous increase in the offer of wind training programs at all levels, they are still lacking specificity and practicality in the contents they transmit.

The chart below presents a summary of the most relevant training programs in wind energy considering the diversity of training centers and training programs. It is important to insist that the SKILLWIND initiative is more concentrated on maintenance whereas the rest of the training courses have a more extended scope, integrating other areas of activity in the wind farm supply chain.

Educational initiatives	Apprenticeships and technical courses	Dedicated training centres	University courses	Knowledge sharing networks and supporting wind energy training
BZEE Skills passport	Energy Management Technician in Europe	Asociación Empresarial Eólica	Erasmus Mundus European Wind Energy (TU Delft)	Bundesverband WindEnergie
European Academy of Wind Energy	Siemens, Renewable UK and Weir apprenticeships	Cabinet Metrol	European Master's in Renewable Energy	Centro Nacional de Energías Renovables
European Institute of Innovation and Technology		National Renewable Energy Centre (CENER)	MSc Wind Power Project Management (WPPM)	EWEA
Upwind project		Danish University Wind Energy Training	University of Strathclyde Doctoral courses	Global Wind Organisation
Windskill initiative		Danish Wind Power Academy	Wind Energy MSc (DTU)	Innovate
		German Wind Energy Institute (DEWI)		IIR
		ForWind		IRELP
		GL Academy		Italian Wind Energy Association
		Haus Der Technik		Renewables Innovation Network
		Training Centre for Renewable Energy (BZEE)		

Chart 1.Overview of education and training initiatives (Source: European Wind Energy TP)

Even with the wide training offer in wind energy, there are still some specific jobs that require skilled worked and that currently the work market has difficulties to provide. As it can be observed all the occupations in question are related with the technical field that requires mostly highly qualified engineers and service technicians.

Sub-sector	Occupations
Wind energy	Project developers, service technicians, data analysts, electrical, computer, mechanical and construction engineers
Solar energy	PV and solar thermal system installers and maintainers, building inspectors
Hydropower	Electrical and operation &maintenance engineers, technicians, trade personnel, sustainability specialist
Geothermal	Trainers, geothermal engineers
Bioenergy	R&D and design engineers, service technicians, trainers

Chart 2. Principal occupations difficult to fill per sub-sector (Source: REN Aliance survey)

This analysis of the wind sector work market poses a question that has not been answered yet. As it was stated currently there are plenty of training programs with diverse scope. In addition, renewable energies are more and more accepted by society considering the increasing pollution problem in big cities and the tendency to reduce the green house gases. Therefore, the seeds have been sown and have started to sprout, but there is still a long way to go in which motivating young adults and

teenagers to involve them in green energy policies and grant a future workforce for the industry.

The key would be to keep wind training programs up to date, guaranteeing a practical approach no matter the learning level, i.e. technicians or engineers, and evolving with the technology. Something is clear in this aspect, technology evolves so does the tools and this evolution requires constant update.

In the following table is summarized the main characteristics of each training course, concentrated in o-shore installations.

Training name	Goal	Organization	Contents
WINDSKILL	To develop an European Qualification Framework	Modules based on technical criteria	• Installation • Inspection and maintenance of electrical systems • Inspection and maintenance of mechanical systems • Inspection and maintenance of the hydraulic systems • Inspection and maintenance of safety-relevant apparatus • Inspection of rotor blades • Repair of rotor blades • Trouble shooting • Fire fighting • Working at heights and rescue • Environmental awareness and protection • General health and safety • Wind energy systems
DANISH WIND POWER ACADEMY	To provide with basic training for those who want to work in wind turbines O&M	Training contents structured by wind turbine form different manufactures	• Personal and turbine safety • Wind turbine types • Maintenance programs • Blades • Gearboxes • Cooling systems • Hydraulic systems • Instruments and measurering • Electrical circuits • Control systems and operation • Sensors • Trouble shooting
BZEE	To provide with a flexible program complying with the European Qualifications Framework in order to enable a personalized training plan	Modules structured by career either installer or technician and by onshore or offshore wind turbine technology	• Health and safety • Wind turbine electronics • Wind turbine mechanics • Hydraulics • Rotor blade • Transport • Wind energy technology • Offshore operations • Operations management
GWO	To develop a standard in technical training for the wind	Modules are divided by mechanical, electrical and	• Mechanical module • Electrical module • Hydraulic module

	industry	hydraulic systems in a wind turbine generator	

SKILLWIND	To standardize the maintenance training and develop an App based on the serious game approach.	Modules organized in different blocks based in the different training paths	• Health and Safety (GWO)
			• Wind Energy systems
			• Installation and EPC
			• Maintenance WTG specifics
			  • Preventive
			  • Corrective
			  • Predictive
			• Blades inspection and reparation
			• Converter reparation
			• HV (lines and SE) repairs

3.1. The Windskill project

The "Windskill" project (2006-2009) was a first-time initiative to meet the skills gap in the expanding wind industry via the development of a flexible European qualifications structure that puts specific assignments into the context of the wind energy work process. The integrated process approach to qualifications replaces the fragmented delivery of stand-alone skills and certificates and allows for skills development and individual career paths within the industry. Within the value chain frame framework the prime focus of project development has been directed towards operation and maintenance assignments in both onshore and offshore work environments.

The Windskill Qualification Standard was compiled within a multi-stakeholder network and consists of both demand profiles and customized training modules designed to deliver the targeted process competencies. Both individual stakeholder perspectives and inputs from pioneer training activities within the partnership have been merged to implement the European Union's Lifelong Learning agenda in the field of vocational education; the European Qualifications Framework has been deployed as a development platform thereby providing a transnational reference framework for wind energy qualifications.

In the latter part of the project the training programme was positively tested and evaluated at a range of European training locations, hence contributing to the building of the needed training infrastrure. Finally, the Windskill Agency was designed with a view to ensuring ongoing development of both the Windskill Profiles and Modules and to monitoring compliance of training activities with the Windskill Standard. The set-up of the Agency as an industry accreditation body is targeted for 2010 immediately following the completion of the project and will provide quality assurance and certification measures for the European and international qualification market.

More specifically the objectives of the project were:

I. Build a Wind Energy Education Network
II. Develop a European Qualification Profile
III. Develop a modularized training programme to deliver the Profiles
IV. Coduct a series of pilot training sessions to test the market feasability ofthe profiles
V. Design the Windskill Agency to enable ongoing development and monitor the implementation the Windskill Standard in training activities

3.2. The Danish Wind Power Academy

Reviewing some training programs from the Danish Wind Power Academy it can observed that the majority of training courses approach the wind energy education from the point of view of each of the main manufactures and some of them are dedicated exclusively to specific machines maintenance.

The training offered by the Danish Wind Power Academy in wind energy is divided in different courses that have a very different approach and duration. Seminars in turbine technology and practical maintenance are offered with duration of 3 hours and a half in order to give a general understanding in the subject aiming to create foundation knowledge.

2 days training is available in wind turbines from Vestas and Siemens in order to obtain a specific maintenance training in depth, going through all the procedures theoretically to undergo the maintenance of each manufacturer wind turbine in the bottom section, tower, nacelle and hub.

The Danish Wind Power Academy also offers a more general training program with a duration of 10 days which is denominated “Wind industry Essential Training”. This training has three different training methods including class room lectures, group work and workshops.

This course contents are designed as an introduction to the wind industry, creating a good start point for the professionals who want to develop a career in the wind industry as technicians or in operation and maintenance.

The training contents present the following topics:

- Personal and turbine safety
- Wind turbine types
- Wind turbine documentation
- Maintenance programs
- Blades
- Gearboxes
- Cooling systems
- Hydraulic systems
- HV working

- Instruments and measurering
- Electric circuits
- Control systems and operation
- Sensors in wind turbines
- Operation and safety strategy
- Trouble shooting

3.3. BZEE Academy

BZEE training programs are vaster and some of them are dedicated exclusively to professionals who have already knowledge of the wind industry or even of that popper training module but need refreshment in the subject.

The training courses are modularized and tailored to wind-specific activities targeting different professionals of the wind industry. The main courses offered are the following:

- Wind turbine manufacturing specialist
- Service technician for onshore wind energy facilities
- Service technician for offshore energy facilities
- Assembly technicians for onshore and offshore wind energy facilities
- Service technicians for rotor blade repairs

In addition, there is training specifically designed for training professionals in the field.

It has to be remarked that the BZEE training is certified by Det Norske Veritas and count with the satisfaction of GWO meeting its minimum requirements.

Some of the modules taught are compulsory for some of the courses mentioned above, others are highly recommended for different courses and some of them are specific for specialist in the subject. The modules are structured in the following topics:

- Health and safety
- Wind turbine electronics
- Wind turbine Mechanics
- Hydraulics
- Rotor blade
- Transport
- Wind energy technology
- Offshore operations
- Operations management
- Support

The module contents comprehend different sub-modules of training, although some of them offer a basic insight in a concrete subject and have an advanced sub-module that follows each targeting different technicians training. In addition, some sub-modules offer a refreshment of the subject that would be convenient for the professional technicians.

3.4. Basic Technical Training GWO

The GWO basic technical training (BTT) program is still developing and the information used in this report comes from the draft version of the program as the final version has not yet been released.

The contents of the GWO BTT are structured in three main modules which are: electrical, mechanical and hydraulic.

Each of those modules have a very general approach and include the main technical topics that can be of interest for an operation and maintenance technician in order to acquire basic technical knowledge.

The mechanical module introduces the principles of bolted connections and how to tighten them as well as the main mechanical components of a wind turbine such as the gearbox, the braking system, the yaw system, the cooling system and the lubrication system.

The electrical module follows the same pattern. It is divided in eight lessons introducing electrical concepts, safety related to electricity, symbols and components, sensors, circuits and measuring instruments.

To conclude the evaluation of the GWO BTT, the hydraulic module will be reviewed. It is as extense as the mechanical module, both structured in 12 lessons. Those lessons give general information about the main components of the hydraulic system such as pumps, actuator, valves, accumulators, sensors, pipes and connection and oil filters.

All of the three training modules include a lesson of introduction and summary, as well as a safety lesson.

3.5. Skillwind modules

Skillwind training consists in customized training modules designed to deliver the targeted process competencies in the wind industry. Its aim has been filling the educational gap in the expanding European wind industry developing training course oriented to maintenance and operation within a European Qualification Standard.

The Skillwind training course is structured in six modules which are the following:

- Basic concepts
- Engineering, Procurement, Commissioning and Operation
- Predictive maintenance
- Preventive maintenance
- Corrective maintenance
- Health and safety

The training modules are structured as it can be observed in the following figure, having three different levels. The training begins with the more basic concepts, advancing through the specifics and finalizing with the advanced ones.

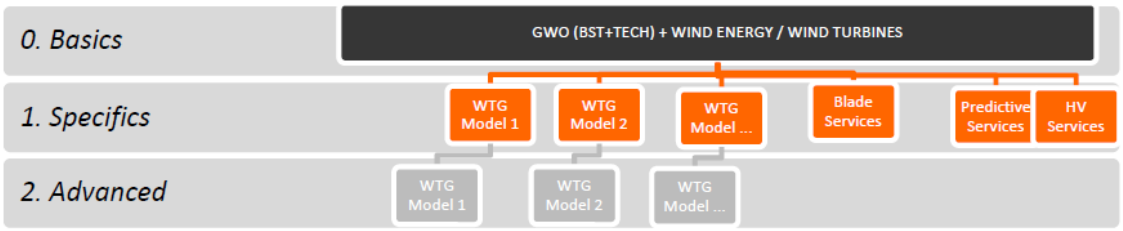


Figure 9. Skillwind training structure

The Skillwind modules offer a very complete training in the wind energy industry, giving a wide insight of the wind farm and the wind turbine generator, remarking the maintenance procedures from the predictive, going through the preventive and ending with the corrective maintenance and paying special attention to the basic safety training in the following areas:

- First aid
- Fire awareness
- Working at heights
- Sea survival

Related to the training in terms of wind farm, it comprehends from the task of design, the study of wind conditions in a specific site, the calculation of the wind generation, etc. to the wind farm arrangement, the road transport and the assembly task of the wind turbine facilities describing precisely the equipment and tools to be used in the assembly as well as the assembly sequence. In addition, the wind turbine energization procedure is explained in detail, including all the tests that should be run in the pre-operation state in order to guarantee the perfect functioning of the wind turbines.

The wind turbine module describes the basic key points of the technology as well as the systems and components, detailing the operational states and safety systems. Among the systems operating in the wind turbine generation, all of them are explained in detail including the mechanical system with all its components such as the drive train, yaw system, pitch system, blades, etc., as well as the hydraulic and electrical system, paying special attention to the control system and its elements.

4. WIND ENERGY COURSE PROGRAMS COMPARISON

Skillwind training VS. the Danish Wind Power Academy

As it can be observed the training programs offered by the Danish Wind Power Academy, they only have one training course in the wind sector that is comparable with the Skillwind training manual that would be the Wind Industry Essential Training because of the contents of the training program.

The main differences between these two programs are the module concreteness. As it was stated before the training program offered by the Danish Wind Power Academy targets two wind turbine generators from two of the biggest manufactures in the industry such as Vestas and Siemens. And all the control systems and operation, the

sensors as well as the trouble shooting are explained concretely for the the Siemens and Vestas wind turbine generators.

The rest of the modules of the Danish Wind Power Academy have a more general insight, as it does the Skillwind training in the Serious Game application.

Skillwind training VS BZEE training

The training offered by BZEE Academy approach wider contents and more specific modules oriented to different professional that may be already working in the field. That is the main difference observed between the BZEE training program and the Skillwind training modules.

As it was mentioned before, BZEE Academy have different courses oriented to different professional, in order to concrete the comparison only the training for service and assembly onshore technicians is compared as it is the training that have more similarities with the training offered by Skillwind. Having the latest in addition, the interactive training offered by the Serious Game, that allows anyone training in the Wind industry repeat and revise those modules which could be his or her weakest points.

In the comparison module by module is allowed, it can be observe that both training programs cover the same main contents. For instance in the Health and Safety modules training about first aid, working at heights, fire awareness even rescue and evacuation are taught in both training programs.

If the comparison is kept module by module, it would be found the same level of coincidence. The main differences in the program lay in the following modules:

- Hydraulics
- Rotor blade
- Transport
- Operations management and support

While doing the comparison, it was observed that the Hydraulics module contents are very specific in the training offered by BZEE, up to the point of describing each component of the hydraulic system of a wind turbine generator assembly and maintenance.

The other three modules mentioned above do not have their equal in the Skillwind program. The rotor blade module contents of the BZEE Academy are far too specific for what it is intended in the Skillwind training, although Skillwind includes the rotor blades in its training, it is done in a more general approach.

The transport module offered by BZEE Academy is focused in the licensed needed by the operators in order to drive the necessary truck, forks and cranes used during the assembly and maintenance. On the contrary, the transport module in the Skillwind training is oriented to the different transports used depending on the size of the wind turbines.

The modules about operation management and support do not have the equivalent in the Skillwind training, as the information given in management is not specific from the wind energy sector and it would not fit in the Skillwind project goals. And the support module offers training in English, which is not necessary in this project as it would be available in four different languages, and team training and industry internship which is not part of the self training offered by Skillwind.

Skillwind training VS GWO Basic Technical Training

There are several coincidences between the GWO Basic Technical Training and Skillwind approach. Both programs have been thought to be used by future technicians of wind farms.

However, if a comparison is done lesson by lesson of each of the modules, it can be observed that the GWO training modules are oriented to safety and how to work with some of the wind turbine components and using the measuring instruments.

On the other hand, Skillwind training program includes a general description of the whole wind turbine and how it works apart from the description in details of each of its main components and circuits and the main operations carried out

5. CONCLUSIONS

From the research in European training programs with solid structure and expertise in the wind industry that has taken place it can be taken into account that the Skillwind program and the Serious game fill the existing training gap in the wind industry, offering an ambitious training program with vast contents related not only to operation and maintenance but also all the general information needed in order to understand the wind energy and the wind turbines operation.

The Serious Game offers not only the contents of a very complete training program but also the means to acquire the knowledge from the basic concepts to the more advanced ones. By simply installing this application, the user would have access to the contents, would be able to be tested periodically and know the advance in the different subjects. Obtaining in the end, solid knowledge in Wind energy which is the main aim of the Skilwind project.