Vocational Training in Wind Energy Technologies – Good Practices

"Transfer of Innovative VET System In Wind Energy Technologies" –TrainWIND

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Introduction

The intent of this document is to compile the most significant aspects of the VET_WIND (TrainWind) project in relation to the tasks carried out, procedures followed, experience acquired and results obtained so that they may serve as an aid for all those who intend to tackle a project related with on-line training in technical areas.

The document has been divided into five sections, each of which corresponds with a work package of the project.

Section 1. Study market needs

Approaches to find out job profiles and training gaps

To communicate and collect information within the wind sector, in the project TrainWind the following activities were undertaken:

- we carried out meetings with companies in the sector in all four countries (BG, UK, ES, BE);
- there were two questionnaires filled in by employers and by the trainees participating in the pilot courses;
- we visited several renewable energy conferences in EU, where we collected information from a wide range of participants and distributed our TrainWind brochures and newsletters;
- from internet research, we compiled a database of more than 200 companies from the wind sector and periodically informed them about the project, the e-learning platform and our newsletters;
- we created two TrainWind promotional video clips that were broadcasted in BG and used to promote the course.

European wind sector employment

In 2007, the European wind turbine and component manufacturing industry employed 64,000 people directly and another 43,000 indirectly. Wind farm development, installation, operations and maintenance (O&M) employed 29,000 directly and an additional 15,000 were employed directly in other wind energy related jobs. These figures do not take into account the higher employment effect of installing, operating and maintaining offshore wind turbines. The survey in the sector shows that 0.4 jobs are created per MW of cumulative capacity in operations and maintenance and other activities. It suggests that there will be one lasting job for a maintenance technician for every 3MW of capacity installed. Employment levels in other sectors of the industry will be maintained only for as long as the rate of installation continues.

The offshore industry is forecast to see a steep rise in employment numbers over the course of the next decade. It is estimated that the wind energy sector will employ 462,000 people in 2020. Among these 169,500, almost 40% will be in offshore. By 2030, jobs in offshore are expected to count for 62% of total employment in the wind energy sector: around 300,000 jobs out of a total of 480,000.

Employee Profile & Skills

There are a lot of professions in the wind industry that require a very high level of training and technical expertise. There are skills shortages particularly in engineering and management positions, and those requiring Science, Technology, Engineering and Mathematics (STEM skills).

The development of the wind power industry and related services has created a new class of professional wind specialist jobs that are supported by more conventional jobs which are carried out by technicians and professionals, from the metal, electronics, chemistry and energy industries, including the specialties related with the maintenance of these industries.

Profiles in manufacturing of wind turbines

The professional profiles which appear within the wind turbine manufacturing sector included are:

- Electrical engineers
- Mechanical engineers
- Aeronautical engineers
- Manufacturing engineers

Profiles in development and management of wind farms

The main profiles can be broken down into the following roles:

- Research and Development (R&D) engineers: Industrial engineer, specialty in electrotechnics and energy, specialist software to design and calculate electrical generation installations.
- Project engineers: Industrial engineer, electrotechnics, civil, canal and port constructions, specialised in electro-technical and energy. Good understanding of specialist software to design and calculate electrical generation installations.
- Wind farm assemblers and technicians: civil, mechanical and electrical assembly of the wind farms. Skills include working at heights in electrical generation apparatuses, ground works, civil works, mechanical fixing.
- Operation and maintenance of wind farms: Superior professional training in the specialty of electro-mechanics; Software at a user level to control electro-mechanic installations; Necessary experience: work on the assembly and repair of electricity generation mechanisms. Small repairs of circular moving transmissions and rotors. Use of electronic control mechanisms.

For all profiles English language is necessary, technical reading and general comprehension of social situations.

Section 2. Recommendations for e-learning development

Work package 3 of the TRAIN-WIND project consisted of the transfer of the curriculum and the study programme of the on-line course developed in the e-WindTech project and its adaptation to the training needs of the target audience of the TrainWind project. Later, the adapted course contents would be loaded in the project platform.

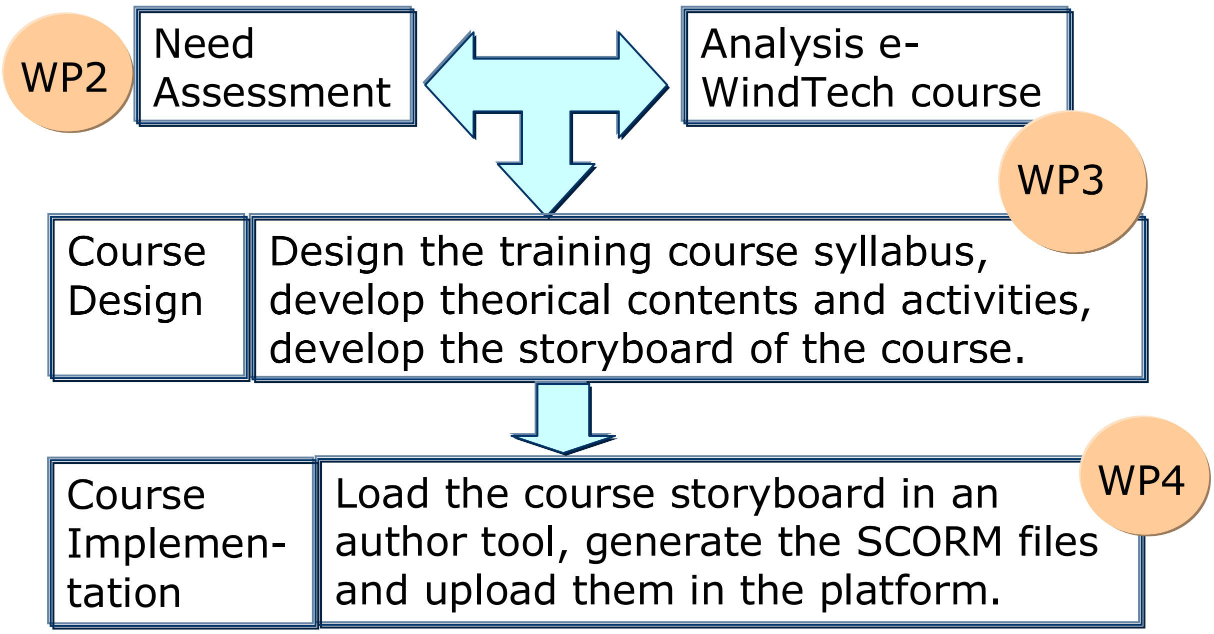


Fig.2.1 From Need Assessment to TRAIN_WIND e-learning course implementation

Before adapting the educational material that already exists, it was necessary to outline what the new educational programme would be by taking into account who the target audience is, what objectives they have and what resources they have (both during the design phase of the course and the teaching phase). This was used to establish the most adequate teaching method to reach the objectives.

There are various educational theories although in our case we try to integrate two of them in the design of the educational programme - the Programmed Instruction and the Constructivism.

Programmed instruction is a method of presenting new subject matters to students in a graded sequence of controlled steps. Students work through the programmed material by themselves at their own speed and after each step test their comprehension by answering an examination question or filling in a diagram. They are then immediately shown the correct answer or given additional information. Computers and other types of teaching machines are often used to present the material, although books may also be used.

Constructivism encourages learners to build their own knowledge based on individual experience and apply this directly to their environment. Constructivist pedagogy sees the learner at the centre of the learning experience rather than the tutor. It sees the learner as an active participant in their learning experience rather than a passive vessel to be filled with information. E-learning forces learners to be adventurers seeking out information, making connections and building knowledge.

The combination of Programmed Instruction and Constructivism is a successful approach used in the current project because programmed instruction is good at helping students learn a set of terms and very structured information, while constructivist approaches help students deal with real problems in ways that enable them to solve problems.

The design of the course has been outlined as programmed instruction but, in turn, various interactive charts have been included which, along with the work of the tutor, introduce the constructivist aspects of the course.

One of the commonly used models to conduct an instructional design is known as ADDIE. It is a recursive and systematic process, valid for any educational context, whether it is based on ICT or not, made up by five phases: analysis, design, development, implementation and evaluation.

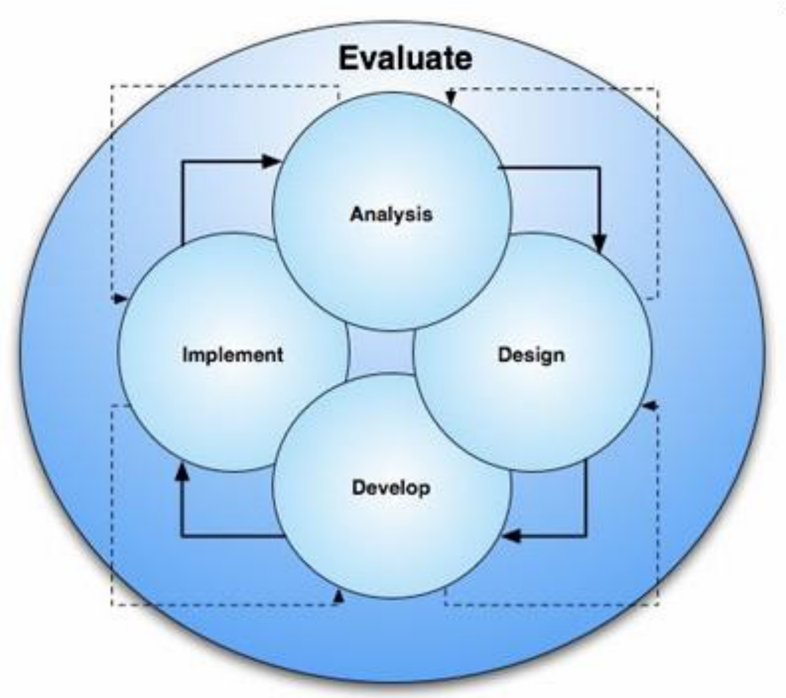


Fig.2.2

Analysis

- During analysis, the designer identifies the learning problem, the goals and objectives, the audience's needs, existing knowledge, and any other relevant characteristics. Analysis also considers the learning environment, any constraints, the delivery options, and the timeline for the project.

Design

- A systematic process of specifying learning objectives. Detailed storyboards and prototypes are often made, and the look and feel, graphic design, user-interface and content are determined here.

Development

- The actual creation of the content and learning materials based on the Design phase.

Implementation

- During implementation, the plan is put into action and a procedure for training the learner and teacher is developed. Materials are delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated.

Evaluation

- This phase consists of two parts: formative and summative evaluation. Formative evaluation is present in each stage of the ADDIE process. Summative evaluation consists of tests designed for criterion-related referenced items and providing opportunities for feedback from the users.

Another very important aspect in the development of an e-learning course, especially for those who design for the first time, is to understand the difference that exists between traditional training and e-learning training.

Traditional training courses are built as large, monolithic structures that are difficult to repurpose into searchable self-paced objects. For example, the average instructor-led training (ILT) can be a five-day event, built around 60-minute lectures followed by 30-minutes of Learner activities. The ILT experience is fixed in length, sequence and scope. This instructor-led model does not addressed the need for similar knowledge and skills to be taught on self-paced, media driven platforms such as the Web.

But there are strategies which address this problem, as is the case in the RIO (Reusable Information Object) strategy adopted by CISCO (for more information consult the following articles: Cisco Systems Reusable Information Object Strategy and Reusable Learning Object Strategy: Designing and Developing Learning Objects for Multiple Learning Approaches)

An Reusable Information Object is granular, reusable chunk of information that is media independent. An RIO can be developed once, and delivered in multiple delivery mediums. Each RIO can stand alone as a collection of content items, practice items and assessment items that are combined based on a single learning objective. Individual RIOs are then combined to form a larger structure called a Reusable Learning Object (RLO).

Reusable objects are popular in the fields of human performance technology and knowledge information management. Other terms used in the industry include:

- Educational objects
- Learning objects
- Content objects
- Training components
- Nuggets
- Chunks

Ideally, a learning object is based on a single learning or performance objective, built from a collection of static or interactive content and instructional practice activities. Any learning object can be “tested” through assessments that measure the learning or performance objective and are either positioned with the learning object or collected as an assessment group. Within the learning object, content, practice, and assessment groupings are built from raw media assets such as text, audio, animation, video, Java code, applets, Flash, and any other asset needed for the given delivery environment. Finally, everything found in the learning object is identified with metadata so that it can be referenced and searched both by authors and learners.

With their granular structure, learning objects can be combined to form a hierarchy such as a lesson, module, course, or curriculum that gives the objects the necessary context in which to ensure a meaningful learning experience. Likewise, the same learning objects can be leveraged in problem-based learning, exploratory environments, performance support systems, job aids, help systems, or any blended learning solution.

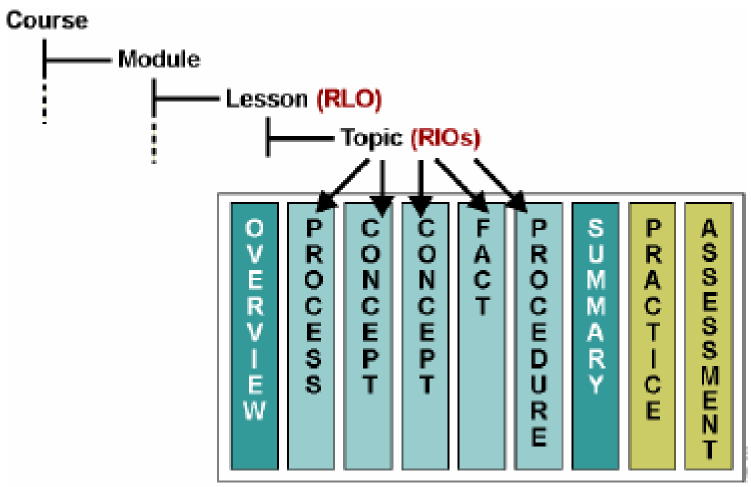


Fig.2.3 Course Hierarchy

For the authors who create the content, some of the advantages to adopting this strategy are:

- Supports the design of many learning approaches, including receptive, directive, guided discovery, and exploratory.
- Provides guidelines for authors, improving their ability to write effective and efficient performance-based training, assessments, and resources.
- Allows authors to combine old and new objects to build new solutions to meet the needs of their learners.
- Supports both reusing and repurposing from the smallest media element up to larger course structures and learning contexts.

Section 3. E-learning platform

This set of good practices is developed during the transfer of the course e-WindTech into the online education tool - TrainWind. The transfer includes update of existing media by introducing modern interactive tools in order to improve and extend the education quality and value.

During the transfer and update the team has noted the usefulness of several techniques applied into the development of the interactive media. Those techniques were adopted to solve specific problems related to the course. Their application however can be extended beyond the premises of their appointed purpose and can be introduced as a solution to other problems as well.

Problems and concerns

By analyzing the content of the initial source course material and the specifics of its multimedia content several direction of improvements trough interactive content were considered. Those included:

Reducing the window space that each of the multimedia materials takes.

Since the course is online - best reading and browsing through the materials is obtained by concentrating the education material of one sub-section into one computer screen - scrolling should be avoided since it distracts the reader. This however proves difficult because of the size and number of formulas, diagrams, pictures and their description - contained in each section.

Adding user interaction in order to improve the learning process.

A major advantage for online education materials is the possibility of adding user interaction. This allows - learning trough visual demonstration and experience. Such materials however are not widely available and should be developed for the specific case.

Developing additional interactive tools for visualizing and describing material that is otherwise difficult to explain.

Wind turbine specifics contain a lot of effects and processes that can be hard to explain and be thought outside the scientific and engineering language. The TrainWIND on the other hand is course aimed at vocational training of people with high education. In order to present those materials special animated movies and user interactions can be developed.

Improving the overall quality of the course and developing materials that can be viewed in the selected platform.

Here conventional materials can be further developed in order to improve their graphical quality and compatibility with online platforms.

Good practices developed

Following the indentified specific described in the previous section several approaches based on existing and newly developed interactive media concepts were taken. Those included:

Interactive equations

The interactive formula content includes a set of wind energy specific equations that presented as an application. In conventional visual representation the different elements of the equitation which have not been presented to the reader are described in text bellow the equation - Figure 3.1.

The developed E-learning platform uses simple interactive media with a minimum of code programming. In this interactive media the elements of the equation are presented to the user by pointing on them - providing description to one element at a time. This saves up screen space, as well as adds exploration to the learning process. It also lets the user to learn and understand the equation components.

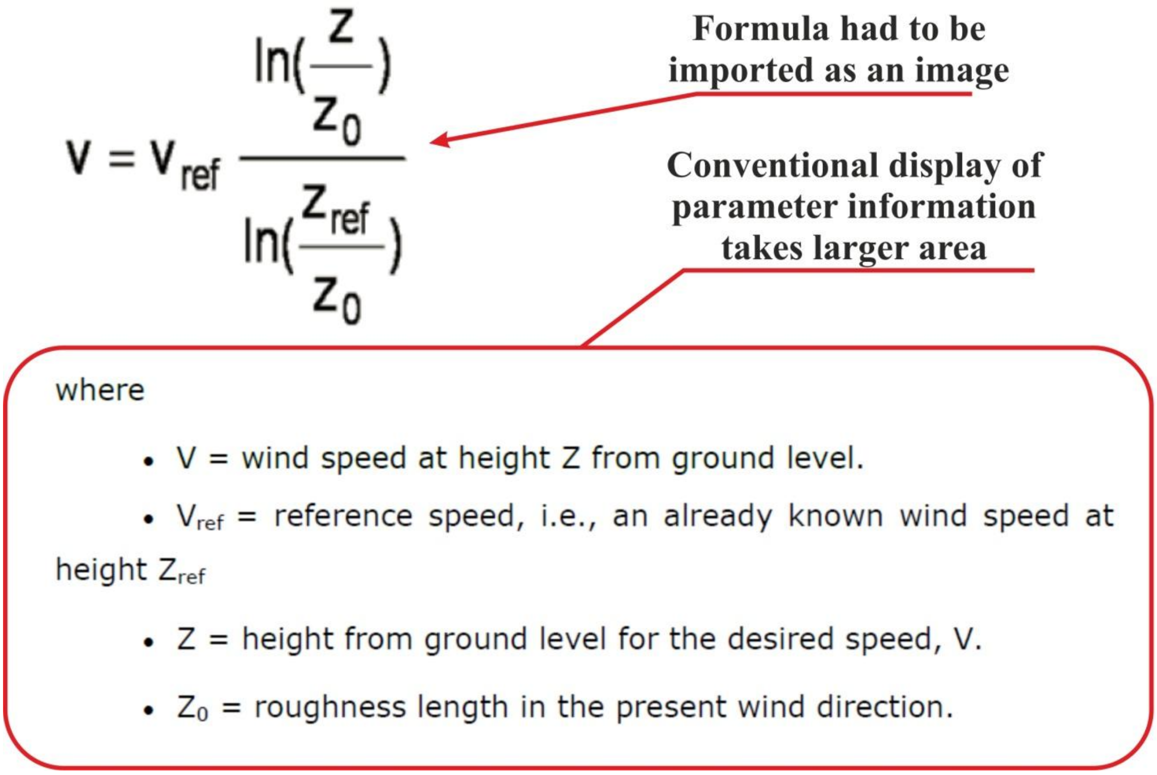


Fig.3.1 Conventional formula display

The developed interactive equation is presented and described in detail on figure 3.2.

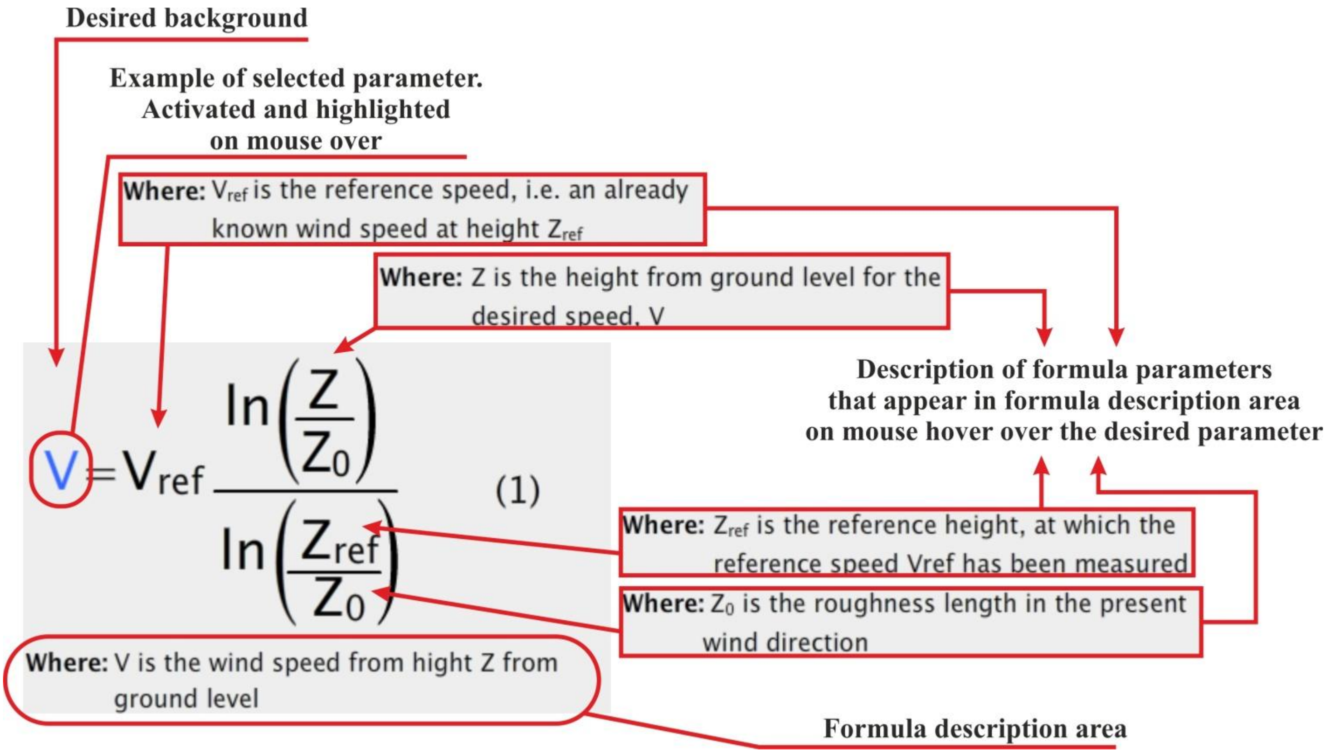


Fig.3.2 Block diagram of the developed interactive formula

This simple approach was used to represent formulas and equations in the field of wind energy technologies, but it can be used in any other field of online or face-to-face education. This solution has already been applied in several other courses by TU-Varna and proved useful and valuable.

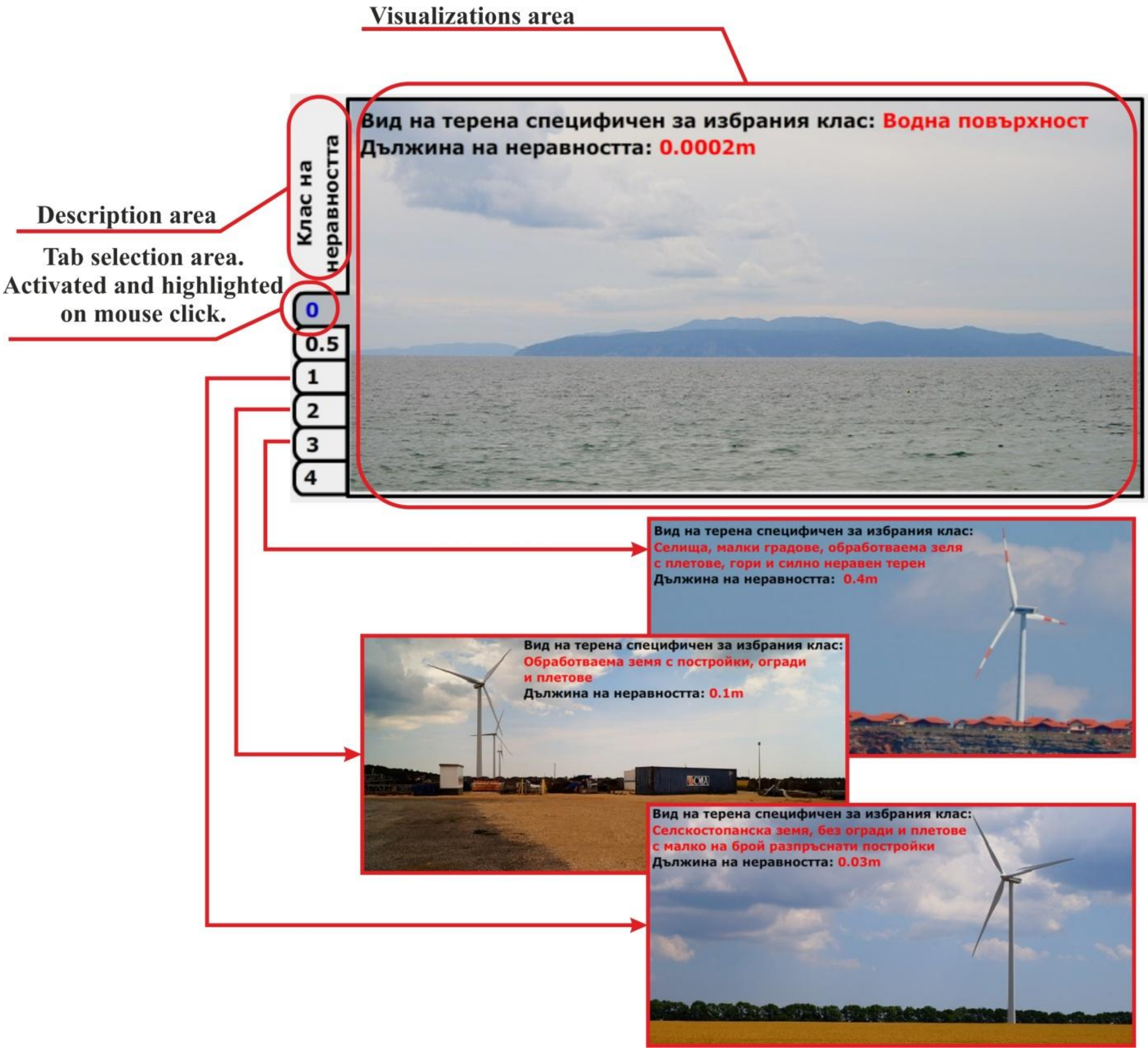


Fig. 3.3. Block diagram of the developed interactive multimedia for specific details of installing wind turbines

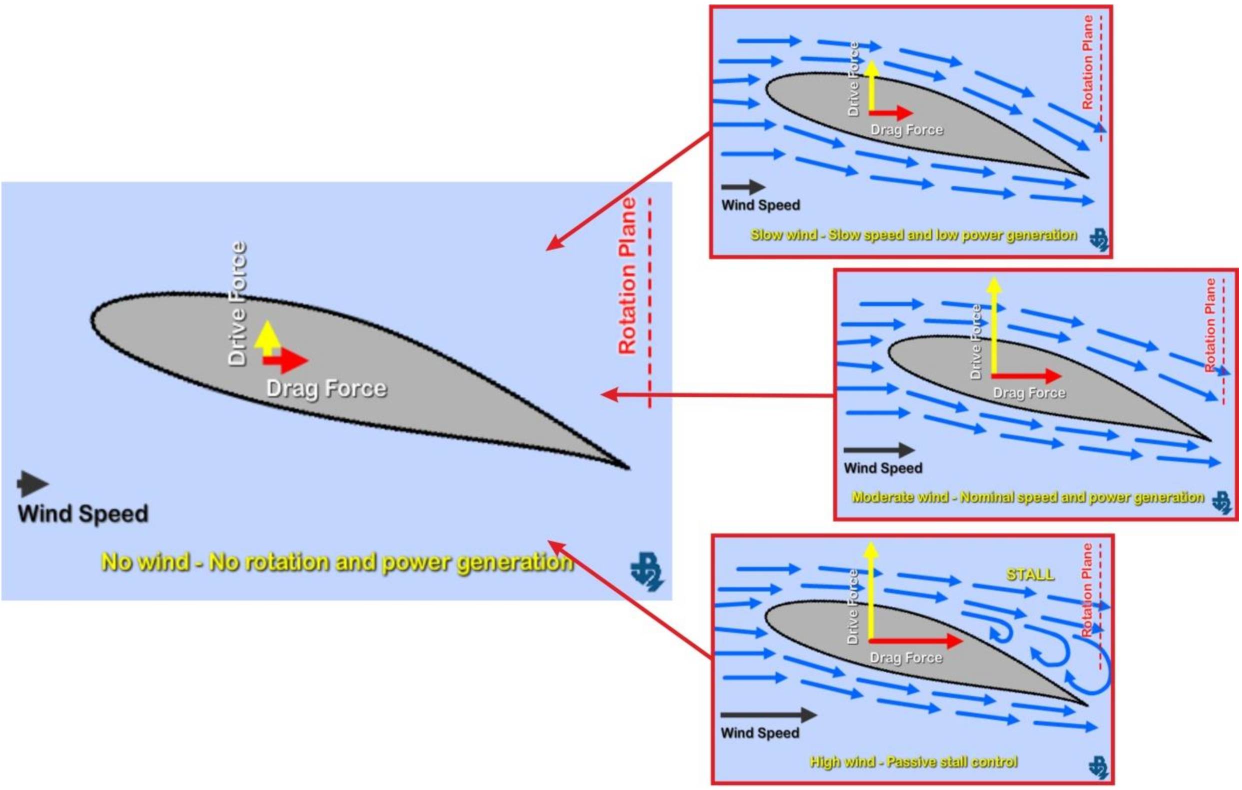
__Interactive visualization of for specific details of installing wind turbines__

Visualization in vocational education and training is a prominent factor. Usually when courses are short visual information plays an important role. A majority of the visuals developed for the course are dedicated to the installation of wind turbines. In order to comply with the set directions in the previous chapter, most of the information is presented in the form of interactive tables. Those tables allowed an easy grouping of the information in sections, as well as reducing the overall space taken up on screen.

The developed interactive media that is used for visualization is presented and explained in figure 3.3.

Interactive representation and visualization of controls in wind turbine

Visualizations were used in order to improve the presentability of the course materials and to allow the wind turbine specifics to be explained without the use of high-level engineering or scientific language. Those materials included two types of representations - three dimensional (3D) animations and two dimensional (2D) animations. An example of the 2D approach is presented at figure 3.4 and an example of the 3D approach is presented at figure 3.5.



Frames from the animation demonstrating the stall control. Animation activated on mouse hover over.

Fig.3.4. Block diagram of the developed interactive 2D representation and visualization of control in wind turbines

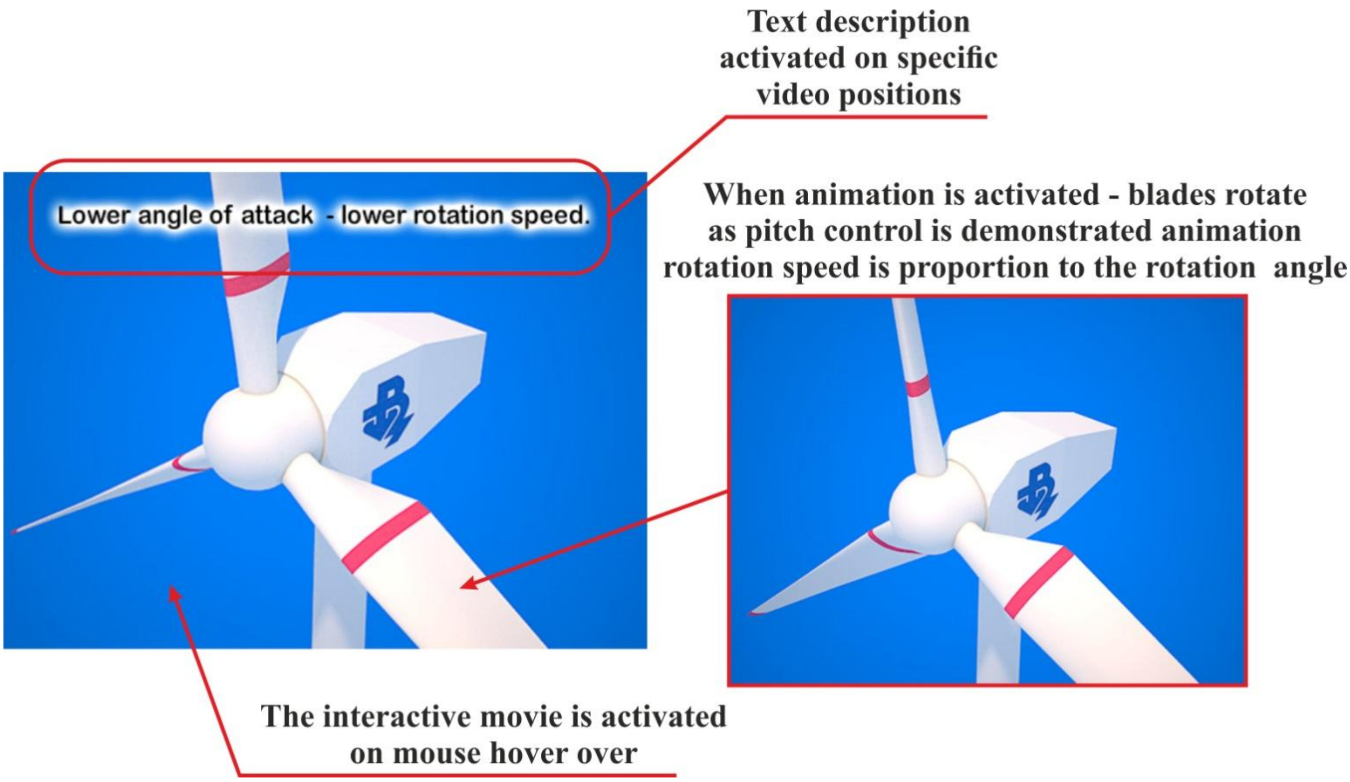


Fig.3.5. Block diagram of the developed interactive 3D representation and visualization of controls in wind turbines

Good practices – Transferability of code

Example of each of the described and additional tools can be found on the TrainWind webpage - http://www.tu-varna.bg/trainwind/. Additional source code is available for some of the materials.

The source code presented is developed in processing - http://www.processing.org/ - can be used free of charge.

HUMAN RESOURCE DEVELOPMENT CENTRE

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Section 4. Pilot courses/ Languages

Based on the TrainWind e-learning platform, Pilot Courses were deployed for remote training of technical staff on wind energy technology. Considering the European scale and the social innovation which wind energy technology brings, multilingualism is a major objective. Thus, the content of the Pilot Course is available in four EU languages: Bulgarian, English, Dutch and Spanish. Pilot Courses were implemented in Bulgaria and the UK.

The main steps of the organization and the implementation of the TrainWind Pilot courses in Bulgaria and in the UK are summarized in the flowchart shown in Figure 4.1:

Fig. 4.1. The process of organization and implementation of the TrainWind Pilot Course

In the following subsections, we detail on the individual steps of the TrainWind courses organization and implementation, and the lessons learned during the TrainWind Pilot Course in Bulgaria and UK.

Identification of the Target Groups

The precise identification of the target groups allows that individuals who take the TrainWind Pilot Course can acquire the knowledge required when qualifying for job positions in companies that deploy, operate, and maintain wind parks.

A starting point for the identification of the respective target groups is heavily based on the Market Needs Analysis and study of the stakeholder roles in the wind energy sector. Discussion with recruitment officers and managers of companies in the wind energy sector, and more specifically analysis of the hiring strategies, the availability and qualification of technicians available on the labour market, and the fluctuation of workforce employment in the sector were also considered when selecting the target groups.

For that purpose, in the particular case of the Pilot Course in Bulgaria, we interviewed:

- a recruitment manager of the ABC Wind Farms OOD, a company that installs, operates and maintains wind park installations on the territory of the Balkan Peninsula,
- managers of companies members of the Association of Producers of Ecological Energy (APEE) in Bulgaria, but also
- managers of companies involved in the training of technical staff for the wind energy sectors in Belgium, Spain and the UK.

Analysis of this information, collected during these interviews and discussions, allowed us to shape the profile of target groups to find suitable trainees:

- Technicians from the wind energy sector,
- Technicians from other sectors,
- Technical School / High School Graduates,
- Unemployed young people.

Recruitment of trainees

The recruitment of trainees required a few weeks of preparation as it depended on careful planning of the recruitment campaign. This involved preparation of presentations, which explain the purpose and the benefits of the TrainWind project and the opportunities, which the TrainWind Pilot Course offers.

Initially, members of the TrainWind project gave presentations to managers of companies from the wind energy sector. These aimed at presenting the functionality of the TrainWind e-learning platform and the main features of the TrainWind Pilot Course. Such presentations are an important step towards motivating industrial partners to support the implementation of the TrainWind Pilot Course.

Obtaining the support of the management body of industrial entities opens the way for a new round of presentations aiming to motivate employees from the wind energy sector to join the course. During these presentations, it is of utmost importance to emphasize the benefits of continuous improvement of qualification and the opportunity for combining theoretical knowledge with practical skills.

Another round of presentations and advertisement campaigns aimed at informing undergraduate and graduate students about the benefits of attending the Pilot Course. The information campaign was oriented towards students from the University programs on “New Energy Sources” and “Power Engineering”. Information about the TrainWind course was posted on the project web-site and internet forums. For these target groups the main motivation is acquiring knowledge, skills, and the TrainWind certificate that collectively improve the chances for getting a job in the wind energy sector.

The TrainWind certification was also an important recruitment tool for those trainees who successfully complete the Pilot Course and succeed on the Unit Tests.

Eventually, 40 trainees were recruited for the Pilot Course in Bulgaria and 14 trainees for the Pilot Course in the UK. The distribution of trainees by category is shown in Table 4.1.

Tables 4.1 Distribution of trainees by category

Category of trainees	***Distribution***
Technical stuff working in wind energy parks (partners APEE and ABC),	60 %
Undergraduate and Master Students (TU-Varna),	20 %
Technicians working in the Electricity P&D sector,	5 %
Unemployed and individuals with not-relevant technical background.	15 %

During the recruitment campaign trainees were encouraged to fill in the TrainWind Entry Test. The results of the entry test were used for assessing the competence levels of the trainees before the course and classified as follows: beginners, advanced, very advanced.

For each of the three categories we set curriculum paths, where the advanced and the very advanced trainees were allowed access to the Unit Tests of Units 1 and 2 straight from the very beginning of the Pilot Course. The successful completion of these tests allowed trainees to continue with the next Unit without requiring mandatory studying all the content of the basic Units. However, all trainees had the chance to go through the content of all Units, at any time.

Kick-off Seminar & Initial Training session

The main objective of the Kick-off seminar is to explain the procedure which the trainees are going to follow and to specify the time-schedule for the TrainWind Pilot Course.

Self-study with the on-line Units & Tests

As most of the Pilot Course trainees work or study, they were instructed to take one Unit per week. The time-schedule was set in the

Calendar tool of the TrainWind e-platform so that trainees can synchronize their progress. Trainees were instructed to study the material of each Unit then do the Unit Test. Besides the Unit Tests, some Units also included one or two intermediate tests.

Face-to-face Seminars & Training sessions

After the first and the second weeks of the TrainWind Pilot Course, face-to-face training sessions were organized (and held on two subsequent Saturdays). These aimed at checking the trainees' progress and querying for problems with the TrainWind e-platform or with the content of the Pilot Course. Question and Answer (Q&A) sessions helped the trainees who experienced problems. These seminars also gave feedback from the trainees which help for fine-tuning of the e-learning platform.

Practical training sessions & Visiting industrial wind farm installations

After the first four weeks of the TrainWind Pilot Course, the trainees were brought to installations of the ABC Wind Farm OOD near the town of Kavarna. Trainees had the chance to get acquainted with different types of equipment. Highly qualified technical staff explained specific procedures for checking and maintaining of equipment.

Progress Evaluation (COMET tool)

After completion of all Units and the Unit's Tests, trainees' progress is evaluated via the COMET assessment tool (See also Section 5). Analysis of the trainees' progress is estimated based on the results from the Entry Test and the COMET tool.

Graduation ceremony (Certificates) & Feedback collection (TrainWind Questionnaire)

The TrainWind Pilot Course concludes with a graduation ceremony, where all trainees who successfully finished all Units, receive the TrainWind Certificate. The trainees are offered to complete the TrainWind Questionnaire, which aims to collect feedback about the e-platform user interface and the usability of the TrainWind Pilot Course.

After the Pilot Course all trainees are included in a post-course e-mail and are kept informed about post-course events and subsequent educational opportunities.

Section 5. Assessment of competences

Comet stands for Competence Measurement Tool. It is a competence assessment tool and not an actual testing tool (for tests, exams etc).

For the TrainWind project we have created a competence profile for wind turbine technicians. This competence profile was a set based on research, experience from other projects and looking at existing training curricula.

The competence profile has been drafted and clustered into different sections:

- Basics
- Mechanics
- Hydraulics
- Electronics
- Health&Safety

For each set/cluster of competences different statements have been created. These statements are formulated in a way to assess a specific topic, skill, knowledge, or attitude. The tool provides the opportunity to do a self-assessment or a peer assessment. Participants answer each statement with a slide bar scaling the competence from “Layman” to “Limited experience” to “Guru” (Fig.5.1).

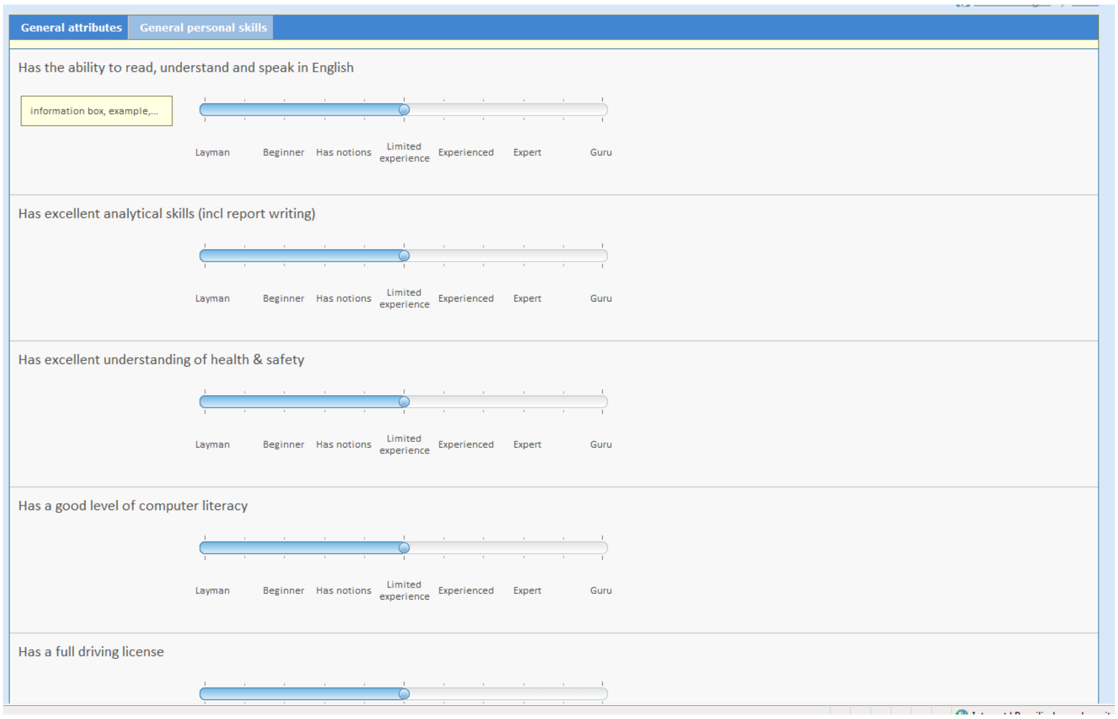

Fig.5.1

Because of this clustering it is even possible to only assess one of the clusters instead of the whole competence profile.

The clusters of the competence profile however do not match the set-up of the different course modules. This leads to the fact that one cannot give an exact training suggestion for a certain gap in competences.

Further assessment of the gap is necessary to align which course module would best solve this problem, which training content is lacking.

Once the assessment has been completed there are different possibilities to view the result. There is an overview of personal competences, or the lack thereof. This can be made visual as a radar chart or bar diagram (Fig.5.2, Fig.5.3). This could also be done per cluster, per competence or per individual statement. Results can also be compared with a norm.

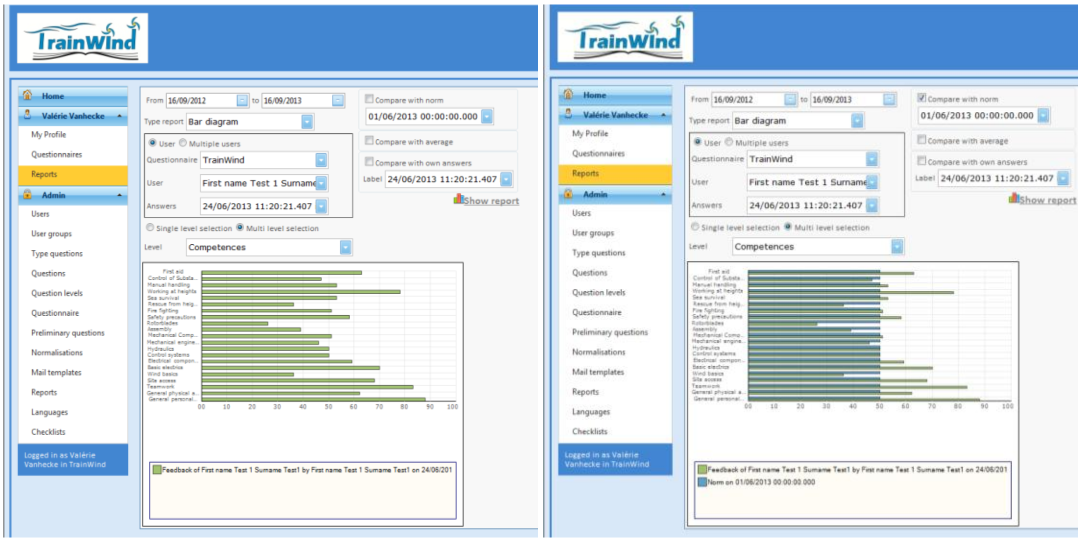

Fig.5.2

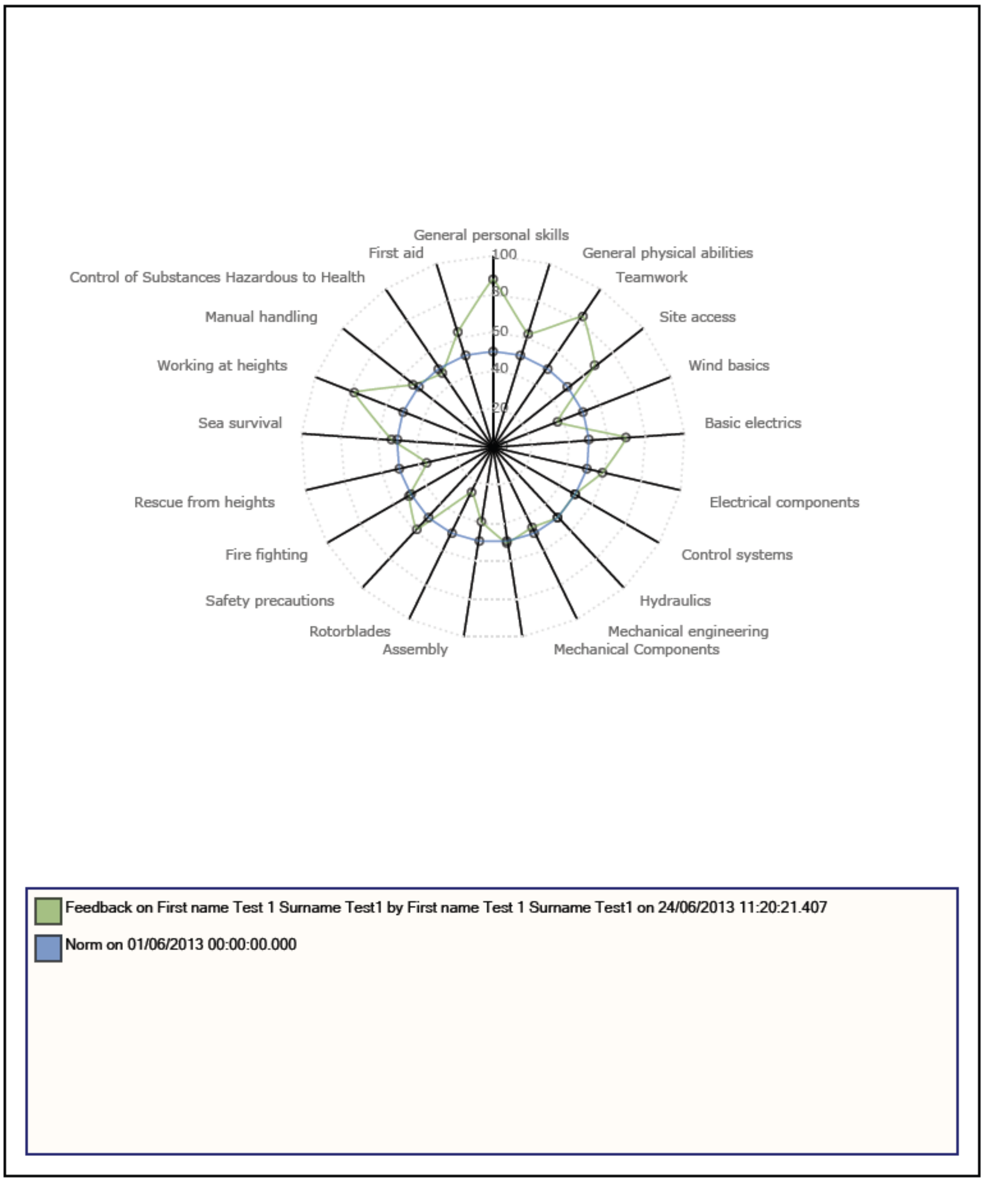

Fig.5.3

The self-assessment results can be matched with the assessment results of the personal competences assessed by someone else (peer, supervisor, colleague…). This gives a wider perspective on the results.

In the wind sector a lot of work is done in teams. The Comet Tool also provides a team analysis feature. This can be done a self-assessment, a peer assessment or all the way up to a 360° review of one person or multiple persons. This gives the opportunity to see whether all necessary competences are gathered in one team (Fig.5.4, Fig.5.5). This can be useful to put together complementary teams.

It also allows highlighting training needs early in a project or pre-planning (and succession planning) if a certain person would leave the project/ company.

In addition it also enables more experienced colleagues to train less experienced colleagues because the competency tool (when done honestly) will higlight differences in personal/ professional development.

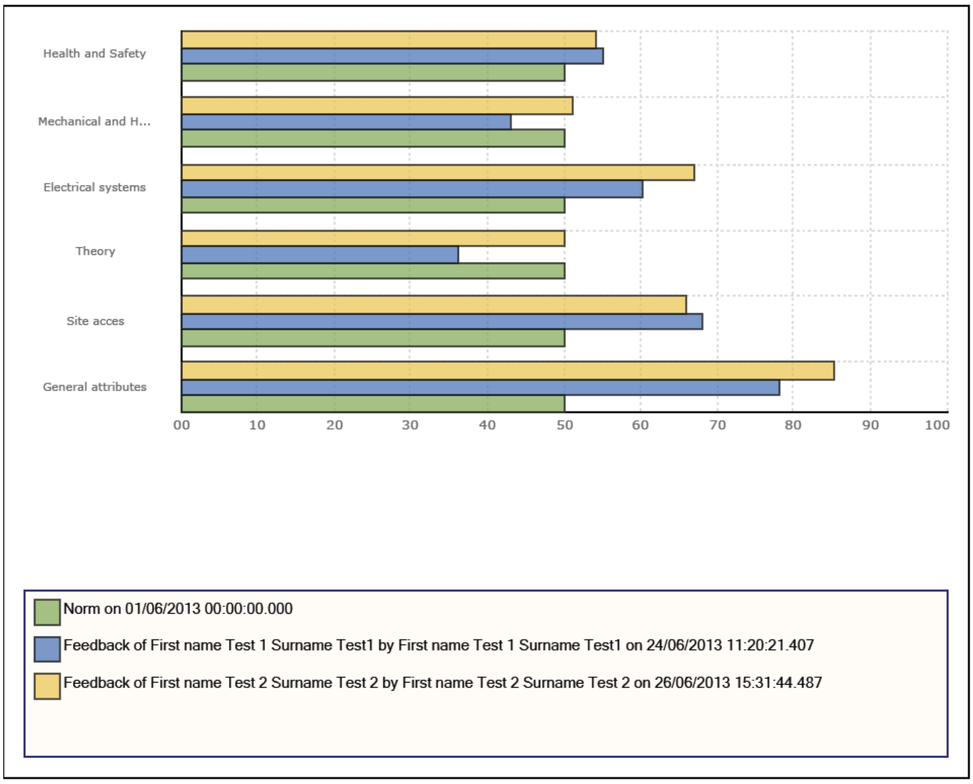

Fig.5.4

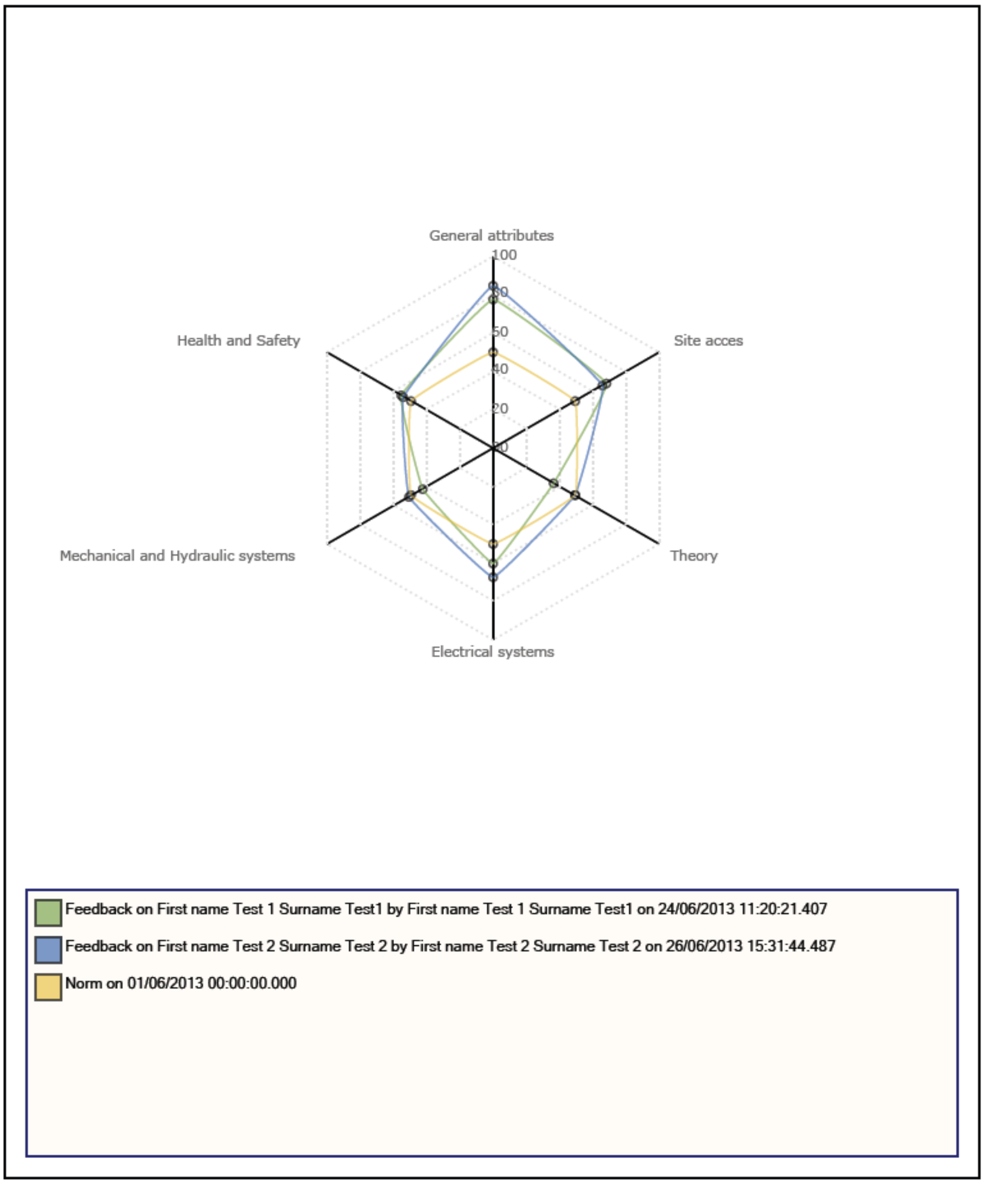

Fig.5.5

The Comet Tool is not specifically a tool for validation of training, but it can also be used in this way as well. Comet is an assessment tool for competences acquired through training, experience, on-the-job learning… If the assessment shows certain competence gaps, one solution might be training, but other possibilities are mentorship, coaching… The assessment gives an overview of competencies and how someone scores against the set criteria.

Based on the results of an assessment one can work out a training plan (training, coaching…). The assessment can then be repeated to see whether the employee has improved. The tool offers the possibility to compare scores over time (i.e. from one year ago to more recent results). This enables an assessment whether training, coaching or other CPD (continuous Professional Development) was successful.

Lessons learned/Suggestions for future projects:

- Ideally we should have had the mind turbine technician profiles completely validated by the sector/ industry and on a country-by-country basis. Competence profiles should be checked against necessary requirements by sector companies and be updated or changed to their needs. In that way the promoter/ partner will get a tailor-made competence profile per country, as requirements and demands may be different in every country. It is also possible to create a specific profile per company to focus on their specific needs.
- This was a Transfer of Innovation project, with the transferred information being the course material from the previous WindTech project. This led to the fact that the created competence profile and the transferred course modules do not match completely. In a development project we could have created the competence profile first, based on input and discussions with the sector, and then set-up the course content. This would give a match and then it would be possible for the tool to provide a concrete and specific training suggestion.