Deliverable 3.1
SKILL GAPS ANALYSIS

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INTRODUCTION

**KnowRES**, The Knowledge Centre for Renewable Energy Jobs, provides *job intelligence* to industry, candidates and academic and training institutions, while performing an analysis of the skills needed by the industry to ensure that the provided education and training courses are tailor-made to the sectors’ needs. The overall aim of the project is to help closing the skill gaps in the Renewable Energy sector.

The project co-funded by the European Union is coordinated by EUREC. The KnowRES consortium is composed of nine partners coming from four European countries, with complementary expertise. Five associations active in the area of renewable energy, one research centre, located in Spain, recognized expert in providing socio-economic analysis in the area of renewable energy; one University of applied sciences, located in the Netherlands; one recruitment company, located in Brussels, specialised in providing experts for the clean tech sectors.

The Renewable Energies (RE) sector is one of the fastest growing sectors in terms of jobs creation. According to the 2015 Annual review *Renewable Energy and Jobs* by IRENA, an estimated 7.7 million people are currently working in the RE field worldwide and the number will continue to rise. It is a fast evolving sector, highly dependent on technological development; it is therefore important to understand what the existing competences in the area are.

The KnowRES online platform ([www.knowres-jobs.eu](http://www.knowres-jobs.eu)) collects information on Renewable Energy candidates: students, employees, or former employees in the Renewable Energy sector. A survey was built in order to analyse their skills and expertise. Results are matched to the ones from the survey on industry needs. The comparison between needed skills and existing competences will enable to define areas where specific and additional training is needed in order
to better respond to the requests of the renewable energy industry. The skill gaps analysis report will present matching results of the two surveys. On the basis of this comparison, project partners will define areas where training is needed in order to reduce the knowledge and competence gap.

Figure 1: chart flow of the main project activities
1- SKILLS AND RENEWABLE ENERGY

1.1- ABOUT THE SKILL GAPS ANALYSIS REPORT

The Skill gaps analysis report identifies gaps and bottlenecks between the skills needed by the renewable industry and the competences currently available on the market.

This report puts together the results developed in the two first work packages of the KnowRES project by analysing where the gaps lie in terms of skills needed by the industry and available competences.

Identified target groups are: employers, candidates, and training and education institutions. KnowRES produces a set of sectorial reports and regularly updated EU wide Renewable Energy job profiles validated within the industry. A sectorial approach was selected due to its effectivity to analyse and strategically identify skills. In addition, technical sectors such as renewables are more sensitive to labour market imbalances and that can have a quicker impact on productivity and costs, it seems therefore more appropriate to select a sectorial approach\(^1\). Sectorial reports are based on information coming from energy agencies, companies, associations of the different industries, secondary sources, market analyses, etc. in which the accuracy and interpretation of the data are directly related to the objective of the agents involved.

In measuring a changing occupational structure, surveys of employers (companies and business sectors) and surveys of employees and candidates (labour force surveys) will be used:

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\(^1\) Please see KnowRES Deliverable 1.1 : Good practices examples of industry friendly green assessment and forecasting tools enabling the detection of green skill gaps
• **Employer surveys** can provide immediate information, including a useful measure of levels of activity and overall employment levels as well as the occupational structure within industries. They are also used to assess employers’ opinions and perceptions about current skill deficiencies and anticipated future changes.

• **Employee or candidate surveys** are used for analysing skills mismatch at individual level, reflecting over-education (within sectors) or misemployment (across sectors).

This information is complemented by a screening of the relevant education and training programmes currently available on the market in the area of renewable energy.

A literature review of recent studies on similar and relevant topics have been performed, and a practical case study on the development of new education programmes based on a skill gaps analysis in the North of the Netherlands will illustrate the purpose.

### 1.2- EMPLOYMENT IN THE RENEWABLE ENERGY SECTOR

Even though the main purpose for the stimulus of the implementation of Renewable Energy technologies in industrialised countries has been to reduce the environmental impacts of energy consumption, renewables provide many other benefits in the social and economic fields. Among other socioeconomic impacts such as energy security, economic growth, territorial cohesion, it is the **employment generation** which seems to gather most of the interest from various stakeholders. While companies are usually interested in the employment created by a specific project, public administration focus its studies in the employment created by a stimulus program and different associations of industries highlight the importance of the total employment in a sector.
As a result of the energy policy promoting renewable energy, a dynamic and continuously developing business sector has sprung up in Europe. According to data from the Employ-RES project, in 2005 the European RES sector employed 1.2 million people, equal to 0.65% of the total EU workforce and generated €58 billion value added equal to 0.58% of EU Gross Domestic Product (GDP). In 2011, only the direct gross value added generated by the renewable energy industry reached €93 billion, which is equivalent to 0.6% of total EU GDP. The renewable energy industry employed roughly 2 million persons or 0.8% of the total EU workforce. Technically speaking, the gross economic impacts (as well as the employment impacts) of the RES industry include the renewable energy industry itself and the industries depending indirectly on the activities of the renewable energy industry, either as suppliers of the intermediary inputs needed in the production process, or as suppliers of capital goods. About 55% of value added and employment occurred directly in the RES sector and 45% in other sectors due to the purchase of goods and services. Next figures show the evolution of the total gross value added and employment induced by RES deployment between 2005 and 2011.

![Figure 2: Development of total gross valued added induced by RES deployment between 2005 and 2011](source: Support Activities for RES modelling post 2020, Final Report)
Figure 3: Development of total employment induced by RES deployment between 2005 and 2011 (Source: Support Activities for RES modelling post 2020. Final Report)

A comparison between total employment induced by RES deployment and the development of gross value added shows that employment grew less strongly. This is a direct consequence of the increasing labour productivity (the ratio of gross value added to employment) over time.

If technology and expenditure category are considered, photovoltaics, wind and biomass technologies, especially the non-grid-connected use of biomass for heating purposes are the most important accounting for the 23% of the total impact on the total gross valued added.
In terms of employment, non-grid biomass showed the largest share of employment in 2011, followed by PV and wind energy. Other important contributors are the other biomass technologies (except bio waste) and hydropower.
RES deployment in EU induces a substantial share of employment impacts in small and medium enterprises in the EU: two thirds of the total employment can be attributed to RES deployment. Regarding technologies, those having an above average relevance for SME include non grid-connected biomass use, biofuels and deep geothermal energy use. Additionally, this kind of technologies trigger to a larger extent indirect employment in sectors such as the primary sector, the wood industry or construction.

Employment is largest in Germany with approximately 450,000 jobs, followed by Italy with almost 300,000 employed persons and Spain, France and the United Kingdom with between 100,000 and 150,000. Employment is higher in the new Member States due to their significantly lower labour productivity. Furthermore, RES fuel use generally has a higher share in employment, since the connected primary sector is also characterised by relatively low labour productivity.

The majority of the studies on renewable employment are focusing on jobs generated in the construction stage of an installation and the stable jobs as result of its operation. However, the economic activities surrounding the exploitation of renewable energy are numerous and cover all the links of the supply chain of the energy business, from the component design and manufacturing to the O&M through the assembling, the installation and the commissioning.

![Figure 6: Renewable Energy value chain](image)
Regarding quantity of jobs, it seems clear that there is a significant relationship between the stage of the activity in which the employment is created and the duration of this stage. It is stated that renewable technologies have a common life cycle that includes 5 stages: research and design, development and manufacture, construction and installation, operation and maintenance or service and updating and/or dismantling. Several differences were observed between the installation and start up stages, where duration of work is relatively short, and the stage of operation and maintenance (or fuel processing) in which duration of employment depends on the lifetime of the corresponding installation. It is also important to note that the employment that is more likely to remain in a region is related to the stages of operation and maintenance, and is, generally, not very labour intensive with the exception of the biomass sector.

An analysis of value added by economic sector shows that a broad range of sectors are active in directly or indirectly supplying the goods and services needed for the deployment of renewables. Countries with high investment expenditures in renewables (e.g. Germany or Denmark) see strong activity in the sectors supplying investment goods or in the construction sector. In countries with a strong use of biomass resources (e.g. France or Sweden), agriculture, forestry and the wood industry are important. In addition to the primary and the manufacturing sectors, trade, transport and other service sectors are also significantly involved.

For example, the wind power value chain incorporates five main stages: materials; components; manufacture; logistics, development and operations (which includes project development, geotechnical services, transportation, construction, and operations and maintenance); and end use. Every time a wind power project is installed it creates jobs, not only in the manufacturing sector, but also for structural engineers, surveyors, mechanics, sheet metal workers, machinists, truck drivers, construction equipment operators and wind turbine operators.

Next figure shows projections on the development of value added in 2030 and 2050 compared to 2011, subdivided by type of activity (investment in RE facilities, operation and maintenance of
existing RE facilities and use of biomass fuels in RE facilities). In a Business As Usual (BAU) scenario total value added will reach €75 billion, which is lower than the value in 2011. In the policy scenarios, value added in 2030 reaches amounts between €90 and 100 billion in the 30% target scenarios and about €120 billion in the 35% target scenario. Two policy scenarios are considered: SNP= Strengthened National Policies (continuation of the current policy framework with national RES targets - for 2030 and beyond- is assumed) and QUO= quota (in the case of the quota system, an EU-wide harmonised support scheme is assumed for the electricity sector that does not differentiate between different technologies). Value added in the SNP scenarios is slightly higher than in the quota scenarios due to higher RES expenditures.²

Figure 7: RES related gross value added in the EU-28 by type of activity (Source: Support Activities for RES modelling post 2020. Final Report)

² For more details on policy scenarios, please see: https://ec.europa.eu/energy/sites/ener/files/documents/EmployRES-II%20final%20report_0.pdf
All four RES deployment scenarios show moderately positive employment effects on the EU-28 level. For the different scenarios and models, the average results for 2021-2050 range between just above 0% and 0.64% compared to BAU. However, the positive impact on employment would be higher with a more optimistic scenario. The development of GDP is a key driver of employment. Thus, the difference between the GDP results for the Member States also translate into differences in employment. However, the composition of the economies with regard to importance of labour intensive versus non-intensive sectors also plays a role.

Next figure shows the generation of employment in the four RES deployment scenarios:

![Graph showing employment generation in different RES scenarios](image)

Figure 8: RES related employment in the EU-28 by technology (Source: Support Activities for RES modelling post 2020. Final Report)

If these previsions are promising in the current economic situation, the real impact of the exploitation of renewable energy on economic activity and ultimately on job creation must be analysed using factors such as *maturity of the RE technology*, and *availability of training plans*. 
Besides other well-known factors, the growth of the renewable energy sector can be limited by the system's capacity to provide the labour market with professionals with the profiles that companies require. Although the specific skills of a sector can be acquired on the job or through courses offered by the manufacturers and incorporated into the company's own training plans, professionals are currently sought to join companies with a high level of training. The training provided in engineering faculties and intermediate and higher level degrees guarantees generic and transferable knowledge but no specific skills in renewable energy as they have not yet been integrated into the official study programs.

2- OCCUPATIONAL NEEDS, SKILL GAPS AND LABOUR SHORTAGE

2.1- SKILL SHORTAGE IN THE RE SECTOR

Since the industry importance is constantly growing, the European Renewable Energy industry is expected to experience a rise in jobs creations. The demographic shift in Europe (lots of workers exiting the workforce) will also increase the number of jobs openings in all sectors.

The Renewable Energy sector will create jobs across the entire value chain from equipment manufacture, project development, construction and installation, to operations and maintenance. The majority of jobs will be found in the engineering and technical sectors, but not only, since project development needs skilled workers also from less technical fields, such as from finance or legal sectors.
If we focus on electricity generation projects, jobs needed will be associated with retail, installation and maintenance. In particular, ‘new’ and priority skills related to innovation may be needed, such as problem-solving and working with stakeholders. Emerging occupations have been identified relating to the manufacture of renewable equipment (e.g. wind power design engineers), project development (e.g. wind resource assessment specialists), and production and operation (e.g. wind service mechatronics technicians; biomass production managers).

A single project in the Renewable Energy sector involves many workers in different positions; a wide range of backgrounds and skills is therefore needed.

Here are examples of positions that can be found all along the project development phase:

- **Research, planning and development** - e.g. data analysts, planners, software developers, GIS technicians, environmental analysts, oceanographers, ecologists, aerodynamics specialists, technical experts, scientists, mechanical and electrical engineers.

- **Design and manufacture** - e.g. procurement and selection of kit, technical designers, mechanical and electrical engineers, electrical and grid connection design, geophysicists, marine/technical experts.

- **Construction and installation** - e.g. project managers, contract managers, site management, cabling, civil engineers, construction.

- **Operations and maintenance** - e.g. grid connection, electricity generation, physical inspection and maintenance, technician.

- **Support services** - e.g. business development, communication and public relations, human resources, finance, legal support, administration, facilities management.
The RE sector is already experiencing shortages in technical occupations, a focus should then be put on the STEM skills (Science, Technology, Engineering and Maths). “Core STEM subjects are needed for most roles in renewables,” says Sophie Bennett, skills and employment policy officer at Renewable UK. “Some enter the industry through apprenticeships which offer the chance to gain paid experience and learn ‘on the job’ while studying for a qualification."
Alternatively, entrants can gain higher qualifications with relevant graduate and postgraduate courses. If you’re a graduate in a STEM subject, you already have skills that are sought after. “Employers tend to look for entrants with professional qualification as a benchmark of competency and a sign of dedication and achievement. They are a good way to progress your career. The IET (Industrial Engineering Technology), IMechE (Institutions of Mechanical Engineers), and ICE (Institutions of Civil Engineers) are particularly relevant to renewables,” she notes 3.

Nevertheless, it should not be the only concern, since many more general occupations, such as finance specialists, auditors and lawyers are also searched by companies. Shortages are therefore threatening in all type of occupations in the sector, from the STEM skills to communication, marketing and managerial skills. 4

2.2- ANALYSIS OF COMPANIES SURVEYS RESULTS

In order to assess companies and organisations’ challenges, their recruitment needs and projections, a tailor made survey was designed by the KnowRES Green jobs specialist and reviewed together with the concerned industry association’s designated staff to ensure that the information to be collected would be useful and exploitable to all concerned parties (i.e. industry association, companies, training institutions/universities and job candidates). In this regard and for consistency purposes, it was important that all partners involved agreed on working with the same value chain and generic job occupations which were incorporated in the questionnaire.

3 Sophie Bennett, skills and employment policy officer at Renewable UK. Quoted in Working in the renewable energy sector, http://www.theiet.org/apprentices/area-engineering/renewable-energy.cfm
4 EU Skills Panorama (2014) Renewable energy sector Analytical Highlight, prepared by ICF GHK and Cedefop for the European Commission
The rationale behind the survey research is to assess current recruitment challenges and employment opportunities in the European renewable energy industry by providing an instant picture of the sector’s job market with concrete information that could be exploitable immediately by concerned stakeholders.

All surveys are composed of 13 to 16 questions that are adapted to each sector covered by the KnowRES project.

Three questions that can be found in each of the six sectors are particularly relevant to understand skills needs and possible gaps:

- In the past years, did your companies come across any difficulties in finding suitable candidates?
- Do you anticipate any new job opening in the coming 1 or 2 years?
- What occupations/jobs are the most difficult to fill with qualified workers?

There are two fundamental dimensions of the labour market dynamics: changes in skills and competencies needs for existing or new occupations (content), and changes in the number of professionals required (volume).

“Skill” is defined as “the ability to perform specified tasks”\(^5\) or to perform a productive task at a certain level of competence.

According to the International Labour Office, there might be two main causes of labour shortage in a sector:

- there are not enough people interested in working in an area with the underlying abilities required to do the job well; there are deficiencies in training and education arrangements that make it difficult for suitable people to develop the skills required (skill shortage)

\(^5\) United Kingdom Commission Employer Skills Survey, 2010, p.4
requirements change so quickly that the supply of skills that was broadly satisfactory in the past no longer meets requirements, and systems of skills anticipation, careers counselling and provision of training and education fail to keep up with change (skill gap).

A summary of the results from the industry survey related the skill shortage and gap for the following six sectors (biomass, photovoltaics, ocean energy, small hydropower, solar thermal electricity and geothermal)\(^6\) is presented below:

**BIOMASS**

- a skill gap with 32 per cent of responses saying “the candidate had insufficient professional experience” and nearly 29 per cent saying “the candidate did not have appropriate education”
- a skill shortage with nearly 11 per cent of replies stating they did not receive enough applications for their job vacancies.

The labour shortage is mainly caused by the sector’s skill gap, the lack of sector’s attractiveness (working conditions, salary package) and leakage of workforce to other sectors. The consequences are delays in projects (longer recruitment processes), higher costs (raising salary trends) and a skill mismatch.

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Bioenergy developments create employment all along the supply chain: forest management; logistics; commercialisation; production of boilers and stoves; installations; maintenance, etc. The majority of surveyed companies/organisations -almost 71 per cent- said they will be recruiting in the coming 1 to 2 years. This is a testimonial of companies’ confidence and optimism about the future of their businesses and consequently of the sector.

**PHOTOVOLTAICS**

While the majority of companies (over 33 per cent) said they had no problem in finding suitable candidates to fill their job vacancies, the analysis of the replies shows:

- **a skill gap** with over 18 per cent of responses saying “the candidate had insufficient professional experience” and over 12 per cent saying “the candidate did not have appropriate education”
- **a skill shortage** with nearly 11 per cent of replies stating they did not receive enough applications for their job vacancies.

The labour shortage is mainly caused by the sector’s skill gap, the negative reputation (due to some foul installations which shattered consumers’ confidence), the lack of sector’s attractiveness (working conditions, salary package). The consequences are delays in projects (longer recruitment processes), higher costs (raising salary trends) and a skill mismatch. Moreover, further discussions with stakeholders show the main recruitment challenges remain skill gap and staff retention in a context of cost reduction pursuit.

No new significant capacity additions are expected in the European PV market in the near future. Current activities in Europe are mainly focusing in increasing the performance of existing installations, acknowledging the growing importance of **Operations & Maintenance (O&M)**.
Given the market shift from Europe to countries such as China, Japan or the USA for new capacity addition of solar PV, European companies are looking to recruit people who are **flexible and adaptable** not only to a changing market but also to new market, new network and new countries.

**OCEAN ENERGY**

The replies gathered from companies tend to show that there is no relevant skill shortage in the sector given that nearly 70 per cent of them responded that their company never had any problem in finding suitable candidates. This can be misleading because many companies simply do not have recruitment needs for the moment and some companies have not hired any additional staff for the past 4 to 5 years.

There is however a **skill gap** or skill mismatch as almost 27 per cent of companies said the candidates had insufficient professional experience while some companies stated that the selected candidates was not willing to relocate because of the low attractiveness of the duty station. The many positive replies (74%) to the question on future jobs openings show that the sector is expected to be hiring quite a number of staff for the following occupational functions with engineer and non-engineer backgrounds

**SMALL HYDROPOWER**

Data analysis tends to show that there is a **skill gap** in the sector given that 31 per cent of companies had difficulties in finding suitable candidates because they had insufficient professional experience while 25 per cent did not have appropriate education. However, 37 per cent of companies never had problem in finding suitable candidates to fill their job vacancies. While mobility does not seem to be an issue, the lack of language skills is problematic especially in project involving transnational collaboration. 60 per cent of companies/organisations said they
are forecasting new recruitments in the near future (i.e. six months to one year-time). Among the rest, 22 per cent are not recruiting at all while 18 per cent of companies are still uncertain about their recruitment planning as recruitment for them are directly linked to projects in the pipeline for which contracts are awaiting for signature.

**SOLAR THERMAL ELECTRICITY**

- **a skill gap** with 25 per cent of responses saying “the candidate had insufficient professional experience” and nearly 14 per cent saying “the candidate did not have appropriate education”
- **a skill shortage** with nearly 9 per cent of replies stating they did not receive enough applications for their job vacancies.

While 4/5 of the companies said they will be hiring in the near future, the detail of the job to be filled remain often quite generic. For instance many companies cited engineering or project manager occupational functions. However the more specific job vacancies could be classified as follows:

**Phase I: Pre-assessment project development**
- Marketing
- Central receiver design (CFD)
- Sales

**Phase II: Equipment manufacture and distribution**
- Modeling of process (meteorological for technical application)
- STE Development (modeling, programming)
- Automation, process, material sciences (fluid)

**Phase IV: Operation & Maintenance**
- Leaks repairs and hot tapping services
Cross cutting/enabling activities

- Business development

GEOTHERMAL

- a skill gap with 17 per cent of responses saying “the candidate had insufficient professional experience” and nearly 10 per cent saying “the candidate did not have appropriate education”

Nevertheless, we cannot talk of a skill shortage, since less than 4 percent of companies replied that they did not receive enough applications for their job vacancies in the geothermal sector.

More than half of the companies had no particular difficulty to find a suitable candidate to their jobs openings.

2.3- MOST WANTED PROFILES

The most wanted profiles companies or organisations that replied to the survey are currently looking for are:

BIOMASS

- Engineers profiles (mechanical engineer, process and construction, production and control)
- Business developer and/or technical sales
- Research engineer
PHOTOVOLTAICS
- Technology researchers for manufacturing
- Field technicians (Operations & Maintenance)
- Engineers (PV system designer) for project planning

OCEAN ENERGY
- Project manager
- Structural engineer
- R&D engineer

SMALL HYDROPOWER
- Business development manager / Technical sales
- Field service technician
- Mechanical design engineer

SOLAR THERMAL ELECTRICITY
- Technology researcher
- Chief Sales & Marketing officer
- Solar Thermal O&M Technician

GEOTHERMAL
- Drilling engineer
- Hydrogeologist
- Project Manager
2- SKILLS RESPONSE

3.1- EXISTING TRAINING

Training and skills development is understood in broad terms, covering the full sequence of life stages. Basic education gives each individual a basis for the development of their potential, laying the foundation for employability. Initial training provides the core work skills, general knowledge, and industry-based and professional competencies that facilitate the transition from education into the world of work. Lifelong learning maintains individuals’ skills and competencies as work, technology and skill requirements change.\(^7\)

Training in Renewable Energy has quickly increased over the past few years. However, employers still face difficulties finding qualified people to fill some jobs opening A number of EU Universities developed Master programmes related to the field, and a number of summer schools or other short term training courses appeared in Universities offers in the last five years. Vocational training and in-house training in companies are also increasing.

Concerning the offer for Master programme, European Copper Institute, in collaboration with EUREC and the IRENA Renewable Energy Learning Partnership (IRELP), published a report on European postgraduate programs in sustainable energy. The report is intended for students interested in pursuing education in the field and provides a comprehensive overview of the landscape of programmes offered in Europe. While European graduate and post-graduate programmes in renewable energy can vary in terms of duration, content, curriculum, level of detail, degree, etc., there are a few common characteristics that can be used to segment them.

\(^7\) A Skilled Workforce for Strong, Sustainable and Balanced Growth, ILO, 2010
Many programmes have been launched within the last 5 years following the developing job market in renewable energy technology. Accordingly, the majority of programs are strongly focused on providing job and employment specific education rather than training students for academic research although most programs provide qualification for ongoing postgraduate studies.8 A useful table of leading European postgraduate programmes was produced:

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<table>
<thead>
<tr>
<th>Program</th>
<th>Institution/ University</th>
<th>URL</th>
<th>Topic/ sector</th>
<th>ECTS credits/ Duration</th>
<th>Delivery mode</th>
<th>Degree</th>
<th>Language(s)</th>
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<tbody>
<tr>
<td>EUREC European Master in Renewable Energy</td>
<td>MINES-Paristech, France Loughborough University, UK University of Zaragoza, Spain Oldenburg University, Germany Hanze UAS, Netherlands Additional universities providing specializations</td>
<td>Program website</td>
<td>Renewable Energy overview plus one specialization in Ocean Energy, Photovoltaic Wind Energy, Solar Thermal or Grid Integration</td>
<td>90 ECTS/ 3 semesters (16 months) including internship and Master thesis/project</td>
<td>Face-to-face on campus (2 different universities)</td>
<td>Master of Science in Renewable Energy plus Certificate of Equivalence from EUREC</td>
<td>English (French or Spanish available in first semester)</td>
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<tr>
<td>Master en Energias Renovables</td>
<td>CIRCE University of Zaragoza</td>
<td>Program website</td>
<td>Core module in Renewable Energy (Diploma) plus one specialization module of the EUREC Master</td>
<td>75 ECTS/ 16 months on-campus, internship 2 years online</td>
<td>Face-to-face on campus and online</td>
<td>Master propio</td>
<td>Spanish</td>
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<tr>
<td>Master propio en Eficiencia Energética Y Ecologia Industrial</td>
<td>CIRCE University of Zaragoza</td>
<td>Program website</td>
<td>Industrial Ecology &amp; Energy Audits &amp; Energy Management Systems</td>
<td>70 ECTS/ 16 months on-campus, incl. internship 2 years online</td>
<td>Face-to-face on campus and online</td>
<td>Master propio with 2 diplomas (Industrial Ecology and Energy Audits &amp; Energy Management Systems)</td>
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<td>Master propio en Energy Management</td>
<td>CIRCE University of Zaragoza</td>
<td>Program website</td>
<td>Renewables, Energy Markets and Energy Management and Audits</td>
<td>60 ECTS/ 2 years including presentation of Master project</td>
<td>Online only</td>
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<td>Spanish</td>
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<td>Master Online Photovoltaics</td>
<td>University of Freiburg (Germany) in cooperation with ISE Fraunhofer</td>
<td>Program website</td>
<td>In-depth solar call/ photovoltaics technology and development with focus on mass production technology of solar modules</td>
<td>120 ECTS (for students with Bachelor degree) / Up to 3 years online</td>
<td>Online only</td>
<td>Master of Science Photovoltaics</td>
<td>English</td>
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<td>Carl-von-Ossietzky University of Oldenburg</td>
<td>Program website</td>
<td>Renewable Energy overview plus module on key technologies</td>
<td>90 ECTS/ 3 semesters (18 months)</td>
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<td>MSc Renewable Energy Systems Technology</td>
<td>Loughborough University (UK)</td>
<td>Program website</td>
<td>Sustainability &amp; Energy Systems and in-depth review of renewable technologies</td>
<td>90 ECTS/1 year face-to-face on campus or 3-5 years distance learning</td>
<td>Face-to-face on campus and online</td>
<td>Master of Science</td>
<td>English</td>
</tr>
<tr>
<td>Master Energy Management and Sustainability</td>
<td>EPF-Lausanne, Switzerland, and EPFL, U.A.E.</td>
<td>Program website</td>
<td>Energy Management and Sustainability across disciplines plus elective specialization</td>
<td>120 ECTS/2 years (4 semesters)</td>
<td>Face-to-face on campus</td>
<td>Master of Science</td>
<td>English</td>
</tr>
<tr>
<td>MSc Renewable and Sustainable Energy Technologies</td>
<td>Northumbria University (UK)</td>
<td>Program website</td>
<td>Sustainability concepts and renewable energy technologies</td>
<td>180 ECTS/16 months</td>
<td>Face-to-face on campus</td>
<td>Master of Science (also offered as PG Dip or PG Cert)</td>
<td>English</td>
</tr>
<tr>
<td>Program</td>
<td>Institution/ University</td>
<td>URL</td>
<td>Topic/ sector</td>
<td>ECTS credits/ Duration</td>
<td>Delivery mode</td>
<td>Degree</td>
<td>Language(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
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<td>------------------------</td>
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</tr>
<tr>
<td>MSc Solar Energy</td>
<td>Université de Perpignan, France with support of PROMES-CNRS</td>
<td>[Program website]</td>
<td>In-depth technology study related to solar technology (modelling, materials)</td>
<td>120 ECTS/ 2 years (4 semesters)</td>
<td>Face-to-face on campus</td>
<td>Master of Science</td>
<td>French</td>
</tr>
</tbody>
</table>
| Nordic Master in Sustainable Urban Transitions | Chalmers University, Sweden  
Aalto University, Finland  
KTH, Sweden  
NTNU, Norway  
DTU, Denmark                       | [Program website]                      | Choice of 5 study tracks:  
Human Oriented Urban Transitions  
Area Based Transitions  
Urban Ecology  
Transitions of Urban Structures  
Urban Regional                     | 120 ECTS/ 2 years (4 semesters)        | Face-to-face on campus (2 different universities) | Double Master of Science with one diploma from each university attended | English      |
<table>
<thead>
<tr>
<th>Program</th>
<th>Institution/ University</th>
<th>URL</th>
<th>Topic/ sector</th>
<th>ECTS credits/ Duration</th>
<th>Delivery mode</th>
<th>Degree</th>
<th>Language(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Wind Master</td>
<td>Delft University, Netherlands</td>
<td></td>
<td>Wind Energy Technology with specializations in:</td>
<td>120 ECTS/ 2 years (4 semesters)</td>
<td>Face-to-face on campus (2 different universities)</td>
<td>Double Master of Science with one diploma from each university attended</td>
<td>English</td>
</tr>
<tr>
<td></td>
<td>DTU, Denmark</td>
<td></td>
<td>Wind Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NTNU, Norway</td>
<td></td>
<td>Rotor Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oldenburg University, Germany</td>
<td>Program website</td>
<td>Electric Power Systems</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Offshore Engineering</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Program</td>
<td>Institution/ University</td>
<td>URL</td>
<td>Topic/ sector</td>
<td>ECTS credits/ Duration</td>
<td>Delivery mode</td>
<td>Degree</td>
<td>Language(s)</td>
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<td>-------------</td>
</tr>
<tr>
<td>MSc Innovative and Sustainable Energy Engineering (ISEE)</td>
<td>Aalto University, Finland</td>
<td></td>
<td>Choice of 6 study tracks:</td>
<td>120 ECTS/ 2 years (4 semesters)</td>
<td>Face-to-face on campus (2 different universities)</td>
<td>Double Master of Science with one diploma from each university attended</td>
<td>English</td>
</tr>
<tr>
<td>DTU, Denmark</td>
<td>DTU, Denmark</td>
<td>Program website</td>
<td>Bio Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTNU, Norway</td>
<td>NTNU, Norway</td>
<td></td>
<td>Energy Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalmers University, Sweden</td>
<td>Chalmers University, Sweden</td>
<td></td>
<td>Geothermal Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Iceland</td>
<td>University of Iceland</td>
<td></td>
<td>Heat and Power Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Solar Cell Systems and Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>System Integration of Wind Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Program</th>
<th>Institution/ University</th>
<th>URL</th>
<th>Topic/ sector</th>
<th>ECTS credits/ Duration</th>
<th>Delivery mode</th>
<th>Degree</th>
<th>Language(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master CARE (ICARE project – Institute for Clean and Renewable Energy)</td>
<td>Huazhong University, China ParisTech, France 5 other European universities for specializations</td>
<td>Program website</td>
<td>All areas of renewable energy: Solar energy Wind energy Biomass Geothermal Hydrogen and energy storage Energy efficiency Specialization in 3rd semester</td>
<td>120 ECTS/ 2 years (4 semesters) for Master by European university (3 years required for Chinese Master)</td>
<td>Face-to-face on campus (Universities in China and Europe)</td>
<td>Double Master of Science (Energy Science &amp;Technology from Huazhong University and Clean and Renewable Energy from ParisTech)</td>
<td>English (first semester can be taken in Chinese) Chinese required for international students</td>
</tr>
</tbody>
</table>

Table 1: Some of the leading postgraduate programs in Europe
To complement this postgraduate offer, Vocational Education and Training (VET) can be a good response to the skill gaps, since it would help workers coming from other fields to specialise in the sector, building on skills they already acquired from previous experience. It should provide adequate basic, transversal, and vocational skills that fit the needs of employers, but also equip learners to engage in Long Life Learning (LLL), and to manage transitions from education to employment as well as from one job to another or from unemployment to employment.

Examples of vocational trainings targeting very specific skills needed in the Renewable Energy sector can be found in Universities or research centres in Europe. Some examples are given here:

<table>
<thead>
<tr>
<th>Name of the training</th>
<th>Technology</th>
<th>Targeted audience/pre-requisites</th>
<th>Website for more information</th>
</tr>
</thead>
<tbody>
<tr>
<td>photovoltaic installer and planer</td>
<td>PV</td>
<td>electrical engineers, installer, designer</td>
<td><a href="http://www.ait.ac.at/weiterbildung">www.ait.ac.at/weiterbildung</a></td>
</tr>
<tr>
<td>quality aspects in PV-systems</td>
<td>PV</td>
<td>electrical engineers, installer, designer</td>
<td><a href="http://www.ait.ac.at/weiterbildung">www.ait.ac.at/weiterbildung</a></td>
</tr>
<tr>
<td>solar thermal installer and planner</td>
<td>ST</td>
<td>installer, plumber, designer</td>
<td><a href="http://www.ait.ac.at/weiterbildung">www.ait.ac.at/weiterbildung</a></td>
</tr>
<tr>
<td>heat pump installer and planner</td>
<td>HP</td>
<td>installer, plumber, designer</td>
<td><a href="http://www.ait.ac.at/weiterbildung">www.ait.ac.at/weiterbildung</a></td>
</tr>
<tr>
<td>Energy Label</td>
<td>HP; ST, Biomasss</td>
<td>installer, plumber, designer</td>
<td><a href="http://www.ait.ac.at/weiterbildung">www.ait.ac.at/weiterbildung</a></td>
</tr>
<tr>
<td>Name of the training</td>
<td>Technology</td>
<td>Targeted audience/pre-requisites</td>
<td>Website for more information</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Renewable energy on the UK power grid</td>
<td>PV, solar thermal, wind, hydro, biomass, anaerobic digestion</td>
<td>companies or individuals interested in developing a greater understanding of the financial benefits to be gained from installing small scale renewable technologies that generate electricity or heat. No prerequisites.</td>
<td><a href="http://www.narecde.co.uk/training/introduction-onshore-renewable-technologies/">http://www.narecde.co.uk/training/introduction-onshore-renewable-technologies/</a></td>
</tr>
<tr>
<td>Renewable technologies in the built environment</td>
<td>PV, solar thermal, wind, hydro, biomass, anaerobic digestion</td>
<td>companies or individuals interested in developing a greater understanding of the financial benefits to be gained from installing small scale renewable technologies that generate electricity or heat, with specific reference to using these technologies in towns and cities. No prerequisites.</td>
<td><a href="http://www.narecde.co.uk/training/renewable-technologies-built-environment/">http://www.narecde.co.uk/training/renewable-technologies-built-environment/</a></td>
</tr>
<tr>
<td>Biomass technology and fuel awareness</td>
<td>Biomass</td>
<td>interested individuals or those who will be specifying or selling systems as it will offer sound technical knowledge for the building requirements for a Biomass system. No prerequisites.</td>
<td><a href="http://www.narecde.co.uk/training/biomass-technology-fuel-awareness/">http://www.narecde.co.uk/training/biomass-technology-fuel-awareness/</a></td>
</tr>
<tr>
<td>G59/3 connecting large scale embedded generators</td>
<td>Grid connection - relevant to all electrical low carbon technology</td>
<td>It is suitable for contractors installing solar PV systems and small wind turbines up to around 100kW. Although no strict entry requirements exist, electrical background is recommended.</td>
<td><a href="http://www.narecde.co.uk/training/g593-connecting-large-scale-embedded-generators/">http://www.narecde.co.uk/training/g593-connecting-large-scale-embedded-generators/</a></td>
</tr>
<tr>
<td>DC commissioning course</td>
<td>DC connection - for PV</td>
<td>Engineers and other construction professionals. Although no strict entry requirements exist, candidates must have a sound construction background and underpinning knowledge from the PV Design and Application course, or the PV First Fix Installation course and site experience.</td>
<td><a href="http://www.narecde.co.uk/training/dc-commissioning-course/">http://www.narecde.co.uk/training/dc-commissioning-course/</a></td>
</tr>
<tr>
<td>Solar photovoltaic system maintenance</td>
<td>PV</td>
<td>Practicing electricians and those individuals with a knowledge of electrical systems. Although there are no strict entry criteria to this course, it would be advantageous to have electrical knowledge.</td>
<td><a href="http://www.narecde.co.uk/training/solar-photovoltaic-system-maintenance-narec-accredited/">http://www.narecde.co.uk/training/solar-photovoltaic-system-maintenance-narec-accredited/</a></td>
</tr>
<tr>
<td>Name of the training</td>
<td>Technology</td>
<td>Targeted audience/pre-requisites</td>
<td>Website for more information</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------</td>
<td>----------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Solar Thermal System Design and Application</td>
<td>solar thermal</td>
<td>Aimed at providing system specifiers, planners, architects and other building professionals. No entry requirements, but very detailed course</td>
<td><a href="http://www.narecde.co.uk/training/large-scale-solar-thermal-system-design/">http://www.narecde.co.uk/training/large-scale-solar-thermal-system-design/</a></td>
</tr>
<tr>
<td>Solar thermal hot water system maintenance</td>
<td>solar thermal</td>
<td>Practicing installers and those individuals with a knowledge of solar thermal systems. Although there are no strict entry criteria to this course, it would be advantageous to have completed the solar thermal installation course</td>
<td><a href="http://www.narecde.co.uk/training/solar-thermal-hot-water-system-maintenance/">http://www.narecde.co.uk/training/solar-thermal-hot-water-system-maintenance/</a></td>
</tr>
<tr>
<td>Financial incentives for renewable energy</td>
<td>PV, wind, micro-CHP, hydro</td>
<td>This course is ideal for anyone interested in developing a greater understanding of the financial benefits in the energy market. No prerequisites</td>
<td><a href="http://www.narecde.co.uk/training/financial-incentives-renewable-energy/">http://www.narecde.co.uk/training/financial-incentives-renewable-energy/</a></td>
</tr>
</tbody>
</table>

Table 2: Examples of existing short term trainings

“Evidence shows that the employability of young VET graduates increases with participation in high-quality work-based learning programmes fostering skills acquisition responding to labour market needs.”

3.2- CANDIDATES DATABASE ANALYSIS

The KnowRES candidates’ database is being built thanks to a survey available on the KnowRES website and is completed by information given by the EUREC Masters alumni network as well as by partnering Universities learning outcomes.

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9 Cedefop (2012), From education to working life.
The candidates’ database is regularly updated and the survey remains open for the whole duration of the project. Further individual interviews are carried out in order to specifically assess competences related to the most wanted job profiles found as results of the industry surveys.

In January 2016, 293 candidates created an account on the KnowRES website, 181 entirely filled the registration survey and submitted their information. Figures given in this report will be based on the 181 fully completed forms.

The European Master in Renewable Energy is coordinated by EUREC since 2002. It is a technical Master programme in which students learn about all Renewable Energy technologies, as well as their socio-economics aspects. Its Alumni network is composed of more than 500 members. 85% of the EUREC Alumni still work in the Renewable Energy field. Learning outcomes, competence profile of the programme and information provided directly by the EUREC alumni are completing the survey results.

Thanks to the candidates’ database, it is possible to provide an overview of the existing competences in the Renewable Energy job market and to compare these existing competences to the industry needs.

The candidates database is composed essentially by young workers. The average age of candidates is 30 years old. The youngest registered candidate was born is 1994, and the oldest in 1957.

There is a good balance between male and female candidates, which is not completely representative of gender distribution in the field, with a strong presence of male workers.
48 different nationalities are represented, with 58% of them coming from the European Union. Nevertheless, non-EU job candidates either studied or are currently living in the EU.
EDUCATION AND EXPERIENCE

All candidates have a good level of education, with a minimum of 3 years of post-secondary studies. 36 of them have a Bachelor (or equivalent), the large majority have a master degree (or other 5 years degree), and 11 of them have a PhD.
When did they graduate?

- 60 candidates are still students and will graduate from Master studies this year or have just graduated last December.
- 20 graduated before 2005
- 35 graduated between 2006 and 2010
- 66 between 2011 and 2014

It is interesting to see that most candidates studied technical subjects. More than half candidates studied engineering (mostly electrical or mechanical engineering, but also aerospace, agricultural or industrial engineering). Only 25 candidates have non technical backgrounds. Here are KnowRES candidates backgrounds:

![Candidates study backgrounds](image)

**Figure 13: Candidates study backgrounds**
Years of experience:

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1 year</td>
<td>48</td>
</tr>
<tr>
<td>1 to 3 years</td>
<td>48</td>
</tr>
<tr>
<td>3 to 5 years</td>
<td>32</td>
</tr>
<tr>
<td>5 to 8 years</td>
<td>25</td>
</tr>
<tr>
<td>Over 8 years</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 3: Candidates years of work experience

SKILLS

Candidates are asked to auto evaluate their skills, if they choose ‘yes’, they have to justify their choice and provide examples/work situations in which these skills are put into practice.

Figures in the table below show replies from the candidates’ auto-evaluation. When confronted with examples given and work experience as detailed in their CV, they conform to reality.

<table>
<thead>
<tr>
<th>Type of skill</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical Skills</td>
<td>149</td>
<td>32</td>
</tr>
<tr>
<td>Business/entrepreneurial skills</td>
<td>80</td>
<td>101</td>
</tr>
<tr>
<td>Communication skills</td>
<td>148</td>
<td>33</td>
</tr>
<tr>
<td>Creativity skills</td>
<td>117</td>
<td>64</td>
</tr>
<tr>
<td>Interpersonal skills</td>
<td>111</td>
<td>70</td>
</tr>
</tbody>
</table>
A large majority of candidates possess the skills indicated in the above table and identified as the most important to work in the Renewable energy industry.

Candidates are more at ease with analytical, communication, organisational and team work skills. Project and team management as well as business and entrepreneurial skills could be further developed.

From these, we can identify the typical KnowRES candidate as a young person with a good level of education, recently graduated from technical studies and with 1 to 5 years of work experience. As far as his/her skills are concerned, they seem to fit the most needed soft skills identified by the Renewable Energy industry, nevertheless some improvement would be needed concerning entrepreneurial skills, as well as for project management and team management skills.
3.3- CASE STUDY: ILLUSTRATION OF SKILL RESPONSE IN THE ENERGY VALLEY AREA (NL)

This section shows how a University of applied sciences worked in collaboration with multiple stakeholders and in particular companies in order to develop new education offers to fill the industry needs in the region.

The environment

National challenges and ambitions

The Netherlands is an important player in the global field of energy. In the oil industry, the Dutch-British multinational Shell has strong roots in the Netherlands. The port of Rotterdam is a hub in the European energy supply. Since exploitation of the ‘Slochteren’ gas field started in the early 1960’s the Netherlands, particularly the northern part, has also developed an internationally acclaimed position in exploration and R&D on gas technology. This position was further strengthened by realisation of a multimillion research programme in gas: the Energy Delta Gas Research (EDGaR) finished in March 2015. This programme has gathered a lot of knowledge and understanding about (1) changing from a mono mode to a multimode gas system, (2) views on future energy systems and (3) changing energy markets. The disclosure of results, papers, thesis, magazines etc can be found on the project website.

Based on this historic background, the Dutch Ministry of Economic Affairs defined renewable energy as one of nine 'top sectors of innovation' in the Netherlands. These top sectors are all growing at a faster rate than the average growth of the Dutch Gross National Product and will receive extra government investment as they contribute substantially to the country’s economic growth. The government’s main aim is to stay a frontrunner in the development of renewable energy, since new business opportunities will be created here.
In its report ‘Energie in Beweging’ (June 2011) the Dutch Top Team Energy (TKI Energy) identifies an important obstacle in achieving this strategic agenda:

“A shortage of (technically) trained personnel, at both university/university of applied science level (HBO) and college level (MBO), is seen by industry as a major obstacle and risk for the further development of the sector\textsuperscript{10}. Such barriers are experienced in the oil and gas industry, but also in the industry for offshore wind in the installation sector. Strengthening policy is mainly focused on two aspects: demand articulation by increasing the role of business in education and regional profiling by specialisation.”

In other words, The Top Team Energy states that there is a shortage of trained staff at every educational level. This is seen as a major obstacle to further development of the energy sector. Reinforcement of the policies will be aimed at two aspects: more demand-articulation by increasing the role of industry in education and by strengthening the regional profile through specialisation.

**Regional ambitions and needs**

EU coastal areas are developing into key energy areas. Energy production is shifting towards coastal areas due to a number of factors:

- Increasingly strict environmental standards (e.g. restrictions on the use of rivers for cooling water);
- Public opinion on safety and health (e.g. the inability to build renewable energy installations in densely populated areas);
- Economic considerations (e.g. the ability to build flexi fuel power plants);
- Logistic considerations (deep water harbors);
- Energy efficiency considerations (linking of various production facilities);
- Development of offshore wind parks.

\textsuperscript{10} Note that the term level used by the actors is not linked to the three level cycle used in the education sector in Europe (known as bachelor, master and PhD).
These factors explain why considerable investments in energy production have been made in the North Sea coastal zone in recent years, in particular near harbors. In the Netherlands this is evident in the Energy Valley: the region comprised of the provinces of Groningen, Fryslân, Drenthe and the northern part of the province of Noord-Holland. Deepwater harbors are found in Den Helder, Harlingen, Eemshaven and Delfzijl ports. Geographically, the focal point of the strong Dutch position in the energy sector is the northern part of the Netherlands, also known as Energy Valley.

Energy Valley has a strong European position because of interconnections for gas (Balgzand-Bacton, NordStream) and wind-generated electricity (NorNed, Cobra), a focused energy policy, and the practical knowledge needed to create powerful coalitions for innovation projects. Energy companies such as Gasunie, Gasterra, Nuon, Essent/RWE, Electrabel, NAM and the Energy Research Centre of the Netherlands (ECN) are key participants in the Energy Valley, as are Hanze UAS and the University of Groningen.

In order to increase the focus on energy even further, Hanze UAS joined forces with the University Groningen in the development of the Energy Academy Europe (EAE) initiative. In its Policy Letter, the Dutch Ministry of Economic Affairs states that the Energy Academy Europe is an important development for the Dutch energy sector. In October 2011, the national government made the Academy part of its Green Deal Policy investments.

**National and Regional Agreements Operating Stakeholders**

In 2014 several national operating stakeholders made an agreement for target setting ambitions in energy transition. Regional bodies supported this national agreement with regional agreements. Part of the agenda is the expected shortage in qualified staff (e.g. the Social and Economic Council of the Netherlands –SER- expects about an increase of 15,000 professionals due to energy transition needs till 2020\(^\text{11}\)). These figures are added totals based on sector (e.g.

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\(^{11}\) National Energy Agreement (SER 2014) sustainable growth
wind onshore, wind offshore, bio based, solar power etc) specific estimates. Some actors use a more detailed need analysis e.g a value chain approach used by TKI offshore Wind, to identify the fte\textsuperscript{12} needed in the value chain related to financial revenues, see figure below.

![Offshore Wind value chain](image)

**Figure 14: Offshore Wind value chain**

**Gap analysis energy transition skills**

**Hanze UAS approach**

Confronted with the major developments described above, Energy Valley regional parties (together they represent a regional triple helix e.g. industry, government and knowledge institutes) decided to set up the Energy Academy Europe with a focus on research, innovation and education. The ambition for energy education is more detailed in a business plan stating that there should be 3000 students by 2022 studying energy in the educational programmes at the University of Groningen (1500) and Hanze UAS (1500). Hanze UAS decided to focus on a selected set of new energy Master education programmes based on 3 different perspectives.

\textsuperscript{12} Generally we see quantitative figures instead of qualitative estimates of full time equivalents (fte)
It was also decided to focus on initial education e.g. providing not vertical programs related to a renewable area sector but horizontal perspective oriented programmes see figure below.

![Diagram showing three perspectives on energy transition Master education](image)

**Figure 15**: Three different and partly overlapping perspectives on energy transition Master education

The reason for doing this is the believe that the energy transition sector requires fresh new potential where graduates should be capable of fulfilling a diversity of professions in society/industry value chains at three different educational levels, guiding the energy transition. In our vision every perspective should have its own basic education, realised by a core semester and several specialisations. Different core semesters are linked to others (overlap), e.g. Renewable Energy (RE) will play its role in all perspectives, but design of new technology is achieved in the Technology perspective due to the necessary background knowledge on physics, electrical engineering etc. A specialisation is based on the topics of regional/institutional strengths. The different perspectives with core and specialisations allows us to have different
focus on content areas, it could also be linked to the well-known perspectives of People (Society), Planet (Technology) and Profit (Business).

Hanze UAS has also decided also to set up a practice based R&D environment, EnTranCe supporting educational initiatives. Therefore, Hanze UAS established an **Energy Education Development Roadmap** with a focus on main perspectives of energy transition e.g. renewable energy technology, energy transition business, energy transition and society and finally energy trading, regulation and financial risk management. It should be emphasised that each development follows a multi-step approach with a go-no go decision making after each step by the executive board of Hanze UAS.

**Multi step gap analysis and programme design**

The process of the gap analysis and subsequent curriculum design consists of the following steps:

1- **Idea Generation Phase using a funnel approach.** Engagement of essential stakeholders to support the idea is essential here. Idea generation makes sense if there is a context giving opportunities for development. The existence of Energy Valley, Energy Academy Europe, Regulatory Framework, Appropriate Staff and Research Development & Education Environment makes the development of new educational program possible.

2- **Vision Generation and Qualitative stakeholder analysis phase.** This step was facilitated by a Charrette approach, a kind of pressure cooker for answering essential questions in a limited time frame. Relevant questions are: is there a need? What kind of program structure is needed? What main trends do we see? It encompasses also the vision about the program structure and education principles. This output is actually used in the next phases identifying the opportunity for internal and external stakeholders.
3- **Business case development phase**, answering the essential questions for Hanze UAS (e.g. should we do this, what kind of student market do we see, is funding of this master possible, could we reach the essential quality level etc.), and what costs are associated with the development how is the international level assured.

4- **Development of a new degree programme profile**, describing the main characteristics of the new programme, i.e. it should contain a job profile description, stakeholders, programme competencies divided in subject specific and generic, employability, educational styles etc. The job profile contains statements attributed to job competences, written concisely in statements as: *Is able to perform <abc>, Has knowledge and understanding of <rwt>, is able to demonstrate <xyz>*. This phase includes the development of a dossier for proving macro efficiency. The dossier needs to prove that there is clearly a need for a new programme in the labor market, the scientific community and society. It should also prove that there is a complementarity in offerings of education programmes in the Netherlands. It should also provide information about European developments. In this procedure, communication to other universities of this endeavor takes place asking universities if they have serious objections. Actually this dossier and procedure provides an educational gap analysis at national level.

5- **Development of the educational programme**, describing the information dossier for national accreditation, setting up internal quality review bodies as professional boards, academics boards etc and development of the organisation. The accreditation dossier needs to prove that quality in all aspects, e.g. programme learning objectives, assessment system, staff and educational environment is guaranteed.
Characteristics of Energy Master programmes at Hanze UAS

A shift to transdisciplinary programmes

There is a need for academic professionals with energy transition knowledge and skills. Societal challenges are getting more and more complex, and there is a shift from mono disciplinary education via multi (or inter) disciplinary to transdisciplinary education\(^\text{13}\).

In the Master programmes, Hanze UAS integrates following competencies and transferable skills:

- To be able to work in a multi-disciplinary team
- To be able to communicate with different stakeholders
- To use a system approach in solving problems
- To understand the context of a challenge
- To be able to implement a project idea

T-shaped\(^\text{14}\) Master programmes are the combination of broad knowledge and competences combined with Master of Sciences (MSc) level knowledge. Hanze UAS applies this concept of T-shaped education programmes.

In the future Hanze UAS wants to deliver:

- People who understand other competences and get excited about them
- Creative, active people

\(^\text{13}\)Transdisciplinarity connotes a research strategy that crosses many disciplinary boundaries to create a holistic approach. It applies to research efforts focused on problems that cross the boundaries of two or more disciplines, such as research on effective information systems for biomedical research (see bioinformatics), and can refer to concepts or methods that were originally developed by one discipline, but are now used by several others, such as ethnography, a field research method originally developed in anthropology but now widely used by other disciplines.

\(^\text{14}\)The concept of T-shaped skills, or T-shaped persons is a metaphor used in job recruitment to describe the abilities of persons in the workforce. The vertical bar on the T represents the depth of related skills and expertise in a single field, whereas the horizontal bar is the ability to collaborate across disciplines with experts in other areas and to apply knowledge in areas of expertise other than one's own.
Research suggests practicing work with experts from different fields than your own. Expertise develops in participation to experts’ practices rather than by studying theoretical knowledge. Critical is the access to the tacit knowledge of experts. Didactic approaches, three metaphors of learning are used:

1- Knowledge acquisition
2- Participation
3- Knowledge creation

In the T-shaped Master programmes students participate in case-based research projects. These are real life projects making energy transition work. Our education programmes stay aligned with practice development by case-based applied research projects.

Adaption to the future and curriculum flexibility

Of course the energy world is constantly moving and education should follow. The development of a new international master is a time- and money-consuming endeavor. This development process is not fast. So that’s why we need some form of curriculum flexibility allowing close engagement with external stakeholders. The Dutch accreditation body, NVAO, allows a modification of about 30% of the curriculum (~1 semester) without a time consuming accreditation procedure, providing some flexibility to adapt to new situations. The specialisation part of the programmes can be used for this. One example is the development of a new specialisation on ‘Sustainable Fuel Systems for Mobility’ within the European Master in Renewable Energy, coordinated by EUREC. This specialisation was developed based on the proven experience in bio based, especially biogas-based fuel systems within Energy Valley region. Of course flexibility is certainly constrained to a shared vision on labour needs and curriculum gaps identified within a consortium and also in this case efficiency (e.g. complementarity) goals should be met and the available core should support the specialisation.
And finally more minor changes can be performed without external agreements, e.g. using cases from and presented by stakeholders. To give an example, if there is a need for more FTEs in the offshore wind manufacturing sector, we could develop an educational module covering the needs for fulfillment of manufacturing jobs and/or we could provide a thesis subject in this area depending on the quantity of students interested and job positions available. An example of a mapping of value chain elements and related job positions of the offshore wind could look like the figure below.

![Figure 16: Example of a mapping offshore wind value chain to master programmes](image)

The realisation of this mapping is done by comparing competences of the job position in the value chain, with competences of the curriculum. If the view on the gap analysis and design is shared, the curriculum could be adapted if the stakeholder parties agree.
Quality Control/Assurance

A tool for guaranteeing achievement standards of delivery (e.g. programme competence framework) is governed by a Plan Do Check Act (PDCA) quality control procedure. In this procedure, external stakeholders are represented in different steps of the evaluation and design cycle. As described above, a professional board is regularly asked to give advice on the programme outcomes in order to keep pace with external developments. Members of the professional board are involved in the programs either via a supervising role or being guest lecturers. Expert clusters are organised around expertise areas of professors. A module may mean a whole curriculum or a more detailed educational unit. Panel evaluation provides the necessary feedback from students, alumni and/or external stakeholders.

Figure 17: Evaluation and design cycle educational programmes
Case study conclusions

We do not find examples of gap analysis of energy transition jobs in the Netherlands. Hanze UAS observed more generic agreements of shortage of qualified staff in the energy transition. Hanze UAS developed our own approach in the gap analysis and the corresponding solutions and procedures. This is based on 5 to 6 years’ experience in development of energy transition Master programmes at Hanze UAS. Currently we implemented two Master programmes covering two different perspectives of energy transition: the renewable energy technology perspective (European Master in Renewable Energy) and the energy transition business perspective (European Master in Sustainable Energy System Management). These Masters are intended for different students target groups and aim at different job vacancies in the energy transition sector, as identified in the Energy Valley.
CONCLUSION

The skills gap issue in the Renewable Energy sector is to be solved quickly in order to fully develop the important potential of jobs creation: “employment growth can be expected in renewable energies and activities to support energy efficiency, especially in construction and transportation. What does it take to turn this potential into real jobs? Part of the answer to that question lies in overcoming skills gaps.”\textsuperscript{15}

An effective response to the fast technological development and structural changes in the field is a high commitment to invest in skills upgrading and life-long learning in order to maintain a high qualified workforce. “With the resulting restructuring of the market, flexibility in these developments is crucial, building bridges from one field to another, and allowing the development of transferrable skills and competences. While new professionals will enter the market, the existing workforce will also have to undergo quick and effective re-training in order to be able to respond to new requirements. Building the right re-training programmes becomes an important pre-requisite for facilitating movements across fields.”\textsuperscript{16}

A need for engineers and technicians (STEM studies) has been clearly shown in the most wanted profiles survey research, but also for specialised workers such as financial and legal specialists who should understand the Renewable Energy sector in order to contribute to RE projects and deployment. Competences in management, business, entrepreneurship and economics and finances will therefore be necessary. A need for trainers and teachers is also to be forecasted, to accompany new programmes deployment.

\textsuperscript{15} A Skilled Workforce for Strong, Sustainable and Balanced Growth, ILO, 2010
\textsuperscript{16} Energy Technology (SET) Plan Roadmap on Education and Training, 2014
As stated in the SET-Plan Roadmap on Education and Training, “the complexity of the system calls also for multidisciplinary and system integration education. Interdisciplinary education is often needed for paradigm shifts in new concept and technology developments”. This need for **multidisciplinary trainings** is indeed useful to have an overall understanding of the complexity of systems, and of their interconnections.

Multidisciplinary programmes are also a solution for new job occupations that crosses occupational boundaries (we can take the example of an installer of PV panels, an occupation including roofing as well as electrician skills). Initial training in Renewable Energy should be broad enough to prepare skilled workers to work on the technology through its lifecycle, from installation, through maintenance during its lifetime, to removal, disposal and recycling at the end of its life.

The facilitation of the new knowledge, techniques and tools is also an element to consider for the development of the RE sector and to fill the skill gap. It can be done through observatories, skills recognition and information platform. Virtual learning can complement these solutions.

The occupational needs, skill gaps and labour shortage of this fast-evolving sector should be constantly measured, through skills observatories, and strong collaboration frameworks among academia, research institutes and business should be implemented. The speed with which technology changes and the consequent demand for applied science and qualified professionals requires curricula to be continuously adapted as a response to the needs of the industry. Training programmes must count on the active participation of companies as the best way to avoid weaknesses in the training results.

Harmonised curricula and mutual qualification recognition across European countries can help, as well as common quality standards. This would ease the adaptation of curricula to the industry needs and speed up any accreditation process needed to implement or to modify a training programme.
Regardless of the level of specialisation, professions in the renewable energy sector are transferable to and from other sectors (for example, offshore petroleum and gas, fishing and aquaculture) which opens up opportunities for the transfer of skills from industries in decline and for the design of action to redirect professional profiles.

Through the survey research and by bringing together information from the industry, job candidates, students and academia and by making it available on its online platform, KnowRES contributes at easing the skill gaps and shortage in the renewable power generation sector: PV; solar thermal electricity; geothermal; biomass; ocean and small hydropower.
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ANNEX A: CANDIDATES SURVEY QUESTIONNAIRE

Candidates registration form:  http://www.knowres-jobs.eu/en/Candidates-and-Companies/Registration-Form/Submit-your-registration-form/ (Candidates must create an account to access the registration form)

1-Personal Information

Title
First Name
Last Name
Date of Birth
Nationality
Current status (employed, unemployed, self-employed, passive job seeker, other)

Contact Details
Country
City
Postal Code
Address
Email
Phone number

2-Educational Level

Degree (secondary school diploma/ 2 years after secondary degree/ Bachelor or equivalent (3 years)/ Master or equivalent (5 years)/ PhD)
Title of diploma
Graduation Year
School, Universities, Training institutions

3-Work Experience

Years of Experience

Field of experience

Technologies (list the technologies you are specialised in)

4-Languages

Mother Tongue

Other Fluent Languages

5-Skills (if click ‘yes’, a box to explain/justify appears)

Analytical Skills

no yes

Business/entrepreneurial skills

no yes

Communication skills

no yes

Creativity skills

no yes

Interpersonal skills

no yes

Organizational skills

no yes

Project management skills
Research and planning skills

Leadership/team management skills

Team work skills

6-Miscellaneous information

Which type of position(s) would you be interested in?

Are you open to job offers from locations abroad?

Would you like to participate to future match-making events/career days?

Would you be interested in receiving career advice & coaching information?

CV to be uploaded