Research brief

Investment in renewable energy generates jobs. Supply of skilled workforce needs to catch up.

International Labour Office

Geneva

European Union

1. Why renewable energy is important

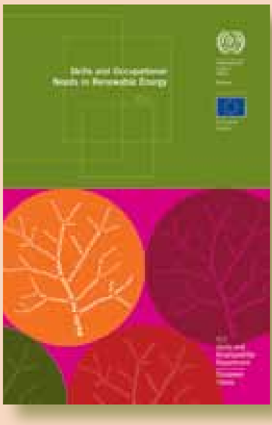
Renewable energy has a major part to play in the transition to the low carbon economy. Energy supply is the highest greenhouse gas (GHG) emitting sector, accounting for about 26 per cent of overall carbon emissions (IPCC, 2007) (Figure 1). A key way to reduce this is to switch from fossil fuels to renewable energy, which currently contributes only a very small share of total energy generation and usage. Renewables together make up only about 13 per cent of primary energy supply (IPCC, 2011) (Figure 2).

The urgent need to cut carbon emissions makes the development of renewable energy technology essential. But renewable energy brings other potential benefits as well. One is the provision of electricity in areas not connected to a central grid or where the grid is unreliable and back-up systems are required. Renewable energy can enable economic development in developing countries, many of which are geographically well-placed to be able to exploit the energy potential (such as those in low latitudes with high sunlight).

Renewable energy helps address increasing concerns about future energy prices and energy security, against a background of a rapid global increase in demand for energy, driven primarily by rising living standards in developing and emerging countries.

There are economic opportunities in renewable energy. Several renewable energy technologies are already competitive at market prices. Decentralised electricity generation potentially mobilises small-scale private investment.

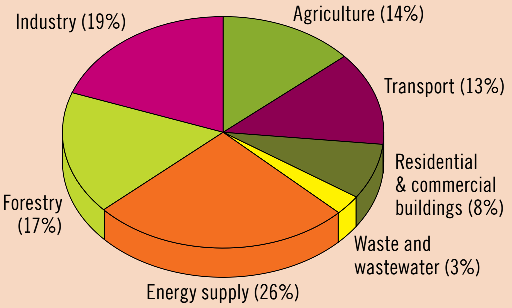
Investment in renewable energy also offers considerable scope for generating employment opportunities, a key public policy concern in many countries. There is substantial employment potential associated with project development, construction and installation for all renewable energy technologies.



About this research brief

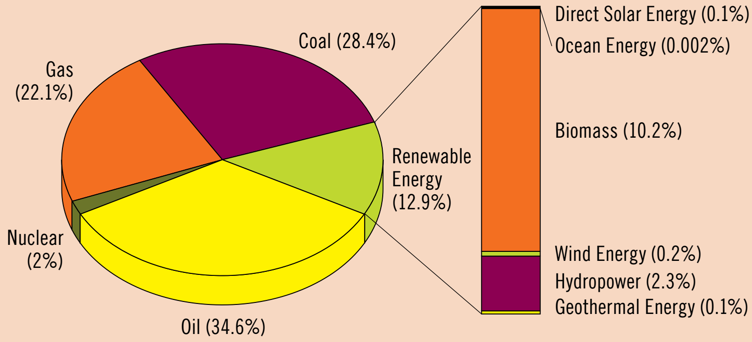
This research brief is a digest of the study *Skills and Occupational Needs in Renewable Energy* (ILO, 2011), which resulted from a joint EC-ILO project on *Knowledge sharing in early identification of skill needs*. The project covered over 30 countries worldwide – both developed and developing. It was supported by the EU Programme for Employment and Social Solidarity – PROGRESS (2007-2013). It was implemented in the framework of the Green Jobs Initiative – a partnership between the ILO, UNEP, IOE and ITUC. The study is based, among others, on a survey undertaken on behalf of the project by the International Renewable Energy Alliance (REN Alliance). The findings were validated through a focus group discussion and an experts workshop.

Figure 1. Share of different sectors in total GHG emissions in CO_2-equivalent (2004)



Source: IPCC, 2007, p. 36.
Note: Forestry includes deforestation.

Figure 2. Shares of energy sources in total global primary energy supply (2008)



Source: IPPC, 2011, p. 6.
Note: Modern biomass contributes 38 per cent of the total biomass share

Five main areas of renewable energy covered in the research brief

Wind. Wind turbines are used to convert wind into electricity. A group of turbines forms a wind farm, which may be sited onshore or at sea (offshore). Small scale wind turbines for domestic or local use are also available.

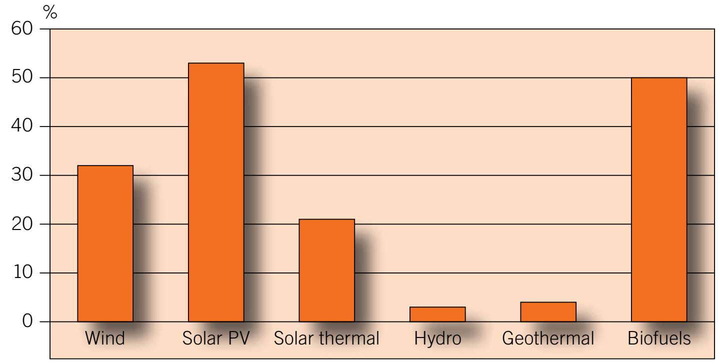
Solar. There are three main types of solar technology. Photovoltaic panels, used to convert sunlight directly to electricity, are usually installed on individual buildings but can be grouped in large numbers in commercial solar farms. Solar thermal technologies are used to heat water for buildings or neighbourhoods. Concentrated solar power plants are typically large scale electricity generating installations connected to the electricity grid.

Hydro. Hydropower converts kinetic energy from the gravity-driven flow of water into electrical energy by using it to drive generators. Large hydropower plants use turbines which are usually built into purpose built river dams. Small hydropower plants may make use of a dam, or may use the flow of river water to drive a generator. Hydropower is the most developed of the renewable energies considered in this brief.
Ocean energy, including wave, tidal and ocean current power, is only moving towards commercialisation at present, and it is not addressed in this brief.

Geothermal. Geothermal energy is used in two ways: either heat from the earth is used directly in industrial processes or to heat buildings, or indirectly by driving turbines to generate electricity.
Deep geothermal systems are based on drilling to reach hot rock, and using this rock to heat water. Deep geothermal systems may have a large generating capacity. Shallow geothermal systems make use of modest temperature differentials to extract heat, typically to heat buildings.

Bioenergy. The term bioenergy refers to energy derived from any organic matter that is available on a renewable basis. A wide range of products can be used, including forest and mill residues, wood waste, agricultural crops, animal excreta and other organic waste supplies. Bioenergy uses a number of different types of process. The biomass may be burned directly to produce heat and/or fire the generation of electricity. It may go through a process to produce a liquid fuel such as biodiesel. It may go through a gasification process or a process of anaerobic digestion to produce gasses which can be stored and then used to produce electricity, cook, or produce heat. Biomass energy covers a broad spectrum of technologies, from primitive applications (for example, traditional charcoal making and wood stoves) to advanced bioenergy processes, collectively often described as modern biomass.

Figure 3. Worldwide growth in installed capacity in renewable energy (2008-2009)



Source: Based on data from IPPC, 2011.

2. Where the jobs are – and where the jobs will be

In 2009, a little over three million people worldwide were estimated to work directly in the renewable energy sector, with additional indirect jobs well beyond this figure. Employment has grown rapidly in recent years.

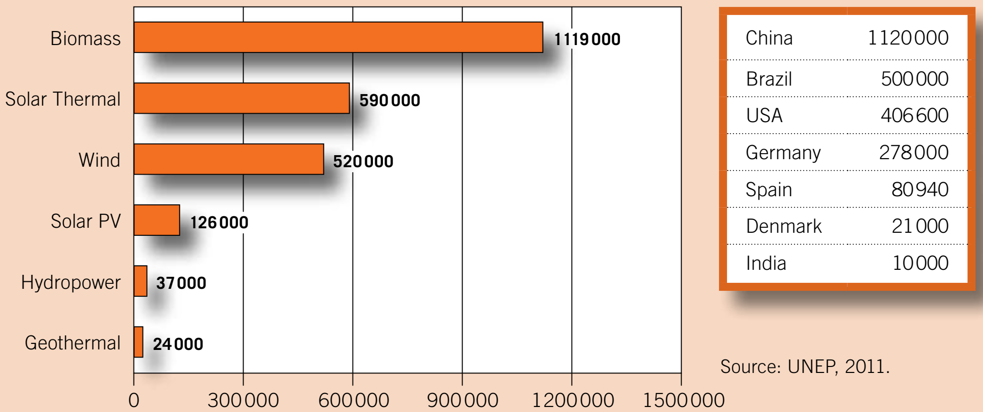
Figure 4 shows the estimated direct employment figures for the seven countries with the largest workforces engaged in the sector. It demonstrates the dominant role played by four countries, China, Brazil, the US and Germany. This current focus on a relatively small number of countries has a number of implications, including potential international mobility of highly skilled workers.

Figure 4 also shows that the biofuels industry is currently the most important sub-sector of renewable energy in terms of employment.

The Green Jobs Report (2008) estimated that by 2030 – with strong policy support – up to 12 million people could be employed in biofuels-related agriculture and industry, up to 2.1 million could find work in wind energy, and up to 6.3 million could be employed in solar PV (UNEP/ILO/IOE/ITUC, 2008).

The wind energy sector has become a significant generator of jobs internationally, growing from 235,000 in 2005 to 550,000 in 2009 (WWEA, 2010). Leading countries include China, the US, Germany, Spain and India. A recent survey estimates that there are currently 300,000 jobs in solar hot water, 300,000 jobs in photovoltaic and around 2,000 jobs in solar thermal power (REN21, 2010). It has been estimated that, in the US alone, strong policy support for renewables could support 1.4 million cumulative jobs in developing new hydropower capacity in the period to 2025 (US NHA, 2009). In geothermal, current growth is steady if rather slow. The main driver is the growing success of geothermal heat pumps. Data on employment are limited, being confined to Germany and the US. Bioenergy is employment intensive, with jobs being created all along the bioenergy value chain, from biomass production or procurement

Figure 4. Employment in renewable energy by technology in selected countries



Source: UNEP, 2011.

Table 1. Average employment (jobs per megawatt of average capacity) over life of facility

	Manufacturing, construction, installation	Operating & maintenance/ fuel processing	Total
Solar Photovoltaic	5.76–6.21	1.20–4.80	6.96–11.01
Wind Power	0.43–2.51	0.27	0.70–2.78
Biomass	0.40	0.38–2.44	0.78–2.84
Coal Fired	0.27	0.74	1.01
Natural Gas Fired	0.25	0.70	0.95

Source: UNEP/ILO/IOE/ITUC, 2008.

Table 2. Occupations in selected renewable energy sub-sectors by value chain*

Value chain elements	Occupations	
Equipment Manufacture and Distribution (Wind energy)	• R&D Engineers (computer, electrical, environmental, mechanical, wind power design) (H) • Software Engineers (H,M) • Modellers (prototype testing) (H,M) • Industrial Mechanics (M) • Manufacturing Engineers (H) • Manufacturing Technicians (M) • Manufacturing Operators (L) • Manufacturing Quality Assurance Experts (H,M)	• Certifiers • Logistics Professionals (H,M) • Logistics Operators (L) • Equipment Transporters (L) • Procurement Professionals (H,M) • Marketing Specialists (H,M) • Sales Personnel (H,M)
Project Development (Solar energy)	• Project Designers (Engineers) (H) • Architects (H) (small projects) • Atmospheric Scientists and Meteorologists (H) • Resource Assessment Specialists and Site Evaluators (H) • Environmental Consultant (H) • Lawyers (H) • Debt Financier Representatives (H) • Developers/Facilitators (H,M)	• Land Development Advisor (H) • Land Use Negotiator (H) • Lobbyist (H) • Mediator (H) • Environmental and Social NGO Representatives (H,M) • Public Relations Officer (H) • Procurement Professionals (H,M) • Resource Assessment Specialists (H)
Construction and Installation (Hydropower)	• Engineers (civil, mechanical, electrical) (H) • Project Managers (H) • Skilled Construction Workers (Heavy Machinery Operators, Welders, Pipe-fitters etc.), (M) • Construction Labourers (L)	• Business Developers (H) • Commissioning Engineer (Electrical) (H) • Transportation Workers (L)
Operation and Maintenance (Geothermal energy)	• Plant managers (H) • Measurement and Control Engineers (H) • Welders (M) • Pipe Fitters (M) • Plumbers (M)	• Machinists (M) • Electricians (M) • Construction Equipment Operator (M) • HVAC technicians (M)
Biomass production (Bioenergy)	• Agricultural Scientists (H) • Biomass Production Managers (H,M) • Plant Breeders & Foresters (H,M)	• Agricultural / Forestry Workers (L) • Transportation workers (L)
Cross-cutting/ Enabling Activities (all sub-sectors)	• Policy Makers and Government Office Workers (H,M) • Trade Association and Professional Society Staff (H, M,L) • Educators & Trainers (H) • Management (H,M,L) • Administration (H,M,L) • Publishers and Science Writers (H,M)	• Insurer Representatives (H,M) • IT Professionals (H,M) • Human Resources Professionals (H) • Other Financial Professionals (Accountants, Auditors and Financers) (H) • Health and Safety consultants (H,M) • Sales and Marketing Specialists (H,M) • Clients (H,M,L)

* H: Highly-skilled (professional/managerial); M: Medium skilled (technical/skilled crafts/supervisory); L: low skilled.

to transport, conversion, distribution and marketing. It is estimated that globally there are about 1.5 million direct jobs (REN21, 2010).

As table 1 demonstrates, solar PV is the most labour-intensive, in terms of jobs required for each megawatt of energy generated (coal and natural gas fired generation is included for comparative purposes).

Women are still underrepresented in employment in renewable energies. Data for Germany, for instance, suggests that women are underrepresented in the sector (23.6 per cent against 45 per cent in the whole economy). This share equals the percentage of women in the energy and water supply sector as a whole which implies that the new sector replicates existing gender patterns. This largely derives from the fact that enrolments of women in education and training related to technical and engineering occupations are low. By contrast, in rural India, mainly women get trained as solar energy technicians, which shows that new occupations can counter gender stereotypes.

The value chain

The renewable energy sector has four major elements to its value chain: equipment manufacture and distribution, project development, construction and installation, operations and maintenance (Figure 5).

Patterns of employment in manufacturing and distribution of renewable energy technologies are broadly similar to those in other capital investment goods industries. Patterns of employment in project development and in construction and installation, however, are quite different, in that work is project based, and so continuity of employment depends on a fairly steady flow of projects. Patterns of employment in operations and maintenance are more stable. Total employment tends to increase in jumps, when a significant new installation is commissioned.

These employment characteristics apply especially to larger projects. If renewable energy is introduced through large numbers of smaller projects (for example, installation of solar PV in existing individual buildings), this is likely to result in smoother variation in demand over time.

Occupations in renewable energy

The full report on which this research brief is based includes a comprehensive survey of occupations for each sub-sector of the renewable energy industry for the four major elements of the value chain, as well as for cross-cutting and enabling activities. Table 2 gives a snapshot of this work, focusing on occupations for just one sub-sector for each segment of the value chain. (Readers are invited to consult the full report for the full table.)

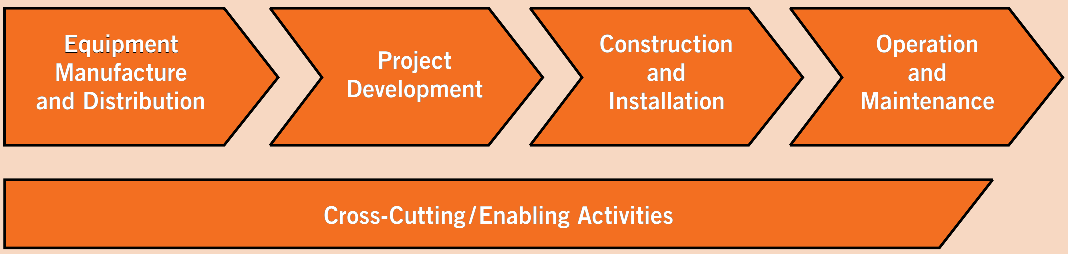
Making green jobs decent jobs

Unfortunately, 'green' jobs are not necessarily decent jobs. For example, the working conditions of cane cutters for bioethanol production in some areas of Brazil are reported to be poor given that they require extreme physical efforts (Zafalon, 2007).

Since many enterprises in the renewable energy sector are young, the degree of unionisation in the industry tends to be lower than in other sectors. Where workers are unionised, a large number of different unions may be involved, since renewable energy cuts across many traditional sectors.

A recent European study identifies new and emerging risks to occupational safety and health associated with new technologies in green jobs (European Agency for Safety and Health at Work, 2011). However, renewable energy avoids some of the particularly hazardous working conditions such as coal mining associated with traditional non-renewable energy generation.

Figure 5. Renewable energy value chain



Source: ILO, 2011.

Studies in Germany (BMU, 2010) and Spain (Fundacion Biodiversidad, 2010) indicate that qualification levels of workers in the renewable energy sector are higher than average. Data from Canada also suggest that opportunities for training and career progression are more widely available in green energy than in low-paid service-related jobs (Pollin and Garrett-Peltier, 2009). However, elsewhere there are reports that some jobs created may be short-term: in Portugal, the majority of jobs created by a large wind power project were found to be temporary (Prata Dias, 2010).

3. Skills gaps and labour shortages

Viewed globally, most parts of the renewable energy sector are still in the early stages of their development and, proportionate to the current low base, are growing rapidly. Hydropower is something of an exception, with a relatively large installed base.

Seen from the perspective of national labour markets, the pattern is more varied. For each major technology, there is limited activity in some countries, very rapid growth in activity in some others, steady growth in capacity in others, and a relatively mature industry elsewhere.

Problems with skills and labour shortage or surplus in renewable energy at country level appear to occur both when activity takes off quickly, causing demand for labour to switch suddenly from a trivial to a substantial level, and then later, when the rate at which new installations are undertaken either increases or falls rapidly.

Skills shortages arising from these changes are likely to be less severe in developed countries that already have a highly skilled population. Most developing countries are less well supplied with quality providers of training and education, making it more difficult for them to respond to emerging skills needs.

There will be some scope for workers in existing energy industries or other industries where skills sets are sufficiently similar to move to renewable energy as the transition progresses. However, it is important not to overstate the potential. For example, renewable energy plants will not necessarily be located close to legacy fossil-based operations.

The principal occupations difficult to fill

The International Renewable Energy Alliance (REN Alliance) has identified the following as the principal occupations difficult to fill in many member countries which include both developed and developing countries.

There is a widespread skill shortage of engineers and technicians in all parts of the renewable energy industry, which in many countries comes from a broader trend by students away from engineering studies. Qualified design engineers (civil, mechanical and electrical) with specific knowledge of particular renewable energy technologies are especially needed.

In the wind energy sector, electrical, computer and mechanical engineers are most needed. There is a sizeable hydropower-specific engineering and technical skill gap in emerging and developing countries. There is also a lack of qualified engineers

Table 3. Principal occupations difficult to fill per sub-sector

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

Source: REN Alliance survey, 2011.

in the bioenergy industry and a general shortage of properly trained bioenergy technicians.

There are also skills shortages in non-technical occupations. For example, in many countries, sales specialists, inspectors, auditors, lawyers, and those working in investment finance lack specific skills important for the development of renewable energy. A widespread shortage of qualified trainers with these skills has also been identified.

A range of core skills is important. Environmental awareness and motivation are highly desirable among renewable energy employees at all levels. Managers and professionals require dynamism, leadership, negotiation and strategic skills to make the most of the market opportunities opening up.

4. Taking action to avoid labour shortages

Skills availability plays an important role in facilitating the development of renewable energy, and there is scope for governments and for the renewable energy sector to assist providers of relevant training and education to develop their training programmes.

Whilst it is true that existing education and training courses and apprenticeships go a long way towards meeting the headline skills needs of the sector, the more specialised skill sets identified above may well not be communicated. Training and education providers may be slow to decide to focus specifically on the skills required for renewable energy. Developing a course and running it for the first time requires a significant investment of time and effort and providers are also constrained by the expectations of prospective students and trainees: courses offered before activity in renewable energy really takes off may not get the buzz of interest needed to make them attractive.

There is scope for retraining (and supplementary training) focused specifically on renewable energy for workers with relevant skills who are looking to transfer to the sector, as well as for graduates of less specialised courses. Retraining may in practice make up the largest training need, since construction and installation work is often temporary and labour needs may fluctuate (this requirement for retraining programmes could be reduced, however, if sound policies are adopted which phase investment and therefore smooth out jumps in job growth). Those already working in renewable energy require appropriate education and training to fill gaps in their existing skills.

Finally, skill and labour shortages can at least partially be solved if renewable energy as a young and dynamic sector succeeds in overcoming traditional gender barriers and occupational segregation and involves more women into technical and engineering jobs. This however will only be possible if relevant education and training opportunities are accessible to women, if women are empowered to overcome cultural and social barriers, and if vocational guidance and incentives are available to attract women to these types of technical studies.

Courses for technicians and skilled crafts workers

Important sources of training at this level include:

- technical and vocational education and training (TVET),
- apprenticeships,
- suppliers of renewable energy technologies.

Ideally, TVET programmes strike a good balance between providing a sound education which will be useful once current technologies are obsolete, developing knowledge to work with current technology from all suppliers, and developing detailed knowledge to work with one or more specific suppliers.

Examples of recent initiatives:

- A new course in Installation and Maintenance of Wind Farms is being offered by vocational training colleges in Spain.
- A two year course to train as a geothermal technician is being offered in British Columbia, Canada, in collaboration with employers and unions.
- The National Biodiesel Programme in Brazil helps rural technicians assist agricultural producers growing bioenergy crops.
- In Bangladesh, training for young people and for women to qualify as certified solar technicians is linked to a programme of micro-loans for solar power for homes offered by Grameen Shakti.

University courses

Examples of recent initiatives:

- The Oregon Institute of Technology (US) offers a first degree in Renewable Energy Engineering.
- The University of Miskolc, Hungary, offers a degree course in Mechanical Engineering, with a Major in Energy Conversion.
- The University of Auckland (New Zealand) offers a postgraduate diploma in Geothermal Energy Technology.
- In Uganda, the Faculty of Technology at Makerere University offers a masters degree programme in Renewable Energy.

The international perspective

Examples of recent initiatives:

- The Windskill Initiative, funded by Intelligent Energy Europe, is a transnational training strategy for the European wind market.
- DESERTEC University brings together eighteen universities and research facilities in North Africa and the Middle East to provide education and training in solar power.
- A global network of universities and centres of excellence in geothermal research (together with industry partners) is being created around the International Geothermal Centre of Excellence (IGZB) in Bochum, Germany.
- In the hydropower sector, agreements have been established between Brazil, Paraguay and Argentina for training engineers and technicians.

University courses

Existing university courses in areas such as engineering, biosciences, geosciences, agriculture and forestry, and business provide the necessary foundation for professional level work in renewable energy. Many universities are already shaping their courses to better reflect the growth of interest in renewables.

Many universities are also offering postgraduate courses specifically focused on renewable energy.

Continuing education and training

Continuing education and training is important for the renewable energy sector. Providers are diverse, including renewable energy businesses, industry associations, trade unions, technology suppliers, universities and colleges, and private training providers. In technical occupations, it is required to keep skills and knowledge up to date as technologies change, to develop cross-disciplinary skills and knowledge, and to improve core skills in areas including problem solving, communication and team-working. In non-technical areas (clerks, lawyers etc.), there is a particular need to develop industry knowledge, and keep it up to date.

The international perspective

Because renewable energy technologies and (to a great extent) skills requirements are similar between different countries, there is significant scope to standardise skills and qualifications requirements. Transnational networks and cross-country initiatives make it easier for employers to understand qualifications issued by institutions in other countries, facilitating international mobility among workers.

The role of the social partners

Social dialogue has an important role to play both in identifying skills needed for the renewable energy sector and in ensuring that adequate education and training provision is available. Interaction between private companies and their trade associations, workers' representatives, and training providers is crucial.

In many countries, governments are working with employers' and workers' organisations in tripartite arrangements to adapt or create new curricula for renewable energy. This is the case, for example, for the apprenticeship system in Germany and in Denmark. In France, the Comité de Liaison Energies Renouvables (CLER) is an association of companies, public institutions, trade unions and other organisations promoting renewable energy. Among other things, CLER organises annual meetings with training institutions.

Other examples of valuable initiatives include the creation in Canada of a Renewable Energy Advisory Committee on Training, with representation from industry, colleges and the government's Natural Resources Canada agency (The Delphi Group, 2007).

In other countries, existing Skills Councils are turning their attention to renewable energy. This is the case in the Republic of Korea, for example, where two new sector skills councils have been created, one for renewable energy and one for green finance (Strietska-Ilina et al., 2011).

5. The way forward

Many valuable initiatives to promote the development of renewable energy are potentially being held back because of shortages of skills. It is important that renewable energy programmes and projects are established with strategies which address skills issues.

Smooth transitions to renewable energy by pacing investment

When renewable energy initiatives are being planned, one major concern should be to smooth the pace of investment over time. This helps to provide stable employment for workers, to avoid periods of serious labour shortages for employers, and to assist providers of training and education in their planning work.

It may not always be possible to achieve this. But where it is possible, a gradual ramp-up in the rate at which new capacity is added will allow the sector to avoid an initial spike in the demand for project development, construction and installation work followed by a steep or prolonged decline in demand. It will help ensure that the demand for people to work subsequently in operations and maintenance is also maintained at a steady level.

Coordinate renewable energy policy and investment with skills provision

Skills shortages (and surpluses) are the natural outcome of weak coordination between large-scale initiatives to promote renewable energy, such as those adopted by many governments, and agencies concerned with vocational education and training.

This issue is not unique to renewable energy, but there are reasons why it is particularly significant in this instance. Firstly, the project nature of much of the work can lead to booms and busts in project development and in construction and installation work. Secondly, employment in operations and maintenance often increases in significant step-moves rather than linearly, each time that significant new capacity is commissioned.

Although these specific factors are less significant where smaller scale renewable energy projects (such as solar PV panels and solar water heating for individual buildings) are concerned, these initiatives may be driven by government subsidies which may also be subject to sudden introduction or removal. Here, too, renewable energy initiatives should also include a skills component.

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Where there are reasons why it may not be possible to adopt a smooth transition to renewable energy – where it is more a question of a stop/start approach – it is important to prioritise flexible training initiatives focusing on retraining the existing workforce, in particular for construction/installation occupations.

Plan renewable energy skills for developing countries

There are major opportunities in developing countries to exploit renewable energy, and the key challenge will be to maximise the local economic benefits of these developments. Although initially it may be necessary to contract-in skilled workers from outside the country, it should be possible as projects develop to decrease reliance on international expertise. In many cases, installation of renewable electricity generating capacity in developing countries will bring new opportunities to rural and isolated communities, offering them the chance to establish new businesses and services. Extending entrepreneurship training in rural communities is a valuable complementary activity to the work of installing new renewable energy generating plants.

Put emphasis on portable skills

Training targeted on the renewable energy sector should invest in skills that are portable. Even with efforts taken to adopt a smooth transition approach, employment in development, construction and installation may be volatile. In occupations linked to operations and maintenance, there may also be periods when scope to employ newly trained workers will be limited.

Education and training courses should therefore be built around a core qualification that will be useful in a broader range of sectors.

Consider standard training content

Because skills requirements in renewable energy are fairly uniform across national and regional boundaries, there is scope for international collaboration on standard approaches and content of training courses, helping to reduce the up-front costs of pioneering new courses.

Bipartite structures bringing renewable energy businesses and trade unions together could establish internationally recognised industry certification to complement national qualifications.

Anticipate skill needs

Since renewable energy projects are often planned a number of years in advance, effective skills anticipation work would be desirable. For each sub-sector, employment in project development, construction and installation can be linked to the rate at which new capacity is being installed.

Current skills anticipation in renewable energy is mostly qualitative. Quantitative studies, which are faced with a number of methodological challenges, are limited to employment figures and would need to be extended to the occupational level. For all skills anticipation, it is paramount to ensure all main stakeholders are engaged, including renewable energy businesses, workers' representatives and providers of education and training.

Facilitate a just transition for displaced workers

As the transition to renewable energy gathers pace, it seems inevitable that there will be substantial reductions in employment in fossil energy. As with any industry which is being wound down as a result of public policy, it will be important to plan for a just transition for employees affected. This implies that the wind-down should also be smoothed over time, rather than allowed to take place abruptly. It also requires workers affected to be given the opportunity to learn new skills: where possible, retraining to work in renewable energy should be made available to them.

Enhance quality of employment in renewable energy

There is a need for policymakers promoting the transition to renewable energy to take account of decent work principles when designing policies and interventions, and to ensure that workers have the opportunity to organize themselves to pursue high quality working conditions. In areas where there is a significant risk that the quality of working conditions will fall below decent work criteria, there is a particular need to enforce labour law effectively.

Develop a strategy for corporate social responsibility

In addition to mechanisms for social dialogue with representatives of stakeholders, the transition to renewable energies opens many important opportunities for corporate initiatives. Large-scale renewable energy projects in developing countries have a significant impact on the local population.

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It is important both to the local population and to the sector itself that renewable energy projects are developed and operated in a responsible manner that takes account of the project's wider social impact. Large-scale renewable energy projects should have a strategy for corporate social responsibility.

Use instruments of social dialogue in design and delivery of skills interventions

Governments, employers and workers' organizations have a shared interest in tackling skill gaps in the green building value chain. For these reasons, dialogue between the social partners on anticipating and meeting the skills challenge is required to design and implement the best possible skills development responses. With increasing levels of organization of workers and employers, the sector will improve its potential for active social dialogue on training.

For specialist technician and skilled crafts workers, workplace-based initial training such as apprenticeship systems continues to benefit from social dialogue at national or sector level. Parts of the continuing education and training system relevant to renewable energies are organized by business associations, in some cases by trade unions, and employment services also provide retraining in the area. At higher skilled levels, universities should also engage closely with social partners to determine course content and forge links with industry.

Boost supply of trainers

Frequently, one of the main choke points constraining employers and providers of education and training from responding sufficiently quickly to emerging skills requirements in renewable energy industries is a shortage of suitable trainers and educators. As demand for people to work in renewable energy often emerges relatively suddenly, there is often a need for education and training institutions to source the trainers and educators they need at fairly short notice, to allow them to respond to emerging skills requirements in a timely manner. Collaboration with institutions that are already experts in training in renewable energy, staff exchanges or placements, and collaboration with industry are practical ways to achieve this.

Encourage international collaboration between providers of education and training

Given the significance of the international dimension, supranational and international organizations such as the EC and the ILO should work to promote cooperation between countries. This can include collaboration between providers of education and training, researchers and practitioners involved in the development of qualification standards in different countries, and measures to increase mobility of trainers.

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