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RESEARCH PAPER

Future skill needs for the green economy

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Foreword

Environmental challenges raise serious concerns for the welfare of current and future generations. Responses should be driven by independent but commonly reinforcing policies for environment, energy, transportation, employment, and training. International organisations are joining their forces to help realise the potential for green jobs with the participation of employers and employees.

The initiative *New skills for new jobs: anticipating and matching labour market and skills needs*, launched by the European Commission ⁽¹⁾ responds to the Council's (Education, Youth and Culture, November 2007 and Employment, Social Policy, Health and Consumer Affairs, June 2008) and European Council (December 2007, March 2008) requests to the Commission to present a comprehensive assessment of future skills requirements in Europe up to 2020 and to propose further steps to anticipate future needs. Strengthening international cooperation with global partners is crucial to address the impact of climate change and the economic crisis.

The recent green jobs initiative (UNEP, ILO, ITUC and IOE) highlighted the dual challenge of green jobs: to make economic growth and development compatible with climate stabilisation and a sustainable environmental footprint. The shift towards greening the economy will require the second greatest economic transformation after the industrial revolution. We have not paid enough attention to the social dimension of sustainable development: its implications for employment, training and decent work.

This publication examines the links between education, training, employment and environment policies. Green sectors will require new jobs, but they will also need to redefine many existing job profiles. The demand for new related skills will also rise in most occupations. To meet this challenge, education and training systems will need to supply a well-trained, highly skilled labour force. Training and guidance services that steer people towards jobs in growing sectors should focus on skills related to energy efficiency and renewable energy implementation. Putting in place the right training programmes for employees in declining sectors will help European economies redeploy workers who are difficult to place. A well-trained and environmentally aware workforce will also be more innovative in improving resource efficiency. To achieve this we need comprehensive lifelong learning strategies and training systems that integrate sustainable development and ensure that the right skills are supplied.

To discuss and explore these challenges Cedefop organised a workshop which showed that 'green skills' are not only needed in the eco-industry itself. Practically all jobs will need to develop knowledge and skills related to the environment, such as the efficient use of energy. We will all need to learn how to think about the consequences of our work practices and types of adjustments required.

Aviana Bulgarelli
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⁽¹⁾ European Commission (2008). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: new skills for new jobs; anticipating and matching labour market and skills needs. Luxembourg: Publications Office (COM(2008) 868 final).

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This publication is the outcome of the workshop on 'Future skill needs for the green economy', held in Thessaloniki, October 2008.

Preface

A key issue for policy-makers and stakeholders dealing with climate change is how to reduce greenhouse gas emissions through energy efficiency and alternative forms of energy and transport. Mitigation technologies, policies and measures are designed at national, European, international and sector levels. They include mainly construction, agriculture, manufacturing and transport.

Green technologies offer the possibility of new green jobs for those who respond quickly to the developing green economy. New green jobs will require new skills in new and emerging occupations. Identifying those skills may make action to combat climate change more effective.

Everyone needs to be involved in mitigating climate change. Efficient coordination of measures in Member States, regions and communities is vital to keeping costs low. The EU plays an important role in supporting action to adjust to climate change by finetuning policies, filling knowledge gaps and coordinating strategies.

On 6 and 7 October 2008 Cedefop's workshop on 'Future skill needs for the green economy' identified and increased knowledge about the implications of climate change for educating and training professionals and associate professionals who are involved in mitigating climate change. Relevant professionals include natural resource managers, science and engineering professionals, especially in physical and earth science, life science professionals, architects, planners, surveyors and designers. The main focus was on energy efficiency and renewable energy implementation skills determining the core element of future green jobs. We felt that there was an urgent need to bring interested parties together to review the latest research findings on emerging skills needed for the green economy.

This publication is based on the contributions from workshop participants. A strong international portfolio of presenters confirms our view on timeliness and importance of the subject. The case studies highlight the results of initiatives carried out by researchers identifying skills for green jobs. Key trends and future skills and occupational requirements were examined. An international perspective on skills required is followed by skill needs for green jobs for sustainable development and changing qualification needs in jobs for renewable energies. The challenge after such an event is how to carry on the work, considering present economic and social transformations.

The current economic downturn has spurred response packages in many countries with large-scale infrastructure and energy projects with greening components. The success of these response packages in overcoming the economic crisis is fully conditional on availability of adequate skills, as well as policies and capacities to prepare the labour force for the greening economy requirements. Cedefop, in cooperation with ILO, will continue to identify the strategic skills development responses of Member States in the light of environmental degradation, climate change and the global call for greening economies.

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PART I

International initiatives on
future skill needs
for the green economy

1. ILO green jobs initiative and implications for skills development

Christine Evans-Klock, Peter Poschen (presentation)
Ana Belén Sanchez, Christine Hofmann (paper)

Abstract

The paper considers the report *Green jobs: towards decent work in a sustainable, low-carbon world* (UNEP et al., 2008), the first comprehensive study on the emergence of a green economy and its impact on the world of work. It shows a changing pattern of employment in which green jobs are being generated in many sectors and economies around the world as a result of measures to tackle climate change and to reduce emissions of greenhouse gases. This has also led to changing patterns of investment flows into areas such as renewable energy and energy efficiency at household and industrial level. Within current policy frameworks, only a fraction of the potential benefit for jobs and development is forthcoming.

1.1. Introduction: joint promotion of green jobs

What skills are needed to green economies? The ILO green jobs initiative and skills development framework provide initial findings and policy directions. The initiative is a partnership between the United Nations environment programme (UNEP), the International Labour Organisation (ILO), the International Trade Union Confederation (ITUC), and the International Organisation of Employers (IOE). It was launched to promote opportunity, equity and just transition to green economies. It is intended to mobilise governments, employers and workers to engage in dialogue on coherent policies and effective programmes leading to a green economy and decent work for all.

The first product of the green jobs initiative is the report *Green jobs: towards decent work in a sustainable, low-carbon world* (UNEP et al., 2008). This indicates the impact transformation to a green economy will have on work, on enterprises and on the way people earn a living. It is the first study which provides a global overview, drawing on available information from around the world.

1.2. The dual challenge: environment and decent work

Green jobs hold the promise that humankind will be able to respond effectively and fairly to the following two defining challenges of the 21st century. First is averting dangerous and potentially unmanageable climate change and protecting the natural environment which supports life on earth. Environmental degradation, including the pollution of water, land and air, the irreversible loss of biodiversity, the deterioration and exhaustion of natural resources such as water, fertile agricultural land, and fish, is one of the most serious threats facing economic and broader sustainable development. The environmental and health costs already often outweigh the gains from the economic activity causing the damage. Such degradation will be exacerbated by the impacts of climate change, which are already felt in

many developing countries. In the medium- to long-term, projected climate change will lead to the serious disruption of economic and social activity in many sectors worldwide. Scientific scenarios for avoiding dangerous and possibly unmanageable climate change require global emissions of green house gases to peak over the next 10-15 years and then to decline by half until the middle of the century. Stabilising the climate will require a rapid shift to a low-carbon world economy.

The second challenge is providing decent work ⁽²⁾ and thus the prospect of wellbeing and dignity for all. Decent work is defined as opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. Decent work sums up the aspirations of people in their working lives: opportunity and income; rights, voice and recognition; family stability and personal development; for fairness and gender equality. Ultimately these various dimensions of decent work underpin peace in communities and society. Decent work is central to efforts to reduce poverty, and is a means for achieving equitable, inclusive and sustainable development.

The social challenge of the working poor looms just as large: a staggering 1.3 billion people, over 40 % of the global workforce, and their dependants live in poverty and insecurity because their earnings are too low and they are relegated to the informal economy. There are 190 million unemployed and tens of millions of young job-seekers cannot find a place in society.

The above challenges are closely linked and need to be addressed together. Green jobs are crucial to meeting both simultaneously. Making economic growth and development compatible with stabilising the climate and with a sustainable environmental footprint will require a drastic shift towards clean development and green, low-carbon economies worldwide.

The green jobs and the decent work agendas are mutually supportive and include several interdependent elements, such as rights at work, more and better jobs for women and men, social protection measures, labour protection – in terms of occupational safety and health, migration, laws on wages and working time – and social dialogue, including freedom of association and collective bargaining.

1.3. Employment potential for green jobs

Some of the conclusions of the green jobs report show that millions of green jobs already exist and, in areas such as renewable energy, their numbers are growing fast. The report emphasises the potential for new green jobs, but, to realise this potential, a strong, coherent and stable policy framework and government leadership is necessary.

There is a need to speed up the achievement in energy efficiency and in the proportion of sustainable sources of energy. Progress in key sectors such as transport, basic industries,

⁽²⁾ See ILO, *Decent work for all*, available from Internet: http://www.ilo.org/global/About_the_ILO/Mainpillars/WhatisDecentWork/index.htm [cited 23.4.2009].

recycling and agriculture has been slow and patchy. Investment is rising although it should rise faster in all regions.

Encouragingly, the business case for greening both the economy and the job market is becoming increasingly powerful. The greening of the economy presents a major opportunity to start new businesses, develop new markets and lower energy costs. Observed trends in markets and investments confirm this assessment. The global market for environmental products and services is projected to double from USD 1370 billion per year at present to USD 2740 billion by 2020 (BMU, 2007). Half of this market is based in energy efficiency and the balance in sustainable transport, water supply, sanitation and waste management.

1.3.1. What kind of jobs are green jobs?

Green jobs reduce the environmental impact of enterprises and economic sectors, ultimately to sustainable levels. Green jobs are found in many sectors of the economy from energy supply to recycling and from agriculture and construction to transportation. They help to cut energy, raw materials and water consumption through high-efficiency strategies, to de-carbonise the economy and reduce greenhouse-gas emissions, to minimise or avoid altogether all forms of waste and pollution, to protect and restore ecosystems and biodiversity.

1.3.2. How good are they?

Green jobs do not automatically constitute decent work. Many current recycling jobs, for instance, recover raw material and thus help to alleviate pressure on natural resources, but apply a process which is often dirty, dangerous and difficult, causing significant damage to the environment and to human health. Employment in this industry in developing countries tends to be precarious and incomes are low.

If green jobs are to be a bridge to a truly sustainable future, then they also must be decent jobs. Decent, green jobs effectively link Millennium development goal 1 (poverty reduction) and Millennium development goal 7 (protecting the environment) and make them mutually supportive rather than conflicting ⁽³⁾.

1.3.3. Who takes green jobs?

Skills shortages have emerged as a constraint on the greening of economies in industrial and developing countries alike. This is why developing the right skills to ease just transitions is a crucial element in the process. In response to the urgency for greener economies, young persons and workers with the right skills and the ability to learn new ones will be prepared to shift out of declining and into emerging industries.

⁽³⁾ Goal 1: eradicate extreme poverty and hunger. Target 2: achieve full and productive employment and decent work for all, including women and young people.

Goal 7: ensure environmental sustainability. Target 1: integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.

Currently, green jobs tend to be concentrated in certain countries and regions. Yet this is a reflection of proactive policy initiative and current investment patterns, rather than inherent to the concept. The green jobs report demonstrates that there will be opportunities for green jobs for people and enterprises in both developing and industrial countries. Public policy on investment, protection, and education and training must come together to turn this potential into reality.

1.3.4. Just transition to green jobs

Available studies of labour-market dynamics both for sectors and entire economies, suggest that there will be more jobs in green economies. Not everybody will gain from such a change, however. The typically positive job balance from greening an economy is the result of major shifts often within sectors. While some groups and regions are gaining significantly, others incur substantial losses. Therefore, just transitions are needed both for those affected by the transformation to a green economy and also for those having to adapt to climate change. The industries hardest hit by climate change and those most in need of adaptation are those in developing countries that have historically contributed least to the emissions causing global warming.

The overall balance of available jobs will depend on those created and lost in the sector concerned, such as energy, transport or buildings. Government assistance to both workers and enterprises, including social protection and active labour-market policies, will be a necessary complement in many cases. Meaningful social dialogue will be essential to ease tensions and to arrive at effective cost-sharing and resource allocation.

1.4. ILO framework for skills development

The ILO adopted a framework for skills development at the International Labour Conference in 2008 (ILO, 2008a; 2008b). The conclusions of the discussion stipulate that skills development is crucial to stimulating sustainable development by helping increase both productivity of enterprises and employability of workers. Investment in education and training helps pivot an economy towards green and dynamic growth sectors that provide good jobs. Changing technologies, products and consumption patterns generate demand for new skills while reducing the relevance of others.

1.4.1. Vicious to virtuous circle

Inadequate skills development can be the cause of a vicious downward circle of low skills, low productivity and low income. If quality education and training is unavailable, the working poor will remain trapped in low-skilled, low-productive and, as a result, low-wage jobs. Many of these jobs can be found in informal economies in developing countries. In developed economies, disadvantaged groups such as migrant workers, people with disabilities or older workers can suffer similar constraints. Lacking access to skills development excludes workers from participating in economic growth and social development.

However, more and better skills can turn this vicious circle into a virtuous circle, leading to better and more productive jobs. Improved and more widely available skills enable individuals, enterprises and society to innovate, adopt new technologies, and diversify the economy. Skills to develop, adopt, implement or adapt new technologies, such as improved home insulation or decentralised renewable energy supply systems, are essential to address the opportunities and challenges of low-carbon economies. Skills fuel technological change, investment, diversification of the economy and contribute to the competitiveness of enterprises and industries. Skills development, therefore, is a leverage to boost job quantity in growing sectors and job quality through more productive and sustainable enterprises and through improved working conditions and worker employability.

1.4.2. Sustaining a virtuous circle

According to a review of country experiences, skills development policies sustain the virtuous circle of improved productivity of enterprises and improved worker employability if they serve the following objectives:

- (a) match demand and supply of skills: this short to medium-term objective calls for skills development policies that respond to labour-market demands. Information on present skills demand and supply needs to be made available through labour-market information systems and employment and career services;
- (b) help workers and enterprises adjust to change: skills development policies should ease the transition of workers and enterprises from declining or low-productivity activities and sectors into growing and higher-productivity activities and sectors. Reskilling, skills upgrading and lifelong learning support workers in maintaining their employability and enterprises in adjusting and remaining competitive;
- (c) sustain a dynamic development process: taking a long-term perspective, skills development policies need to prepare economies for future skills requirements. This strategic skills development role should focus on early identification of skills to avoid future bottlenecks. It should also focus on coordinating skills policies with national strategies on technology, trade, rural development and the environment, for example, to anticipate the sources of economic and employment growth and better prepare young people and the workforce for them.

1.4.3. Towards more and better green jobs

Low-carbon economies require skills development policies addressing all three objectives. Yet, the third objective is particularly relevant for economies striving to prepare for the future by reducing their ecological footprint. The responsible reaction to climate change is to shift to low-carbon, less resource and energy-intensive, and more sustainable, ways of production and consumption.

First, effective response strategies by enterprises to update skills and to link them to longer-term business strategies help prepare businesses to take advantage of upcoming opportunities, for instance through improved recycling, which mitigates greenhouse gas emission and reduces resource scarcity.

Second, forward-looking national development policies and strategies can include the greening of jobs and economies. Sustaining a dynamic development process implies anticipating where economies will be competitive and developing the skills needed to encourage new investments and adoption of new green technologies.

Promoting renewable energies for instance means setting the right policy incentives for enterprises and consumers to invest in these technologies. However, if skills development policies are not aligned with national priorities, the sector is likely to face shortages of skilled personnel. Skills bottlenecks are reported in the biofuels industry in Brazil, in the renewable energy and environment industry in Bangladesh, Germany, and the US and in the construction sector in Australia, China, Europe and South Africa (BVET, 2007; London Energy Partnership, 2007).

The key to curbing skills shortages is a forward-looking approach, having a vision of the opportunities and challenges ahead and anticipating the skills needs of the economy to reap potential benefits (in terms of quality jobs and environmental sustainability) and address the challenges (of increased international competition or climate change) wisely.

1.4.4. Implications for greening economies

The first objective is to meet new skill needs as part of mitigation and adaptation efforts. New skill needs will arise due to policy changes or due to environmental changes themselves, as well as to policy responses to ease adjustment to them. The current skills sets available in labour markets might no longer match demand regarding pollution control or emission trading. Upskilling of workers, opportunities for lifelong learning, and updated education and training need to be provided. The greening of current occupations is expected largely to outnumber the need for new occupations. Core skills portable from one work place to another become increasingly important when economies are in transition. While much of the attention focuses on technology, experience demonstrates that the weakest link in the production chain will determine the performance that can be attained. Without qualified entrepreneurs and skilled workers, the available technology and resources for investments cannot be used or cannot deliver the expected environmental benefits and economic returns.

Next it is important to support a fair transition to more sustainable production. Shifting economies towards greener ways of production entails that jobs in declining sectors, such as coalmining, are lost. Supporting a fair transition of displaced workers to more sustainable production requires retraining and effective employment services. Active labour-market policies can help bridge the employment gap and aid transition from one job to another.

It is also necessary to create dynamic and sustainable development. New technologies and production processes for low-carbon production, reduced pollution and improved energy- and resource efficiency require anticipation of skills needs. Therefore, governments need instruments to forecast skills needs. Also they need institutions and feedback mechanisms to ensure that the information is translated into training systems, so that training offers can be adjusted accordingly. Technology forecasting is an instrument used in many countries around the world, such as Brazil, France, Malaysia, Mexico, Poland and the Republic of Korea, to anticipate future developments and prepare for technological and skills changes to come.

1.5. High potential sectors for green jobs

The green jobs report has identified the sectors which are particularly rich in potential for green jobs. The criteria applied were greenhouse-gas emission, use of raw material, substantial contribution to the economy and sources of employment and income:

- (a) energy supply, in particular renewable energy, where more than 2.3 million green jobs have been created in recent years. However, renewable energy sources supply only 2 % of the world's energy. The wind power industry employs some 300 000 people, the solar photovoltaic sector an estimated 170 000 and the solar thermal industry more than 600 000, a large proportion of these in China. Countries with active policies to promote renewable energy have seen employment surge in this sector;
- (b) energy efficiency, particularly in building and construction, which is one of the areas with the highest potential to reduce greenhouse-gas emissions and to create jobs in the process. Some four million direct green jobs, based on improving energy efficiency, already exist across the economy in the US and certain European countries;
- (c) transportation is the lifeblood of the globalised economy. While efforts are being made to reduce the footprint of cars, public transport offers lower emissions and more green jobs. Railways can generally be regarded as sources of green employment;
- (d) basic industry and recycling sectors such as iron and steel, aluminium, cement, pulp and paper account for a large proportion of the use of energy and raw materials, as well as of greenhouse-gas emissions, but a relatively small proportion of global employment. The best option for reducing the environmental impact of these industries is through recycling. Secondary steel production, based on recycled scrap, requires 40-75 % less energy than primary production and can, therefore, be seen as a proxy for greener production. Recycling in all its forms provides 12 million jobs in the three countries for which data is available (Brazil, China, and the US). However, many existing recycling jobs cannot be considered green because they cause both pollution and health hazards and are not examples of decent work;
- (e) agriculture is still the single largest employer in the world, with 1.3 billion farmers and agricultural workers in total. Agriculture is both extremely vulnerable to climate change and a major contributor to it. It is also a major user and polluter of water, a driver of deforestation and of loss of biodiversity. Small farms are more labour-intensive. With adequate technical and infrastructure support, yields from small farms using crop rotation, manuring, natural pesticides, and other sustainable methods can match larger but often more environmentally damaging facilities.

1.6. Closing the skills gap to green economies

There are common principles for meeting skills needs for all sectors with high growth potential for green jobs.

An emphasis on high-end skills would be misplaced. Engineers, designers, and researchers are needed to develop new technologies and more sustainable work processes.

Applying green technologies, however, requires technicians to install, repair and maintain them. These jobs are often referred to as 'green collar' jobs.

Apart from technical know-how, a whole range of business and social skills are critical to shift economies to more and better green jobs:

- (a) entrepreneurial skills to seize the opportunities of low-carbon technologies;
- (b) management skills to make sure that processes respond to adaptation and mitigation challenges;
- (c) core skills such as ability to learn and to innovate;
- (d) leadership skills for policy-makers to be able to set the right incentives and create enabling conditions for cleaner production, cleaner transportation and so forth.

Teaching sustainability not only to policy-makers but to worker and employer organisations, civil society organisations and the public is a vital component in a just transition. Sustainability content needs to be embedded in education and training at all levels to promote clean production and consumption.

For a just transition to materialise, it is important to consider whose skills are upgraded. Measures to improve the capacity to adapt to the impact of climate change need to be targeted, principally at the most vulnerable social groups and geographical regions. Poor people in developing countries, who are often engaged in agriculture in tropical, semi-arid or arid regions, and people in low-lying areas, tend to be the most severely affected, as their economic activity and location are most climate sensitive. Within cities, poor people are also more vulnerable to changes and so require special attention (Huq et al., 2007; Abramovitz et al., 2002).

1.7. Coordination critical for success

For a just transition to more and better green jobs, coordination is critical for success.

Coordination is required at three levels. First, coordination needs to bridge basic education, vocational training, lifelong learning and the labour market by establishing coherent learning paths that lead to jobs. Second, coordinating mechanisms are needed between employers and skills providers that help match skills demand and supply. Third, skills development policies and strategies need to be coordinated with and closely linked to industrial, trade, technology, macroeconomic and environmental policies. Coherent policies are needed to achieve constructive results and cooperation between policy-makers is decisive.

Institutions play a key role in managing these processes; in particular, as markets can fail to provide information, incentives and coordination. Institutions such as interministerial coordination mechanisms are effective in embedding skills policies into national development frameworks, improving information exchange between different areas of expertise and improving policy coherence. Skills forecasting systems in line with environmental policies and labour-market information systems generate data on skills requirements. They need to make sure that the exchange of information is regular and that the data are used by all stakeholders. Local feedback-mechanisms between employers and training providers are as important as sectoral and national mechanisms to adjust training systems to new demands.

Value chains and industrial clusters can also aid coordination and shared learning and investment opportunities. Most of the climate change-related policies and measures apply at sectoral level, so that institutions are often sector-specific.

Social dialogue is a vital coordination mechanism, relevant to all three above challenges. It is the ILO's major instrument for promoting decent work. Social dialogue means the involvement of representatives of governments, employers and workers, on issues of common interest relating to economic and social policy. South Africa provides an interesting example of a country in which social dialogue has resulted in the successful development of the national skills development strategy (Bird, 2006).

1.8. Conclusions: skills and the green jobs initiative

To increase the number of new green jobs and to green existing jobs in different sectors, it is crucial to consider the skills implications of greening economies and to close the skills gaps that already present a bottleneck for spreading clean and low-carbon technologies and practices.

There are other factors besides skills development critical to securing more and better green jobs: respect for workers' rights, gender equality, health and safety standards, strong employment growth policies, a sustainable business environment, local empowerment and economic development, good labour relations, effective social protection, good leadership and a high standard of organisational processes, and effective and active labour-market policies and employment services.

Transformation on the scale and at the speed that is required will depend on deliberate policy choices including:

- (a) securing a strong, coherent and stable policy framework for green jobs;
- (b) assessing the potential for green jobs and monitoring progress;
- (c) greening workplaces;
- (d) easing just transitions;
- (e) enabling good leadership.

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2. Climate change mitigation and EU employment

Sophie Dupressoir

Abstract

This article presents the results of a study carried out in 2007 by a consortium of experts led by the European Trade Union Confederation (ETUC) to assess the potential impact on EU employment of a 30 % emission reduction by 2020. The study provides recommendations on measures to minimise the social cost of transition for workers and support job creation in the new low-carbon sectors.

ETUC is the only trade union organisation recognised by the European Union Treaty. Its membership counts 81 national trade union confederations and 12 industry federations, with a total of 60 million workers.

2.1. Introduction

We are just at the beginning of a fundamental transformation of our economies. If developed countries manage to cut their greenhouse gas emissions by 25 to 40 % by 2020, as recommended by the international panel on climate change, it is likely to lead to major changes in living and working conditions, requiring, not least, accelerated job changes (ETUC et al., 2007).

The challenges raised by the transition to a low-carbon economy – as compared to other process of changes that governments and social partners have had to deal with in the past – are threefold:

- (a) the limited timescale of the transition and the magnitude of change needed. To keep temperature increase below 2°C in the next 15 years will need profound changes in the energy mix and the technologies used to manufacture energy intensive goods and services. As a comparison, the industrial revolution took 150 years. If action is delayed much beyond this, the scale of cuts will have to be much greater. Moreover, a complete decarbonisation of the economy is required by 2050, with emissions cuts by 80 % to 90 %. The anticipated job gains and job losses are sizeable (ETUC et al., 2007);
- (b) the uncertainties associated with the technology and energy path to a low-carbon economy, leading to uncertainties about the net impact on sectoral employment. Whereas climate change experts tend to agree that the technologies needed to achieve deep emissions cuts are available today, they do not agree on the mix of energy sources and technology needed to achieve a given emission reduction objective. Different assumptions regarding the relative costs of the different technology options lead to different technology scenarios, hence different employment and skills impacts. Building employment anticipation and management strategies linked to climate change mitigation needs to be based on alternative mitigation scenario;
- (c) the wide range of sectors that will potentially be affected by climate change mitigation measures if the EU is to meet its climate commitment. No economic sector can afford to ignore the consequences of measures to tackle climate change, be they positive or

negative. That should make it harder for policy-makers and the social partners to identify threatened jobs and new job opportunities. In this sense, climate change represents an unprecedented challenge for employment policies and for the social partners.

2.2. Emission reduction impact on employment and skills

A study was commissioned by the European Commission, Directorate-General for the Environment, as a contribution to improve current understanding of the relationship between climate change and employment. The study was carried out by a consortium led by the European Trade Union Confederation (ETUC) and the Social Development Agency (SDA), which includes Syndex, the Wuppertal Institute and ISTAS.

The report considers the challenge for employment of the transition towards a lower CO₂ European economy up to 2020, in four key economic sectors: energy production, transport, steel and cement industries, construction/housing (ETUC et al., 2007).

The study combines two approaches. First is sectoral employment projections for 2020 using labour intensities of different energy and transport technologies: various scenarios of mitigation measures and policies are used and compared to a reference scenario describing the continuation of the current trend (business as usual). The second strand is case studies relying on analysis of existing literature and interviews with the players.

2.3. Overall impact on employment

Two general conclusions may be drawn from sectoral results.

First, the findings of this study do not dispute those of research using macroeconomic modelling, concluding that there will be some positive impact on employment from climate change, provided appropriate economic policies are put in place. This is explained by the fact that, at least in the medium term, jobs will be gained in labour intensive sectors such as energy efficiency of buildings and renewable energy, while job losses will occur in capital intensive sectors such as energy production.

Second, climate policies should also contribute to rising demand for increasingly educated and qualified workers, not only in terms of technological developments, but also in innovation. This is a general evolution of the economy and is also valid for the process of combating climate change. The integration of new, low-carbon information and communication technologies (design and management of control systems in building and transport) and research into new products and services (new composite materials in wind energy) will require high-level qualifications.

The next part presents the impact of climate change mitigation policies on employment trends by sectors.

2.3.1. Electricity production and distribution

Electricity generation has undergone major restructuring initiatives over the past decade, resulting in a regular reduction of its staff numbers, and will experience profound changes in employment in the coming decades as it adapts to combating climate change.

Reduced demand for energy, a priority measure of EU climate policy, should have automatic repercussions on direct employment in the operation and maintenance of power plants. A reduction in electricity consumption of some 16 % compared to the reference scenario could cause the loss of up to 20 % of direct jobs in maintenance and operation activities.

Within this overall trend, jobs related directly to renewable energy would fare well, growing by around 50 %. Jobs in gas and nuclear energy would remain stable or progress, depending on the scenario considered. The coal sector would lose 50 % of its jobs compared to the reference scenario under a scenario without carbon capture and storage technology.

If jobs generated indirectly by investment (manufacturing of equipment and the construction and installation of power plants) are considered, all subsectors are driven by a growth dynamic of around 23 %, superior to the level seen in the reference scenario. For the gearing-up period for new electricity generating sectors, the combined effect of the two dynamics is positive because the erosion of direct employment is more than offset by gains in the capital goods industry. Given the long useful life of such equipment, however, job losses are not likely to be offset on a sustainable basis.

Such changes will also involve a change to the needs for qualifications within the electricity sector, which will not come cheap. For example, operators in the old electricity production plants will not be able simply to switch to an electricity plant using renewables; these are often located somewhere entirely different.

The net impact of energy savings on employment would be positive. The jobs lost in the coal sector would be largely compensated for by employment gains resulting from the options allowing energy savings (given the highly capitalistic and low labour intensity of the energy production sector) and from the redistribution of savings in business and household energy bills. Such jobs are also harder to relocate and are created mainly in small local companies.

2.3.2. Transport sector

Huge potential for job creation exists in transport by alternative means to road vehicles (lorries, cars, motorbikes) but there are risks for the automobile sector and road freight.

Transport is seen as difficult as far as combating climate change is concerned, due to the strong trend growth in CO₂ emissions and its significant position in the European economy and employment. Around 15 million jobs in EU-25 relate directly and indirectly to transport, more than 7 % of European employment, largely in road transport.

Yet the study shows that it is possible to stabilise transport emissions in 2030, with reference to 1990, while creating 20 % more jobs overall compared to the reference scenario. By reducing the volume of traffic by the order of 10 % and creating more balance through greater use of rail and public transport, the number of direct and indirect jobs in rail

and public transport (tram, bus, underground, bicycles) would be multiplied fourfold compared to the reference scenario.

In contrast, the employment dynamic in the road transport of freight, while still positive, would subside by some 50 % compared to the reference scenario.

Employment in the automotive sector, moreover, could show a decline of the order of 60 % compared to the reference scenario, with numbers employed remaining stable for the period as a whole (2000 to 2030), notably through the added value of clean technologies dissemination, which could give the European industry a significant technological lead.

2.3.3. Building and construction

This sector represents an important source of employment, but it has to tackle the challenges of 'sustainable building' and innovation.

Building and construction represent an important source of new jobs related to prevention of climate change. Thermal renovation of existing buildings, in particular older housing, is an option extremely intensive in direct employment, mostly non-relocatable because it is connected to a territory or to regional or national markets.

The extension of the scope of the EU directive on energy performance of buildings would create a further 30 000 to 90 000 man-years in EU-15 compared to the reference scenario, on top of which will come another 90 000 man-years in the new Member States. The job gains compared to the reference scenario are in excess of one million man-years for works corresponding to high energy quality (50kWh/m²), or 10 % of European employment in the sector.

The launch of an initiative on the thermal renovation of social and subsidised housing would have a particularly important leverage effect because it would tackle much housing and many emissions in a brief period. Further, such activities are likely to create additional social benefits: the integration of the long-term jobless or socially impaired persons, easing of energy costs, and improved living conditions for less favoured households.

The direct jobs created are of relatively low qualification level. However, the building and public works sector will have to take up the challenge of training its workers in 'sustainable building' and the sector is not reputed for being highly innovative on research and development or dynamic on worker training and qualification.

2.3.4. The energy-intensive industries

The climate policy the EU has set for the decade ahead might, without care have significant negative social consequences in energy-intensive sectors, which are already largely internationalised and where jobs are more open to relocation, such as steel or cement manufacture.

The steel industry could see losses amounting to some 50 000 jobs out of a total of 350 000 across EU-25, as a result of relocation of the liquid phase towards low-cost countries not applying limits on CO₂ emissions. There would also be leakages of carbon emissions towards those same countries. Even with little formal relocation, there might be lack of fresh investment in Europe (an investment freeze) or an increase in job insecurity.

We should not conclude from this observation that the emissions trading system applied to these sectors needs to be rethought. The point is to emphasise that these industries deserve specific attention and a coherent strategy, something lacking at the moment.

Though research and development are happening, the risk for employment remains that the sector is not putting enough effort into them. However, the technologies are available, and the financial resources already earmarked.

This risk could be lessened by mobilising the enterprises concerned and putting into place, in parallel with binding measures to combat the greenhouse effect, an industrial policy that combines public aid for research and development programmes, training programmes, and an adjustment mechanism on imports not covered by climate change regulations.

2.4. Conclusions and recommendations

The study concludes that large-scale redistribution of jobs will result from ambitious climate policies. This dynamic is better described as 'job opportunities' and 'job at risk' than as 'losing' and 'winning' jobs, as it is often described.

In each sector there will be redistribution of added value between the economic players, depending on their strategies and their ability to manage the opportunities and risks created by climate policies. Jobs will be created in companies that can take advantage of opportunities created by climate policies and jobs will be lost in companies that cannot adapt. A good example is developing renewable energy which brings added value and new jobs that can be capitalised on both by newcomers in the sector (large power and oil groups, SMEs) and traditional power companies.

The study results indicate that the redistribution of jobs that will result from implementation of climate policies will occur within, rather than between, sectors. That seems initially a positive element, because it is considered easier for workers to change companies within the same sector than to find work in a different sector. Job changes within a sector can, for example, mean lower retraining costs for workers and shorter search periods.

However, changes resulting from climate policies are closely interwoven with those of other dynamics in the different sectors, in particular globalisation and technical progress. This suggests that climate change must be integrated into all EU policies, in particular industrial, trade and employment policy.

Coherence between climate and employment policies is crucial if we are to ensure that climate policies have significant positive effects on employment and that restructuring operations are managed in a socially responsible manner. This is also necessary if an ambitious European policy on combating climate change is to be rooted in a broad social consensus.

The study recommends that employment transition programmes with adequate funding, negotiated with the social partners, be set in place to anticipate, control and manage the social changes linked to CO₂ emission reduction, to ensure that workers are both able to adapt, and offered security. Extra European funding needs to be made available to support such programmes in the Member States.

Employment transition programmes must include at least:

- (a) use of job forecast and skills management tools to assess the likely qualitative and quantitative job developments and to match the training on offer to trends in skills required;
- (b) programmes to help workers from affected industries get jobs in industries offering alternatives;
- (c) income support during any periods of unemployment.

Social dialogue and collective bargaining instruments adapted to the context of climate change should be developed. The study recommends the opening of tripartite European dialogue (employers, unions and public authorities) on implementing adaptation and mitigation policies. The experience of the round tables in Spain on implementing the Kyoto Protocol shows that there is no obstacle in principle to greater involvement by the social partners in these matters.

Governments and the EU should give rights to workers' representatives, in particular in European works councils, so that they are entitled to be informed, consulted and able to participate in decisions about climate change. A good example is the promotion of energy efficiency improvements through worker involvement. Many projects across the EU, involving workers and their representatives, have successfully implemented energy conservation measures. In Germany and the Netherlands, works councils have been given the right to information and consultation and the right of initiative in environmental matters.

Finally, a European observatory on the economic and social upheavals linked with climate change should be set up, tasked with supporting developing industrial relations in this new area.

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PART II

Skill needs for green jobs
and sustainable
development

3. Skills for sustainable development: necessary but not sufficient?

Malcolm Rigg

3.1. Introduction

'The European Union (EU) is firmly committed to sustainable development. It is a key principle of all its policies and actions. The EU aims to create a society which is based on freedom, democracy and respect for fundamental rights, fostering equality of opportunity and solidarity within and between generations. It will work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment, a high level of education and social progress, and a high level of protection and improvement of the quality of the environment' (European Commission, 2005, p. 2).

A commitment to sustainable development implies a coherent and holistic approach to a diverse and often conflicting set of issues, which include:

- (a) how do we generate wealth;
- (b) how can we improve the quality of life especially for those living in poverty;
- (c) how can we substantially reduce our greenhouse gas emissions;
- (d) how can we conserve the environment;
- (e) how can we minimise the depletion of non-renewable natural resources;
- (f) how do we assess and balance the 'needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland Commission definition; WCED, 1987).

3.2. The sustainable development agenda

The notion of one planet and global interdependence is a dominant theme of sustainable development. Falk (1972), for instance, asserts that the values underpinning sustainable development include 'the unity of mankind and the unity of life on earth, with particular recognition that the future of man and the planet are tied to one another'. He argued the need for a 'new world order' based on 'harmony within limits, harmony among human groups and harmony between man and nature'. *The United Nations millenium declaration* (United Nations, 2000) was founded on a core set of fundamental values closely aligned with the sustainable development agenda:

- (a) freedom: men and women have the right to live their lives and raise their children in dignity, free from hunger and from the fear of violence, oppression or injustice. Democratic and participatory governance based on the will of the people best assures these rights;
- (b) equality: no individual and no nation must be denied the opportunity to benefit from development. The equal rights and opportunities of women and men must be assured;

- (c) solidarity: global challenges must be managed in a way that distributes the costs and burdens fairly in accordance with basic principles of equity and social justice. Those who suffer or who benefit least deserve help from those who benefit most;
- (d) tolerance: human beings must respect one other, in all their diversity of belief, culture and language;
- (e) respect for nature: prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development. The current unsustainable patterns of production and consumption must be changed in the interest of our future welfare and that of our descendants;
- (f) shared responsibility: responsibility for managing worldwide economic and social development, as well as threats to international peace and security, must be shared among the nations of the world and should be exercised multilaterally.

The sustainable development agenda is complex and calls for many types of actions including agreements at many different levels, from global downwards, which set rules and targets to inform the actions of individuals and a wide array of formal and informal organisations and networks. The outcomes of agreements and these actions can have considerable implications for the skills agenda which needs to evolve in response to these changes. As important, we need to ensure that society has the ability to address and agree how to proceed in the face of considerable differences in interests, values, development levels and perspectives between nations and between different stakeholders at all levels of society. The context in assessing whether any particular course of action is appropriate is also important. Biofuel production is a classic case. Its impact on food production can range from negligible to severe according to context. Its impact on the livelihoods of a local population can be catastrophic.

One of the main difficulties we face in progressing these complex issues is that, in reality, there are major disagreements about progressing the sustainable development agenda. The dominant values of western societies include competitive individualism, instrumental rationality and material success. Differences in values frequently reflect differences in interests, especially economic ones, not simply ethical differences. The idea that business should take social responsibility for its actions was, until fairly recently, dismissed: 'few trends would so thoroughly undermine the very foundations of our free society as the acceptance by corporate officials of a social responsibility other than to make as much money for their shareholders as they possibly can' (Friedman, 1962).

Many business corporations accept a notion of corporate social responsibility, but few would deny the pre-eminence of shareholder value as the driving force of their activities⁽⁴⁾.

As a result, sustainable development in its broadest sense often sits uncomfortably with private enterprise. Strands such as poverty reduction are not generally considered to be part of the private sector remit. (The production of food for profit rather than need, for instance,

⁽⁴⁾ Inevitably, there are individuals and organisations implacably opposed to sustainable development as the following quotation illustrates: 'there is an agenda being implemented before your very eyes. It's called sustainable development. And I will tell you now, if you want to keep your guns, your property, your children and your God [...] if you love liberty [...] then sustainable development is your enemy!' (DeWees, 2004).

has created considerable poverty: according to the United Nations, one billion people live in urban slums and most are former farmers or their descendants who have lost their land.) Historically the depletion of natural resources has been treated as a cost to society rather than to business. Even within a more limited conception of sustainable development, private enterprise is more likely to favour actions rather than others, such as carbon capture rather than a reduction in the use of fossil fuels. Those concerned with the impact on future generations may take the opposite view. In one sense the importance of the sustainable development agenda, as opposed to a narrower agenda on environment and climate change, is precisely that it focuses on the unintended consequences of actions for society as a whole.

3.3. Learning and skills

It is widely acknowledged that learning does not or should not take place outside the context of values. According to OECD (2005), sustainable development depends ‘critically on the competences of all of our population – with competences understood to cover knowledge, skills, attitudes and values’.

The UK government states ‘All learners will develop the skills, knowledge and value base to be active citizens in creating a more sustainable society’ (DfES, 2002).

The UK government conceptualises sustainable development as an agenda with three pillars supporting two desirable outcomes or aspirations.

Table 3:1 **Securing the future – delivering the UK sustainable development strategy, March 2005**

Outcomes	Living within environmental limits		Ensuring a strong, healthy and just society	
	Respecting the limits of the planet’s environment, resources and biodiversity to improve our environment and ensure that the natural resources needed for life are unimpaired and remain so for future generations.		Meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity for all.	
Drivers	Achieving a sustainable economy		Using sound science responsibly	
	Building a strong, stable and sustainable economy which provides prosperity and opportunities for all, and in which environmental and social costs fall on those who impose them (polluter pays), and incentives are provided for efficient resource use.		Ensuring policy is developed and implemented on the basis of strong scientific evidence, while considering scientific uncertainty (through the precautionary principle) as well as public attitudes and values.	
			Promoting good governance	
			Promoting effective, participative systems of governance at all levels of society: engaging people’s creativity, energy, and diversity.	

In this paper, focus is on good governance (⁵), the role of which is to promote and support democratic decision-making about sustainable development issues (using sound science). Such decisions arise at all levels of society and are not without conflicts between levels. Participatory decision-making at one level can conflict with strategic planning or strategic targets at another.

The core skills that underpin good governance are generic rather than specific. A recent review, *Skills for sustainable communities* describes the kind of skills required locally: ‘the initial focus of the review was very firmly on professional built environment skills. But our work to define and operationalise the common goal, clarify responsibilities, and outline process improvements, made clear to us that there is a much larger range of skills needed to deliver sustainable communities. We believe that it is the generic skills, behaviour and knowledge that will make the difference between successful delivery and failure. Skills such as the ability to create a vision, leadership to achieve buy in to the vision, communication, team-working, project management, process reengineering, understanding sustainable development, effective financial management, understanding the economics of development and the processes of local democracy. [...] These skills are needed, to different degrees and varying levels, by all those with a role to play in delivering sustainable communities. [...] we identified around one hundred different occupations engaged in this agenda. All of these need their individual professional/specialist skills, but they also need the generic skills outlined above, so that they can work together to deliver the vision for their areas. Of the 100 or so occupations, we identified a significant number as ‘core’ occupations – people who spend almost all of their professional time in activities to do with planning, delivering and maintaining sustainable communities. These are the built environment professionals – planners, architects, urban designers, etc. – and decision-makers and influencers – staff from local, regional and central government, developers and investors, staff from voluntary and community associations. A second group comprised “associated occupations” – those whose contribution is extremely important to creating sustainable communities but who are not involved full time in the development process – examples are police officers, educators, health service managers, and staff in local businesses. A third group comprised those who have a legitimate interest in sustainable communities but who are not necessarily employed in the sector [...]’ (The Egan review, 2006, pp. 9-10).

The review also argues that ‘generic skills [...] must be [...] practised [...] by working in a variety of projects, [...] jobs, within multidisciplinary teams [...] with people who already demonstrate some or all of the skills’ (The Egan Review, 2006, pp. 69-70). Embodied learning ‘ [...] facilitates the individual in acquiring dispositions, skills and attitudes for

(⁵) The sustainable development strategy of the UK government states: ‘we need a major shift to deliver new products and services with lower environmental impacts across their lifecycle, and new business models which meet this challenge while boosting competitiveness’ (HM Government, 2005, p. 7). It is surprising, therefore, that the recent Leitch review on UK training, *Prosperity for all in the global economy – world class skills* (Leitch review of skills, 2006), focuses entirely on competitiveness and employability. The core recommendation is that skills should be ‘employer-led’. There is no mention of sustainability, or sustainable development, or an acknowledgement that a major shift is needed.

learning how to learn, and how to negotiate the values issues and dilemmas of the real world which forms the basis for active citizenship, and to do so in a way which is grounded in experience and identity' (Deakin Crick, 2008).

These skills are further classified by Turok and Taylor (2006) in relationship to community regeneration and planning into:

- (a) strategic and leadership skills: initiating and promoting change;
- (b) process skills: enabling change;
- (c) practical skills: delivering change.

The group involved at all levels of society is a subset of professionally trained and qualified workers. They, it is argued, are pivotal in the process. Turok and Taylor point out that 'there is a challenge to the ethos of professionals working in separate disciplines and institutions, and especially to any suggestion that specialists know what is best for local communities. Instead there are demands for public bodies and experts to be more responsive and sympathetic to other views and interests'.

The sustainable development agenda and values are premised on engagement and democratic processes. The activities taking place in the UK to promote sustainable development and these values in key professions are described below.

The rationale for focusing on professionals is that they engage in continuous professional development, are required to recognise obligations to their profession and to their clients or employers, conform to a code of conduct and are expected to consider the public good (although increasingly in a participative way). They exercise considerable influence over clients on projects and they deal with complex challenges, often involving other professional disciplines. They must take responsibility for their work and show leadership. Their professional bodies are heavily involved in designing and developing professional qualifications for the next generation and increasingly these professional bodies are incorporating sustainable development into their codes of conduct. This is not to suggest that all 'professionals' and their professional bodies are potentially leaders in sustainable development. Professional bodies can be found on a spectrum from those motivated by self-interest to those which are strongly 'other' interested. Those which adopt sustainable development are most likely to have members are directly concerned with sustainability issues.

3.4. Professional practice for sustainable development initiative

In the UK, the professional practice for sustainable development (PP4SD) initiative ⁽⁶⁾ is working with 14 professional institutions to help members improve their capacity to support sustainable development. The current members cover building services and research, information, building services engineers, water and environmental management, purchasing and supply, energy, waste management, chemical engineering, civil engineers,

⁽⁶⁾ Available from Internet: <http://www.pp4sd.org.uk/default.asp> [cited 27.4.2009].

environmental sciences, mechanical engineering, architecture, chartered surveyors, chemistry, and town planning.

The PP4SD framework describes a sustainable society as one where:

- (a) any materials extracted from the earth should not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects to humans and the environment;
- (b) synthetic substances in their manufacture and use should not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects to humans or the environment;
- (c) the biological diversity and productivity of ecosystems should not be endangered;
- (d) a healthy economy should be maintained, which accurately represents the value of natural, human, social and manufactured capital;
- (e) individual human skills, knowledge and health should be developed and deployed to optimum effect;
- (f) social progress and justice should recognise the needs of everyone;
- (g) there must be equity for future generations;
- (h) structures and institutions should promote stewardship of natural resources and the development of people.

They have created training materials to support the framework. The approach is based on systems thinking. The essence of a systems thinking is that 'systems provides a set of ideas, tools and methods for engaging with and improving complex situations, referred to as messes. It is a holistic approach that emphasises the connections between issues and components in the mess and simplifies the complexity by thinking at a greater level of abstraction or generality. Systems fosters a multiple perspective approach to complexity and assumes that insights and ways of improving situations will be generated by helping stakeholders and participants to shift their established way of thinking about the mess. Systems is likely to be most useful in contexts where reductionist, single perspective or command and control processes have failed to provide adequate management of the complexity involved' (Chapman, 2001, p. 84).

A report of a workshop organised by PP4SD and the Science Council in 2006 (PP4SD, 2006) made recommendations about how professional bodies could support their members in furthering sustainable development. These included:

- (a) governance: professional bodies need to be leaders and strong advocates for sustainability and need to find appropriate ways of doing this. A culture change within the profession and their clients may be needed ⁽⁷⁾;
- (b) policy:
 - (i) professional bodies should make sustainable development a priority;
 - (ii) professional bodies should ensure sustainable development is in all policy areas;

⁽⁷⁾ Those directly engaged in governance itself, such as politicians, have similar needs. The skill/knowledge/values proposed for UK local councillors are local leadership; partnership working; communication skills; political understanding; scrutiny and challenge, and regulating and monitoring (Silvester, 2007).

- (iii) professional bodies should consider setting minimum professional competence standards in sustainable development;
 - (iv) professional bodies should make more explicit their vision of a sustainable profession and a sustainable professional;
- (c) practice:
- (i) professional bodies are already active in many aspects of sustainable development. Developing a sustainable development framework could be used to review what their institution is doing and what still needs to be done;
 - (ii) professional bodies should develop and promote guidance on how to integrate sustainable development principles into professional practice. (Are there new skills to be learned, or is it a matter of using existing skills for achieving sustainability?);
 - (iii) professional bodies should develop codes of practice and/or standards relating to sustainable practice;
 - (iv) professional bodies should take a stronger lead on continuous professional development for sustainability;
- (d) cross-profession actions: the umbrella bodies should provide a leadership role in interprofessional dialogue on sustainability and sustainable development, for example by supporting cross-profession networks.

The workshop identified several next steps including:

- (a) professional bodies should encourage and support developing skills for systems thinking ⁽⁸⁾;
- (b) professional bodies should promote cultural change that favours working towards sustainability;
- (c) professional bodies should promote the learning of communication skills so that professionals can communicate with stakeholders more effectively.

3.5. Conclusions

There is still a long way to go in developing generic skills and skills for systems thinking. These are rarely prioritised in mainstream professional development where the extent of interdisciplinary engagement is usually small. Added to this, participative approaches favoured under good governance principles require resource and time. Both are often in short supply. Time, in particular, is a major challenge on account of the urgency of the climate change agenda. If we fail to reduce greenhouse gas emissions rapidly, the speed and unpredictability of climate change will change the agenda from one of seeking to live within environmental limits to another of living with the consequences of climate change ⁽⁹⁾.

⁽⁸⁾ See for instance, Checkland (1981) and Checkland and Scoles (1990). For an excellent overview of the issues, challenges and an integrated approach to integrated planning and a sustainable environment see Ravetz (2000).

⁽⁹⁾ For instance, *Climate change: adapt or bust*, published by Lloyds of London in 2007 states: ‘a growing body of expert opinion now agrees that the climate is changing – and that human activity

The threats posed by rising sea levels, clean water shortages and unpredictable climates are likely to undermine good governance and pose many challenges for the skills agenda.

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is playing a major role. Most worrying, the latest science suggests that future climate change may take place quicker than previously anticipated' (Lloyds, 2007, p. 3).

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4. Emerging skill needs in a greener UK economy

Terence Hogarth

Abstract

This paper explores what is known about emerging skill needs in environmental science in the UK and offers insights into whether skill demand is being met. There is relatively little representative data on the skill needs resulting from the demands of environmental change or the greening of the UK economy. Hence, there remain unknowns relating to the type and volume of skills demand resulting from what are commonly referred to as green issues.

4.1. Introduction

While climate change may have increased individual and business awareness of environmental issues over recent years, especially with the publication of the Stern review (Stern, 2006) on global warming, concerns about the environment date back much further. In 1956 the UK Government introduced the clean air act in response to the great London smog of 1952, where a thick fog settled over the city for five days resulting in rising air pollution and around four thousand deaths more than usual; the act sought to control smoke pollution through use of smokeless fuels and greater use of electricity. Concern with the environment and the need for protective regulation is not just a recent phenomenon.

Today the environment agenda has expanded beyond air pollution to encompass sustainable development including climate change, energy production, management of waste, water supply, flood management, biodiversity, etc. Governmental policy seeks to modify the behaviour in all of these domains through:

- (a) regulation (such as EU Directives on waste, soil, etc.);
- (b) carbon pricing (EU emissions trading scheme);
- (c) raising public awareness;
- (d) the promotion of environmentally friendly technologies;
- (e) ensuring people have the skills to meet the demands established by regulation and the production of new technologies (BERR et al., 2007).

All of these have skill needs attached to them, including the supply of environmental scientists, policy-makers, engineers, and technicians. In addition, the environmental infrastructure (renewing the country's ageing water infrastructure to reduce underground leaks) creates demand for construction and civil engineering skills.

This paper explores what is known about emerging skill needs in the UK and offers insights into whether skill demand is being met; however, there is relatively little representative data on the skill needs resulting from the demands of environment change or the greening of the UK economy. Hence there remain unknowns relating to the type and volume of skills demand resulting from what are commonly referred to as green issues.

4.2. UK employment and skills

If environmental factors alter consumption patterns this may result in some displacement of employment. Where consumption is switched from one activity to another following environmental regulation or policy change, there is an expectation that employment patterns will alter accordingly. A central thrust of employment and skills policy since the early 1980s has been ensuring that people possess the skills which will allow them to switch between jobs and sectors in response to changes in labour-market demand. Recent changes to vocational education and training, outlined below, are directed at raising the demand for skills and also making the supply-side more responsive to demand. Given the pace of change in the environmental sector this may be an exacting test for vocational education and training without a degree of foresight about future change and the types of skill need this will give rise to.

Following the Leitch review (2006) vocational education and training is undergoing restructuring designed to raise skills performance by:

- (a) setting several qualification targets to be met by 2020 benchmarked against the top quartile of OECD countries;
- (b) engaging employers, via the sector skills councils, so that they have a greater say in the content and delivery of skills and employment programmes, in return for which they will be expected to take responsibility for developing their workforces through signing skills pledges ⁽¹⁰⁾;
- (c) the skills debate is also being broadened to look at the relationship between workforce development and innovation (DIUS, 2008), with reference to intermediate-level skills, and further developing links between universities and employers to benefit both (Lambert, 2003). There is also discussion about how to improve the supply of science, technology, engineering, and mathematics skills.

In summary, the proposed changes are designed to make education and learning more demand led. This is important for skills needed to meet the environment agenda over the medium-term given the speed with which this is developing, and the capacity of the supply side to keep pace with demand. In order to plan for the future, evidence needs to be obtained about trends over the recent past, but such evidence tends to be piecemeal.

4.3. Where is skill demand emerging?

A means of measuring skill demand is required but this is limited by neither the standard industrial classification nor the standard occupational classification defining environmental activities or environmental occupations ⁽¹¹⁾. Ideally, there is a need to know in which activities

⁽¹⁰⁾ The skills pledge is a voluntary commitment from an employer to support employees to develop their basic skills and work towards a full level 2 qualification if they do not already have one. It is one of several proposals made in the Leitch review of skills.

⁽¹¹⁾ The most recent sectoral classification contains information about environmental services but respective data are not yet available.

people work and the types of job they fill, but existing classifications do not allow this to be readily identified ⁽¹²⁾.

It is possible to outline where skill needs emerge:

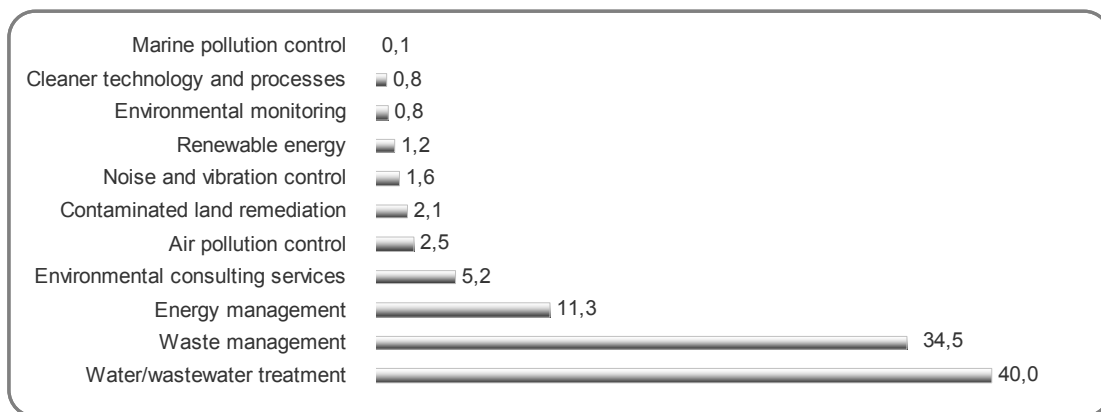
- (a) among primarily public sector agencies responsible for establishing environmental policy (central government, local government, etc.);
- (b) organisations where the principal economic activity is the provision of environmental goods and services (environmental consultancies);
- (c) organisations having a significant carbon footprint and, therefore, requiring employees with the skills to manage their environmental needs.

There is also a need to identify the level at which skill needs arise:

- (a) high-level, professional-level skills relating to graduates in science, technology, engineering, and mathematics, at national qualification framework (NQF) levels 4 and 5;
- (b) intermediate-level skills where people are typically qualified at a technician level, at NQF level 3;
- (c) lower level skills, NQF levels 1 and 2.

The most comprehensive information exists on organisations whose principal economic activity is in production of environmental goods and services, referred to here as environmental technology and services sector (ETS). In part, the attention devoted to this sector derives from its central role in meeting environmental demand – for example, by providing services to companies which have a significant carbon footprint to manage – and its potential to generate both output and employment growth.

Figure 4:1 **Value of output from the environmental sector by subsector (%)**



Source: Based on UK CEED data from 2006.

Estimates of the value of output produced by the environmental technology and service sector suggest that was around GBP 25 billion in 2004, up from GBP 16 billion in 2001), and provided around 400 000 jobs, up from 170 000 in 2001 (DTI, 2006). Projections based on previous growth suggest that the market is expected to grow to GBP 34 billion in 2010 and to GBP 46 billion by 2015 (Selwyn and Leverett, 2006). If the value of output is disaggregated

⁽¹²⁾ In addition, there is no single sector skills Council (SSC) – the bodies responsible for identifying skill needs in the UK – covering the environmental sector.

by subsector it is possible to infer where employment – and hence skill need – is concentrated (Figure 4:1). The evidence is that most activity is focused on waste management (which accounted for around 34 % of all output in 2004) and water/wastewater management (40 %). It follows that these are also the subsectors with the highest demand for labour and skills.

4.4. Environmental technology and service skill needs

Reports looking at different aspects of the ETS often make passing reference to skill shortages being widespread, but these findings are difficult to substantiate. The *National employers skills survey 2007* (LSC, 2007) indicates that employers in scope of the sector skills councils (SSCs) that cover part but not all the ETS, tend not to report relatively high levels of skill shortages.

The principal skill needs of organisations in the sector are at intermediate and higher levels relating to professional scientists, engineers (electrical, mechanical, nuclear, civil, instrument engineers) and technicians. Where shortages occur these tend to relate to generic skills required in the environmental consultancies, including:

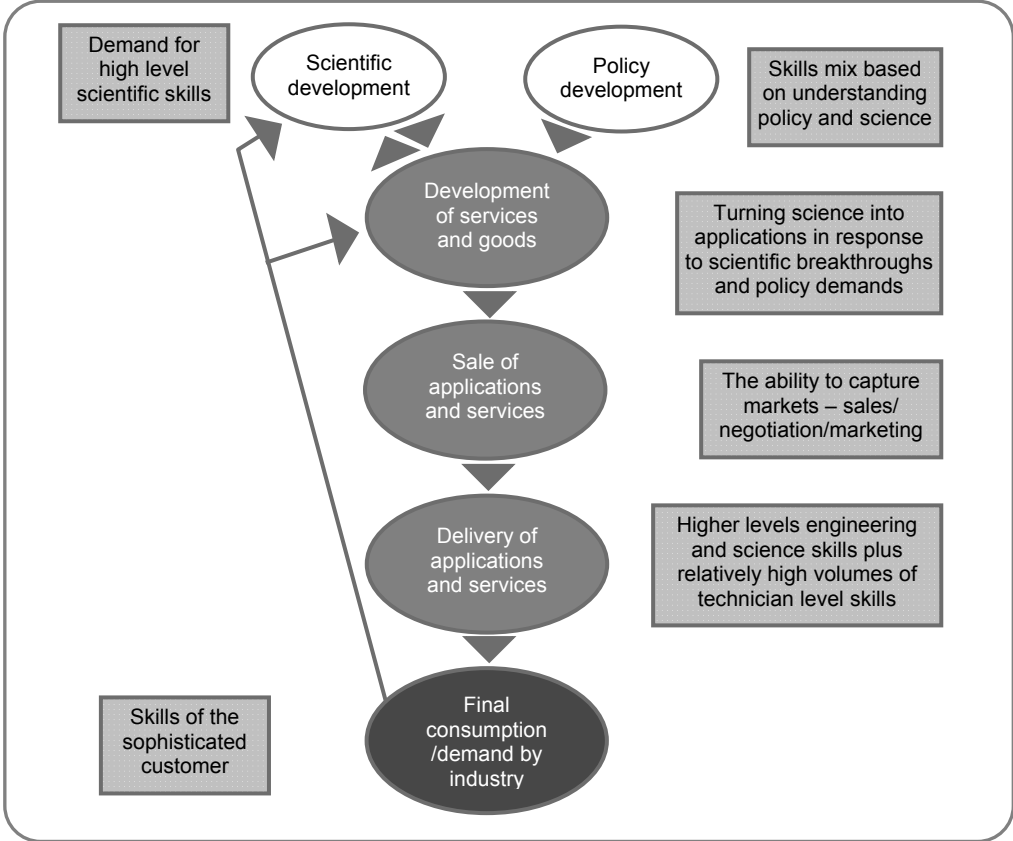
- (a) entrepreneurship;
- (b) marketing/sales;
- (c) networking skills;
- (d) consulting skills.

The extent to which these are transitional skill shortages, reflecting the rapid development of the sector, is not clear. On the whole, available data are ambivalent. Some evidence suggests that the supply of engineers and technicians is more or less keeping pace with demand, but other data looking at particular branches of the sector suggest that shortages are sometimes acute. For example, in the nuclear sector skill shortages have been reported for engineers and technicians and these are thought to be exacerbated by the decline in the number of apprenticeships (Cogent SSC, 2006)

Figure 4:2 provides a more rounded, though simple, view of skill needs in the ETS, outlining how the sector responds to scientific breakthroughs and policy developments, then devises applications and services that can be sold, and which are finally consumed by industry. The square boxes in Figure 4:2 outline the skill needs required at each stage. The starting point is the possibility of turning a scientific breakthrough or technique into an application of some kind, which tends to require a mix of skills encompassing both knowledge of the underlying environmental science and engineering solutions. The next stage is the capacity to sell the product based on individuals engaged in this activity having the necessary marketing and sales skills coupled to technical understanding of the good or service they are selling. Finally, there is the delivery of the good or service such that it meets the consumer's requirement, which tends to require high-level project management skills as well as technician-level skills in relatively substantial volumes. Finally, those purchasing the goods or services in industry require the skills of the intelligent consumer, capable of articulating their need, identifying whether the required need has been met, and obtaining value for money.

This is a simplistic outline of the sector’s skill needs and the backward and forward links it has with other sectors. The available evidence suggests that there are skill deficits which are common across the sector – such as entrepreneurship – but also skill needs that are specific to particular subsectors, especially at higher level/technician level interface.

Figure 4:2 Schematic outline of skill needs in environmental technology and services



The general picture is one of high uncertainty in both the current and future skill needs of the ETS, given foreseeable policy developments over the next 10 years. Relatively little is known about the skill needs of employers, and similarly little is known about the age profile of the workforce so that replacement demands might be estimated. To some extent the key issue is where the sector wants to position itself with respect to value-added and skills.

4.5. Strategic choice and skill demand

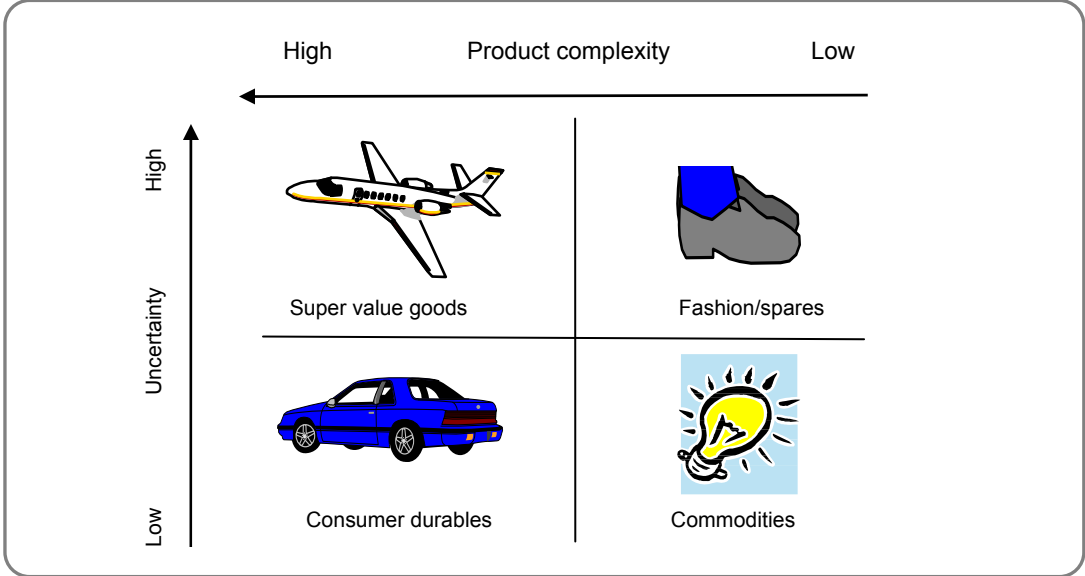
In many respects the challenge posed to companies is to capture the opportunities that emerge as the environment or sustainable development agenda gathers pace. Opportunities arise from the scope to capture new markets with new products/services, and threats emerge from the capacity of producers outside the UK (or the EU) to capture a larger share the national market. It also offers potential opportunities to look at shorter supply chains (which reduce energy consumption and waste handling) with more products and services originating from national or local producers.

Sidestepping the sustainable development issue is not an option for national producers because it is embodied in regional, national, and EU policy; the issue is whether sufficient businesses will adapt quickly and innovatively enough to offset competition from elsewhere. Environmental sustainability affects all sectors, but the impact depends on several supply chain factors including source of innovation and design, opportunity for innovation, product/market change going on, availability and source of sustainable materials, information, awareness, supply side employment and skill sets, and consumption and waste streams.

Strategic choice exists in relation to where employers want to position themselves in the market. There are various ways of classifying an organisation’s product market position. The Puttick Grid, first published in *Factory of the future* in 1995, provides one means of doing so based on the complexity embodied in a product or production process versus the degree of certainty attached to demand in the market (Figure 4:3) (cited in Bonser et al. 2006).

Factory of the future demonstrated that products/services were subject to a migration from the ‘super value-added’ quadrant (upper left quadrant in Figure 4:3) to the ‘commodity’ quadrant (lower right quadrant). In the context of the current discussion, the Puttick Grid provides a means of identifying the skills required either to sustain or shift product market position.

Figure 4:3 Puttick Grid sector classification



Source: Factory of the Future, 1995 (Warwick Manufacturing Group) (cited in Bonser et al., 2006).

The key issue is the balance of production in environmental technology and services between the various sectors of the grid in Figure 4:3. As activities become increasingly commoditised, employment levels can fall as technology is used to substitute for labour, and consequently the demand for skills falls away. As Figure 4:1 reveals, a considerable amount of activity is concentrated in waste management which, from a skills perspective, can result – in a worst case scenario – in too much activity being concerned with relatively low skill activities connected to the routine collection and disposal of non-hazardous waste. Pushing activities towards more high-value activities is dependent on a degree of organisational

vision supported by a workforce capable of supplying the skills that will allow the product market vision to be realised.

4.6. Conclusion: meeting the wider skill needs of the economy

The discussion so far has been on the needs of the ETS but this accounts for only part of overall demand as there is also a demand for people skilled in different aspects of environment related activities in the economy as a whole. These include organisations:

- (a) meeting their statutory environmental obligations (waste management);
- (b) improving their energy efficiency;
- (c) meeting their social obligations (reducing travel).

There are also State-wide initiatives resulting in large-scale civil engineering (renewal of the environmental infrastructure).

The extent to which the wider needs of the economy can be satisfied is partly dependent on the capacity of the ETS to meet market demand which, in turn, is dependent on it having the skills it requires. Many of the skill needs exist where, historically, the UK has been relatively weak with respect to the supply of skills (intermediate-level). Meeting future demand is very much dependent on identifying existing trends, and assessing how these are likely to change. Meeting that demand ultimately requires a skill mix that includes high-level scientific needs – much of which is currently situated in higher education – through to the production, application, and sale of environmental goods and services that requires a broad mix of high and intermediate-level skills. It should not be forgotten that there is also a strong demand for relatively low-skilled employment, such as routine collection and disposal of non-hazardous waste.

The major challenge is developing the more high-value added goods and services and the skills base it requires.

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PART III

Changing qualification
needs in jobs for
renewable energies

5. Future skill needs in renewable energies in Germany: the ADeBar project

Helmut Kuwan, Simone Martinetz, Miriam Gensicke

Abstract

This article presents selected results on future skill needs in renewable energies in Germany based on findings from the ADeBar project, carried out within the German research network on early recognition of skill needs (FreQueNz). It starts with information about FreQueNz and the concept of the ADeBar project and then moves on to three main issues:

- (a) the economic situation and the importance of political support to the renewable energy sector;
- (b) company strategies in recruiting skilled personnel;
- (c) present skill needs in the renewable energy sector and expected changes.

5.1. ADeBar project concept

The ADeBar project is embedded within the FreQueNz network, both financed by the German Ministry of Education and Technology (BMBF). FreQueNz aims to improve early recognition of skill needs in Germany. The network is based on the assumption that companies, employees and continuing education and training providers, plus the social partners and educational experts, are dependent on future-orientated information with regard to skill needs. It currently comprises 11 institutions, mainly research institutes and the social partners. The network coordinator is the Fraunhofer Institute for Industrial Engineering (IAO) in Stuttgart.

The focus of the network's research activities is employees with a middle level qualification, mainly apprenticeship in the dual system or comparable vocational school qualification. In contrast to some other countries, apprenticeship in the dual system is not directed at disadvantaged or handicapped youth. It still is the most frequent regular initial vocational qualification for young people, although this has been decreasing in recent years ⁽¹³⁾.

FreQueNz uses various information tools and activities to present research results according to the different target groups: a web-based electronic platform with information on research results and many other functions; a book series with 12 volumes to date; a newsletter with short articles from current projects, published every year in print and e-mail versions; and conferences, workshops and discussions ⁽¹⁴⁾.

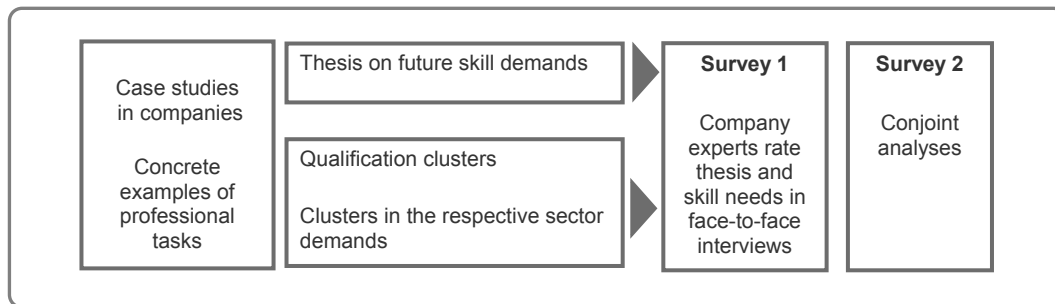
The ADeBar project combines quantitative and qualitative research, its main aim being to make available early information about changing skill needs in the workplace and in

⁽¹³⁾ In international comparison this educational level would be classified as ISCED 3 or 4.

⁽¹⁴⁾ For more information on FreQueNz see the website of the network: <http://www.frequenz.net/> [cited 5.5.2009].

enterprises. The basic idea is that new skill needs can be identified in the work processes of innovative companies before they diffuse to 'mainstream' companies.

Figure 5:1 **Concept of the ADeBar-project**



Source: Fraunhofer IAO, TNA Infratest, Helmut Kuwan, 2008.

Consequently, case study analyses carried out by Fraunhofer IAO are at the core of the research project. These studies analyse complete tasks within the working system and business processes by observation (workplace and business process-related operations). They consider the workplace of the skilled worker as a basis and analyse, in addition, proceeding and subsequent working sectors, and the perspectives of managing directors, line managers and company experts in education and training.

Hypotheses developed in the case studies are valid for the observed company. It is not clear, however, whether those trends are company-specific or more general. Therefore, the second step is to test new developments identified in innovative companies by a quantitative survey in 'normal companies'. TNS Infratest Sozialforschung and Helmut Kuwan (Social Research and Consultancy Munich) are responsible for the quantitative surveys.

The target for the quantitative survey is the most competent contact person in the company. In small and medium companies, this is usually the owner or the managing director; in larger companies it is mostly the head of the education function. The survey is based on face-to-face interviews and, if necessary, the target person may be changed during the interview. In the renewable energy sector 334 interviews were conducted ⁽¹⁵⁾.

The following results refer to case studies and the survey, with a main focus on quantitative survey data.

5.2. Political support in the renewable energy sector

The share of renewable energies in total energy production has grown continuously over the last 15 years. In 2006, about 240 000 employees were working in this sector, nearly double compared to 2004. Forecasts to 2020 expect a continuing growth in the share of the total energy production and employees working in this sector.

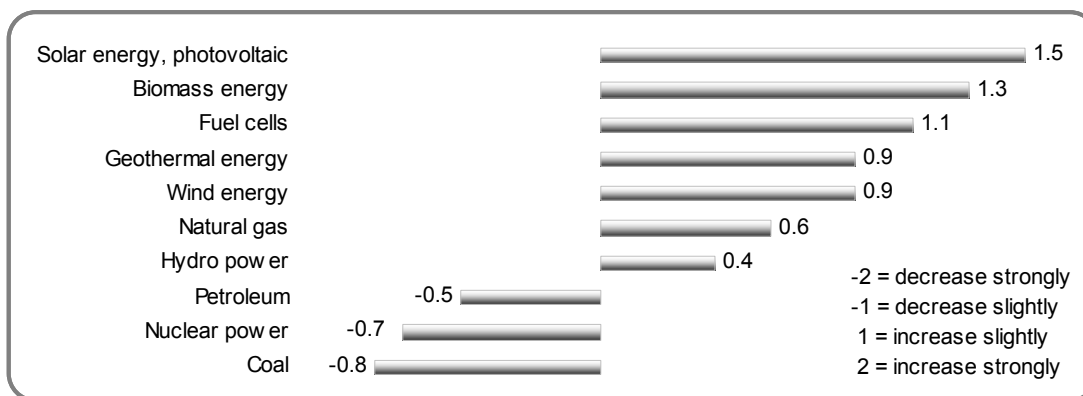
⁽¹⁵⁾ The interviews were conducted in the summer of 2004. For more information on the sample, etc., see www.frequenz.net, keyword 'ADeBar'.

Against this background, it is not surprising that companies in this sector judge their economic situation as positive. Most of the 46 % of the respondents consider the economic situation of their company to be good, 42 % medium, and 12 % think it bad.

Company experts also offer an optimistic view of potential market development ⁽¹⁶⁾ of energy sources. Figure 5:2 shows they expect an increase for all renewable energies within the next three years and a reduction for other energy sources. The experts expect the highest increase for 'solar energy, photovoltaic' and 'bio mass'. Expected growth for geothermal energy and wind energy is more moderate but higher than for natural gas and hydro power.

In contrast, the respondents expect a decreasing share for petroleum, nuclear power and coal. The biggest reduction is expected in the coal sector ⁽¹⁷⁾.

Figure 5:2 **Expected development of energy sources within the next three years (basis: answers from 334 company experts, deviation from scale average)**



Source: Fraunhofer IAO, TNS Infratest, Helmut Kuwan, 2008.

Expected growth rates also have to be viewed in the light of the present market share of energy sources. For example, fuel cells presently have a small base whereas wind energy already covers a remarkable market share. According to the case study results, expected further expansion of the wind energy segment mainly results from three developments: increasing offshore use, extension of export business and new technical development (using wind engines with higher power output).

5.2.1. Political regulatory framework

The case studies of Fraunhofer IAO indicate that the political regulatory framework plays an important role in the success of renewable energies. Therefore, the quantitative survey tried to obtain more information on the strength of this factor. The company experts were asked to name the crucial factor for market success of renewable energies until 2010, prioritising

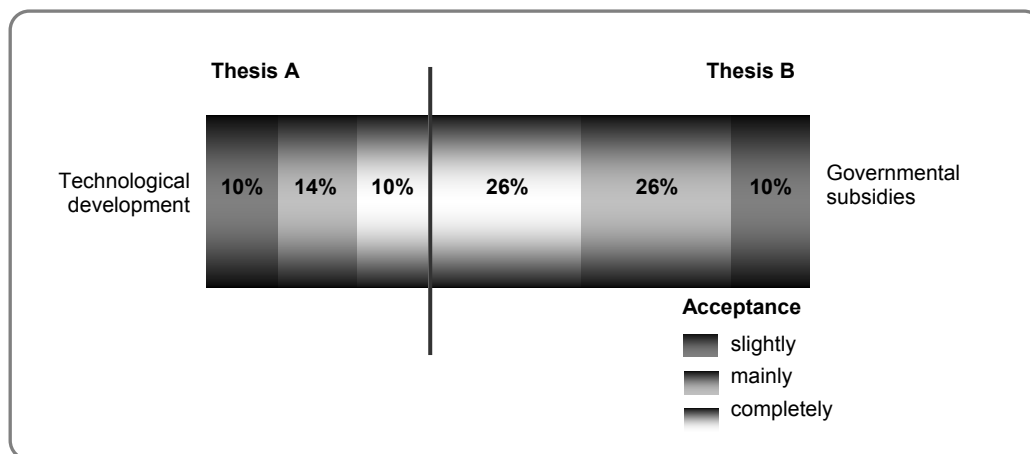
⁽¹⁶⁾ The term 'market development' here refers to a general estimation with regard to production of energy, technical products and services in the respective field.

⁽¹⁷⁾ The development of new technologies in the coal segment could change this picture.

technical development or government subsidies. Although this approach reduces complex relations to a dichotomous question ⁽¹⁸⁾ it provides important information to validate the stability of the positive situation that was shown for the renewable energy sector in the section above.

Of the 90 % of company experts answering this question (Figure 5:3), two-thirds state that the crucial factor influencing the market success of renewable energies until 2010 is governmental subsidies. This puts the optimistic situation described above into perspective. Serious changes of government policy – for example a suspension of the renewable energy law and/or a massive shift to nuclear power – might direct renewable energies off their road to success.

Figure 5:3 **Crucial factors influencing market success of renewable energies until 2010 (basis: companies with valid answers in %)**



Source: Fraunhofer IAO, TNS Infratest, Helmut Kuwan, 2008.

5.3. Recruiting skilled personnel for renewable energy

It is important for education policy to know how companies meet their skill needs in a growing sector. There are three main strategic options for companies: initial education, continuing education and training, and external recruitment.

Every second company in the sample considers continuing education and training to be currently the most important strategic option in meeting their skill needs in renewable energy. Roughly every fourth company chooses initial education and about every fifth chooses external recruitment ⁽¹⁹⁾.

Looking at the next three years, 58 % of the company experts with valid answers anticipate increasing importance of continuing education and training in meeting their skill

⁽¹⁸⁾ For example, neither marketing nor distribution are considered separately, nor are interactions between technical development and government subsidies.

⁽¹⁹⁾ Residual to 100 %: missing values.

needs ⁽²⁰⁾. About one third select initial education in their company and a quarter select external recruitment. However, the majority expects the importance of these two recruitment strategies to remain nearly the same in the next three years.

New skills in the growing renewable energy sector in Germany have mostly been met through continuing education and training or by adding new contents to existing professions. Although some companies reported skill shortages, most skill needs seem to have been met by a good skill base from the professional initial education system combined with the flexibility of the continuing education and training segment.

Figure 5:4 **Case study results on future skill needs for wind energy technician**

<p>Technical skills</p> <p>Actual technical availability, new technological skills, application of ICT, specific (equipment-) software skills (e.g. Visopro), wind energy onshore and offshore</p>	<p>Professional skills</p> <p>Fault management and prophylaxis, complementary skills (mechanics/electronics), electronic documentation, situational details, interpretation of Internet production logs</p>
<p>Organisational skills</p> <p>Maintaining safety standards, comprehending overall processes, changing points of use, network human-electronics</p>	<p>Social skills</p> <p>High integration and cooperation skills, ability for teamwork, high mobility, intercultural skills, temporary leadership skills</p>

Source: Fraunhofer IAO, TNS Infratest, Helmut Kuwan, 2008.

5.4. Present skill needs and expected changes

A catalogue of skill needs can be deduced from the case study results of Fraunhofer IAO in innovative companies. Figure 5:5 shows a case study example for wind energy technicians.

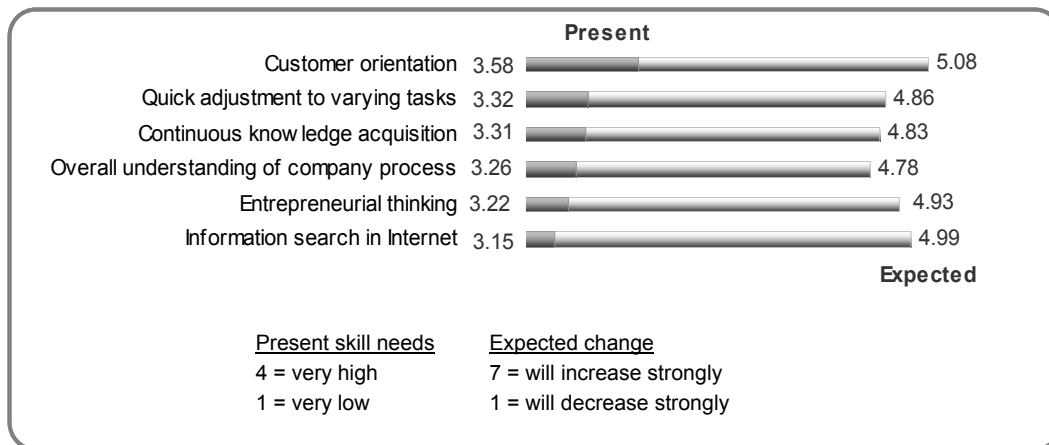
The case studies are translated into a quantitative company survey. The following results are a selection of company ratings for 35 general and specific skill needs in the renewable energy sector.

Important generic skills are presented in Figure 5:5: customer orientation; quick adjustment to varying tasks and continuous knowledge acquisition; overall understanding of company processes and entrepreneurial thinking; and information search using the Internet. These skill needs all are rated at an average scale value between 3 (rather high) and 4 (very high) ⁽²¹⁾.

⁽²⁰⁾ 40 % of the companies with valid answers expect that importance of continuing education and training will remain the same and only 2 % anticipate a reduction.

⁽²¹⁾ Present skill needs are classified in a scale from 1 to 4 whereas expected changes are rated in a scale from 1 to 7 (Figure 5:5).

Figure 5.5 **Expected changes in generic skill needs in renewable energy for skilled workers. Present average and expected changes in the next three years – Part A.**



Source: Fraunhofer IAO, TNS Infratest, Helmut Kuwan, 2008.

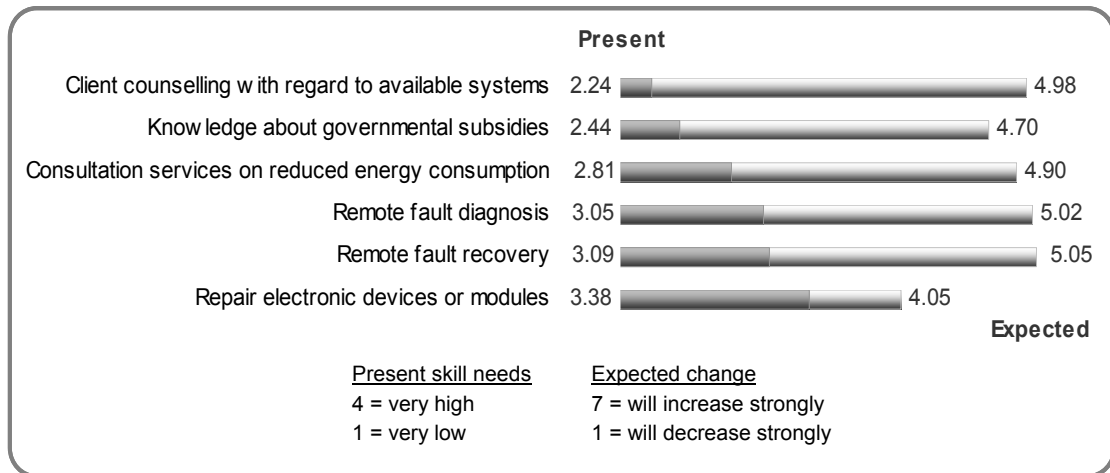
For the next three years, company experts expect the strongest increase in customer orientation, followed by information search using the internet. Other identified skill needs, understanding of company processes, entrepreneurial thinking and quick adjustment to varying tasks, also are expected to grow within the next three years.

Looking at specific skill needs across the renewable energy sector, the following aspects were identified as important at the time of the survey: client counselling with regard to available systems, knowledge of government subsidies, and consultation services on reduced energy consumption. Remote fault diagnosis and remote fault recovery presently are rated at a medium level and repairing electronic devices or modules at rather low level.

For the next three years, respondents anticipate the biggest increase in remote fault diagnosis and remote fault recovery, both rated presently only at medium level. The need for client counselling on available systems and consultation and services on reduced energy consumption, already rated high, are expected to grow further, and so is knowledge about government subsidies, although a more moderate increase is expected here.

Company experts do not expect an increasing need in repair of electronic devices or modules. In general, they expect stagnating or even declining skill needs for aspects connected with physical power or more traditional manual skills such as brazing and soldering or welding.

Figure 5:6 **Expected changes in specific skill needs in the renewable energy sector for skilled workers (presented average values and expected changes in the next three years – Part B)**



Source: Fraunhofer IAO, TNS Infratest, Helmut Kuwan, 2008.

5.5. Conclusions and outlook

The results presented here are a selection from the complete ADeBar report which is available only in German. For the renewable energy sector, three aspects seem to be particularly important:

- (a) the expected strong increase in remote fault diagnosis and remote fault recovery, both rated presently only at medium level;
- (b) the stagnation or even reduction of 'traditional' manual skills;
- (c) the combination of technological skills with aspects of client counselling and advice on available systems, reduced energy consumption or government subsidies.

The need for understanding of technical processes and products for professionals in sales and distribution seems to be widely accepted. The reciprocal idea for technicians needing knowledge in customer counselling and consultation, identified by the ADeBar approach, still seems to be less familiar.

6. Curriculum development in Slovakia for biomass energy production

Ladislav Nozdrovicky

Abstract

A substantial increase in the local and national use of biomass for energy purposes requires new knowledge and skills reflecting the complexity of the whole biomass-based energy system. The knowledge and skills needed to establish biomass production cropping can be considered basic but special knowledge and skills are necessary for cost-effective biomass transport, logistics and processing. Biomass-based power plants will create jobs for managers who will manage, control and evaluate green energy systems; these should be supported by value analysis allowing comparison of input costs and green energy outputs. A curriculum based on key study subjects reflecting the needs of green jobs was developed within the bioenergy bachelor study programme at the faculty of engineering of the Slovak University of Agriculture in Nitra.

6.1. Introduction

Global climate changes, reductions in fossil energy sources and urgent calls to reduce dangerous emissions all feed the need to look for new energy sources. Biomass used for energy purposes has become a significant phenomenon in this context (Edwards et al, 2008).

As an EU Member State, the Slovak Republic follows agreed regulations, decisions and parliamentary orders on use of renewable energy sources and aid for growing of crops intended for non-food purposes. Documents such as the Directive on the promotion of the use of biofuels and the draft report of the European Parliament on the promotion of crops for non-food purposes ⁽²²⁾ include relevant facts which prove the importance and advantages of the use of renewable energy sources.

Slovakia has considerable potential for using renewable sources such as biomass, geothermal, hydro and solar energy: biomass has the best potential for technical use. The Slovak government has approved the use of agricultural and forest biomass for energy purposes, but realisation raises many questions and problems.

The faculty of engineering of the Slovak University of Agriculture in Nitra has introduced the subject of biomass use for energy into study content to create the separate programme bioenergy at bachelor level, reflecting society needs and EU measures. The faculty was formerly known as the faculty of agricultural engineering, was established in 1969, and has produced more than 6 000 graduates up to the academic year 2007/08.

⁽²²⁾ European Parliament and Council of EU (2003); European Parliament (2006).

6.2. Curriculum development platform

The European Commission biomass action plan (European Commission, 2005) was used, as a platform for the basic content of a new curriculum. The Commission encouraged Member States to take up biomass opportunities to develop and diversify the rural economy through their national rural development programmes. National biomass action plans can reduce investor uncertainty by:

- (a) assessing the physical and economic availability of biomass of different kinds, including wood, wood residues, wastes and agricultural crops;
- (b) identifying the types of biomass to be used and how to develop biomass resources, plus indicating national measures to promote this.

To develop the use of biomass for the energy purposes, the government approved, on 27 February 2008, the national biomass action plan for 2008 to 2013 (Ministry of Agriculture, 2008). The action plan resulted from government decree No 383/2007 on strategy for the higher exploitation of renewable resources in the Slovak Republic and the biomass action plan approved by the European Commission. The national biomass action plan has three priorities: competitiveness, sustainability and security of supply.

Climate change, energy security and rural development are the three main drivers for the regional, national and global development of bioenergy and the biofuels industry.

This action plan sets out measures to develop further biomass energy from agricultural crops, wood, wastes; creating market-based incentives to its use and removing barriers for developing the market are also included. In this way Europe can cut its dependence on fossil fuels, cut greenhouse gas emissions and stimulate economic activity in rural areas. This action plan is a first coordinating step. It sets out measures to promote biomass in heating, electricity and transport, followed by cross-cutting measures affecting biomass supply, financing, research and human resources development. It is accompanied by a general impact assessment. As a second step, individual measures will be brought forward subject to specific impact assessment in line with Commission rules.

It is not easy to express numerically the significance of biomass. Using it for energy allows reduction in CO₂ emissions due to the lower consumption of natural gas and coal. There are also cost savings related to the storage and liquidising of waste, as a part of municipal waste dumps. The total financial savings should reach substantial amounts, but it is not possible to determine exactly the effects of increasing life environment quality, new jobs creation, higher competitiveness, lower energy prices, lower farm production costs, food processing and storage.

Biomass has high energy potential, potentially as much as 15 % of annual energy consumption. The use of this potential may help to increase energy from renewable resources generated in Slovakia. Part of the agricultural biomass may be used in agriculture: heat generation for heating, hot water preparation, drying and production of biogas, with subsequent generation of electricity and heat. It may also be sold in the market in the form of fuel (briquettes, pellets, chips) or energy (electricity, heat, cold).

Branch transport will be the most likely consumer of biofuels. Biomass will also be used for production of electricity, for residential and industrial heating or cooling. District heating faces problems in that biomass schemes require modern plant, new infrastructure and

modern managerial approaches to improve their fuel use and efficiency. All these problems can be solved only by specialists having adequate knowledge, skills and experience. The biomass should burn only in special boilers with adequate combustion control and pollution prevention: non-correct biomass incineration can be a strong source of pollution.

It is also important to consider that the development of biofuels is in progress. The first generation of biofuels comes from energy field crops; the second will be made mostly from wood and wastes.

The potential of forest dendromass sources may increase after 2010, due to energy crop output based on fast-growing trees (willow, poplar, acacia, elder) planted on an area of 45 400 ha, with production of about 440 000 tons in a short production cycle. Some agricultural businesses are now experimenting with the use of agricultural biomass.

A start point was to analyse the experience of the farms using biomass:

- (a) the Prašice agricultural cooperative farm uses straw to heat the buildings;
- (b) Liptovský Ondrej agricultural cooperative farm heats the workshops with wooden chips from the forest trees;
- (c) the university farm Kolinany at Nitra uses slurry and maize silage for biogas production and powering of a cogeneration unit (22 kW);
- (d) Agros, limited liability company Bátka, process manure and poultry droppings and produces biogas for heating;
- (e) the Brezov agriculture cooperative farm produces biogas for heating;
- (f) Kapusany near Presov produces biogas out of manure for heating.

6.3. Biomass international project

The Department of Machines and Production Systems introduced biomass production as a study programme as one of the results of the project within the neighbourhood programme Hungary-Slovakia-Ukraine Interreg Huskua III. A (No 14420100021). Programme Interreg III can be considered as a new phase of the Interreg initiative, designed to strengthen economic and social cohesion throughout the EU, by fostering the balanced development of the continent through cross-border, transnational and interregional cooperation.

The project title was 'Cooperative model of the complex utilisation of biomass for energy purposes' in one Hungarian region and three Slovakian districts. The Office of Research and Development (Károly Róbert Főiskola) in Gyöngyös, Hungary, was our partner.

We focused our attention on biomass because by using domestic sources of renewable energy we increase security and diversification of energy supplies. We also reduce the dependence of the national economy on the unstable price of oil and natural gas.

The main aims of the project were (Maga et al., 2008):

- (a) to specify the opportunities for mutual Slovak-Hungarian cooperation in biomass use;
- (b) to exchange information and data;
- (c) to establish the model of the cluster covering six districts on both sides of the Slovak-Hungarian border;
- (d) by synergy effects, to achieve more intensive cooperation of both partners working in biomass research for energy purposes.

During the cooperation with our Hungarian partner the following topics were studied:

- (a) economic and legislative aspects of biomass use for energy: analysis of EU legislation, subsidies policy, legislative constraints and restrictions (biodiesel, bioethanol, biogas);
- (b) investigation of the use of biomass for energy and sustainable development: energy crops, wood and wood chips as a biomass, wastes from wood processing, wastes from agricultural production, materials for biodiesel, bioethanol, biogas;
- (c) green energy cluster: specification of the cluster structure, participants, technical and organisational prerequisites, and human resources;
- (d) effect of biomass use on life quality: green energy social programme, protection of environment, environmental effects (soil, water, air);
- (e) micro and macroeconomic evaluation of biomass use for energy: preparation of economic models, economic calculations, analysis of the results;
- (f) horizontal and vertical model of biomass use for energy: machines for biomass cropping systems, technologies for biomass incineration (phytomass, dendromass), biomass logistics and transport, green energy marketing.

Among the topics studied, priority attention was given to the bioenergy cluster. Biomass used for energy has the potential to create benefits from externalities, such as:

- (a) attraction and development of related industrial branches providing specialised inputs (manufacturing of pelletizers, boilers, etc.);
- (b) development of human resources having new skills and knowledge;
- (c) broadening and extension of ideas, knowledge and technical development among the companies within the sector;
- (d) opportunities to stimulate a long-term and self-sufficient development to create a good business environment, through development of externalities (biomass production, specialised companies, skills, knowledge, suppliers) depends on adequate knowledge and skills among people in the industry.

According to Maga et al. (2008), in the renewable energy market there are barriers such as lack of understanding and information combined with few key participants with limited resources for marketing and dissemination of information.

For a substantial increase in local and national use of biomass, new knowledge and skills are required, reflecting the complexity of the whole biomass-based energy system. The knowledge and skills important to establishing biomass production cropping can be considered as basic; special knowledge and skills are necessary for cost-effective biomass transport, logistics and processing. Biomass-based power plants will create jobs for managers who will manage, control and evaluate green energy systems; these should be supported by the value analysis allowing comparison of input costs and green energy outputs.

A curriculum based on key study subjects reflecting the needs of the green jobs was developed within the bioenergy bachelor study programme at the faculty of engineering of the Slovak University of Agriculture in Nitra.

The content of the bioenergy study programme should consider the real potential of the Slovak Republic to produce biomass for energy and should be conservative as estimates are based on the following assumptions:

- (a) no effect on domestic food production for domestic use;
- (b) no increase in pressure on farmland and forest biodiversity;
- (c) no increase in environmental pressure on soil and water resources;
- (d) no ploughing of previously unploughed permanent grassland;
- (e) a shift towards more environmentally friendly farming, with some areas set aside as ecological stepping stones;
- (f) the rate of biomass extraction from forests adapted to local soil nutrient balance and erosion risks.

We accepted the idea from the international project that the graduates of the bioenergy study programme are prepared as managers in the bioenergy industry and should know the prerequisites for the successful function of the bioenergy cluster:

- (a) the cluster should be managed by business and public leaders;
- (b) partners should understand the importance of cooperation and competition;
- (c) strong contacts should be created among companies and institutions, based around biomass production and utilisation;
- (d) the bioenergy cluster should be based on value chain with defined network of suppliers and contractors;
- (e) links between the bioenergy industry and the academic sphere, and links with suppliers, can be considered as most important ones.

In the first stage of curriculum development we defined the most important factors of the bioenergy industry:

- (a) legislative and economic conditions;
- (b) biomass yield;
- (c) biomass transport;
- (d) technologies for biomass processing;
- (e) transport distances;
- (f) capacity of equipment for the biomass processing (pelletizers, etc.);
- (g) installed energy plants power, etc.

6.4. Bioenergy programme

Key subjects for the bachelor study programme are courses such as:

- (a) machinery and technologies for biomass production and utilisation;
renewable energy sources and biomass; energy and environmental problems; potential for energy produced from biomass; thermal balance of the earth and energy balance of biological systems; global warming, greenhouse effect; Kyoto protocol; 'three-e' system: energy, economy, environment; ecological technologies for agriculture; technologies for saving non-renewable energy sources, reducing energy requirements in agricultural production and securing the ecological stability of the countryside;
- (b) study subject: energy crops;
different energy crops; appropriate energy crop production and their yield potential (annual and perennial) energy value of the crops, harvest and post harvest processing; cropping of fast-growing woody plants; type of suitable fast-growing woody plants for,

- energy plantations; site selection, establishment of woody plant plantations, planting patterns, plantation cultivation, harvest;
- (c) machinery for establishing and cultivating biomass plantations; machines for tillage, seeding and planting; machines and equipment for seedling preparation in greenhouses and forest tree nurseries; machinery for crop protection and crop-stand cultivation;
 - (d) evaluation of biomass energy potential; opportunities for biomass use for energy; biomass boilers; bioenergy technologies permitting the highest energy efficiency with regard to ecological requirements; environmental issues of biomass use for energy; general classification of biomass energy technologies: direct combustion systems, gasification systems, biogas systems, alcohol production;
 - (e) theoretical basics of technologies for biomass processing; physical, chemical, dry and wet processes of biomass transformation; waste heat as a by-product during biomass processing; biomass incineration; properties of biomass as a fuel, its energy value; conditions for efficient biomass combustion and effects on the environment; biomass gasification; gasification process and its phases; liquid biofuels; technologies for alcohol-type biofuels and their use in internal-combustion engines;
 - (f) equipment and machinery for the bioenergy industry; renewable energy sources and biomass; biomass energy potential ecologically sustainable technologies for agriculture; production of liquid biofuels: ethanol, methanol, biodiesel, mixed fuels; production of gas fuels made of biomass, wood gas, dump gas; use of energy crops for energy production; biomass heating; electricity from biomass; methods of introducing equipment for use of renewable energy resources;
 - (g) biomass harvest and processing; machines and technologies for harvesting of forages, grain, tubers and beets for energy purposes; basics of dendromass harvest; theory and design of mechanisms for postharvest biomass processing (phytomass and dendromass): machines and technologies for grinding, shredding, chopping, cutting, pressing of biomass, with regard to the final process (biogas production, incineration, etc.);
 - (h) equipment and technologies for biofuels production; production of biodiesel and its energy balance; comparison of different fuels; biogas from phytomass and zoomass; aerobic and anaerobic decomposition: principles of biogas generation; waste dump gas and its harvesting; cogeneration and fuel cells; biogas powered fuel cells as a technical solution; combined production of heat and electricity; operation of cogeneration units; fuel cell technology;
 - (i) biomass waste processing; processing of residual biomass by composting; composting of biowastes; machinery and materials for composting; frequent mistakes in composting;
 - (j) trade in machinery; quantitative analysis of the machinery used in agriculture and bioenergy; technical requirements and appraisal of quality; machinery prices and price policy; manufacturing, import and sale of machines in Slovakia; commercial contractual relations, export and

- import operations; communication policy in machinery trade; operational parameters of machines in relation to duration of use, product life cycle, optimal time of use;
- (k) modelling and simulation of production processes;
 - using computer-based methods for solving tasks related to the agricultural machine exploitation; legislation framework for utilisation of renewable energy sources; energy self-sufficiency by operational unit, company, region, etc.; logistics of material related flows; biomass industry machinery: selection, investment and management;
 - (l) basics of bioenergy cluster building;
 - process of the cluster development; activation of initial interest to participate (initial research to know the situation and studying of partial problems, selection of the problems to be solved for growth); participation in the cluster growth (selection of action initiatives to solve the problems); strategy development (new selection based on experience and new information);
 - (m) project on bioenergy;
 - calculation of biomass needs by operational unit (workshop, machine line, division, company, region);
 - (n) biomass industry legislation;
 - basics of State ecological and energy policy; legislation for biomass production and use for energy purposes; State energy policy; perspectives of biomass production and use for the energy purposes in the EU; EU financial support for biomass energy.

6.5. Specialisation post graduation

Experts in biomass use for energy should be specialised according to the classification of the agricultural biomass, divided into groups according to its energy use:

- (a) experts in biomass incineration (biomass heating, warming of the utility water, product drying, generation of electricity from different types of biomass), use of phytomass (straw), dendromass (solid wooden chops, wood for heating purposes, use of wastes after wood processing), energy crops (Chinese silver grass, sorghum, miscanthus, poplar, willow, acacia, Poaceae (true grasses), etc.);
- (b) experts in biofuels production in the form of methylesters of the plant oils as a component of diesel (rape, grains) or in the form of bioalcohol as a component of gasoline (maize, grain crops, sugar beet, potato, etc.);
- (c) experts in new technologies allowing decomposition of dendromass to obtain bioethanol or decomposition of cellulose and lignin to obtain biobutanol;
- (d) experts in biogas production with subsequent combined production of heat and electricity by cogeneration (using slurry, green crops, silage, dendromass).

6.6. General graduate profile characteristics

Graduates from the bioenergy study programme (bachelor level) are able to exploit the technical equipment and machinery used in different production and environmental systems.

They can analyse problems and opportunities arising in different areas of crop and animal production as regards environment protection. As they have passed subjects such as ecology, environmental protection, machinery for biomass production, equipment and machinery for bioenergy, equipment and technologies for biofuels production, technologies for biomass processing, and bioenergy they are able to operate and manage machines related to biomass use for energy purposes. They can find jobs in the use of forest machinery for cropping, harvest and primary processing of wood as biomass.

Graduates are able to design both parts of the technical systems and whole systems to match economy, effectiveness, safety and environmental requirements. They have sufficient knowledge and skills to create such systems and to introduce them in suitable climatic, natural and production conditions. They can cooperate with production engineers, machinery systems users and experts from other professions. In their work they can use basic knowledge of business, management and economy.

Graduates have knowledge of microelectronics, system theory and their application in solving technology problems. If they also passed the study programme on basic economics, production management and planning, trade law and commercial activities, they can work as technical managers or could run their own business.

Looking for the jobs in different branches of agriculture, forestry, industry, public sector and private sector is a typical characteristic of graduates from the bioenergy study programme.

These graduates are able to manage, operate and maintain the operational capacity, performance and reliability of the agricultural and forestry machinery. Language competences allow them to communicate with foreign partners.

6.7. Conclusion

Present development of biomass use for energy purposes confirms that it is a complex matter which should be supported by intensive research and advisory services. The success of bioenergy will depend on human resources and staff qualifications, experience, skills and readiness to solve problems.

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7. Future skill needs in renewable energies in Spain: a vision of enterprises

Javier Gomez

Abstract

Globalisation, new markets and emerging sectors such as renewable energies invite us to think about current and future skill needs. This paper presents the main findings of the study carried out by Union Institute of Work, Environment (ISTAS) which aimed to estimate the number of direct jobs required by each subsector or technological branch of renewable energy (wind, photovoltaic, thermal with high temperatures, thermal with low temperatures, biomass and biofuels) for its adequate development in the short (2010) and long (2020) term.

7.1. Introduction

Policies have been put in place in Spain to comply with international agreements on reducing greenhouse gases. One such policy is the use of renewable energies which has experienced massive development. This strategy is not only a mechanism to mitigate the effects of climate change and protect the environment but also a positive social contribution in terms of employment.

The Union Institute of Work, Environment and Health (ISTAS) is a self-managed trade union technical foundation supported by the Spanish Trade Union Confederation (CCOO) to promote improvement in working conditions, occupational health and safety and environmental protection in Spain. ISTAS has produced research on renewable energies and employment generation in Spain, present and future. It considers that the constant development of renewable energies is not only a mechanism to mitigate the effects of climate change and to protect the environment, but also a positive social contribution in terms of employment.

7.2. Renewable energies and employment generation

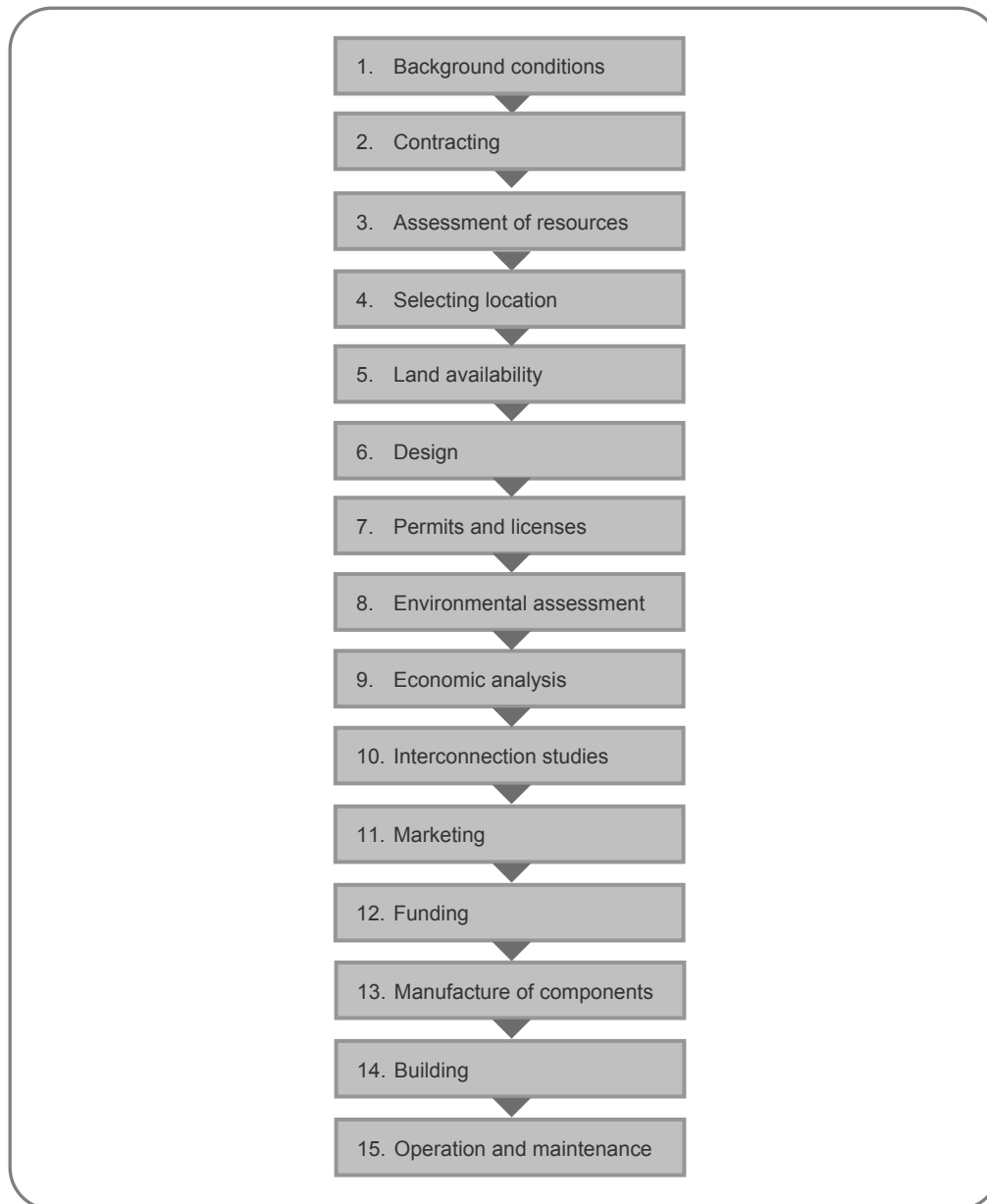
The purpose of the ISTAS was to estimate the number of direct jobs required by each subsector or technological branch of renewable energy (wind, photovoltaic, thermal with high temperatures, thermal with low temperatures, biomass and biofuels) for its adequate development in the short (2010) and long (2020) term.

Also, ISTAS try to assess profession categories by type of technology, by professional level (specialists, engineers, architects, non-qualified workers) and, when possible, by type of activity (operation, installation and maintenance).

7.3. Renewable energies: stages of development

Production of renewable energies involves numerous phases, many employees with different professional profiles, public and private institutions and domestic and imported technologies. There are, however, many common phases in the development of the different classifications of energies, as shown in Figure 7:1. Since this is a generic chart, the sequence of phases may be altered or, in some cases, some specific phases might be omitted.

Figure 7:1 **Production process of renewable energies**



Also, a specific description for each component manufacture technology – which differs for each type of energy – and a classification of economic activities in the production process have also been developed. This classification is based on the categories of the national catalogue of economic activities (CNAE) by the National Statistics Agency (INE).

The legislative aspect has played a significant role and regulation has been reformed along with the evolution of these energies. A good example of this is Act 661 of 2007 (MYTIC, 2007; which replaced Act 436 of 2004), which aims at establishing a legal and economic framework for special electric energy production systems. It also sets up a general methodology for administrative processes and authorisations.

7.4. Employment generation

The study considers direct jobs as jobs necessary to develop each of the facilities involved in producing renewable energy, starting with the manufacture of components, including design, engineering, administrative tasks and installation, operation and maintenance.

The production process has been divided into two main categories:

- (a) operation and maintenance: jobs required to carry out operation and management of the plant. These jobs would be permanent throughout the lifespan of the energy plant;
- (b) building and installation: this category includes the jobs required to start up new energy plants. Employment will remain stable as long as renewable energy facilities are being set up.

Most of the jobs in this sector concentrate on the categories of building of new facilities, installation and maintenance followed by equipment manufacture; but subcontracting makes it difficult to calculate the number of newly created jobs. Subcontracted work requires lower qualifications and is usually directed by the criteria of those sectors where they were initially registered.

The sector is now becoming more stable in terms of building and installation jobs. Operation and maintenance jobs (requiring specific qualification) are acquiring more significance and expected technical development will presumably concentrate on:

- (a) development of offshore wind farm projects;
- (b) commercial implementation of solar thermoelectric energy.

Table 7:1 **Distribution of employment by subsectors of renewable energy**

Subsector of renewable energies	Number of workers	Renewable energies (% in total employment)
Wind	32 906	36.97
Small hydropower	6 661	7.58
Solar thermal	8 174	9.28
Solar thermoelectric	968	1.08
Solar photovoltaic	26 449	29.90
Biomass	4 948	5.65
Biofuels	2 419	2.17
Biogas	2 982	3.45
Others ^(a)	3 494	3.92
Total renewable energies	89 001	100.00

^(a) Hydrogen, geothermal.

Source: ISTAQ.

There are no great differences among different subsectors but there is general lack of sufficient technical experience. Nevertheless, higher technologies offer better defined occupations and experienced workers.

Research estimates the number of workers in the sector at 89 001 in 2007, including administrative departments, sales, projects and operation/production tasks. Of those, 67 000 are construction, operation and maintenance jobs and around 22 000 are administrative, sales and project/engineering jobs.

7.5. Jobs and qualifications

University and vocational courses cover training needs for the different technologies, hence it is more advisable to orient senior engineering and vocational training students than to repackage existing syllabuses. So, intensive training of advanced students at university, including a practical approach in final stages of the courses, is preferred as a reformulation of the career programme.

Despite the heterogeneous nature of the sector, there are two major common qualification requirements. In electricity generation, there is a demand for specialists in medium and low voltage. Also, international aspects have created demand for workers with language skills, especially English.

Globalisation creates the need to adapt to any training requirements of the international market and continuous training is useful as it is more adaptable to the realities of a rapidly growing sector. Employee willingness to travel across the scattered geographical layout of the facilities is considered an essential requirement but there are two particular characteristics: expatriates, as workers hired in Spain and sent to carry out tasks abroad, which implies long periods of residence in foreign countries; and international workers, who are those working abroad but still reside in the country.

Companies generally try to secure highly qualified workers through permanent contracts and subcontract the rest of the tasks. At same time, they complain about lack of necessary experience of workers given the premature stage of development of the sector.

7.6. Professional profiles

A professional classification based on education/training can be structured as follows:

- (a) university graduates: mainly industrial, mechanical and electrical engineers. As there is good theoretical basis but lack of experience, enterprises provide specific training. Industrial engineers are in demand, mainly through promotion or for management positions in plant construction, installation and manufacturing. Other graduates are also required to establish interdisciplinary work teams;
- (b) technical and technician graduates: there is a wide spectrum of training. Mainly, they have electrical or mechanical backgrounds. Though other languages are less in demand, it is important to train in them;

- (c) power plant operator: requires more training to develop the skill for optimising the power plant operation;
- (d) sales technician: this requires a salesmanship, combined with specific knowledge of renewable industries. This job requires availability to travel frequently to client premises.

The proportion of university graduates is high in this sector. The structure of professional qualifications is illustrated in Table 7:2, by company size and number of workers.

The distribution of personnel by main departments is illustrated in Table 7:3, by company size and number of workers.

Factors other than training are considered when recruiting staff, varying in their importance. Table 7:4 offers a list of these factors by job.

Table 7:2 **Distribution of personnel by qualification (%)**

Qualification	Company size by number of workers					Total
	< 10	11-50	51-250	251-1 000	>1 000	
University graduates	38.0	19.7	24.9	33.4	26.9	32.3
Technical graduates	21.2	17.1	15.4	17.0	11.4	18.4
Management	9.4	8.3	7.7	7.9	4.4	8.6
Supervisors	21.7	30.7	38.2	31.7	18.0	28.0
Workers	9.7	14.3	13.8	10.0	39.3	12.7

Source: ISTAS.

Figure 7:2 **Distribution of personnel by qualification**

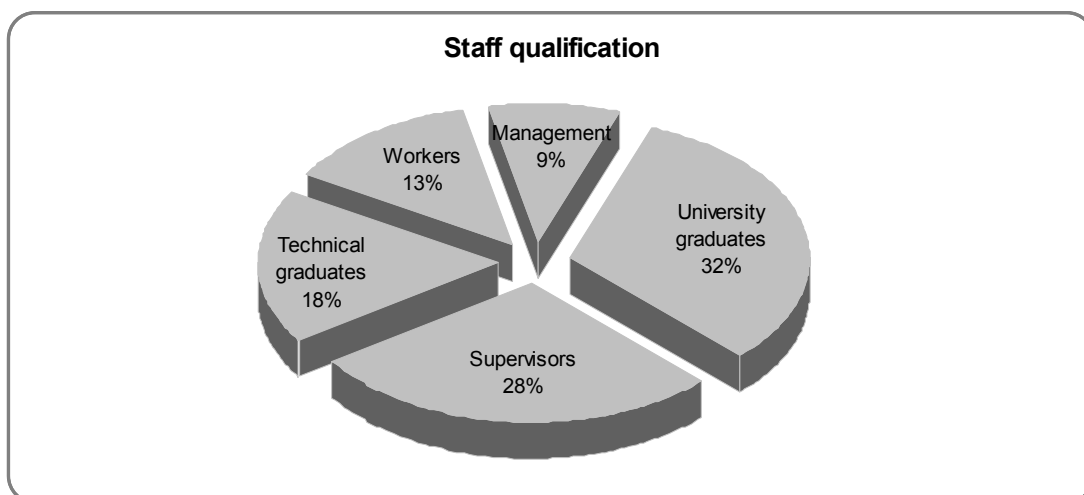


Table 7:3 **Distribution of personnel by departments (%)**

Main departments	Company size by number of workers					
	< 10	11-50	51-250	251-1 000	> 1 000	Total
Production	33.5	45.4	48.5	44.5	45.5	40.9
Marketing	8.9	12.6	11.1	13.9	3.0	10.8
Administration	14.7	13.2	11.5	12.3	9.7	13.5
Project development	19.7	18.6	20.3	20.5	40.8	19.8
Management	18.9	9.8	8.5	8.8	1.0	13.2

Source: ISTAS.

Table 7:4 **Importance attached to different factors**

Features	Director's position	University graduate	Technical graduate	Management	Supervisors	Workers
Availability to travel	41.5	56.4	32.9	17.1	19.0	7.3
Continuous training	16.6	37.0	42.9	33.4	33.2	14.2
Postgraduate Courses	26.5	32.5	4.7	0.5	–	–
English knowledge	41.7	58.5	26.8	6.9	4.7	2.4
Other languages	18.7	16.1	6.4	1.7	1.2	0.2
Experience	34.6	51.9	35.5	35.5	34.6	11.4
Age limit	2.1	5.9	4.5	2.6	7.8	4.7

7.7. Jobs difficult to fill

Two factors affect the capacity to fill vacancies:

- decentralisation of activity: not everyone wants to be out of their home, and renewable energies is a dynamic sector which needs a lot of people willing to go abroad;
- lack of experienced workers: poses a major problem in the highest qualification area. Sometimes companies prefer training unskilled people instead of looking for workers.

Table 7:5 **Difficulties in finding an adequate professional profile (% of enterprises surveyed)**

Type of job	% companies
Management	4.3
University graduates	16.1
Technical graduates	11.4
Management Supervisors	4.3
Supervisors	27.7
Workers	6.9
NA – no difficulties	53.8

Source: ISTAS.

7.8. Conclusions

Improving the skills and qualifications of workers is a prerequisite for renewable energy development, which is a high added-value industry with demanding technological aspects.

Energy technologies studied are at different levels of development, with a clearer definition of occupations and qualifications in the longer-established energy technologies. A stronger focus on emerging technologies will lead to an increase in the workforce in the medium term. Continuous training is essential to the creation of qualified and well-paid jobs.

Identification and assessment of particular occupations must be a shared effort from enterprises, government and workers to provide training in appropriate skills and competences.

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PART IV

Skill profiles in
environment and
eco-innovations

8. Environment and labour force skills

Allister Slingenberg

Abstract

Research conducted by Ecorys for the European Commission was used as a basis for providing input to the workshop on 'Future skill needs for the green economy', hosted by Cedefop in Thessaloniki. This paper is a tailored version of some of the results of the research, focusing on skills profiles in green sectors and lifelong learning trends. The research involved an extended literature review while outcomes from the workshop itself provided valuable input for understanding some of the links between skills factors and the environment. One of the immediate outcomes from the research is verification that there are strong links between economic and social policy and the impact on the environment. The current skills profiles in environment-related industries show that better skills are essential for European economies, making it easier to innovate, adopt new technologies, attract investment, compete in new markets, and diversify the economy. This, in turn, increases job growth along with labour productivity. One way of solving the skills shortages in certain sectors and Member States is through lifelong learning; it is essential for countries to have access to the required skills. Lifelong learning and vocational training give employees the education, training and information to adjust to changing economic conditions and the labour market.

8.1. Introduction

Ecorys was invited to attend a workshop at Cedefop addressing 'Future skill needs for the green economy' and to present the results of their research, as part of the work carried out for the European Commission (Directorate-General for Environment) on the links between the skills profile of the labour force and environment factors. At the time of the workshop the research was in its preliminary phase, so only a limited review could be given. This paper goes further than what was presented at the workshop, but aims to keep the central theme in line with the subject of skill needs in the green economy of the future.

For productivity and growth it is not only the number of employees that is important but also the skills profiles of these employees. The knowledge, skills and competences Europe needs to be competitive in the global labour market is a high priority on the EU policy agenda (Cedefop, 2008a). More and better skills are essential for economies as they make it easier to innovate, adopt new technologies, attract investment, compete in new markets, and diversify the economy. This in turn increases job growth along with productivity (Evans-Clock and Poschen, 2008).

8.2. Current environmental skills profiles

According to the OECD, the main characteristic of environmental job qualifications and skills is that they are traditional qualifications and skills applied to environmental issues. This would mean that there are no environmental qualifications as such, but rather there are, for example, chemists working in the sectors of water or waste (OECD, 2000). A comparative study done by the Austrian *Institut für Wirtschaft und Umwelt* (Institute for Economy and

Environment) states that the environmental goods and services industry does not necessarily have different qualifications from general qualification requirements. Proof of this could be that the number of people in specific training programmes for environmental jobs (most often in higher education) is significantly higher than the need. This means that those people cannot find jobs even though the field is enlarging (OECD, 2000).

However, according to other experts, there are specific skills needed in the green economy: knowledge of sustainable materials, relevant traditional skills, 'carbon foot printing' skills, environmental impact assessment skills (flora, fauna) and good understanding of the 'sound' sciences. Generic skills needed are strategic/leadership skills, adaptability/transferability, systems analysis (primacy of design), holistic approach, risk analysis, coordination skills, and entrepreneurship. The complexity of these skills increases with the complexity of the jobs (Cedefop, 2008c).

8.2.1. Insufficient data on green economy skills profiles

As a result of technological progress, the economy as a whole has reduced demand for low-skill workers and increased demand and rewards for higher-skill workers (World Bank and IBRD, 2008). Unfortunately, little is known about the skills base of the green economy; it is not well defined as a sector of activity and environmental skills are not necessarily distinct. However, it is possible to gain information on skills in certain sectors of the eco-industry by drawing together various data (Hogarth, 2008).

According Ernst and Young (2006) little information is available on the skills profile of nature protection, biodiversity conservation and natural hazards prevention. Most information is available for the eco-industry sector. The OECD (2004) and the European Commission (2005) state that the environmental goods and services industry has a relatively polarised skills profile. According to the OECD, in 1999 more than 70 % of environment-related jobs were manual and clerical positions (OECD, 2000). In addition, UNEP et al. (2008) argues that green jobs consist of a wide range of skills and educational backgrounds. Ecotec (2002a) states that parts of the environmental sector consist of highly educated and skilled workers: examples are environmental consultancy and research.

8.2.2. Specific skill profiles

Not much information is available on skills in environment-related sectors, though information exists on the skills necessary in eco-consulting, eco-industry and waste management (2000, educational background), agriculture and fishery (number of skilled workers) and the agri-food sector (education level). For the total labour force in the EU, as well as for the three sectors (eco-consulting, eco-industry and waste management) the highest share of educational background is grammar school, secondary school, or a completed apprenticeship (varying between 48 % and 58 %). However, the proportions of the other educational backgrounds differ significantly within sectors. For example, while the proportion of people without a learning certificate is 42 % in waste management (waste collection, handling and recycling pick-up tasks), it is only 1 % in eco-consulting. For most of the jobs in waste management it is not necessary to have completed education and training (OECD,

2004). The eco-consultant sector has the highest share of people with a university degree and the waste management sector the lowest. Jobs in environmental consulting are thus mainly undertaken by highly-skilled people, while jobs in waste collection and sorting are mainly undertaken by relatively low-skilled people. In eco-consulting more technicians and crafts people are employed than in other sectors; however, the sector as a whole has more helpers and labourers than average (European Commission, 2005).

Table 8:1 **Environment-related employment by educational background and sectors (2000)**

Shares in %

Level of education Countries and sectors	University	Advanced technical college	Grammar school, secondary school, apprenticeship	Compulsory school, no learning certificate
Austria				
Total labour force	7	2	69	22
Eco-consulting	25	15	60	0
Eco-industry	3	4	69	24
Waste management	1	0	42	57
Germany				
Total labour force	15	9	59	14
Eco-consulting	54	22	21	2
Eco-industry	6	9	57	28
Waste management	5	6	61	28
The Netherlands				
Total labour force	26	-	43	31
Eco-consulting	13	26	54	2
Eco-industry	11	21	52	15
Waste management	2	7	55	35
Spain				
Total labour force	17	8	17	58
Eco-consulting	41	20	40	0
Eco-industry	33	29	27	11
Waste management	3	3	28	66
Sweden				
Total labour force	13	16	50	21
Eco-consulting	15	23	62	0
Eco-industry	13	16	59	13
Waste management	4	4	47	45

Source: OECD, 2004.

Table 8:1 shows environment-related employment by educational background and sectors in 2000 by country. For most countries the highest share of educational background in the sectors is grammar school, secondary school, a completed apprenticeship in each sector. Two countries differ: Austria (highest share of educational background in waste management is compulsory school, no learning certificate) and Germany (highest share of educational background in eco-consulting is university). Spain has a quite different profile:

the highest share of educational background in eco-consulting and eco-industry is university-level. In waste management this is compulsory school, no learning certificate. It is also striking that the highest share in the total labour force is compulsory school, no learning certificate (58 %).

8.2.2.1. Skilled workers in agriculture and fishery

In agriculture only 17 % of farmers in EU-15 finished basic or full training in agriculture-related disciplines; however the range is from 3 % in Greece to 64 % in the Netherlands (Hortet, 2006). The number of skilled agriculture and fishery workers by Member State is the only direct statistic Eurostat provides on skills in environment-related sectors. The number of skilled agriculture and fishery workers in EU-27 has been decreasing since 2000 and was 8 580 100 in 2007. Employment in medium-skill intensive occupations (agricultural and fishery workers) also declined between 2000 and 2005 (Cedefop, 2008b).

8.2.2.2. Education levels in the agri-food sector

The level of education in the agri-food sector increased substantially between 2000 and 2006. Although the proportion of highly educated people in the agri-food sector in 2006 is lower than in other economic sectors, it increased compared to 2001. However, this increase is mainly due to the increase of the share of medium-educated people.

The demand for new skills and for a different type of workforce in the sector comes from the diversification of primary production (to generate more income from other sources) and enlargement of farms. Important skills are: entrepreneurship, employability, coping with waste management, innovation on an interdisciplinary level and human resources management (Cedefop, 2008b).

8.2.2.3. Skills in renewable energies

The renewable energy sector and energy-efficiency-related parts of the economy employ workers at all education and skill levels. Some occupations in these sectors employ highly-educated and specialised personnel such as technicians, engineers, and skilled trades. Jobs in biofuels processing require more technical skills; those in recycling are very diverse in required skills, health and occupational conditions, and wages (UNEP et al., 2008). UNEP states that the technologies that can be used in the renewable energy sector do not need highly skilled workers to operate them (UNEP, 2007). Higher skills are required in biofuels processing than in feedstock production and harvesting (Renner, 2008). While the volume of jobs has been slipping for several years in the European cement sector, the level of qualification of the jobs has increased, following the evolution process and the constant improvement of product quality (ETUC et al., 2007).

8.2.3. Skills in EU environment-related industries

There is information only on a few environment-related sectors in a few Member States. For several sectors, information on Spain, Portugal and the UK is available. There is quite a lot of information on skill profiles in environment-related industries in Portugal in 1997.

8.2.3.1. *UK environmental technology and service*

The types of skills needed in the British ETS vary by subsector. There are low-skill segments (routine collection and disposal of non-hazardous waste), medium segments and high-skill segments. There is not much reporting of technical skills shortages (Strietska-Ilina, 2007) and there is uncertain information about the supply of scientific and engineering skills (Hogarth, 2008). In this sector many graduates and post-graduates are employed. In the south west of the UK; 80 % of firms in the sector employed graduates and 50 % employed post-graduates (2002). However, 75 % of firms in the survey had 20 employees or less (Energy and utility skills, 2006).

8.2.3.2. *UK environmental and sustainable development specialists*

The report *Mind the skills gap* (ASC, 2007) looks at the skills needed for sustainable communities in the UK. It also focuses on the environmental sector, which includes environmental and sustainable development specialists. It finds shortages of environmental specialists, which will worsen temporarily, but will improve again. By 2012 a surplus of 8 % is expected. The shortage of sustainable development experts will gradually increase and reach more than 70 % by 2012.

Individuals in the environmental sector are concerned about the depth and breadth of their technical skills. Identified gaps are in project management, stakeholder management, leadership, conflict resolution, inclusive visioning and breakthrough thinking. Sustainable development experts think that there is a gap in resolution and project management. The need for generic skills is increasing in this sector. For more than 20 % of the respondents their organisation needed more environmental specialists and sustainable development experts with generic skills (ASC, 2007).

8.2.3.3. *Renewable energies in Spain*

The proportion of highly educated people in the Spanish renewable energy sector is the highest for enterprises with less than 10 employees and enterprises up to 1 000 employees (respectively 38.0 % and 33.4 %). Firms with more than 1 000 workers have the highest share of workers. The demand for various occupations does not differ greatly between subsectors (wind, solar, solar thermal). There is lack of sufficient technical experience. Industrial engineers are required by promoters and for management positions in plant construction, installation and manufacturing (Gómez, 2008).

8.2.3.4. *UK ecologists, nuclear energy and waste management industries*

Very little information exists on the skills profiles of ecologists, in the nuclear energy and waste management industries. In the British waste management industry, skill levels were increasing at the end of the 1990s due to the shift towards more value-added services (such as provision of waste audit advice to private sector companies) (Ecotec, 2002b). In contrast, according to the Institute of Ecology and Environmental Management, there is a gap in the skills and competence of ecologists, due to lack of specific skills, a poor science base and lack of essential general skills (Wade, 2008). The nuclear energy sector also has problems with skill shortages related to generic skills (Hogarth, 2008).

8.2.3.5. *Environment-related sectors in Portugal*

All environment-related industries in Portugal employ a high proportion of unskilled labour. However, there are big differences between the shares of professions within the industries. For example, the proportion of managers is the highest in wholesale metal waste and scrap, and is much higher than that in waste management and public hygiene generally. The share of mid and higher technical management is the highest in waste water collection and treatment.

8.2.4. **Future skill trends in environment-related sectors**

The increase in demand for more highly- educated people also holds for environment-related industries, according to several sources. For UNEP et al. (2008) a transition to a green economy will create demand for workers. There is clear proof that a high share of future green jobs will be high-skilled (and thus better paid) and adequate training programmes will be needed to fill the new positions.

The aim of the environmental technology action plan, for example, is to promote integrated rather than end-of-pipe solutions, which means that high-skill jobs are more likely to be promoted at the expense of low-quality jobs (European Commission, 2005). This is also argued by the AK Wien study, which states that upgrades in existing processes and machinery regularly goes together with in-firm training and an increase in the skills of employees and job quality (cited in European Commission, 2005). However, some sectors already face skill shortages (Cedefop, 2008a), and there are signs that skill shortages could hamper the green expansion (UNEP et al., 2008). The directive on energy efficiency of buildings promotes combined environmental and training measures but, according to several national trade unions, a shortage exists of skilled people and there will not be enough qualified workers to implement the directive (ETUC, 2006).

8.2.4.1. *Skill shortages in the EU and OECD*

Certain skills gaps have already emerged in particular sectors of various economies. Examples of such shortages are:

- (a) certain sectors in the British economy going 'green' are experiencing a skills gap due to the shortage of supply of technical specialists, designers, engineers, and electricians ⁽²³⁾;
- (b) Germany's renewable energy industry is suffering from a shortage of qualified workers. More technical skills are needed for the renewable energy sector, i.e. consulting skills, communication skills;
- (c) skills gap in sales staff in the retail sector in different countries, and project managers specialising in delivering a range of mitigation and adaptation solutions;

⁽²³⁾ CBI, Confederation of British Industry. Available from Internet: <http://www.cbi.org.uk/ndbs/staticpages.nsf/StaticPages/home.html/?OpenDocument> [cited 19.5.2009].

(d) in many OECD countries firms in the growing green economy are struggling to find workers with the required skills because of deindustrialisation and locating manufacturing firms offshore (UNEP et al., 2008).

There is, however, little information on future skill trends in environment-related sectors. Table 8:2 describes future skill trends in several sectors, most of the information being on global trends and not on Europe. However, the table gives an overview of available literature on certain sectors of activity.

Table 8:2 **Future skills in environment-related sectors**

Carbon capture and storage	technically more complex operations will involve workers with a very different skill set
Buildings	<ul style="list-style-type: none"> • due to energy-efficient equipment higher-skilled, higher-paying employment; • jobs are likely to be performed by workers who already work in the building sector. However, they will be redefined in terms of new skills, training, and certification requirements; • potential for highly skilled researchers and engineers. Extensive training needs in three main areas: diagnostic techniques, knowledge of renewable energy, installation, organisational skills (i.e. town planning).
Cement	jobs are expected to require higher levels of skills.
Wind power industry (renewable)	<ul style="list-style-type: none"> • many positions will require highly-skilled people; • universities need to consider offering entirely new study fields and majors due to technology development.
Climate change	climate information and forecasting, research and development into crops adapted to new weather patterns could create specialised and high-skill employment.
Agriculture	<ul style="list-style-type: none"> • jobs for agricultural skilled workers, clerks and craft and related trades workers will decrease; • requirement for skilled agricultural and fishery workers about 2.2 million in 2015
Electricity	probable that, together with technical competences, management skills will be required.
Rail sector	a dangerous shortage of skilled workers is emerging. This shortage might take place by 2030.
Waste treatment and recovery/recycling	rapid technological changes are increasing the demand for new skills.

Source: UNEP et al. (2008), ETUC et al. (2007), ECOTEC (2002a), Dupressoir (2008), Cedefop (2008a).

8.2.4.2. *Climate change and skills*

Community, national and international policies to combat the effects of climate change will directly affect the level and structure of employment and skill needs worldwide. Skills development is important to mitigate and adapt policies on global warming (ILO, 2008). According to the UK government, building a low-carbon economy is only possible by releasing the skills, creativity, entrepreneurialism and capacity for innovation in firms, the

workforce and communities (HM Government, 2007). According to the stakeholders⁽²⁴⁾, climate policies should contribute to an increase in better educated and skilled workers and a reduction in employment for low-skilled workers, in sectors which should be most influenced by climate change (agriculture/forestry/fisheries, tourism, and finance/insurance) (ETUC et al., 2007).

8.2.4.3. *Near future education levels in environment-related sectors*

Eurostat does not provide statistics on future skills in environment-related industries. However, it does provide statistics on the number of graduates in four environment-related industries: agriculture and veterinary services, agriculture, forestry and fishery, veterinary and environmental protection. As the number of graduates in a certain field does not automatically mean this is reflected in the labour market, it cannot be used as an indication for the skills of the labour force in the near future. Still, these statistics provide information on the education level of new labour supply and could indicate whether skills supply and demand will be matched.

Tables 8:3 and 8:4 show respectively the number of graduates in upper secondary education and those in tertiary education. In the EU there are more graduates in upper secondary education level than at tertiary level in 'agriculture and veterinary' and 'agriculture, forestry and fishery'. The opposite holds for veterinary and environmental protection. For Italy and the UK there is no information on the number of graduates in upper secondary education, so it is not possible to determine whether the same is true for these two countries as it is for Germany, France and Poland. In Spain there are more graduates at tertiary level than upper secondary in agriculture and veterinary. There are no graduates at secondary level in veterinary.

⁽²⁴⁾ For the study 'climate change and employment' interviews were held with key European stakeholders, mainly in the sectors believed to be the most influenced by climate change (agriculture/forestry/fisheries, tourism, and finance/insurance) (ETUC, 2007).

Table 8:3 **Graduates in upper secondary education, level 3, prevocational and vocational programmes (2006)**

	Agriculture and veterinary	Agriculture, forestry and fishery	Veterinary	Environmental protection
EU-27	104 762	102 861	1 900	9 158
BE	1 203	1 163	40	64
BE (Wa)	498	498	0	64
BE (Fl)	705	665	40	0
BG	2 300	2 125	175	79
CZ	3 730	3 484	246	454
DK	1 159	1 100	59	0
DE	13 555	12 600	954	941
EE	195	195	0	0
IE	:	:	:	:
EL	:	:	:	:
ES	4 577	4 577	0	185
FR	24 191	24 160	31	5 056
IT	:	:	:	:
CY	0	0	0	0
LV	145	123	22	32
LT	109	109	-	-
LU	83	83	0	0
HU	1 084	1 084	0	39
MT	11	11	0	0
NL	4 991	4 991	0	203
AT	:	:	:	:
PL	8 375	8 223	152	1 698
PT	:	:	:	:
RO	29 275	29 275	-	-
SI	896	799	97	0
SK	2 276	2 152	124	279
FI	2 893	2 893	0	0
SE	3 119	3 119	0	26
UK	:	:	:	:
HR	:	:	:	:
MK	1 087	771	316	0
TR	239	239	0	0
IS	72	72	0	0
LI	0	0	0	0
NO	696	696	0	0
CH	2 443	2 306	137	13
AL	98	60	38	0

NB: The numbers for Germany, Spain, France, Italy, Poland and the UK are in bold as there is a special focus on these countries.

Source: Eurostat.

Table 8:4 Graduates in tertiary education, levels 5-6 (2006)

	Agriculture and veterinary	Agriculture, forestry and fishery	Veterinary	Environmental protection
EU-27	64 948	53 132	10 659	26 055
BE	1 881	1 234	647	173
BE (Wa)	:	:	:	:
BE (Fl)	:	:	:	:
BG	928	761	167	541
CZ	2 506	2 304	202	995
DK	992	820	172	17
DE	7 648	6 165	1 483	1 379
EE	250	230	20	263
IE	326	:	:	:
EL	:	:	:	:
ES	5 211	4 068	1 143	2 887
FR	9 753	9 004	749	6 765
IT	4 804	3 611	1 193	1 588
CY	7	7	0	0
LV	266	227	39	298
LT	767	671	96	542
LU	:	:	:	:
HU	1 829	1 697	132	1 122
MT	26	26	0	0
NL	1 800	1 235	315	636
AT	720	468	252	38
PL	8 312	6 950	781	5 362
PT	1 303	1 046	257	1 367
RO	4 756	3 655	1 101	:
SI	412	355	57	174
SK	1 156	1 069	87	411
FI	912	840	72	183
SE	625	492	133	174
UK	5 577	4 494	1 083	702
HR	753	612	141	42
MK	262	234	28	35
TR	14 895	10 351	4 544	1 348
IS	25	25	0	5
LI	0	0	0	0
NO	375	316	59	234
CH	1 125	720	405	451
AL	187	129	58	33

NB: The numbers for Germany, Spain, France, Italy, Poland and the UK are in bold as there is a special focus on these countries.

Source: Eurostat.

8.2.4.4. Expected speed of change for renewable energy

Information is available only on future skills requirements in the renewable energy sector in Germany, with 45 % of firms expecting a slight increase in speed of changes of skill needs;

and 34 % believing the rate will stay the same. A strong increase is expected by 19 % of the firms. Only 2 % of the firms expect a reduction (either strongly or slightly). The current need for all the general skills is very high and will increase strongly. The current need for the skill 'customer orientation' is the highest and is also expected to increase the strongest compared to the other general skills. The need for the skill 'information search on internet' is the lowest now, but this need is expected to increase more than almost all the other skills.

The need for the skill 'repair electronic devices or modules' is moderate now and will increase the least compared to the other skills. The current skill need for 'remote fault recovery' is relatively low, but it is expected to increase strongly and more than all the other skills. The need for 'remote fault diagnosis' will also increase strongly. The current need for the skill 'client counselling with regard to available systems' is the highest compared to the other skills and will also increase strongly in the next three years.

A German study on energy-intensive industries suggests that there will be a shift towards jobs on the level of master's equivalent and bachelor's degree and foreman/technicians (ETUC et al., 2007).

8.2.5. Mainstreaming environmental skills and qualifications

There is hardly any information available on how likely it is that environmental skills and qualifications will become a normal employee attribute regardless of employment sector. However, according to the OECD, the main characteristic of environmental job qualifications and skills is that they are traditional qualifications and skills applied to environmental issues. This means that there are no environmental qualifications, but that there are traditional trades such as chemists working in the sectors of water or waste (OECD, 2000). This is supported by the Austrian Institut für Wirtschaft und Umwelt (Institute for Economy and Environment) which states that the environmental goods and services industry does not necessarily have different general qualification requirements (OECD, 2000).

According to UNEP et al. (2008) many existing green jobs (plumbers, electricians, metal workers, and construction workers) will be used as day-to-day skill sets and work methods. Environment-related industries do not necessarily need environment-related skills. People with the skills needed in environment-related sectors do not need to have a degree in environment-related studies. In theory, anybody with the requisite skills could perform tasks within environment-related industries, which could be seen as mainstreaming of environmental skills and qualifications.

8.3. Conclusion

Many skills gaps in the European economy must be closed to help drive the sustainable growth desired by the EU, as indicated in the Lisbon strategy and other initiatives. Skills gaps identified in this report are dependent on Member States and on particular sectors. The coverage of these gaps in literature is by no means complete; further research is needed to properly document the various problems and potential solutions. A good way of starting to close skills gaps is by identifying local economic strategies that will help build sustainable

models of growth and put adequate resources into training workers with the necessary tools to enable them to participate effectively in the strategy outlined.

The specific sector often referred to as the eco-industry in literature does not necessarily have different general qualification requirements for its workers compared to general qualification requirements of traditional jobs. However, skills they have often require adaptation to environmental phenomena and technologies that means they can apply their traditional skills in changing circumstances.

Skills development is important to mitigate and adapt global warming policies (ILO, 2008). Building a low-carbon economy is only possible by releasing the skills, creativity, entrepreneurialism and capacity for innovation in firms, the workforce and communities. According to the stakeholders ⁽²⁵⁾ in the sectors believed to be most influenced by climate change (agriculture/forestry/fisheries, tourism, and finance/insurance), climate policies should contribute to an increase of better educated and skilled workers and a reduction in employment for low skilled workers (ETUC et al., 2007).

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9. A new industrial revolution: eco-innovation and the Humboldtian approach

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Abstract

The growing impetus of eco-innovation in Europe cannot stem the tide alone if the major part of the world does not provide significant contributions to the struggle against climate change. The combined endeavours necessary to get a decisive grip on climate change and resource shortages can be summed up as a new industrial revolution. The Humboldtian approach, the central focus of this paper, should reach and reform all strata of society and every relevant economic, educational and administrative institution to initiate the new industrial revolution. To become true knowledge societies, European countries and the European Union could achieve significant progress by applying the Humboldtian approach.

9.1. Introduction

Since the dawn of the industrial age, one key element of the modern economy is the extent of energy consumption and the quantity of natural resources that used in industry. The smoking chimney has been rightly used as a symbolic icon for industrial strength and economic abundance. In the global comparison, the 'western' approach has been far more successful in the past 200 years than any other economic model. This is one of the reasons why the rest of the world is copying our 'proven' strategy now. But there are other reasons, too. Emulation of the western industrial paradigm appears to be the swiftest and surest road out of poverty and dependence for non-western countries, and many developing countries face the choice between rapid industrialisation along 'traditional' western parameters or the looming collapse of their societies. The global food crisis of spring 2008 illustrates the vulnerability of poor countries – and particularly their poorer inhabitants – to global market shifts.

9.2. Challenges of climate change

It is at least 20 years the EU became aware that shortages may eventually turn out to be a major risk of continuing to build economic welfare by excessive use of natural resources. This core element of 'traditional' industrialism may turn out to be its stumbling block and European stakeholders have become aware of two major factors indicating a need for change. First, a reliable and cheap flow of natural resources from non-industrialised countries can no longer be taken for granted. Second, the negative impact 'traditional' western industry and its complementary lifestyle have on the environment bring serious global threats; climate change is preeminent. Although climate change, as a global economic phenomenon, will be most devastating in the poorest regions of the world, both its direct and indirect impacts on Europe will be serious. How serious they will be depends on the degree of success in the struggle against climate change.

Several compelling economic and political reasons prevent a future-oriented policy overemphasising the importance of increasing resource productivity:

- (a) rising raw material and energy prices are the fastest growing cost factor in production today. As exemplified by mineral oil, continuing vast consumption leads to alarming economic and political consequences. The degree of dependence on a given natural resource determines the vulnerability of an economy to shortage and depletion. There is one notable exception: renewable energy which cannot be exhausted;
- (b) globalising western lifestyles with a business as usual approach would require at least two planets as resource basis. Developing countries do not consent to remain poor to support continued prosperity in industrialised countries based on vast consumption of natural resources. Increasingly dangerous conflicts about access to resources threaten the economy of industrialised countries;
- (c) the region which invents and uses alternatives without losing quality of life will be the most successful in global economic competition. Further, it will be able to contribute significantly to the struggle against poverty in other regions of the globe without sacrificing its own abundance. Thus, it can deescalate global conflicts, establish stability and safeguard its own continued prosperity.

Climate change is a global threat and must be tackled on a global scale; the growing impetus of eco-innovation in Europe cannot stem the tide alone if the major part of the world does not provide significant contributions to the struggle. Emission reduction and mitigation measures in Europe, for example, have an impact on the speed of climate change but, compared to the steadily growing quantities of greenhouse gases emitted by newly industrialised countries (NICs), emission reduction in Europe loses significance within a global scenario. It has to be kept in mind, however, that it is neither feasible nor recommendable to try to deny the desire for development brought forward by developing and NICs.

Having to combat both poverty and climate change, NICs face a dilemma. Subtracting capacity from their endeavours to develop to mitigate CO₂ emissions and adapt to the manifestations of climate change threatens to undermine their basic needs, particularly development. But they cannot refuse to employ adaptation measures because of the dramatic impact climate change will have – and in some cases already has – on their lands and populations. For the same reason, NICs cannot refuse to mitigate greenhouse gas emissions, and they are urged to do so at the international climate negotiations, but doing so endangers their economies. At the international climate negotiations in Bali (Bali action plan, 2007; addendum, 2008), NICs and developing countries stated their willingness to join the struggle against climate change. Many of their representatives, however, pointed out that, for their countries to be able to act as intended, massive transfer of sustainable technology from industrialised countries has to take place. Although the most significant decision of the negotiations, as the Bali action plan acknowledges, up to now there is little tangible progress. However, for NICs and developing countries, the procurement of technology which can be employed to meet the requirements of development without accelerating climate change is crucial. The swift and broad implementation of these technologies in these countries is indispensable to the global struggle against climate change.

The combined endeavours necessary to get a decisive grip on climate change and resource shortages can be summed up as a new industrial revolution. This revolution has to dwarf its precursor in two respects: it has to happen three times as fast and it has to take place on a global scale (MGI, 2008).

9.3. Eco-innovations in the light of industrial revolution

Eco-innovation is both the keyword and the key of this new industrial revolution. From a European perspective, this means employing a bundle of already proven policies, lessons learned and best practices on the global scale. It means accelerating European eco-innovation – and, thus, supporting Europe’s competitive edge – by a continuous stream of knowledge dividends resulting from the implementation of European sustainable technologies in NICs and developing countries. It also means safeguarding the future of Europe both from the impacts of climate change and the turmoil of global economic and political disruptions.

‘The EU-innovation panel ⁽²⁶⁾ has defined eco-innovation as follows: eco-innovation aims at the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life at life-cycle-wide minimal use of natural resources (material including energy, water and surface area) per unit output, and a minimal release of toxic substances’:

- (a) the concept of eco-innovation should be supported as a cross-cutting issue with adequate focus on knowledge/learning gaps, good practices and opportunities in each sector;
- (b) the logic of public support for eco-innovation should be different, to include different calculations of the cost of innovation. Hence, public policies should support eco-innovation considering its integrated costs, which implies that even if innovation is not cost-effective under the current market price regime, it will become profitable under a global competition aspect;
- (c) the European Commission is asked to support actions on awareness-raising, capacity building, demonstration projects identifying and disseminating existing good practices in eco-innovative products and services (Schmidt-Bleek, F. et al., cited in Rao et al., 2008).

As the McKinsey-report (2008) states: ‘productivity growth, such as occurred in the industrial revolution, is largely a microeconomic phenomenon. New technologies are developed and deployed, new investments made, new infrastructure put in place, and changes occur in the decisions, practices, and behaviours of millions of business managers, workers, and consumers’.

⁽²⁶⁾ Europe Innova is an initiative for innovation professionals supported by the European Commission under the sixth framework programme. The fundamental objectives of this initiative fall in line with the policy direction set out within the sixth framework programme priority ‘structuring the European research area’. In acting as the focal point for innovation networking in Europe, Europe Innova aspires to inform, assist, mobilise and network the key stakeholders in entrepreneurial innovation, including firm managers, policy-makers, cluster managers, investors and relevant associations.

9.4. European eco-innovations and the emerging markets

This is what will happen in Europe, both as a result of the new industrial revolution and as its core characteristic. European business will transcend the satiated markets of the industrialised countries. Instead of stagnating, European business will grow and multiply to satisfy both new customer demands at home and those of the emerging markets which will appear in countries whose populations currently cannot afford European products. There, Europe-based global eco-innovation will provide sustainable energy and sustainable, reliable logistics, the core elements of stable, growing economies of the future.

The new industrial revolution also has to transcend the established patterns of development policies and north-south relations in general. The global struggle against climate change is a challenge to mankind and requires the willing participation of all continents. Antiquated concepts and approaches have to make way for innovative ones. To develop and implement technologies which are adapted to the needs and demands of populations in NICs and developing countries, a top-down approach does not appear to be advisable. Diversified, regional and local demand will remain a vastly unknown factor. It is necessary speedily to allocate locally adaptive, technological and economic intelligence and creativity. To date, companies have established research departments in urban regions of development countries which appear to be or to become attractive markets. These research departments are expected to study local markets and wants, to initiate technological innovations. But bottom-up approaches like these have to proliferate if we take the right to develop and the willingness to develop climate-neutral ways of life and the economic opportunities of emerging markets seriously. About half of the human population of the planet lives in rural areas, around one billion people live off less than USD 1 per day (purchasing power equivalent). To maximise innovation potential, the necessary technological innovation thrust has to reach the particular conditions of rural and sparsely developed areas, and it has to be complemented by a thrust of lifestyle innovations. This is only feasible given a vast network of supporting institutions, structures and basic technologies.

Evidently, both spheres of action – accelerating European eco-innovation and transforming economic development in NICs and developing countries towards a sustainability path – require many green skills and many people possessing them. Although the basic conditions in these two spheres differ drastically (and differing conditions in different European countries as well as significant differences between NICs and developing countries are to be considered), there is one question that has to be faced: is there a basic approach meeting all requirements to be considered? Even for the strongest national economies in Europe, this revolution of knowledge and skills is a daunting task. Do institutions already in existence have the necessary capacities? Can the costs be reduced to reasonable amounts that do not endanger national economies in transition? Are traditional methods and structures of knowledge transfer fit to enact a knowledge revolution? How is structural inertia, and the efficiency loss caused by it, to be overcome? How can recipients of training and teaching be motivated to invest time and effort? How can the necessary high quality green skills be safeguarded? As all these questions can, and must, be answered in respect to the new industrial revolution both in Europe and in NICs and developing countries. It becomes apparent that, despite the differences, the problem is basically the same.

9.5. Humboldtian model for eco-innovations

About two centuries ago, Prussia had to face the challenge of being scientifically and technologically backward compared to the neighbouring principalities. It answered the challenge by creating an education system wherein students, by participation in research processes, were expected to learn process-oriented knowledge generation. This approach was opposed to the established practice of conveying knowledge through a top-down model. Self-reliance, independence, critical and theoretical reflexion, interdisciplinarity and a cosmopolitan attitude were intended to enable and accelerate scientific productivity. This Humboldtian ideal of education caused an academic generation to appear which was already used to rational and autonomous production of knowledge. The unfolding of knowledge structures based on this phenomenon and its basic and accompanying technologies initiated an innovation thrust in catching-up Germany which safeguarded its technological and scientific top position. Recently, Narahari Rao, a philosopher focusing on culture and development theory, elaborated an approach to apply the Humboldtian model to eco-innovation and a new global deal.

If an innovation thrust comparable to Prussia's advancement sketched above is to take place today to initiate a new industrial revolution, the Humboldtian approach should widen its base. It should once again become the core structure of learning and teaching, but this time throughout Europe and throughout society. High-level skills and profound knowledge have already ceased to be the privilege of a minority in Europe. This trend should be strengthened, and opposite trends such as efficiency loss in public education should be eliminated. It is important to point out a crucial difference between the Prussian model and the current scenario. In Prussia, the Humboldtian model was restricted to an elite, which was perceived as a supportive pillar of the State, and to the universities. Today, in a democratic Europe, the role of supportive pillar of society is no longer restricted to an elite. Accordingly, the Humboldtian approach should reach and reform all strata of society and every relevant economic, educational and administrative institution to initiate the new industrial revolution. European countries and the EU could achieve significant progress in becoming true knowledge societies by applying the Humboldtian approach.

At the same time, the rewards for the efforts invested should be made transparent and tangible: for institutions, especially those involved with education, businesses of every size, and for individuals. This is necessary to ensure that all stakeholders understand the nature and the need for the profound change that is taking place and their own auspicious prospects in this scenario. A core element of the European green skill revolution is willing and eager cooperation of all stakeholders, and this can only be safeguarded by providing a clear and convincing perspective for all of them.

There can be no doubt that the costs of this transformation will be considerable but Europe should perceive this process and its costs as a rational and calculated investment that will bear fruit both in the near and in the distant future. A well-educated, highly-skilled population is a powerful asset for every national economy, and also for democracy. Business, especially green business, thrives on proficient employees and farsighted corporate leaders, and as green skills require self-reliance, continuous adaptation and learning and innovative models of thinking, European business will radically transform and

prosper. Public institutions will reform and improve, and public life in Green Europe will be shaped and conducted by well-informed, considerate and cultivated citizens.

In NICs and developing countries, the Humboldean approach should be applied by establishing novel knowledge centres for grown-ups, in diversified urban and rural areas. There, the local population, guided by experienced teachers, researches how local ways of life can be transformed into sustainable lifestyles which, at the same time, provide prosperity. As in Prussia long ago, the aim is the emergence of creative, autonomous subjects of research which enable the constitution of a network of institutions and knowledge areas. Local needs and demands are connected within a global perspective characterised by resource effectiveness and climate protection to develop local solutions for adaptation and mitigation in everyday activities such as cooking, transport, and waste disposal. Research in these post- or rather para-academic knowledge centres for sustainable lifestyles, helpful technologies, solutions, institutions and abilities takes place through participation: research and teaching are one and the same. This process has to be comprehensive; theoretical reflection and interdisciplinarity are as important as the broadness of the subjects of education, which must not be limited to technical disciplines.

For these knowledge centres, service centres for dissemination of technologies (biogas, solar cooking gear, solar panels, etc.) and consultation centres for other skills (cultivation methods, husbandry and others) could serve as a base. The Internet provides fast cross-linking of knowledge centres, for example by generating special online platforms. Solutions and ideas developed in a suburb of Bangalore may prove useful for a local group in the area of Rio de Janeiro, and similar phenomena might occur when knowledge generated by a rural community in Kenya proves helpful in Bangladesh. For companies participating in these research processes there will be a direct knowledge dividend: innovations. Considering the comparatively small investment cost for innovation cores in developing countries, the knowledge dividend may be much higher than from comparable projects in industrialised countries.

9.6. Conclusions

Employing the Humboldean approach in NICs and developing countries would not only be a significant input to the struggle against climate change: it would also be an important step towards a new global deal. Identifying and employing climate change as a megadriver, initiating the new industrial revolution and applying the Humboldean approach would also transform the relations between Europe and NICs and developing countries. Being perceived as a fair, reliable partner in global regions currently facing dramatic threats would be a positive outcome for Europe.

Both spheres of action – accelerating European eco-innovation and transforming economic development in NICs and developing countries towards a sustainability path – are complementary. The new industrial revolution has the potential for global synergy that would provide auspicious prospects for Europe in this century.

‘The core elements of eco-innovation, namely sustainable energy, sustainable technology and the vast and ever-increasing knowledge base related to them are Europe’s

strongest assets in the new millennium. Hence, it is of utmost importance for the future of Europe in a changing world how this asset is employed' (Schmidt-Bleek, F. et al. cited in Rao et al., 2008).

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PART V

Conclusions and perspectives

10. Future skill needs for the green economy

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The workshop on 'Future skill needs for the green economy', part of Cedefop's continuing investigation of developing skill needs across different sectors, brought together contributors to several recent studies on green skills and green jobs: social partners, academics and international organisations. The aim was to gain better insight into how the 'greening' of the economy is affecting the job market.

What are the main trends and mechanisms restructuring Europe's green economy? Which specific and general skills are new and emerging and which are declining? Which occupations are needed to mitigate climate change and what policies (national or EU initiatives) should be designed to meet the demand for green occupations? How can education and training systems be developed to respond quickly to continuously changing requirements? How can educational and training standards be brought closer to occupational standards and employer priorities in green jobs? These were the questions addressed by focus groups. The workshop concluded that the new prominence of environmental considerations is already having an impact on the job market. Workers from all walks of life need to expand their skill set so that they can help safeguard the environment.

10.1. Trends in restructuring Europe's green economy

The expansion of the green economy in Europe is being accelerated by concerns relating to energy generation, resource use and environment management. Energy policies, addressing the need to tackle climate change by reducing greenhouse gas emissions and, at the same time, achieve greater energy security along with a diversity of generation that has the flexibility to meet variable demand, are driving the development of renewable energy technologies. The impetus towards creating a European green economy comes from the widespread consensus among the scientific community of the dangers posed by greenhouse gases and the depletion of fossil fuels.

These concerns are reflected in several international agreements, notably the Kyoto accord and, prompted the EU, by agreement with the Member States, to impose targets on carbon emissions. The rising cost of energy and concerns over the security of supply of energy (Russia and the Ukraine) have added a sense of urgency to the campaign for energy conservation in the Member States.

10.2. EU policies

Within the EU an array of policies to tackle climate change are setting targets for national emissions, renewable energy, biofuel use, energy efficiency standards and so on. These EU policies, and associated mechanisms such as the EU emissions trading scheme, are accelerating the growth in 'green jobs'. Better waste management is also being driven by EU

policy while the habitats, birds and water framework directives have been essential to improving environmental protection across Europe. These changes will be eased by greater flexibility of labour markets and the potential for labour movements within the EU.

10.3. Incentives in Member States

While the main drivers of change will apply across Europe, there are varying priorities between countries. For example, solar technology may be prioritised in Spain while wave and tidal generation are more likely to be developed in the UK. These incentives include subsidies for improving thermal efficiency in buildings and preferential tax treatment for eco-friendly transport. Such national differences will be determined by the natural capacity for generation, industrial capacity to develop facilities, and political priorities, along with differences in both legislation and public acceptability. In the UK, Scotland and Wales have produced green jobs strategies that seek to define the extent of the green economy and identify actions that may help its development. Yet, researchers have had difficulty in defining the scope of 'green jobs' and, recognising that all occupations will need 'greening' with all workers requiring some generic 'green' skills, the identification of a specific 'green jobs' sector seems inappropriate. Within the workshop it was agreed that the skills gap should be identified within the European climate change programme II and its associated action plan and addressed through the relevant national measures such as renewable energy strategies and national energy efficiency schemes.

10.4. Green economy versus sectoral changes

The growth of the green economy will not result in the loss of business sectors. Some may decline, such as coal mining and other heavy industries, but most sectors will simply evolve. Although waste management and agricultural production of biofuels are likely to provide many low-skills jobs, a decline in physical low-skills employment is anticipated. A growth in virtual, electronic interaction and more multidisciplinary working are anticipated, for example, with the need for technical staff to have better communication skills. It is likely that innovation requiring high skills research, including value engineering methods that evaluate the relative inputs and outputs of both products and processes, will grow. However, there will also be an increase in 'green collar' vocational employment to implement new low-carbon technologies.

Adopting 'green issues' can inadvertently result in some sections of society incurring losses. A concerted move away from private road transport for example, would damage the freight industry. One way of possibly eliciting the support of industries who may suffer as a result of 'going green' is to create a compensation fund at EU level. There is an example of such a fund in operation; the 'globalisation fund' is specifically designed to assist those who have suffered unemployment as a result of global competition. Other policies which might promote the adoption of a 'green agenda' include selective incentives for the adoption of sustainable practices and training programmes which are designed to equip participants with a more holistic perspective on their skills and business practices.

10.5. Skills paradigm

The skills associated with the emerging green economy can be categorised into generic skills and specific skills. The latter group are particularly relevant for the green economy, which creates a new skills paradigm that, in general, is more holistic in approach than the traditional one. The new paradigm places greater emphasis on design and working in multidisciplinary teams with a high degree of autonomy and responsibility. Projects often entail bringing together professionals from widely diverse backgrounds such as engineers, planners and architects with ecologists and archaeologists. This means that generic skills such as strategic leadership and adaptability will be important in the green economy. Good knowledge of the sciences, including engineering, environmental and biological, is a general feature of many of the skill sets required by the emerging green economy.

10.6. Specific skills

It is generally agreed that the specific skills associated with the merging green economy are not entirely new skills; they are either an add-on or an amalgamation of existing skills. An example of add-on skills are the competences required in installing sustainable biomass heating technologies (wood pellets or wood chip boilers) technologies such as solar tubes and panels, photo-voltaic tiles or geothermal heating systems. In these cases, some knowledge of plumbing is required; similarly solar tube and panel technologies require fitting or electrical skills. Good diagnostic skills will also be in demand in the emerging green economy, with the ability to measure the carbon footprint an important competence. The rising cost of energy, combined with greater awareness of environmental issues and legislation such as the European building performance energy directive, will create strong demand for energy assessors.

10.7. Greening of occupations and skills

All occupations will need 'greening' with a spectrum from those new jobs focused solely on the delivery of green goods or services to those that will require more limited changes to improve energy efficiency and reduce resource use. There will be a need to develop the skills base for each mitigation technology, whether in terms of renewable energy generation or energy/resource efficiency. There will be demand not only for technological expertise but also communication skills to provide advice on new technologies to both businesses and consumers. It will be vital to cascade information to a wide range of professionals, such as planners, architects, builders, and plumbers. Broader provision of advice on carbon auditing and low-carbon technologies for both business and individuals is likely to become an increasingly important sector. Professionals, such as carbon auditors, could be crucial to the delivery of emission reductions and achieving greenhouse gas targets but, given their relatively small numbers within green jobs as a whole, there is the danger that their skills needs may be overlooked.

10.8. Curriculum development

It is important that a revised curriculum, particularly in terms of science and technology, provides the necessary knowledge of mitigation technologies. However, this will only be applicable to students. Both professionals and blue-collar workers will need retraining with relevant green skills. All lifelong learning programmes should provide appropriate skills updates to ease the transition to low-carbon business. The provision of both specific technological skills and generic training related to carbon auditing and management are equally important. There is a case for developing carbon auditing or management qualifications and their accreditation and recognition across the EU.

10.9. Social dialogue on education and training

Education and training systems will be better able rapidly to develop green skills requirements if there is improved social dialogue between those developing education systems and training standards and both employers and trade unions. The education system should promote multidisciplinary learning environments and, together with the social partners, should be encouraged to take a broader view of how competences are defined and acquired. In particular, national qualifications frameworks should aid both vertical and horizontal career progression; the need for more holistic skills entails a requirement for a flexible qualifications system that supports and encourages the continuous acquisition of additional competences. Such a framework should include the recognition of informal learning mechanisms, accreditation of prior learning, and the increasing scope for 'train the trainer' programmes; it should also include both the opportunity and support for more quality internships. A closer working relationship needs to be developed between the needs of industry and formal education and training. There may be a role for the EU in this context in promoting green awareness in education and exploring the possibility of creating EU-wide certification for green skills such as energy assessors.

There is a requirement for better coordination between those developing environmental policy and managing the transition to a low-carbon economy and those developing skills training. Continuous professional development, through greening or mitigation technology modules, is essential for most of the future workforce.

10.10. Training of trainers

Rapid technological innovation and market response may result in the availability of adequately trained professionals becoming a key rate limiting factor for greenhouse gas reductions. If the market develops ahead of education there will be a need for better links with those innovators and professionals who are leading technological developments. In a fast moving technological area the training of trainers, through rapidly developed 'greening' or technological modules, and the accreditation of those working in newly emerging areas will be important.

10.11. New skills for new jobs

New skill needs should be identified early so that there is support for training the trainers in the skills implications of new mitigation policies. For example, targets for the use of biomass may be set, yet it is essential that gaps in agricultural training and knowledge of the production technologies are bridged if changes are to be realised. Matching of skills to jobs is a strategic priority for the EU. The European Commission's new skills for new jobs initiative, therefore, sets the outline for one of the key future priorities: how to anticipate better skill needs and coordinate employment and education policies.

10.12. Societal aspects of green economy skill needs

Societal aspects of the green economy are evident, though inadequately researched. Tackling climate change requires a new way of working that will affect the whole of society. Therefore, skills and education needs should be examined across not just all business and jobs sectors but wider society too. Behavioural and technological changes to deliver mitigation across society will happen because they are either economically beneficial, driven by legislative or fiscal measures, a response to training and education, or a combination of these. Skills training and education have perhaps received less attention to date than the other factors in their importance to achieving a rapid transition to a low-carbon society. The type of policies which would promote a green economy includes measures designed to improve public awareness of the benefits of green policies. Such a campaign should be organised nationally and at EU level.

List of abbreviations

ETS	environmental technology and services sector
FreQueNz	<i>Früherkennung von Qualifikationserfordernissen im Netz</i> [research network for early identification of qualification needs]
ILO	International Labour Organisation
IOE	International Organisation of Employers
ISTAS	Union Institute of Work, Environment and Health
ITUC	International Trade Union Confederation
NICs	newly industrialised countries
OECD	Organisation for Economic Cooperation and Development
PP4SD	professional practice for sustainable development
UNEP	United Nations environment programme

Country names and codes

The order of protocol for the Member States is alphabetical, based on the original written form of the short name of each country.

BE	Belgium	NL	Netherlands
BG	Bulgaria	AT	Austria
CZ	Czech Republic	PL	Poland
DK	Denmark	PT	Portugal
DE	Germany	RO	Romania
EE	Estonia	SI	Slovenia
IE	Ireland	SK	Slovakia
EL	Greece	FI	Finland
ES	Spain	SE	Sweden
FR	France	UK	United Kingdom
IT	Italy	HR	Croatia
CY	Cyprus	MK	former Yugoslav Republic of Macedonia
LV	Latvia	TR	Turkey
LT	Lithuania	IS	Iceland
LU	Luxembourg	LI	Liechtenstein
HU	Hungary	NO	Norway
MT	Malta	CH	Switzerland

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Future skill needs for the green economy

Europe set the pace in the drive to a low-carbon economy. The expansion of the green economy is being accelerated by concerns relating to energy generation, resource use and environmental management. Skills are a critical ingredient in coherent education, training, employment and environmental objectives. This publication is based on the Cedefop workshop on future skill needs for the green economy, which presented research results of several recent studies on green skills and green jobs, in Thessaloniki, on 6 and 7 October 2008. Case studies present emerging skill needs, the changing qualification needs in jobs for renewable energies and skill profiles in environment and eco-innovations.

Climate change mitigation policies represent a serious challenge for education systems and employment in Europe. All occupations will need greening, with a spectrum from those new jobs focused solely on delivering green goods or services to those that will require more limited changes to improve energy efficiency and reduce resource use. Workers from all walks of life need to expand their skill sets so they can help safeguard the environment.

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