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Green skills and environmental awareness in vocational education and training

Synthesis report

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The **European Centre for the Development of Vocational Training** (Cedefop) is the European Union's reference centre for vocational education and training. We provide information on and analyses of vocational education and training systems, policies, research and practice.
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Foreword

European economies are undergoing substantial transformation. The economic crisis has accelerated structural change within many sectors. There is an urgent need for strategies to help 'displaced' people leave declining economic sectors and find employment in more viable activities.

Such activities include green jobs and jobs in 'green' sectors that encourage eco-friendly production and consumption not only to create a more sustainable economy, but also to generate quality jobs.

'We must see that "green" and growth go together' (Barroso, 2011). This is the basic idea behind the 'green pillar' of the Europe 2020 strategy. The new Recommendation from the Commission *Towards a job-rich recovery* identifies green economy as the main area of future job creation. But how can we ensure that the transition to a green economy will actually generate jobs and inclusive growth?

To get the most out of greening the economy, we must develop the skills, knowledge and competence that resource-efficient processes and technologies need and integrate them into policy and the practices of business and the community. The European Union's strategy on climate change and the development of a cleaner, more resource-efficient Europe will affect the labour market: new regulations, new materials and new technologies will change job content.

In many Member States this shift is already under way and new green occupations are emerging. Many expect that green technologies and practices will come to pervade the economy. The green economy significantly affects labour demand, education, skills, occupations and the geographical distribution of jobs and workers.

Yet we know little about how this trend affects the demand for skills and the provision of education and training. It is this lack that the study seeks to remedy. The study complements a previous Cedefop study (2010a), which explored skills development for new and greener jobs.

The report finds positive trends in providers' and employers' attitudes towards the development of the green economy and its implication for skills and training activities. But it also reveals an uncertain and fragmented picture of both policy coordination and stakeholders' cooperation. Uncertainty about environmental regulations and policies makes it difficult to anticipate skill needs; multiple entry routes and insufficient recognition of skills acquired through non-formal or informal learning tend to deter workers from transferring to green jobs;

learning providers are not sufficiently active in anticipating demand and are discouraged by uncertain and diverse employer needs.

In these circumstances, policymakers, the social partners and training providers need to work closely together to ensure a consistent policy framework that can promote future investment in the green economy. The aim should be to improve recognition of green skills, making it easier for people to apply them to new jobs, new workplaces or new regions. Cedefop will continue to explore how these developments affect employment and skills and how VET policies can help support a greener economy.

Christian F. Lettmayr
Acting Director

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Executive summary

In the light of the strong policy commitments at European level to the development of a sustainable and resource-efficient economy, in recent years Cedefop has been focusing on 'green' growth and its implications for skills and vocational education and training policies.

This report examines trends in employment, skill needs and training provision for a selected group of occupations likely to be affected by the development of a low-carbon and resource-efficient economy and makes policy recommendations that seek to ensure that businesses can take advantage of the opportunities presented by this transition and that the skill needs it generates are met.

Nine occupations were selected to provide a balanced mix of sectors and skill levels in the labour market:

(a) nanotechnologist, engineering technologist and environmental engineer as examples of high-skilled occupations;
(b) energy auditor, transport vehicle emissions inspector, insulation worker, electrician, solar photovoltaic installer and sheet-metal worker as examples of medium-skilled occupations;
(c) refuse/recycling collector as an example of a low-skilled occupation.

Eight Member States were analysed, representing different stages of the development of a sustainable, resource-efficient economy: Germany, Greece, Italy, Hungary, the Netherlands, Slovakia, Finland and the UK.

The study draws on data from several sources including: the EU labour force survey (EU-LFS); a review of national policy documents concerning skills, employment, energy, environment, innovation and industry; interviews with national experts on a range of the target occupations; some small-scale survey data from employers and learning providers; and validation of findings through a workshop with a range of experts.

Main Findings

Demand for green skills subject to various policy influences

The demand for skills in the occupations selected for this study is influenced primarily by the regulatory and incentive schemes introduced under energy and environmental policies, for example in the construction sector. Innovation and industrial policy appear to influence the demand for skills indirectly through tax

breaks, subsidies and direct government investment in infrastructure, which stimulate market demand particularly for renewable energy technologies.

Economic policy appears to play an important support role by creating a stable financial environment that encourages businesses to invest. Skills and employment policy appears to play a mostly indirect role by shaping the quality of the labour supply. In general, there is limited evidence of environmental issues being 'mainstreamed' in other policy areas.

Mixed evidence for employment trends in green jobs ([1])

Employment trends are clearly affected by the current economic crisis. EU-LFS data show that in the last three years there has been an increase in the number of jobs for insulation workers and electricians and, in relative terms, for nanotechnology engineers and environmental engineers. The data also show stable or slightly increasing demand for sheet-metal workers and refuse collectors. Only in the cases of solar photovoltaic (SPV) installers and transport vehicle/energy auditors does it appear that employment has contracted. Inevitably there are some differences between the results of the EU-LFS and what interviewees report. The differences are due not only to imperfections in matching the selected occupations with current ISCO codes, but also to experts' subjective perceptions of the impact of the economic crisis. Interviewees from Finland and Germany tend to report job growth in most occupations except those of refuse collector, sheet-metal worker and (in Germany) electrician. For the UK, Greece and Hungary predictions are more mixed with differences between occupations, while interviewees from Italy and Slovakia were very reluctant to make any predictions at all, often citing a sense of great economic uncertainty. Generally, the occupations for which job growth is most frequently predicted are in renewable energies, the environment and new technologies, while occupations in which job numbers are most commonly reported to be in decline are in sectors worst affected by the recession such as construction.

([1]) Given the lack of comparable, detailed national statistics and differences in the results of analyses of primary and secondary data sources, the results of quantitative analysis need to be interpreted with caution. In particular, qualitative information derived from a limited number of experts (employers, employee representatives and/or learning providers) for each occupation may not fully capture variations within sectors and geographical variations in labour markets; while EU-LFS data overestimate the number of people working in some of the occupations of interest because the classification used may either be broader than the precise occupation of interest or cover the number of employees in a sector rather than the precise occupation of interest (see Chapter 3 for further explanation).

Some gaps in learning provision, which can be slow to adapt to new demands

In their survey responses, learning providers expressed enthusiasm and willingness to change the content of curricula to meet new demands. However, action has been rather piecemeal and reactive so far, although less so among those providing tuition for new occupations such as energy auditors and SPV installers. Some learning providers gave cautious responses owing to concerns about insufficient demand, and others said that they would probably wait to see how the market developed before investing. Most learning providers do not yet include green skills in their learning strategy.

Although learning provision for some occupations is considered adequate, lack of demand and the slow pace of new qualification development are the main factors deterring learning providers from developing new learning content. It is also difficult for them to meeting the needs of employers with diverse occupational profiles and to understand the skill needs of organisations. On the other hand, employers are seeking closer cooperation with VET providers to influence the content of provision.

One of the main gaps in learning provision is for insulation workers and SPV installers. This is of concern for employers of insulation workers in particular because demand for labour is predicted to expand in the near future. Learning provision for SPV installers is relatively fragmented in some countries (Germany, the Netherlands and the UK) and employers may experience lack of transparency in the content and quality of training (the UK), while in other countries the amount of provision appears limited (Slovakia and Hungary). The quality of learning provision appears relatively high in Finland, the Netherlands and Germany.

What are the current skill shortages and skill gaps?

Generally, there appear to be few skill shortages ([2]) in most of the occupations selected for this study since employers have no difficulties in filling vacancies owing to the current crisis. The crisis has reduced energy demand and has hit the construction sector particularly hard, which may mask skill shortages temporarily.

Despite the downturn, some skill shortages persist, particularly for sheet-metal workers, electricians and insulation workers. Germany, Finland and the UK report sizable skill shortages in these occupations. It is particularly worrying that these skill shortages are due not so much to growing demand, but

([2]) For a discussion and definition of terms, see Chapter 5.1.

to a lack of young people willing and able to replace retirees. Difficulties in attracting young people affect many countries wanting to invest in the expansion of green jobs. It is difficult to attract young people to practical, manual work in what are wrongly seen as 'dirty' jobs with poor working conditions and low pay. Shortages are also linked to the dearth of young people studying science, technology, engineering and mathematics (STEM).

Sheet-metal workers in most countries have gaps in their skills. This appears to be caused partly by a lack of qualifications of new recruits and partly by a lack of practical work experience during vocational training and a failure to keep trainees abreast of new technologies and IT.

The UK has skill gaps in more occupations than the other countries in the study. Some countries where newer occupations are only beginning to develop tend to report more skill gaps in basic areas of job competence than countries where the occupations are more established (e.g. Hungary and Slovakia).

Overall, gaps in practical and specific skills appear to be more common than in generic skills. However, some generic skills are becoming critically important for many occupations, for example sales and customer service skills for occupations engaged in delivering energy-efficient technologies to consumers and management and leadership skills in intermediate trades.

What are the future skill needs?

The shift to a green economy will not only generate new jobs, but will also change the scope and character of existing jobs.

Demand for energy auditors, electricians, SPV installers, sheet-metal workers and insulation workers is forecast to rise in most of the eight countries in the study. These occupations, which require medium-skill levels, have more growth potential than higher-skilled occupations, which employ fewer people.

Germany, Finland and the UK predict future increases in the number of jobs across the widest range of occupations. Southern and eastern European countries were less confident in predicting future skill needs because of a lack of national baseline data, the small numbers employed in some occupations and a highly uncertain outlook for the economy owing to the crisis.

Subsidies in Greece and Italy have raised awareness of the advantages of the Mediterranean climate for the use of SPV power. However, changes to legislation in the Netherlands and the UK are expected to reduce demand for energy auditors, SPV installers and insulation workers.

Demand for refuse collectors is expected to be stable, while demand for high-skilled workers involved in waste management collection and recycling activities is expected to increase in some countries including Germany, Italy and Slovakia.

Conclusions

What lessons from the study can help us to achieve the objective of having and deploying the skills necessary to develop a greener economy?

Regulation drives demand for energy efficiency

Improved economic growth is likely to increase investor and consumer confidence and stimulate demand for technologies, products and services to promote energy efficiency, waste reduction and environmental protection. However, policies designed to reduce energy consumption and greenhouse gas emissions and to increase the share of renewable energies are currently the main drivers of the demand of employers and private consumers for energy-efficient technologies and services. Consistent regulation and sustained investment in Member States over a prolonged period of time is likely to be required to ensure that the markets for these products and services become self-sustaining. For example, financial incentives need to be phased out gradually to prevent dependency on State funding and to avoid 'shocks' that could cause businesses to fail and jobs to be lost.

Better information and promotion

Developing demand in these sectors is, however, not just a question of regulation. Businesses and private consumers need to be better and more actively informed of the benefits of investment in energy-efficient equipment, systems, products and services, through better marketing and information, advice and guidance from governments. Businesses and consumers require more convincing evidence of the financial benefits before they invest, and it is up to governments to provide it. Furthermore, some forms of insulation and SPV systems may involve a substantial initial investment and lengthy payback periods. Support could therefore be targeted at those least likely to be able to afford the investment, such as SMEs and low-income groups, to ensure that the benefits of energy efficiency are distributed evenly.

Mainstreaming support needed to meet medium-term skill needs

There are very few examples of projects seeking to steer unemployed workers, young people or disadvantaged groups towards the target occupations. In the medium term, there may be growing latent, unmet demand for skills. More robust research is needed to assess the scale and significance of potential shortages. If shortages are found and action is not taken to ensure an adequate supply of high-level skills, particularly where lead times are longest, the development of energy-efficient technologies and services could be held back.

Moreover, if green skills are to be provided, existing curricula, qualification standards and training programmes will need to be revised and teachers and trainers will need to be retrained. Employers and training providers will need to work together over the long-term partnership to bring these changes about.

Promoting green career opportunities and raising the status of green occupations

National governments could do more to promote careers in some of the target occupations among young people through existing national systems of information, advice and guidance. This could help reduce youth unemployment and meet employers' concerns about a decline in the supply of new labour-market entrants. There may be a need to provide young people with opportunities to have a 'second chance' to acquire STEM qualifications and practical skills.

The potential contribution of several occupations to the greening of European economies is clear. The work of energy auditors, insulation workers, SPV installers and environmental engineers is regarded as unequivocally beneficial and central to a green economy. However, these occupations are not always widely known, and prospective employees are not necessarily aware that they are career options. This may be due in part to a lack of clear training routes into some of the occupations and in part to a relatively low profile or their novelty. Improving the status of these occupations could make the general public, policy-makers and learning providers more aware of the labour-market needs and opportunities created by the transition to a low-carbon, resource-efficient economy.

Skill needs forecasting methods need strengthening

Countries vary significantly in the degree to which they coordinate efforts to forecast future skill needs. While a one-size-fits-all approach is unlikely to be appropriate, there is potential for EU Member States to learn from one another, for example through continued support for exchange visits to countries where skills forecasting methodologies are relatively well developed, for example the Netherlands, Finland and the UK. Forecasting outputs could then usefully be fed into VET development and planning processes.

Further research gaps

This research is one of the first pieces of work to seek to systematically compare employment trends between occupations using European-level standardised data from the EU-LFS combined with the views of expert

interviewees, rather than forecasts of future employment trends based on econometric modelling. Possible improvements to the evidence base for the future are:

(a) improved data collection through the EU-LFS for some emerging occupations that may be central to the development of the green economy by, for example, tracking trends in the occupations of nanotechnologist, engineering technologist and solar photovoltaic installer (new ISCO 08 codes will in the future capture specific information only for energy auditors and environmental engineers), or collecting basic quantitative data at national level through specific surveys in collaboration with national and or EU-level sectoral associations;

(b) further research to identify the dynamics of occupational and internal labour-market change at sectoral level to help assess mismatches of skills within tightly defined occupational boundaries, focusing, for example, on obstacles to worker mobility between related occupations, the lack of recognition for some occupations as distinct jobs, or the adequacy of labour supply and skills mismatch;

(c) further analysis of trends in the age profiles of each occupation and the age of trainees to understand the exact nature of any mismatch in the supply of young workers for crafts/trades and in STEM occupations;

(d) analysis of the employment outcomes/destinations of those qualifying to work in each STEM occupation to improve measurement of entry into initial training/education for these occupations.

CHAPTER 1.

Introduction, purpose and objectives

1.1. Project aims and objectives

This research project was commissioned by Cedefop in December 2010 to identify the challenges and priorities for green skills in selected occupations and EU Member States. It aims first to ensure that education and training provision responds to the needs of businesses and enables them to take advantage of the opportunities presented by smart, sustainable and inclusive growth and, second, to help open up employment opportunities to individuals. The project therefore has the potential to help organisations and individuals to recover from the global crisis. It may also help EU Member States to tackle some of the challenges associated with the transition to a low-carbon, resource-efficient economic status, which promotes sustainable economic development and minimises the impact of human activity on the environment.

The rationale for the study lies in the effects of greening economies on skill needs. The transformation brought about by greening economies affects skill needs in three ways: first, structural changes lead to increased demand for some occupations and skill profiles, called green increased demand occupations (GIDOs), and decreased demand for others. This creates a need for training to enable enterprises and workers to move from sectors and occupations in decline to those that are growing; second, new economic activities generate entirely new occupations that require the provision of appropriate training courses and the adaptation of qualification and training systems to green new and emerging occupations (GNEOs); thirdly, and most pervasively, many existing occupations and industries experience a greening of existing jobs (green expanded skills occupations (GESOs), which leads to significant changes in the tasks and skills required of workers. This source of change in skill requirements is the most common and calls for a major effort to revise existing curricula, qualification standards and training programmes at all levels of education and training. All three sources of change – shifts between industries, development of new occupations and changing skill profiles within occupations – alter the skill profiles of occupations and thus affect training needs and delivery.

Policy has been identified as a major driver for the evolution of the green economy and associated skill needs, while the importance of integrating climate and environmental objectives across policy domains is often noted. Indeed, the

European Commission's Directorate-General for Climate Action and many national ministries have been created in recent years and are responsible for this task. Furthermore, understanding of the impact of policy and of the transition to greener economies at the occupational level is under-developed. In particular, the coherence of different inter-related policy areas and consideration of their impact on occupational skills and training needs to be investigated.

The main objectives for this research are therefore:

(a) to identify policy and regulatory trends in the transition to a green economy and their impact on skills for the occupations of interest;
(b) to understand the existing and potential interrelationship between skills, energy, employment, innovation, industry and environmental policies for these occupations;
(c) to understand where opportunities lie for skills policy to make a difference.

These objectives are to be met through a focus on identifying mismatches between the current and future skill demands of employers and the supply of skills from the education system in the case of nine selected occupations that may be affected by the development of 'greener' economies in selected Member States.

A summary of the research activities undertaken to achieve this is given in the next chapter. Details of the occupations and countries selected for study are provided in Table 1.

Table 1. **Occupations selected for study**

Occupation	Brief description	Skills level	Occupational category
Environmental engineer	Design and implement programmes and techniques to manage and mitigate environmental risk arising from industrial hazards, using knowledge of health and safety standards and regulatory requirements, modelling of environmental impacts using IT, and communication skills to advise and persuade colleagues and managers of the need to address risks.	High	GESO
Nanotechnology engineering technologist	Use technical skills and expert knowledge to design experiments, process nanoscale particles and eliminate contaminants, analyse lifecycle and environmental impact of nanomaterials, implement and guide production of nanomaterials and devices, use analytical skills to interpret results of experiments and communication skills to convey findings of experimental results.	High	GNEO

Energy auditor	Use practical knowledge of measurement tools and energy costs to conduct energy audits of buildings, building systems and process systems, documenting and reporting findings, relying on communication skills to advise consumers on methods for energy saving.	Medium	GNEO
Insulation worker	Select, measure and cut materials where necessary to line and cover structures with insulating materials, observing required safety standards and principles of construction and building practices.	Medium	GIDO
Solar photovoltaic installer	Design layout, assemble, install or maintain solar photovoltaic systems on roofs, ensuring safety and optimal positioning of panels to maximise energy generation, identifying, fixing and testing electrical connections required and documenting system used.	Medium	GNEO
Transport vehicle, equipment and systems inspector	Inspect, test and monitor transport equipment, vehicles or systems using suitable diagnostic equipment against appropriate benchmarks to ensure compliance with regulations and safety standards, documentation of results; may conduct investigations into causes of accidents and provide information to consumers and public organisations on vehicle fitness.	Medium	GESO
Electrician	Using knowledge of regulations and safety standards, interpretation of diagrams and practical skills to install, maintain, diagnose faults in and repair electrical wiring, equipment, and fixtures, eliciting users' needs and persuading them of requirements for change based on results of any diagnostic work.	Medium	GIDO
Sheet-metal worker	Interpret diagrams and drawings and use practical skills and/or computerised machinery and technologies to measure, cut, assemble, install and repair sheet-metal products and equipment, meeting required product quality and safety standards.	Medium	GESO
Refuse and recyclable material collector	Collect and dump refuse or recyclable materials from containers into truck, using judgement in sorting waste, operation of machinery and driving vehicle where needed	Low	GESO

Source: Cedefop, 2010a.

The Member States selected for this study are Germany, Greece, Italy, Hungary, the Netherlands, Slovakia, Finland and the UK. They represent countries which are at different stages of their journey towards the development of a low-carbon, resource-efficient economy. The selection of countries was intended to capture and represent a diverse range of experiences across Europe along with differences in size, date of EU accession and sectoral specialisation. They therefore include a mix of longstanding and recent EU Members States and have different approaches to VET, different industrial profiles and degrees of emphasis on environmentally sensitive economic development within current national policy.

1.2. Policy background – The implications of environmental change for economic development and employment

The project lies in the policy context of EU economic strategy and sustainable development strategy. The EU's economic strategy for 2020 stipulates that economic growth must be 'smart, sustainable and inclusive'. The sustainable dimension of growth refers to the long-term impact of economic growth on the natural environment and on European citizens. There are three complementary core EU 2020 targets for reducing environmental damage: a 20% reduction in greenhouse gas emissions in relation to the levels in 1990 (rising to 30% 'if conditions are right'); a 20% reduction in energy consumption from the levels predicted for 2020; and renewable energy sources to meet at least 20% of energy needs ([3]).

The EU sustainable development strategy adopted in 2006 and revised in 2009 seeks to ensure that Member States 'meet the needs of present generations without compromising the ability of future generations to meet their needs' ([4]). The strategy covers: climate change and clean energy; sustainable transport; sustainable consumption and production; conservation and management of natural resources; public health; social inclusion, demography and migration and global poverty. Within this policy, education for sustainable development (ESD) has been recognised as a key component to attain its goals because of the need to ensure citizens are equipped with requisite skills. The Council of the European Union published conclusions in 2010 calling for

([3]) http://ec.europa.eu/resource-efficient-europe/ [accessed 9.3.2012].

([4]) http://ec.europa.eu/environment/eussd/ [accessed 9.3.2012].

Member States to mainstream ESD within existing learning provision, from school to lifelong learning activities, through inter-disciplinary learning and it emphasises this is best achieved through personal experience in a real world context (Council of the European Union, 2010a).

A complex web of influences will ultimately affect the degree to which progress is made towards a low-carbon, environmentally sustainable economy in Member States. In addition to the influence of international regulation, Member States may adopt their own fiscal and regulatory policies to promote transition to a green economy, and these policies will interact with other factors affecting the development of different sectors. Such factors include the development of technology, climatic drivers themselves and, critically, the level of business and consumer demand for environmentally sensitive products and services (OECD; Martinez-Fernandez et al., 2010). The appeal of investment in green economic growth has been accentuated by the global economic crisis, as a result of which many governments have been seeking to reinvigorate their economies by redirecting their investment strategy. Supporting the transition to a low-carbon, resource-efficient economy is attractive because it encompasses the primary, secondary and tertiary sectors and is a societally unifying objective, in the long-term interest of all citizens. The European Commission has explicitly endorsed government action to help sectors benefit from low-carbon growth through its flagship initiative 'An integrated industrial policy for the globalisation era' and that of a 'Resource efficient Europe' adopted on 26 January 2011. The initiative includes provisions on support for sectors such as advanced manufacturing technologies including nanotechnology, construction, bio-fuels and road and rail transport, to improve resource efficiency. These provisions will be accompanied by a flagship initiative 'Transition to a resource efficient Europe' ([5]).

The long-term implications of the transition to a green economy for employment and labour markets are far from clear. As industries dependent on non-renewable energy sources decline, there will be a need to support their workers through labour market transitions, and low-carbon industries may offer good prospects to these workers (OECD, 2010). However, the potential scale and impact of green growth is considerable. The Council of the European Union (2010b) notes that economic sectors likely to experience most profound change in types and volumes of employment are agriculture and fisheries, beach and skiing tourism, infrastructure building, energy supply, construction and finance and insurance. Recent research by Cedefop identifies in addition renewable

([5]) http://ec.europa.eu/resource-efficient-europe/ [accessed 9.3.2012].

energy, energy efficiency, particularly in building and construction, transport, primary manufacturing and recycling sectors for basic materials (Cedefop, 2009). The timescale of the impact is also variable, with initial effects being felt in businesses that are being replaced by low-carbon alternatives, but later and wider impacts being felt in a wider range of industries, particularly once the initial cost of investment and technological development has fallen, which is likely to result in rising demand due to lower prices (European Commission, 2009). The impact may be felt more sharply in some areas such as renewable energy, where the relevant European Commission directive (2009/28/EC) requires Member States to ensure an adequate labour supply through appropriate vocational training and qualifications.

The employment impacts of a developing low-carbon, resource-efficient economy may be highly diverse. While there is some agreement that the effect of an environmentally sustainable economy on employment levels may be neutral or slightly positive overall, these effects are likely to be spread unevenly across countries, regions and different types of worker. The rate of progress of the Member States is also likely to be uneven, depending on their different starting positions, possible trajectories and aspirations. The impact on employment and skill demands may also be unevenly distributed over time, with initial sharp increases in employment to develop labour-intensive technologies possibly receding once a sufficient stock has accumulated. Within countries, difficult transitions may be encountered, especially for industries which are location-dependent due to the presence of natural resources or assets, where fostering worker mobility may be challenging. Workers with higher levels of skills are likely to find it easier to shift into new occupations or to acquire new skills to meet changing demands within their own roles (Council of EU, 2010b). There are consequently some risks that frictional unemployment may turn into structural unemployment unless suitable measures are deployed to mitigate such risks.

1.3. Implications for skill needs and training provision

The level of skills required for occupations affected by the greening of the economy will be highly variable. Much research has focused on the need to generate a labour supply to meet demand for relatively few high-skilled technology roles, but operational and maintenance roles will be required to sustain the infrastructure developed. The relative demand for different levels of skills must, however, be considered against a backdrop of a general demand for increased volumes of higher-level skills, or even better (Cedefop, 2010a).

Several studies have already been conducted to understand the likely nature of skill demands for 'green' jobs. A recent report for the European Commission on job prospects arising from restructuring finds that policies on climate change have created skill shortages in sectors such as renewable energy, energy and resource efficiency, building renovation, construction, environmental services and manufacturing. There are also examples of occupational shortages at national level, namely energy auditors and solar panel installers in France (OECD, 2010). However, the OECD concludes that 'much remains to be learned about the types of skills that will be in increased demand' (OECD, 2010).

Cedefop has already undertaken much work in this area and developed an understanding and definition of 'green' skills. This term refers to 'the knowledge, abilities, values and attitudes needed to live in, develop and support a society which reduces the impact of human activity on the environment' (Cedefop, 2010a). This is the definition used in this project. It is broad definition in terms of both the scope of what is meant by 'skills', which encompasses beliefs as well as technical capabilities, and the potential range of jobs which could become 'green'. The United Nations environmental programme takes a slightly narrower definition, naming specific sectors but including jobs through which waste creation and pollution are minimised, which potentially includes a range of pertinent jobs. The International Labour Organisation (ILO) includes jobs in any sector that has a lower than average environmental footprint, and Eurostat focuses on jobs specifically in the environmental goods and services sector. Some of the occupations studied in this report such as solar photovoltaic installer, energy auditor, insulation worker and environmental engineer are clearly central to the green economy, while others, such as sheet-metal worker, electrician, transport vehicle emissions inspector, nanotechnologist and refuse collector, may lead to a beneficial environmental impact owing to their particular specialisation or changes in the nature of their work.

There is an important distinction to be made between changing job content arising from low-carbon economic growth and changing job numbers arising from the same factor. This leads to several classifications or typologies that can be used to understand how skill needs are changing and that share many common elements. The important dimensions include:

(a) any change in the level of skill required;
(b) any change in the type of skill required;
(c) whether the skill is required within an existing occupation or a new occupation;
(d) whether the job is required within a new industry or within an existing industry.

It is important not to assume that skill gaps in these occupations are confined to 'green' skills linked to the technical content of the occupation. Rather the skill gaps of those highly specialised in STEM skills may lie in the areas of leadership, risk management, design, communication or commercial and entrepreneurial skills (Cedefop, 2009). Similarly, research for the European Commission has shown a general need for the technical diagnostic skills required to assess the carbon footprint of individuals and organisations, and for design, planning and installation skills in the renewable energy sector, where new systems will be required (European Commission and GHK, 2009). Managers may require the skills necessary for the promotion and consolidation of commitment to 'green' business life cycle analysis, financial modelling of the return on investments in resource-efficient technology, performance monitoring and reporting and sustainable procurement (European Commission and GHK, 2009). Overall these kinds of 'green management' skills emerged as highly important in an analysis of skill needs across multiple sectors in the EU (European Commission and Oxford Research, 2009). Those in lower-skilled roles may need to understand the impact of changing regulatory and environmental priorities on their existing skills and tasks.

There is relatively little detailed and reliable information available about skill needs in some of the occupations of interest in sectors which are likely to be profoundly affected by the 'greening' of the economy. Moreover, how policies on the economy, energy, skills, employment, the environment and innovation influence the demand and supply for these occupations is as yet poorly understood. Research reveals a weakness and fragmentation of the Member States' planning and coordination of policy on forecasting skill needs with a view to ensuring an adequate supply skills for the low-carbon economy (except possibly in France) (Cedefop, 2010a). The Member States also have very diverse responses to skill needs, ranging from centralised updating of the curricula of tertiary programmes to regional and/or market-led development of training, depending largely on the structure of the VET systems in the different Member States.

These findings have implications for further research into the education and training requirements addressed by this research project. It is important to be aware of the existence of and to understand reasons for any mismatch between the supply of and demand for skills, to understand the attitudes of employers and training providers towards the expansion potential of the low-carbon economy and to provide advice to policy-makers on how skills policies and initiatives could be used to promote the development of a greener economy. The potential benefits are threefold: economic growth and more employment;

better long-term mitigation of environmental damage; and a lower risk of harmful effects.

1.4. Methodological approach and report structure

This study employs a range of qualitative and quantitative methods to ensure a more comprehensive approach. The strands of this research approach are:

(a) desk research and analysis of relevant and up-to-date policy documents and literature. An analysis of the policy context was prepared for each country highlighting key developments in the areas of energy, environment, innovation, industry, employment and skills. This analysis provides a context within which to interpret the empirical findings for each country and to establish whether there are any links between levels of policy effort and developments in the occupations of interest;

(b) in-depth interviews were conducted with staff from trade unions/employers' associations in the relevant sectors and with learning/training providers currently offering training to the relevant occupational groups. Additionally, a sample of learning providers and employers was asked to participate in an online survey. The advantage of in-depth interviews is that those training or employing workers in the individual occupations are likely to be able to provide more detailed information on changes in skill needs. However, the disadvantage of relying on a single interview for each occupation is that the interviewees may not have perfect knowledge of all organisations in the relevant sector, which means that alternative data sources must be used. In total, 54 learning providers and 84 employers replied to the online survey. During the study, 72 experts were interviewed, although it was not possible to interview an expert for all occupations in all countries (e.g. where occupations did not yet exist);

(c) the European labour force survey (EU-LFS) analysis provided an overview of changes in employment levels and trends. The advantages of using data from a large-scale survey are that they can provide some measure of the scale of employment volumes and trends and comparability between countries. Analysis of the numbers of individuals in each occupation, their qualifications and demographic characteristics has been conducted at national level since 2005 in all countries where the occupational classification is available at level 4 of the international standard classification of occupations (ISCO). Data are not available for Greece, Italy and Germany (a fuller description of the analysis procedure used for these data can be found in the Annex).

Finally, a validation workshop was held in London with experts from different EU Member States to discuss the implications of the research and policy recommendations.

The rest of the report is divided into eight further chapters.

Chapter 2 provides a summary of the extent of each country's efforts and outcomes in a range of policies with the potential to stimulate the development of a green economy, including energy, the environment, innovation, industry, employment and skills.

Chapter 3 summarises the employment volumes, trends and demographic characteristics for workers in each occupation, broken down by age and sex, drawing on EU-LFS data supplemented by estimates gathered from interviewees and national statistics where available.

Chapter 4 outlines the recruitment methods, qualifications and entry requirements laid down by employers or any regulation on recruitment to each occupation. This gives a picture of the basic level of educational and vocational achievement that workers need, which is important for understanding any subsequent skill gaps or skill shortages.

Chapter 5 outlines current skill needs in terms of skill shortages and skill gaps among existing workers, and the actions taken by employers and/or governments to remedy them directly or indirectly.

Chapter 6 outlines future skill needs using expected general trends in the number of jobs and the types of skill needed and the views of learning providers about the sources of demand for new skills.

Chapter 7 outlines the volume and type of continuing vocational training received by existing workers, the problems and challenges facing employers and training providers in offering training, and the future drivers of changing demand.

Chapter 8 presents a summary of the study's main findings, recommendations and policy implications.

CHAPTER 2.

Comparative summary of relevant policies in each country

This chapter summarises the main findings concerning policies on energy, the environment, innovation, industry, skills and employment in each of the eight countries included in this study, and it highlights the implications of these policies for demand for labour, supply and skill requirements in the occupations of interest. The analysis is not an attempt to cover every aspect of national policy but rather to capture broad trends in major policy initiatives and strategies and the links between them, with particular emphasis on the areas of most relevance to the occupations under investigation.

2.1. Major policy trends

What emerges most strikingly from a comparison of how the Member States use policy to promote the development of a green and sustainable economy is the uneven and often non-existent coordination of social policy measures, industrial and innovation policy measures and policy measures directly concerned with energy and the environment. There are, for example, relatively few cases of governments adopting specific employment policy measures to steer individuals towards employment in green occupations, although there is some evidence in Germany and the UK of efforts to improve science, technology, engineering and maths (STEM) skills and to promote careers in which they are in demand.

A comparison of the energy policies of the Member States reveals a relatively widespread commitment to the use of targets for achieving a reduction in carbon and greenhouse gas emissions and energy consumption. These targets vary between EU countries, with Germany, the Netherlands, Finland and the UK seeking to exceed their share of the EU 2020 targets. Tax incentives to encourage use of renewable energies are a feature of policies in Italy, the Netherlands, Finland and the UK and have more recently been introduced in Hungary. However, recent policy reviews and public spending cuts as a result of the economic crisis have led to a partial reduction in green incentives in some countries. Feed-in tariffs for solar photovoltaic energy have been introduced in Greece, Italy, Germany and the UK. The Netherlands has actually reduced direct income tax to offset increases in energy taxes, offering consumers the chance to pay less tax if they are able to use less non-renewable energy.

Policies tend to vary depending upon each nation's track record in developing alternative energy sources. In Greece, the solar energy industry has previously received financial support under the country's energy policy, but the sector is much less well developed in the Netherlands and Finland, while Germany has a well-developed sector resulting from its strengths in engineering manufacturing and as one of the world's biggest solar panel producers. The UK plans to introduce payments for surplus micro-generation of energy by consumers, and taken together with similar incentives in other countries, this may lead to increased demand for solar photovoltaic installers.

Most countries have policies to encourage energy efficiency, ranging from providing information, advice and guidance to businesses and consumers to the mandatory requirements of European law. One common requirement is the imminent implementation of the Directive on the energy performance of buildings (European Parliament and Council, 2002). This may lead to increased demand for energy auditors in some countries, particularly those in which energy monitoring of buildings is less well developed, including Greece, Hungary and Slovakia. (Greece has imposed a particularly stringent requirement for those wishing to become certified energy auditors: they must 10 years' previous experience).

All countries are demonstrating a commitment to reducing energy consumption and adopting measures to improve energy efficiency. This could increase the demand for insulation workers, electricians and solar photovoltaic installers, but it will depend on the existing supply of workers, which is related to how developed the industry is and how construction and related sectors have fared during the recession. A surplus or shortage of workers could be produced depending on whether workers in these occupations have left the sector for other careers.

The environmental policies of the Members States vary widely in terms of their focus, targets and policy instruments. They include a focus on waste minimisation with: a new regulation on waste management in Finland; the establishment of targets and investment in recycling; car scrappage schemes in Germany, Italy, Slovakia and the UK; promotion of public transport in Italy; targeted reduction of carbon emissions for vehicles and introduction of new taxes on car ownership (the Netherlands and Finland). Specific policies in particular countries include flood avoidance and mitigation measures in Hungary and Slovakia and efforts to regenerate brownfield sites and restore historic buildings. The Netherlands in particular has used regulation and infrastructure provision to develop an extensive recycling programme, as has Germany, but in some countries including Greece and Italy, policy efforts to encourage recycling have been less intensive and to date, they have not been

particularly successful. Broader environmental protection policies are very mixed, with Germany having more developed land use policies but other countries – for example Italy and the UK – devolving planning responsibilities to the local level. Germany and Finland have relatively well developed mechanisms for introducing environmental awareness into the school curriculum. In other Member States such initiatives are voluntary (the UK), still in the planning stage (Hungary) or vary in sophistication owing to regional responsibility for implementation (Italy).

These policies are likely to increase the demand for environmental engineers, solar panel installers, electricians and insulation workers. The level of demand for refuse collectors may be influenced by the existence of opportunities to transfer to roles in recycling and by the scale of the development of the recycling sector in each country. The impact on the demand for transport vehicle emissions inspectors is uncertain; where 'cleaner' cars are introduced and inspections become less frequent, fewer inspectors may be needed. The introduction of car scrappage schemes may temporarily reduce the demand for inspectors as new vehicles will not require inspection. Otherwise the introduction of tougher carbon emission limits is likely to change the nature of the work rather than the number of people required to perform it.

There is considerable variation between the Member States' innovation policies Member States, and in particular the extent to which they focus funds on the industries that employ the occupations of interest and the level of development of national innovation systems. Moreover, some innovation policies are broad-based. For example, Slovakia is beginning to create an innovation infrastructure and aspires to become a knowledge economy, but it has no sectorally targeted policies, while Germany's approach focuses on reducing barriers to innovation through a favourable tax treatment and increasing the supply of young people for R&D roles under an innovation strategy developed in 2006.

Some countries have chosen a different approach and have adopted specific policy instruments to support innovation in sectors employing the occupations of interest. Many of these instruments include renewable energy and energy efficient technologies (Greece, Italy, Hungary, the Netherlands, Finland and the UK). Finland is investing in power electronics, waste recycling, clean combustion technologies and environmental monitoring tools. Italy has numerous, overlapping innovation funding programmes at regional level but they lack integration and coherence. The Netherlands and the UK are targeting funds at nanotechnologies. Greece has made commitments to fund projects to support the development of the renewable energy and nanotechnology

industries but these projects may be scaled back, delayed or not implemented owing to the country's current economic and economic crisis.

All countries have set policy priorities to encourage innovation among SMEs, often drawing on EU funding. This suggests that innovation in the broad sectors of renewable energy and energy-efficient technologies may be market-led. There is likely to be some increased demand initially for higher-skilled roles in the R&D phase of product and service development, particularly in nanotechnology, but for occupations connected with manufacturing or installation, the extent of any expansion in employment or in the demand for new or higher level skills will depend on the development of these industries.

Approaches to industrial policy vary considerably in the degree to which countries target particular industries for policy support. Germany has a strategy of fostering growth across industrial sectors and supports exports of environmentally friendly technologies, building on its existing strengths in solar panels and wind turbines. Slovakia supports a broad-based knowledge economy without sectoral specificity. Italy does not have a fully developed industrial policy but has put in place horizontal measures to support SMEs and service sector enterprises. Finland's industrial policy is strongly linked to its innovation policies and is focused on supporting industrial clusters including energy and transport. Other countries are more selective in their support and some include energy efficiency, renewable energy technologies and public construction and renovation projects as target areas for support. These countries include the UK, Hungary, which is targeting construction and transport, and Greece, which is targeting environmental services, landscaping and materials science among others. However, the extent to which Greece will be able to provide funds to support these sectors is unknown.

The impact of green policy on skill needs is likely to be quite broad. Germany is likely to see increased demand for sheet-metal workers to service its solar panel production industry and perhaps nanotechnologists for the development of new energy-efficient technologies. Greece, Hungary and the UK may see increased demand for insulation workers and electricians for construction projects and for nanotechnologists to help develop new energy-efficient technologies, as well as environmental engineers to mitigate the environmental impact of development. Hungary may experience increased demand for vehicle emissions inspectors if the number of vehicles increases as a result of the construction of new roads. All the countries that intend to support energy efficiency and environmental services may see a growing demand for energy auditors.

Most countries focus their employment policies on job creation because of the global recession, but the extent to which they develop jobs schemes in

industries that provide environmentally friendly and energy efficient goods and services varies. Some of these schemes target specific groups in the labour market including younger workers, women and older workers. The major policies are shown in Table 2, and trends across countries are then summarised.

Greece and Italy, where a large proportion of young people are unemployed, provide training programmes to help this group find work in the renewable energy sector. Italy and Hungary also encourage the labour-market participation of women. Italy does this by promoting green jobs in female-dominated sectors and promoting jobs for women in the energy sector and Hungary does so by providing childcare support. Greece and Finland have programmes to create jobs in public sector construction projects. The Netherlands has programmes to create jobs in the renewable energy and energy efficiency sectors. These initiatives are likely to create a demand for energy auditors, insulation workers and electricians for public sector construction projects.

Finland and the UK use a combination of regulations and policy, and Germany uses training programmes to encourage older workers to find employment. Hungary, Slovakia and the UK encourage employers to hire workers – in Hungary and the UK through employment regulation reform and in Slovakia through the employer's social security contribution.

In several Member States there appears to be relatively little integration of industry and employment policies, which raises questions about the extent to which skill needs in expanding industries will be met. However, because of the recent recession and public sector spending cuts, for the next few years there is likely to be a surplus of labour to meet employers' demands for medium-level skills.

National policies on skills are critical to ensure that the supply of skills is adequate to meet labour market demands. Many countries gear their policies to increasing the proportion of adults with higher levels of education, including post-compulsory education and graduate level education. Some Member States, including Greece and Hungary, are keen to reduce school drop-out rates.

There is a marked variation in the extent to which the Member States investigated have both a VET infrastructure and a coordinated approach to identifying skill needs and signalling labour-market demand to individuals. Slovakia is in the process of setting up a VET infrastructure to build labour-market needs into the planning of training provision at the local and regional levels, but this is in the early stages of development. In Italy, the provision of vocational education is patchy and there is a need to boost vocational training as an alternative to tertiary education because new entrants to the labour market are commonly found to have acquired only theoretical rather than

applied knowledge. Germany and Finland have more comprehensive and integrated systems with multiple pathways and re-entry routes to different forms of education. The UK is currently seeking to raise the level of the basic qualifications of school leavers and increase employers' ownership of and their contribution to the funding of training.

The planning of skill needs is relatively sophisticated in the Netherlands, Finland and the UK, using numerous sources of evidence and modelling techniques. In Germany employers and unions jointly plan skill needs through the dual system. There is limited skill need planning in Greece and Italy. Both Hungary and the UK are overhauling their careers advice systems and Germany and the UK are placing more emphasis on making young people aware of the potential benefits of developing STEM skills. Most countries have adopted policies to raise basic skill levels, and Germany and Finland have championed policies to support older workers to change careers. There is evidence that, as countries reduce public sector spending, public funding of qualifications may be reduced and targeted at those who are most disadvantaged. Thus, in the UK adults who already have basic school-leaving qualifications or the equivalent will be required to contribute to the cost of any additional qualifications they seek. Most countries are promoting entrepreneurship and self-employment and employment growth through small firms, and it may be difficult for fledgling businesses to fund training for staff in new technologies and emerging occupations. Moreover, individuals who have lost their jobs may also find it hard to fund the full cost of a change of career. Evidence from countries including Germany and the UK suggests that there may be some skill shortages for higher-skilled roles, including nanotechnologist, partly because of the amount of time required to educate individuals for such roles. It will therefore be important for countries to monitor skill shortages and gaps to ensure that a lack of skilled labour does not hamper the development of new technologies in the emerging environmental goods and services sector and hence economic recovery.

Table 2 compares main policy trends across countries.

Table 2. **Comparing major policies across countries**

	Major energy policy trends	Environmental policies	Innovation policies	Industrial policies	Employment policies	Skills policies
IT	Financial measures to encourage use of renewable energy sources and energy efficiency, driven partly by compliance with EU legislation. Potential for SPV installers.	Financial incentives for adoption of efficient or carbon-free transport, car scrappage scheme, green public procurement policies and promotion of recycled products. Limited evidence of change in waste disposal.	Many, overlapping policies with emphasis on financial schemes, often at regional level. Some of these are targeted at businesses to encourage R&D in energy efficiency and sustainable transport.	Focus on cross-cutting measures, e.g. support for SMEs rather than sectoral support, which is mostly focused on service sector and state-owned firms. Very weak and unsystematic approach.	Targeting of unemployed women to take up green jobs in the energy sector and promotion of energy saving roles in female-dominated sectors including health, education and care. Rapid development of jobs in renewable energy sector from a low base.	Complex legislative framework and frequent reform but no national coherent training strategy. Most training is financed privately by companies or workers, supplemented by ESF national funds and sectoral training funds.
EL	Strong recent policy support but limited government investment, now exacerbated by economic crisis. Targets for renewable energy use. Targets for reducing energy consumption and expanding use of renewable energy.	Goal to achieve compliance with EU targets for greenhouse gas emissions and to integrate environmental sustainability principles within key sectors, e.g. tourism, and to develop clean manufacturing processes.	Emphasis on innovation in renewable energies and nanotechnology but numerous fragmented programmes with broad definition of eligibility and weak implementation of policy hinder development.	Industrial policy currently under review. Priority sectors to date are tourism, culture, energy/environmental services, health, materials science with green issues cutting across these but few concrete policy measures.	Targeted training programmes for unemployed graduates in tourism and sustainable development, waste management and environmental conservation. Status of this scheme unknown due to economic crisis.	Focus on integrating environmental education within the curriculum. Additional courses on environmental awareness and management provided to unemployed citizens. Training provision for existing workers much more patchy.
HU	Wide range of policy initiatives to stimulate green economy including energy efficiency and development of renewable sources, using tax incentives and other measures.	Environmental protection has low priority. New strategy for Danube region concerning air, water and land quality adopted in 2011 but impact not yet evident.	Major overhaul of innovation policies with improved institutional support. SMEs and eco-innovation in nanotechnology, energy efficiency are prioritised.	A new Green Economy Programme and programmes to create residential buildings and new transport routes explicitly target industries which employ relevant occupations.	Measures to tackle low employment through reform of tax system, incentivising employment through benefit system reform.	Focus on increasing proportion of population with first degrees and reducing dropout rates from education. Development of VET system and improvement of careers advice.

SK	Compliance with energy efficiency policies and requirements for energy audits leading to demand for insulation workers and energy auditors.	Sustainable development policy to foster urban renewal, village and rural regeneration, promotion of waste reduction measures and reduction of energy consumption. Car scrappage scheme.	No strong history of policy intervention. Creation of an innovation infrastructure and plans to build a knowledge-based economy but no specific general measures to promote eco-innovation.	Focus on development of a knowledge economy without sector specificity. Could allow growth of high-skilled jobs, e.g. nanotechnologists and environmental engineers, which may not, however, be very significant.	General reduction in social security contributions planned combined with incentives for unemployed. Plans to attract foreign-owned businesses to expand employment prospects.	Infrastructure reforms to set up local and regional sectoral councils. Requirement for schools to consider labour market needs in planning curricula. Demand for occupations of interest dependent on a devolved and market-driven education system.
FI	Use of energy taxes and promotion of renewable energy sources. Solar photovoltaic power use is marginal and other renewable energies are being promoted by government, leading to limited potential demand for installation workers and sheet-metal workers.	Longstanding taxes on carbon and electricity use and tax incentives for use of renewable energies, further emphasised by recent green fiscal stimulus package. New law on waste management may shift demand for jobs to plant management instead of collection.	Relatively high levels of R&D funding targeted at power electronics, waste recycling, clean combustion technologies, and environmental monitoring.	Strong and broad-based support has enabled development of industrial clusters including construction, health care, forestry, energy and transport. Relatively strong integration of science, industry and innovation policy.	Fiscal stimulus package for housing renewal, building and public construction projects may stimulate demand for insulation workers, electricians, sheet-metal workers and environmental engineers.	Extensive training system segmented to meet needs of different groups in labour market reflecting policy commitment to lifelong learning. Use of sophisticated labour supply/demand models to plan educational provision and inform careers guidance.
NL	Ambitious targets for carbon emissions reduction and of renewable energy use and tax incentives for adoption of energy efficient systems.	Extensive and successful policies to encourage recycling and minimise waste including infrastructure for recycling at local/national levels.	Extensive funding for investment in renewable energy technologies and energy-efficient buildings and construction. Public investment and public/private funding to support nanotechnology development.	Relatively liberal tradition of trade policy, support for establishment of business networks and strong profile in electronics, ICT and engineering and expertise in waste management and recycling.	Explicit incorporation of green policies to address unemployment effects of global recession including funding for renewable energy and energy efficiency programmes to create jobs.	Well-developed training and education system and use of sophisticated labour supply/demand models combined with employer surveys to plan educational provision and inform careers guidance.

DE	Significant track record of investment in renewable energy sources resulting in well-developed sector and promotion of solar energy generation. Investment of funds to improve energy efficiency of buildings.	Strict targets for reduction of greenhouse gas emissions and action plans for tackling climate change being drawn up at state level, car scrappage schemes. Education and information service for children and young on environmental matters run by Ministry of Environment.	General policy of fostering conditions for innovation through reducing regulation and creating favourable tax regime; focus on stimulating business start-ups and attracting young people into primary science disciplines to boost human resources to enable R&D.	Broad set of policy measures focused on creating favourable infrastructure for enterprise rather than targeting sectors. Some focus on supporting export of environmentally friendly technologies building on national engineering expertise.	Retraining policies targeted at older workers, for example, combined with strengths in renewable energy and energy efficiency activities may lead to employment opportunities in these fields.	VET system is characterised by strong links between employers, unions and training providers. National system of occupational classification linked to training provision can cause some inflexibility and delay in development of training provision to meet new skill needs.
UK	Energy reduction targets exceed those set under EU 2020 strategy. Financial incentives planned to encourage investment in energy saving systems.	Numerous measures to monitor energy consumption including Energy Performance Certificates, building regulations. Regulation has demanded formal qualifications for energy auditors and electricians.	Tax credits for SMEs. New set of technology innovation centres being established to commercialise good ideas. Funding for development of environmental and nanotechnologies.	Low-carbon environmental goods and services named a priority growth sector. Low-carbon industrial clusters and demonstration projects receiving funding.	Major reform and simplification of benefits system with sanctions to encourage unemployed people into work. Ending of default retirement age may prolong working life.	Large expansion of apprenticeship places and development of new body for employers to develop qualifications for low-carbon economy.

Source: Authors.

CHAPTER 3.

Employment trends in selected occupations in selected Member States

3.1. Introduction

Using data from the EU labour force survey (EU-LFS) and from qualitative interviews conducted during the study, it is possible to describe employment across occupations and countries, and to analyse in particular the scale of employment in the occupations of interest; levels of employment in the occupations across selected countries; and employment trends over the past three years in these occupations.

In spite of the data limitations described below, the level of employment and changes in the level can provide useful information about the scale of skill needs in green occupations and across countries.

3.1.1. Limitations and strengths of data sources

Before reporting on levels of employment and trends in these levels, it is necessary to highlight some key points which affect the comparison of results across occupations and countries. All data reported have strengths and weaknesses in relation to the objectives of this study.

3.1.1.1. *EU labour force survey data*

The EU-LFS provides consistent data on employment levels and trends across selected countries for occupations identified by selected ISCO codes. However ISCO codes do not always correspond closely to the target occupations (Table 3). In particular, for five of the nine occupations, the ISCO codes clearly overestimate the level of employment owing to the inclusion of occupations outside the scope of the study.

In addition, some EU-LFS data are not publicly available and therefore have not been supplied. No EU-LFS data for any occupation are available for Germany, Greece and Italy. For the UK no data were provided for code 7134 ‘insulation workers’. This could be due to either a mismatch between national and international classifications or problems with the reliability of data provided at national level.

Table 3. **Mapping of ISCO-88 codes for EU-LFS analysis**

Occupations	ISCO-88	ISCO job title
Nanotechnology engineering technologist	Part 2146	Chemical engineers
Environmental engineer	Part 2149	Architects, engineers and related professionals not elsewhere classified
Energy auditor	Part 3152	Safety, health and quality inspectors
Solar photovoltaic installer	Part 7241	Electrical mechanics fitters and servicers
Insulation worker	7134	Insulation workers
Electrician	7137	Building and related electricians
Sheet metal	7213	Sheet-metal workers
Transport vehicle equipment and systems inspector	Part 3152	Safety, health and quality inspectors
Refuse and recyclable material collector	9161	Garbage collectors

Source: Authors.

3.1.1.2. *Interpreting the ISCO codes for EU-LFS analysis*

The EU-LFS analysis is based on the selection of occupations at the level of four-digit ISCO-88 codes to guarantee that the codes selected are most likely to cover the occupations identified in this study. Nevertheless, in some cases there is a partial mismatch between the ISCO codes and the occupations due to several factors.

In some cases the ISCO codes are broader than the occupations, and some occupational codes apply to several occupational groups as they include professionals from different disciplines working in different fields. This is the case for:

(a) nanotechnology engineer: nanotechnologies are developed and applied in several disciplines (e.g. electronics, physics, chemistry, etc.). Therefore workers classified under other occupational codes may be working in the nanotechnology field but will not be covered by the EU-LFS analysis;

(b) energy auditor: this new occupation attracts professionals from different disciplines (e.g. architects, engineers, safety inspectors, etc.). ISCO code 3152, which covers the occupation of 'energy auditors', also covers 'transport vehicles equipment and system inspectors'. Therefore some of the workers classified under this ISCO code may not be working as energy auditors. It is also possible that workers covered by other occupational codes may be working in roles which involve energy assessment and auditing;

(c) solar photovoltaic installers and designers are included under the ISCO code 7241 'electrical mechanics fitters and services' but workers classified

under code 7137 ‘building and related electricians’ may also be working in this occupation;

(d) environmental engineers are classified under the broad code 2149 ‘architects, engineers and related’, which contains additional occupations. Therefore some of the trends in the data for this code may be due to developments that relate to other engineers and architects.

Consequently, the employment estimates for these occupations may be inaccurate and unreliable, which can be partly compensated for by using alternative data sources. However, the alternatives may also be unreliable since they are based on the estimates of informants rather than nationally representative large-scale data collections.

The new ISCO-08 classification is a more accurate indicator for some occupations (e.g. energy auditing has a separate code and a distinction is made between refuse/recycling roles), but it is not currently available from Eurostat.

3.1.1.3. *Data gathered from interviews and national sources*

Interviews and national sources sometimes provide more accurate data on selected occupations, but they are not based on methodologies that are consistent and systematic across countries and they rely on the interviewees’ knowledge of specific sectors, which may be incomplete.

In some countries there are no official statistics for these occupations. This is because:

(a) they have developed from existing occupations (e.g. SPV installer from electrician);

(b) some of the new occupations are not officially recognised (e.g. nanotechnologist);

(c) some occupations do not have a national occupational framework (e.g. energy auditor);

(d) in some countries fragmentation of the labour market and of the administrative bodies responsible for the data made it impossible to collect national data and make national estimates.

Countries such as Germany and the UK have more readily available national statistics and therefore it was relatively easy for interviewees to make estimates. In countries with an exceptionally fragmented economic and administrative structure, such as Italy, it is generally more difficult to gather aggregate data at national level on sectors and occupations. Interviewees were therefore much more reluctant to provide information on employment trends.

3.1.1.4. *Comparing data from different sources*

Before discussing trends across occupations and Member States, it is worth noting how findings vary depending upon the sources used and the implications for comparability of employment trends.

Comparative analysis of countries and occupations is useful but requires caution because of differences between economies. For example Germany, Italy and the UK are among the biggest European economies and any comparison with countries like Hungary or Slovakia needs to take into account differences in the size and type of economies. For example, trends derived from EU-LFS data are likely to be more negative owing to the presence of smaller or weaker economies such as Slovakia and Hungary in the absence of larger, more productive economies such as Germany.

The EU-LFS data and sometimes national sources may overestimate, or in some cases underestimate, the numbers of people working in the occupations of interest because the categories used for each occupation may either be too broad or cover the number of employees in a sector rather than the precise occupation of interest. There may be overlaps between occupations, as ISCO codes are interrelated and cover similar fields, for example code 7137 'building and related electricians' which cover electricians and code 7241 'electrical mechanics and fitters' which covers SPV installers are likely to contain very similar occupations.

3.2. Volume of employment in selected occupations

The first signs of the economic crisis appeared in 2008, and by 2010 all Member States were in the midst of a deep recession hitting many sectors. Unemployment increased throughout Europe with all the countries included in this study seriously affected, except for Germany. The economic crisis badly affected employment in manufacturing and construction. Between 2008 and 2010, 3.9 million jobs were lost in manufacturing (10.4%) and about two million (10.7%) in construction ([6]). This should be borne in mind when interpreting the data presented in this study because a number of the occupations of interest – electrician, insulation worker, SPV installer, energy auditor and environmental engineer – are in the construction sector, while sheet-metal worker and some nanotechnologist are in manufacturing, so while there might be a potential for

([6]) See Cedefop, statistics and indicators, *How economic sectors are doing in the crisis.* http://www.cedefop.europa.eu/EN/articles/18218.aspx [accessed 12.3.2012].

growth for these occupations, actual growth may be hampered by the overall state of the sectors concerned.

Before looking at the absolute and relative number of jobs in green occupations in the different countries, it is interesting to look at the significance of each occupation within the wider group of occupations selected for this study. Table 4 shows the share of the selected occupations in five Member States.

Table 4. **High, medium and low share of total employment in selected occupations in 2010 (EU-LFS data)**

	FI	NL	UK	HU	SK
Nanotechnology engineering (part 2146 ISCO code)*	M	L	L	L	L
Environmental engineer (part 2149 ISCO code)*	H	H	H	H	L
SPV installer/designer (part 7241 ISCO code)*	H	M	L	M	H
Insulation worker**	L	L	n/a	L	L
Electrician**	H	H	H	H	H
Sheet-metal worker**	H	L	M	L	L
Energy auditor/transport vehicle system inspector (part 3152 ISCO code)*	L	L	M	H	H
Refuse and recyclable material collector**	L	L	M	L	H
Total employment in selected occupations as share of total country employment	L	M	M	H	H

* Includes people working in other occupations.

** Includes only people working in the selected occupation.

Source: Eurostat EU-LFS 2010; own calculations.

Employment levels vary markedly between occupations and countries. This is partly due to the fact that the ISCO codes do not always correspond closely to the occupations under study. This may lead to overestimates for occupations which include people working in other occupations in addition to those of interest to the study (e.g. SPV installer and energy auditor).

Based on the average employment for the selected occupations in the five countries, the occupations can be divided into three groups – large, medium and small – according to the number of jobs in each:

(a) occupations with a large number of jobs are: electrician and environmental engineer;

(b) occupations with a medium numbers of job are: energy auditors and transport vehicle inspector; sheet-metal worker, SPV installer and refuse collector;

(c) occupations with a small number of jobs are nanotechnologist engineer and insulation worker.

According to estimates gathered during interviews with employers' organisations and learning providers and from desk research, employment levels mirror the EU-LFS statistics, although with some differences.

Occupations with a large number of jobs are: electrician and environmental engineer, driven by large numbers employed in the major economies of Germany and the UK. Occupations with a medium number of jobs are: sheet-metal worker, refuse collector, nanotechnology engineer and transport vehicle inspector. Occupations with a small number of jobs are: energy auditor, SPV installer and insulation worker.

Bearing in mind the limitations of the data available, the main discrepancies between the EU-LFS data and the interviewee's' estimates concern the occupations SPV installer, nanotechnology engineer and energy auditor, while results for the other occupations results appear to be consistent.

3.3. Changes in employment volumes

Trends in employment from 2008 to 2010, based on EU-LFS data, reveal that the occupations that have gained the largest number of jobs over the past three years are insulation worker and electrician, while the number of jobs for sheet-metal workers and refuse collectors has remained virtually stable and has tended to decline for the other occupations. Of course these trends are affected by the current economic crisis. Comparing the trends for the selected occupations with the average trends for total employment in the observed countries provides a different picture. Performance is above average for most of the occupations, namely insulation worker, refuse collector, electrician, nanotechnology engineer, sheet-metal worker and environmental engineer. Only the occupations of SPV installer and transport vehicle inspector/energy auditor have experienced a relative decline.

Rising trends for all occupations are found mainly in the UK, although in Finland too the selected green occupations perform well compared to the trend for total employment. Countries with more negative trends are Hungary and Slovakia.

The experts interviewed did not always confirm the results of the EU-LFS analysis on employment trends. Interviewees from Germany and Finland tended to report job growth across most occupations except for refuse collector, sheet-metal worker and, in Germany, electrician. Forecasts for Greece, Hungary and the UK were more mixed and varied between occupations, while interviewees from Italy and Slovakia were highly reluctant to make any predictions at all, often citing considerable economic uncertainty. Moreover, the occupations for which job growth was most frequently predicted were in the fields of renewable energies, the environment and new technologies, including nanotechnologist, environmental engineer and SPV installer. The discrepancy

between the interviewees' predictions and the EU-LFS results was particularly striking for SPV installer. This appears to be due to a bias in the perception of the interviewees, who often identify these occupations as the ones most likely to provide a significant contribution to national economic growth. Occupations where a decline in job numbers is most commonly reported are: sheet-metal worker, electrician and insulation worker. This is because interviewees considered that construction was sector worst affected by the recession.

Several factors could explain these discrepancies. The timing of the study and the perspective of the individual interviewees may have affected forecasts of occupational trends provided by interviews. The field work was carried out in the first half of 2011, after two years of deep recession in some key sectors including construction and manufacturing, so the recent negative experience could have predisposed interviewees to make cautious estimates. Conversely, interviewees from employers' organisations and professional bodies are often keen to accentuate the importance of the sector or occupation they represent to lend weight to their lobbying of national government. This can lead to overestimates of employment volumes.

However, bearing in mind the limitations of the EU-LFS data, it is worth examining the main evidence from qualitative interviews with national experts.

The downward trend in the EU-LFS data for sheet-metal workers – with the important exception of the UK – was confirmed by qualitative interviews. This appears to be a mature occupation and the demand from new sectors such as renewable energies is not sufficient to offset trends such as offshoring in the manufacturing sector. In addition, interviewees reported that the demand for sheet-metal workers was in decline, as it was becoming relatively unattractive to young people choosing careers.

Energy auditors and transport vehicle inspectors were presented as growth areas by most interviewees, mainly owing to changes in regulations requiring energy saving measures and low-carbon emissions. It is difficult to compare findings with the EU-LFS statistics because ISCO code 3152 covers both occupations, and some others, so EU-LFS trends are likely to be driven by declining trends in other sectors.

The growth in the number of refuse collectors according to the EU-LFS was only partially confirmed by interviewees because it was difficult for interviewees to provide estimates: in some countries (e.g. Germany, Greece and Italy) refuse collection is the responsibility of local authorities and there are limited national employment data or none at all.

Some national features reported by interviewees are worth noting. In Finland employers reported slow and steady growth for all occupations; however, it was difficult to provide estimates of the scale of change, which may

vary significantly. In the Netherlands, although the estimated trends are not based on official statistics, the number of jobs for SPV installer appears to have doubled in the past two years, while employment for sheet-metal workers has declined by 5-10% during the recent recession.

In Germany the renewable energy sector has grown dramatically and is predicted to experience further growth. Although the nanotechnology sector in Germany is relatively small, it has been identified as an important and growing area of innovation. The occupations classified as 'other engineers', which includes nanotechnologist and transport vehicle inspector, has seen significant growth of 61% compared to 1999. Likewise 'energy consultant', which includes energy auditor, has increased by 8% since 2007. Although the construction sector is experiencing a decline in job numbers, interviewees in Germany predicted an increase in the demand for insulation workers due to the requirement for buildings to comply with energy efficiency standards and increased demand for insulation in domestic and public buildings, exacerbated by supply side shortages common to the whole building industry. A recent slowdown in the sheet-metal sector is due to the shortage of new sites for wind turbines and increased competition from outside Germany.

In the UK, the number of environmental engineers is reportedly stable after increasing by 2% over the past five years. The recession has also affected the number of insulation workers and electricians. In contrast, there was a clear increase in job numbers in occupations related to the environment and renewable energy. For example, encouragement of recycling and changes in collection methods have had a positive impact on the number of refuse collectors.

There is evidence from Greece of recent growth in sectors related to the green economy and more specifically nanotechnologies, certification of energy consumption and SPV panel installation. However, employment of insulation workers is on a downward trend. In Hungary the number of firms and workers in the photovoltaic sector has doubled in recent years, mainly in micro businesses, and it is forecast to increase by a further 20% over next two years.

3.4. Characteristics of workers in the selected occupations

The available data allow us to analyse the gender distribution, age and level of education of workers in the target occupations.

3.4.1. Trends in the gender of workers in occupations and countries

Table 5 shows a clear majority of males in the workforce in all occupations. However, there are some interesting differences between sectors and jobs.

Overall, the occupations with the highest rates of male employment are insulation worker, electrician, SPV installer and sheet-metal worker. The UK has the highest average male employment rate for all occupations and Hungary and Slovakia the lowest. Occupations in sectors using new technologies linked to the green economy have a higher proportion of women, although they are still male-dominated. About 20% of nanotechnology engineers and environmental engineers are women, as are nearly 30% of transport inspectors and energy auditors. This suggests that there may be further employment opportunities for women in these occupations or at least that they can provide female role models that could make the occupations more attractive to women.

Table 5. **Percentages of males in each occupation by country (EU-LFS data)**

(%)

Occupation	FI	NL	UK	SK	HU	Average
Nanotechnology engineering (part 2146 ISCO code)	75-90	<75	>90	75-90	<75	75-90
Environmental engineer (part 2149 ISCO code)	75-90	<75	>90	<75	<75	75-90
SPV installer/designer (part 7241 ISCO code)	>90	>90	>90	>90	75-90	>90
Insulation worker	>90	>90	n/a	>90	>90	>90
Electrician	>90	>90	>90	>90	>90	>90
Transport vehicle system inspector/energy auditor (part 3152 ISCO code)	75-90	<75	<75	<75	<75	<75
Sheet-metal worker	>90	>90	>90	>90	75-90	>90
Refuse and recyclable material collector	<75	>90	>90	<75	75-90	75-90
Country average	88	89	90	84	80	

NB: Numbers highlighted in blue represent the highest percentage in an occupation; numbers highlighted in orange represent the biggest percentage in a country.

Source: Eurostat EU-LFS 2010; own calculations.

Although interviewees did not provide precise estimates, they all confirmed this picture of a mostly male workforce.

3.4.2. Trends in age profiles in occupations

Table 6 shows the age distribution in occupational groups from EU-LFS statistics for three main age groups.

The youngest group (15-24) makes up a relatively small share of workers in all occupations. The highest shares of young workers are to be found among

insulation workers, sheet-metal workers, electricians and refuse collectors. This contradicts to some extent the interviewees, who reported that these occupations are not attractive to young people. However, it should not be forgotten that (un)attractiveness is assessed in relative terms, and occupations requiring physical labour may place a premium on youth.

The largest shares of older workers (55-65) are found among nanotechnology engineers, SPV installers and environmental engineers. This can be explained by the higher levels of education and/or greater work experienced required for higher-skilled jobs. Moreover, some of those occupations have emerged from existing occupations and build on existing skills, and for some of them there are no easy or direct training routes, making it less likely that young people would enter the labour market as environmental engineers, for example.

Finally, the largest shares of workers aged between 25 and 54 are found among nanotechnology engineers, transport vehicle inspectors and energy auditors, followed by environmental engineers and refuse collectors.

Table 6. **Age distribution per occupation (EU-LFS data)**

(%)

Occupation/age groups	15-24	25-54	55-64
Nanotechnology engineering (part 2146 ISCO code)	2	81	17
Environmental engineer (part 2149 ISCO code)	7	79	14
SPV installer/designer (part 7241 ISCO code)	11	73	16
Insulation worker	15	74	11
Electrician	12	75	13
Transport vehicle system inspector/energy auditor (part 3152 ISCO code)	6	83	11
Sheet-metal worker	13	73	13
Refuse and recyclable material collector	11	79	10

Source: Eurostat EU-LFS 2010; own calculations.

Although the quality of data does not allow us to take full advantage of individual country information, it is possible to gain some insights into age variations between countries, which may reflect differences between economies and labour-market structures.

Slovakia has the highest proportion of environmental engineers in the 15-24 age group. Similarly, SPV installers and designers in the UK are relatively young and make up 26% of workers in this occupation. Almost one in five electricians in the Netherlands and the UK are young, as are nearly one in four

sheet-metal workers in Finland and the Netherlands. Finally, refuse collectors are younger than average in Finland and the UK.

Relatively high percentages of nanotechnology engineers, environmental engineers and SPV installers in the Netherlands, Finland and the UK are aged between 55 and 64. SPV installers are older in Finland and the UK than in other countries, as are transport vehicles inspectors and energy auditors in the UK, sheet-metal workers in Finland and insulation workers in Slovakia. This confirms the average trends for occupations which require a long period of educational attainment or professional experience (e.g. engineers or SPV installers) and reflect mature sectors such as construction and manufacturing in some countries (insulation workers in Slovakia and sheet-metal workers in Finland).

3.4.3. Age profiles across occupations and countries as reported by interviewees

The data collected during interviews allow us to identify the age profile of workers in selected occupations (Table 7):

(a) nanotechnology engineers are relatively young, between 30 and 40 in most countries, apart from Finland where there is a broader age range of between 25 and 50;
(b) people working as environmental engineers are relatively young; they are under 50 in all countries;
(c) energy auditors are relatively young. However, there is significant variation across countries. For example, the average age is 30 in Italy, 40 in the Netherlands, between 30 and 50 in Hungary and there is a polarisation in the UK, with most workers being either under 30 or over 50. In contrast, in Germany energy auditors are older than the average worker in Germany, with national statistics showing only 17% under 35 but a larger proportion over 50;
(d) SPV installers are on average aged under 50. UK interviewees stated that SPV installers were mostly under 50 as this is a relatively young industry;
(e) insulation workers are relatively older, aged on average over 35 in all countries and over 50 in the UK. This contradicts the results from the EU-LFS but could reflect employer perceptions rather than reality, as these sectors may be important sources of jobs for young people with low levels of education who are likely to be concentrated in low-skilled jobs;
(f) electricians are relatively young, with an average age of around 35-40 in all countries. In Germany around 40% of electricians are between 35 and 50 years old;

(g) for transport vehicle inspectors there are limited age profile data available, but in both Finland and the UK they are usually aged 30 or over. In the UK there are many older workers, including some who are well over the usual retirement age;
(h) sheet-metal workers are usually over 40 years of age. However in the Netherlands interviewees stated they were 'very young or very old', which reflects the EU-LFS findings;
(i) there are limited data available for refuse collectors apart from in the Netherlands where workers are on average 40 years old and in the UK where there is an almost equal split between under 30, 30 to 50 and older than 50. In the Netherlands this occupation has a bigger share of younger workers than others in the sector, and it is considered an entry-level occupation from which people move onto other occupations within the sector.

Occupational age profiles in Finland do not appear to follow the same patterns as in other countries. Apart from transport vehicle inspectors, all interviewees described an ageing workforce, with the average age in all occupations around 45 and employers trying to recruit new and young workers under 30. Evidence elsewhere in this study shows a concern in Germany over shortages of younger people to meet replacement demand in medium-skilled occupations requiring STEM skills. However, the only such occupation where there were more workers over 50 than under 30 was sheet-metal working (28% versus 24%).

3.4.4. Levels of education in occupations and countries

Table 8 shows the average level of qualifications held by workers in each of the selected occupations by country.

Occupations in which workers generally have a high level of qualification are nanotechnologist and environmental engineer, which reflects the high levels of skill demanded in these jobs. Occupations in which workers generally have a medium level of qualification are SPV installer, insulation worker, electrician, sheet-metal worker, transport vehicle inspector and energy auditor. The occupation in which workers generally have a low level of qualification is refuse collector.

Table 7. **Average age of people for each occupation (interviewees' estimates)**

Occupation	FI	NL	DE	UK	IT ([a])	EL	SK	HU
Nanotechnology engineering (part 2146 ISCO code)	45	25 ([b])	*	25-40	30-35	*	*	*
Environmental engineer (part 2149 ISCO code)	45	35-45	<50	30-40	25	*	*	*
Energy auditor (part 3152 ISCO code)	45	40	>35	<30/>50	30	*	*	30-50
SPV installer/designers (part 7241 ISCO code)	45	*	*	<50	30	*	*	*
Insulation worker	45	35-40		>50	38	*	50	*
Electrician	45	35-50	<35	40-50	30-35	*	50	>40
Transport vehicle system inspector (part 3152 ISCO code)	30	*	*	>30	*	*	*	*
Sheet-metal worker	*	<25/>50	*	>50	40-45	*	*	*
Refuse and recyclable material collector	*	40	*	<30/30-50/>50	*	*	*	*

NB: Interviews with learning providers and employers' organisations.
* Information not provided.
([a]) In Italy data relate to trainees.
([b]) Average age of learners.
Source: Authors.

Table 8. **Average level of qualification held by workers in each occupation in 2010 (EU-LFS data)**

Occupation	FI	NL	UK	HU	SK
Nanotechnology engineering (part 2146 ISCO code)	H	H	H	H	H
Environmental engineer (part 2149 ISCO code)	H	H	M/H	H	H
SPV installer/designer (part 7241 ISCO code)	M	M	M/H	M	M
Insulation worker	M	L	*	M	M
Electrician	M	M/L	M	M	M
Sheet-metal worker	M	M/L	M/L	M	M
Transport vehicle system inspector/ Energy auditor (part 3152 ISCO code)	H	M	M/H	M	M
Refuse and recyclable material collector	L	L	M/L	L	L

* Data on insulation worker not provided in EU-LFS.
H = high qualification, equivalent to ISCED 5 or above (degree or above).
M = medium qualification, equivalent to ISCED 3-4 (higher-level secondary qualification).
L = low qualification, equivalent to ISCED 0-2 (up to middle secondary education).
Source: Eurostat EU-LFS 2010; own calculations.

3.4.5. Levels of education in occupations and countries as reported by interviewees

Qualitative data broadly confirm the European statistics:

(a) occupations in which workers generally have a high level of qualification are nanotechnologist, environmental engineer and energy auditor. Qualitative research records higher levels of qualification for the occupation of energy auditor probably because, unlike the EU-LFS, it classifies energy auditor as a separate occupation rather than merging it with transport emissions inspectors;

(b) occupations in which workers generally have a medium level of qualifications are SPV installer, insulation worker, electrician, sheet-metal worker and transport vehicle inspector;

(c) the occupation in which workers generally have a low level of qualification is refuse collector.

3.5. Conclusions

Inevitably there are some differences between EU-LFS results and what interviewees reported because the ISCO codes used for international classifications overlap for many occupations. For example, estimates for nanotechnology engineer, environmental engineer, SPV installer/energy auditor/transport vehicle inspector take into account professionals working in different fields and they are thus too high. In addition, it has been difficult to gauge numbers from national sources as the occupations in question are still in a developmental phase and they are present across sectors.

According to EU-LFS statistics, the occupations with the highest number of workers include environmental engineer, energy auditor and transport vehicle inspector. Occupations with medium numbers of jobs are sheet-metal worker, SPV installer and refuse collector. Occupations with small numbers of workers are nanotechnology engineer and insulation worker. The size of occupational groups varies widely between countries. In the last three years there has been an increase in the number of insulation workers and electricians but a decline in the number of environmental engineers, SPV installers, transport vehicles/energy auditors and sheet-metal workers and the number of nanotechnology engineers has declined or remained constant. These trends derived from EU-LFS statistics have not always been confirmed by interviewees. National interviews have reported rising trends in the number of nanotechnology engineers, environmental engineers, energy auditors, transport vehicle inspectors and SPV installers. The rising trend for SPV installers clearly contradicts EU-LFS data.

The occupation typology proposed in Table 1 suggests that the demand for insulation workers and electricians may increase because they are categorised as GIDO occupations, which are characterised by an increasing number of jobs rather than by major changes in the types of skills used. This hypothesis is clearly supported by EU-LFS data but not by interviewees. The discrepancy is likely due to the effect of the economic crisis in the construction sector, which has experienced a great many job losses. Nanotechnology engineers, energy auditors and SPV installers have been identified as GNEO occupations, characterised by a new job type. Thus, we would expect to see the numbers of jobs increasing from a low base. This is supported by interviewees but not by EU-LFS trends, probably due to difficulties in mapping the EU-LFS codes to the occupations of interest. Finally, environmental engineers, transport inspectors, sheet-metal workers and refuse collectors are included in the GESO group, which is characterised by changes in skills and tasks but no definite implications for the number of jobs. For these occupations there were mixed findings from the EU-LFS and interviewees.

All these occupations are male dominated. Essentially this reflects the gender segregation in the construction and manufacturing sectors. However, there are higher percentages of women in the occupations of environmental engineer and transport vehicle inspector/energy auditor than in the occupations of sheet-metal worker, electrician, SPV installer and insulation worker.

The highest level of qualifications held by workers varies between occupations. Nanotechnology engineers and environmental engineers require a high level of qualification, namely a master's degree or a PhD. Occupations with a medium level of qualification are SPV installer, insulation worker, electrician, sheet-metal worker, transport vehicle inspector and energy auditor. Refuse collectors have a low level of qualification. There are some variations between countries because some of these occupations are still developing and in many cases qualification levels and training standards have not yet been agreed. Other differences are determined by differences between national economies and legislative frameworks.

Finally, there are also differences between EU-LFS statistics and interview reports in terms of the average age profiles of occupations. According to interviews, which, although incomplete, appear more reliable from this point of view, insulation worker and sheet-metal worker are ageing occupations because they do not appeal to young workers. Nanotechnology engineer, environmental engineer, energy auditor and electrician were reported to be relatively young occupations, although with some differences between countries probably due to reflect their different education systems and economies.

CHAPTER 4.

Recruitment, training and qualifications in selected occupations

4.1. Introduction

Understanding the recruitment methods, initial qualifications sought by employers and initial training undertaken by workers entering the occupations under study is important to help assess the skill levels of new workers, the adequacy of their educational background both for immediate entry-level roles and for lifelong learning, and how these factors may influence any skill gaps which are subsequently identified among experienced workers. In some circumstances the recruitment method may give an indication of shortages of people seeking to enter the occupation.

Information about recruitment methods, training and qualifications is drawn primarily from the individual interviews with representatives of employers and learning providers and it has been verified by analysis of documentation relating to, for example, qualifications, entry requirements and training provision/content for particular occupations, where available.

4.2. Recruitment methods

Table 9 summarises the most common recruitment methods, by occupation.

Some general trends in recruitment methods by country can be identified. In Italy recruitment often takes place by word-of-mouth. The Italian recruitment system is based on informal networks and methods, which differ according to the level of skill needed and the labour market for each occupation. In Greece, because there have been major efforts to develop training linked to the development of a green and energy-efficient economy, recruitment tends to be closely linked to specific learning and training providers for many occupations, such as insulation worker, electrician and sheet-metal worker. In Germany, the Netherlands and the UK, well-developed links with specific universities or research institutes are used to recruit for more high-skilled positions, such as nanotechnology engineering technologist and environmental engineer. Employers in Finland also exploit links with universities, but more frequently, they use private recruitment agencies, their own websites, general recruitment websites and newspapers. Poaching skilled people from related occupations is

more common in the UK, particularly for the more niche occupations of transport vehicle emissions inspector and SPV installer.

4.3. Training and qualifications in the selected occupations

Table 10 summarises the typical entry-level qualifications required, by country and occupation of interest. The table analyses the qualifications required for each occupation in different countries, the content of qualifications and average duration for acquiring them.

4.3.1. Variations in qualification requirements by occupation

4.3.1.1. *High-skilled occupations*

The typical entry-level qualification for nanotechnology engineering technologist and environmental engineer in all countries is a graduate or postgraduate degree in a related field of study. For nanotechnology engineering technologist, the level of degree varies in some countries; in Italy, a PhD is usually required whereas in Finland and the UK a master's degree can be acceptable, although a PhD now carries more weight among UK employers. The level of degree often depends upon the specific nature of the job. Undergraduate degrees may be sufficient for those working in technician/support roles. For environmental engineers, countries including Italy, the Netherlands and Hungary accept other higher level qualifications, such as higher vocational and technical qualifications in a related subject, or diplomas gained in post-secondary education. In Germany, Greece, Slovakia, Finland and the UK, an undergraduate degree is required as a minimum.

4.3.1.2. *Medium-skilled occupations*

For energy auditors, the typical entry-level qualification is a degree in a related subject, such as electrical engineering, physics, material sciences or geography. In a few countries, this qualification can be replaced by relevant experience in the field (for example, 10 years in Greece) or by a diploma or similar from a vocational school in a relevant field (Hungary, the Netherlands and Slovakia). However, there is no consistency in the level of qualification required across Member States; for example, training in the UK is based on proof of competence and may only require a five-day training course.

Table 9. S**ummary of recruitment methods by occupation**

Occupation	Recruitment methods
Nanotechnologists	The most common recruitment method is through universities because of employers' emphasis on relevant graduate and postgraduate qualifications. Employers often draw on existing collaborative networks and contacts with universities and research institutes to identify appropriate students for their vacancies, but these may differ according to the level of job. For example, in Greece scientific staff tend to be recruited from technical universities, whereas those at technician level tends to be recruited from technical education institutions (TEIs) because they have a solid background in basic science. Another common recruitment method is through work placements or internships in the UK and Germany. Again, however, placements are usually filled by universities that can offer qualified students. A less common recruitment method is headhunting in Finland and Germany.
Environmental engineers	Universities are an important source of potential recruits because of the qualifications needed to work in this field in most countries, but other methods include advertising on the employer's website, on private recruitment websites, trade fairs and recruitment days in Germany. Recruitment methods also depend on the employer's needs. Employers may recruit university graduates but if they wish to recruit more experienced candidates, they are more likely to employ people who are already employed in a similar role in another company. Similarly, if a particular specialism is required, employers may recruit through advertising on specific recruitment websites/agencies or through subject-specific journals in the Netherlands and the UK. The Netherlands appears to use a slightly more diverse range of methods than other countries, which may be due to shortages of some niche skills in this occupation (Chapter 6).
Energy auditors	Recruitment takes place mainly through collaboration with universities, higher-level vocational schools and research institutes. It takes the form of contacts with specialists in these organisations or links to careers services. Recruits to more basic energy assessment roles come from a diverse range of labour-market backgrounds, including the building industry, manual trades and architectural technicians. In these cases, any additional training that is required for the role is usually provided in-house.
Transport vehicle emissions inspectors	Recruitment takes place mostly through internal recruitment of staff already employed in similar roles, such as motor vehicle technicians or mechanics. A less common method of recruitment is through work placement schemes, which form part of specific vocational training programmes for this occupation in Finland.
SPV installers	Most recruits are people already working in related occupations who are given additional training in SPV installation. In most countries SPV installers are recruited mostly from among electricians or roofers. In countries such as the UK, where the growth of the industry has outstripped the supply of SPV installers, poaching is common. Other methods of recruitment include the use of private recruitment agencies, the use of personal networks and apprenticeships (the Netherlands and Finland).
Electricians	Most recruits work in other roles in the construction sector, or come from secondary schools and universities through cooperation arrangements designed to gain early access to potential recruits. Certified vocational training centres are another source of recruits in countries where such centres exist, e.g. the Netherlands and Finland. Other recruitment methods include advertisements in local newspapers (e.g. the UK), company websites, recruitment agency websites and local employment offices in Germany and Finland. A less common method of recruitment is through informal networks, e.g. in Italy and the Netherlands.
Insulation workers	Insulation workers are usually recruited from vocational training centres or as apprentices from among school and colleges leavers. However, employers may also recruit from their networks and partnerships with colleges and schools, through newspaper advertising, employers' networks and associations, or careers services for young people (the Netherlands, Finland and the UK). Where there is no specific vocational training for this occupation, employers recruit from similar trades and offer in-house training.
Sheet-metal workers	Employers used a range of different methods. Many seek staff who are already skilled in this field or a similar one, others place advertisements in local newspapers (the Netherlands and the UK,) or recruit through private recruitment agencies (Finland, the UK) and in some countries (Germany) workers are recruited directly from training providers.
Refuse collectors	Recruitment usually takes place using a range of methods including private recruitment agencies, newspapers or the internet, and existing employee networks.

Source: Authors.

Table 10. **Summary of typical entry-level qualifications by country and occupation**

	Nano-technology engineering technologists	Environmental engineer	Energy auditor	Transport vehicle emissions inspectors	Solar photo voltaic installers	Electricians	Insulation workers	Sheet-metal workers	Refuse collectors
Italy	University degree, often at PhD level. ISCED 5 or 6	Secondary or postsecondary education. ISCED 3-4	University degree plus a training course, which could be a master's degree or a regional vocational course. ISCED 5 or 6	Ministry of Transport centres are required to have a manager (*responsabile technico*) with a medium or high technical degree and a vocational training of 30 hours. No specific qualifications for testers	Secondary and post-secondary education, plus training course of about 80 hours. ISCED 3-4	Secondary education, two years or five years from technical schools (technical diplomas). ISCED 3-4	Secondary education level (high school graduates in science or technical subjects) or university degree (in engineering) ISCED 3-5	Secondary education with two-to-five-year course in technical subjects. ISCED3-4	No training or entry level qualifications required; only a driving licence.
Greece	For scientific staff: Graduate or postgraduate degree from Technical Universities in engineering, physics, material sciences or similar. ISCED 5 or 6	Graduate degree in engineering, followed by a licence to practice from Technical Chamber of Greece. ISCED 5-6	Graduate or postgraduate degree in engineering or at least 10 years work experience as an engineer. ISCED 5-6	Intermediate Technical and Professional School. ISCED 3-4	Usually certified electricians with a licence to practice. ISCED 3-4	Completion of minimum compulsory education or a certified electrical apprenticeship. ISCED 3-4	Completion of secondary education, technical colleges or Centres of Vocational Training. ISCED 3-4	Information not available	No minimum qualifications required.

Finland	Master's degree from a technical university/ traditional university. ISCED 5 or 6	Master's/polytechnic degree in a technical university. ISCED 5-6	Bachelor's/master's of science preferably in mechanical and electrical engineering. ISCED 5-6	Polytechnic qualification in general/automotive engineering. ISCED 5	No qualifications specified but background in electrical engineering preferred with practical experience. No standard vocational training for SPV installers.	Post-secondary education vocational training and diploma. ISCED 4	No specific vocational training available but general secondary vocational training required. ISCED 3	No specific qualifications or vocational training required/ available, but relevant experience preferred.	Some relevant vocational training or relevant experience suitable for the job and a 'heavy vehicles' drivers licence.
Nether-lands	Master's degree or PhD. ISCED 5 or 6	Higher vocational or educational background in environmental studies, environmental management, acoustics or environmental technology. ISCED 4-5	Diploma in a relevant field from a higher vocational school, particularly if in the area of construction engineering. ISCED 4	Initial vocational qualification as a mechanic. ISCED 4	Variable depending on employer. No specific vocational training available.	Diploma in medium level vocational education. ISCED 4	Specialist vocational education at minimum of ISCED 3, and lasts 2-4 years.	Diploma or certificate at low or medium level vocational education. ISCED 3-4	Medium-level vocational education for more skilled roles. For basic tasks, no requirements except Dutch language knowledge.
UK	Usually an MSc or PhD in a specialist nanotechnology programme. ISCED 5 or 6	A degree in engineering or with an environmental focus. ISCED 5	Higher level energy audit roles: undergraduate or postgraduate degree in geography, physics, material sciences or similar. ISCED 5 or 6. Basic energy assessment roles: proof of competence required for vocational qualification equivalent to a single subject at secondary school level. ISCED 3	Minimum of four years' experience repairing the relevant type of vehicle, and NVQ level 3 or equivalent in vehicle servicing and repair, followed by short training course and practical assessment. ISCED 4.	No qualifications as these are currently under development	NVQ level 3 in electrical work, often with a professional certificate of competence through the Electrical Contractors Association Scheme. ISCED 4	NVQ level 2 in thermal insulation. Those employers who are members of the national employers' association for thermal insulation also require a technical certificate in underpinning knowledge and literacy/ numeracy competence. ISCED 3	NVQ level 2 or 3 in sheet metal fabrication or a similar subject. ISCED 3-4	Clean heavy vehicle licence (if recruited as drivers). Otherwise, no formal qualifications are required.

Slovakia	Minimum level masters or PhD degree. ISCED 5 or 6	Graduate or postgraduate degree in Environmental Engineering. ISCED 5-6	Three-year course at a secondary vocational school. ISCED 3	Usually graduates of technical universities, followed by part time training course. ISCED 4-5	Usually university degree in renewable engineering. ISCED 5	Three-year course at a secondary vocational school. ISCED 3	Completion of vocational secondary education. ISCED 3	Completion of vocational secondary education ISCED 3	No qualifications or vocation training required.
Germany	Graduate or postgraduate degree in nanotechnology or similar. ISCED 5 or 6	Graduate or postgraduate degree on environmental engineering or similar. ISCED 5 or 6	No specific qualification or training required for this vocation but usually a graduate degree in architecture, engineering or similar is required. ISCED 5 or 6	Work experience as a foreman or engineer in the automobile sector and driving licence, plus specialist exam. ISCED 3-4	Meister or craft qualification. ISCED 3-4. Training lasts around four months full time run through craft associations or Chambers of Commerce.	Secondary school certificate 'Realschule', 'Abitur' or 'Hauptschule'. ISCED 3-4	Vocational training lasting up to three years. ISCED 3-4	Completion of apprenticeship. ISCED 3	No qualification or vocational training required.
Hungary	Occupation does not exist outside academic pure research roles	Higher education diploma. ISCED 5	Diploma and complementary training in architecture or engineering. ISCED 5	Information unavailable.	Basic skills gained in vocational training schools. ISCED 3	Vocational training. ISCED 3	Further education or vocational training. ISCED 3-4	No specific qualification or training. General qualification in a related area is acceptable as the basis for more specialised training.	No qualifications or vocational training required.

Source: Authors.

Transport vehicle emissions inspectors usually require an initial vocational qualification in car mechanics or similar to enter the occupation, usually gained from a technical or vocational college, followed by an approved qualification in vehicle testing, which is usually standardised at national level (Germany, Greece, the Netherlands, Slovakia, Finland and the UK). In the UK, a minimum of four years' experience repairing the relevant type of vehicle is also required in addition to vocational training, while Germany requires previous work experience in the automobile sector and a driving licence. Entry-level qualifications for electricians are completion of secondary education and vocational training in electrical work, which is often strictly regulated to ensure health and safety (e.g. Germany, Greece, the Netherlands and the UK). For insulation workers, completion of secondary education (usually in science or technical subjects) or related vocational training is the minimum entry-level qualification.

For other medium-skilled occupations, there is much greater variation in the entry-level qualifications; they can vary according the level or type of job and according to what individual employers are prepared to accept. There are sometimes no specific qualifications for SPV installers because the qualifications are still under development (the UK). What is usually required is completion of secondary education followed by some vocational training or work experience in electrical engineering or roofing. For sheet-metal workers, the most common entry-level qualification is an apprenticeship (Germany and the UK) or completion of a specific vocational training programme.

4.3.1.3. *Low-skilled occupations*

For refuse collectors, there are generally no entry-level qualifications required, but in a few countries, such as the Netherlands and Finland, there is a requirement to have completed relevant vocational training. In Italy, Finland and the UK, it is desirable, but not essential, to have a driver's licence to allow new recruits to operate waste collection vehicles, but sometimes training is provided to enable recruits to gain the qualification.

4.3.2. Variations in training content and duration by occupation

4.3.2.1. *High-skilled occupations*

Generally, there is no specific qualification or training for nanotechnology engineering technologists apart from a master's or PhD degree in a related area. Employers tend to prefer to recruit graduates in specific subjects such as engineering, science, mathematics, chemistry or in a related field, or from specific learning providers (depending on the role). In Greece, for example,

employers prefer to recruit scientific staff from technical universities and technicians from technical education establishments. This is consistent with EU-LFS data in Chapter 3, which show that 87% of workers employed in occupations employed in these occupations have at least a first degree.

The qualifications on offer to those who wish to study to become environmental engineers vary slightly, but are all related to environmental engineering. The most common are qualifications in engineering or environmental studies. Most employers prefer a graduate degree in at least one of these fields, although in Slovakia some employers prefer recruits who have a postgraduate qualification. In Greece and Hungary a licence to practice is needed before starting work in this field, and in other countries practitioners are often members of professional bodies.

Undergraduate courses typically last around three years and are usually full-time. In most countries, graduate qualifications are nationally recognised, even though they may be accredited and regulated at the university level. The exception is Italy, where qualifications are recognised only at regional level.

4.3.2.2. *Medium-skilled occupations*

There is some consistency in the level of formal qualification required to be an energy auditor. Most countries expect this role to be performed by staff with graduate-level qualifications in related occupations such as construction, engineering or architecture. However, there is a high degree of variation in the type of training offered specifically for the occupation. Training is offered mostly by training agencies and vocational colleges and schools. In a few countries, training is offered by industry-wide agencies or employer bodies (Germany and Hungary). The nature and content of training courses vary between the eight countries and often within them. In the UK, the training course to qualify as an energy assessor can be delivered in a five-day block of training, supplemented by a portfolio of evidence. However, in Germany the training varies according to a candidate's experience (from 80 to 260 hours). In most countries, this training has not yet been standardised or fully regulated and can vary. Consequently, the quality of training is also variable. Most courses are offered on a full-time basis, although Germany and the UK also offer part-time courses, and Hungary offers training only on a part-time basis because of the health and safety implications of having too much contact with bitumen. Again, in Italy, this type of training varies according to the different regional qualification systems and so it is recognised only at regional level. This level of variation in training provision poses some challenges for the harmonisation of standards in the regulation and training of energy auditors across Member States, provided for in the Directive, as noted by O'Rourke and Taylor (O'Rourke, K.; Taylor, C., 2011).

There are few specific formal qualifications required to become an SPV installer or insulation worker, but it is necessary to have a basic general vocational qualification acquired after completing secondary education and/or to have skills/experience as an electrician or roofer (in the case of SPV installers) or relevant vocational training (in the case of insulation workers). Because SPV installation is a relatively new occupation and not regulated, it still lacks qualifications or accreditation frameworks. Employers tend to stress the need for practical experience and technical knowledge often found among electricians and roofers. Training courses are often provided to companies that wish to update the occupational profiles of their staff and carry out SPV installation, and certified electricians who are self-employed will occasionally follow this training on their own initiative. The training is usually delivered through seminars that last from four days to 12 weeks, depending on previous experience. However, as all eight countries still appear to lack an accreditation framework for this occupation, this training is unlikely to be nationally accredited. The QualiCert project to ensure mutual recognition of training provision for workers installing renewable energy systems across Member States is ongoing and may contribute to the Member States' efforts to implement national quality certification schemes by the end of 2012 ([7]). In the case of insulation workers, accreditation of vocational training varies between countries. Training in Greece is recognised by other countries; training in Hungary is recognised nationally; but training in Italy is recognised and accredited only regionally. The length of training also varies between countries. In some countries, such as Germany, there are very few training organisations which offer courses specifically for this occupation. Training is often offered by organisations which train more generally in the areas of construction. The preference for skilled workers, with some experience or vocational qualification in this area is broadly confirmed by EU-LFS data in Chapter 4, which indicate that 77% of workers employed in this occupation have a medium level of education.

Most electricians and sheet-metal workers gain their qualifications from certified vocational training providers. These qualifications are usually technical diplomas gained either through training or apprenticeships. Training is offered on a part-time or full-time basis, depending on whether candidates work at the same time. Accordingly, the length of training can vary from a year and a half to

([7]) QualiCert, common quality certification and accreditation for installers of small-scale renewable energy systems. http://www.qualicert-project.eu/ [accessed 12.3.2012].

three years. Training is usually accredited nationally, although in Italy training is recognised only regionally. Employers of sheet-metal workers prefer recruits with some experience in the occupation rather than school leavers. The preference for skilled workers, with some experience or vocational qualification in this area, is broadly confirmed by EU-LFS data in Chapter 4. Eighty-nine per cent of those working as electricians and 79% of those working as sheet-metal workers have a medium level of education.

For transport vehicle emissions inspectors, training is either provided by private training providers or sometimes by state-owned training providers and the contents of training is usually tightly specified and regulated. In Slovakia, courses on offer cover transport machinery and economics, they last for four years and are nationally accredited and recognised. All courses on offer are full time. In Germany, training is offered exclusively by training institutions such as Technischer Überwachungs-Verein (TUV) and Deutscher Kraftfahrzeug-Überwachungsverein e.V. (DEKRA), which are associated with the sector. In the UK, training to become a Ministry of Transport tester consists of two short training courses lasting around three to four days each and a practical assessment. However candidates must already be qualified mechanics with around four years' experience before they can take the courses.

4.3.2.3. *Low-skilled occupations*

Training for refuse collectors is generally not formally regulated and is mostly provided on-the-job by employers. It is typically of short duration, varying between a few hours and a few days, and may be supplemented by informal mentoring or supervision by more experienced staff.

4.4. Conclusions

There are some clear trends in how employers recruit in the nine occupations and eight countries. In general, the more high-skilled the occupation, the stronger the links between employers and universities, colleges, research institutes and other specialist networks because of the level of qualifications and knowledge required for the job. The more 'niche' or the newer an occupation, the more employers tend to target their searches by drawing on specialist recruitment sources, such as private recruitment agencies, trade fairs, advertisements in specialist journals and head-hunters.

There is evidence that when employers invest considerable effort to find staff, they employ more than one recruitment method, including reliance on temporary staff and poaching through head-hunters, which may be indicative of

skill shortages. Overall, however, the most frequently cited methods are private recruitment agencies, advertisements in local papers and employers' websites.

For most medium-skilled occupations, employers use work placements and apprenticeships as a source of recruits, as well as links with employers' associations, college and school networks. However, for 'niche' or newer occupations, such as SPV installer or energy auditor, most employers recruit skilled workers from related occupations and offer them in-house training. Several experts also highlighted difficulties in recognising or assessing practical skills, and/or informal, on-the-job learning among employees and recruits, which may help to explain the preference for work placements as a means of assessing potential employees' performance.

In Germany, the Netherlands and the UK, well-developed links with specific universities or research institutes are used to fill more high-skilled positions, such as nanotechnology engineering technologist and environmental engineer. In Greece and Italy, recruitment is based more on word of mouth and personal connections to education and training providers. Employers in Finland also draw on links with universities, but more frequently use private recruitment agencies, their own websites, general recruitment websites and newspapers. Poaching skilled workers from related occupations is more common in the UK, particularly for the more niche occupations of transport vehicle emissions inspectors and SPV installers.

The type, level and duration of initial training sought by employers are closely linked to the level of skills involved in the occupation, with the highest skilled occupations typically requiring a (postgraduate) degree, usually acquired through full-time study, though sometimes with a work experience placement. For medium-skilled occupations, initial training is usually vocational and completed after leaving school, and it lasts between one and four years depending on the occupation. There is some variation between occupations and countries in the regulation and standardisation level for each occupation. Training provision is more fragmented for insulation workers and solar photovoltaic installers. For refuse collectors it is least extensive and may involve only on-the-job training provided by the employer, which usually does not lead to qualifications.

CHAPTER 5.

Skill shortages and skill gaps in the selected occupations

5.1. Introduction

Skills can be difficult to define and measure at an aggregate level because they are a socially constructed concept, intangible and often unobservable. Research uses several measures to assess the quantity, level and content of the skills possessed and deployed in the workplace. These vary from sociological approaches emphasising the practice of skills in a workplace to economic approaches based on human capital theory. These conceptual differences create challenges for detecting the presence or absence of skills and in forecasting skill needs.

Measures of employer demand for skills can take different forms. A key distinction is whether skills are deemed to lie in the person or the job, since this affects the unit of analysis used to determine their presence. This report assesses skill shortages on the basis of numbers of people and it is assesses skills deficiencies in individuals through the concept of skill gap. This research project focuses on skill shortages and known skill gaps.

Skill shortages are defined as ‘a situation in which the demand for a particular type of skill exceeds the supply of available people with that skill’ (Cedefop, 2010b). This is marked by the absence of sufficient appropriately qualified and experienced people to undertake particular roles when employers seek them. Skill shortages may be caused by a shortage of applicants with the relevant knowledge, personal qualities, qualifications or experience or by low pay and unattractive working conditions, which may deter suitable recruits from applying.

Skill gaps are defined as ‘a situation in which the level of skills of the currently employed is less than that required to perform the job adequately or the type of skill does not match the requirements of the job’ (Cedefop, 2010b).

5.2. Skill shortages by occupation and reasons for them

Most countries reported no skill shortages for most occupations based on the perception that employers had no difficulties in filling vacancies. Where unfilled

vacancies were perceived to exist, in most cases it was impossible to quantify skill shortages as interviewees simply did not have access to suitable data for individual occupations and several countries do not have formal systems for forecasting skill needs. The simple presence or absence therefore of a skill shortage is illustrated in Table 11, while the discussion that follows comments on whether the shortage is widespread or localised and explores the causes.

Looking at skill shortages by country, skill shortages are most widespread for sheet-metal workers, electricians and insulation workers. These shortages are due more to a continuing decline in interest among young people making first time career choices than to growth in market demand. There is some dissatisfaction with the skills of trainees in sheet metal working in Germany because they usually have lower levels of academic ability, and there are some concerns about the quality of training provision in the Netherlands in terms of its practical rather than theoretical content. Germany is suffering from skill shortages across the widest range of occupations, closely followed by the Netherlands. The situation in Germany reflects long-term shortages of engineers and workers with the STEM skill needed to enter medium-level occupations.

Most countries and most occupations are experiencing no skill shortages probably because of the economic downturn, particularly in the construction and building industry where there is reduced demand for energy auditors, environmental engineers, insulation workers and electricians. This has meant that vacancies have been easier to fill in all countries and it has even led to oversupply in a few occupations. Employers tend to prefer to train existing workers rather than to take on new recruits. Slovakia and Hungary in particular report no skill shortages for any occupation, because of the severity of the recession in each country.

Lack of interest in technical occupations requiring both STEM skills and manual work or seemingly unattractive working conditions and/or low pay are reportedly contributing to a decline in the number of young people wishing to enter some occupations. Skill shortages in high-skilled jobs are partly caused by the level of specialisation required, especially in relatively new occupations such as nanotechnology where there is a relatively small pool of people qualified to undertake the work. There may be a lack of market development and national demand for some of the occupations, for example solar photovoltaic installers in the Netherlands and nanotechnologists in Greece.

Table 11. **Reported skill shortages by country and occupation**

	Nanotechnology engineering technologist	Environmental engineer	Energy auditor	Transport vehicle emissions inspector	Solar photo Voltaic installer	Electrician	Insulation worker	Sheet-metal worker	Refuse collector
Italy	**	**	**	**	**	**	**	**	**
Greece	+	**	*	**	**	**	**	**	**
Finland	**	**	**	+	**	+	+	+	**
Netherlands	**	+	+	**	+	**	**	++	+
UK	**	**	*	**	**	+	+	+	**
Slovakia	**	**	**	**	**	**	**	**	**
Germany	++	++	**	+	**	+	+	+	**
Hungary	**	*	**	**	**	**	**	**	*

+ = skill shortage, ++ = significant skill shortages, * = oversupply of workers, ** = information not provided/available.
Source: Authors.

Turning to skill shortages by occupation, overall, there are few skill shortages in the occupation of nanotechnology engineering technologist. Where there are shortages in this field, they tend to be on a very small scale or difficult to measure because this is a relatively new occupation. However, there is a skill shortage for this occupation in Germany where the field is more developed (Mertin, 2007).

The picture is slightly more mixed for the occupation of environmental engineer. In the UK and Hungary, evidence suggests that there are no skill shortages in this occupation, mostly because of the recent economic downturn. In the Netherlands, there are reported shortages of environmental engineers because the occupation has never been popular. There is also evidence of quite severe skill shortages in Germany.

There are almost no skill shortages for the occupation of energy auditor in the eight countries. In the UK, this is due to a good relationship with the source of recruits, the effects of the recession on the construction sector and a change in the regulation on energy audit requirements for home buyers, which has led to an oversupply of auditors. In Greece, there is also an oversupply while in Germany demand for these services is currently low. In Italy there are no professional requirements at national level for this occupation and the tasks are often performed by architects or engineers, so it is difficult to assess whether there are any skill shortages. In the Netherlands, there are limited skill shortages but only for specialised types of audits.

There are some skill shortages in the occupation of transport vehicle emissions inspector but they tend to be minor. In Finland and Germany, there are minor skill shortages because vehicle inspection is not considered to be an attractive job with low levels of pay. In the UK, there have been skill shortages in this occupation for the past five to six years, but the situation has recently changed due to the economic downturn as more people take up this occupation in the hope of a secure career.

Overall, there are no significant skill shortages in the occupation of SPV installer. In the Netherlands, there is some evidence of skill shortages but they can often be remedied quite easily, partly because of the economic downturn but also because there are many employers who place less emphasis on the quality and safety aspects of the job and are therefore not particularly selective in their recruitment. In Italy, there are no significant skill shortages, mostly because the construction sector has slumped due to the economic downturn. In the UK regulatory change capping the price of electricity generated from large SPV installations is very likely to reduce the demand for installers. In Finland, Hungary

and Slovakia the market for SPV panels is as yet relatively undeveloped so there is limited demand for labour.

There are some skill shortages among electricians. This is primarily due to the economic downturn and its effects on the construction industry, which has seen a sharp decline in the number of vacancies. In this context, where employers have a vacancy they seem to have high expectations of skilled workers – who are not always easy to find – to avoid the cost of training.

There are few significant skill shortages in the occupation of insulation worker. There are some minor shortages in Finland, mainly because the work is considered to be hard and dirty. There is also no formal vocational training, which makes remedying skill shortages more challenging. In the UK, the number of workers in industrial insulation remains about 20% below the optimum level, but employers are unwilling to invest in training because of the economic climate. In Italy, there are few reported shortages because most companies prefer to provide training to help employees specialise within the occupation. Germany' ageing workforce hesitates to enter the unappealing occupation of insulation worker, even though the construction industry pays one of the highest training allowances in Germany.

The picture is mixed for skill shortages among sheet-metal workers. In Finland, the UK and the Netherlands the image of the work as hard and dirty deters young people from entering the occupation, although experts in the UK in particular stressed this was a misconception because, for one thing, the job was becoming increasingly computerised. In the UK, there are some skill shortages among sheet-metal workers because of a lack of investment in training by employers over the past five years. In the Netherlands, there appears to be a more severe skill shortage among sheet-metal workers, with one expert suggesting that there are several tens of thousands of unfilled vacancies.

There are no skill shortages among refuse collectors, mostly because of the economic downturn. In contrast, there is an over-supply of refuse collectors in Hungary and in the UK. One major employer reported receiving many applications for vacancies and had no difficulties in filling vacancies for five years. Similarly, in Germany there is little evidence of skill shortages and employers seem to be able to fill vacancies very quickly. Only in the Netherlands are there some skill shortages for drivers of refuse trucks.

5.3. Action taken by employers to mitigate skill shortages

Relatively few actions have been taken by employers to mitigate skill shortages, reflecting the fact that relatively few occupations were experiencing significant skill shortages at a time of economic downturn. In many countries, employers tend to prefer to train existing staff rather than take on new recruits. Where a country has reported skill shortages but no action has been taken to address them, this is usually because the shortage is not significant enough or does not have sufficient impact to warrant attention.

In Greece, skill shortages were reported among nanotechnology engineering technologists. Greek employers have taken remedial action by providing appropriate on-the-job training to staff already in these jobs.

In Germany, skill shortages were reported among both nanotechnology engineering technologists and environmental engineers, partly because nanotechnology was a relatively new field but also because of a broader problem in getting younger people interested in engineering jobs. One solution to skill shortages among environmental engineers has been to awaken interest among children in schools and day care through visits to universities and 'hands on' technology centres. Other efforts have included raising salaries and recruiting workers who are not German nationals.

In the Netherlands, where skill shortages have been reported among environmental engineers, little has been done to address them. However, a variation of the dual system of study and work, which already exists in medium-level vocational education, has been introduced in higher level vocational education. It is thought that this will help address skill shortages by improving learning provision and boosting the supply of workers with suitable knowledge and skills. It may also provide opportunities for part-time study for people who want switch career.

There were very few skill shortages among transport vehicle emissions inspectors. Germany reported some, but interviewees did not consider them substantial. One approach taken by some companies to address these skill shortages is to train the master mechanic (*Kfz-Meister*) to become a mechanic-technician (*Kfz-Techniker*), and perform tasks usually done by engineers. There is also a grant which part-finances the training costs for retired soldiers to undertake training in transport vehicle equipment and systems inspection. However, one interviewee reported that the training institutions offering these classes are not recognised by employers and the graduates have trouble finding work. In the UK, efforts to fill skill shortages in this area include higher salaries, increased training for the existing workforce, poaching qualified staff from other

employers, more advertising and use of recruitment agencies and recruiting workers who are not UK nationals.

There were very few reported skill shortages in any of the eight countries in SPV installation. As this is an emerging occupation in some countries, recruitment efforts are still in their infancy or on a very small and localised scale. In Finland, a recent pilot education programme has included SPV installation in adult education courses, thus providing more specific vocational training for this occupation. In Germany, companies seek to fill shortages by word-of-mouth from among existing staff or through job advertisements. In the UK, there is a more cautious approach to taking on new recruits given the economic climate and anticipated regulatory change, which will affect the large-scale installation sector.

The only country which reported significant skill shortages among electricians was Germany. To counter this, companies have tried to broaden the scope of their searches to a wider region, engaged school pupils, offered internships and a promise of further education to apprentices. Also, companies have tried to make up for the lack of electronics technicians with other occupations, such as plant mechanics. However, this has had limited success since under German law some tasks are performed exclusively by electricians. Other efforts have included increased training provision for the existing workforce. The UK reported some skill shortages among electricians but they were not substantial. Efforts to address the shortages include higher salaries, training for existing staff, adapting the content of existing jobs, more job advertisements and use of recruitment agencies.

Germany was the only country to report significant action to address skill shortages among insulation workers, partly because of the negative image of the industry. To improve this image concerted actions with all stakeholders in the industry are now in development.

Skill shortages among sheet-metal workers were reported in Germany, the Netherlands, Finland and the UK. In the UK, efforts to address them have included higher salaries, more training for the existing workforce, increased advertising/recruitment spend, increased use of recruitment agencies and recruiting workers who are not UK nationals. In the Netherlands, employers have reacted to this problem by subcontracting work, particularly to companies in Eastern Europe, or have used employment agencies to recruit staff. In Germany, where employers are finding that apprentices do not meet the usual requirements for training, they are offering extra tutoring or are using training companies to provide it. One interviewee suggested that this might be a growing trend as employers increasingly find that apprentices and new recruits do not meet the

requirements for training and as many trained metal workers switch to other occupations because of the relatively low pay.

Only the Netherlands reported significant skill shortages among refuse collectors. Employers seem to address this issue through ongoing recruitment drives to fill vacancies.

5.4. Skill gaps among new recruits or existing workers in each occupation

The main skill gaps identified for each occupation can be summarised as following:

(a) sheet-metal workers have skill gaps in the largest number of countries. This appears to be partly due to deficiencies in the personal attributes of new recruits but also to employers' desire for vocational training to have more practical content and a need to keep trainees up to date with new technology and IT;

(b) skill gaps are reported in the widest range of occupations in the UK;

(c) some countries where newer occupations are only beginning to develop tend to report more skill gaps in basic areas of job competence than countries where the occupations are more established (e.g. Hungary);

(d) employers report a desire for training for some medium-skilled occupations to have a more practical than theoretical content.

Overall, few skill gaps are reported in the occupation of nanotechnology engineering technologists. This is partly because it is an emerging occupation and some countries lack, or are still developing, a vocational framework of training and qualifications for the occupation, as is the case in Slovakia.

In Finland, there is some indication that communication skills and commercialisation skills to turn good ideas into products and services are needed among new nanotechnology graduates, and entrepreneurship was also suggested as a skill need in Germany. There are no skill gaps among the highest qualified staff in professional roles in Greece. However, there are practical skill gaps among technicians. As a result, IMEL/Demokritos ([8]) take remedial action by providing appropriate on-the-job training for such staff.

([8]) IMEL (Institute of microelectronics) is one of the eight research institutes of NCSR Demokritos (National Centre for Scientific Research), a multidisciplinary research centre under the General Secretariat for Research and Technology of the Ministry of Development.

New graduates working in nanotechnology in the UK do not usually have particularly noticeable skill gaps when working in small companies, because they have usually worked on student projects in these organisations. There is some evidence that in larger companies, newer recruits may need to develop understanding of legal processes, such as patenting, to protect new inventions, a good understanding of broader scientific disciplines and properties of new materials, and may need high levels of communication skills to work in multiple scientific disciplines, which is characteristic of nanotechnology product development. Large companies may not identify skill gaps as lying in individuals; rather they look at gaps in specialist capability within the organisation as whole in response to market developments. A relatively common response is to identify a smaller specialist company which has the required capability and to buy the whole company rather than hire individual staff.

Where skill gaps exist among environmental engineers, companies usually address them by providing further on-the-job training either to eliminate the skill gap or to allow new recruits to specialise in a particular area. In the UK, for example, there is no clear pattern of skill gaps among environmental engineers because of the range of different academic disciplines from which new recruits are drawn; in addition employers expect to have to provide graduates with some development opportunities to enable them to specialise in different areas. Similarly, in the Netherlands, employers may find that new recruits do not often meet all the job requirements. However, candidates are still hired and are then given an opportunity to show that they are suitable for the job. In that case, training is given to try to eliminate the skill gaps over time. In Hungary, there are temporary skill gaps among environmental engineers in waste, water and natural disaster management.

Overall, few skill gaps are reported in the occupation of energy auditor. Greece and the Netherlands report no shortages. In Greece, this is because the Technical Chamber of Greece runs several training seminars on the subjects of energy audit and efficiency to ensure that their members, including engineers who work as energy auditors, have the relevant skills and knowledge of the most up-to-date regulations, certification and procedures. In the Netherlands, where there are skill gaps, employers provide additional training to keep staff abreast of developments in their field.

For higher level energy auditors in the UK, there have cases where employers have recruited holders of post-graduates degrees and found that their IT skills were not that much higher than those of graduates holding a first degree. New recruits to basic energy assessment roles often lack knowledge about construction, because they come from completely different career backgrounds,

and the qualification is open to anyone regardless of previous work experience. In addition, because the training course is competence-based, on the basis of a portfolio of evidence, there was no real requirement either to show that the trainee had a sound basic knowledge of construction or of the software that they were being trained to use. This meant that new recruits could not easily solve problems or work in non-standard situations. Some higher-level training for energy audit work is delivered by tutors who have not worked as practitioners and are therefore unable to provide advice on how to apply the principles of the assessments in a real situation. Much of the information used to carry out assessments is provided in a neat and packaged format from documents which have been created for another purpose (e.g. building plans). Employers would like to see more 'raw' data being used in training.

There is some indication of skill gaps among energy auditors in Slovakia where it is reported that it is difficult to find recruits with appropriate IT skills. In Italy, the occupation of energy auditor has no fixed occupational characteristics or professional requirements recognised at national level, which makes it difficult to assess whether there are skill gaps.

Where information has been provided, it is possible to identify skill gaps among vehicle transport emissions inspectors in the Netherlands and the UK. Skill gaps in vehicle emissions inspectors can be assessed directly through the rate of failure of assessments of whether vehicles have been tested thoroughly. The regulator is trying to reduce the failure rate, which is partly caused by lack of attention to detail and conscientiousness among inspectors, neglect in reading updates to standards in vehicle testing manuals and sometimes by lack of time allocated by employers for training.

In the Netherlands, technical skill gaps occur because recruits from technical schools are not adequately trained due to the course content being too general and theoretical. Interpersonal skills have often been found to be lacking over the past three years with regards to behaviour and attitude, and employers have found it increasingly difficult to motivate students. Employers also value communication skills, which they currently find lacking but which are important for dealing with customers. The main skill shortage in the Netherlands is the diagnosis of faults in circuits which requires analytic as well as practical skills.

Where information is available, there is evidence of skill gaps in Germany and the UK among electricians. In Germany, gaps in practical and technical skills in installation and repair are reportedly due to lack of appropriate levels of education and skills. In the UK, where apprentice electricians are hired, there can be problems if the apprentice has not gained the full range of experience during training, or has been 'taught to the exam' rather than to the syllabus. There is

some evidence that the training provided is based on what learning providers believe is needed, or what the training provider can teach, rather than what the industry requires. However, there is also some concern that employers in this sector do not really know what training is needed and have not undertaken much training needs analysis, making it difficult for providers to know what to offer.

UK companies hiring insulation workers report gaps in young trainees' literacy and numeracy skills, which they must address to gain their technical qualification. Employers are particularly critical of these gaps because they believe that adequate skills in these fundamental areas should be gained during compulsory education and not at the expense of employers. These deficiencies may be due to the difficulties in recruiting young people to the occupation, resulting in young people with poorer academic ability seeking a job in the industry.

In Hungary, gaps in knowledge of new technologies occur because vocational schools have difficulty in keeping the training curriculum up to date and have difficulties in finding skilled trainers who are familiar with the latest technologies and have sufficient practical experience. In Germany, again a lack of appropriate qualifications/skills was reported as a cause of skill gaps in this occupation.

Among new recruits and trainees for sheet metalwork in the UK, a common skill gap is in basic practical aptitude to manipulate materials manually. Most school leavers are given little exposure to practical tasks such as designing and constructing objects during secondary education because more and more schools no longer provide wood-working and metal-working facilities and equipment, preferring to invest time and resources in developing pupils' IT skills. Some new recruits also lack confidence, partly due to lack of experience, and are not willing to ask for help. In these cases, companies provide their own on-the-job training, through informal transmission of knowledge and expertise between workers. Finnish recruits to sheet-metal work have skill gaps in specialist welding and CAM techniques.

In Italy, there are skill gaps among new recruits because technical secondary schools do not provide students with practical skills. There are also fewer learners in technical institutes other subjects are more popular. Employers fill the gaps through internal on-the-job training or vocational training specifically commissioned from regional learning providers.

In Hungary, traditional occupations in the steel industry, such as roller, smelter, etc., are no longer covered by courses in vocational training schools. This means that new recruits usually have a rather general qualification and lack occupation-specific knowledge in use of new technologies and IT. Therefore,

each company is forced to employ workers with a general ironworker qualification and to train them through their own in-house training systems. When that is not an option, skill gaps are filled by training other employees.

Lack of appropriate qualifications and skills was reported to be the cause of skill gaps among sheet-metal workers in Germany.

Where information exists, there is evidence of skill gaps among refuse collectors in the UK. The main skill gap reported by a major employer is highway safety. Employers find that some new starters are not sufficiently aware of risks and do not have road sense. There has been a tendency for new employees to take risks and have near misses, so on-the-job support is provided by the rest of the team to remind workers of the need to work safely.

In the Netherlands, lack of literacy and numeracy coupled with lack of experience of using IT creates skill gaps for staff who may be required to use IT in refuse trucks.

5.5. Conclusions

The ongoing effects of the recession are relatively widespread in the construction and building industry, namely reduced demand for energy auditors, environmental engineers, insulation workers and electricians. Consequently, vacancies have been easier to fill in all countries and there has even been oversupply in a few occupations. Employers tend to prefer to train existing workers rather than recruit. Hungary and Slovakia in particular report no skill shortages for any occupation because of the severity of the effects of recession. Overall, most experts believed that employers had no difficulties in filling vacancies for most occupations.

Skill shortages for sheet-metal workers, electricians and insulation workers are most widespread; even for these occupations, shortages are present in only a few countries. These shortages are due primarily to declining interest in the occupation among young people making first time career choices, rather than to growing market demand. The difficulty in attracting young people reportedly due to fewer young people studying STEM subjects and their lack of interest in practical, manual work coupled with unattractive working conditions and, sometimes, low pay. There is some dissatisfaction with the skills of trainees in sheet-metal working in Germany because they usually have lower levels of academic ability, and there are some concerns about whether the training provision in the Netherlands is sufficiently practical. Germany is suffering from skill shortages across the widest range of occupations, closely followed by the

Netherlands. The situation in Germany reflects a long-term shortage of engineers and workers with appropriate STEM skills to enter medium-level occupations.

Sheet-metal workers have skill gaps in the largest number of countries. This appears to be partly due to deficiencies in the personal attributes of new recruits but also to desire among employers for greater practical content in vocational training and a need to keep trainees abreast of new technology and IT.

Skill gaps are reported across the widest range of occupations in the UK. Countries where newer occupations are only beginning to develop tend to report more skill gaps in basic areas of job competence than do countries where the occupations are more established.

Overall, practical skill gaps are more common than generic skill gaps and employers often expressed a preference for the content of training for some medium-skilled occupations to be more practical. However, although not widely reported, some generic skills may be critically important to the occupation, for example sales and customer service skills for some occupations in delivery of energy-efficient technologies to consumers; management and leadership skills for workers in intermediate trades seeking promotion; and entrepreneurial skills for nanotechnologists seeking to commercialise a new invention.

There are few common trends in solutions to skill shortages and skill gaps, partly because they do not appear to be particularly widespread. Germany is making concerted efforts to attract more young people as part of a broader effort country to increase young people's interest in careers using STEM skills, particularly in the engineering industry. The UK is rather more likely to intensify advertising activity and raise salaries than to train staff, and there is some evidence of poaching. Elsewhere the choice of solution varies depending on the occupation and the employer's circumstances. The most common solutions are to diversify methods for recruiting skilled staff, rely on and train existing staff, and sometimes 'muddling through' or coping with skill gaps. It was much more common for employers to mention re-organisation of work than recruitment and training of new staff. There were very few examples of organisations or countries trying to expand the labour supply by attracting atypical recruits such as women, older workers or disabled workers into these occupations. Where examples of initiatives were found, they were usually on a small scale.

CHAPTER 6.

Future skill needs

On the basis of international research, three main ways have been identified to assess green skill needs:

(a) the number of additional jobs required. This corresponds to the GIDO and GNEO categories of green jobs. In this case, predictions are made for the following two years because employers and learning providers typically find it very hard to make longer-term predictions. Additional job requirements may result from replacement demand, i.e. the demand created by workers who are expected to leave the labour market, or expansion demand, i.e. the demand created when sectors expand their products and services. Most experts interviewed referred to expansion demand, but where replacement demand was mentioned, this was noted;

(b) changes in the types of skills required. This corresponds to the GEDO category of green jobs. It may include both job-specific technical or practical skills, involving the application of subject-specific knowledge, and generic skills, including teamwork, oral and written communication, numeracy, client/customer service, use of IT, foreign language competence, self-management and entrepreneurship skills;

(c) changes in the level of the skill required (i.e. higher or lower level skills). This may correspond to the GEDO category of green jobs. It reflects situations where existing skills may continue to be important, but workers may be expected to deploy them at a higher level or with a greater degree of proficiency. Interviewees generally identified skill needs arising mainly from changes in job numbers and types of skills but less commonly from changes in the level of the skills needed.

6.1. Predicted changes in the volume of employment

Tables 12 and 13 indicate the scale of the change in employment volume in the occupations over the next two years, primarily based on information gained from expert interviewees. Most were able to express an opinion on the direction of change, but not on the numbers of jobs involved.

Table 12. **Predicted changes in employment volumes – High-skilled occupations**

Country	Occupation	
	Nanotechnologist	Environmental engineer
Finland	Possible increase, but scale unknown	Possible increase but scale unknown
Netherlands	No change	Increase due to demand for environmental protection services
Germany	Large growth predicted	Likely growth, based on environmental policy and continuance of current shortages
UK	Likely increase	Likely increase
Italy	Uncertain, dependent on government support	Unknown
Greece	Likely growth	Unknown
Hungary	Occupation does not currently exist except within universities, no immediate growth expected	Possible growth
Slovakia	Occupation does not currently exist except in universities, very limited growth expected	Increase of 30% predicted

NB: Blue cells = predicted employment growth.

These data show that expectations of growth in net demand for environmental engineers are relatively common, with growth particularly marked in Slovakia, albeit from a likely low base. This growth is reported to be driven by demand for services, stimulated by awareness of the environmental risks of business activities and supported by legislation.

Growth in the number of nanotechnologists is concentrated in the larger economies of northern European countries, including the UK and Germany, as applications for the technologies are discovered and commercialised.

The next table shows predicted changes in employment volumes for medium- and low-skilled occupations. Although interviewees were able to comment on the direction of change in employment volumes, they were generally unable to provide any information on the magnitude of the change.

Anticipated changes in employment volumes for medium- and low-skilled occupations:

(a) energy auditor, electricians, sheet-metal worker and insulation worker are predicted to experience higher demand for labour in the largest number of countries;

(b) Germany, Finland and the UK predict higher employment volumes across the widest range of occupations;

(c) south and east European countries were less confident in predicting future skill needs, partly due to lack of available national baseline data, the small numbers employed in some occupations and a highly uncertain outlook for economic growth because of the crisis;

(d) there may be fewer jobs for transport vehicle emissions inspectors due to regulatory change in the UK requiring less frequent testing of vehicle emissions and reduced car use in Germany owing to changes in consumer behaviour due to heightened environmental awareness;
(e) demand is predicted to be mainly stable for refuse collectors. Increased or constant demand for higher-skilled workers in the management of waste collection or recycling activities was predicted for some countries including Germany, Slovakia and Italy, but due to the difference in skill levels, there currently are limited possibilities for refuse collectors to move into these roles.

Slovakia predicts significant employment growth in some occupations, but this is likely to be from a low base.

The Cedefop typology would suggest that growth is most likely to be found in GIDO and GNEO occupations, i.e. SPV installer, nanotechnologist, energy auditor, electrician and insulation worker. This is partially confirmed in that growth is predicted for energy auditors and insulation workers in a fairly wide range of countries, but the pattern is by no means uniform. This is largely because of the difficulties that interviewees in some countries had in estimating future employment change, which resulted in missing data or uncertainty about the scale of change.

Many interviewees cited considerable uncertainty when making predictions about demand for labour demand for labour due to three factors: first, the effects of the recent economic crisis and recession were particularly marked in the construction sector, thus affecting demand for electricians and insulation workers; second, interviewees cited uncertainty about implementation or reversal of policy direction as having a major effect on occupations in the construction sector, which were most likely to be affected by policies on environmental protection and energy efficiency; thirdly, energy costs were expected to be particularly influential on employment growth for solar photovoltaic installers and, to a lesser extent, energy auditors and insulation workers.

6.2. Predicted changes in types of skill needed

The following table indicates the degree of change in the type of skills required for high-skilled jobs over the next two years, primarily based on information gained from expert interviewees, verified against the limited data available from the employer and learning provider surveys.

Table 13. **Predicted changes in employment volumes – Medium- and low-skilled occupations**

Country	Occupation						
	Energy auditor	SPV installer	Transport inspector	Electrician	Insulation worker	Sheet-metal worker	Refuse collector
Finland	Possible increase but scale unknown	Possible increase but scale unknown	Ageing workforce may cause replacement demand	Possible increase but scale unknown	Possible increase but scale unknown	Ageing workforce may cause replacement demand	Possible increase but scale unknown
Netherlands	Increased demand, scale dependent on government subsidy	Increase not likely unless production costs drop	No change in short term	Increase due to introduction of fibre optic cabling	Short-term stability, possible long-term growth	No change predicted	No change predicted
Germany	Possible growth in commercial sector but dependent on higher energy costs	Not identified for short term, but possible in longer term	Decrease due to less (and safer) car use	Continuing replacement demand, due to current skill shortages	Likely to increase, exacerbated by ongoing skill shortage	Unknown	Limited change in demand anticipated
UK	Increase likely, volume unknown	Decrease due to reduction in subsidy for power generated from large-scale installations	Possible reduction, depending on government plans to reduce frequency of vehicle testing	Unknown, depends on state of construction industry	Large potential increase over the next five years, but depends on full implementation of proposed legislation	Ageing workforce may cause replacement demand	Possible increase but scale unknown
Italy	Unknown, will depend on regulation and state of economy	Unknown, will depend on technological change, regulation and state of economy	No information available	No information available	No change over the next five years	No information available	No information available
Greece	No information available	No information available	No information available	No information available	No information available	No information available	No information available

Hungary	Unknown	Unknown	No information available	No information available	Possible growth due to cost of energy, supportive energy policy and ageing infrastructure	No anticipated change in volume	No change
Slovakia	Likely increased demand of 20-30%	Likely growth but on small scale	Likely growth but on small scale	Growth unlikely as ongoing effects of recession in construction sector continues to limit demand.	Growth possible but small scale as ongoing effects of recession in construction sector continues to limit demand.	Increase predicted but small scale	Small scale increase possible

NB: Green cells = short-term employment growth predicted; orange cells = employment volume decrease predicted; blue cells = no change in the short term, but possible medium-term growth.
Source: Authors.

Table 14. **Predicted changes in types of skill needed – High-skilled occupations**

Country	Occupation	
	Nanotechnologist	Environmental engineer
Finland	Job-specific skills: regulatory awareness, knowledge of environmental issues, life-cycle analysis, management of health and safety and security; generic skills: handling publicity and media communication; persuasion skills in justification of product/process safety; commercialisation skills to secure funding and sales skills to 'pitch' new products/services.	Job-specific skills: knowledge of energy consumption, costs and consequences of use; generic skills: commercial awareness, leadership, negotiation and people management.
Netherlands	Technical skills: ability to integrate and apply different scientific disciplines, management of health and safety risks; generic skills: marketing.	No major change in skill needs anticipated.
Germany	Technical skills: management of health and safety risks.	None reported.
UK	Technical skills: skills in identifying/understanding applications of new particles and materials; management of health and safety risks and developing appropriate safety tests; development of products using common materials to mimic properties of rare ones.	Generic skills: marketing, especially in SMEs to promote and sell services to consumers.
Italy	Knowledge of technological developments, but very hard to predict due to market uncertainty.	Updating of regulatory awareness in waste management and environmental protection.
Greece	No information available.	Technical skills: design and planning; generic skills: team work, client and customer service, communication and documenting skills.
Hungary	Unknown as role does not exist outside academic institutions.	Technical skills: risk assessment and management of bio-waste.
Slovakia	Unknown as role does not exist outside academic institutions.	Technical skills: knowledge of new technologies and machinery when assessing compliance of commercial production facilities with environmental regulation.

Source: Authors.

In those countries where nanotechnologist is more developed as an occupation, the dominant skill need is in the management of health and safety risks. In many countries, there has been adverse media speculation about the risks associated with nanoparticles entering the human body through inhalation or absorption through the skin. It is also commonly mentioned that nanotechnologists will need to ensure they keep pace with the very rapid technological developments in their field.

The skill needs for environmental engineers are more diverse. There is a recurrent need for technical skills, most commonly in countries where the occupation is less well established such as Slovakia, Hungary and Greece, and these skill needs could be attributed to the emergence of the occupation. In countries which have a longer history of environmental protection, such as the Netherlands and Germany, no changes in future skill needs were reported. Some generic skill needs reported in Finland, the UK and Greece relate to commercial awareness, customer service and marketing to persuade consumers to purchase environmental engineering services.

Energy auditors in Slovakia, Greece, the UK and the Netherlands have a recurrent skill need for technical knowledge of energy systems and measurement techniques. Broader contextual knowledge of energy consumption in different settings and principles of construction are reported as important in the UK and Germany. Finland and the UK report skill needs for marketing and persuading consumers to take action on the basis of energy audit results, similar to the skill needs of environmental engineers in those countries.

SPV installers will need technical knowledge of developments in SPV systems in the UK, Germany, Slovakia, Hungary and Italy. Generic skills for commercial aspects of running an installation business are required in Greece. The Netherlands reports no major changes in skill needs; this is probably because the government is promoting other of renewable energy sources (RES) instead of SPV power, so the market may not develop quickly.

Transport vehicle emissions inspectors will require up-to-date regulatory knowledge in Slovakia, the UK, the Netherlands and Finland, and an understanding of emissions standards and the mechanics of hybrid and electric vehicles (NL, FI, UK). Overall, few changes are predicted in the types of skill needed in this occupation compared to others.

Electricians will require technical knowledge of changes in construction techniques in the Netherlands and knowledge of energy monitoring and management systems in the UK, coupled with understanding of RES power supply in Germany, customer service skills in Finland and a range of generic skills in Greece.

Insulation workers will need to update their technical knowledge and skills, but the precise requirements appear to vary from country to country. The main requirement will be the ability to apply existing knowledge and principles to new contexts and technologies.

Sheet-metal workers' will need primarily up-to-date knowledge of new technologies and production techniques in Hungary, Slovakia, Italy, the UK,

Finland, Germany and the Netherlands. Generic skills are also required in the UK and Hungary with a common focus on IT.

Refuse collectors have relatively few future skill needs; they focus mostly on generic skills in communication, teamwork and use of IT. These needs partly reflect the persistence of existing skill gaps in the current workforce rather than profound change in job content. New activities and tasks are evolving in the recycling industry largely separately from and without implications for refuse collection.

The Cedefop classification would suggest that GESO occupations (environmental engineers, transport vehicle emissions inspectors, sheet-metal workers and refuse collectors) are most likely to experience changes in demand for the types of skill needed. There is certainly some evidence of changes in skill requirements for sheet-metal workers and environmental engineers. However, there is more limited change anticipated for transport vehicle inspectors and refuse collectors; indeed the range of anticipated change in skill needs is lower than for some occupations in other categories. For the occupation of refuse collector, this is likely to be a reflection of the relatively low-skilled nature of the work, while for vehicle inspectors, regulatory change, e.g. for emissions levels, has a relatively limited impact on the tasks. For occupations such as those in the GNEO category, the emergent nature of the job is likely to be reflected in changes in the skills required as well as the absolute numbers of workers in the occupation.

6.3. Learning providers' views of future demand for and provision of skills

Table 16 shows learning providers' beliefs about sources of demand for skills.

This illustrates that strong growth is anticipated in the demand for green skills from employers and learners, with demand from employers only slightly stronger. In addition, a majority of learning providers see existing workers requiring new or higher level skills as the main source of demand. This illustrates the importance of continuing vocational education and lifelong learning for workers. Some uncertainty about growth areas means that learning providers are likely to be adapt the provision of green skills according to where the impact on occupations is felt most strongly.

Table 15. **Predicted changes in types of skill needed – Medium- and low-skilled occupations**

Country	Occupation						
	Energy auditor	SPV installer	Transport inspector	Electrician	Insulation worker	Sheet-metal worker	Refuse collector
Finland	Generic skills: sales and persuasion skills to make customer act on results of energy assessments.	Difficult to predict due to smallness of sector.	Regulatory awareness and understanding of electric cars, but overall limited change in types of skill needed.	Generic skills: customer service.	No major change.	Technical skills: multi-skilling.	No major changes in types of skill needed, but understanding of recycling helpful.
Netherlands	Technical skills: using more complex energy assessment equipment.	No change likely as sector not a target RES for government support.	Possible awareness of emissions standards for hybrid/electric cars.	Transfer of technical skills to apply in new settings, e.g. modular/lean construction.	No major change in types of skills expected unless any technological change.	Application of lean manufacturing principles to reduce energy consumption and improve production quality; ability to work with composite material in long term.	No major change except improvement in social skills, e.g. teamwork, communication.
Germany	Technical knowledge: understanding of energy use across different industrial sectors.	Technical skills: multi-functional installation of energy/roofing systems and use of electronic QA systems.	No immediate change identified.	Technical skills: knowledge of RES systems.	Technical skills: assessment and operation of thermal imaging equipment.	No information available.	Limited change. Use of ICT, familiarity with new equipment and regulation needed. Possible occupational regulation may demand proof of competence but no change in skills required. Generic skills: possible extension of teamwork across the sector.

UK	Technical skills: knowledge of construction and energy management; knowledge of energy management solutions systems; generic skills: sales and marketing skills to persuade consumers to make changes to save energy.	Technical skills: awareness of changing regulation; technical understanding for installing integrated roofing/SPV systems.	Minimal change; simply knowledge and application of any changes in emissions standards, e.g. for electric/hybrid cars.	Technical skills: installation of new energy monitoring and management systems, especially in domestic sector.	Possible voluntary sectoral regulation may demand proof of competence from all insulation workers but this may not involve change in actual skills required.	Technical skills: knowledge of new technology; generic skills: commercial awareness, IT skills.	Generic skills: basic IT skills to use vehicle IT systems for weighing rubbish and route management.
Italy	No common trends: highly variable depending on interpretation of standards for energy certification of buildings at regional level.	Uncertain, depending on technological development.	No information available.	Unknown.	Technical skills: no immediate change but possibly understanding of polymers over next five years.	Technical skills: firm-specific practical skills, due to wide variety of metal working roles which are usually product and firm specific.	No information available.
Greece	Generic skills: entrepreneurship. Technical skills: regulatory awareness, risk management and practical skills in using technology.	Generic skills: foreign languages, IT, numeracy, financial management, budget planning and self-management.	Technical skills: regulatory awareness, risk management, inspection and monitoring, communicating and documenting, analysis and decision-making. Generic skills: written/oral communication, foreign languages, IT, self-management and team work.	Generic skills: written/oral communication, self-management; technical skills: regulatory awareness and risk management.	Technical skill needs in regulatory awareness, risk management skills, analysis and decision-making.	No information available.	Practical skills: maintenance and repair skills, communications and producing documentation Generic skills: written and oral communication, self-management, teamwork.
Hungary	Technical skills: stronger multidisciplinary skills in architecture and engineering.	Technical skills: awareness of developments in technology and practical skills to apply them.	No information available.	Technical skills: New technology may affect skills required in long term but not in immediate future.	Technical skills: no major change to job content, but scale/complexity of work in commercial sector may increase and awareness of RES desirable.	Technical skills: update knowledge of new technologies, environmental awareness for production processes. Generic skills: foreign languages and IT.	No major change predicted.

Slovakia	Technical knowledge: power consumption in range of electric appliances, efficiency rating systems and suitable alternative power sources; generic skills: numeracy and IT; analysis; verbal and written communication; foreign language (English); customer service.	Technical skills: choice of material and SPV system for each context; SPV system design; numerical skills to calculate system performance; financing and auditing of energy consumption; SPV system safety.	Technical skills: regulatory awareness of anticipated legislation limiting emissions from older commercial vehicles; use of IT systems in inspection.	Unknown as ongoing effects of recession in construction sector continue to limit demand.	Unknown as ongoing effects of recession in construction sector continue to limit demand, but untrained workers in industry would benefit from basic training.	Technical skills: design and planning; understanding properties of raw materials and quality improvement in production processes.	Practical skills: possible use of new technology/machinery.

Source: Authors.

Table 16. **Demand for green skills in the future (% agreeing or disagreeing with statement)**

	Disagree	Neither Agree or Disagree	Agree	Total	Base (N)
Anticipate strong growth in demand for green skills mainly from employers	9	31	61	100	59
Anticipate strong growth in demand for green skills mainly from learners	14	36	51	100	59
Believe most demand for learning provision will come from existing workers who need to upgrade existing skills	20	27	53	100	59
Anticipate that most of the demand will come from a few key jobs and sectors	7	39	54	100	59
Very uncertain where the growth areas are going to be	27	36	37	100	59

Source: *Meeting the needs of future learners*, Survey of learning providers, IES, 2011.

Changes in types of technical skills that training providers intend to offer future learners are difficult to report by occupation level within countries because there were too few responses. Overall, learning providers for electricians report that they will place more emphasis on inspection and monitoring skills in future provision, increase the overall volume of provision for energy auditors, SPV installers and environmental engineers, make few changes to provision for refuse collectors or sheet-metal workers, and increase the focus on regulatory awareness, practical and written communication for transport inspectors.

The types of generic skills which learning providers envisage including in future provision across most occupations of interest include: team-working, customer service, and oral and written communication. They are much less likely to plan to include generic skills in managing others, foreign language skills and entrepreneurship (although very few responses were received for the high-skilled occupations of nanotechnology, where there is likely to be greater demand for some management skills). Some generic skills are identified as future skill needs by employers, but further more detailed work in each country would be required to assess the extent of any mismatch between supply and demand at occupational level.

6.4. Conclusions

Our interviewees predicted growth in demand for labour in the largest number of countries for energy auditors, electricians, sheet-metal workers and insulation

workers demand for labour. These are occupations which require medium levels of skills and are therefore also most likely to experience higher growth than higher- or lower-skilled occupations, which employ fewer people in absolute terms.

Germany, the UK and Finland predict future increases in employment volumes across the widest range of occupations. Southern and eastern European countries were less confident in predicting future skill needs, due in part to a lack of available national baseline data, the small numbers employed in some occupations and a highly uncertain outlook for the economy owing to the crisis.

The number of transport vehicle emissions inspectors may decline owing to the proposal to test vehicle emissions less frequently in the UK and to changes in taxation on CO2 emissions from vehicles in the Netherlands. Reduced car use in Germany as a result of changes in consumer behaviour due to heightened environmental awareness may have a similar effect.

Demand for refuse collectors is predicted to remain mainly stable. Increased or constant demand for higher-skilled workers for management of waste collection or recycling activities was predicted for some countries including Germany, Slovakia and Italy, but due to the difference in skill levels, there currently are limited possibilities for refuse collectors to move into these roles.

The main skill needs for nanotechnologists are likely to be management of health and safety risks, coupled with commercialisation skills in some countries. Environmental engineers have a diverse set of skill needs which varies depending on specialisation and country, including technical skills, and commercialisation, customer service and marketing.

Insulation workers and sheet-metal workers will require updated technical knowledge and skills. Energy auditors, electricians and SPV installers are likely to require enhanced knowledge of new technologies and developments in energy systems and construction tools and techniques.

For transport vehicle emissions inspectors, relatively few changes are predicted in the types of skills they need compared to other occupations; they simply require up-to-date awareness of regulations and knowledge of how new hybrid or electric cars are designed. Refuse collectors have relatively few future skill needs; they are mainly generic skills in communication, teamwork and use of IT. Training providers regard employers rather than learners as the source of demand for skills in these occupations.

CHAPTER 7.

Training provision and practices

This chapter assesses training provision and practices for workers in the occupations of interest. The focus is on continuing professional development rather than the initial education and training path to each occupation, although where employers have strong views on initial training that affect subsequent training provision, they have been included. The focus is on work-related training which contributes to lifelong learning.

The chapter begins by presenting information on the incidence and content of training for experienced staff rather than new recruits, and then reports problems encountered in provision and barriers to employer engagement in training. The final section reviews the drivers of business change and their perceived impact on the selected occupations.

7.1. The provision of training

The EU-LFS provides information about the provision of on- and off-the-job training to workers within the last four weeks. No information is collected by the EU-LFS about whether this training is work-related. It was possible to provide an analysis for five countries where EU-LFS data are available: Finland, the Netherlands, the UK, Hungary and Slovakia.

It is worth repeating that the occupation codes offer only partial coverage for some occupations (nanotechnology engineer, environmental engineer, vehicle emissions inspector occupations) and in one instance cannot distinguish between two of the occupations of interest (energy auditor and vehicle emissions inspector).

Table 17 shows the rate of training for each occupation in each country. The rate of training is compared to the average for all other workers in each country.

While these data must be treated with some caution since they do not capture full occupations, do not provide information for all countries of interest and may be based on interpretations of training that differ for cultural reasons, the key points are:

(a) workers in Hungary and Slovakia were least likely to report participation in training. This may be for a wide range of reasons, such as high unemployment, and hence easy access to labour, and the characteristics of national VET systems;

(b) workers in the UK and Finland have the highest rate of participation in training;
(c) nanotechnologists and environmental engineers were, in most countries, most likely to receive training. This is consistent with commonly observed patterns of higher levels of participation in training among workers who already have high levels of skills/qualifications;
(d) the lower-skilled occupations (insulation workers and refuse collectors) were least likely to receive training and in the case of refuse collectors, the rate of participation in training was heavily influenced by the relatively high levels of training in one country (UK). It is not known why refuse collectors in the UK have high rates of participation in training: this may reflect the workers' aspiration to train for other occupations requiring higher levels of skills/qualifications;
(e) occupations with common licensing or certification requirements, e.g. energy auditor, vehicle emissions inspector and electrician, had a higher rate of participation in training than others in the mid- to low-skilled occupational groups, which may reflect the need for regular certification to continue to practise these occupations.

Table 17. **Overview of on- and off-the-job training in the last four weeks (% of workers receiving training)**

	Finland	Nether-lands	UK	Hungary	Slovakia
Nanotechnologist	25	15	26	13	8
Environmental engineer	27	18	24	6	8
Energy auditor/transport inspector	26	14	30	2	2
SPV installer	19	20	20	0.7	0.8
Electrician	23	26	21	1	2
Insulation worker	4	4	n/a	0	2
Sheet-metal worker	10	21	10	0.5	0
Refuse collector	0	9	16	2	0
All other workers	28	25	22	3	3

Source: Eurostat EU-LFS: IES' own analysis.

7.2. Extent of training provision and nature of training practices

The insights of the key informants interviewed in each country helped to explain variations in levels of participation in training between different occupations. There were considerable differences in the types of training available and the

forms of delivery used, but the key informants were not able to comment on the amount of training in the occupations.

7.2.1. Training provision in the high-skilled occupations

Nanotechnology engineers and environmental engineers are highly skilled and receive significant training prior to entering their occupation. However, the form of the training available after entry varied considerably between the two occupations. It also varied by country, although the variation was greatest for environmental engineers.

Table 18. **Provision of training for the high-skilled occupations based on key informant information**

Country	Nanotechnology	Environmental Engineer
Finland	Initial training to post-graduate level but highly qualified individuals frequently recruited who do not need training.	In house workshops and seminars, on-site and on-the-job.
Netherlands	Postgraduate qualifications delivered by universities and/or higher vocational schools.	On the job training takes place with some industry-higher education collaboration, funded by employers.
Germany	Additional training provided by employers for leadership positions following initial postgraduate training.	On- and off-the-job training is provided by most companies to support specialisation.
UK	On-the-job training after initial postgraduate training and significant industry-higher education collaboration to support 'state-of-the-art' information exchange.	Employer commitment to training if a business case is identified. Variation in nature and extent of training by region.
Italy	Postgraduate qualification required but costs high and public funding not available. Consequently individuals are discouraged from taking up training, which has led to none being delivered since 2009.	Extent and nature of training depends on level of responsibility of role. Certification required for all levels in some fields, e.g. ecology, which necessitates training.
Greece	Extensive postgraduate provision is available.	Training is available to support specialisation within the occupation, although information is not provided about whether this is on or off the job.
Hungary	No information available.	No information available.
Slovakia	The occupation is not well developed. Pre-entry training would be to postgraduate level.	The occupation is not well developed and a range of specialisms exist which require their own development. On-the-job training for practical application of the skills gained in university is essential.

Source: Data from national country reports commissioned for this project.

For nanotechnologists, further training and continuing professional development (CPD) take place mainly at postgraduate level and was reported to

involve knowledge exchange and collaboration between universities and industry through seminars and workshops, particularly in the UK. In Finland, entrants to the occupation of nanotechnologist are reported to be so well qualified that further training is often unnecessary. All countries reported that entrants to the occupation were highly trained. In Germany, nanotechnologists wishing to take on management and leadership roles would require training in these generic skills. In Italy, the cost of this training is prohibitive and none has been delivered since 2009.

Further training for qualified environmental engineers was quite different from that available for nanotechnologists. Specialisms appeared to be more diverse in this occupation than in the occupation of nanotechnologist. Training, including seminars and workshops, was more commonly delivered in house and more frequently 'on the job'. Some collaboration took place between higher education and industry in the Netherlands and there was more likelihood of 'off-the-job' training in Germany. In Italy the need to achieve professional accreditation of practice ensured that training was delivered regularly and at all levels within the occupation (an example given was for ecology). A professional body in the UK noted that employers were willing to invest in training in this occupation if a business case existed. In Finland, any training was likely to be delivered in-house by companies. There was not clear indication of the nature of training in this occupation in Greece.

7.2.2. Training provision in medium- to low-skilled occupations

In all countries, training provision for low- to medium-skilled occupations was more likely to take place on the job, and in some cases it was driven by regulation and focused on safe practice and the introduction of new technologies, practices or processes. It appeared overall that training would have a more practical focus than was the case in the high-skilled occupations (nanotechnologist and environmental engineer).

Germany, the Netherlands and the UK provide the most developed and regulated training for medium- to low-skilled occupations. In some occupations the training focuses on health and safety and new technologies. In other countries, training following initial qualification is based on company standards rather than on industry standards. The incidence, type and content of training were more variable by specialisation within occupations. Training for some occupations was regulated, e.g. vehicle emissions inspector and electrician.

Table 19. **Provision of training for the low to medium-skilled occupations based on key informant information**

	Energy auditor	SPV installer	Vehicle inspector	Electrician	Insulation worker	Sheet-metal worker	Refuse collector
Finland	On the job through workshops and seminars plus on-site practice. Mentoring offered by senior colleagues.	On-the-job training for general practice.	On-the-job workshops and seminars Specialised courses, e.g. heavy vehicle inspection. All training employer-funded.	On-the-job training. Mentoring offered by senior colleagues.	On-the-job – pre-entry training is limited. Employers offer training including apprenticeship-type provision for existing workers.	On-the-job training is made available.	Training programmes offered depend on job and position, after initial induction/seminar.
Netherlands	Lack of external opportunities. Companies therefore provide training. No government subsidies but employers invest.	Lots of provision available and employers willing to invest. Quality of training needs quality assurance. No funding available.	Employer and employee-funded training and exam costs, e.g. for refresher training and certification.	Courses funded by sectoral association and sufficient supply of external training.	On-the-job training or none. Few providers involved, which places onus on employers. No government subsidy is available but some sectoral funding.	Training mostly corporate and offered for career progression into supervisory roles. External training for social skills.	Mainly in-house On-the-job training focused on work attitude and responsibility. Some external provision is available.
Germany	Professional bodies require accredited training to practice (e.g. 20 hours of CPD per annum).	CPD is expected. Some employers unwilling to fund due to cost and loss of production.	Employers with membership of professional bodies pay for 5-8 days training per annum for accredited CPD courses	Accredited training related to specialisation available or use of new products/technologies. Management training taken up by around one-third of workers for progression to middle management positions.	Training for competence in new products and processes and is typically certificated, e.g. foam insulation.	On-the-job training is includes CPD to achieve *Meister* status after two years' professional practice.	Training mostly focused on work tasks and tools. Training available for promotion into foreman role but perceived to be challenging and taken up by few workers.

UK	On-the-job training for graduates. Further courses to meet professional standards lasting 3-5 days followed by assessment and supervised practice.	On-the-job training with supervision from more experienced workers.	Three days training every five years provided by regulator required to maintain certification.	Refresher training in legislation updates required to maintain professional accreditation. Some employers support Certificate of Competence, e.g. for energy microgeneration quality assurance scheme.	Training limited and driven by regulatory bodies, i.e. health and safety.	Most training provided by employers internally, often through supervision by experienced staff or technology updates provided by supplier of new equipment.	Training for safe working practices, awareness of risks, and machine operation. Possible certificate in level 2 (ISCED 3) in waste management.
Italy	Postgraduate training available with mix of off- and on-the-job training. Re-accreditation training courses required for energy certification of buildings, and e-learning available.	External provision available focusing on systems design. Delivery through blended learning. Training courses relatively intensive, e.g. 80 hours to qualify.	Regulator requires training for manager of each test station in equipment, tools and health and safety.	More training for specialist workers in larger firms. Training provision focused on RES. Courses typically require 68 hours of theory (off the job) complemented by project work.	Courses for materials/technologies and systems and enable specialisation, often lasting one day. Seminars give updates on regulations, standards and technologies.	Technical knowledge and regulation updates, Q&A systems, H&S, etc.	No training required.
Greece	Training available to support specialisation within occupation.	Licence to Practice training is mandatory. On-the-job training, seminars and mentoring are typical.	Certified seminar attendance is mandatory – externally provided and certified by government.	Training for specialisation is available to existing workers for example, in energy efficiency. This is typically provided through seminars led by professional bodies.	No pre-entry training requirements. Technical training is available and externally provided, for workers in the occupation.	No comments.	No training usually provided.
Hungary	No information available.	No information available.	No information available.	No information available.	No information available.	No information available.	No information available.
Slovakia	Provision mostly internal, focused on health and safety and limited due to costs, lack of perceived need and time.	Provision mostly internal, focused on health and safety and limited due to costs, lack of perceived need and time.	On-the-job training for proficiency in practical of skills learned in training.	On-the-job training in new technology or updates from equipment suppliers.	On-the-job training and technology updates from suppliers.	In-house training on technical use of machine tools and equipment.	Regular, compulsory training defined by the Waste Act and for the health and safety protection at work.

Source: National country reports commissioned for this project.

All countries provided training for energy auditors, with Germany, Italy, Hungary and the UK having regulated training. The amount of training appears to vary between countries, but there are not sufficient data to make a full comparison. The occupation is subject to rapid technological development, particularly in Germany and the Netherlands, and this was a key driver in the provision of training, together with the Directive on the energy performance of buildings due to take effect in 2012. It was also noted that Netherlands employers were willing to invest, despite a lack of public subsidy – perhaps also reflecting rapid development and potential growth in this occupation.

The occupation of SPV installer was viewed as quite specialist in comparison with other medium- to low-skilled occupations, and training was provided in all countries. Much of this training was delivered on the job and could be extensive (for example, in Greece up to 80 hours of input in any specialism). In Germany, while workers were expected to undertake CPD, some employers were not willing to invest in this training. This reflects the ambiguous status of this occupation in some countries (e.g. Hungary and the Netherlands) where it is not fully recognised yet as a legitimate, discrete occupation. The UK provided the least formal training in this occupation, relying on supervision by more experienced workers. The varying nature of regulatory development and the need for re-accreditation to practice may be driving these trends in training.

All countries offered training to vehicle emissions inspectors to comply with regulatory requirements; the training covered changes in and updates to standards for vehicle testing. Consequently, employers invested more time and money in training for this occupation than for most other medium- to low-skilled occupations, although there were some variations between countries. For example, in the Netherlands employees also had to contribute to training costs. In addition to the regulated training, in most countries (e.g. Germany, Greece, the Netherlands and the UK) vehicle emissions inspectors had access to training in new specialised equipment, tools and processes in their occupations.

The regulation of electrical installation and supply ensured that training for qualified workers was delivered in all countries for this occupation. Electricians received on-the-job training and regular off-the-job refresher courses to maintain certification of competence, and they were given opportunities to follow specialised training in new products and services. For example, in the UK it is possible to have competence in micro generation installation certified; in Italy comprehensive training in electrical supply for SPV is available; and in Greece, training to raise energy efficiency awareness in SPV operation is available.

Training provision for qualified insulation workers varies from country to country, which may reflect the degree to which this occupation is regulated. For

example, in Finland, a system of company-verified certification exists, and similarly in the Netherlands there is company-specific training. In Germany and the UK, specialised processes/technologies (e.g. foam insulation) were more regulated, although training in these specialisations was reported to be quite limited in the UK. Greece and Italy noted high levels of training of short duration and in-company training in specialised tasks and technologies. However, regulation of qualifications and vocational training was less systematic across countries than for some other occupations.

Again, for sheet-metal workers, the picture was mixed although it tended to focus on technical knowledge and skills. In Germany and Italy, some of the training available was reported to be a response to regulation. In the Netherlands the industry is viewed as innovative so greater professionalism may become apparent, which will in turn foster the provision of external and specialised training. It is anticipated that environmental sustainability will be included in training. A new professional training body has been set up to start training workers to the higher levels of qualification now required. In the UK training was mostly in-company and informal, delivered through supervision by experienced workers and it focused on new technologies and/or health and safety.

Training for refuse and recycling collectors was minimal and focused on health and safety. Some countries included employability attributes such as attitude and service skills (the Netherlands). Generally, training was provided in companies and on the job. The training in the UK focused on safe working practices and training to level 2 (ISCED 3-4) in waste management was available. In Germany, the lack of progression opportunities meant there were few drivers to engage to train or to train to a higher level. More frequently, there was little training for this occupation, with Italy requiring no particular training and very limited training being available in Finland.

7.3. Problems and challenges for training provision

No problems or challenges common to all countries or occupations were noted in the provision of training for workers. However, the key informants highlighted some challenges for specific occupations.

7.3.1. Problems with training provision for high-skilled occupations

Although training for high-skilled occupations is widely available, some problems were noted that tended to be country specific.

Collaboration between higher and further education institutions and employers in delivering CPD for nanotechnologists was a positive feature of the

training offered for this occupation. However, the nanotechnology occupation is relatively new in Italy and requires a postgraduate qualification. This qualification was first developed in 2004 and was innovative in Europe, but the expense and lack of public subsidy mean that it has not been available since 2009 because individuals and employers are reluctant to pay fees of around EUR 18 000. The high cost of post-graduate training for nanotechnologists was also noted in the UK, and SMEs consequently tended not to use externally provided training. Few other issues were noted by the key informants, and indeed in Finland, for example, provision was noted to be easy to find and of suitable quality.

Slightly more concern was expressed in all countries about training for environmental engineers because it varied more between specialisms and was more likely to take place on the job or in the workplace. For example, in the Netherlands the quality of training was felt to have declined and there was too much emphasis on theory at the expense of practice. In Italy, lack of opportunities to advance in the occupation was felt to hinder the uptake of training among workers. In the UK, the diversity of specialisms meant it was difficult to find training that was tailored to companies' needs.

7.3.2. Problems in the provision of training to medium- to low-skilled occupations

Employers in the Netherlands reported a lack of externally-led provision for energy auditors. Employers in the Netherlands and the UK wanted more focus on contextual knowledge of building, construction and energy generation, reflecting weaknesses in initial training. In Germany, the main problem for this occupation was felt to be the lack of career advancement opportunities. This meant there was no motivation for workers to undertake further training. In the UK workplace scenarios were not replicated in training and tutors lacked the practical experienced required for some higher level training.

In the Netherlands, the government did not provide quality assurance for the training of SPV installers and it was felt that training providers should place more stress on occupational standards in curricula and should also include environmental sustainability. In the UK, rapid expansion of this industry had led to a considerable increase in training provision, but employers reported that the quality was mixed and it was difficult to find high-quality provision. In Greece, it was felt that training should place greater emphasis on soft skills. In Finland, it was reported that it was difficult to find any training for this occupation.

In the UK, it was felt that the mandatory refresher training for vehicle emissions inspectors was too theoretical but that it would be difficult to incorporate more practice-based elements because the training was short (three

days) and needed to deliver a considerable amount of material. More frequent refresher training was suggested as a solution.

In the Netherlands, for electricians, rapid specialisation has meant that employers do not understand all the training that is being made available and need help to navigate the options. The key informants saw a need for clearer regulation here. Employers reported that training providers were not keeping pace with developments in the industry and the content of their provision was opaque. A stronger link to occupational standards was desired. In the UK, provision needed to be more closely linked to employers' needs, but as many employers do not undertake training needs analysis so that they can inform learning providers of their requirements, it is difficult for providers to identify the changes required in the content of training.

A lack of training provision for insulation workers was reported to be a problem in Greece, the Netherlands, Finland and the UK. In Greece and Finland, this was due to inadequate training to support entry into the occupation. In the UK, the training that is available would benefit from greater emphasis on practical skills. Furthermore, there is only one training centre, which means employers have to release workers for block training, which may not fit in well with other business needs.

Few comments were made about the training available for sheet-metal workers. In the Netherlands there was an indication it was too generic and needed to be tailored more closely to the occupation, while in the UK very little was delivered to experienced workers. The key informants from Finland noted difficulties in finding any suitable provision.

Refuse collectors in Germany were reported to lack interest in training, possibly due to the low level of existing qualifications and lack of interest in learning or because of the challenging nature of the training to prepare for promotion to supervisory positions. Training provision for this occupation in the UK was reported to be satisfactory, although employers were said to be unwilling to pay the costs associated with training at some distance (i.e. to fund the travel and subsistence costs of training off the job). Comments were not received for other countries that reported problems with the training provision for this occupation, although that may simply reflect the limited training available for these workers.

7.3.3. Employers' views of training

Table 20 below illustrates the spread of views among employers in the survey on whether the training delivered had met their expectations. The figures illustrate that in most countries training met their expectations to some extent. In the UK

there appeared to be greater satisfaction with training than elsewhere, and in Finland there appeared to less satisfaction than encountered elsewhere.

Table 20. **The spread of views among surveyed employers about the extent to which training met expectations**

Expectations met	UK*	FI	DE	NL*	IT	HU*	EL	SK
To a great extent								
To some extent								
Not at all								

NB: Green cells = majority of employers; blue cells = minority of employers; blank cells = no answers.

* for HU, NL and the UK the same number of employers reported that training met expectations 'to a great extent' or 'to some extent'.

Source: Authors.

Where the employers provided a reason for their level of satisfaction, there was an indication that training could have been more relevant (in Finland) and of better quality (in Finland and the UK). However, in Italy and the UK, it was reported that the problem was due to reluctance on the part of workers to attend the training provided and to engage sufficiently with it.

There is very limited variation in the employers' views by occupation. Almost all employers stated that their expectations were met, although they were most likely to be partly rather than fully met. The small numbers of responses precludes more detailed reporting.

7.3.4. Providers' views of challenges in meeting training needs

The main challenges reported by providers in delivering training are shown in Table 21.

Table 21. **Challenges in providing training for green skills (% of all learning providers)**

	Disagree	Neither agree nor disagree	Agree	Total	Base (N)
At the moment, trainee numbers are too small for us to deliver training efficiently	33	23	44	100	52
It is difficult to know what organisations want in terms of green skills training	24	26	51	100	51
Employers requiring green skills are too dispersed to target effectively	21	33	46	100	52
Employers requiring green skills are very disparate in terms of occupational profiles	14	29	58	100	52

NB: No responses from learning providers in Germany were received to these questions.

Source: Authors.

Over half of learning provider responses reported that it was difficult to meet the needs of employers with diverse occupational profiles and to understand the skill needs of organisations. Just under half reported that employers are too geographically dispersed to target effectively and that there are still too few learners to deliver training effectively. Employers in the eastern and southern European countries under study were more likely to report difficulties in identifying employer needs (Greece, Italy, Hungary and Slovakia) and that employers were too geographically dispersed to target effectively (Greece, Hungary and Slovakia). Learning providers reported that identifying the skills employers want and coping with the diversity of occupational profiles tended to be the most significant problems in all occupational groups.

7.3.5. Learning providers' views on sourcing, content and employer demand for qualifications

Table 22 shows the views of learning providers on the development of qualifications to meet skill needs for these occupations.

Table 22. **Learning providers' views on qualifications by occupation (% of all learning providers agreeing and disagreeing with statement)**

	Disagree	Neither agree nor disagree	Agree	Total	Base (N)
The demand for new qualifications is low	21	25	54	100	52
The content of qualifications is not developing fast enough to meet changing demand for green skills	12	37	52	100	52
We cannot find relevant qualifications for green skills	26	37	37	100	51
Employers want to add on modules to existing qualifications rather than have new qualifications	10	34	56	100	50
It is hard to persuade those who develop qualifications that green skill need to be included	31	43	26	100	51

NB: No responses from learning providers in Germany were received to these questions.
Source: Authors.

The main barrier for learning providers is low demand for new qualifications from employers. However, where employers do have unmet green skill needs, the content of qualifications is not keeping pace with the emergence of demand. Lack of employer demand was the biggest problem in Finland and the pace of development of qualifications was the biggest problem in Greece, Italy and the UK. The pace of development of qualifications also tended to be the main

obstacle when the data are broken down by occupation, but small response rates prevent further analysis.

7.3.6. Learning providers' views on trainers' interest and capability

Table 23 reports on learning providers' views about their trainers' capability and interest in meeting the skill needs for these occupations.

Table 23. **Learning providers' views of trainers (% agreeing and disagreeing with statement)**

	Disagree	Neither agree nor disagree	Agree	Total	Base (N)
Our trainers lack the necessary green skills themselves	37	29	35	100	52
Our trainers are excited by the opportunities offered by green skills	6	37	58	100	52
Trainers are reluctant to change tried and tested curricula	42	44	14	100	52

NB: No responses from learning providers in Germany were received to these questions.
Source: Authors.

Trainers appear to be willing to develop curricula and to be excited by opportunities to teach in new areas, but they are more commonly reported to lack the skills to deliver training. Across occupational groups, it was slightly more common to hear reports of trainers lacking the required skills and enthusiasm from learning providers for electricians, insulation workers and sheet-metal workers. These data should be treated with great caution, but the relevance of 'green' skills may be less obvious to those teaching learners in existing rather than newer occupations.

7.3.7. Learning providers views on and response to changing skill needs

The response of learning providers to the demand for green skills was mixed (Table 24).

The most common response from learning providers is to increase the volume of provision and change course content to accommodate new market demands. A substantial minority reported close collaboration with employers to meet green skill needs and are investing in ability to provide training in green skills. A substantial minority of learning providers are however cautious in their response due to concerns about insufficient learners and market development.

Table 24. **Learning providers' approach to the provision of green skills**

(%)

	Disagree	Neither agree or disagree	Agree	Base (N)
Investing heavily in our ability to train in green skills	26	33	41	58
Waiting to see how the market develops before we extend our provision of courses for green skills	32	30	39	57
Increasing the volume of provision of training for some 'green' occupations where course content is unchanged	33	35	32	57
Increasing the volume of provision of training for some 'green' occupations and change course content	17	21	62	58
Training too risky to design and deliver as insufficient numbers of learners may come forward	24	36	40	58
Advanced in developing provision to meet enhanced and emerging green skill needs	31	45	24	58
Working closely with employers to meet their 'green' training needs	18	35	47	57
Most employers will end up providing their own training for green skills	29	48	22	58

Source: Authors.

Learning providers in Slovakia were most likely to claim they were investing heavily in their ability to train learners in green skills, while providers in Hungary and the UK were more likely to report caution and uncertainty. Greek providers gave the most mixed responses, with a number claiming to have well developed provision and to be investing heavily, while similar numbers were uncertain about the future and cautious about investing. However, the numbers of responses are too small to report in more detail.

Where the implications of economic greening were clearer and possibly more predictable, for example in the occupations of energy auditor and SPV installer, learning providers were more likely to report heavy investment and changes to course content. This may be due to government regulation and resultant consumer demand, as well as the novelty and emerging nature of these occupations with possible newly recognised skill needs. Learning providers for electricians, insulation workers and sheet-metal workers viewed change as more risky and were more likely to wait for further market developments.

7.3.8. Learning providers' activities to monitor changes in demand

Table 25 shows responses to a range of potential activities that learning providers could take to meet future needs.

Table 25. **Current actions/strategy (in readiness for green skills)**

(%)

Strategy that includes green skills	42
Regular review of current learning provision	67
Regular review of the skills and skill needs of trainers/teachers	54
Regular overview of changing demand for training	72
Regular review of client satisfaction	58
None in place	12

NB: Base (57 learning providers).
Source: Authors.

Reviewing changing demand and the current learning provision to meet green skill needs was the most widespread activity among learning providers, consistent with the 'wait and see' or ad hoc responses reported earlier. Few learning providers included green skills in the organisation's learning strategy. Learning providers in Italy and the UK were most likely to adopt this approach. There was very limited variation in strategies adopted by learning providers in the different occupations.

7.3.9. Future plans of learning providers for meeting demand for green skills

Table 26 shows learning providers' major plans for meeting green skill needs.

Table 26. **Planned responses to green skill needs**

(%)

Responding to green skill needs as a training provider by:	%
Recruiting new trainers	26
Offering training to our staff	46
Strategic partnering with other organisations	51
Asking nominated staff to examine the implications of green skills	30
In other ways	7

NB: Base (57 learning providers; 21 non-responses).
Source: Authors.

Learning providers reported adopting a combined approach of training their own staff and partnering with other organisations to meet green skill needs. Training staff is consistent with the lack of staff knowledge reported by a substantial minority of learning providers, while partnering may help to spread the risk of investment. For some learning providers tight finances may lead to consolidation in the sector in some Member States, which may be another reason why partnerships are formed. Learning providers in Italy were most likely to recruit new trainers, but because response rates are low, further analysis of the

data at country level is not possible. There was limited variation in the responses of learning providers according to the occupation they train for.

7.4. Future drivers of business change and their impact on occupations

The final section of this chapter reviews the findings of the survey of employers and learning providers for indications of the facts that will determine green skill requirements in the occupations of interest and hence the green skills provision that will be made available.

7.4.1. Employers views of the factors driving change

Employers rated their organisations' level of awareness of environmental as excellent, good or adequate in almost equal numbers. Awareness is highest in the UK and Germany, followed by Finland, Italy and the Netherlands. There appears to be an opportunity to raise awareness of environmental issues in organisations throughout Europe. There appears to be very little difference between occupations, although the numbers are too small to be certain.

The survey explored what actions employers were taking in response to environmental factors that might affect their operation. Employers highlighted compliance with environmental protection regulations as the most important form of action both now and in the future, although it was considered reducing pollution, waste, environmental degradation and biodiversity loss would be higher priorities in the future than they have at present.

There was little to differentiate responses by nation or occupation, although this could be attributed to the fact that few employers were involved in the survey overall.

7.4.2. Impact of change on occupations

Most employers in the survey reported that they had adapted products, services or working methods in the last two years to take account of environmental issues. However, it appeared that these changes had only a slight impact on the occupations of interest. An impact was most commonly felt in the occupations of SPV installer and energy auditor and least commonly in the occupation of refuse collector. This is consistent with the relative novelty of energy auditing and SPV installation works and their obviously closer connection with the green economy.

7.5. Conclusions

In most countries nanotechnologists and environmental engineers had the highest incidence of training participation. This is consistent with the common tendency for workers who already have high levels of skills/qualifications to have higher rates of participation in training.

Workers in lower-skilled occupations – insulation worker and refuse collector – were least likely to receive training, and in the case of refuse collectors, the rate of training participation was significantly influenced by relatively high rates of training in one country (the UK). The reasons for the high rates of participation in training among UK refuse collectors are not known: this may reflect an aspiration among workers to train to enter other occupations requiring higher levels of skills or qualifications.

Occupations that commonly have licensing or certification requirements, e.g. energy auditor, vehicle emissions inspector and electrician, had a higher rate of participation in training than others in the medium- to low-skilled occupational groups, which may reflect the need for regular certification to continue to practice in these occupations.

Nanotechnology engineers and environmental engineers are highly skilled and have received significant training prior to joining their occupation. Further training and CPD is focused at postgraduate level and was reported to involve knowledge exchange and collaboration between university and industry through seminars and workshops. Training provision for qualified environmental engineers was commonly delivered in house, including in seminars and workshops, and more frequently on the job.

In all countries, training provision for each of the low- to medium-skilled occupations was more likely to take place on the job, and in some cases it was driven by regulation and it focused on safe practice and the introduction of new technologies, practices or processes. Training for these occupations was more practical and task-orientated than training provided for the high-skilled occupations. In some occupations training focuses on health and safety and new technologies. Training for some occupations was regulated, for example for vehicle emissions inspectors and electricians.

Survey responses from employers show that in most countries training met their expectations to some extent, and there was very limited variation in employer views by occupation. The main area of deficiency in learning provision identified is either absence or fragmentation of learning provision for insulation workers and SPV installers in some countries.

In several occupations employers want closer cooperation with VET providers so that they can influence the content of training to ensure that it is up

to date and meets their needs. In some countries the mix of theory and practice in the content of training should be reviewed to ensure that it is more balanced in both vocational and non-vocational courses

In their survey responses, learning providers tended to express enthusiasm and willingness to change curricula to meet new demands from employers and learners, where they exist. The most common response from learning providers is to increase the volume of provision and change course content to accommodate new market demand, in addition to collaborating with employers, training their own staff and entering into partnerships with other organisations.

However, so far the action taken by learning providers appears to be rather piecemeal and reactive, which is understandable. Most learning providers do not yet include green skills in their learning strategy. In addition, a substantial minority of learning providers are very cautious in their response because of concerns about the lack of learners and the pace of market development. Learning providers for the obviously 'green occupations' of energy auditor and SPV installer were more likely to report heavy investment and changes to course content than those for other occupations, while learning providers for electricians, insulation workers and sheet-metal workers viewed change as more risky and were more likely to await market developments.

The main barriers preventing learning providers from grasping the opportunities presented by the developing green economy are the low demand for new qualifications from employers and employers' preference for 'add on' modules rather than new qualifications, combined with the slow pace of qualification development. The pace of qualification development was also revealed to be the main barrier when the data were broken down by occupation, but small response rates prohibit further analysis. It is also difficult to meet the needs of employers with diverse occupational profiles and to understand the skill needs of organisations, particularly when employers are too geographically dispersed to target effectively and there are still too few learners to deliver training effectively.

For some occupations, learning provision appears adequate to meet the current and future skill needs of employers. The quality of learning provision appears relatively strong in Germany, the Netherlands and Finland, where fewer skill gaps are reported.

CHAPTER 8.

Conclusions and recommendations

8.1. Introduction

This report identifies the implications of the transition to a greener and resource-efficient economy for training and skills policy to help countries meet the challenges and opportunities that this transition presents. To do this, the report gathers indications of possible mismatches between the skills provided through the VET system and the skills sought by employers for a sample of occupations that may be affected by this economic transition. The study must be considered as an exploratory, not only because the low-carbon and resource-efficient economy is developing from different starting points and at very different speeds in different countries, but also because industrial development in emerging fields is highly vulnerable to policy shifts. The report draws on small-scale qualitative data from expert interviews, secondary statistical data and some small-scale survey data from learning providers and employers. It is also worth mentioning in this connection that the evidence base is often weak for new and emerging occupations.

Achieving a complete picture was difficult for several reasons. The research was conducted at an aggregate level, focusing on the input of national experts for each occupation. However, in larger Member States and/or those where labour markets and VET systems are strongly decentralised or regionalised (e.g. Germany, Italy and the Netherlands), much more detailed research may be needed to capture any variations at the subnational level. The data gathered are likely to be more representative of the situation in some Member States than in others. There are also significant differences between the findings of EU-level statistical data sources and the information provided by national experts. Thus, the preliminary findings are stronger in breadth than in depth and would need more detailed validation for each occupation in each country. What are the common trends in current skill needs (if any) at the levels of countries and occupations?

8.1.1. Employment trends

Current skill needs must be placed in the context of recent employment trends. Expert informants reported that occupations with the most frequent job creation were those in the fields of renewable energies, the environment and new technologies. Interviewees often stated that these sectors have not been affected

by the recession as much as other sectors, and they were likely to make a significant contribution to national economic growth. In contrast, occupations in which a decline in job numbers was most commonly reported were in the sectors worst affected by the recession, such as construction.

Analysis of EU-LFS data shows a partly different picture. Over the last three years there has been an increase in the number of jobs for insulation workers and electricians and, in relative terms, for nanotechnology engineers and environmental engineers, whereas demand for sheet-metal workers and refuse collectors has been stable or has increased only slightly. Only SPV installers and transport vehicles/energy auditors appear to have suffered a marked decline.

In terms of national employment trends, Germany and Finland reported the strongest recent employment growth across the widest range of occupations, while Hungary and the Netherlands reported the most widespread decline in employment volumes. Interviewees in Finland and Germany reported employment growth in most occupations, while the in the UK, Greece and Hungary there were mixed predictions for the different occupations. The EU-LFS statistics and the reports from interviewees both revealed negative employment trends in the Netherlands and Slovakia.

Some differences between the EU-LFS data and the information from national experts are likely to be due to: difficulties in matching the occupations of interest with the ISCO codes available at the time the research was conducted, which may mean that trends in these newer occupations are not accurately reflected; time differences between the collection of the EU-LFS data and the data available to expert informants; the fact that the data available to experts may not be fully representative of an entire occupation in an entire Member State.

8.1.2. Current skill shortages

Most countries reported no skill shortages for most occupations based on perceptions that employers had no difficulties in filling vacancies. The effects of recession were relatively widespread in the construction and building industry, which reduced demand for energy auditors, environmental engineers, insulation workers and electricians. This has meant that vacancies have been easier to fill in all countries as the recession has made workers available and has even led to oversupply in a few occupations. In addition, employers tend to prefer to train existing workers rather than take on new recruits, thus reducing reliance on the external labour market. Slovakia and Hungary in particular report no skill shortages for any occupation, because of the severity of the effects of recession in each country.

Skill shortages among sheet-metal workers, electricians and insulation workers are most widespread, but shortages are present in few countries. These shortages exist primarily because there are more people leaving the occupation (usually through retirement) than joining it, rather than because of expansion in demand. The limited supply is due to a continuing decline of interest in entering the occupation among young people making first time career choices. This lack of interest reportedly stems from the fact that fewer young people study STEM subjects and they lack interest in practical, manual work coupled. Unattractive working conditions and, sometimes, low pay also contribute to the lack of interest. Germany is suffering from skill shortages across the widest range of occupations, closely followed by the Netherlands. The situation in Germany reflects a long-term shortage of engineers and workers with appropriate STEM skills to enter medium-level occupations. These findings largely corroborate previous research in this area. Recent reviews by Cedefop identify skill shortages as one of the factors limiting progress towards greener economies. They also note the existence of skills bottlenecks in Germany in the renewable energy and environment industry and report a wider concern about skill shortages in the construction sector across Europe (Cedefop, 2009). Similarly, other research from Cedefop confirms a lack of interest in STEM subjects among young people throughout Europe, and shortages of STEM skills and management skills are more likely to hinder economic expansion in this area that shortages of 'new' green skills. In particular, the lack of such skills is a major cause of the shortage of engineers in Germany, which is the main problem in the environmental sector (Cedefop, 2010a). Elsewhere, despite the marked reduction in overall employment in manufacturing, a recent study in the UK found that the sector is experiencing skill shortages due to two main factors: a lack of young replacements for people who are leaving the industry and a need for higher-level skills caused by structural changes that are moving this sector towards higher-value production (House of Commons, 2007).

8.1.3. Current skill gaps

Sheet-metal workers have skill gaps in the highest number of countries. This appears to be partly caused by deficiencies in the personal attributes of new recruits but also by a desire among employers for more practical content in vocational training and by a need to keep trainees abreast of new technologies and IT.

Skill gaps are reported across the widest range of occupations in the UK. Some countries where newer occupations are only beginning to develop tend to

report more skill gaps in basic areas of job competence than countries where the occupations are more established.

Overall, practical skill gaps are more common than generic skill gaps and employers often expressed a preference for more practical rather than theoretical content in training for some of the medium-skilled occupations. However, although not widely reported, some of the generic skill needs may be critically important to the occupation. These include sales and customer service skills for some occupations engaged in delivering energy efficient technologies to consumers; management and leadership skills for workers in intermediate trades seeking promotion and entrepreneurial skills for nanotechnologists seeking to commercialise a new invention.

8.2. What are the main challenges faced by employers in securing suitably skilled workers?

While few occupations face major skill shortages at present, employers in this study commonly voiced their concern about the declining numbers of young people actively seeking careers in some of the occupations. Two reasons were put forward for the decline:

(a) there is a perceived decline in the numbers of young people taking general and vocational qualifications that require knowledge of scientific subjects as opposed to arts or humanities subjects. This concern was noted in the cases of insulation workers, electricians, sheet-metal workers and nano-technologists (in contrast, there was slightly more optimism about interest in environmental engineering among young people entering the occupation from an environmental science rather than with a 'pure' engineering qualification);

(b) there was a widely reported reluctance among young people to choose occupations which were characterised in several countries as requiring them to 'get their hands dirty'. Interviewees commonly reported that this was reducing the supply of new recruits to these occupations, and where actual skill shortages were not experienced, employers were sometimes facing either less choice of applicants or a field of applicants of deteriorating quality.

In addition, a largely unrecognised challenge for employers is to recruit more women into some of these roles. Most occupations were exclusively undertaken by men, suggesting that up to half the potential labour force is deterred in some way from entering these jobs.

8.3. What action is being taken to meet skill shortages and skill gaps by employers?

There are few common trends in the ways that skill shortages and skill gaps are tackled, partly because they do not appear to be particularly widespread. Germany is making concerted efforts to attract more young people as part of a broader effort country to increase young people's interest in careers using STEM skills, within the engineering industry particularly. The UK is rather more likely to intensify advertising activity and raise salaries than to train staff, and there is some evidence of poaching. Elsewhere the choice of solution is variable and usually specific to each occupation and employer's circumstances. The most common responses are to widen recruitment methods for skilled staff, rely on and train existing staff, sometimes just coping with the skill gaps. Employers are much less likely to report that they recruit new staff and train them; they more commonly mention work reorganisation. There were very few examples of organisations or countries trying to broaden the labour supply by seeking to attract atypical recruits such as women, older workers or disabled workers into these occupations. Where examples of such initiatives were found, they were usually small scale.

A recent German study has analysed the reasons behind the low take-up rate of engineering work among young people (Becker, 2010).The shortage of engineers in the market suggests that one of the readjustment mechanisms should be a salary increase, and the study highlights that entry-level salaries for engineers suffered a reduction in purchasing power in real terms. In addition, the educational system provides high-quality theoretical expertise but seems to fail in improving other skills required by employers, such as soft and managerial skills. Intellectual property rights for technological innovations are not as strongly protected as those for music and manuscripts, which contributes to the perceived lower status of engineering occupations. In general, there is lack of visible engineering role models in modern society, especially for women, and schools are failing to promote a change of attitude. Thus, the lack of interest among young people in a career in engineering is due to a number of factors that are embedded in society, the educational system and the labour market.

8.4. What are the drivers of change for employer demand for 'green' skills?

Developments in the market for new renewable energy services are highly influenced by government legislation. There is some evidence of inertia and

reluctance to invest in these sectors on the part of business due to economic uncertainty and governments' indecision about the implementation of legislation. This is exacerbated where there is evidence of governments repealing or amending legislation, for example in the Netherlands and the UK, which has had an impact on the level of demand for energy auditors, SPV installers and insulation workers. Regulation may also reduce demand for some occupations. For example, plans to reduce the frequency of vehicle emission testing may reduce the need for transport vehicle emissions inspectors in the UK.

Regulation can also have an indirect impact. It seems clear from the differences in views among interviewees in different countries that regulation has shaped and stimulated markets by raising awareness among individuals and business consumers through information, advice and guidance. Therefore, in more mature markets such as Germany, government policy to support environmental sustainability has led to relatively positive attitudes and helped to create demand for services to improve energy efficiency. Similarly, previous subsidies for SPV power in Greece and Italy have served to raise consumer awareness of the range of benefits, including the financial and environmental benefits. Recent studies confirm these findings by identifying policy change as main factor in creating new skill needs and boosting the growth of greener economies. Countries which have pursued the development of renewable energies through policies that support products and services have experienced an increase in employment in this sector (Cedefop, 2009; Cedefop, 2010a).

There is also some evidence of path dependency in industrial development; thus there appear to be more opportunities for new higher-skilled occupations such as nanotechnologists in Germany, the UK and to some extent, the Netherlands where basic and applied engineering and electronic research capacity are well developed. While there is some evidence of interest in these fields in Greece and Italy, policy support has been less sustained and in Hungary and Slovakia the absence of a coherent innovation policy at national level until recently means that these sectors are currently embryonic at best.

For occupations which are heavily dependent on demand in the construction sector including electricians, insulation workers, energy auditors and, to some extent, environmental engineers, the effects of recent economic crisis and global recession are still being felt. Investment by national government in major national infrastructure projects and corporate lending by financial institutions to commercial construction projects are likely to be the major drivers of future increased demand.

Rising energy prices is another market pressure which will affect the demand for goods and services that generate employment in some of these

occupations. These pressures are likely to intensify over the next 12 months and may have positive effects on the demand for insulation workers, electricians and energy auditors.

There is some evidence of changes in consumer trends that have implications for particular occupations. For example, decreasing car use in Germany as a result of greater environmental awareness among consumers may lead to reduced demand for vehicle emissions inspectors. In other occupations, technological trends are more important. For sheet-metal workers, ongoing computerisation in the sector combined with the development of new materials will require a broadening and deepening of skills. While overall, there was limited evidence of a change in demand for refuse collectors, there was some evidence of a potential need for increased interaction with technologies to monitor volumes of waste.

Lastly, demographic trends also influence demand for workers because they change the supply side. This effect was noted particularly for sheet-metal workers, where the major source of change was replacement demand as existing workers retire.

8.5. How do government policies in different areas interact with and affect demand for 'green' skills?

Energy and environment policies create the primary regulatory mechanisms that appear to have the most direct effect on the demand for skills in sectors directly affected by regulation, for example construction. Innovation and industrial policies appear to have indirect effects by providing financial support through favourable taxation or subsidies or direct government investment in infrastructure, which stimulate market demand particularly for renewable energy technologies. Economic policy appears to play an important supporting role in achieving stable financial conditions, which are conducive to business investment. Skills and employment policies appear to play a mostly indirect role by shaping the quality of the labour supply. In most countries there is limited evidence of policy activity to promote the occupations of interest and so influence individual's career choices. Overall there is limited evidence of 'mainstreaming' environmental issues in other policy-making areas.

This evidence confirms other recent findings from Cedefop studies. Some Member States do not have explicit national skills strategies or skills programmes integrated with environmental strategies to respond to changes in skill needs that may arise from low-carbon economies. This is because Member States with traditionally well-developed skills forecasting systems believe that what is already

in place is sufficient to respond to new skills required by a greening economy. Other countries with a history of inadequate forecasting systems have consequent structural weaknesses in their responses to labour-market demand, which affects all sectors, including the environmental sector (Cedefop, 2010a).

8.6. What are the future areas of greatest need

The occupations that are predicted to experience employment growth in the largest number of countries are energy auditor, electrician, sheet-metal worker and insulation workers. These occupations require medium levels of skills and are therefore also more likely to experience higher volumes of growth than higher- or lower-skilled occupations, which employ fewer people in absolute terms.

Germany, Finland and the UK predict future increases in job numbers across the widest range of occupations. Southern and eastern European countries were less confident in predicting future skill needs, partly owing to lack of available national baseline data, the small numbers employed in some occupations and a highly uncertain outlook for the economy owing to the crisis.

The number of transport vehicle emissions inspectors may decline owing to the less frequent testing of vehicle emissions proposed in the UK and changes in the tax on CO_2 emissions from vehicles in the Netherlands. Reduced car use in Germany as a result of changes in consumer behaviour due to heightened environmental awareness may have a similar effect.

Demand for refuse collectors is predicted to remain mostly stable. The demand for higher-skilled workers involved in the management of waste collection or recycling activities was predicted to increase or remain stable in some countries including Germany, Italy and Slovakia. However, due to the difference in skill levels, there are currently limited possibilities for refuse collectors to move into these roles.

These results are early evidence that impact of the development of a green economy across occupations will be mixed and that there may be losers as well as winners. Employees in refuse collection and transport vehicle emissions inspectors may need to seek opportunities to switch to jobs in greater demand. Renewable energies, energy efficiency in building and construction, and public transport have been identified as sectors with a high green jobs potential (Cedefop, 2009). Against this backdrop, continued demand for workers in advanced manufacturing industries should be acknowledged (Cedefop, 2008). It should also be recognised that, in addition to the revolutionary development of entirely new occupations, some occupations are undergoing an evolutionary

process whereby workers' skills are updated and become specialised to address environmental issues (Cedefop, 2010a).

8.7. How well equipped are training providers to meet future skill needs?

Learning providers' survey responses tended to express enthusiasm and willingness to change the content of curricula to meet new demands from employers and learners, where these were encountered. The most common responses from learning providers are:

(a) to increase volume of provision and change course content to accommodate new market demand;
(b) to collaborate with employers;
(c) to train their own staff;
(d) to partner other organisations.

However, the action taken to date by learning providers appears to be, understandably, rather piecemeal and reactive. Most learning providers have not yet incorporated green skills in their learning strategy. In addition, a substantial minority of learning providers are very cautious in their response due to concerns about insufficient learners and the pace of market development. Learning providers for the obviously 'green occupations' of energy auditor and SPV installer were more likely to report heavy investment and changes to course content than those for other occupations, while learning providers for electricians, insulation workers and sheet-metal workers viewed change as more risky and were more likely to wait for further market developments.

The main factors preventing learning providers from grasping the opportunities presented by the developing green economy are low demand for new qualifications from employers and employers' preference for 'add on' modules over new qualifications, combined with slow development of qualifications. Lack of employer demand was the biggest problem in Finland, and the pace of qualification development was the biggest problem in Greece, Italy and the UK. The pace of qualification development also tended to be the main barrier when the data are broken down by occupation, but small response rates preclude further analysis. In addition, it is difficult to meet the needs of employers with diverse occupational profiles and to understand what organisations' skill needs are, particularly when employers are too geographically dispersed to target effectively and when there are too few learners to deliver training effectively. Employers in southern European countries were more likely to report that it was

difficult to identify the needs of employers and that they were too geographically dispersed to target effectively.

8.8. How does learning provision need to change to meet the needs of employers and learners?

Learning provision appears adequate to meet the current and future skill needs of employers for several occupations. The quality of learning provision appears relatively high in Germany, the Netherlands and Finland, where fewer skill gaps are reported. However, in some countries including Italy, Hungary and Slovakia, a greater training culture needs to be fostered by extolling the benefits of training and facilitating access by offering flexible provision, offering appropriate incentives and raising awareness.

One of the main shortcomings in learning provision identified in this study is the absence or fragmentation of learning provision for insulation workers and SPV installers in some of the Member States studied.

Employers in Greece, the Netherlands, Finland and the UK reported some lack of coherence or limitation in training for insulation workers. This is of concern because demand for labour in this occupation is predicted to expand due to rising energy prices, the need to reduce energy consumption to meet carbon emission targets for industrial sectors and the expansion of the EU emissions trading scheme to additional sectors in 2013. At the same time, there is some evidence in Member States that representatives of the insulation sector and policy-makers are seeking to raise awareness of the financial benefits that adequately maintained insulation can yield for businesses. Large parts of industry have not yet recognised these benefits but may do so in the short to medium term, which may stimulate the insulation sector. While in some countries, the number of insulation workers has declined due to the effects of the recession on the construction sector, growth in the numbers employed in this occupation is predicted in the long term in several Member States.

The level of market development in the SPV installation sector varies significantly between Member States depending on the different degrees of government support. Germany is a world leader in the manufacture of the equipment that SPV installers use, while the favourable climate in some countries may have stimulated policy support in the past (Greece and Italy). Nevertheless, learning provision for SPV installers is relatively fragmented in some countries (Germany, the Netherland and the UK) and employers may experience lack of transparency in the content and quality of training (the UK), while in other

countries the amount of provision appears limited to date (Hungary and Slovakia).

One theme which is common to some occupations is the employers' for closer cooperation with VET providers so that they can influence the content of provision to ensure that it is up to date and meets their needs. This has been a trend in VET for many years and employers sometimes have expectations that newly trained workers will have a level of practical expertise that can only be acquired from prolonged experience. There are examples of relatively successful collaboration both at the level of the national VET system and at the level of specific occupations. For example, the German VET system tends to produce a curriculum which reflects the needs of employers by embedding those needs in a tripartite training system, while in the nanotechnology field the pace of development in several countries in effect forces educational institutions and employers to cooperate. However, in some countries there is a need to reconsider the balance between theory and practice in the content of training provision to ensure that it is more equitable in both vocational and educationally orientated courses. For example, in Italy the content of learning provision in many occupations emphasises theoretical principles at the expense of practice, while in the UK learning provision for energy auditors would benefit from additional contextual knowledge. In the Netherlands and the UK, employers would like more practical knowledge in initial training for energy auditors. Such cooperation could be enhanced where there are mandatory requirements for training in particular occupations by managing or coordinating this at EU level to enable mutual recognition and thereby enable firms to address localised skill shortages more easily. In addition, to avoid overloading the VET system and to encourage employer engagement, it would be helpful to use additional modules to address employer needs rather than create entirely new whole qualifications, unless they are absolutely necessary.

The findings from this research are supported by other studies which highlight the need to place more emphasis on practical knowledge and application of skills to meet employer needs. In addition, the provision of generic managerial skills, soft skills, education for sustainable development and environmental issues need to be included in educational and training programmes (Cedefop, 2010a).

8.9. Policy recommendations to help organisations take advantage of the opportunities of the green economy and meet skill needs

8.9.1. Consistent direct and indirect regulatory support for development of resource-efficient green economies

There are several ways in which policy at the EU and Member State levels could be used to support the development of green economies. It is evident from this research that regulation is currently a dominant driver of employer and private consumer demand for energy efficient technologies and services. Regulatory consistency and sustained investment in Member States over a substantial period of time is likely to be required to ensure the markets for these products and services mature adequately to the point of being self-sustaining. Where incentives are used, they need to be phased out gradually with appropriate warning, transparency and consistency. The timing of the phase-out of support should be considered at project inception to avoid creating shocks or fostering dependency on state funding, while companies need to be wary of over-reliance on single sources of state funding in planning future investment in and expansion of green economic activities. There is a time lag in generating skills, and sustaining an adequate supply is difficult in volatile markets because the supply side finds it difficult to adapt to fluctuations in demand. In addition to direct regulation, use of fiscal policy to achieve economic stability and improve economic growth is likely to contribute to improving investor and consumer confidence, which will stimulate demand for technologies, products and services to support energy efficiency, waste reduction and environmental protection.

Previous research has stressed that the proactive role of national and regional governments is crucial in stimulating job creation and enabling businesses to take advantage of all opportunities arising from the development of new low-carbon technologies. Public measures are a big driver of the process of greening the economy, but they can also have major negative impacts when subsides and feed-in tariffs are withdrawn, as shown by the collapse of the SPV industry in Spain (Cedefop, 2010a). Some countries will need a strategic industrial plan that includes integrated skills development strategies that can be translated into coherent actions (e.g. Greece in particular, Italy, Hungary and Slovakia, although all countries in the study would benefit from reviewing the links between their policies on innovation, employment/skills, industry, energy and the environment).

Developing market demand in these sectors is not just a question of regulation. There is some evidence that businesses and private consumers may

need to be made more aware of the benefits of investments in energy efficient equipment, systems, products and services, for example SPV panel installation. While this can be done by companies marketing their services in this sector, national governments may be able to support them by providing information, advice and guidance. Greater awareness should be raised of the environmental impact and energy costs of all business activity and all development and use of products, and it should be recognised that 'greening' permeates a very wide variety of occupations.

While there is already considerable activity to promote the opportunities of green business, interviewees in this study reported that businesses and consumers required more convincing evidence of the financial benefits before investing. Governments may be able to help businesses by providing research evidence which they can draw on for marketing purposes. In the current economic climate, the initial investment required for some forms of insulation and SPV systems can be considerable and the payback periods can be lengthy. It may be worthwhile focusing on setting standards and providing incentives for renovation of existing building and capital stocks, as these are very important for the achievement of environmental goals and Member States may adopt them as important policies for stimulating economic growth and job creation.

To ensure fair access to the benefits of energy efficient products and services, governments may wish to consider how best to target existing and new subsidies at those groups least likely to be able to make the necessary investment, including SMEs and citizens on low incomes or in public housing. SMEs in particular need to be involved in the development of new regulatory support mechanisms and standards for occupational training to ensure that the regulatory burden is not disproportionate.

8.9.2. Mainstreaming of green economic development in employment and skills policies

A dominant feature of the policy landscape in several of the Member States investigated is the boundaries existing between the different policy domains and lack of mainstreaming of the 'green' policy objectives of environmental and energy policy, in particular in skills and employment policies. Very few examples were found of projects seeking to direct unemployed workers or young people into green occupations or to attract workers from under-represented groups into the labour force, which may reflect the current adequate labour supply. Where examples were found, the projects were often at the local or regional level and on a small scale. While in the short term, there are unlikely to be significant unmet skill needs in these occupations owing to unfavourable economic conditions, in

the medium term there may be growing latent, unmet demand. More robust research is needed to assess the scale and significance of any shortages. If shortages are found and action is not taken, particularly to ensure an appropriate supply of high-level skills where lead times in education are longest, this could slow down the development of energy-efficient technologies and services.

It would also be helpful for the bodies responsible for maintaining standards in VET provision in each country to consider auditing or requiring self-auditing of VET providers to assess the need for inclusion of 'green' skills across their full range of learning provision. This would help meet employer desires for inclusion of green skills as 'add on' modules in the learning provision offered for existing occupations, where appropriate. Similarly, previous research has noted the need for coordination between employers, education system and skills providers as crucial to match skills demand and supply (Cedefop, 2009).

8.9.3. Promotion of careers in 'green occupations' through information, advice and guidance to ensure an adequate labour supply

Given the extremely high levels of youth unemployment in several Member States and employer reports of difficulties in attracting young trainees, some policy attention could be given at national government level to raising awareness of careers possibilities in some of these occupations among young people through existing national information, advice and guidance systems. This may need to be coupled with suitable signposting to enable young people without the requisite STEM qualifications to have 'second chance' access to them, possibly while gaining some of the practical experience which is valued by employers. For some young people, the best way of awakening their interest in careers in these occupations may be to stress the contribution that the job makes to supporting environmental sustainability or the 'eco-friendliness' of the occupation, rather than the STEM skills involved. It was particularly striking that almost all of the occupations are male-dominated, although employers often reported a preference for more female recruits (even if the reasons they gave were based on gender stereotyping of skills). Consideration could be given to promoting green occupations in a way that would achieve a better gender balance in the labour supply. There is no uniformity among Member States in the way they introduce environmental awareness into the education curriculum, which needs to be strengthened and harmonised, but without duplication of the many policy initiatives. Parents and citizens also need to be included as the targets of this information, and it would probably help to expose students to real workers either in the workplace or in the classroom. This reaffirms the ongoing need identified in previous research to educate workers, employers and the public about the

importance of sustainable production and consumption to support shifts towards greener ways of living (Cedefop, 2009).

8.9.4. Strengthening skill needs forecasting

While the difficulties of forecasting skill needs for some industries and occupations were exacerbated by the ongoing effects of the recession and the economic crisis, the countries vary significantly in the extent to which they coordinate attempts to forecast skill needs. There is no suggestion that a one-size-fits-all approach should be adopted, but there is potential for useful learning across Member States, for example through continued support for exchange visits to countries including the Netherlands, Finland and the UK where skills forecasting methodologies are relatively well developed. Forecasting outputs could then usefully be fed into VET development and planning processes and may help counteract the uncertainty surrounding investment decisions expressed by some VET providers in this study. At company level, organisations may need to be encouraged to undertake more succession planning, especially where there are risks to the labour supply due to an ageing workforce, though this is not specific to green occupations.

8.9.5. Actions for specific occupations

For some occupations, their potential contribution to the greening of European economies is clear. The work of energy auditors, insulation workers, SPV installers and environmental engineers was regarded as unequivocally beneficial and central to its development. However, it is far from clear that these occupations are widely known, their functions and tasks are understood or that they are widely recognised as career options. In part, this may be due to lack of clear training routes into some of the occupations and to their relatively low profile or to the fact that they have emerged only recently. This suggests that raising the status of these occupations may help to stimulate awareness among the general public, policy-makers and learning providers of labour market needs and of the possibilities presented by the transition to a green economy.

However, it was evident from the empirical work undertaken in the research that the implications of greening economies for some occupations were not immediately evident to employers, learning providers and workers. For example, for refuse collectors the compatibility of their role with the principles of environmental sustainability depends on the subsequent disposal method, and given that in all countries, refuse collection was a separate activity from refuse processing, this could vary enormously. As Cedefop (Cedefop, 2009) points out, many existing recycling jobs can hardly be considered green because of the health hazards that they pose for workers and their by-products. The role of these

occupations in supporting green economic development needs to be articulated and supported through policy measures encouraging sustainable growth.

For the role of transport vehicle emissions inspector, it is not clear that the development of the green economy will be unequivocally beneficial. Indeed, reduced car use and development of electric or hybrid cars may lead to a decline in the number of jobs in this occupation, which raises the policy question of how best to redeploy any displaced workers.

8.10. Further research

The research is one of the first pieces of work to seek to compare employment trends in occupations systematically using European-level standardised data from the EU-LFS combined with the views of expert interviewees rather than to predict future employment trends on the basis of econometric modelling. This has revealed some insights into the tensions between the qualitative data collected during the ongoing economic crisis and recovery and historic survey data, showing some prospects for growth in 'green' occupations, albeit in a context of fragility against a backdrop of economic uncertainty. It is unsurprising that the research encountered discrepancies when making comparisons between standardised EU-level data from the EU-LFS, national statistical data on employment levels and information from expert informants. This suggests that current data collection on some of the emerging occupations, which may be central to the development of the green economy, is inadequate. While the new ISCO-08 codes will in future capture data on energy auditors and environmental engineers, some consideration should be given to the best means of tracking trends in the occupations of nanotechnologist engineering technologist and solar photovoltaic installer. In the first instance, it could be appropriate to collect basic quantitative data at national level through government surveys or in collaboration with national and or EU-level sectoral associations.

The research has also been innovative in providing a linked assessment of the impact of policy developments, with the implications for sectors at meso level and the impact on occupations at micro level. This has shown the overall lack of sustained, consistent and cohesive integration of environmental concerns in policy domains in all the countries investigated, except Germany. Assessing occupational skill needs in numerous countries will always face challenges because of different trajectories in the development of markets for 'green' products and services, different labour market institutions and VET systems affecting labour supply and the overall level of decentralisation in political and

education systems. The current focus on occupational change in tracking the impact of green economic development has encountered some limitations:

(a) some of the occupations are not (yet) recognised as distinct jobs in some countries. Occupations which are not always recognised as distinct jobs include energy auditor and solar photovoltaic installer. There is some interest in developing occupational and professional profiles that could be used to enhance worker mobility between Member States;

(b) an occupational focus limits the opportunities to study worker mobility between related occupations, which may be particularly important in identifying the adequacy of labour supply and skills mismatch, from the point both of view of economic growth and of the career development prospects of workers. Evidence from the study suggests that there may be concerns about the possibility of smooth transitions between occupations in the recycling sector (from front-line to managerial and technical specialist roles), nanotechnology sectors (from technician level to high-skilled roles), the sheet-metal sector (from front-line to IT specialist, managerial and supervisory roles) and the insulation sector (from front-line to managerial and supervisory roles). Moreover, assessing the impact of a green economy on skill needs for related groups of occupations, for example implications for different engineering specialisms may be helpful;

(c) the development of new products and services arising from the 'greening' of economies cuts across occupations, so an occupationally based analysis runs the risk of ignoring or failing to identify more significant changes in other occupations within the same sector;

(d) occupations not covered by this study will be affected by development of a resource-efficient, sustainable economy, albeit in a more limited way, as efforts to reduce unnecessary consumption of materials and improve the efficiency of energy use will touch workers in a wide range of roles.

Understanding of the dynamics of occupational and internal labour-market change could be improved by conducting research at sectoral level, starting from an understanding of the pressures that employers face and how these pressures affect activities and tasks, and then considering broader occupational impacts and the implications for learning providers. A 'bottom-up' approach with a broader scope of study in specific sectors is recommended to complement the 'top-down' approach of specific named occupations adopted in this research. According to recent research, while there will be an increase in the level of jobs in green economies, the major changes in labour-market dynamics will take place mainly at sectoral level rather than at occupational level, by shifting the overall balance

of jobs within sectors (Cedefop, 2009). A cross-sectoral approach is therefore crucial to identifying skill needs of the low-carbon economy (Cedefop, 2010a).

The complexity of providing a comprehensive picture of emerging occupations and skill needs has been emphasised in other studies. There are no clear boundaries between new green occupations and existing occupations in need of retraining as this is relative and dependent on the country context. A 'new' job in a Member State could be an 'old' job in need of additional skills in another country, depending on the development of the economy. To move towards a low-carbon economy it is necessary to give priority to the updating of existing skills and the mobility workers within industries, rather than trying to create new sets of skills. This complex scenario is probably the reason why attempts to identify skill needs for 'green' jobs have been made only locally, mainly by partnerships between regional authorities, industry bodies, educational and vocational institutions (Cedefop, 2010a).

Finally, a common and potentially significant trend has been identified in many occupations, namely the difficulty reported by expert informants of attracting young people to several occupations due to negative perceptions of working conditions and the shortage of young people with requisite STEM skills. To understand the exact nature of any mismatch in the supply of young workers for craft/trade and STEM occupation, further analysis of trends in the age profiles in each occupation and in the age of trainees needs to be coupled with an analysis of the employment outcomes/destinations of those qualifying to work in each occupation. This is because measures of entry into initial training or education for these occupations are, in themselves, insufficient, as attrition may take place during or after training.

List of abbreviations

CPD	continuing professional development
EU-LFS	European labour force survey
GESOs	Green expanded skills occupations
GIDOs	Green increased demand occupations
GNEOs	Green new and emerging occupations
IES	Institute for employment studies
ISCO	International standard classification of occupations
R&D	Research and development
RES	Renewable energy sources
SMEs	Small and medium-sized enterprises
SPV	Solar photovoltaic
STEM	Science, technology, engineering and maths
VET	Vocational education and training

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ANNEX
Methodology information

Interviews with learning providers and employers

The trade bodies and providers were initially approached through an e-mail endorsed by Cedefop, which outlined the project and requested participation in a face-to-face interview. The e-mail was accompanied by a research briefing giving more information about the project and contact details to enable prospective participants to obtain more information about the project from their nominated country expert, from IES or from Cedefop. The e-mails were followed up by telephone calls to secure participation in the research project and to arrange appointments to visit or telephone the individuals to conduct the interviews. The interview guide was drawn up in consultation with Cedefop and an overview of topics discussed is shown below. All materials were translated into the relevant national target language by a fluent or native speaker and customised to meet cultural norms in requesting research access.

Each interview took place between February and July 2011; each lasted approximately one hour and was tape-recorded where permission was given. Due to economic and political instability in Greece, combined with transport strikes, fieldwork was curtailed.

Employer interview guide

- introduction (the research; definition of green skills; the purpose of the interview; confidentiality and anonymity);
- background: about role of interviewee and organisation;
- current situation: current nature of sector (major employers in the sector; scale of employment; employment trends; average age of people working in the sector and gender);
- current supply (recruitment and existing workforce);
- skill shortages that employers are currently experiencing;
- adequacy of current training provision;
- issues affecting future demand (factors likely to particularly affect demand for this/these jobs in the next two years; impact on this/these jobs/skill needs arising from developments to products and services in the sector in the next two years, etc.);

- anticipated changes in demand (ways in which demand for skills may change over the next two years);
- likely training requirements to meet future business needs, and respond to the anticipated changes;
- good practice.

Learning/training provider interview guide

- introduction (the research; definition of green skills; the purpose of the interview; confidentiality and anonymity);
- current and recent training provision of selected occupations;
- current nature and quantification of client sector(s);
- employers' skill needs and use of training;
- barriers to employer engagement with training;
- future demand for workers in selected occupations, drivers of future demand, and the implications for future education and training provision;
- issues affecting future demand for training provision;
- anticipated changes in demand for skills;
- current supply of tutors and trainers.

Learning provider and employer surveys

The learning provider and employer surveys were designed around a standard set of questions in consultation with Cedefop; native speakers translated each survey into the native language of each participating country and checked that the survey functioned properly in online format. The contact details of each national expert and Cedefop were provided to respondents so that they could ask for further information, although no requests were received. Occupational descriptions and indicative task lists were provided in the survey text to ensure that respondents had as a clear an understanding as possible of the jobs of interest to the study.

Lists of suitable learning providers and employers were identified by each national expert in each country. The targeted learning providers were those that offered training relevant to at least one of the occupations of interest and the targeted employers were identified using online business directories and personal contacts to locate employers who were known or likely to employ workers in the target occupations. Learning providers were invited to participate in April 2011 and employers were invited to participate by e-mail in June 2011, using individual

contact names where available. Target respondents received two reminder e-mails. For most countries, the response rates reflect our predictions of approximately 5-10% response rate to online surveys. The overall low absolute number of responses from learning providers in some cases reflects the size of the learning provider population, but for Germany and the Netherlands the rates are well below the anticipated level of response. From the expert interviews, it is evident that the Netherlands and Germany in particular have their own system of occupational classification which may not recognise the target occupations as distinct jobs, but rather a collection of tasks that another occupation may undertake. For example, energy auditing work may be undertaken by a building surveyor. This may explain the low response rates in these countries. A summary of topics covered in the learning provider and employer survey is given below. For the employer survey, there is no particular relationship evident between sample size and response rates, except that response rates are higher in new Member States although the sample frame is smaller. There are lower response rates for some of the newer occupations where relatively fewer people may be employed and the job title may not be recognised or well established. Thus, there are relatively few responses from employers of nanotechnologists and energy auditors.

Learner survey: meeting the needs of future learners

- background: information about the organisation;
- recent learners and learning provision for each selected occupation;
- learner trends in selected occupations;
- estimates on future demand in selected occupations;
- future trends in demand for green skills and learning providers strategy to meet future skill needs;
- challenges in providing training for green skills.

Employer survey: understanding the skill needs of employers

- background: information about the organisation;
- information about composition of current workforce with regards to selected occupations;
- recruitment and vacancies for each selected occupations;
- proficiency of current workforce;

- demand for technical skills;
- training;
- environmental issues (awareness of environmental issues changes in products or tasks performed; whether and how environmental factors are likely to affect future demand for staff).

EU-LFS analysis procedure

The analysis was based on harmonised data at Member States level relating to groups of workers under particular International Standard Classification of Occupations (ISCO) codes within the EU labour force survey (EU-LFS).

Not all the occupations correspond exactly to occupational classifications because the ISCO-88 codes are broadly organised by skill levels (at their highest level of aggregation) and then further major and minor subgroups and unit groups provide the specific (most disaggregated) information about the economic sector and the specific occupational field. Since new occupations follow changes in demand for goods and services, they often outgrow existing fields of occupations or represent only a part of the workforce of particular ISCO codes.

We identified workers classified under eight four-digit ISCO-88 codes expected to undergo significant changes due to the transition to the green economy. While the new ISCO-08 classification actually contains more detailed information for some occupations (energy auditing/refuse collector), these occupation are currently not available from Eurostat. Therefore, the implementation of the secondary data analysis will follow ISCO-88.

It is worth emphasising that in some cases the selected occupations do not fully correspond to the green occupations of the study because in some cases the selected four-digit ISCO codes are broader. Table A1 provides an overview of the ISCO codes chosen in relation to the occupations of our study. The final column includes the job title as known taken from the official ISCO system.

In particular ISCO 2149 (including environmental engineer) includes many further occupations, including architect and engineer, unrelated to the green economy. To some extent, energy auditors as well as occupations in nanotechnology and solar photovoltaic applications are parts of broader occupational groups with skills and knowledge to work in such occupations.

Countries covered

In the following, we provide a description of employment in these occupations based on aggregations of the EU-LFS. Since the collection and provision of four-digit ISCO-codes is not compulsory, the information is available only for the

following countries covered in our study: Hungary, the Netherlands, Slovakia, Finland and the UK. Germany, Greece and Italy do not offer similar information at disaggregated level.

Table A1. **Code mapping of ISCO-88 for EU-LFS analysis**

Green occupations	Sector	Type of change	ISCO -88	ISCO job title
Insulation worker	Construction	Increase	7134	Insulation workers
Electrician	Construction	Increase	7137	Building and related electricians
Energy auditor	Construction	Novel	part 3152	Safety, health and quality inspectors
Environmental engineer	Environment	Enhanced	part 2149	Architects, engineers and related professionals not elsewhere classified
Refuse and recyclable material collector	Environment	Enhanced	9161	Garbage collectors
Sheet metal	Manufacturing	Enhanced	7213	Sheet-metal workers
Nanotechnology engineering technologist	Manufacturing	Novel	part 2146	Chemical engineers
Solar photovoltaic (SPV) Installer	Renewable energy generation	Novel	part 7241	Electrical mechanics fitters and services
Transport vehicle equipment and systems inspector	Transport	Enhanced	Part 3152	Safety, health and quality inspectors

Source: Authors.

Time period and variables chosen

The EU-LFS was first carried out in several countries in 1983. Since the set of variables has been modified several times (the last time in 2006), some variables do not exist for all periods. A consistent set of annual averages of employment data for ISCO-88 codes exists from 2005 to 2010 and was used in the following.

We requested a multidimensional breakdown of employment in eight specific four-digit ISCO codes as shown in Table A1 and, in comparison, all other employment. The breakdown was structured by basic demographic information, particularly by:

- gender;
- age group: under 25 years old; 25 to 54 years old; 55 to 64 years old; 65 or older;
- three broad skill levels: low, medium, high;

- data on training and education activities (as reported in the variable 'in education in the last four weeks' included in the EU-LFS).

We initially requested further variables, in particular on the level of educational attainment as well as structural characteristics of the learning activities (non-formal education) in the last four weeks, number of hours spent on all taught learning activities within the last four weeks, purpose of the most recent taught learning activity, field of the most recent taught learning activity, whether most recent taught learning activity took place during paid working hours, field of highest level of education or training successfully completed. However, as with further disaggregation by NUTS-1 ([9]) areas, it was decided to restrict the description to these four dimensions.

Reliability/confidentiality of data and implications for reporting

Eurostat provided data in a fully fragmented table, with cells representing all dimensions of the requested breakdown for the four-digit ISCO codes, which were then aggregated to report the specific figures presented in the following. For quality purposes and confidentiality reasons, the individual cells of the fully fragmented tables included flags with information about the reliability of individual cells, which are particularly relevant to this analysis as we extracted very narrowly defined occupational groups. There were three flags ([10]):

- cells with flag 'a' should not be published, but can be aggregated with other cells to achieve numbers sufficiently high to be published;
- cells with flag 'b' can be reported, but are based on small sample sizes and a potentially unreliable;
- cells with flag 'c' must not be reported in publications because there are issues with confidentiality as they are based on three or fewer responding units in the sample.

Table A2 gives an overview on the mean cells size and the reliability information.

([9]) *Nomenclature d'unités territoriales statistiques* [Nomenclature of units for territorial statistics].

([10]) http://circa.europa.eu/irc/dsis/employment/info/data/eu_lfs/index.htm [accessed 17.10.2011]

Table A2. **Reliability/confidentiality information of EU-LFS extract used**

	Number of cells	Mean number of (weighted) persons	Standard Deviation	Minimum	Maximum
No flag	5 780	445.97	2 156.48	1.50	41 800.87
Flag a	7 344	1.86	2.81	0	19.74
Flag b	1 276	5.56	4.17	0.52	27.89
Flag c	6 224	0.28	0.45	0	4.61

Source: EU labour force survey 2010.

As is the usual rule with publications of EU-LFS data, cells with flag 'c' should not be reported and a minimum cell size of 500 persons should be achieved to publish the data.

We provide an analysis based on aggregations of many individual cells, but there are still many small cell size problems as some of the specific four-digit ISCO codes show very small numbers, so we have aggregated cells for several years in presenting the data where required.

Validation workshop

A workshop was held on 5 October 2011 in London attended by 18 experts from different European countries. The workshop debated the implications of the research for meeting skill needs arising from the development of the green economy and policy recommendations to enable organisations to take advantage of the opportunities presented by the green economy. Additional recommendations and points of information from experts were considered and used to refine the final report.

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