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Skills for a low-carbon Europe

The role of VET in a sustainable energy scenario

Synthesis report

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Foreword

The transition to a low-carbon economy inevitably brings about changes in sectors and occupations, and therefore in workforce skills and competences. The starting point of this study is the observation that, to date, insufficient attention has been paid to adapting the labour market to these changes.

The current economic crisis has not weakened Europe's commitment in the field of climate change and sustainable development. Not only are climate and energy targets at the heart of Europe 2020, the EU’s main strategic policy document, but new impetus has been provided by the employment package which regards greening of the economy as an areas with great job potential for the future.

Much attention has been focused on how carbon emissions can be reduced, as well as on the possible implications for economic and employment growth. However, to meet the 2020 strategic targets, fundamental changes of the structure of EU economy and its sectors and occupations will be required.

Within the continuous process of structural economic change, the transition to a low-carbon economy massively affects all economic activity, not just ‘green’ or ‘brown’ sectors. Carbon emissions arise from activities which are central to the everyday lives of citizens and businesses, contributing to shelter, heat, food, travel, as well as to the production of goods and services.

The main finding from this study is that a more sustainable and energy-efficient economy can be achieved at the same time as employment growth, but to do so requires greater integration of climate and energy polices with measures to support employment and skills development.

Workplace learning for green skills is critical as the increasing rate of change in skills needs, at least in some sectors, requires updating the skills also of those already in employment. This also means that national responses need to be complemented by flexible and dynamic action at sector and local and regional levels.

Recognising the role education and training policies need to play in low-carbon strategies is essential to ensuring that skills needs will be met, and that skills gaps will not hold back the transition.

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Acting Director

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Executive summary

This report provides an analysis of the labour market impacts associated with European Union policy interventions designed to support the transition to a high employment, low-carbon economy.

In the European Union (EU), regulation and policy are influenced by the '20-20-20' targets in the Europe 2020 strategy. The EU is aiming to reduce greenhouse gas emissions by at least 20% compared to 1990 levels, increase the share of renewable energy sources in final energy consumption by 20%, and reduce energy use relative to projected 2020 levels by 20%.

In this context, the study has sought to:

(a) develop a feasible policy scenario consistent with Europe 2020 targets, building on existing macroeconomic and energy scenarios at EU level;

(b) deepen the understanding of workforce composition and skill needs driven by renewable energy and energy saving targets and the implications for education and training policies;

(c) consider the broader policy context and governance of VET, to identify practices which support (or hinder) the effective development and deployment of skills necessary for a low-carbon Europe.

The report also examines the impacts of this transition in selected sectors, with a particular focus on establishing the challenges and responses required at sector level for ensuring that economic actors have the relevant skills to allow them to support a 'low-carbon transition'. There is particular focus on the role and responsiveness of vocational education and training (VET), both initial (IVET) and continuing (CVET).

Combining econometric modelling and case study analysis

An innovative approach used in this research combines quantitative (econometric modelling) and qualitative (case study) approaches to investigate the expected impact of sustainable energy policies on employment and skill demand within and across sectors, while providing insights into effective IVET and CVET policies and activities that allow skills demands to be met. The top-down modelling allows an appreciation of overall changes in the labour market in response to policy scenarios and provides a context for the more detailed research, using sector-based case studies to examine VET challenges and responses. In turn, findings from the case studies can be understood in the context of the overall scale of change implied by the use of polices to drive the transition.

Labour market impacts of policies to promote a high employment, low-carbon economy

The analysis indicates that, in the baseline case, EU climate, energy and employment targets will be met by 2020, despite some assumed recovery from the current slow-down. However, the combined achievement of EU climate, energy and employment targets is feasible assuming implementation of specific measures alongside the same rate of recovery from the crisis assumed in the baseline.

In the first part of the analysis, the combination of energy related measures has the effect of achieving the specified EU climate and energy goals. However, although there is a small positive effect on employment (a lower-carbon economy is not one which leads to a loss of employment), it does not have a major effect on overall employment levels: additional measures are required to meet employment targets.

In the second part of the analysis, a set of specific measures likely to have significant employment effects were added to the energy measures: incentives for employers to hire additional workers (i.e. lower taxes on labour); incentives for individuals to offer their labour (i.e. lower unemployment benefits); and greater investment in research and development (i.e. higher levels of R&D financing). These measures were applied such that they were revenue neutral in terms of overall public income and expenditure. Results indicate a consequent rise in EU employment rate from 71% in 2020 in the baseline scenario to 75%, equivalent to an additional 13.5 million jobs.

Despite the uncertainties which may constrain the level of investment in the various domains, the employment projections suggest relatively strong growth in the low-carbon sectors, which may potentially be constrained by skills shortages. Policy and market environment uncertainties may represent a significant challenge for VET responses.

More generally, the analysis demonstrates, at least at a technical level and putting political constraints aside, that the climate and energy targets can be achieved at the same time as EU employment targets. Not only have the additional employment measures a substantial positive effect such that employment targets in most Member States are achieved, but the additional economic activity associated with the employment-led growth strategy does not jeopardise the EU climate and energy policy goals. However, this requires greater integration of climate and energy polices with measures to support employment and skills development across the EU.

There is a continuous process of 'churn' in the economy, with businesses expanding and contracting, and opening and closing. The changes introduced by the energy and employment policy measures operate within this dynamic process of economic change, and affect the whole economy through changes in relative prices. This is important in shaping VET system responses to cope with the transition:

- VET must continuously respond to significant structural changes in the economy; the transition to a low-carbon economy is another – particularly pervasive – structural change;
- VET, in responding to the low-carbon transition, must recognise that the whole economy is affected, even if certain sectors may experience especially acute change.

Employment effects in the selected strategic domains and impacts on occupational structure

The study has assessed the future changes in labour demand and skills requirements in four domains of strategic importance for a low-carbon transition: wind power, solar thermal heating, public buildings, and road freight transport and logistics. Case studies examine the development of VET programmes in response to the skills needs of these domains.

Comparing employment projections across domains provides a view of the relative contribution of the domains to achieving high employment and sustainable energy objectives, and highlights the scale of VET response likely to be required.

Of the four domains, employment associated with the development of wind energy capacity is the most significant; the 333 000 wind-related jobs projected by 2020 are more than employment related to the other domains together. However, while total levels of employment in 2020 sustained by the EU markets for solar thermal and energy-efficient buildings is relatively small (84 000 and 69 000 respectively), these two markets are each expected to grow by over 20% per year in 2012-20.

These projections of employment in low-carbon domains clearly underestimate the demand for training, since they do not include skills obsolescence as existing workers age or new technology is introduced or the need to meet replacement demand as individuals exit the workforce.

Demographic shifts in Europe are also likely to place further pressure on training responses at all levels.

The principal trend in the baseline, and after policy intervention, is towards more employment being concentrated in higher level occupations (i.e. those associated with higher qualifications) under all the scenarios to 2020. In comparing the scenarios to the baseline case at the observable level of aggregation (NACE two-digit level), the key message from the analysis is that any shifts in occupational and qualifications structure in the two scenarios are relatively modest in their net effects, but greater effects may occur at a more disaggregated level.

VET challenges and innovation in Member States responses

The challenges facing the Member States in responding to demands for skills training are considerable. They arise in the first instance from rapid growth in employment and technological developments, accelerating skills obsolescence. But there are a range of other factors that combine to create difficulties for government and industry seeking to plan investment and to deliver the requisite skills training.

The study investigated 15 VET programme case studies of across the four strategic domains. Some of them have developed approaches that appear to be effective and which may serve to inform programme responses elsewhere. Through the case studies it has also been possible to explore the scope for transferring good practice to other countries and regions in Europe, recognising the varying degrees of innovation in governance, and the processes of programme design and delivery. This has been examined in relation to four dimensions:

(a) labour market intelligence: to collect and systematically apply labour market information (e.g. comprehensive skills reviews, employment projections and qualifications mapping):
    (i) creation of inter-ministerial committees to integrate low-carbon drivers into quantitative forecasting tools and qualitative needs assessments;
    (ii) gap analysis to compare the needs derived from such analysis, with an assessment of the existing provision;

(b) networks and social dialogue: to create and manage networks, partnerships and other collaborative forms to engage policy-makers, social partners and other stakeholders in the governance, design and delivery of training in the labour market;

    (i) strengthening of existing alliances to support employer engagement in VET;
    (ii) partnerships and collaboration between existing alliances across industries, to engage with all stakeholders (public and private);
    (iii) creation of new alliances and channels for dialogue between new and non-traditional industries across the value chain;

(c) incentives and outreach strategies: to promote uptake in training, particularly among vulnerable groups and SMEs;
    (i) improved signposting of career paths in sustainable energy sectors through the creation of information portals for learners;
    (ii) targeting of particular groups embedded into the objectives of a programme, or attached as a condition for funding, to ensure the programme takes the necessary steps to achieve minimum levels of inclusion;

(d) capacity building, quality assurance and monitoring processes: to improve the quality of VET delivery and assess the relevance of learning outcomes to the labour market;
    (i) develop capacity of teachers and trainers to deliver tailored training to industry and enterprise needs;
    (ii) the use of procurement for training provision to provide freedom and flexibility, allowing (public and private) education and training providers to tailor course delivery to respond to the objectives and challenges associated with meeting specific needs.

Policy recommendations

In assessing the potential to meet EU objectives for a high employment, low-carbon economy, this study has highlighted the need for greater coherent strategic alignment between policy responses; specifically, better integration of climate and energy polices with measures to support employment and skills development is essential.

If shortages are found and action is not taken, particularly to ensure appropriate supply of high-level skills where lead times in education are longest, the development of low-carbon technologies and services will be held back. Workplace learning provision is critical in this respect, also because of the increasing rate of change in skills needs, at least in some sectors, which means workforce skills require regular updating. Further, skills demand and supply will be conditioned by the specific nature of low-carbon sectors and technologies, and their role in the low-carbon transition. This means that national, institutionally-led, responses need to be complemented by more flexible and dynamic responses at a sector and/or local and regional levels.

By highlighting variations across Europe in approaches to VET in response to low-carbon economy developments in different domains, this study also serves to underline the need to modernise VET systems and develop programmes capable of delivering the skills needed to foster a low-carbon future. In total, eight recommendations for policy actions can be identified.

Integrate low-carbon and skills development strategies

By integrating consideration of employment effects and the associated skills and training needs with strategies to achieve energy and climate objectives, national governments can foster greater awareness of the dependence of low-carbon policies on the availability of a skilled workforce. In turn, this awareness can promote integrated programmes to develop at sectoral, regional and local levels, and encourage channels of communication between ministries and the social partners.

Develop joined-up policy responses to meet employment and low-carbon goals

This study has demonstrated the technical feasibility of simultaneously achieving employment, energy and climate goals. Policy-makers have at their disposal a wide range of labour market, skills, economic and energy policies to promote job creation, which are either neutral or support low-carbon transition. Better understanding of the particular impediments and challenges to employment creation in a national context, and the impact of policies designed to stimulate jobs on energy and climate targets, needs further research.

Develop new and adapt existing systems of social dialogue

Evidence from the study underlines the fundamental importance of establishing social dialogue between governments and social partners to develop and design VET responses that are relevant to worker, employer and industry needs. Where formal systems for such dialogue already exist, these need to be increasingly flexible to reflect changes in industrial composition and structural change.

Promote institutional flexibility and qualification reform

The precise institutional structure of such social dialogue systems is likely to need to vary on a case-by-case basis, though it is likely to involve the active engagement of industry representatives and employers in designing training activities in collaboration with professional associations and trade unions. Institutional flexibility is also required to ensure qualifications and occupational profiles adapt to changing labour market needs, ensuring that training responses are of the appropriate content and standard. This requires institutions responsible for accreditation and qualifications to be an integral part of low-carbon policy responses.

Develop and use labour market information to identify skills needs

Uncertainty in anticipating the future profile of jobs and skills requires a mixture of methodologies capable of shedding light on the range of outcomes possible; these are then left for policy-makers and the social partners to interpret and translate into training needs. Social dialogue is necessary to support the development and use of labour market information and training needs analysis.

Consider use of procurement processes to achieve quality, cost-effective training

Funding arrangements can be met in a mixture of ways and the most appropriate arrangement will be determined by the specific characteristics of a programme. Procurement models which draw in solutions to training needs from public and private providers, some of whom may sit outside the formal institutional structure responsible for training provision, can provide one way of promoting quality and best value training provision.

Establish frameworks to monitor and evaluate new programmes

Particularly in pilot stages and early phases of new programmes, it is critical to monitor continuously the progress and outcomes of VET programmes to establish their role in achieving positive learning, employment and low-carbon outcomes. Occasional external and independent evaluations have the added benefit of improving learning and underpin the credibility of programme outputs and outcomes.

Share and disseminate good practice

Programme managers should work with partners at national level to exchange and share information and materials created as part of their training programmes. They should also discuss potential for highlighting lessons on training activities, materials and content, and the approach to financial and contractual arrangements, to the benefit of other similar programmes and initiatives. The development of a portal or repository of good practice responses to VET across different sectors can help to showcase the findings of this and similar research, and create a platform from which stakeholders can discuss practices and exchange experiences.

CHAPTER 1.
Introduction

1.1. Objectives of the study

The primary assumption of the study was that the positive impacts of a transition to a low-carbon economy can be maximised only by developing the skills, knowledge and competences of organisations to operate energy-saving processes and technologies; and integrating these requirements into VET policy frameworks and instruments, to ensure they are specified, recognised and supported.

The study aimed to combine quantitative and qualitative approaches to investigate the expected impact of sustainable energy policies on future skills demand within and across sectors, and to provide insights for effective policies for initial and continuous VET activities that allow skills demands to be met. Considering that the use of resources which are naturally replenished and energy conservation are essential for achieving a low-carbon, energy-secure Europe, the specific focus of this study is on renewable sources and energy saving policies and strategies.

The particular objectives were:

(a) provide a sustainable energy policy-driven economic scenario consistent with Europe 2020 targets for renewable energy and energy efficiency – particularly in terms of employment and growth – building on existing macroeconomic and energy scenarios at EU level;

(b) deepen understanding of workforce composition and skill needs relating to renewable energy and energy saving targets and implications for education and training policies;

(c) consider the broader policy context, particularly in terms of the coherence and coordination between VET and other relevant policy areas, and how they support (or hinder) the effective development and deployment of skills necessary for a low-carbon, sustainable Europe.

1.2. Methodological approach

This study employed a range of qualitative and quantitative methods to ensure a comprehensive approach to identifying skill needs in a labour market driven by the transition to a low-carbon Europe; and to analyse the role and experience of VET activity in responding to these needs to date.

The mixture of methodologies used reflects the complexity of the issues at hand. It balances the need to anticipate and build understanding of the macroeconomic effect of a transition to a low-carbon economy, with insight into implications for VET policy response to far-reaching questions such as:

- is there an inherent conflict between increasing rates of employment and reducing energy use and greenhouse emissions?
- how many jobs will be created (or lost) as a result of energy and climate policy in the medium term, in which sectors or occupations and at what levels of qualification?
- in what ways can vocational education and training (VET) policies respond to overcome the challenges of achieving the goals of transition to a low-carbon, job-rich Europe?

The strands of the research approach are as follows:

(a) desk research and analysis of relevant and recent policy documents. Analysis of the EU policy context was prepared, highlighting key developments in renewable energy and energy efficiency legislation at EU level and in the Member States;

(b) a rapid evidence assessment of literature. Conducted to extract existing evidence on the employment impact of climate and energy policy, and the specific challenges and skill needs in relation to key sectors of interest and their value chains, to provide a synthesis to inform the development of employment projections and the identification of further policy developments;

(c) econometric modelling and scenario analysis. This approach builds on the latest data and developments in skills forecasting (Cedefop, 2010) to project employment impacts up to 2020 by broad sector and occupation, under different sustainable energy policy scenarios. The scenarios were constructed in line with plausible macroeconomic trends in light of the EU 2020 policy objectives and developments, to provide an up-to-date view on progress towards transition to a low-carbon Europe and added insight into the employment and skills impacts of achieving EU 2020 objectives;

(d) estimates of job creation for specific sectors of interest. Due to the mismatch between official statistical classifications of sectors and those that are more relevant to the study of transition to a low-carbon economy, employment projections for specific sectors of interest were calculated. Along with projections directly from the model, these estimates serve to frame the VET responses in line with anticipated future skill needs;

(e) in-depth studies of particular VET policies aimed at responding to the multiple challenges for transition to a low-carbon Europe. Desk-based research and stakeholder consultations were carried out to bridge the gap between the quantitative projections and VET policy responses, to identify and assess examples of good practice. The research draws on secondary sources (annual reports, journalistic accounts, prior research and policy documentation) and semi-structured interviews with those responsible for the design, governance and delivery of the VET response;

(f) validation workshop. Academic experts, policy analysts and government researchers from different Member States were invited to Brussels to discuss the adopted methodological approach, the implications of the quantitative research, and to inform the establishment of criteria to assess good practices in low-carbon employment, skills and VET.

Box 1. **Selection mechanisms to draw policy recommendations**

The study presents examples of the role of VET in supporting renewable energy and energy savings within the context of four domains:

- wind power,
- solar thermal heating and cooling,
- public buildings,
- road freight transport and logistics.

These domains were selected on the basis of their importance for transition to a low-carbon Europe, their role in terms of public policy developments, and their expected contributions to reducing energy consumption and carbon emissions in line with the 2020 policy cycle. Selection also sought to ensure broad coverage of the range of industries associated with the achievement of the EU energy and climate targets.

The policy case studies were selected on the basis of identified national policy developments and projected changes (compared to baseline) in employment and workforce composition in these domains. In establishing country clusters, selection also ensures broad coverage of the range of VET systems and policy responses in Europe.

By taking advantage of the various VET models across Europe and the developments of a low-carbon economy in different domains, these selection mechanisms support policy recommendations for actions of practical relevance, which focus on industries of particular interest and importance, and which may be transferable and so have far-reaching implications for VET and low-carbon policy developments at EU and national levels across all industries.

1.3. Structure of the report

The remainder of the report is structured as follows:

- Chapter 2 provides the policy context and background to the study;
- Chapter 3 presents the scenario analysis of the quantitative impact on skill needs of meeting EU 2020 energy and employment targets;

- Chapter 4 complements the scenario analysis with contextual information on trends in domain employment and skill needs, and highlights the key challenges for VET;
- Chapter 5 maps and analyses tactical VET responses in relation to low-carbon policy developments;
- Chapter 6 explores the role of strategic, proactive VET responses in supporting strategies for sustainable economic development;
- Chapter 7 provides conclusions, recommendations and policy implications.

A glossary of terms, a list of abbreviations and full references are provided in Annexes 1-3. Technical details of the modelling approach and scenario development are provided in Annex 4 and detailed tables of model outputs are provided in Annex 5. A full description of the methodological approach: the econometric modelling, scenario development, employment projections, qualitative research tools and their detailed outputs are provided in Annexes 6-7.

CHAPTER 2.

Policy background and literature review

This chapter sets the policy background. Based on a literature review, it describes the transition towards a low-carbon economy as a driver of structural labour market change, characterised by the reallocation of jobs across the economy (from energy-intense to low-carbon industry) and within industry (as all jobs become increasingly low-carbon).

The low-carbon agenda has gained added prominence and traction in the context of global climate change. In the EU context, various top-down legislative instruments have been introduced, including legally binding climate and energy targets. Meeting these targets, while also contributing to high levels of employment, requires the support of labour market and VET policies.

2.1. The Europe 2020 Strategy

The Lisbon Agenda, adopted in 2000, set an ambitious goal for Europe to become the world's most dynamic knowledge-based economy by 2010. However, the economic crisis has eliminated much of the economic and social progress previously made and exposed some of the structural weaknesses present in Europe's economy. Meanwhile, the worldwide and long-term challenges of globalisation, climate change and pressures on resources have intensified. Other key factors include technological and demographic change (related to falling labour supply).

In response, the European Commission launched the Europe 2020 strategy to promote collective action to turn the EU into a smart, sustainable and inclusive economy delivering high levels of employment, productivity and social cohesion (European Commission, 2010d). Learning the lessons of Lisbon, it is proposed that the success of Europe 2020 shall be determined by its performance against a range of headline targets.

For this study the critical indicators are the EU 20-20-20 climate and energy targets, established in the European climate change programme (ECCP) and binding from June 2009 (European Commission, 2008). This package promotes transition to sustainable and secure energy in Europe and includes the following objectives:

(a) reduction in EU greenhouse gas emissions of at least 20% below 1990 levels ([1]);
(b) the need for renewable sources to represent 20% of EU final energy consumption ([2]) and 10% of overall final energy consumption in transport;
(c) a reduction in energy consumption of 20% from projected 2020 levels by improving energy efficiency;
(d) a reduction in greenhouse gas emissions from sources outside the EU emissions trading system (ETS) of 10% between 2013 and 2020 from 2005 levels ([3]).

On 15 December 2011, as part of its *Energy roadmap 2050* (European Commission, 2011d) the EU signalled its long-term commitment to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 in the context of necessary reductions by developed countries as a group. In the *Energy roadmap 2050* the European Commission explores the challenges posed by delivering the EU's decarbonisation objective while ensuring security of energy supply and competitiveness.

Taken together, more efficient, conservative use of energy across all sectors and greater use of renewable energy sources aim to promote transition to sustainable and secure energy in Europe. Within the Europe 2020 strategy, achieving sustainable energy transition presents opportunities not only to tackle the recession but also 'to create a more productive, more innovative, more inclusive, low-carbon economy' (European Commission, 2009a). Seizing these opportunities, however, is not without challenges, requiring direction and policy support.

Achieving the employment target as set out in the Europe 2020 flagship initiative, an agenda for new skills and jobs (European Commission, 2010b), means modernising labour markets: empowering people through the acquisition of new skills to enable the current and future workforce to adapt to new conditions and potential career shifts, reduce unemployment and raise labour

([1]) To be increased to 30% if other developed countries outside the EU commit to comparable reductions (as part of a new climate treaty to replace the Kyoto Protocol, which expired in 2012), and if economically more advanced developing countries contribute adequately according to their responsibilities and respective capabilities.

([2]) Final energy consumption means at the point of end-use, as electricity, heat, and directly used fuels. This method therefore counts all forms of electricity equally, regardless of origin.

([3]) Notably buildings, transport, agriculture, waste and industrial plants falling under the threshold for inclusion in the ETS. These sources currently account for approximately 60% of all EU greenhouse gas emissions.

productivity. The agenda highlights four priorities that will raise employment levels, allowing the EU to fulfil the employment target rate of 75% by 2020 for the population aged 20-64:

(a) better functioning labour markets;
(b) a more skilled workforce;
(c) better job quality and working conditions;
(d) stronger policies to promote job creation and demand for labour.

In light of the need for sustained economic recovery, the European Commission singled out the 'employment potential of green growth' for special focus in its 2012 communication *Towards a job-rich recovery*. This communication, and the accompanying staff working document (European Commission, 2012a; 2012c), highlight the growing need:

(a) to mainstream green employment into national job plans;
(d) to strengthen intelligence on the skills needed in a green economy;
(e) for smart green investments;
(f) to build partnerships between labour market actors.

The Europe 2020 targets clearly demonstrate the importance of energy and labour policies for the future of Europe. Interactions between policies could also be significant, with potential win-win opportunities emerging for the benefit of employment and the environment, while conflicts may also emerge. Therefore, both the impacts on the European labour market of meeting the 20-20-20 targets, and the scope for synergy and conflict in meeting both energy and employment targets, should be considered.

Employment, education and training policies can play an important role. In response to the need to improve the EU capacity for skills assessment, anticipation and matching, this study considers the role of stronger policies to promote job creation and the role of VET in developing a more skilled workforce.

European and national policies have set high expectations for the increased responsiveness of VET to meet changing labour market needs and its flexibility to address skills imbalances and shortages (Cedefop, 2009). As defined in the Copenhagen process and subsequent communiqué ([4]), VET should strive to:

- be an attractive option for young people and adults to foster the acquisition of professional qualifications and their updating throughout working life;
- be a model of excellence, while being transparent to all actors at individual, company and State levels;

([4]) Council of the EU and European Commission, 2010.

- promote high-level, transferable skills within the EU population as well as active social inclusion and citizenship.

2.2. Sustainable energy transition and structural change

The low-carbon economy agenda has gained added prominence and traction in the context of global climate change. In the EU context, various top-down legislative instruments include the establishment of legally binding climate and energy 20-20-20 targets, in turn supported by market-based instruments and regulation to internalise environmental costs, such as the EU ETS and eco-design directives.

Despite the policy and legislative framework, the strategy for sustainable energy future recognises, and seeks to promote, the role of consumers, businesses and industry from across a wide range of established and emerging sectors to support innovation and change. In this sense, the top-down frameworks are seen as establishing the conditions in which European enterprises can thrive, leaving room for entrepreneurial and industry initiatives to develop. The approach to a sustainable energy transition can therefore be seen as a special case of technical change: it is ‘purposeful’ in the sense that it has the explicit aim of increasing resource efficiency and reducing the carbon intensity of production and consumption.

Sustainable energy policy in Europe is supported by the ‘twin pillars’ of renewable energy and energy efficiency: both need to be developed aggressively to stabilise and reduce carbon dioxide emissions in our lifetimes. Efficiency and energy savings are essential to slowing growth in energy demand so that increasing clean energy supplies can make cuts in the use of fossil fuels. If energy use grows too fast, renewable energy development will chase a receding target. Reduced carbon content in energy sources is also needed. While clearly interconnected, EU and Member State policies for energy efficiency and renewable energy are generally pursued on separate tracks, and are each considered in turn below (Prindle et al., 2007).

2.2.1. Renewable energy policy in Europe

In March 2007, the EU Member States agreed to a binding EU-wide target to source 20% of their energy needs by 2020 from renewables (compared to 9.2% in 2006). The directive on promoting the use of energy from renewable sources ([5]) sets mandatory national targets for Member States for the share of renewables from final energy consumption based on a 2005 baseline capacity. Together these meet the 2020 target. The framework covers a balanced mix of all existing renewable sources including electricity, heating and cooling, and biofuels.

Member States presented national renewable energy action plans in 2010, setting out how they intended to meet their targets across their renewable energy mix. Collectively, initial analysis indicates plans to slightly surpass 2020 targets, with particularly developed policies relating to renewable electricity and less developed schemes regarding renewable heating and cooling. The 2012 energy efficiency directive ([6]) seeks to address this bias by introducing 10-year national heat and cooling plans; a formal obligation to improve the transparency, predictability and alignment of policies for investments in this area.

As well as promoting investment, many supporting measures are also necessary to stimulate private sector involvement, overcome market failures and ensure that viable economic conditions remain in the longer term. The sustainability of renewables post-2020, when subsidies have been reduced or removed, is particularly important in this context, as are the employment impacts and fiscal multipliers generated by the low-carbon energy sectors.

It is for Member States to decide on the specific policy instruments to encourage renewable energy technologies. It follows that each Member States operates different support schemes using various policy measures: feed-in tariffs, premium systems, green certificates and tax exemptions, obligations on fuel suppliers, public procurement policy and research and development (R&D) (European Commission, 2011f). Long-term support schemes help provide stability to markets, often by guaranteeing a minimum income stream and hence reducing risks to investors. Indicative mapping of the policy instruments in place for renewable energy across the EU-27+ is highlighted in Annex 6.

2.2.2. Energy efficiency policy in Europe

Reducing energy consumption and eliminating energy wastage are among the main EU goals. At the end of 2006, the EU pledged by 2020 to cut its annual consumption of primary energy by 20% compared to projections. To achieve this, the EU has set minimum energy efficiency standards and rules on labelling for products, services and infrastructure, notably in the appliances and buildings markets, and established financial, fiscal and ‘softer’ tools to encourage energy

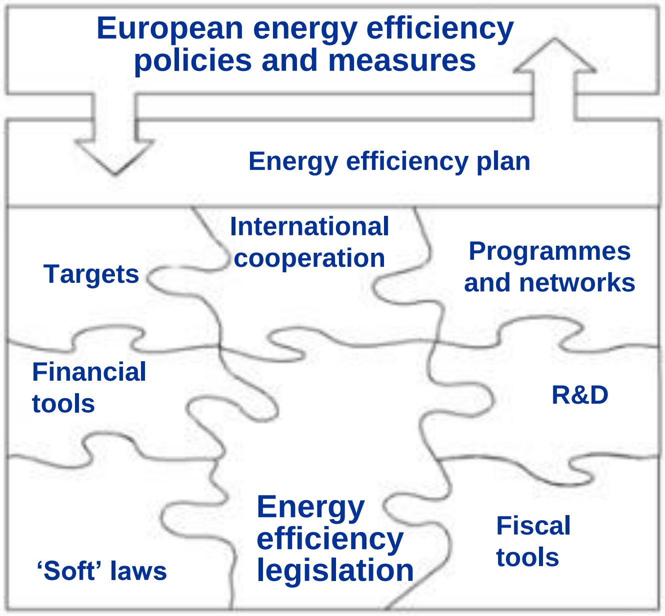
([5]) European Parliament and Council of the EU, 2009.

([6]) European Parliament and Council of the EU, 2012.

savings across the Member States. This group of EU-led energy efficiency measures is conceptualised in Figure 1.

At present, however, despite this combination of policy efforts, the EU is not on track to meet its (non-binding) 20% energy saving target. In response, the European Commission reinforced efforts at sector level in the energy efficiency directive of 25 October 2012 ([7]). This aims at bridging the anticipated shortfall, making energy saving schemes legal obligations and, in particular, places further emphasis on the exemplary role to be played by the public sector.

Figure 1. **Pieces of the European energy efficiency puzzle**



Source: European Commission, 2011a.

In line with the EU legislation for energy efficiency, Member States can decide on additional measures and on policy instruments used to promote energy savings and energy-efficient technologies. In 2009, Member States presented national energy efficiency action plans, setting out how they intend to meet energy savings targets across non-ETS sectors (European Commission, 2009b).

Within these different sectors, Member States operate different schemes using various policy measures, which also seek to encourage private sector involvement. The range of policy instruments seeks to change behaviours (eco-driving courses, energy audits), internalise the costs of emissions (eco-taxes), improve energy and fuel efficiency (standards and regulations) and promote the

([7]) European Parliament and Council of the EU, 2012.

take-up of low-carbon technologies (soft loans, grants, procurement) or the adoption of alternative modes of transport (enabling investments in infrastructure). An indicative listing of the policy instruments, included in the national energy efficiency action plans, to promote energy savings in buildings and freight transport across the EU-27 is provided in Annex 6.

Energy efficiency covers a wide range of sectors and all stages of the supply chain, from raw material sourcing, through production and distribution to the end user, to end-of-life recovery, recycling and reuse of materials.

Improving energy efficiency often requires that changes are made across one or all of these stages, while measures in one part of the chain can create ripple effects in others (e.g. increased demand for related goods and services), with implications for employment throughout the supply chain. Retro-fitting existing building stock, for example, in many cases requires products such as secondary window glazing and insulation material to be manufactured, for the products to be installed, and the waste products to be recovered and recycled.

Box 2. **Investing in energy efficiency**

The role of public and private investment

In the most comprehensive assessment of the cost of investment needed in meeting the EU 2020 energy efficiency objectives, estimates for the building sector [alone] range from EUR 286 billion to EUR 587 billion in low and high policy intensity scenarios respectively.

Due to well-documented market failures, which lead to the private sector failing to provide optimal levels of funding, public intervention is required to take adequate advantage of the total cost savings to be gained from energy efficiency programmes. In particular, prohibitively high initial upfront costs, problems of split incentives (whereby decision-makers are detached from price signals, e.g. in landlord-tenant relationships), asymmetric and imperfect information, as well as regulatory uncertainty and a lack of account being taken of the full external costs of energy use, can deter cost-effective investments.

Information failures are also ‘compounded by the fact that many actors in the building sector do not have adequate training and knowledge regarding energy efficiency issues.’ A clear role for public intervention is apparent, though, as the background and literature review has shown, many different possible policy options exist, which can help to overcome the market failures and barriers to private investment or provide public sources of financing.

Source: European Commission, 2012b, p. 9 and p. 15.

2.2.3. Structural change

Transformation of the present European economy to one which can be sustained over the long-term, given the physical limits to natural resources, is a major challenge for businesses and industry. On the one hand, legislative reforms and carbon prices will bring about a downsizing and restructuring in carbon-intensive industries. On the other hand, employment growth can be expected in renewable energies and activities seeking to support energy efficiency, particularly in construction and transportation.

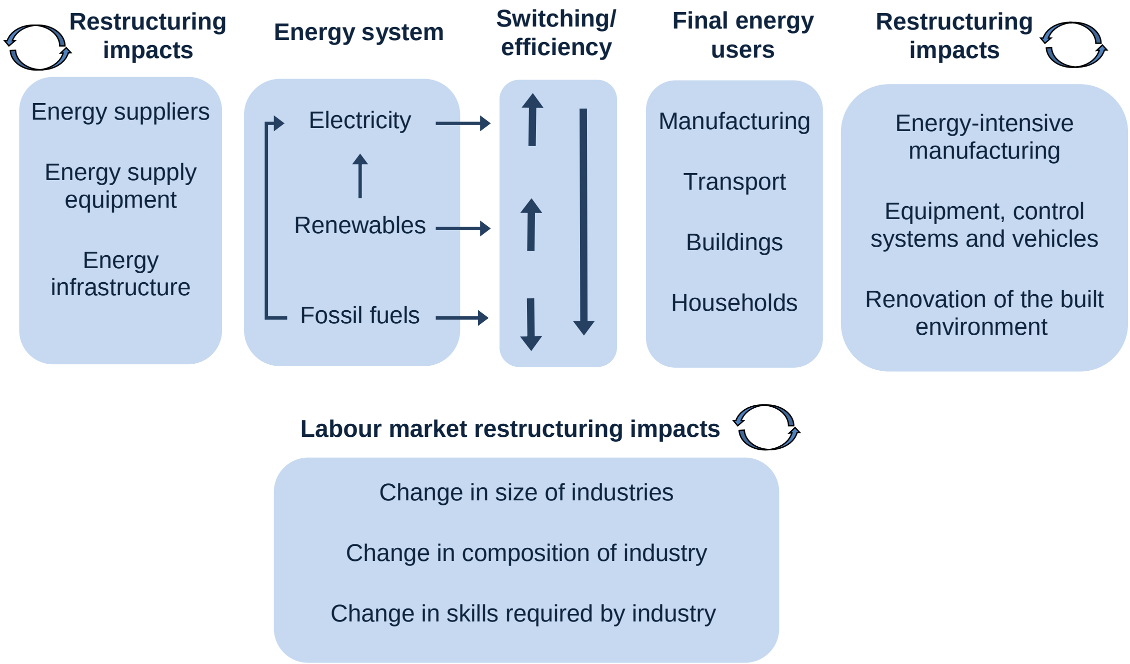
Naturally, the main restructuring effects associated with a shift to a low-carbon economy centre around the energy supply system in the first instance. Within the energy system itself, there is a shift away from the production of fossil fuels towards indigenous, low-carbon energy sources, with restructuring impacts on economic activity both upstream and downstream the supply chain (Figure 2).

Upstream there is a clear shift away from energy based on fossil fuels towards those based on low-carbon and renewable sources. These impacts feed through to the suppliers of natural resources, supply equipment and infrastructure. Downstream, there is a shift away from energy-intensive industries and products (European Commission and Cambridge Econometrics et al., 2011).

This dynamic process of change is associated with substantial churn related to the closure and contraction of existing businesses alongside new and expanding businesses (European Commission and GHK, 2011). Some sectors or regions will decline and jobs will be lost, while other activities will thrive and generate new employment. However, on balance, evidence from the literature suggests that, after an initial cost to the EU from switching to a low-carbon economy (i.e. implementation of the EU 2020 targets), over the medium to longer term there is a modest positive outcome in terms of employment and economic growth.

When looking at specific policies and industries, the impacts are much more differentiated, with some sectors such as steel, oil and cement typically reported to experience a decrease in employment, while sectors such as renewable energy, construction and transport are projected to witness positive employment growth by 2020. The overall positive net effects can be explained by the relative labour intensities of these industries (ILO, 2011). Since low-carbon industries typically require a relatively larger workforce per unit of output, it follows that the job gains associated with the shift towards a low-carbon economy offset job losses in the sectors that contract, leading to a small positive employment effect.

Figure 2. **The restructuring effects associated with a shift to a low-carbon economy**



Source: Adapted from European Commission and Cambridge Econometrics et al. (2011).

Shifts will also occur within industries, as final energy users (industry, transport, buildings and households) adopt new low-carbon technologies and practices. Jobs in the economy will mirror this pattern of adjustments in economic activity, with jobs being reallocated:

(a) across the economy: from energy-intense industries towards those sectors with more moderate energy usage;

(b) within industry: as patterns of production adjust and every sector moderates energy usage and shifts to more sustainable inputs, jobs are reallocated to take account of these changes.

Managing this industrial transformation will require labour markets and VET systems that aid adjustment in an efficient, sustainable and inclusive way. If the availability of the skills required along sustainable growth trajectories is inadequate, this could be an obstacle to a low-carbon Europe.

As well as changing the size and composition of industries, structural changes have implications for occupational skill requirements. The strategic framework for European cooperation in education and training (ET 2020) highlights that while economic restructuring gains additional pace, and unemployment in declining sectors goes hand in hand with recruitment bottlenecks in others, skills requirements are also changing in many existing jobs.

The studies reviewed offer different perspectives on the debate over the positive and negative effects on employment and growth of transition to a low-carbon economy: double dividends, path dependency, threshold and lock-in effects and/or the role of demand stimulus and eco-innovation. Across the various studies, the most consistently reported findings include:

(a) environmental and climate issues are shown to be having an impact on the labour market and act as a driver of changing skill needs and work tasks. The impact on skill needs is both quantitative –number of jobs – and qualitative –job content (e.g. Cedefop and ILO, 2010);

(b) renewable energy polices, energy-efficiency measures, and associated investment appear to have the most significant positive impacts on employment and output growth across Member States and the EU as a whole; (European Commission and GWS et al., 2011). There is a need, however, to consider possible crowding out, whereby public investment curtails private investment via general equilibrium effects;

(c) coordinated policy approaches (within the EU, globally or across industry sectors) that lower implementation costs and foster a stable investment climate maximise positive employment impacts (e.g. Chateau et al., 2011);

(d) energy supply and construction industries tend to show the most profound changes in labour demand as a consequence of policies designed to offset environmental externalities and climate change in particular. In these industries, manual skills are likely to be in demand, while increased emphasis on research and development and technology deployment will mean that science, technology, engineering and mathematics (STEM) skills are also increasingly needed across industries (e.g. Cedefop and ILO, 2010);

(e) energy-intensive or greenhouse gas-emitting industries are predicted to incur the most negative impacts on employment, which may be spatially concentrated. These industries are already seeing changes in occupational skill profiles as production becomes greener. This is not due solely to low-carbon restructuring but also technological developments and higher labour productivity (e.g. ILO, 2011);

(f) technical change is leading to a growing polarisation of the labour market; the more investments are made in new technologies (many of which are likely to be energy saving or related to new forms of energy generation) the more demand there will be for higher skilled jobs, but also lower skilled jobs (e.g. European Commission and Cambridge Econometrics et al., 2011);

(g) while some sectors affected by the transition to a low-carbon economy have an idea of their future skills needs, many businesses are less assured, resulting in mismatches between the skills demanded by employers, the skills deployed in the workplace and/or the skills possessed by the labour force (e.g. Eurofound, 2013);

(h) since ‘green jobs’ or ‘green skills’ cut across industrial sectors and occupations, the responsibility for the organisation of VET responses is likely to fall across several bodies, both public and private (e.g. Cedefop, 2011).

In summary, research suggests that climate-change mitigation policies in general, and renewable energy in particular, may generate considerable additional employment. In this context, however, job creation possibilities and potential for job destruction in high-carbon or energy-intensive industries should be considered.

A further key consideration for VET policy which emerges from literature is that VET systems are required to respond not only in terms of reacting to demands for new or higher level skills, but also in terms of what people learn, how, where and when, as well as in considering the effective transferability of learning outcomes to a range of work opportunities.

This study explores the nature of VET policy responses by analysing a series of case studies. However, we first turn our attention to deepening our understanding of the interaction of sustainable energy and employment policies and analyse the medium-term impact of these on economic and labour market performance, and occupational skill needs in Europe.

CHAPTER 3.

Policy-driven scenarios for a job-rich, low-carbon transition

3.1. Purpose of scenarios

The key purpose of developing and analysing sustainable energy scenarios is to respond to the following questions:

(a) what effect do low-carbon policies have on employment outcomes?

(b) can measures to meet employment targets be introduced that do not conflict with energy targets?

(c) what trade-offs can be identified?

The research is designed to explore policy possibilities for achieving the energy, climate and employment targets. The analysis, however, is not designed as much to recommend specific policies, but rather to examine the type of interaction that exists between employment levels and energy and climate outcomes, and to derive implications for employment, skills and, ultimately, VET policy. Further, in employing an econometric model to project scenarios (i.e. what might plausibly happen under a certain set of explicit conditions), one refrains from making predictions about the future: instead, emphasis is placed on the likely dynamics and observable direction and magnitude of trends in the medium term (i.e. in line with the EU 2020 policy cycle).

3.2. Policy and socioeconomic context

This analysis is carried out in the context of lasting effects of the recession, fiscal deficits and subsequent austerity measures. The economic crisis of 2008, and the recession that followed, dramatically increased uncertainty about job prospects. In the short term, Europe has seen significant falls in employment; according to the latest EU labour market forecasts, at sector level, the recession appears to have accelerated the trend to shift jobs from primary and basic manufacturing to services. Job losses were concentrated in manufacturing and construction but there is some evidence of a recovery in certain manufacturing subsectors (electricals, computing, and transport) in the year to mid-2011. The latest Cedefop forecasts (Cedefop, 2011) support this view, while noting that, though prospects in the medium to long term may be better, employment and training policies are needed to ease restructuring.

In its Europe 2020 strategy (European Commission, 2010d), the EU has committed to ambitious climate and employment targets. While the recession has in some sense helped to meet these environmental targets (by reducing levels of emissions associated with output and production) it has undoubtedly hindered progress towards employment targets. In a post-recession environment, it also holds true that public resources that could be used to help meet the targets and improve productivity and competitiveness are highly constrained. There is, therefore, a need to identify ways in which the targets can be met at low cost, and to identify the associated benefits and losses, as well as any contradictions and complementarities between the possible policy measures.

This analysis requires a whole economy approach because transition processes affect the whole economy through value chains and other mechanisms. For this, an environment-energy-economy model for Europe (E3ME model) is used to help gain understanding of the impacts of sustainable energy policy on European labour markets.

3.3. Modelling the policy-driven scenarios

This study first develops a baseline case (baseline), before assessing the impact of two sustainable energy policy-driven scenarios. The first policy-driven scenario (energy target scenario) introduces a pure sustainable energy policy mix, which achieves the EU climate and energy targets. In a second scenario (energy and employment target scenario) the energy policy package is augmented to support the achievement of EU employment targets (as defined for each Member State in their 2011 national reform programmes). This allows assessment of the effects on climate objectives and the challenges of pursuing both sets of targets at the same time.

To undertake effective scenario analysis, it is first important to use a baseline set of projections that are as accurate as possible. This is particularly the case when considering the 2020 employment targets, as the baseline determines the amount of work that must be done in the other scenarios to meet these targets.

Box 3. **Main characteristics of the E3ME model**

E3ME is an econometric model that combines the economy and labour markets with Europe's energy systems and related greenhouse gas emissions. The model is well suited to this analysis and has previously been applied for similar analysis for Directorate-General for Employment and is used to produce Cedefop's medium-term projections of skills supply and demand (e.g. Cedefop, 2012a). Further details of the model are provided in Annex 5.

Spare capacity and unemployment

E3ME does not assume that supply and demand automatically meet; in a labour market context this means that there is spare capacity in the form of unemployed workers. In a post-recession environment this is clearly an important feature of the analysis. It means that employment rates can be raised by increasing labour demand, without necessarily introducing policies to increase labour supply. Baseline unemployment rates are set to match those produced in the 2011 skills projections.

Also, the results described in the following sections must be considered within the assumptions of the targets that have been set and the baseline projections of emissions and employment. The likelihood of each country meeting its 2020 employment target is highly dependent on the base path of economic development, and any deviations from this base trajectory may outweigh the effects of implementing energy and climate policy. International energy prices will also determine the amount of effort that is required to meet the 20-20-20 targets. In both cases we use a baseline case that is derived from a published, peer-reviewed document but there is clearly uncertainty in these projections.

The baseline carbon dioxide (CO_2) emission projections are derived from a current policy based on the Directorate-General for Energy's publication, *EU energy: trends to 2030* (European Commission, 2010c), which uses results from the partial equilibrium energy market model for the long term (Primes). The baseline already includes many existing energy and climate policies, including policies and measures implemented in the Member States by April 2009 and legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty as to how they should be implemented in the future, such as the EU ETS directive. Roughly half of the reduction in CO_2 emissions from 1990 levels, required to meet the 20% emissions target, is included in the baseline case.

Further, from the background and literature review, it is clear that Member States have responded in different ways to the low-carbon agenda. This will therefore be reflected in the baseline case used which, in addition to the existing environmental policy such as the EU ETS, also includes the structural changes to the workforce that are related to the environment but not the direct result of policy.

The baseline, therefore, represents the 'do nothing new' or 'zero additional policy' option. Its employment projections across sectors, which in turn are linked to occupational groups, and broad qualification levels, provide a basis for comparison with the results from sustainable energy 'policy-on' scenarios, assumed to achieve all of the EU 2020 energy and climate targets, as well as the 75% target rate of employment. An overview of these sustainable energy scenarios are provided in the box below.

3.4. Macroeconomic effects

3.4.1. Challenging shift to sustainable energy: results of the 'energy target' scenario

Key results from the analysis, which is consistent with the results from the recent studies by Directorate-General for Employment (European Commission and Cambridge Econometrics et al., 2011) and literature more widely, are that:

(a) budget-neutral, sustainable energy policies do not lead to a large reduction in employment; in fact, the investment-driven policies associated with meeting 20-20-20 targets lead to a net increase in jobs within countries and across the EU;

(b) the impact of the recession, included and updated in these results, does not change this outcome, but it does ensure spare capacity in the labour-intensive sectors, such as construction, that are driven by the sustainable energy policy mix to undertake the investments needed to achieve the EU 2020 targets;

(c) economic activity goes hand-in-hand with energy demand and carbon emissions under conventional strategies for growth.

(d) Starting with overall employment trends, the impact of sustainable energy policies in the 'energy target' scenario is positive, albeit fairly limited, leading to a rise in employment rate to 70.8%. This represents an additional 250 000 jobs in 2020 compared to baseline levels (a difference of 0.1%) ([8]).

([8]) Under the baseline, employment is projected to increase by 2.8% in 2012-20. The baseline scenario already includes many of the major policy drivers in place prior to 2012 such as the EU ETS, thereby representing an underestimate of the total employment effects of climate and energy policy as a whole.

Box 4. **Overview of the modelling scenarios**

The baseline scenario

The baseline scenario has been designed to be consistent with the 2009 variant of the projections derived from the Primes energy model and published by Directorate-General for Energy (European Commission, 2010c). Based on current implemented policy (as of 2009) and long-term economic growth rates published by Directorate-General for Economic and Financial Affairs, it is regarded as a business-as-usual case, representing expected outcomes if no further policy is implemented. This is the standard modelling baseline for use in European Commission studies, and provides a degree of consistency with other research.

The energy target scenario

Apart from energy-efficiency measures, the policies implemented to reach the emissions and renewables targets are the same as those used by the Primes model to produce the reference case of the Directorate-General for Energy (European Commission, 2010c). Energy efficiency is assumed to be achieved through additional investment (for a discussion see below).

In the energy-target scenario (similar to the S4 scenario assessed for Directorate-General for Employment in European Commission and Cambridge Econometrics et al., 2011; but updated to include the most recent economic data), the 2020 targets for reductions in greenhouse gas emissions and uptake of renewables technologies are met; the objective of reducing final energy use by 20% is also met. This changes the relationship between economic activity and energy demand by industry and households and provides an assessment of the impact on employment of meeting the climate and energy targets.

The energy-target growth scenario

To draw out the links and interactions between economic activity, employment and energy outcomes, a further supplementary scenario was devised (energy-target growth scenario). In this, rates of economic growth are increased (by raising export volumes) to the point where employment targets are met. This scenario is designed to account for the fact that target employment rates have become very difficult to achieve post-recession in many European countries and gives an indication of the sort of stimulus that would be required to get back on track. It also explores the relationship between economic output, employment levels and energy consumption.

The energy and employment target scenario

The energy and employment target scenario provides the opportunity to examine a policy mix whereby the EU 2020 employment target is met without compromising the climate and energy targets. For this, policy measures are required that provide appropriate incentives and conditions for employers to hire more workers and for individuals to be able and willing to supply their labour.

The energy and employment target scenario drew on the common themes that focus on employment and skills in the country specific recommendations, published by the European Commission ([a]). Environmental and economic policies that are intended to lead to a 'job-rich recovery' were also reviewed.

Proposed measures for inclusion in the policy mix were assessed against four criteria:

- carbon impact (CO_2 emissions),
- energy impact (GWh),
- employment impact (jobs),
- the feasibility of modelling.

Broadly speaking, the full set of policy options investigated represent different tools through which it may be possible to offset any conflicts in meeting both the EU climate and employment targets. The full assessment of policy options, included in Table A4.2 in Annex 4, led to the modelling of three policy measures:

- reduced level of social benefit payments (i.e. lower unemployment benefits);
- reduced taxes on labour (i.e. a lower tax wedge);
- increased levels of R&D financing.

The modelled measures were targeted at those countries which were otherwise unable to achieve EU employment targets. Rather than representing a policy prescription, the selected policies served as modelling tools and were assumed to have a beneficial impact on job creation, while having a neutral or positive effect on both emissions and energy use. Their effectiveness in promoting job creation in practice may be limited by the extent to which such measures provide sufficient incentive to employers to hire additional workers and for individuals to supply their labour.

To maintain a certain degree of plausibility, the measures were smoothly introduced into the model over a three-year period. To meet the employment target, it was also necessary for the scenario to be augmented with a 0.5 percentage point increase in annual economic activity from 2012 to 2015 above baseline assumptions.

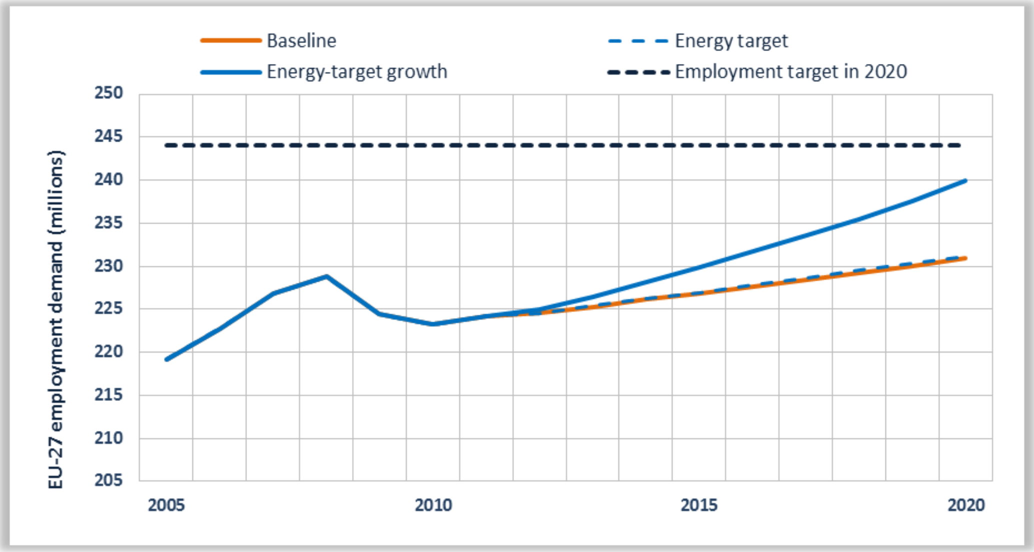
This scenario (and also the energy target scenario) is revenue neutral, meaning that there is no net impact on government budgets, and the scenarios therefore represent a shift in net tax revenues rather than any increase or decrease.

([a]) The country specific recommendations are documents prepared by the European Commission for each country, analysing its economic situation and providing recommendations on measures it should adopt over the coming 12 months.

While meeting the EU 2020 climate goals, the ‘energy target’ scenario falls short of delivering the 75% EU employment target, which would require an estimated total of 13 million jobs by 2020 (5.7% above baseline) ([9]). The modelling results therefore suggest that European countries, under current economic conditions and in the absence of a positive external shock or significant boost to levels of employment, will face significant challenges in meeting both their 2020 employment and energy targets.

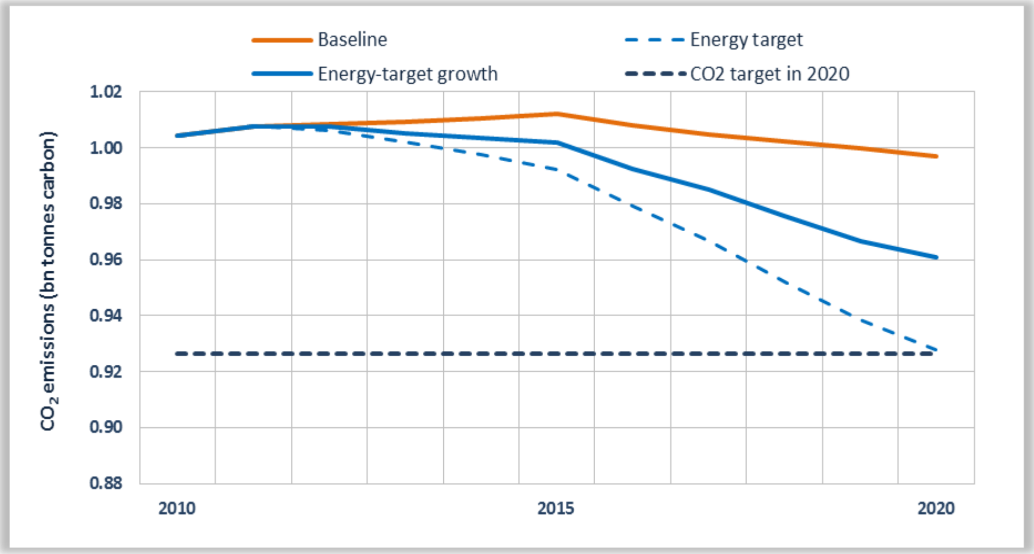
([9]) Based on Cambridge Econometrics calculations, the 75% target translates to approximately 244 million workers by 2020 based on the E3ME model, i.e. after accounting for differences between labour force survey data on which the EU targets are made and the national accounts data in E3ME.

Figure 3. **Pursuing additional environmental policies necessary to achieve energy and climate targets associated with small net positive effects on employment demand**



Source: Cedefop (based on Cambridge Econometrics estimates).

Figure 4. **A trade-off currently exists between economic activity and climate outcomes**



Source: Cedefop (based on Cambridge Econometrics estimates).

To assess the extent of this challenge, the model tested the effect of a 1% higher annual rate of economic growth in 2012-20 in an augmented 'energy-target growth' scenario. Although these optimistic rates of output growth generate a further 9 of the 13 million additional jobs needed to meet EU employment targets, 0 shows that this leads to higher energy demand and carbon emissions.

Comparing the 'energy-target growth' scenario with the 'energy target' scenario offers the following approximate relationship: achieving a 1% increase in employment, requires a 2% increase in aggregate output. This leads to an increase in energy consumption of around 1%, and an increase in greenhouse gas emissions of 1%.

Without further action to break the link between economic activity and energy demand, strategies to achieve growth in economic activity will come at the price of missed energy and climate targets.

3.4.2. Decoupling the relationship between employment growth and energy consumption

This finding raises two key questions: how can employment rates be increased within the constraints of realistic growth prospects, and does this necessarily mean that energy and climate targets are no longer met? The economies of Europe are slowly, and unevenly, emerging from the economic crisis. While dealing with the immediate challenges of high unemployment and fiscal deficits, new ways of ensuring that growth and progress are assured in the years to come need to be devised.

Figure 5 presents a simplified overview of how the environmental and labour market targets link together and interact. Economic activity, i.e. output, is the driver of both employment demand and energy use/emissions (although the magnitude of the effects differs by sector). There also exists a feedback loop from employment to the economy through household incomes and consumption.

These relationships are represented in the E3ME model and suggest that there will be a trade-off between the climate and employment targets. However, this need not necessarily be the case, provided policy is carefully targeted.

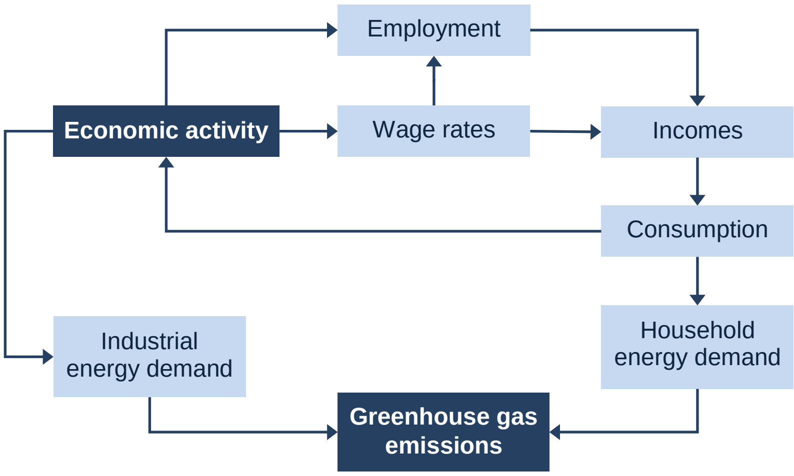
In terms of their relationship to sustainable energy outcomes, the policies that could be used to increase employment further fall into three categories:

(a) those that reinforce the shift to sustainable energy and better environmental outcomes;

(b) those that may lead to a worsening of environmental outcomes;

(c) those that are independent of energy and climate policy or environmental outcomes.

Figure 5. **Linkages between economic activity, energy demand and the labour market**



Source: Author.

The first group of policies relates to the development of jobs in sectors which serve to mitigate environmental damage, for example through reskilling workers to the development of renewable energy or other similar sectors. Previous studies have shown that, although growing, these sectors tend to be relatively small in employment terms. The sustainable energy policy assumptions included in each of the scenarios fall into this first group.

The second group of policies includes those which serve to protect employment (and so increase the relative number of jobs) in energy or energy-intensive sectors. These may seem counter-intuitive in the context of the 20-20-20 targets, but there are often social reasons for protecting such industries. For example, when a local community is dependent on a single plant or mine for much of its employment, there are grounds to support the jobs, even though they contribute to environmental damage.

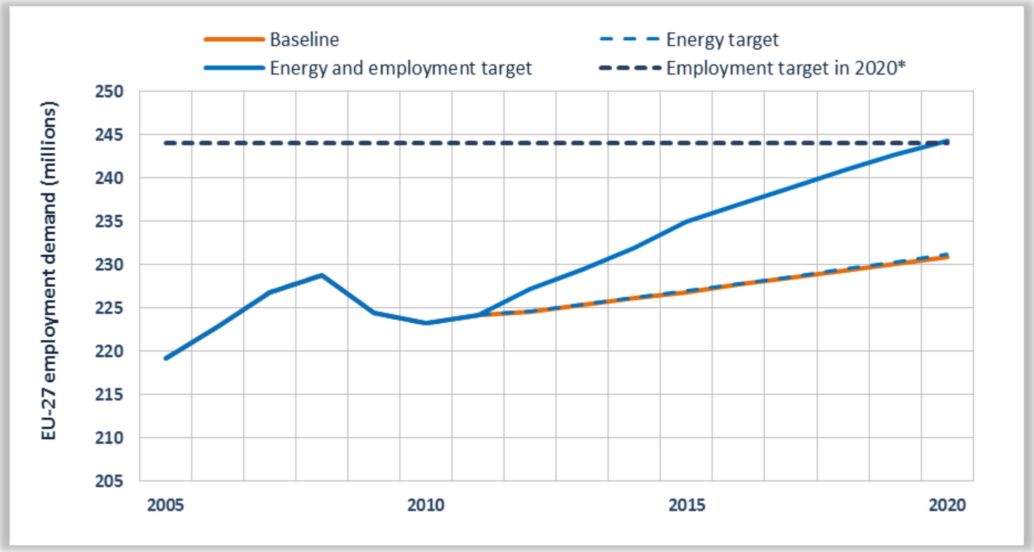
The final set is the broadest and includes almost the entire range of labour market policies that have been implemented in Europe to date. These policies include both the demand side and the supply side of the labour market. The labour market policy assumptions modelled in the 'energy and employment target' scenario fall into this final group.

3.4.3. A low-carbon, job-rich recovery: the results of the 'energy and employment target' scenario

Under the 'energy and employment target' scenario, specifically tailored to increase labour demand and supply in the Member States, and assuming a relatively faster recovery in 2012-15 than predicted by the baseline, the EU 2020 employment target is reached ([10]). The labour market adjustments and faster recovery here result in an estimated 13.5 million jobs (compared to baseline), raising the EU rate of employment to its target level of 75%.

In its impact on final energy demand and CO_2 emissions, the modelled 'energy and employment target' scenario is associated with further reductions in energy demand compared to both the baseline case and the 'energy target' scenario (Figure 7). It follows that policies to achieve higher rates of employment do not preclude achieving the energy and climate targets, even while operating within the imposed constraint of budget neutrality.

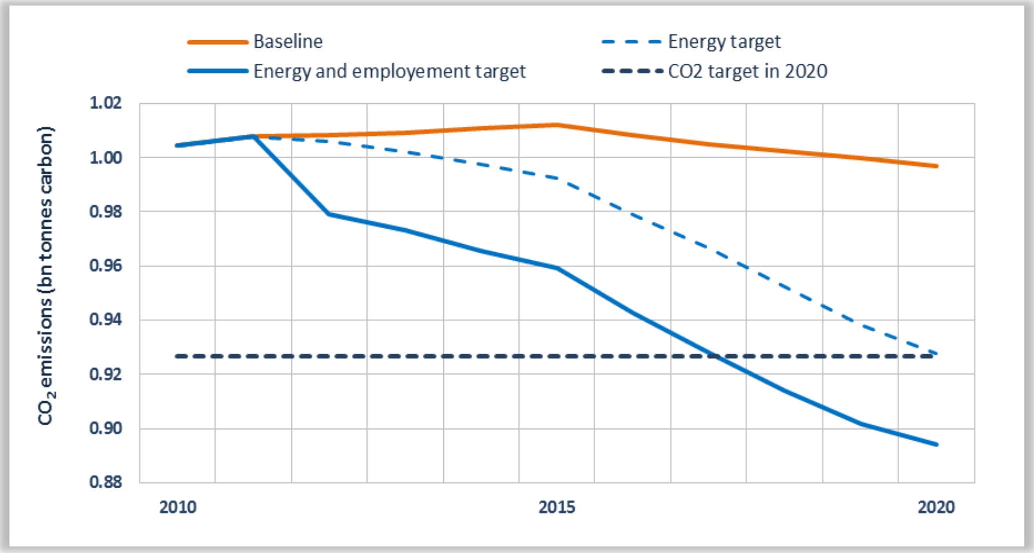
Figure 6. **Achieving EU employment targets requires significant actions by the Member States**



* Estimate based on aggregation of Member States targets.
Source: Cedefop (based on Cambridge Econometrics estimates).

([10]) A per annum increase in GDP growth above baseline levels of 0.5 percentage point from 2012 to 2015 is introduced into the model.

Figure 7. **Achieving the employment targets has the potential to reinforce transition to a low-carbon economy**



Source: Cedefop (based on Cambridge Econometrics estimates).

The encouraging conclusion is that the employment-led growth strategy modelled in the 'energy and employment target' scenario reinforces the shift to a low-carbon economy. In contrast, following the more conventional growth path illustrated in Figure 4 was not only unsustainable, but also less able to support employment growth on the scale required.

This is largely explained by an increased shift from capital- and energy-intensive industries to more labour-intensive industries (explored further in Section 3.5) as a result of the targeted reductions in non-wage labour costs. Another driver of this outcome is, however, the effects the scenario has on aggregate output, measured by gross domestic product (GDP). While the 'energy target' scenario stimulates a slight increase in annual GDP growth, the 'energy and employment target' scenario is associated with a relatively slower output growth path for the EU-27+ ([11]).

Further, the employment-led, low-carbon growth strategy modelled in the 'energy and employment target' scenario provides for greater incentives for employers to take on extra workers, particularly among the unemployed, young and inactive populations. While covering their costs, these workers add less output per head than those in the current workforce. So although the measures

([11]) This is a direct result of the modelling assumptions employed to maintain a balanced budget under the E scenario, whereby revenue is raised from households, with a relatively higher propensity to consume, to offset the lower tax revenues resulting from the modelled reductions in taxes on labour.

deliver higher output growth than the baseline, and enable EU employment targets to be met, they also reduces overall labour productivity (the other side of the coin of increasing labour intensity). Though trade-offs in achieving high levels of employment, and classical measures of economic production are therefore likely, Stiglitz et al. (2009) emphasise the need to consider also the quality of outputs, and whether this quality endures over time (i.e. if they are sustainable). In targeting a strategy of low-carbon, employment-led growth, the 'energy and employment target' scenario favours integrated consideration of social and environmental goals over conventional business models with a singular focus on economic growth.

3.4.4. A sustainable job-rich recovery for all: job creation in individual countries

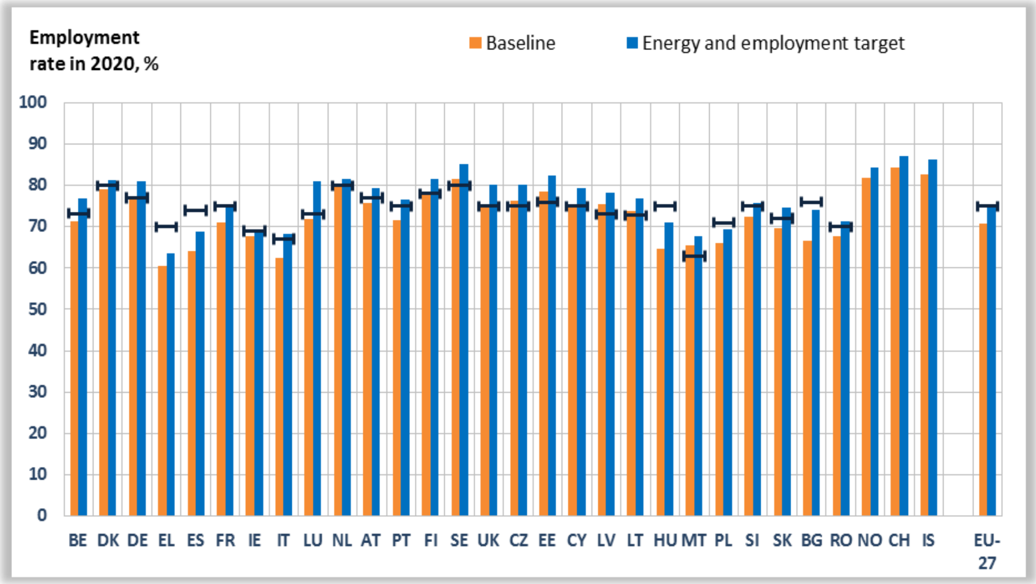
While most EU-27+ countries meet the employment targets specified in their national reform programmes, several are unable to meet their national targets in any of the modelled scenarios.

Table A5.4 shows the employment rate in each European country in 2020 in each scenario. The first point to note is that some countries already meet their employment targets in the baseline: the recession is a key factor in determining the remaining work to be done for countries to meet their 2020 employment targets.

In the 'energy target scenario', 11 countries meet their employment targets. This is the same number as in the baseline, with EU-27 employment in 2020 remaining unchanged at 71%. Therefore, while sustainable energy policies alone do not generally lead to net reductions (or increases) in employment, in many countries the policies leave a gap that must subsequently be covered if each Member State is to meet its employment target. In four Member States (Bulgaria, Greece, Spain and Hungary) this gap is greater than nine percentage points; in France, Italy, Poland and Portugal it exceeds three percentage points.

Once higher levels of employment overall are induced in the 'energy and employment target' scenario, 22 countries meet their national targets instead of 11 in the baseline and the 'energy target' scenarios. However, this suggests that five countries still do not meet their employment targets: Bulgaria, Greece, Spain, Hungary and Poland. Of these, Greece, Spain and Hungary remain adrift of their national 2020 employment rate targets by four percentage points or more (Figure 8).

Figure 8. **Projected employment rates in 2020 compared to national targets under the 'energy and employment target' scenario**



Source: Cedefop (based on Cambridge Econometrics estimates).

The observed employment outcomes are largely explained by projections in the overall level of economic activity (i.e. output), and changes in investment over the period. However, other relevant factors include:

(a) sectoral composition (Section 3.5),

(b) responses of wage demands to higher prices,

(c) substitution rates between energy and labour,

(d) other local labour market conditions, including the degree of flexibility.

Slack in the labour market, or the availability of spare capacity, is observable in the model through the rate of unemployment. While under the 'energy target scenario', there is little change from baseline with EU-27 unemployment rates at 8.4% (0.1 percentage point below baseline 2020 levels), the decline in unemployment across Europe observed in the 'energy and employment target' scenario indicates a far greater tightening of the labour market as spare capacity is absorbed.

However, from the results in Annex 5, even in this relatively optimistic 'energy and employment target' scenario, labour market slack persists in each of the three countries furthest from their national employment objectives. Unemployment rates in Greece and Spain in particular remain stubbornly high at 15.9% and 13% respectively. This suggests that, subject to the limitations of the modelling approach [12], the employment objective in these countries is particularly challenging given the existing economic constraints. Another country failing to meet its employment objective, Bulgaria, provides a case where unemployment rates in the 'energy and employment target' scenario have fallen by almost seven percentage point compared to baseline down to 3.8%, making it less likely that the missed employment targets here are driven purely by demand-side constraints.

Box 5. **Caveats: key conditions for job creation**

The preceding analysis of macroeconomic impacts assumes that employment demand is a sufficient condition for job creation and that the jobs created endure until at least 2020. The former is instead constrained by the ability to reallocate labour effectively and match workers with jobs, which can be impeded by insufficient awareness of employment trends and job opportunities (labour market intelligence), lack of transferable skills, and other sector- or occupation-specific rigidities in labour mobility, including for example, individuals' attachment to their current work.

For the targeted energy and employment outcomes to be achieved, the preceding scenario analysis can be considered to presuppose three key conditions:

- the skills of the existing workforce are effectively developed and/or realigned through relevant upskilling and reskilling programmes;
- (re)integration of the unemployed and economically inactive population into the workforce is supported;
- the transition of young people and those vulnerable to exclusion into the workforce is facilitated.

Given their role in skills formation and development, and in supporting individuals' transition to the labour market, the effectiveness of VET systems is likely to play a key role in achieving a high employment, sustainable energy future.

Greater coherence and coordination between education, training, employment and low-carbon policy will be needed to engender an effective job-rich, sustainable energy transition.

3.5. Sector restructuring and the implications for skill needs

3.5.1. The process of economic churn and the effects of climate and energy policies

While the total level of employment affected by the two sustainable energy scenarios is of particular interest for high-level macroeconomic discussions of the

(12) Perhaps one of the key limitations here is the absence of a mechanism for internal (cross-country) mobility and/or extra-EU migration.

economic and social impacts of transition to a low-carbon Europe, previous research and our analysis finds that net job creation, in the absence of further demand stimulus or labour market policy reforms, is relatively modest.

However, from a VET perspective, the distributional effects of the process of job reallocation (the sum of sectoral job creation and destruction) or 'churn' can be significant, since it typically entails the need for the affected individuals to be equipped (or re-equipped) with the skills and competences needed for a new position, another enterprise, or industry sector. Mitigation policies are likely to exacerbate this restructuring process through the resulting rise in the relative price of energy which translates into changes in relative prices between and within economic sectors.

The sectoral impacts of the modelled scenarios and their consequences for occupations and skills needs are particularly important. The overall pattern of structural shifts in our model mainly relates to the 'energy target scenario' in which employment increases slightly in the investment-related sectors, but decreases in some of the energy and energy-intensive sectors (Table 1).

In the 'energy and employment target' scenario, a set of additional policy assumptions is introduced to boost employment levels, resulting in increased rates of employment growth (or slower rates of decrease) in all sectors ([13]). The policy assumptions work primarily through reducing labour costs and the value of out-of-work benefits, while increasing the rates of R&D. Under the 'energy and employment target' scenario, there is likely to be a larger impact on more wage-sensitive (and low-skilled) occupations. The model results also suggest that many people who would otherwise be inactive or unemployed end up in employment.

([13]) Chateau et al. (2011) note that the observed level of job reallocation between sectors is sensitive to the industrial classification (NACE one- and two-digit levels) retained for the analysis. At a more detailed unit of analysis, it remains likely that there will be more significant effects.

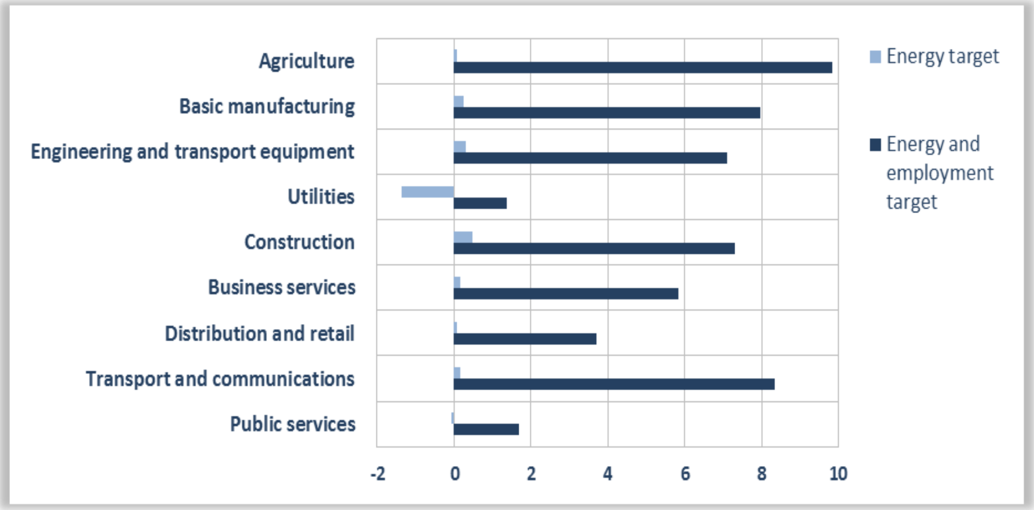
Table 1. **Employment by broad industry in EU-27+ (average annual growth rate, %)**

	Baseline scenario	Energy target scenario	Energy and employment target scenario
Agriculture	-0.93	-0.92	0.24
Extraction industries ([a])	-1.98	-1.98	-1.98
Basic manufacturing	-0.20	-0.17	0.76
Engineering and transport equipment	-0.04	0.00	0.82
Utilities	-0.51	-0.68	-0.34
Construction	0.36	0.42	1.25
Distribution and retail	0.68	0.69	1.14
Transport and communications	0.36	0.38	1.37
Business services	1.22	1.24	1.94
Public services	0.25	0.24	0.46
Total	**0.37**	**0.39**	**0.96**

([a]) It is assumed that the extraction sectors operate in global commodity markets and that their output levels are determined by supply constraints (i.e. they operate at maximum available capacity and sell surplus output to the rest of the world). Output and employment in these sectors therefore does not change in the scenarios.

Source: Cedefop (based on Cambridge Econometrics estimates). Detailed sectoral results at country level and a detailed breakdown across 42 sectors are provided in Annex 5.

Figure 9. **Employment by sector across scenarios, 2012-20 (% difference from baseline)**



Source: Cedefop (based on Cambridge Econometrics estimates).

A key feature is that many job reallocations are projected to take place outside 'green' or 'brown' sectors. Employment in downstream retail, transport, communications and business services expands more quickly than otherwise, since the relative price changes in turn induce changes in the composition of final demand and, hence, labour demand.

Investment in energy-efficient equipment and technologies creates jobs in construction, mechanical and electrical engineering, and their supply chains. Beyond 2020, the scale of the jobs that will endure is questionable unless the levels of initial investment continue, or further investments are made. There will be jobs in maintenance and replacement, but far fewer than those stimulated during periods of heavy investment. Within these investment-intensive sectors there may also be very specific subsectors that suffer adverse effects. These could include energy-intensive production methods that have specific skills requirements.

Employment in energy-intensive industries is sensitive to the net impact of offsetting effects. In the sustainable energy scenarios, these will be affected by either higher carbon prices, higher energy prices, or both. The higher energy costs may in turn be passed on in prices to consumers, lowering demand for their products or those of their downstream industries, so lowering employment demand. In some cases, where there is strong international competition in the supply chain, these losses could perhaps be considerable. However, in a period of heavy investment in renewable energy supply, these industries can be among the main suppliers of sustainable energy products.

3.5.2. Occupational structure and educational attainment

In the literature on skill needs, occupational structure and qualification level are increasingly used as measurable proxies for workforce skill needs. The key result from analysis at this level of detail is that there is little discernible difference in occupational structure between the baseline and the ‘energy target scenarios’ in 2020 but more change in relation to the energy and employment target scenario. For this reason the commentary focuses mainly on the differences between the baseline scenario and the ‘energy and employment target’ scenario.

Under the ‘energy and employment target’ scenario, there is projected to be relatively stronger employment growth (or weaker contraction) across all occupations (Table 2). When looking at absolute numbers, the overall direction of occupational change in the EU-27+ is towards an increase in jobs among higher level occupational groups (managers, professionals, and associate professionals) and in the number of people employed in service and sales, plant and machine operators and elementary occupations. At the same time there is projected to be either no growth or a fall in employment across most other occupations.

Table 2. **Employment by occupation across scenarios, 2012-20**

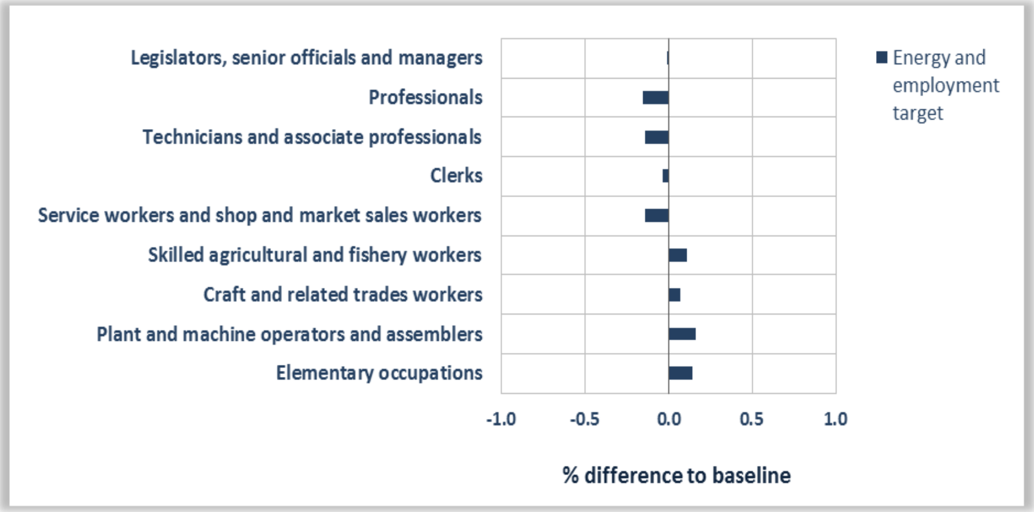
EU-27+	2012	2020	2020	2012-20, % change	
000s	Baseline scenario		Energy and employment target scenario	Base	Energy and employment target scenario
Legislators, senior officials and managers	19 701	21 040	22 240	7	12
Professionals	34 901	37 110	38 843	6	9
Technicians and associate professionals	39 803	43 708	45 854	10	14
Clerks	23 955	22 573	23 771	-6	-2
Service workers and market sales workers	32 710	33 489	35 047	2	6
Skilled agricultural and fishery workers	9 450	8 778	9 555	-7	0
Craft and related trades workers	28 623	27 484	29 242	-4	2
Plant and machine operators and assemblers	17 859	17 863	19 305	0	7
Elementary occupations	23 792	25 857	27 703	9	15
Total	**231 960**	**238 901**	**252 603**	**3**	**8**

Source: Cedefop (based on Cambridge Econometrics estimates).

Another way of looking at occupational change is to compare the share of employment in each occupation under the different scenarios. Figure 10 shows the extent to which the ‘energy and employment target’ scenario accounts for a higher or lower share of employment compared to the baseline scenario ([14]). The key point to emerge is that under the ‘energy and employment target’ scenario the share of employment in higher level occupations (managers, professionals, and associate professionals) will be slightly lower: employment in higher level occupations is increasing, but the overall level of change favours less skilled occupations.

([14]) In other words, the percentage under the energy and employment target scenarios for 2020 has been subtracted from the percentage of employment under baseline scenario.

Figure 10. **Share of people employed in each occupational group in the energy and employment target scenario in 2020 (% difference from baseline)**



Source: Cedefop (based on Cambridge Econometrics estimates).

While under the 'energy target scenario' there is very little difference in occupational structure, under the 'energy and employment target' scenario proportionately more employment – though the relative change is extremely small – will be concentrated in crafts, operators and assemblers, and elementary occupations. Also, under the 'energy and employment target' scenario there will be much more employment growth to 2020, so even the slightest shift in the occupational structure of employment can bring about a relatively large increase in employment in some occupations (especially when replacement demands are considered).

The slight skew towards craft and related trades, machine operatives, and elementary occupations, relative to the baseline, observed in the 'energy and employment target' scenario, reflects the shift from capital- and energy-intensive industries to more labour-intensive sectors. The measures to achieve the employment target and energy targets provide an incentive for employers to take on extra workers, at the expense of reducing overall productivity. Demand for these new entrants to the workforce are concentrated in the jobs which are most sensitive to being substituted by technology across a range of industries, including craft and related trades, operators and assemblers, and elementary occupations, i.e. jobs which are typically associated with low and medium levels of qualification.

In terms of the educational attainment of the workforce (Table 3), the baseline trend envisages a further 16 million workers in the EU-27+ with high-level qualifications and 10 million fewer workers at low levels of qualification.

Table 3. **Employment by level of qualification across scenarios, 2012-20**

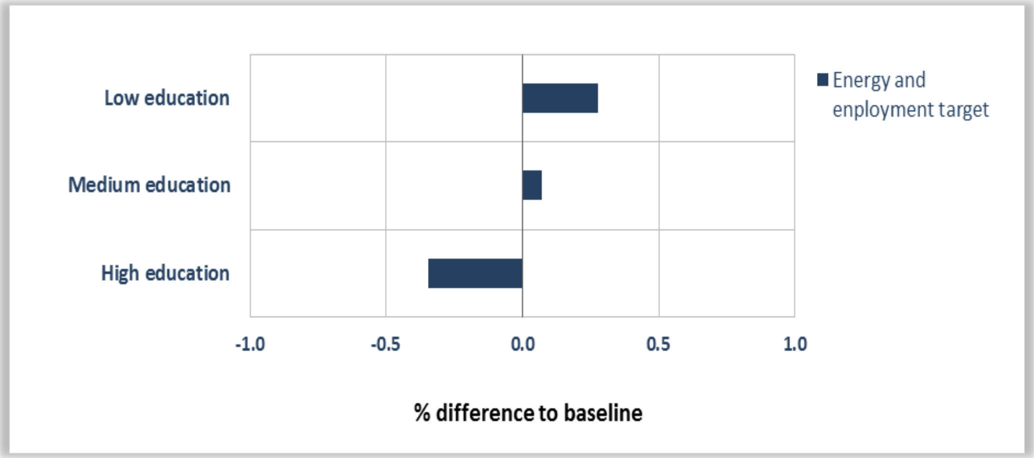
000s	2012	2020 Baseline scenario	2020 Energy and employment target scenario	2012-20 % change Baseline scenario	2012-20 % change Energy and employment target scenario
Low education ([a])	47 395	36 555	40 000	-23	-18
Medium education ([b])	109 395	111 166	117 717	2	6
High education ([c])	75 169	91 180	95 530	21	26
Total	**231 960**	**238 901**	**252 603**	**3**	**8**

([a]) Primary and lower secondary (ISCED 0-2).
([b]) Upper and post-secondary (ISCED 3-4).
([c]) Tertiary (ISCED 5-6).
Source: Cedefop (based on Cambridge Econometrics estimates).

Figure 11 shows that a slightly lower share of people will be employed in the high qualification group under the 'energy and employment target' scenario compared to baseline. The scale of the change being considered is very small against the overall direction of occupational change – and qualification change – in the labour market.

The principal trend, under all the scenarios to 2020, is towards more employment being concentrated in higher level occupations (i.e. those associated with higher qualifications). In comparing the scenarios to the baseline case, the key message from the analysis is that, at this level of aggregation, any shifts in occupational and qualifications structure are modest in their net effects.

Figure 11. **Share of people employed in each qualification group in energy and employment target scenario in 2020 (% difference from baseline)**



Source: Cedefop (based on Cambridge Econometrics estimates).

It remains possible that, at micro level, there will be more significant effects, both in terms of positive demand for certain types of skill associated with low-carbon technologies and more general impacts on jobs in sectors that are hardest hit by the impact of sustainable energy policies; such effects barely register at the observable unit of analysis (NACE two-digit level) where other factors tend to dominate.

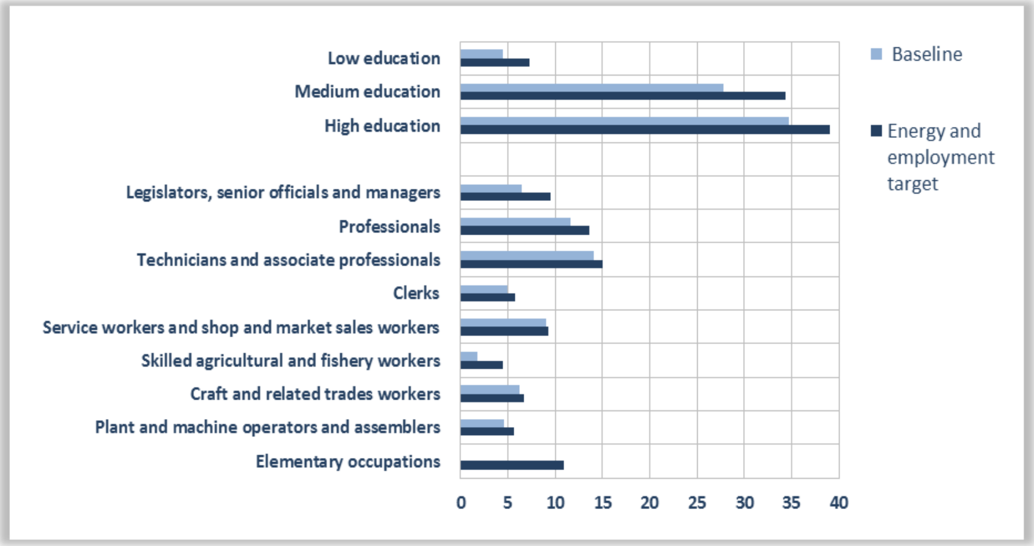
The occupational projections presented above are for expansion demand (i.e. the growth – or decline – in overall levels of employment) and do not consider the level of replacement demand ([15]).

The level of replacement demand for each occupation and qualification level respectively is the same under both the baseline and 'energy and employment target' scenarios ([16]). If the level of replacement demand for an occupation – or qualification level – is added to its expansion demand, this provides the total net requirement. This is the total number of job openings which will need to be filled over a given period.

([15]) Replacement demand refers to the number of job openings arising because of the need to replace those who leave employment for retirement or similar reasons (including those leaving work temporarily to start a family). It excludes more general labour turnover. Estimates of replacement needs are calculated using the cohort component methodology (Kriechel, 2012).

([16]) This is because replacement demands are calculated as a percentage of base year employment level which is the same in both scenarios. In practice replacement demands might be expected to rise a little in those areas where employment is rising, but the methodology used does not allow for this possibility.

Figure 12. **Job openings by occupation and qualification under the baseline scenario and the energy and employment target scenario, 2012-20**



Source: Cedefop (based on Cambridge Econometrics estimates).

Figure 12 shows the total net requirement for each occupation and qualification group in 2012-20. Under the baseline scenario there will be around 67 million job openings which will need to be filled over that period. The total net requirement is positive for all occupations even though the level of expansion demand is negative for some occupations: the overall total number of people employed in an occupation might decline but, due to replacement needs, for example the number of people retiring from that occupation, there will be a positive demand for people to work in that occupation.

Under the 'energy and employment target' scenario there will be more job openings in all occupations and a higher level of demand for people in each qualification group, with the net difference reflecting the expansion demand stimulated under this scenario. Under the baseline scenario, the ratio between the level of replacement demand and expansion demand across all occupations is nine to one; under the 'energy and employment target' scenario it is around three to one, reflecting increased employment growth in 2012-20.

3.6. Summary

The transition towards a low-carbon economy is best understood as an important driver of structural labour market change. Econometric modelling and scenario analysis provides important insights about restructuring, suggesting, for example, that greening of the economy leads only to modest changes in the overall level of employment. The analysis of the ‘energy target scenario’ indicates that:

(a) workers in the energy supply and investment-intensive sectors, such as construction, will be most strongly and directly affected;
(b) indirect effects operating through changes in relative product prices mean that the impact of low-carbon policies is spread throughout the value chain;
(c) the economic process of labour reallocation (churn) that naturally occurs as businesses expand and contract will continue to play a central role in the generation and distribution of employment change.

It follows that policy responses cannot be limited to managing the impact on ‘green’ or ‘brown’ jobs since the impact of low-carbon transition contributes to a drive towards broader structural change affecting the entire economy. However, economic models are not yet able to predict how the overall labour market will be reshaped with sufficient precision to provide detailed guidance for labour market and VET policies.

The principal findings of the ‘energy and employment target’ scenario are that:

(a) delays or a slow pace of policy introduction to promote employment growth, reduces the potential for attaining 2020 employment targets (due to dampened multiplier effects);
(b) those countries which are some distance from national employment targets are unable to reach these within the existing economic constraints;
(c) policy actions are likely to be required in all Member States to meet overall EU targets;
(d) a reduction in emissions does not necessarily mean a reduction in employment: it remains possible for EU energy and employment targets to be met simultaneously.

CHAPTER 4.
Domain analysis of sustainable energy sectors

This section seeks to fill gaps in the modelling analysis, and provide deeper insights into the skills and training needs arising as a consequence of the transition to a low-carbon economy. To this end, the study assesses future changes in labour demand and skills requirements in four domains of strategic importance for a low-carbon transition: wind power, solar thermal heating, public buildings and road freight transport and logistics.

4.1. Introduction

While the quantitative modelling in Chapter 3 is able to project the number of jobs that will be created (or lost) in meeting EU 2020 energy and climate targets, understanding of the nature of these jobs and workforce skill needs is limited by the use of standard sectoral and occupational classifications. To bridge the gap in understanding, future changes in labour demand and skills requirements in four domains of particular relevance to the low-carbon transition are considered.

This domain analysis also adds focus and context to the case study analysis of VET responses presented in Chapter 5. The selected domains are:

(a) wind power,
(b) solar thermal heating and cooling,
(c) low-carbon public buildings,
(d) low-carbon road freight and logistics.

The domains were selected for their strategic importance for transition to a low-carbon Europe, based on their role in terms of public policy developments, and their expected contributions to reducing energy consumption and carbon emissions in line with the 2020 policy cycle ([17]). The four domains also represent the diversity of technologies and industries associated with EU energy and climate targets.

([17]) For details on the EU energy and climate policy context see Chapter 2.

4.2. Domain analysis

Due to the mismatch between official statistical classifications of sectors retained for the scenario analysis in Chapter 3, employment projections for the specified domains are calculated to identify the Member States most likely to require a VET response in line with anticipated future skill needs. To draw out particular challenges associated with the development of renewable energy and energy savings in these domains, it is first necessary to reflect on the main sector specificities, likely to shape the vocational training responses.

4.2.1. Wind power

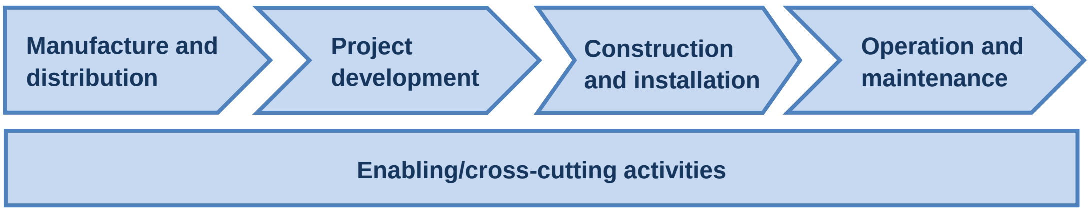
Renewable energy sectors can be classified according to the principal economic activity and the use of technology (Cambridge Econometrics et al., 2011). It is also possible to make a distinction between types of renewable technology, though such distinctions are missing from existing industrial classifications and so the scenario analysis alone is unable to provide a projection of the likely employment effects and skill needs associated with a particular renewable technology. For wind power, a distinction can be made between:

(a) large onshore wind (e.g. turbines over 100kW),
(b) small scale onshore wind,
(c) offshore wind.

To date, most capacity is deployed onshore, typically on hills or by the coast. European countries are also increasingly generating wind at sea, with 10 Member States having wind farms offshore, where it is relatively more difficult and costly to install and maintain them.

A common attribute across all renewable energy sectors is that employment opportunities are not only located in the upstream energy-producing sector, but instead span the value chain from manufacture, construction and installation (CAPEX) activities through to operations, maintenance and fuel processing (OPEX). These phases of the renewable energy value chain are illustrated in Figure 13.

Figure 13. **Wind energy value chain**



Source: Adapted from ILO (2011).

Employment associated with any individual renewable project tends to be front-loaded, with many workers needed in the manufacture, project development and installation phases; this is particularly so in large-scale electricity generation projects. Employment in construction and installation, operation and maintenance and support activities is location-based, where capacity is installed. Given the project-based nature, work associated with these phases is also liable to fluctuate depending on the flow of local projects or the degree of geographical mobility. Levels of employment, therefore, tend to proceed in jumps as new installations are commissioned, though employment will otherwise tend to be relatively stable.

A further complication of estimating employment projections of renewable energy over time with certainty is the globalised nature of the supply chains. Unlike fossil fuel extraction, energy from nature's elements can be harnessed almost anywhere; EU manufacturers with an initial market lead may find this leadership subsequently eroded as global competition in renewable energy supply chains intensifies.

Manufacture and distribution of wind technology is concentrated in a few countries, including Denmark, Germany and Spain, who face increasing competition from China, India and other European countries. Denmark, Germany and Spain are also leading European countries in terms of installed capacity, associated with jobs in all other phases in the value chain (EurObserv'ER, 2011).

France, Italy, Portugal and the UK have installed considerable capacity in recent years to attain similar levels to those in Denmark. With the exception of Portugal, this trend for increased wind energy capacity in this second tier of wind energy producers is predicted to continue. Considerable development from a reasonable base is also anticipated in Greece and the Netherlands and, to a lesser extent, Ireland and Sweden.

Employment in the wind power supply chain is directly related to the development of additional energy generation capacity derived from associated technologies; it follows the pattern of market leadership. Most (84%) wind-sector employment is projected to be derived from manufacturing, construction and installation activities (CAPEX) across all Member States and market growth is foreseen in them all ([18]). From 2012 to 2020, based on projected capacity increases, wind-related employed in the UK is projected to increase by approximately 59 000, at a growth rate of 38% per annum.

([18]) There are no capacity projections for wind power or solar thermal available for the three non-EU Member States which are also included in the analysis: Iceland, Norway and Switzerland.

Table 4. **Key trends in projected employment in wind power sectors, 2012-20**

High employment growth ([a])	2012-20 (000s)	High employment share ([b])	2020 (%)
UK	59	Denmark	0.32
Netherlands	13	Czech Republic	0.32
France	12	Ireland	0.30
Germany	11	UK	0.28
Italy	11	Spain	0.27
EU-27	145	EU-27	0.16

([a]) The five countries with the highest projected levels of employment growth in wind energy supply chains are presented.

([b]) The five countries with the highest projected employment in wind energy supply chains as a share of total employment are presented.

Source: Cedefop (based on Cambridge Econometrics estimates).

The impact of increased capacity on employment within these Member states will be limited by the degree to which components and turbines are manufactured domestically or imported from elsewhere. Overall, installed wind capacity in the EU-27 is forecast to grow by an annual average of 11.6% up to 2020, rising from 80GW of electricity to approximately 230GW. Such increases in capacity may contribute to sustaining or boosting employment across Europe, and manufacturing jobs in Denmark, Germany and Spain in particular, given their established market leadership and capacity to export.

To support this expansion, measures will be needed to attract net entrants to wind industry careers. Accredited learning pathways will need to be developed, with initial training and reskilling programmes to support the development of the practical and technical skills needed (Cambridge Econometrics et al., 2011).

4.2.2. Solar thermal heating and cooling

Solar thermal technologies primarily generate energy for domestic hot water and space heating, though some installations provide heating in industrial processes (in contrast to the more prevalent photovoltaic solar power that primarily generates electricity). Solar thermal heating consists of two types of technology:

(a) forced (pumped) circulation systems, typical of central and northern Europe;

(b) natural (thermo-siphon) circulation systems, which are more widespread in Southern Europe and provide only hot water.

These systems are typically small-scale, though a few, large-scale, forced circulation systems deliver energy to district heating networks in Germany, Austria and Sweden.

Since roughly nine tenths of the solar thermal market volume in the EU is in the small residential sector, the dynamics and balance of employment associated with each phase in the value chain differs significantly from that of wind power generation. This places greater emphasis on the distribution and installation phases of the value chain and estimates that nearly half of solar thermal jobs are found in retail, installation and maintenance.

The project development phase is less significant, comprising little more than a consultation between the installer and a householder or, in cases where the installation forms part of a wider construction or retrofitting project, with additional oversight from an architect or other construction professional. Such projects can often involve a wide range of stakeholders including architects, specifiers, housing associations, local authorities, planning permission officers, building control officers, builders merchants, the construction industry, building surveyors, home advisors and other interested parties.

Another consideration is that many professionals in this subsector (architects, engineers, plumbers, roofers, electricians, etc.) tend not to work exclusively in this field and those responsible for installing the technology also carry out maintenance, typically only when a problem occurs. Such professionals will play a decisive role in the sector's growth, having a strong influence on the consumer awareness and choice of heating and cooling systems. Alongside the provision of financial incentives to reduce upfront installation costs, raising public awareness and accrediting sufficient numbers of installers, while maintaining quality in the training provided, are seen as two further practical restrictions on achieving significant growth in the sector (UK heating and hot water taskforce, 2010).

Markets for solar heating and cooling have developed disparately across the EU and its regions. The traditional European frontrunners in development and deployment are Germany, Greece and Austria; even within these countries there still exists great potential for expansion, since less than one in eight residential buildings have the technology installed. Spain, France, Italy, and, more recently, Poland, have also increasingly developed markets for solar thermal technologies, which are expected to continue to expand in the next 10 years.

For solar thermal, employment in OPEX activities is estimated to be double that of CAPEX activities; it is greatest in the most advanced markets of Germany, Greece and Austria. From 2012 to 2020, the rapid expansion of capacity growth foreseen in Spain, France and Italy is associated with annual employment growth of 26, 48 and 91% respectively.

From a relatively low starting point, annual employment growth of 147% sees Poland become the third largest EU employer of solar thermal workers by 2020. Other potential markets in northern Europe see little, if any, expansion with the exceptions of Belgium and Luxembourg.

Table 5. **Key trends in projected employment in solar thermal sectors, 2012-20**

High employment growth ([a])	2012-20 (000s)	High employment share ([b])	2020 (%)
Italy	17	Cyprus	0.16
Germany	13	Austria	0.14
Poland	8	Greece	0.09
France	7	Italy	0.09
Spain	3	Germany	0.06
EU-27	58	EU-27	0.04

([a]) The five countries with the highest projected levels of employment growth in solar thermal supply chains are presented.

([b]) The five countries with the highest projected employment in solar thermal supply chains as a share of total employment are presented.

Source: Cedefop (based on Cambridge Econometrics estimates).

As more solar thermal capacity is installed, professionals, technicians and retail staff will increasingly specialise in this renewable energy subsector, which is closely associated with the construction industry. It is increasingly likely that all those involved will need to improve skills and competences, to develop and maintain awareness of the regulatory environment, use management and teamwork skills to engage with other trades, and communication and marketing skills to engage with customers and sell their services.

4.2.3. Low-carbon public buildings

The EU buildings sector, comprising residential and commercial property, represents around 40% of final energy use in the EU. Overall, public buildings represent 12% of the total building stock, including 20% of all residential buildings (e.g. social housing), though there are trends towards non-public involvement in Ireland, the Netherlands, Austria and the UK. Non-residential buildings such as hospitals, schools, sports facilities, heritage buildings and offices in public administration vary in terms of size and the intensity of energy needs; end-uses such as lighting, ventilation, heating, cooling, refrigeration, IT equipment and appliances differ from one building category to another. Public ownership of these buildings also differs widely across the EU.

Construction and retrofit techniques on non-residential buildings are largely similar to those in residential buildings and unaffected by ownership. The structure of ownership and occupancy can, however, have a significant relevance on the ability to renovate. Public buildings are in the limelight at the moment partly due to EU policies requiring the public sector to lead by example: all new constructions in the sector are required to be of ‘nearly zero-energy’ standards by end of 2018 (European Parliament and Council of the EU, 2010), while a sectoral renovation rate of at least 3% is recommended (European Commission, 2011c).

The value chain for energy-efficient buildings covers:

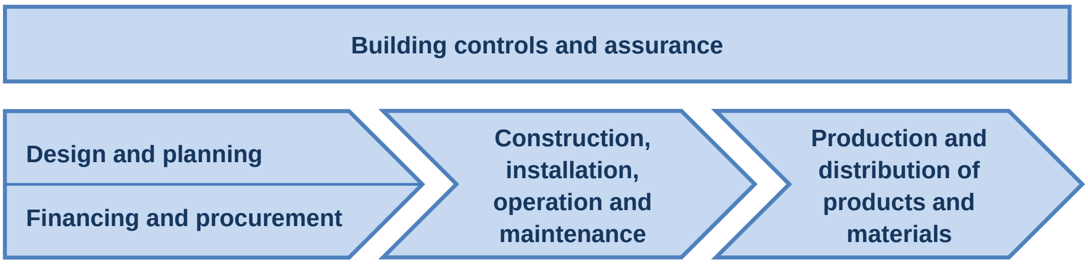
(a) manufacturing and distribution,

(b) design, planning and procurement,

(c) construction, installation and maintenance,

(d) control and assurance.

Figure 14. **Buildings and renovation value chain**



Source: ICF GHK adapted from ILO (2011).

In addition to typical construction workers in the contractor market, energy-efficient building or renovation requires specialist tradesmen such as energy auditors, assessors, and advisers, insulation workers and energy management system installers. Construction workers of all types will also need improved skills and knowledge of new materials, technologies or requirements.

Governments, as consumers with large demand for energy-efficient buildings and appliances, also require internal expertise in procurement and energy management to specify energy efficiency requirements, and evaluate bids against these. The ILO (2011) highlights that civil servants and local authority officers also need to be able to carry out economic and environmental evaluations of building projects and purchases.

The role of publicly-owned and managed buildings is emphasised in the proposed energy efficiency directive (European Commission, 2011e), and progress here is seen as potentially a strong driver for higher market uptake of energy efficiency in other sectors.

Market development related to energy-efficient buildings, and associated employment, can be expected to be higher in countries where the most energy savings have already been delivered, since past standards are built into existing stocks. In their analysis of building energy performance in Europe, the Buildings Performance Institute Europe (2011) cluster the EU-27+ into three broad groups based on climatic, building typology factors and market similarities:

(a) northern and western Europe, where building insulation and energy saving standards have largely been in place since around the 1970s;

(b) southern Europe, where demands for heating are lower, building codes were introduced later and were less stringent;
(c) central and eastern Europe, where cheap access to Russian gas and oil previously insulated them from introducing energy saving standards until the 1990s.

Using the high energy savings potential of the buildings stock estimated by the European Commission and Fraunhofer et al. (2009), realisable based on existing policies and technologies, it is projected that average annual employment growth in Europe in the buildings sector is of the order of 20.8% (or 64 000 additional full-time equivalent jobs) by 2020. Wei et al. (2010), however, estimate that only 10% relates to direct job creation, with the other 90% growth arising from the higher levels of investment and expenditure in the economy that retrofit brings.

Table 6. **Key trends in projected employment related to realising potential energy savings in buildings**

High employment growth ([a])	2012-20 (000s)	High employment share ([b])	2020 (%)
Germany	13	Luxembourg	0.08
France	10	Denmark	0.08
UK	9	Norway	0.07
Italy	7	Greece	0.07
Spain	6	Ireland	0.06
EU-27+	69	EU-27+	0.05

([a]) The five countries with the highest projected levels of employment growth in low-carbon building supply chains are presented.
([b]) The five countries with the highest projected employment in solar thermal supply chains as a share of total employment are presented.
Source: Cedefop (based on Cambridge Econometrics estimates).

Employment opportunities are generated through the production of materials and products that help make buildings more energy-efficient, while energy services working to identify and monitor energy savings are also important. Making buildings more energy-efficient, however, leads to the loss of jobs elsewhere, since the demand for heating and electricity consequently decline, underlining the need for retraining. Labour flows across firms within each sector are also likely to increase as the labour market responds to changing patterns of comparative advantage and market structure.

Those employed in more traditionally oriented construction work are also likely to undergo significant changes in their skill needs as they are required to learn new techniques, adapt to new materials and occupational tasks. Experience also suggests that education and training to upgrade skills are a precondition for a successful shift to low-carbon buildings (ILO and UNEP, 2012). Particularly needed are core construction trade skills and techniques which focus on energy efficiency and increase awareness of the roles of different trades in whole building efficiency and the knock-on effects of their own work on other trades (Ecotec, 2010). Further, since the skills and knowledge required to construct or retrofit energy-efficient buildings is largely the same, public sector energy efficiency drives could serve as a platform for a broader shift across the buildings sector.

4.2.4. Low-carbon road freight transport and logistics

In a recent report, the World Economic Forum (2009) identified the nine following focus areas in the supply chain for potential energy savings, which can in turn be extrapolated across all industries:

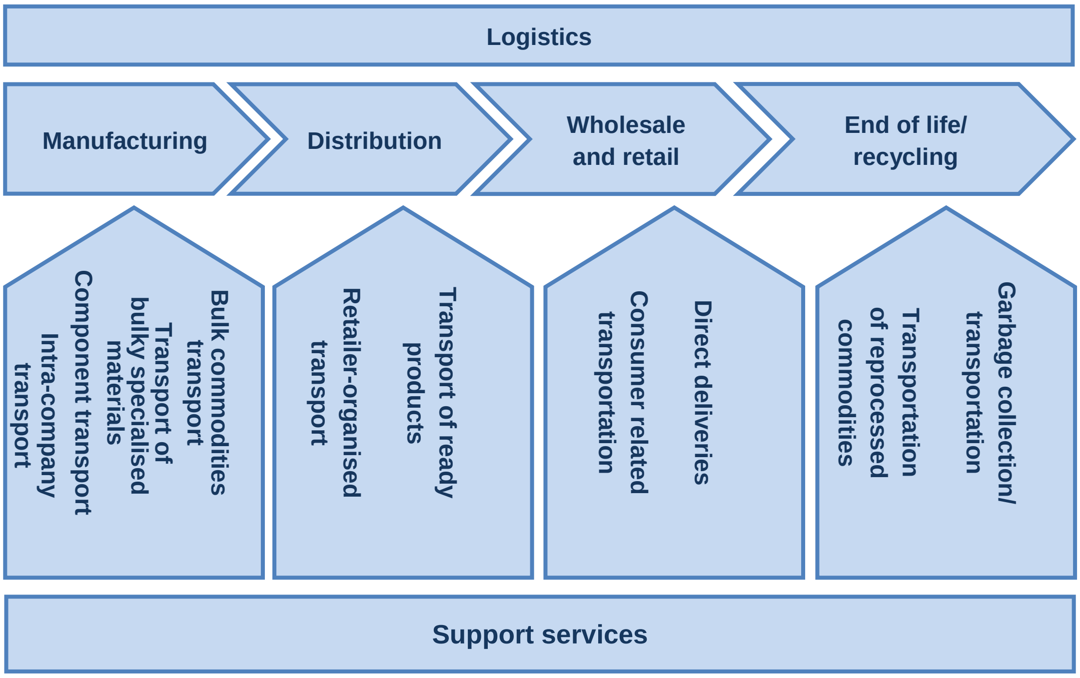
(a) cleaner sourcing/manufacturing,
(b) lower emissions in transit,
(c) cleaner warehouse operations,
(d) reduce transit distances,
(e) remove nodes/legs,
(f) reduce total volume and/or mass shipped,
(g) consolidate movements,
(h) contribute to reductions elsewhere,
(i) increase recycling/reuse.

The above findings highlight the important role to be played by freight transport and associated operations and logistics in achieving energy saving objectives. Figure 16 shows that almost all stages of traditional supply chains depend on freight transport.

The logistics and freight transport sector, considered in isolation, has a carbon footprint of around 2 800 mega-tonnes: road freight contributes the largest share, at around 57% of the total figure (World Economic Forum, 2009). Road freight is also one of the sectors with the greatest potential to benefit from cleaner energy technologies and alternative fuels. As well as being subject to energy efficiency drives, modal shifts from road to rail are also to be expected.

Due to road transport's substantial contribution to total CO_2 emissions and the reliance on imported fuels, it seems inevitable that road haulage will see some changes within the next decade. It is likely that there will be a long-term shift to the use of biofuels (and also possibly electric vehicles), though this would not be expected to affect employment within the sector.

Figure 15. **Road freight transport value chain**



Source: ICF GHK.

From 1995 to 2006, road freight transport increased more quickly than GDP (with tonnes-km increasing faster than tonnes, suggesting the average distances also increased over this time). This sustained increase in road haulage has occurred due to changes in the structure and location of manufacturing, plus increased demand for just-in-time shipments (European Commission, 2009a). However, road haulage was more heavily impacted in the recent recession than the economy as a whole due to its dependency on trade.

In terms of the annual volume of freight transport, employment in related sectors and the number of road freight enterprises, Germany, Spain, France, Italy, Poland and the UK represent about 70% of total activity. In normalising the rates of freight-related employment across each country, however, the Baltic (Estonia, Latvia, Lithuania) and Danube (Czech Republic, Hungary and Slovakia) regions stand out, having over 6% of the working population in companies whose principal economic activity is in freight.

Projections for employment in road freight are mixed with relatively modest swings in employment from 2012 to 2020, ranging from -2% to 6% across Member States. The size of employment in these sectors relating to realisable energy savings potential is broadly reflective of the size of the total labour force, though the relatively high figures in western and central Europe labour force in this domain is indicative of their role as logistics hubs. As a share of total employment, however, employment in low-carbon road freight is very small, and is liable to be affected by other factors.

Table 7. **Key trends in projected employment related to realising potential energy savings in road freight transport**

High employment growth ([a])	2012-20 (000s)	High employment share ([b])	2020 (%)
France	6	Spain	0.11
Germany	1	Luxembourg	0.10
Poland	1	France	0.10
Spain	1	Estonia	0.08
Czech Republic	1	Belgium	0.07
EU-27+	11	EU-27+	0.06

([a]) The five countries with the highest projected levels of employment growth in low-carbon building supply chains are presented.

([b]) The five countries with the highest projected employment in solar thermal supply chains as a share of total employment are presented.

Source: Cedefop (based on Cambridge Econometrics estimates).

Since the demand for freight transport and logistics services is complementary to many other economic activities, employment in the sectors is likely to drive trends in job creation and job destruction (Chateau et al., 2011). Occupational impacts of efforts to improve energy efficiency, along with modal shifts away from road to rail, are reported to be most pronounced on the operations side, requiring retraining, skills upgrading and career moves (ILO and UNEP, 2012). Higher transport fuel costs, are also likely to provide an increasing economic incentive for the road freight to industry to adjust their operations, logistics and fleet management as well as consider investments in low-carbon vehicles and development of eco-driving skills to reduce fuel consumption.

4.3. Summary

Along with the projections directly from the E3ME model, these domain estimates serve to frame the VET responses in line with anticipated future skill needs. They provide useful labour market information and intelligence to place VET responses into the wider economic context.

The key findings from the domain analysis are that:

(a) the impacts on employment and skills needs are likely to be concentrated in particular countries, as well as on particular stages in the value chain;

(b) much uncertainty still remains over the impact that a policy-driven transition to green growth could have on labour market outcomes. This is partly due to the complexity of the general equilibrium and competitive effects that will reshape supply chains worldwide, particularly in the case of manufacturing sectors;

(c) downstream service sectors are likely to be affected by the level of awareness, the level or predictability of public support, and end-user/consumer demand for renewable energy or energy-efficient improvements, as well as the availability of skills to adopt new materials or technologies, implement the policy measures, or communicate the lifetime cost savings of energy improvements;

(d) despite uncertainties, which may constrain investment in the various domains, employment projections suggest relatively strong growth in low-carbon sectors, which may potentially be constrained by skills shortages. Uncertainties in the policy and market environment may represent a significant challenge for VET responses.

Identified challenges that may impede effective VET response to a low-carbon economy are presented in the next section, before analysing 16 case study VET programme responses to these challenges in the domains of interest.

CHAPTER 5.
VET policy responses to the low-carbon transition

This chapter provides an overview of VET responses basis on 16 case studies related to the four domains of interest, selected according to the following eight criteria: information available; relevance to the green economy; degree of policy integration; effectiveness; sustainability; innovation; replicability; and transferability.

In line with the findings of the previous analysis, the cases highlight that the low-carbon transition can be seen as a form of enhanced structural change.

Case studies are able to provide examples where consistent or unified responses across sectors or territories to the low-carbon agenda have emerged. Identified skill set needs, with many occupations adapting to new technologies, regulatory requirements and conserving energy, has led to various responses nationally, regionally and locally, addressing governance and design and their content and delivery.

The case studies are particularly diverse, representing a range of different aims, and levels of governance and policy maturity. They also exhibit marked differences in scale, in terms of their finance and the quantitative response to training needs. Caution is advised in extrapolating more general findings or comments applicable to the VET systems as a whole.

5.1. Introduction

The purpose of the case study analysis is to gauge to what extent vocational training activities can be encouraged, other things being equal, to stimulate, support and respond to the demands of sustainable energy transition, and contribute to employment growth. This needs to take advantage of the variation across the EU with respect to differing models of VET and the development of a low-carbon economy.

For energy and employment targets to be realised, the scenario analysis presupposed two key conditions:

(a) the skills of the existing workforce are effectively developed and/or realigned through upskilling and reskilling programmes;

(b) the transition into the workforce of the unemployed, the young and those vulnerable to exclusion is supported by VET programmes.

The qualitative analysis examines the nature of the modelling constraints, while the sector analysis and employment estimates for the four domains of interest will serve to frame the VET policy context.

5.2. Employment trends and the implications for education and training

Since partial domain analysis and general equilibrium models are not able to predict how the overall labour market will be reshaped with sufficient precision, case studies of specific practices are needed to provide more detailed and nuanced guidance for labour market and VET policies. In particular, we aim to develop a better understanding of the role of VET at national, regional and local levels in responding to the key challenges presented by the transition to a low-carbon economy through case studies.

The case study analysis identifies policies that have as their underlying rationale and intended effects support for the development of the domain, and specifically anticipation of the need for, and provision of, VET.

5.2.1. Identification and mapping of case studies

The case studies identified, covering eight Member States (Denmark, Germany, Ireland, Spain, France, Italy, Austria and the UK) ([19]), across the four domains reflect VET responses at different stages of sustainable energy development, with either relatively high levels of employment or high rates of projected employment growth up to 2020.

These case studies were drawn from an initial pool of over 30 VET policy programmes and initiatives across the four domains in Europe. Following a preliminary review, however, several of these policy responses subsequently had failed to materialise or were developed only on a small, tentative scale: the financial crisis and a consequent lack of funding, as well as delays and reversals in low-carbon policy implementation, were main causes.

Table 7 provides an overview of the level and scale of the VET policy programmes that were reviewed, and maps these against national employment projections. While the projections are only provided at national level, the case

([19]) Recognising that the institutional context is likely to shape the observed responses to the types of evolving and emerging labour market needs identified in Chapters 3 and 4, the case study selection was also shaped by reference to the socio-historical context of national VET systems to ensure coverage of a range of regions and countries.

studies for the VET response programmes assessed include initiatives at various levels, with a predominance of national programmes (9), followed by local initiatives (4) and regional programmes (2).

Table 8. **Domain trends and the implications for VET response by case study**

Domain	Member States	Estimated workforce size, 2012*	E3ME projected workforce growth, 2012-20 (%)*	Country forecasts from case studies (timescale)	Level (**)	Training interventions
Wind power	DK	6 535	4	N/A	National	N/A
	DE	52 351	3	N/A	National	5 211
	IE	2 874	11	10 760 (MT)	National	727
	UK	19 541	38	10 000-20 000 (MT) 45 000 (MT)	Regional National	111 N/A
Solar thermal	AT	5 025	10	+35 000 (MT)	National	2 000
	IT	3 982	91	N/A	Local	300
	ES	2 734	26	N/A	Local	n/a
Low-carbon building	DK	801	18	N/A	National	795
	FR	5 751	22	50 000-120 000 (ST)	National	46 273
	UK	5 622	20	N/A 2 600 (ST) 8 000 (ST)	Regional Local National	642 1 000 3 500
Low-carbon road freight	AT	1 417	1	N/A	National	800
	FR	20 157	3	8 000 (ST)	National	n/a
	UK	18 121	-2	2 600 (ST)	Local	n/a

* Based on estimates of employment projections by domain (Annex 7). ST = short term (2-3 years), MT = medium term (up to 10 years), N/A = not applicable; n/a = information not available; estimates are provided in italics, +forecast covers jobs relating to all types of modern heat system.

** For the UK examples, 'regional' responses refer to programmes governed by the devolved administrations of the UK, and administrative regions of the EU: Wales, Scotland and Northern Ireland.

Before providing a comparative analysis of VET programme responses to support a low-carbon economy, it is worth reflecting on the scale of the challenge in terms of the employment implications.

5.2.2. Employment projections for the sustainable energy domains

The employment projections, based on estimated potential energy savings realised and projected renewable energy capacity growth (detailed in Annex 7), suggest that there is relatively strong employment growth in wind and solar thermal energy, and buildings value chain. With employment rising in these domains, there is potential for such growth to be constrained by skills shortages.

Initial and retraining programmes are likely to be needed to provide skills to meet this increased growth in employment demand, along with measures to facilitate matching of individuals and their skills to labour market needs. To respond to the changing nature of tasks more generally, continuing training is also needed to update the skills needs of the existing workforce.

A further consideration, not captured by employment projections in low-carbon domains, is the need to address instances of skills obsolescence as existing workers age, and the need to meet replacement demand as individuals exit the workforce. Demographic shifts in Europe are likely to place further pressure on training responses at all levels.

Consideration of such demographic and other socioeconomic drivers may serve to explain why the country forecasts of demand, which informed the development of VET responses in nine of the 16 case study examples, tend to project higher level estimates of employment demand:

(a) in France, the national estimate of workforce demand for training in the building sectors in the short term is 10 times greater than that projected by our consideration of the energy savings to be realised in the coming years;
(b) in Ireland and the UK, the country forecasts from the case studies in wind energy are approximately two to three times the level of demand projected by considering only the pipeline of growth in wind power generation capacity.

In country demand forecasts from the case studies, a distinction emerges between renewable energy and energy efficiency: the former is characterised by relatively longer time horizons, reflecting perhaps the time lags in planning, installing and operating of renewable energy technologies and the resultant cascade of jobs as projects progress. A short-term horizon for buildings and transport sectors may also be indicative of relatively more immediate training needs.

5.2.3. Gap analysis: comparing training interventions to demand projections

Employment projections are necessarily limited in the extent to which they are able to forecast accurately a future outcome, subject to uncertainties and modelling assumptions. They are able, however, to provide an informed basis on which to identify risks of emerging skills gaps at an early stage and support strategic response.

Of primary interest is the extent to which the assessed responses reflect the full scale of projected skill needs, at least in terms of the incidence of training interventions. In comparing the numbers of training interventions carried out to date with the projected sector needs, we find that in almost all cases for which sufficient information is available, it is notable that the response is considerably lower than the projected need.

The exceptions here are the training interventions for low-carbon buildings at local level in the UK and at national level in Denmark and France, which are in line with or surpass projected needs in terms of the number of training interventions.

Cedefop (2011) has also highlighted that uncertainties attached to the realisation of a low-carbon economy, as well as investment and market uncertainties in the prevailing economic climate more generally, are a likely dampener on the amount of training support provided. It follows that emphasis is likely to shift towards the need for more immediate or remedial responses.

5.3. Key challenges for VET

Echoing the findings reported in each section of this report, several challenges can be highlighted which corroborate the view that the transition towards a low-carbon economy is best understood as a driver of structural labour market change. In particular, the key challenges for VET associated with transition to a low-carbon Europe can be seen as being broadly aligned with the challenges for VET more generally:

(a) higher rates of economic change. Economic restructuring and higher levels of 'churn', associated with the low-carbon transition, place further pressure on systems of skills formation to provide learners with portable skills, signposting and support services for labour mobility and transfer of existing skills to different sectors, locations or workplaces;

(b) continuing market failures constraining demand. Where skills development is considered a prerequisite for successful policy implementation or market development, policy and market failures can mean that the demand for the skills never materialises as anticipated. Initial spikes in demand following the rollout of a scheme may not always be sustained in the medium term;

(c) greater skills forecast uncertainty. When new fields of study are set up, it is difficult to determine a priori if there will be sufficient demand on the labour market for these skills. Time-lags between initial training and the eventual work placement, mean that decisions over VET design often need to be made in advance of market needs to support low-carbon development, which may caution against the development of more highly-specialised courses;

(d) increasing demand for new industrial alliances. The development of new industries or growing need for multiple occupations to deliver a single sustainable energy project, are liable to cut across the remit of a number of existing institutional structures, necessitating the establishment of new working relationships between different actors along a supply chain, or inter-industry and public-private governance structures;

(e) increasing need for environmental awareness. Skills across all occupations need reframing to incorporate environmental awareness and associated competences to engage with, analyse or communicate energy saving products and technologies. As green skills will require change at all employment levels, all levels of education will have to be considered. Since much of the skills base relevant for jobs in a low-carbon economy can be found in existing occupations, building on existing skills sets and adjusting existing training programmes/pathways may often be more pertinent than creating new qualifications;

(f) increasing need for higher education/VET links. Not all affected occupations are trained through VET systems and qualifications. Some, such as engineers, are more typically trained in higher education systems. There is a need to articulate the nature and content of training across levels, making sure that all the professions involved in a given 'project/product' have the complementary skills. This has implications for cooperation and communication between education and training institutions, for example between engineering schools and VET providers, such that there is clearer definition of roles and allocation of responsibilities within the context of an emerging technology/sector;

(g) overcoming occupational boundaries. To expand renewable energy capacity and support growth in dual roles to deliver energy savings (e.g. plumbers who are also able to promote the benefits of and install solar thermal heaters), VET courses in these areas need to be well signposted and attractive to the individual trainees as well as their current or future employers;

(h) increasing costs of technical training. The economic crisis has placed significant strains on public and private sources of finance, needed to carry out the investments in training; given the need to expose students to training in new low-carbon materials and technologies this is often prohibitively expensive.

Other issues are also likely to be relevant:

(a) regional distribution of the training offer, if some of the industries are localised in certain areas;

(b) the technical infrastructure needed for training and teacher preparation, and especially the costs and risks of investment ahead of clearly signposted demand.

Box 6. **Non-skills barriers to a low-carbon transition**

Skills development and vocational training responses are just one of several barriers to high employment, sustainable energy transition in Europe. In the assessment of the European Commission's *Roadmap to a resource-efficient Europe*, meeting the specific Europe 2020 objectives will require significant increases and shifts in investments, as well as major innovation and technological breakthroughs. In this roadmap, however, several barriers preventing these investments and innovations are set out:

- the need to aggregate small projects to make them attractive to investors;
- high risk levels due to several factors including insufficient maturity of technology, policy uncertainty (for example on subsidies or feed-in tariffs), volatility of resource prices, etc. As the level of risk rises, so does the expectation of return and the cost of access to capital;
- lack of reliable information available to the investors, and the lack of communication between policy-makers and project developers.

These investment uncertainties coupled with any signs of a lack of political will or commitment to the development of a low-carbon economy at all levels, and uncertainty over the prevailing economic climate, make it particularly challenging for education and training policy-makers, providers and the social partners to anticipate the level and extent of response required, compounding any skills mismatch challenges in the future.

Source: European Commission, 2011g.

5.4. Case study overview

The research has identified a range of VET responses which seek to support the signalled investments and developments in renewable energy and energy savings across Europe identified in Chapter 4.

This is set against a wide variety of different cultural, geographic, climatic, economic, policy and legislative backgrounds, resulting in different VET responses. This section examines skills training systems in countries with recognised market leadership or development based on the domain analysis

The case studies examine the VET responses to structural effects of transition to a low-carbon Europe. Employment estimates for the four domains and labour market intelligence inform the VET response. An overview is provided in Table 8.

Table 9. **Overview of the scale and coverage of the case studies**

	Name of initiative	Year started (piloted)	VET response	Type of VET	Training participants (to date)	Skill level	Projected workforce needs (year)	Annual programme costs, EUR 1000*	Funding sources (% share)	Lead role	Advisory role
Wind power											
DK	Talent factory	2006	Match	IVET/higher education	N/A	High/medium	N/A	n/a	Employers	Industry	Employers; providers
DE	Jobstarter	2008	Pre-skill	IVET	5 211	Medium/high	N/A	15 624	State (50); European Social Fund (50)	State	Social partners
IE	Wind Skillnet	2008	Mixed	CVET	727	High/medium	10 760 (MT)	269	State (50); employers (50)	Industry	State
UK	Wind energy modern apprenticeship, Scotland	2009	Pre-skill	IVET	111	High/medium	10 000-20 000 (MT)	3 108-5 328	State; employers	Industry	Employers
UK	Renewable training network (RTN)	2011	Match	CVET	N/A	Medium/high	45 000 (MT)	720	State (50); industry (50)	Industry; employers	None
Solar thermal											
AT	Klima:aktiv	2006 (2004)	Mixed	CVET	6 000	Medium/high	35 000 (MT)	250 (2009)	State; employers	State; industry	Social partners
IT	Building code – Carugate, Emilia Romagna	2003	Upskill	CVET	*300*	Medium	N/A	4	State	State	Social partners
ES	Solar thermal ordinance, Barcelona, Catalonia	2000	Upskill	CVET	n/a	Medium	N/A	20	State	State; Industry	Social partners
Public buildings											
DK	Energy savings knowledge centre	2009	Upskill	CVET	795 (2010)	Medium	N/A	280	State	Providers; industry	Industry
FR	Training for energy savings in buildings (FEE Bat)	2008	Upskill	CVET	47 000	Medium/high	50 000-120 000 (ST)	13 250	Industry (50); employers (50)	State	Social partners
UK	Delivering low-carbon skills (DLCS), Wales	2011	Mixed	IVET/CVET	642	Medium	N/A	1 079	State (75); employer (25)	Industry	N/A
UK	Green deal 'go early' training	2012	Mixed	CVET	1 000	Medium/high	3 500 (ST)	1 000	State; employers	Industry	State
UK	London 2012 job skills future	2011	Mixed	IVET/CVET	3 500	Medium	2 600 (ST)	n/a	State (100)	Industry; employers	State
Road freight											
FR	Objective CO_2	2008	Upskill	CVET	n/a	Medium/low	N/A	n/a	State; employers	State; industry	Social partners
UK	Freight operator recognition scheme (FORS)	2009 (2006)	Upskill	CVET	n/a	Medium/low	N/A	520	State; employers	State	Industry

* Exchange rates: EUR 1= GBP 0.83 = DKK 7.44;

NB: N/A = not applicable; n/a = information not available, ST = short term (2-3 years), MT = medium term (up to 10 years), estimates provided in italic +including 2 000 installers and planners in solar thermal and 800 driving instructors in road freight.

5.4.1. A typology of VET response

The VET programme responses may be conceptualised as playing a key supportive role in transition to a low-carbon economy in three ways:

(a) update or realign skills in the existing labour force to adjust to changing tasks and technologies, and those increasingly in demand (upskilling and reskilling):
   - (i) most assessed cases have the upskilling of the existing workforce as their primary aim (for 6 of the 15 this is also their exclusive aim). Upskilling responses are particularly relevant in established sectors, such as buildings and transport, as well as in responding to skills necessary for successful implementation of a new regulation, for example Building code in Italy, Solar thermal ordinances in Spain, Green deal in the UK, and FEE Bat in France;
   - (ii) public and private employers and industry groups have also taken a lead in designing upskilling programmes to meet demand for renewable technologies, for example Wind skillnet, Ireland, Klima:activ in Austria; or to promote energy saving approaches to road freight transport in France (Objective CO_2) and the UK (FORS);

(b) develop training capacity and equip the young, and those vulnerable to exclusion, with relevant skills to assist their integration into the workforce (skilling):
   - (i) renewal of qualifications, creation of new programmes or modules to adapt existing programmes to meet the needs of a low-carbon economy, typically targeted at initial training of young learners, prior to entry into the workforce: for example, Modern wind energy apprenticeships in Scotland, and the development of traineeships through the German Jobstarter programme. Such programmes are often the result of high level reviews of how to improve the supply of green skills in the workforce;
   - (ii) skilling programmes also include responses to develop VET infrastructure through teacher training or the development of new training facilities or integrated campuses of learning at various levels, for example programmes to construct the Olympics site in London, and buildings retrofit in Wales (Delivering low-carbon skills, DLCS);

(c) develop processes to support the effective matching of skills supply and demand:
   - (i) provide links between students in technical colleges and higher education institutes and businesses in the low-carbon growth sectors and awareness-raising activities of career pathways, for example Talent factory in Denmark for the wind industry;

(ii) assess training needs and provide consistency across industry by ensuring that all courses at various levels contain the right information and have been industry-assessed and approved, for example Renewable training network (RTN) in the UK.

In practice, responses can also include a mixture of two or more of these three dimensions (mixed), an approach which is particularly common in VET systems where on-the-job, firm-specific training is commonplace for initial and experienced recruits alike, such as in the UK and Ireland.

In cases where the development of low-carbon policy drivers is at a relatively early phase, it may be premature to draw strong conclusions about how vocational training policies should be tailored. Despite these caveats, it may be possible to identify promising steps to anticipate, address or respond to those policy drivers and the structural adjustment pressures and opportunities they create.

5.4.2. Response scale and timing

The anecdotal evidence from this study, and the gap analysis undertaken in Section 5.3, suggest that there is a prevailing caution in approaches to developing skills for a low-carbon economy in the domains of interest.

A distinction can be made between IVET and CVET. IVET providers are often constrained by nationally defined qualification requirements that they have to comply with: they technically prevented from develop new training. Sometimes they can adjust existing training but, in many countries, even can be problematic. The timing of responses to new IVET provision is related to the institutional responses from those responsible for establishing qualification structures.

CVET providers have more flexibility to adjust the content of their training but, in the light of uncertainty, may prefer to adopt incremental (wait-and-see) responses to managing investment risks, with no response forthcoming in the short-term. Such lack of wholesale response is likely to afflict any VET system, but will be aggravated by an absence of channels able to take account of market insights, derived labour demand and corresponding labour supply constraints, and to share such information among industry actors, VET providers, public authorities and other relevant stakeholders.

From the timing of the case study responses (mainly CVET), VET responses in Denmark, Germany, Ireland, France and Austria are relatively mature (4-6 years). Policy actions in the UK, and its devolved administrations, however are characterised by their relative newness, with a series of vocational training actions in 2011 and 2012. Responses at municipal and regional level relating to solar thermal in Spain and Italy date back to the early 2000s.

For renewable energy sectors, the advantages of the German and Irish approaches arise in training which achieves a balance between theory and practice, giving participants a solid grounding in both. The right balance between these two aspects should be maintained; in these domains there is a risk that training can over-specialise, thereby making both workers and their qualifications inflexible. Therefore training should not be over-prescriptive and qualifications should develop over time.

However, specialised qualifications may make it easier to encourage take-up within niche markets, where there is some autonomy for providers and industry to agree on its application.

For the more recent responses and those in their pilot phase, full assessment of programme outcomes is not possible. They can, however, provide an up-to-date view of the nature of emerging VET responses at different levels of governance, while the more mature responses are themselves likely to be able to provide lessons on the issues encountered and steps taken to avoid or overcome further challenges as they have arisen.

5.4.3. Training activity targets

Training interventions across all domains include at least some provision of training at medium-level qualifications (ISCED 3-4) and their non-formalised equivalents. The case study examples indicate that vocational training responses are also developing at higher, tertiary levels of education (ISCED 5-6). This is particularly the case in the wind energy sector, where the identified initial and continuing training responses are also aimed at providing higher-level skills, typically in relation to engineering disciplines. Examples of higher-level skills provision is also observed as part of upskilling programmes in the building sectors, albeit to a lesser extent.

Vocational training provision for lower level skills across the 15 case study examples is limited exclusively to road freight and logistics. In these cases, the primary concern remains training provision for medium skill levels.

5.4.4. Governance and institutional context

Not all initiatives relating to the development and matching of skills for a low-carbon economy involve formal adjustment of VET qualifications content. Many relevant skills are delivered through simple short training courses and workplace learning which often arise as a result of strong social partner engagement (or unilateral action).

Reviews of national systems ([20]) have identified that, in almost all countries, the involvement of stakeholders and social partners in VET development is enshrined by law. Structures for engaging employers and social partners can be established nationally (e.g. according to industrial sectors), regionally or locally (e.g. employer representation on school boards). Many of the case studies include the social partners in their VET programmes in at least an 'advisory' capacity: this is so in Germany, Spain, France, Italy and Austria.

Typically the signal to review VET qualification standards or training requirements or to issue new ones in IVET has to come from the social partners. Revision is done in cooperation with education sector representatives, while the social partners often take on the role of initiators. Uncertainty may prompt the social partners to refrain from requesting changes at national level until there is a clearer trend. CVET can offer a more flexible solution.

Employers' associations and private companies (employers), and industry associations, chambers of commerce and utility providers (industry), have taken on a leadership role in governing the VET responses in seven of the 15 case studies. In a further three cases, they possess decision-making powers alongside public authorities (State) and vocational schools, technical colleges, and other VET providers.

To the extent that some of the professions/businesses in the selected domains are in 'niche' areas, they may have difficulties articulating their needs within the social partner structures. This depends on the quality of the dialogue in organisations involved in the design of qualifications; it is likelier be easier for these players to focus on CVET where they have some autonomy to act on their own.

5.4.5. Financing VET responses

State actors are also the major or sole contributor to financing VET responses. The Danish talent factory, aimed at promoting the wind industry to prospective workers, and the programme to increase energy savings in buildings in France (FEE Bat) are the only two examples of VET response programmes solely funded by employers and industry groups from the outset: in the case of FEE Bat, the funds are redirected towards training measures by the national electricity company (EDF) through voluntary contributions to the energy saving certificates scheme. Industry representatives of the occupations benefiting from the training have also contributed up to 50% of the funding of the programme since 2012.

([20]) http://www.cedefop.europa.eu/EN/Information-services/vet-in-europe-country-reports.aspx [accessed 7.5.2013].

The most common financial arrangement in the observed VET responses is through joint funding instruments, with public and private actors both contributing. This is partly a reflection of the number of CVET cases, where there is a risk involved in setting up these courses. Future demand is not that clear, so the State seeks to minimise risks by involving private investors, assuming they will only invest if demand exists.

This takes several forms:

(a) levy-grant systems, through which the State actors release funds for the purpose of training on condition of employer/industry contributions subject to fulfilling certain conditions, for example the funding of industry networks, including Wind skillnet, to develop workforce skills in Ireland;

(b) direct subsidy of the training interventions, in which employers or individual learners make contribution towards the full cost of training, for example by payment of a course fee; examples are low-carbon skills development for buildings in Wales and training for solar thermal and road freight workers as part of the Klima:activ programme in Austria;

(c) pump-prime, initial funding of VET response from the State which seeks to establish the necessary conditions from which to demonstrate the benefits of training or the necessary infrastructure to draw in industry/employer funds, for example Green deal 'go early' training in the UK;

(d) requirements for match funding, such as was initially the case of the Jobstarter programme in Germany. Here, while around 50% of the initial training programme costs are funded by the national government and a further 50% funded through the European Social Funds, the projects involving the social partners are required to cover the costs of certain project expenditures including promotional activities and rent for office space.

There are many variations of VET response programme funding, not only in the training activities themselves but also the accompanying training infrastructure networks and the duration of training activities. Therefore, it is not possible to provide a comparative analysis of the costs per training intervention.

The outcome of the assessment for the selected case studies is presented in Table 9, with the six case studies of good practice highlighted in blue, and explored further in Chapter 6.

Table 10. **Assessment of good practice case studies**

	Name of initiative	Informed	Relevant	Integrated	Coherent	Sustainable	Innovative	Replicable	Transferable	Weighted average*
Wind power										
DK	Talent factory	2	1	1	1	2	2	2	2	2.0
DE	Jobstarter	2	2	1	1	1	2	2	2	2.3
IE	Wind skillnet	2	2	2	2	1	2	2	2	2.4
UK	Wind energy modern apprenticeship, Scotland	2	2	1	N/A	1	1	2	2	N/A
UK	Renewable training network (RTN)	1	2	2	1	2	2	2	2	2.1
Solar thermal										
AT	Klima:aktiv	2	2	2	2	2	2	2	1	2.4
IT	Building code – Carugate, Emilia Romagna	1	2	1	2	2	2	2	1	2.0
ES	Solar thermal ordinance, Barcelona, Catalonia	1	2	1	1	2	2	2	1	2.0
Public buildings										
DK	Energy savings knowledge centre	2	2	2	2	1	2	1	1	2.1
FR	Training for energy savings in buildings (FEE Bat)	2	2	2	2	1	2	2	2	2.4
UK	Delivering low-carbon skills (DLCS), Wales	2	2	2	1	1	2	2	2	2.3
UK	Green deal 'go early' training	1	2	2	N/A	1	2	2	2	N/A
UK	London 2012 job skills future	2	2	2	2	1	2	1	1	2.1
Road freight										
FR	Objective CO_2	2	2	2	2	2	1	2	1	2.3
UK	Freight operator recognition scheme (FORS)	1	1	2	2	2	1	2	2	1.9

* The assessment is weighted (by a coefficient of 2) towards the quality of information and relevance of the case study.

NB: On the rating scale, case study researchers were instructed to assign scores of high, medium and low against each of the eight selection criteria. To reduce possible bias, a three-point scale was adopted to translate assessors' judgment into a numerical value for aggregation. 0 = low, 1 = medium or medium/low, 2 = high or medium/high; N/A = too early to pass judgment on the impact or outcomes of the programme.

5.5. Comparative assessment of good practices

This section reviews approaches to vocational training as case studies, with explicit focus on countries with recognised market leadership or developments in the low-carbon domains of interest as identified in Chapter 4.

5.5.1. Information and relevance

Precise information on the number of training interventions was not provided for some case studies owing to absence of processes to monitor the training measures. A common feature of these programmes is that the delivery of training has tended to be considered as a supplementary measure as part of a broader initiative to reduce emissions, for example to install solar thermal technologies in Barcelona and Milan and to deliver energy savings for road freight hauliers in London and France.

Well-documented and clear programmes tend to have been supported by continuous monitoring of the training activities as well as the outcomes on the individual trainees. Such monitoring is absent in the cases of VET support to the solar thermal industry at municipal level in Spain and Italy, and to the road freight industry in London (the UK) where the VET component of the programmes has not been considered a primary concern. In these cases, outcomes are considered only in terms of energy savings or capacity installed, reflecting a primary focus on energy policy.

There is a clear tendency for case studies that have assembled labour market information to assess the skills needs of the sector, to provide training more relevant to the needs of the workforce and individual trainees. Gathering evidence of skills needs can also, in some cases, be a prerequisite for finance. This is the case in the project-based Jobstarter and Wind skillnet programmes in Germany and Ireland respectively.

5.5.2. Integration and coherence

One implication of implementing low-carbon-specific skills development policies is that they need to be coordinated with employment, industry and innovation policies. One of the difficulties encountered during preliminary screening of case studies was the scope to identify low-carbon policies that explicitly integrate skills and VET response strategies. This suggests that most Member States, unlike the examples highlighted by the identified cases of good practice, do not yet integrate VET response strategies within their wider low-carbon policies, or as part of strategies for sustainable growth.

Most of the good practice examples have tried to integrate support to the development of a low-carbon economy with VET response. Several promising examples of fully integrated low-carbon policy and VET response include the London Olympic sustainability plan, Objective CO_2 for the road freight sector in France, and Skillnet for wind power in Ireland.

In Spain and Italy, where municipal and regional VET responses often emerge in advance of national efforts, examples of vocational training for low-carbon policy in solar thermal energy are presented as 'flanking measures', a side issue to main policy. Experience in these case studies suggests that incremental, rather than piecemeal, integration of the vocational training component may be a preferable approach to ensuring that the level of response remains in line with low-carbon policy drivers. In the absence of more formal integration between the low-carbon policy and VET response, difficulties exist in engaging the existing workforce in training. This, in turn, may be associated with delays in the implementation of the low-carbon policy.

Positive assessments by employers and individual trainees have been observed in case study examples in the FEE Bat and Objective CO_2 programmes in France.

5.5.3. Sustainability

Lack of funding, and the political, regulatory and market uncertainties surrounding low-carbon policy implementation, threaten the sustainability of the case study examples analysed. Demand for emerging low-carbon technologies is understood to be weak at present, given the prevailing economic climate. Recent reductions in government expenditures across Europe are also generating uncertainty. These are considered major factors in lack of new VET provision. Lack of demand for vocational training, and consequent underinvestment, are also associated with the typically cited business concerns such as fears that companies will not benefit from the potential returns on training due to staff turnover, poaching or free-riding ([21]) and concerns over the time spent in training and the associated opportunity costs.

At the same time there is widespread expectation that rising energy prices, stronger regulation (in support of lower-carbon buildings and road freight) and continuing policies such as feed-in tariffs and renewable heat incentives, will lead to a (sometimes rapid) increase in demand from utility providers, downstream industry and final consumers for additional skills.

([21]) The theory of poaching suggests that firms may wait for other firms to spend money on training, and then recruit workers by offering higher salaries or benefits, through the money saved by not having to bear the costs of training. In this case, training provides an external benefit to others, which other firms do not pay for, a case of the free rider problem (Stevens, 1994).

Concerns over regulatory uncertainty prevail across all of the sectors analysed, and the impacts of this on the scale of the required training response is of particular concern in the buildings and solar thermal industry sectors.

The longevity of the programmes examined also relies on continued interest among stakeholders in sustaining the programme, which is likely to be guided by the relevance, coherence, and attractiveness of the programme for employers and individual learners, as well as any emerging evidence of programme benefits ([22]).

5.5.4. Innovation

Examples of innovation in training delivery include interactive learning materials which incorporate new technologies and are tailor-made to meet individual learner and employer needs. For buildings, this has involved the provision of common training for different trades so that they can work together to carry out energy-efficient retrofits at minimal inconvenience to the customer. Examples of innovative developments are also seen in where and when training is delivered, with e-learning and other flexible modes of delivery, including the use of short courses available or provided at a variety of locations.

The National Skills Academy for Construction developed to deliver low-carbon buildings at London 2012 and the Knowledge Centre in Denmark also provide examples of innovative VET programme responses, involving the development of infrastructure necessary to deliver VET.

At the level of governance and design, examples of innovation include network structures and committee membership to foster cooperation and partnership at regional and sectoral levels, incentives to engage with employers and promote awareness, and the development and continual use of labour market intelligence from researchers and social partners active in the relevant labour markets.

Chapter 6 presents, in greater detail, how innovative training responses are contributing to a more proactive role of VET in terms of its contribution to a low-carbon Europe.

([22]) Positive feedback highlighting the satisfaction of participants with the training provided in the buildings sector in Denmark and France. The favourable findings of external evaluations of the Skillnets programme in Ireland and Klima:activ programme in Austria, in terms of relevance to employer needs, provide evidence in favour of their continued political and industry support.

5.5.5. Replicability and transferability

The transnational programmes reviewed above provide interesting insights into other approaches in Europe and lessons that may be applicable to other contexts.

Within the national context, there is emerging evidence of programmes becoming increasingly mainstreamed. Examples include:

(a) the extension of the Objective CO_2 scheme to passenger road transport vehicles is seen as a positive sign regarding the increasing institutionalisation of the scheme;

(b) the piloting of the Wind energy modern apprenticeship in Scotland, has led to replication of the framework to England, Wales and Northern Ireland;

(c) municipal legislation in Spain has provided inspiration to similar legislative efforts requiring minimum levels of solar hot water heating regionally and nationally, though the extent to which lessons from the identified VET policy responses have also been transferred is unclear;

(d) the VET programme responses in Germany (Jobstarter), Austria (klima:activ) and Ireland (Wind skillnet) provide examples in which the model of response is sufficiently flexible to be applied and operated across a wide range of industry sectors and regions in the national context;

(e) VET responses to develop a sufficient pool of skilled workers, capable of performing the necessary energy-efficient retrofit of the existing building stock in the UK (DLCS and Green deal) and France (FEE Bat) are highly sector-specific, due to the specific regulatory environment of the built environment sector.

There are elements in most of the cases examined which could offer cross-border replication and transfer of good practice across Member States. Examples include developing networks to share learning about the development of skills for a low-carbon economy, modifying existing training programmes to include low-carbon elements, creating more effective means to match supply and demand for green skills, and the development of policy responses across government ministries to ensure joined-up policy approaches.

5.6. Responses to VET challenges

The challenges faced by the sustainable energy domains are far from unique and are shared with other sectors subject to change, across Europe. There are several core challenges for VET systems in Member States in the face of current and prospective sectoral and technological change: pursuing a more sustainable, energy-saving mode of economic activity increases these challenges, which need to be addressed if VET systems are to respond to the existing and projected lack of the necessary skills in low-carbon industry sectors.

These challenges reflect the different cultural, geographic, and climatic regions of Europe; national economic policies and legislative backgrounds have resulted in a diversity of different VET systems. This section provides an overview of the strength of VET response to these challenges, recognising differences in national contexts, identified in the six programmes, which demonstrate good practice.

Further details of identified good practices in terms of innovative, proactive VET responses to a low-carbon transition are considered in Chapter 6.

Table 11. **Strength of best practice case study responses to the key challenges for VET systems driven by the transition to a low-carbon economy**

Domain	Country	Name of programme	Higher rates of economic change	Continuing market failures constraining demand	Greater uncertainty of skills forecasts	Increasing demand for new industrial alliances	Increasing need for environmental awareness	Increasing need for higher education/VET links	Overcoming occupational boundaries	Increasing costs of technical training
Wind	DE	Jobstarter	Support of matching process; four additional qualifications	Fund studies to identify regional demand; and focus on growth sectors	Assess future sector skills needs	Strong social partner, provider and employers engagement	n/a	n/a	Common VET provision across standard sectors	Limited pooling of resources and shared finance
Wind	IE	Wind skillnet	Sectoral recognition for all training; access for job-seekers	Driven by policy strategy to develop wind sector	Training needs analysis; flexible design to adjust training	Strengthen existing alliances and employer engagement (especially SMEs)	Training of jobseekers and workers on regulatory environment	VET and higher education providers involved in training delivery	Flexibility to tailor training to diverse needs	Best-value procurement and matched funding
Solar thermal	AU	Klima:aktiv	Support development of national certification	Test market demand prior to course development	Identify need to act; flexible design to adjust training	Interventions guided by collaboration of government and the social partners	Focus on short courses and target trainers – the catalysts for change	n/a	Target range of occupations	e-learning platforms; nominal course fees
Buildings	FR	Training for energy savings in buildings (FEE Bat)	Accredited training provided	Adjusted objectives in light of evidence on demand	Monitor outcomes to assess training relevance to learner needs	Committees to bring together all stakeholders	Structure modules to communicate low-carbon objectives	n/a	Group training encourages exchange of experience across trades	Use of ESCO, the energy saving certificate scheme funds for training
Buildings	UK	Delivering low-carbon skills (DLCS), Wales	Nationally accredited training provided	Deliver pilots to test market, wait-and-see approach	Conduct skills gap analysis	New coalition of sector skills councils (employer representatives)	Focus on short courses and target trainers	Delivery of training by VET and higher education providers	Group training encourages exchange of experience across trades	Best-value procurement and employer contributions
Road freight	FR	Objective CO_2	n/a	Energy saving benefits of training drive market demand		State, industry body and employer cooperation	Employer commitment to reduce emissions	n/a	n/a	Short one-day courses, nominal fee

NB: Orange – moderate response to challenge; blue – strong response to challenge; n/a– limited evidence of response to challenge available.

CHAPTER 6.

Excellence in VET to support a low-carbon Europe

This chapter highlights innovation in vocational education and training, drawn from the identified good practice case study examples. It describes several specific good practice approaches to developing and implementing effective VET responses to changing labour market needs.

Innovation and modernisation of VET in Europe are supported by the aims of the Copenhagen process (Council of the EU and European Commission, 2010) to deliver vocational excellence, capable of promoting smart, sustainable and inclusive growth. This process strives to support VET as a model of excellence that is increasingly responsive to meeting changing labour market needs and sufficiently flexible to address skills imbalances and shortages (Cedefop, 2009).

The identified VET responses are characterised by varying degrees of innovation in governance, and/or the processes of programme design and delivery. The areas highlighted in the literature (European Commission, 2007; OECD, 2009, pp. 63-99), as key markers of a successful VET programme lay emphasis on:

(a) the collection and relevant use of systematic labour market information (e.g. comprehensive skills reviews, employment projections and qualifications mapping);
(b) the creation and management of networks, partnerships and other collaborative forms to engage policy-makers, social partners and other stakeholders in the governance, design and delivery of training for adults in the labour market;
(c) the provision of incentives and outreach strategies to promote uptake in training, particularly among vulnerable groups and SMEs;
(d) capacity building, quality assurance and monitoring processes to improve the quality of VET delivery and assess the relevance of learning outcomes to the labour market.

Our analysis of VET responses follows these four dimensions in turn.

6.1. Labour market intelligence

Many of the challenges for VET programmes (identified in Section 5.3) relate to high degrees of uncertainty about how transition to a low-carbon economy will reshape labour markets and hence about how education and training measures are required to respond.

At national level, large comprehensive skills reviews/mapping of qualifications in one or several sectors are taking place in several countries, to identify needs for updating VET. Some countries, including Germany, France, the Netherlands, Austria, Sweden and the UK, are characterised by well-established institutional frameworks for anticipating changes in skills needs to inform education and training responses via a combination of quantitative forecasting and qualitative needs assessments (Cedefop, 2008).

In France and Austria, such institutional frameworks have also explicitly considered the role of low-carbon drivers:

(a) in Austria, in response to the national climate strategy, an inter-ministerial committee was established to assess skills requirements for different occupations in the solar thermal, construction and transport sectors compared to existing provision, to identify the need for new skills response initiatives for different occupational groups, and revise existing education programmes in accordance with the overall energy savings strategy;

(b) in France, under the national plan for mobilisation for jobs and careers in the green economy, the Ministry of Education established a national observatory whose role is to identify and define the jobs which develop from this transition, and coordinate the observatory's operations which are carried out at regional and sector level ([23]). Municipal level *maisons d'emploi* complete the picture of labour market intelligence systems in France; these may provide a fertile ground for the trialling and piloting of different approaches;

(c) as part of the Skillnets programmes in Ireland, training needs analysis is undertaken with active member companies by the network manager. Training needs analysis is reviewed annually by a steering group composed of industry leaders and enterprises, as basis for ensuring the continued relevance of the training response in line with industry needs and to identify any emerging skills gaps or training issues.

While labour market intelligence systems in the form of forecasts may be less developed or reliable at sector, regional or municipal level than nationally, softer ex-ante assessments of local demand and training needs can provide particularly useful insights for policy-makers at all levels.

([23]) These units carry out a range of studies and analyses of the employment situation within their area and bring together the representatives of the public bodies concerned.

Further actions at local and regional level may often lead in developing and implementing sustainable energy policies and accompanying measures and initiatives to develop the skills needed, without the necessary infrastructure in place.

At regional and municipal levels, major infrastructure works on a single project (e.g. London 2012) or a series of projects (e.g. FEE Bat in France and the solar thermal ordinance in Barcelona) for example, may benefit from efforts to benchmark the current project against the existing evidence of the employment and skill needs associated with previous examples of similar works.

6.2. Networks, partnerships and other models of social dialogue

Besides forecast- and demand-based assessments of skill needs, labour market information can be obtained through formal and informal dialogue with education and training providers, and the social partners. Where such systems of dialogue are established, they tend focus on qualifications systems and established sectoral activity, especially relevant for IVET: there is a strong framework in support of German IVET. Dialogue can support industry-led programmes and initiatives in which industry defines their needs and works with the public sector to adapt VET content, delivery and qualifications accordingly, as is the case with the Jobstarter traineeship programme.

Where such dialogue is not established, such as in France and the UK, the case studies show original forums for discussion and stakeholder involvement of different actors have been established in response to low-carbon policy drivers. In France, industry committees have been able to build on the new channels for systematic dialogue established by the colleges of the Grenelle environment ([24]), to define (and refine) the vocational training responses necessary to promote energy savings in buildings (FEE Bat) and road freight transport (Objective CO_2).

In the UK, the creation of alliances of sector skills councils has enabled industry and employers to inform the design and development of pilot vocational training responses in concert with providers and public accreditation bodies.

Industry- and enterprise-led training networks in the internal labour market systems of VET in Ireland and the UK provide further examples of responses to ensure VET responses are timely and relevant to labour market needs. These

([24]) These colleges are composed of five actors: the representatives of the State, the territorial communities, the employers' organisations, the trade unions and non-governmental environmental organisations.

systems are characterised by pump-prime funding from the State, which maintains and seeks to leverage greater industry ownership over the programme's lifetime. These enterprise networks typically design tailored short courses, to provide companies with a convenient and affordable route to accessing the skills updates required, which is particularly beneficial to SMEs. Here, steering group committees made up of engaged representatives from across the value chain may support network development and assure the continued relevance and quality of the training offers.

The need for exchange and cooperation has particular value in cases such as the buildings and solar thermal heating sectors, where various trades are required to collaborate to deliver energy savings on a given project. In implementing such programmes, policy-makers need to gain the support and know-how of a wide range of employers' groups and their employees, and integrate training and awareness raising measures into the policy cycle.

6.3. Incentives, outreach and targeting to promote vocational training uptake

In cases where there are new courses linked to new or emerging sectors and technologies there will be a need to encourage enrolment through not only advertising the course but also explaining the potential new career opportunities.

Improved signposting of career paths in sustainable energy sectors has the potential to help the young, and those both in and out of the workforce, to make informed choices about their career paths and the education and training that they need. The Danish case study example showcases an innovative approach to engaging with enterprises, to signalling relevant learning opportunities, and promoting awareness of the benefits of vocational training to the young. Provided an industry is sufficiently motivated to improve the attractiveness of the sector and enlarge its pool of qualified workers, such signposting can be easy to transfer.

Adopting an alternative approach to targeting certain groups, the VET responses in Ireland (Wind skillnet), the UK (London 2012 job skills future) and Germany (Jobstarter) have all embedded targets for the inclusion of specific groups such as job-seekers, migrants or young carers across their wider programmes or within specific initiatives, as part of wider policy concern for those most at risk (of remaining on social benefits) if not retrained.

Included in the range of policy options supporting of these programme targets are:

(a) subsidised training, which may be offered free at the point of entry or reimbursed on completion;
(b) introductory sessions or awareness-raising seminars;
(c) networking opportunities through events and job fairs;
(d) conditional programme funding based on the fulfilment of inclusion criteria.

Recruiting sufficient learners is a common challenge for the programmes examined, particularly those aimed at updating the skills of the existing workforce, with employers or the trainees lacking time or engagement with lifelong learning. The models of governance which engage employers and industry in the design of training (Section 6.2) may be one way of addressing this issue, as evidence from the case studies suggests this is a critical factor in establishing a direct link between the relevance of the training offers.

6.4. Capacity building, quality assurance and monitoring processes

6.4.1. Capacity building

To optimise the quality and value for money of training provided, assess its relevance, adapt to a changing socioeconomic environment, and make continual improvements, requires effective mechanisms of assurance, monitoring and accreditation. Further, given the nature of the costs and novelty of many of the low-carbon technologies, it is necessary for training programmes to be delivered by teachers and trainers familiar with, and ideally with direct experience of, using new tools and techniques.

Where such skills are not present in the VET sector, training responses may either need to develop such capacity, or involve industry in the provision of certain types of specialist skills in the workplace. While the former may be costly, the latter may be problematic if enterprises are reluctant to open up their workplaces to outsiders due to confidentiality issues in dealing with new technologies. This, in turn, will prevent VET providers from realising cost advantages associated with engaging with the owners of technological innovations, leading to higher training costs or reduced quality offered to smaller firms and jobseekers.

The case studies analysed provide examples of the development of VET capacity through the establishment of bridges between policy-makers, the educational research community and front-line deliverers (teachers and trainers). In the buildings sector, such as in the Delivering low-carbon skills programme in Wales, pilot programmes focused on the need to develop teaching and training capacity by delivering courses to trainers in areas where there was perceived to be higher future demand for training. In the freight transport sector, the Austrian Klima:activ mobil initiative also directly focuses on updating instructor skills, for them to then market and pass on eco-driving skills to those entering or already in the sector.

To obtain the best available training, formal procurement processes provide an example of a good practice strategy to engage providers and draw out innovative (and affordable) solutions to specific skills challenges facing sustainable energy domains: FEE Bat and Wind skillnet are examples. Procurement has enabled the purchase of delivery methods that specifically target trainees across different occupations or levels of experience at the best available cost.

6.4.2. Monitoring performance

Formative appraisals and assessments of the quality of VET design and the monitoring of outputs and outcomes from delivery can be used to improve the capacity of VET systems to remain aligned to evolving markets, technologies and policy objectives.

As well as undertaking measures to assure the quality of VET activities ex-ante, the case studies provide examples in which training outputs or the overall outcomes are monitored. Few of the programmes, however, fully monitor both outputs and outcomes. Examples of the types of outputs monitored include the number of trainees attending or completing the course, as well as, in certain cases, their background in terms of gender, qualifications, and the companies they work for. Some of the VET programmes, as part of internal or external evaluation processes, also recorded the reported levels of participant satisfaction of the courses provided.

The monitoring of outcomes, in terms of the contribution of vocational training to the sector’s development, energy savings or emissions reductions, is less frequent, undertaken in four cases, all operating at the subnational level. Examples of the types of attributable sustainable energy outcomes monitored by the case study programmes are:

(a) solar thermal heaters installed,
(b) number of buildings retrofitted,
(c) energy or fuel savings achieved,
(d) related emissions reductions.

6.5. Conclusions

Analysis showed that good practice innovations in VET to support the transition to a low-carbon economy in Europe are generally characterised by VET which is:

(a) proactive: identifies the drivers of change, and assesses ex ante the skill needs associated with strategies for employment, innovation and industrial development;

(b) engaging: combines methodological tools to identify training needs and establishes systems of dialogue and stakeholder engagement to update training programmes and provide impetus for the renewal of qualifications and accreditation systems;

(c) attractive and inclusive: utilises outreach and awareness-raising strategies, and incentives to promote training among employers that is accessible to SMEs, and inclusive of vulnerable groups;

(d) high quality: builds capacity of trainers and the training infrastructure to deliver training in line with the latest innovations and developments, and establishes monitoring processes to assure the quality of VET and enable the communication of these benefits to employers.

CHAPTER 7.
Conclusions and recommendations

7.1. Conclusions on employment and low-carbon policies

The study has examined the employment and skills implications of policies designed to implement a sustainable energy scenario, with EU climate and energy targets being met at the same time as EU employment targets.

It has combined an econometric analysis with defined policy measures to establish the labour market impacts of policy intervention, compared to baseline trends, based on a two-part analysis:

(a) measures were defined to achieve the EU climate and energy targets;

(b) additional measures were defined to achieve EU employment targets without compromising the achievement of the EU climate and energy goals.

The analysis shows that, in the baseline, neither climate and energy nor employment targets are met by 2020, despite some assumed recovery from the current slow-down.

However, combined achievement of EU climate, energy and employment targets is feasible using employment growth measures (which either do not compromise energy outputs or which reinforce the shift to a sustainable energy economy) while assuming the same rate of recovery from the current economic slow-down as modelled in the baseline.

7.1.1. Climate and energy measures and impacts

To achieve the EU climate and energy goals (the EU 20-20-20 objectives) an energy policy scenario was used, which has been tested in previous research (European Commission and Cambridge Econometrics et al., 2011). This in turn was based on the Primes model developed to examine the impacts of EU energy policies (see Annex 4 for a technical discussion of the modelling). The combination of energy-related measures has the effect of achieving the specified EU climate and energy goals. However, although there is a very small positive contribution to employment (a lower-carbon economy is not one which leads to a loss of employment), it does not have a major effect on overall employment levels. It follows that additional measures are required to meet employment targets.

7.1.2. Employment measures and impacts

In the second part of the analysis, the following measures were added to the energy measures and assessed:

(a) incentives for employers to hire additional workers (i.e. lower taxes on labour);
(b) incentives for individuals to offer their labour (i.e. reduced welfare payments);
(c) greater investment in research and development (i.e. higher levels of R&D financing).

These measures were deliberately chosen on the basis of an a priori assessment that they were likely to have significant employment effects. They were also chosen because they were capable of being modelled and applied such that they were revenue neutral in terms of overall public income and expenditure.

The results of the analysis indicate that these measures have a substantial positive effect on employment levels such that employment targets in most Member States are achieved (the exceptions are in Bulgaria, Greece, Spain, Hungary and Poland). The EU employment rate rises from 71% in 2020 in the baseline to 75% following the use of the energy and additional labour market measures. The additional economic activity associated with the employment-led growth strategy does not jeopardise the EU climate and energy policy goals.

The analysis demonstrates, at least at a technical level – political constraints aside – that the climate and energy targets can be achieved at the same time as EU employment targets; but to do so requires greater integration of climate and energy polices with measures to support employment across the EU.

It should also be recognised, that there is a continuous process of ‘churn’ in the economy, with businesses expanding and contracting and opening and closing. The changes introduced by these policy measures operate within this dynamic process of economic change and affect the whole economy through changes in relative prices. This is important in shaping VET system responses to cope with the transition process:

(a) VET systems have to respond continuously to significant structural changes in the economy; the transition to a low-carbon economy is another structural change;
(b) VET systems, in responding to the low-carbon transition, have to recognise that the whole economy is affected, even if certain sectors may experience especially acute change.

7.1.3. Employment effects at a sectoral and occupational level

The analysis has also examined the effects of the different policy measures at sectoral level.

In summary, the measures cause a decline in activity in conventional fossil-based energy sectors, and in those sectors that use energy intensively (e.g. cement, chemicals, iron and steel) with higher prices from products supplied by these sectors. At the same time sectors that provide goods and services to manage energy more efficiently (creating jobs in construction, mechanical and electrical engineering and their supply chains) and non-fossil based energy sectors expand. The employment measures are designed to generate employment in labour-intensive industries that can take advantage of the incentives provided.

A key feature is that employment change is projected to take place outside of 'green' or 'brown' sectors. Employment in downstream retail, transport, communications and business services expands more quickly than otherwise, since price changes induce changes in the composition of final demand and hence of labour demand.

The principal trend in the baseline and after policy intervention is towards more employment being concentrated in higher level occupations (i.e. those associated with higher qualifications) under all the scenarios to 2020. In comparing the scenarios to the baseline case, the key message from the analysis is that, at this level of aggregation, any shifts in occupational and qualifications structure in the two scenarios are modest in their net effects, at NACE two-digit level. Greater effects may occur at a more disaggregated level.

7.1.4. Employment effects in the selected strategic domains

The study has assessed the future changes in labour demand and skills requirements in four domains of strategic importance for a low-carbon transition: wind power, solar thermal heating, public buildings, road freight transport, and logistics. Case studies examining the development of VET programmes in response to the skills needs of these domains have been conducted.

Comparing the employment projections across domains provides a view of the relative contribution of the domains to achieving high employment and sustainable energy objectives, and highlights the scale of VET response that is likely to be required.

Of the four domains, employment associated with the development of wind energy capacity is the most significant, with the 333 000 wind-related jobs projected by 2020 being more than the sum of employment related to the other domains put together. However, while total levels of employment in 2020 sustained by the EU markets for solar thermal and energy-efficient buildings is relatively small (84 000 and 69 000 respectively), these two markets are each expected to grow by over 20% per year from 2012 to 2020.

These projections of employment in low-carbon domains are likely to underestimate the demand for training, since they do not include skills obsolescence as existing workers age, and the need to replace workers as individuals exit the labour force. Demographic shifts in Europe are also likely to place further pressure on training responses at all levels.

Consideration of demographic and other socioeconomic drivers may explain why the country forecasts, which informed the development of VET responses in nine of the 16 case study examples, tend to project higher level estimates of employment training demand:

(a) in France, the national estimate of workforce demand for training in the building sectors in the short term is 10 times greater than that projected by our consideration of the energy savings to be realised in the coming years;
(b) in Ireland and the UK, the country forecasts from the case studies in the wind energy domain are approximately two to three times the level of demand projected by considering only the pipeline of growth in wind power generation capacity.

7.2. Conclusions on VET challenges and responses in Member States

7.2.1. The challenges facing national VET systems in the EU

The challenges facing the Member States in responding to the demands for skills training are considerable. They arise in the first instance from the rapid growth in employment and technological developments accelerating skills obsolescence. But there are a range of other factors that combine to create difficulties for government and industry seeking to plan investment and to deliver the requisite skills training.

In response VET programmes have to:

(a) update or realign skills in the existing labour force to adjust to changing tasks and technologies, and those increasingly in demand (upskilling and reskilling):
    (i) most assessed cases have the upskilling of the existing workforce as their primary aim (for six of the 15 this is also their exclusive aim). Upskilling responses are particularly relevant in established sectors such as the buildings and transport sectors, as well as in responding to training necessary for successful implementation of a new regulations,

for example Building code in Italy, Solar thermal ordinances in Spain, Green deal in the UK and FEE Bat in France;

(ii) public and private employers and industry groups have also taken a lead in designing upskilling programmes to meet demand for renewable technologies, for example Wind skillnet in Ireland, Klima:activ in Austria; or to promote energy saving approaches to road freight transport in France (Objective CO_2) and the UK (FORS);

(b) develop training capacity and equip the young, and those vulnerable to exclusion, with relevant skills, to assist their integration into the workforce (skilling):

(i) responses here consist of the renewal of qualifications, creation of new programmes or modules to adapt existing programmes to meet the needs of a low-carbon economy, and are typically targeted at initial training of young learners, prior to entry into the workforce, for example Modern wind energy apprenticeships in Scotland, and the development of traineeships through the German Jobstarter programme. Such programmes are often the result of high level reviews of how to improve the supply of green skills in the workforce;

(ii) skilling programmes also include responses to develop capacity of the VET infrastructure through teacher training, or the development of new training facilities or integrated campuses of learning at various levels, for example programmes to construct the Olympics site in London, and buildings retrofit in Wales (delivering low-carbon skills);

(c) develop processes to support the effective matching of skills supply and demand (matching):

(i) provide links between students in technical colleges and higher education institutes and businesses in the low-carbon growth sectors and awareness-raising activities of career pathways, for example talent factory in Denmark for the wind industry;

(ii) assess training needs and provide consistency across industry by ensuring that all courses at various levels contain the right information and have been industry-assessed and approved, for example renewable training network in the UK.

In practice, responses can also include a mix of two or more of these three dimensions, an approach which is particularly common in VET systems where on-the-job, firm-specific training is provided for initial and experienced recruits alike, such as in the UK and Ireland.

7.2.2. Good practice in responding to these challenges

The study investigated in detail 15 case studies of VET programmes across the four policy domains. This identified six that have developed approaches that appear to be effective and which may serve to inform programme responses elsewhere. We summarise characteristics of these responses to each of the challenges identified in Table 10:

(a) higher rates of economic change. Economic restructuring and higher levels of 'churn', associated with the low-carbon transition. Responses: cases illustrate the development of nationally accredited qualifications to deliver portable skills to learners;

(b) continuing market failures constraining demand. Policy and market failures can mean that the anticipated demand for skills fails to emerge or endure. Responses: cases integrate response as part of a strategy to overcome market failures or focus on sectors with demonstrated evidence of growth;

(c) greater uncertainty of skills forecasts. Difficult to determine a priori if there will be sufficient demand on the labour market for these skills. Responses: examples test the market through pilots in advance of a full-scale response;

(d) increasing demand for new industrial alliances. New industries cut across the remit of a number of existing institutional structures. Responses: cases illustrate the creation of networks, partnerships and committees capable of bringing together public and private stakeholders to engage in the governance and design of VET response;

(e) increasing need for environmental awareness. Skills across all occupations need reframing to incorporate environmental awareness. Responses: cases provide short courses to communicate information on environmental drivers and embed these in training modules and work practices;

(f) increasing need for higher education/VET links. Not all affected occupations are trained through VET systems and qualifications. Responses: cases provide some examples of both VET and higher education providers being engaged to deliver training;

(g) overcoming occupational boundaries. Need to expand renewable energy capacity and support growth in dual-roles to deliver energy savings. Responses: cases illustrate provision of common training across occupations and trades to encourage exchange of experience and support joint work;

(h) increasing costs of technical training. Costs of training in new low-carbon materials and technologies are often prohibitively expensive. Responses: cases provide various options for securing finance by pooling resources among different employers and providers, and sharing the costs of financing between State and Industry actors.

7.2.3. Innovation in VET responses

The study has sought to explore the scope for transferring good practice experience to other countries and regions in Europe, recognising the varying degrees of innovation in governance, and the processes of programme design and delivery.

This has been examined in relation to four dimensions:

(a) labour market intelligence: to collect and systematically apply labour market information (e.g. comprehensive skills reviews, employment projections and qualifications mapping):
   (i) creation of inter-ministerial committees in France and Austria to integrate low-carbon drivers into quantitative forecasting tools and qualitative needs assessments, to consider skill needs for the economy, particular regions and occupations as part of broader strategies for growth, innovation and industrial development;
   (ii) gap analysis to compare the needs derived from such analysis, with an assessment of existing provision has also been effective in Ireland;

(b) networks and social dialogue: to create and manage networks, partnerships and other collaborative forms to engage policy-makers, social partners and other stakeholders in the governance, design and delivery of training in the labour market:
   (i) strengthening existing alliances to support employer engagement in training in established industries, for example the road freight transport industry in France;
   (ii) partnerships and collaboration between existing alliances across industries, to engage with all stakeholders (public and private) in the expansion of a low-carbon economy, for example alliances of sector skills councils across the built environment sector in the UK and alliances of professionals, industry representatives and trade unions in solar thermal sectors at municipal level in Italy and Spain;
   (iii) creation of new alliances and channels for dialogue between new and non-traditional industries across the value chain, including the social partners, and government representatives responsible for skills and training policy as well as low-carbon policy, for example the Klima:activ programme in Austria;

(c) incentives and outreach strategies: to promote uptake in training, particularly among vulnerable groups and SMEs:
   (i) easily transferable good practice is the improved signposting of career paths in sustainable energy sectors through the creation of information portals for learners such as the case of the talent factory in Denmark.

The key requisite here is for an industry with sufficient interest and means to fund development of such a portal;

(ii) targeting of particular groups can also be embedded into the objectives of a programme, or attached as a condition for funding as is the cases of Wind skillnet, Ireland and Jobstarter in Germany, to ensure the programme takes the necessary steps to achieve minimal levels of inclusion. The lack of prescription over the means to achieve these targets provides flexibility and scope for innovations to develop, and provides a lesson which can be transferred to other countries;

(d) capacity building, quality assurance and monitoring processes: to improve the quality of VET delivery and assess the relevance of learning outcomes to the labour market:

(i) develop capacity of teachers and trainers to deliver tailored training to industry and enterprise needs for buildings in Wales, and to eco-driving instructors as part of the Klima:activ programme in Austria;

(ii) having specified the identified needs, the objectives and challenges associated with meeting these, the use of procurement processes can provide freedom and flexibility to allow (public and private) education and training providers to tailor course delivery to respond to these needs. Procurement processes were central to the success of the case study programmes in Germany, Ireland and France and can be combined with financial mechanisms and monitoring and evaluation to offer further incentives for quality training provision that is both flexible and highly relevant.

7.2.4. Towards a ‘blueprint’ for domain specific VET responses

Workplace learning provision for green skills is critical if the European workforce is to be equipped to support and deliver the transition to a low-carbon economy. This includes the acquisition of skills to develop, implement and manage related managerial and technological changes (e.g. in the buildings sector). This places a greater premium on science, technology, engineering and mathematics (STEM) related skills as well as core craft and trade skills. It is also important because of the increasing rate of change in skills needs, at least in some sectors, which mean workforce skills require regular updating.

The demand and supply of these skills will be conditioned by the specific nature of low-carbon sectors and technologies, and their role in the low-carbon transition. Thus national, institutionally-led, responses need to be complemented by more flexible and dynamic responses at sector and/or local and regional levels.

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, the development of low-carbon technologies and services, and the successful implementation of sustainable energy policies, will be constrained.

At the risk of over-generalisation, and recognising the diversity in IVET and CVET frameworks in European countries in which responses have to be crafted, there appear to be core elements in the design of domain specific VET programmes that would make it more, rather than less, likely they would be effective in meeting domain needs for skills training.

The main elements are:

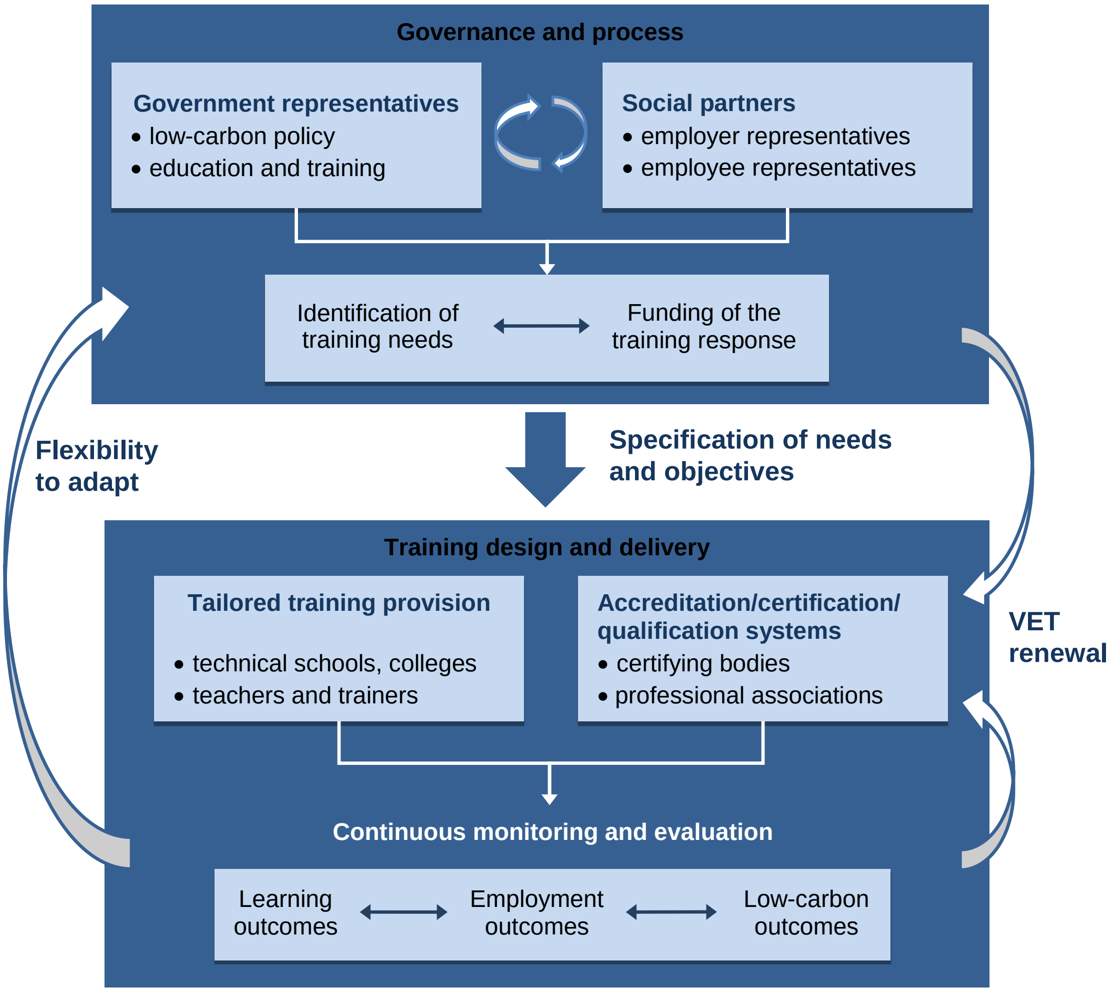
(a) social dialogue and collaboration between various government representatives and social partners, to identify training needs and design the process for response;
(b) advice and impetus to the renewal of qualifications and accreditation systems;
(c) procurement of training provision to tailor training delivery at anticipated or identified needs;
(d) monitoring and evaluation of programme activity.

7.2.4.1. *Social dialogue between government and industry*

Social dialogue offers the basis for establishing communication between industry representatives of the domain (including new and non-traditional sectors or subsectors and cross-sector interests) and government representatives responsible for ensuring skills needs are met (including IVET and CVET representatives). Cooperation within different levels of government between education and training representatives and those responsible for implementing low-carbon policy and shaping the regulatory environment can also serve to ensure that training responses take full account of available information on policy drivers of change.

The dialogue may be local, regional or national. It is focused on defining current and emerging skills needs as the basis for government action to adjust qualification and accreditation systems and to define the required provision and its targeting. Dialogue would also form the basis of joint finance arrangements and for putting in place programme level monitoring and evaluation. There are specific issues which are likely to be case-specific about the particular form of governance and allocation of roles and responsibilities, and the precise composition of a steering committee may need to be refreshed and flexible to incorporate new stakeholders as the policy and market context develops.

Figure 16. **Institutional frameworks can maximise the value of training provided and create mechanisms to inform the development of systematic VET responses**



Given the degree of intra-country variation at sectoral level, regions are likely to also be increasingly important actors in identifying skills needs and organising provision of training related to a low-carbon economy, particularly in the larger Member States.

7.2.4.2. *Advice and impetus to renewal of qualifications and accreditation systems*

Qualification reform aims to ensure that training responses to emerging skill needs are of the appropriate content and standard, where needs represent a requirement for new combinations of competences. This will not be required in all cases, or immediately but, given inertia in the reform process, early action is encouraged. The activity also helps to ensure that IVET (which has to operate to agreed qualification systems) does not fall behind and leave the burden of provision on CVET; this is especially important in domains with well-established standards and systems of training which potentially create inertia in developing new responses, for example as identified in the buildings sector.

Not all initiatives relating to the delivery of skills for a low-carbon economy involve the formal adjustment of VET system content. Many of the relevant skills are delivered through short training and workplace learning which often arises from strong social partner engagement. It is important, however, that the principles of the training needed in the workplace also feed the renewal of learning outcomes required by initial training to ensure new entrants to the labour market are sufficiently prepared for a low-carbon economy and, crucially, that their qualifications are recognised as such.

7.2.4.3. *Procurement of targeted training provision*

Good practice examples indicate a preference for procuring targeted training provision, rather than depending exclusively on existing and established provision. Good practice is more likely to be effective and relevant where based on skills and training needs analysis which combine a mixture of quantitative and qualitative methodologies. The procurement of training provision also creates room for public and private providers to develop innovative solutions to respond to particular challenges that employers and individual learners may encounter when engaging in training.

7.2.4.4. *Monitoring and evaluation of programme activity*

Monitoring and evaluation is rarely introduced at the outset, as programmes focus on the practicalities of needs assessment, access to funding and appropriate training provision. However, such systems are essential for establishing confidence in skills needs analysis and value for money. Lessons from monitoring and evaluation help drive the renewal of qualifications and accreditation systems by highlighting effective training responses. This feeds the materials and lessons developed in training existing workers to ensure initial training of new entrants takes account of these needs, and vice versa.

7.3. Policy recommendations

This study has highlighted the need for greater coherent strategic alignment between policy responses. In reflecting the variation across Europe in approaches to VET in response to low-carbon economy developments in different domains, the study also underlines the need to modernise VET systems and develop programmes capable of delivering the skills needed. Eight recommendations for policy actions can be identified:

(a) integrate low-carbon and skills development strategies.

Integrated approaches are required to identify skills needs and design and implement relevant training responses to support a low-carbon transition. The evidence from this study illustrates that overarching strategies to support skills development for a low-carbon economy can be particularly effective for training responses.

By integrating considerations of employment effects and the associated skills and training needs with strategies to achieve energy and climate objectives, national governments can illustrate the dependence of low-carbon policies on the availability of a skilled workforce. In turn, this can promote the development of integrated programmes at sectoral, regional and municipal levels; and encourage channels of communication to develop between ministries and the social partners to design VET responses capable of tackling the skills challenges which risk inhibiting low-carbon policy implementation;

(b) develop joined-up policy responses to meet employment and low-carbon goals.

This study has demonstrated the technical feasibility of simultaneously achieving employment, energy and climate goals. This is based on a set of specified measures, not all of which might be considered politically feasible. Other potential measures have not been tested because of modelling constraints. It is obviously for national governments, guided by EU proposals, to develop strategic policy responses to promote employment through a mix of measures that are compatible with the achievement of low-carbon goals.

Policy-makers have a wide range of labour market, skills, economic and energy policies available to them to promote job creation, which are either neutral or support a low-carbon transition. Better understanding of the impediments and challenges to employment creation in a national context, and the effect on energy and climate targets of policies designed to overcome these, needs further research;

(c) develop new and adapt existing systems of social dialogue.

Evidence from the study underlines the fundamental importance of establishing social dialogue between government and the social partners, to develop and design VET responses that are relevant to worker, employer and industry needs.

Where formal systems for such dialogue already exist, these need to be increasingly flexible to reflect changes in industrial composition and structural change. Existing alliances need to be strengthened and expanded to include new and non-traditional industries as well as incorporate industry actors at different stages in the value chain.

Where systems of social dialogue are more ad hoc and less institutionalised, the low-carbon transition places further pressure on VET systems for new mechanisms of social dialogue to be established, incorporating new and emerging sectors and cutting across ministerial and occupational boundaries;

(d) promote institutional flexibility.

The precise institutional structure of such social dialogue systems needs to vary on a case-by-case basis. It is likely to involve the active engagement or leadership of industry representatives and employers in designing training activities in collaboration with professional associations and trade unions, to ensure training provision is timely, and relevant to both learner and labour market needs.

Institutional flexibility is also required to ensure that qualifications and occupational profiles adapt to changing labour market needs. This requires that the institutions responsible for accreditation and qualifications are an integral part of low-carbon policy responses;

(e) develop and use labour market information to identify skills needs.

Given the accelerating influence of low-carbon policy on structural change, social dialogue can also support the development and relevant use of labour market information and training needs analysis.

In light of the inevitable uncertainty in anticipating the future profile of jobs and skills, a mixture of methodologies is required, capable of indicating the range of outcomes possible which are then left for policy-makers and the social partners to interpret and translate into training needs;

(f) consider how procurement processes can achieve quality, cost-effective training.

Funding arrangements can be met in various ways and the most appropriate arrangement will be determined by the specific characteristics of a programme.

Procurement models which draw in solutions to training needs from public and private providers, some of whom may sit outside the formal institutional structure responsible for training provision, can provide one way of promoting quality and best value training provision.

To achieve the full benefit of procurement processes, training needs and associated challenges need to be clearly articulated. This has the benefit of enabling those most aware of effective learning tools and delivery mechanisms (providers) to tailor existing provision to specified needs and targeted groups;

(g) establish frameworks to monitor and evaluate new programmes.

Particularly in pilot stages and early phases of new programmes, it is critical to monitor continuously the progress and outcomes of VET programmes to establish their role in achieving positive learning, employment and low-carbon outcomes, both for individual projects or initiatives and for the programme as a whole. Monitoring should be closely aligned with the strategic and operational objectives of the programme and should also entail an assessment of cost.

Occasional external and independent evaluations have the added benefit of improving learning and underpinning the credibility of programme outputs and outcomes, and can improve the scope for mainstreaming a particular response into national and regional frameworks;

(h) share and disseminate good practice.

Programme managers should work with partners at national level to exchange and share information and materials created as part of their training programmes, and to discuss the potential for drawing lessons on the training activities, materials and content, and the approach taken to financial and contractual arrangements, to the benefit of other similar programmes and initiatives. This promotes peer review and learning.

At European, national and regional levels, the development of dissemination strategies to promote awareness of pilot projects and showcase good practice may also support changes in practice and attitudes to training.

Developing a portal or repository of the good practice responses to VET across different sectors can help to showcase the findings of this and similar research, and create a platform from which stakeholders can discuss practices and exchange experiences.

ANNEX 1.
Glossary of terms

Continuing vocational education and training
Continuing vocational education and training (CVET) refers to education or training taken by individuals who have exited initial education and training or after they have entered employment. CVET generally aims at helping individuals to improve or update their knowledge and skills or to acquire new skills for a career move or retraining.

Crowding out
Crowding out refers to the channels through which expansionary fiscal policy (e.g. public investments in sustainable energy) may curtail private investment and, in the end, have little, no, or even negative effects on output.

Double dividend
Sometimes revenue-neutral environmental tax reforms are seen as a means to generate a double dividend. The first dividend is in terms of more effective environmental protection and the second, for example, an increase in employment when direct labour taxes are reduced. However, the double dividend hypothesis is not unquestioned. The double dividend is more likely to be generated in imperfect competition on labour market and product markets (OECD, 2007).

Employment rate
The EU 2020 employment rate indicator is calculated by dividing the number of persons aged between 20 and 64 in employment by the total population of the same age group. Employment refers to the number of people in work (headcount) or the number of occupied jobs in the economy.

Energy efficiency
The term technically means ‘using less energy inputs while maintaining an equivalent level of economic activity or service.’ Examples of energy efficiency measures are technological improvements or new technologies in transport, buildings or energy production (based on European Commission, 2011c).

Energy savings
Energy conservation or energy saving is a broader term than ‘energy efficiency’ and is defined as ‘an absolute decrease of energy consumption which can be achieved through increased energy efficiency, but also through behaviour change or decreased economic activity’. Examples of energy savings without efficiency

improvements are heating a room less in winter, adjusting driving habits or enabling energy saving modes on electronic devices. In practice the two terms are difficult to disentangle and they will be often used in the case studies interchangeably (based on European Commission, 2011c).

Expansion demand
The net change in overall levels of employment in the economy.

Green skills
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, 2012b).

Gross domestic product
Gross domestic product (GDP) is the value of all production activity of resident producer units within a country, including net trade balances (exports minus imports).

Initial vocational education and training
Initial vocational education and training (IVET) generally refers to the initial preparation of young people with skills and/or competences to gain entry into a specific occupation or sector (Cedefop, 2008). In most countries IVET mainly refers to upper secondary education provided in vocational secondary schools and apprenticeship training, although in some countries vocational preparation can be identified at lower secondary and third levels.

Internal labour market
Internal labour markets are characterised by the importance of continuous on-the-job training, which allow the system to adapt quickly to changes required in the content of jobs. Internal labour market workers aim for generic competences to increase labour markets chances, and employers opt for company specific competences. Entrance to the labour market is unregulated. Such systems are mainly found in largely market-driven economies with little tradition of social partnership but where the employer's voice is strong. Social partners are generally less involved in course design and delivery. On-the-job training is non-standardised, specific to the firm concerned.

Job openings
Job openings combine data on expansion demand with replacement demand to calculate the total net employment requirement.

Labour force
The economically active population (labour force) comprises employed and unemployed persons (aged 15 and above).

Lifelong learning
Lifelong learning is continuing access to the renewing of skills and the acquisition of knowledge. This covers all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competence, within a personal, civic, social and/or employment-related perspective' (based on European Commission, 1995; 2001).

Low-carbon economy
An economy that is more restrained in carbon dioxide and other greenhouse gas emissions, which encompasses economic activity to reduce the use of fossil fuels, increasing the efficiency of energy usage and developing and adopting renewable sources of energy.

Occupational labour market
Occupational labour markets are characterised by well-developed systems for VET at intermediate level. Entrance to the labour market is organised through a system of vocational training. There is strong emphasis on training at the initial stages of a person's working life (e.g. apprenticeships). On-the-job training is standardised to occupational norms, resulting in occupation-wide skills transferability. Occupational labour market systems can be further distinguished by the role of government, employers and the other social partners.

Path dependency
Where economic outcomes are dependent on the path of previous outcomes, rather than on current conditions.

Renewable energy
Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in this definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, as well as biofuels and hydrogen derived from renewable resources.

Replacement demand
The concept of replacement demand is based on jobs arising from the need to replace those who leave employment for retirement or similar reasons (including those leaving the workforce temporarily to start a family).

Skills
The relevant knowledge and experience needed to perform a specific task or job and/or the product of education, training and experience which, together with relevant know-how, is the characteristic of technical knowledge (European Training Thesaurus).

Skill gap
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 and ILO, 2010).

Skill shortage
A situation in which the demand for a particular type of skill exceeds the supply of available people with that skill (Cedefop and ILO, 2010).

Social partners
A term generally used in Europe to refer to representatives of management and labour, i.e. organisations representing workers and employers.

Sustainable energy
Sustainable energy is the efficient, cost-effective use of energy resources, in a competitive and affordable way, to enhance security of energy supply and reduce greenhouse gas emissions and other pollutants. Sustainable energy is supported by the twin pillars of renewable energy and energy efficiency (Prindle et al., 2007).

Tax wedge
Sum of personal income tax and employee plus employer social security contributions together with any payroll tax, less cash transfers, expressed as a percentage of labour costs.

Unemployment rate
The indicator of the unemployment rate is calculated by dividing the number of unemployed by the labour force.

ANNEX 2.
Abbreviations

CAPEX	manufacturing, construction and installation activities
CO_2	carbon dioxide
CVET	continuing vocational education and training
E3ME	environment-energy-economy model for Europe
ETS	emissions trading system
EU	European Union
EU-27	the 27 Member States of the European Union
EU-27+	the 27 Member States of the European Union plus Norway, Iceland and Switzerland
Eurofound	European Foundation for the Improvement of Living and Working Conditions
GDP	gross domestic product
ILO	International Labour Organisation
IVET	initial vocational education and training
NACE	statistical classification of economic activities in the European Community
OPEX	operations, maintenance and fuel processing
Primes	partial equilibrium energy market model for the long-term
R&D	research and development
SMEs	small and medium enterprises
UNEP	United Nations environment programme
VET	vocational education and training

Country code

BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary

MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom

IS	Iceland
NO	Norway
CH	Switzerland
US	United States

ANNEX 3.
References

Ahlo, K. (2011). *Review of wider labour market literature and selected models and how they could be utilised in construction of a proper set of labour market indicators.* Working paper; No 1. ETLA with contributions from Wilson, R. and Hogarth, T. (Warwick Institute of Employment Research).

Barker, T. et al. (2009). The macroeconomic rebound effect and the world economy. *Energy efficiency*, November 2009, Vol. 2, No 4, pp. 411-427. http://dx.doi.org/10.1007%2Fs12053-009-9053-y [accessed 8.5.2013].

Buildings Performance Institute Europe (2011). *Europe's buildings under the microscope: a country-by-country review of the energy performance of buildings.* Brussels: Buildings Performance Institute Europe. http://www.bpie.eu/documents/BPIE/HR_%20CbC_study.pdf [accessed 8.5.2013].

Cambridge Econometrics et al. (2011). *Working for a green Britain. Volume 2 – Future employment and skills in the UK wind and marine energy industries.* London: Renewable UK. http://www.renewableuk.com/en/publications/reports.cfm/Working-for-a-Green-Britain-Volume-2 [accessed 8.5.2013].

Cedefop (2008). *Initial vocational education and training (IVET) in Europe: review*. Thessaloniki: Cedefop. http://www.cedefop.europa.eu/etv/Upload/Information_resources/NationalVet/Comparative/IVET_Review_08.pdf [accessed 8.5.2013].

Cedefop (2009). *Modernising vocational education and training: fourth report on vocational education and training research in Europe: synthesis report*. Luxembourg: Publications Office. Cedefop Reference series. http://www.cedefop.europa.eu/EN/Files/3043beta_en.pdf [accessed 1.3.2013].

Cedefop (2010). *Skills supply and demand in Europe: medium-term forecast up to 2020*. Luxembourg: Publications Office. Cedefop Reference series. http://www.cedefop.europa.eu/EN/publications/15540.aspx [accessed 8.5.2013].

Cedefop (2011). *What next for skills on the European labour market?* Cedefop briefing note; February 2011. http://www.cedefop.europa.eu/EN/Files/9059_en.pdf [accessed 8.5.2013].

Cedefop (2012a). *Future skills supply and demand in Europe: forecast 2012*. Luxembourg: Publications Office. Cedefop research paper; No 26. http://www.cedefop.europa.eu/EN/Files/5526_en.pdf [accessed 8.5.2013].

Cedefop (2012b). *Green skills and environmental awareness in vocational education and training*. Luxembourg: Publications Office. Cedefop research paper; No 24. http://www.cedefop.europa.eu/EN/Files/5524_en.pdf [accessed 8.5.2013].

Cedefop; ILO (2010). *Skills for green jobs: European synthesis report.* Luxembourg: Publications Office of the European Union. http://www.cedefop.europa.eu/EN/Files/3057_en.pdf [accessed 8.5.2013].

Chateau, J. et al. (2011). *Employment impacts of climate change migration policies in OECD: a general-equilibrium perspective*. Paris: OECD Publishing. OECD environment working paper; No 32. http://www.oecd-ilibrary.org/environment/employment-impacts-of-climate-change-mitigation-policies-in-oecd_5kg0ps847h8q-en [accessed 8.5.2013].

Chewpreecha, U.; Pollitt, H. (2009). *Extending the E3ME model to 2050: an introduction to E3ME version 4.7*. Cambridge: Cambridge Econometrics. CE working paper. http://www.camecon.com/Libraries/Downloadable_Files/2050.sflb.ashx. [accessed 1.3.2013].

Council of the European Union; European Commission (2010). *The Bruges communiqué*. http://libserver.cedefop.europa.eu/vetelib/2010/75928.pdf [accessed 8.5.2013].

Ecotec (2010). *Skills for climate change: initial mapping and research report identifying the low-carbon skills relevant to London construction and building services engineering businesses.* London: Skills for Climate Change. http://www.cipsonline.com/PDF/SfCC_fullreport_final.pdf [accessed 8.5.2013].

Energy Research Centre of the Netherlands; European Environment Agency (2011). *Renewable energy projections as published in the national renewable energy action plans of the European Member States*. Amsterdam: Energy Research Centre of the Netherlands. http://www.ecn.nl/docs/library/report/2010/e10069.pdf [accessed 7.5.2013].

EurObserv'ER (2011). *The state of renewable energies in Europe.* 10th EurObserv'ER report. Paris: Observ'ER. http://www.eurobserv-er.org/pdf/barobilan10.pdf [accessed 8.5.2013].

Eurofound (2013). *Greening of industries in the EU: anticipating and managing the effects on quantity and quality of job*. Dublin: European Foundation for the Improvement of Living and Working Conditions. http://www.eurofound.europa.eu/publications/htmlfiles/ef1248.htm [accessed 8.5.2013].

European Commission (1995). *Teaching and learning: towards the learning society: white paper.* COM(95) 590 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:1995:0590:FIN:EN:PDF [accessed 8.5.2013].

European Commission (1996). *European system of accounts ESA 1995*. Luxembourg: Publications office.

http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=CA-15-96-001 [accessed 8.5.2013].

European Commission (2001). *Making a European area of lifelong learning a reality: communication from the Commission*. COM(2001) 678 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0678:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2007). *Lifelong learning programme: general call for proposals 2008-10, Part 1: strategic priorities.* http://ec.europa.eu/education/programmes/llp/call08/prior_en.pdf [accessed 8.5.2013].

European Commission (2008). *20 20 by 2020 Europe's climate change opportunity*: *communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* COM(2008) 30 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0030:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2009a). *A shared commitment for employment: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions*. COM(2009) 257 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0257:EN:NOT [accessed 8.5.2013].

European Commission (2009b). *Moving forward together on saving energy: synthesis of the complete assessment of all 27 national energy efficiency action plans as required by Directive 2006/32/EC on energy end-use efficiency and energy services*. SEC(2009) 889 final. http://ec.europa.eu/energy/efficiency/doc/sec_2009_0889.pdf [accessed 8.5.2013].

European Commission (2010a). *A roadmap for moving to a competitive low-carbon economy in 2050: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* COM (2011) 112 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0112:REV1:EN:PDF [accessed 8.5.2013].

European Commission (2010b). *An agenda for new skills and jobs: a European contribution towards full employment: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. COM(2010) 682 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0682:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2010c). *EU energy trends to 2030: update 2009.* Luxembourg: Publications Office. http://ec.europa.eu/clima/policies/package/docs/trends_to_2030_update_2009_en.pdf [accessed 8.5.2013].

European Commission (2010d). *Europe 2020: a strategy for smart, sustainable and inclusive growth: communication from the Commission*. COM(2010) 2020 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2011a). *A new directive on energy efficiency: challenges addressed and solutions proposed*. Brussels: European Commission, Directorate-General for Energy. http://ec.europa.eu/energy/efficiency/eed/doc/2011_directive/20110622_energy_efficiency_directive_slides_presentation_en.pdf [accessed 1.3.2013].

European Commission (2011b). *Country-specific recommendations 2011*. http://ec.europa.eu/europe2020/making-it-happen/country-specific-recommendations/2011/index_en.htm [accessed 8.5.2013].

European Commission (2011c). *Energy efficiency plan: communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. COM(2011) 109 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0109:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2011d). *Energy roadmap 2050: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* COM(2011) 885 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0885:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2011e). *Proposal for a directive of the European Parliament and of the Council on energy efficiency and repealing Directives 2004/8/EC and 2006/32/EC.* COM(2011) 370 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0370:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2011f). *Renewable energy: progressing towards the 2020 target: communication from the Commission to the European Parliament and the Council.* COM(2011) 31 final. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0031:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2011g). *Roadmap to a resource-efficient Europe: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. Com (2011) 571. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0571:FIN:EN:PDF [accessed 8.5.2013].

European Commission (2012a). *Exploiting the employment potential of green growth*. Commission staff working document; SWD(2012) 92 final. http://ec.europa.eu/social/BlobServlet?docId=7621&langId=en [accessed 8.5.2013].

European Commission (2012b). *Financial support for energy efficiency in buildings: consultation paper.* Brussels: European Commission, Directorate-General for Energy. http://ec.europa.eu/energy/efficiency/consultations/doc/2012_05_18_eeb/2012_eeb_consultation_paper.pdf [accessed 1.3.2013].

European Commission (2012c). *Towards a job-rich recovery: communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. COM(2012) 173 final. http://ec.europa.eu/health/workforce/docs/communication_towards_job_rich_recovery_en.pdf [accessed 8.5.2013].

European Commission; Cambridge Econometrics et al. (2011). *Studies on sustainability issues: green jobs, trade and labour*. http://ec.europa.eu/social/BlobServlet?docId=7436&langId=en [accessed 8.5.2013].

European Commission; Fraunhofer Institute et al. (2009). *Study on the energy savings potentials in EU Member States, candidate countries and EEA countries.* Final report. Contract TREN/D1/239-2006/S07.66640. http://ec.europa.eu/energy/efficiency/studies/doc/2009_03_15_esd_efficiency_potentials_final_report.pdf [accessed 8.5.2013].

European Commission; GHK (2011). *Impacts of structural change: implications for policies supporting transition to a green economy.* Final report. Contract ENV.G.1/FRA/2006/0073. http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/transition_costs.pdf [accessed 8.5.2013].

European Commission; GWS et al. (2011). *Macroeconomic modelling of sustainable development and the links between the economy and the environment*. http://ec.europa.eu/environment/enveco/studies_modelling/pdf/report_macroeconomic.pdf [accessed 8.5.2013].

European Parliament; Council of the European Union (2009). Directive 2009/28/EC of the European Parliament and of the Council, of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. *Official Journal of the European Union*, L 140, 5.6.2009, pp. 16-62. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF [accessed 8.5.2013].

European Parliament; Council of the European Union (2010). Directive 2010/31/EU of the European Parliament and of the Council, of 19 May 2010 on the energy performance of building (recast). *Official Journal of the European Union*, L 153, 29.6.2010, pp. 13-35. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF [accessed 8.5.2013].

European Parliament; Council of the European Union (2012). Directive 2012/27/EU of the European Parliament and of the Council, of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. *Official Journal of the European Union*, L 315, 14.11.2012, pp. 1-56. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF [accessed 8.5.2013].

ILO (2011). *Comparative analysis of methods of identification of skill needs on the labour market in transition to a low-carbon economy*. Geneva: International Labour Organisation. http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_166824.pdf [accessed 8.5.2013].

ILO; UNEP (2012). *Working towards sustainable development: opportunities for decent work and social inclusion in a green economy*. Geneva: International Labour Organisation. http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_181836.pdf [accessed 8.5.2013].

Kriechel, B. (2012). *Replacement demand.* Thessaloniki: Cedefop. Forecasting skill supply and demand in Europe to 2020: technical paper; No 7.

OECD (2007). Financing social protection: the employment effect. In: OECD (ed.). *OECD employment outlook.* Paris: OECD Publishing, pp. 157-206. http://www.oecd.org/employment/emp/40776791.pdf [accessed 8.5.2013].

OECD (2009). Innovation in education and vocational education and training. In: OECD (ed.). *Working out change: systemic innovation in vocational education and training*. Paris: OECD Publishing, pp. 63-99. http://dx.doi.org/10.1787/9789264075924-en [accessed 8.5.2013].

Prindle, W. et al. (2007). *The twin pillars of sustainable energy: synergies between energy efficiency and renewable energy technology and policy*. Washington, DC: American Council for an Energy-Efficient Economy (ACEEE). Research report, No E074. http://www.aceee.org/research-report/e074 [accessed 8.5.2013].

Stevens, M. (1994). A theoretical model of on-the-job training with imperfect competition. *Oxford economic papers*, October 1994, Vol. 46, No 4, pp. 537-562. http://www.jstor.org/stable/2663510 [accessed 8.5.2013].

Stiglitz, J. et al. (2009). *The measurement of economic performance and social progress revisited: reflections and overview.* http://stiglitz-sen-fitoussi.fr/documents/overview-eng.pdf [accessed 8.5.2013].

UNEP (2008). *Green jobs: towards decent work in a sustainable, low-carbon world.* Geneva: United Nations Environment Programme. http://sustainableindustries.com/resources/green-jobs-towards-decent-work-sustainable-low-carbon-world [accessed 8.5.2013].

Wei, M. et al. (2010). Putting renewables and energy efficiency to work: how many jobs can the clean energy industry generate in the US? *Energy policy,* No 38, pp. 919-931. http://rael.berkeley.edu/sites/default/files/old-site-files/green_jobs_paper_Oct1809.pdf [accessed 8.5.2013].

World Economic Forum (2009). *Supply chain decarbonisation: the role of logistics and transport in reducing supply chain carbon emissions*. Geneva: World Economic Forum. https://members.weforum.org/pdf/ip/SupplyChainDecarbonization.pdf [accessed 8.5.2013].

ANNEX 4.
Model-based approach

E3ME model

E3ME ([25]) is a computer-based model of Europe's economic and energy systems and the environment. It was originally developed, and is now widely used, in Europe for policy assessment, for forecasting and for research purposes.

E3ME structure

The structure of E3ME is based on the system of national accounts, as defined by ESA95 (European Commission, 1996), with further links to energy demand and environmental emissions. The labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, and international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

The E3ME historical database covers the period 1970-2009 and the model projects forward annually to 2050 (Chewpreecha and Pollitt, 2009). The main data sources are Eurostat, the annual macroeconomic (AMECO) database of the European Commission's Directorate-General for Economic and Financial Affairs and the International Energy Agency, supplemented by the OECD's STAN database and other sources where appropriate. Gaps in the data are estimated using customised software algorithms.

The main dimensions of the model

The other main dimensions of the model are:

(a) 33 countries (the EU-27 Member States, Norway, Switzerland and four candidate countries);
(b) 42 economic sectors, including disaggregation of the energy sectors and 16 service sectors;
(c) 43 categories of household expenditure;

([25]) This appendix provides a short non-technical description of the energy-environment-economy model for Europe (E3ME), developed by Cambridge Econometrics. For further details, including the full technical manual, the reader is referred to the E3ME website: http://www.e3me.com. For a list of acknowledgements see the preface of the model manual.

(d) 19 different users of 12 different fuel types;
(e) 14 types of air-borne emission (where data are available) including the six greenhouse gases monitored under the Kyoto protocol;
(f) 13 types of household, including income quintiles and socioeconomic groups such as the unemployed, inactive and retired, plus an urban/rural split.

Typical outputs from the model include GDP and sectoral output, household expenditure, investment, international trade, inflation, employment and unemployment, energy demand and CO_2 emissions. Each of these is available at national and EU level, and most are also defined by economic sector.

The econometric specification of E3ME gives the model a strong empirical grounding and means it is not reliant on the assumptions common to computable general equilibrium (CGE) models, such as perfect competition or rational expectations. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g., up to 2020) and rebound effects ([26]), which are included as standard in the model's results.

The E3ME results are made consistent with the published figures using a set of scaling factors; this procedure is described in more detail in the model manual. However, some additional steps are necessary to provide E3ME with all the information it needs. These steps mainly include the estimation of economic series that are not included in Primes ([27]) and interpolation to obtain annual results. Additionally, the E3ME baseline has included a more up-to-date version of the short-term estimates for the macroeconomic variables. The estimates are for 2010-12 from the annual macroeconomic (AMECO) database of the European Commission's Directorate-General for Economic and Financial Affairs. The version included was published in November 2011.

The baseline labour market projections are the ones produced for Cedefop as part of the skills forecasting exercise carried out in 2011, which incorporated the latest Eurostat population projections (the 2010 based) and comments from country experts.

The current version of the E3ME baseline projection better captures the impact of the recession than the published Primes baseline because:

(a) data in 2009 are included in the database and the estimation;

([26]) Where an initial increase in efficiency reduces demand, but this is negated in the long term as greater efficiency lowers the relative cost and increases consumption (Barker et al., 2009).

([27]) Projections in Primes are presented from 2010 onwards in five-year steps until 2030.

(b) the latest short-term macroeconomic estimates from AMECO database are included;
(c) the latest (2010 based) Eurostat population projections are included;
(d) the labour market projections produced for Cedefop as part of the skills forecasting exercise carried out in 2011 are included.

E3ME key strengths and limitations

In summary, the key strengths of E3ME lie in three different areas:
(a) the close integration of the economy, energy systems and the environment, with two-way links between each component;
(b) the detailed sectoral disaggregation in the model's classifications, allowing for the analysis of similarly detailed scenarios;
(c) the econometric specification of the model, making it suitable for short and medium-term assessment, as well as longer-term trends.

The main limitation of E3ME is the disaggregation of its sectors. The industry classification is relatively detailed, covering 42 sectors at the NACE two-digit level. However, due to the availability of the data, it is not possible to go into more detail, for example to the firm-based level, or to very detailed product groups. For this type of analysis our recommendation is that the model (which provides an indication of indirect effects) is used in conjunction with a more detailed bottom-up or econometric analysis (which can capture detailed industry-specific effects).

The other main limitations to the model relate to its dimensions and boundaries. Broadly speaking E3ME covers the economy, energy and material demands and atmospheric emissions. While it is possible to provide an assessment of other policy areas, it is necessary to make assumptions about how this is translated into model inputs. Also, the scenario impacts assume no labour market constraints, other than the size of national workforces, while excluding the possibility of cross-border labour mobility or extra-EU migration ([28]). The main assumption regarding labour market flexibility is that it is a continuation of previous trends.

In E3ME, public sector employment is not modelled using econometric equations as it is instead assumed that the employment decisions in these sectors are determined by policy decisions. In light of changes to tax and benefits systems, it becomes necessary for these to be adjusted manually so that employment in these sectors increases to match the fall in the employer's social

([28]) These limitations are common also to the Cedefop forecasts, though attempts to address these have been assessed in the past with only limited success.

security contribution rates, in other words, so that tax revenues from the public sector employment remain the same.

The model also does not account for the potential economic damage from climate change and, hence, omits the economic benefits from mitigation policies that operate through reduced environmental disruption. Evidence suggests that the economic and employment damage from climate change may be large, including substantial destruction of physical capital through more intense and frequent storms, droughts and floods, for example from a rise in sea level and storm surge in heavily populated coastal areas. In the medium term scope of this research, such risks are relatively small (Chateau et al., 2011).

Policy scenario inputs

Energy target scenario

Policies in the environmental policy scenario include the ones in the Primes reference case as well as the energy saving obligations. The following table builds on the one included for the Directorate-General for Employment study to include the energy saving obligations measures (last measure included).

Table A4.1 **How policies are translated into E3ME inputs in the sustainable energy scenarios**

Policy measure	How the measure is reflected in E3ME
Regulations and decisions	
Regulation 2009/642/EC on ecodesign requirements for televisions	Improvement in energy efficiency through exogenous reduction in household and commerce demand for energy (*source*: Primes reference scenario projection compared to the baseline scenario). Assumed labelling costs do not lead to price increases.
Regulation 2009/643/EC on ecodesign requirements for household refrigerating appliances	
Regulation 2009/641/EC on ecodesign requirements for circulators	
Recast of the energy performance of buildings Directive 2010/31/EU	Assumed slight increase in average price estimated in construction industry to reflect higher costs, derived from an estimate of GBP 100 per energy performance certificate (*source*: UK government).
Regulation 2009/1222/EC on the labelling of tyres	A small exogenous reduction in middle distillates demand from road transport (*source*: Primes reference scenario projection compared to the baseline scenario).
Regulation 2009/640/EC on ecodesign requirements for electric motors	not modelled
Regulation 2009/595/EC on type-approval of motor vehicles and engines	not modelled

Decision 2009/406/EC on the effort of Member States to reduce their greenhouse gas emissions	Additional regulation costs to the non-ETS sectors to meet the target (half of the reduction target met by regulation the other half by market-based instruments). Emissions targets calculated from Primes Reference scenario projections compared to the Baseline.
Directive 2009/28/EC on the promotion of the use of energy from renewable sources	Additional renewable investment made by electricity sector (investment figures come from Primes reference scenario). Renewable energy sources in power generation targets are met nationally (information from Primes Reference scenario). The price of electricity increases to finance investment in renewables.
Renewable energy sources Directive 2009/28/EC (Transport)	Exogenous shift in transport fuel demand from middle distillates to biofuels ([a]) (*source*: Primes reference scenario projection compared to the baseline scenario). A 1% increase in average fuel price for road transport to reflect higher costs of biofuels ([b]).
Market-based instruments	
EU emission trading system (ETS)	Full ETS implementation (roughly half of the allowances are auctioned) ([c]).
Decision 2009/406/EC on the effort of Member States to reduce their greenhouse gas emissions	Introduction of carbon pricing to the non-ETS sectors to meet the target (half of the reduction target through market-based instruments, the other half through regulation). Emissions targets calculated from Primes reference scenario projections compared to the baseline scenario.
Other inputs	
ETS price	Adjusted to meet the ETS emission targets in the reference case. ETS price assumption in the baseline case from Primes.
Revenue recycling	
Revenues from market-based instruments	Recycled through reductions in income tax (at national level). Half of ETS revenues get recycled through reductions in income tax (at national level).
Energy efficiency	
Energy efficiency directive proposal 2011/0172/COD (energy saving obligation) Ordinary legislative procedure	Energy efficiency increase is 9.4% (compared to 7.4% in the baseline scenario). Households, commerce and transport sectors have a higher potential of meeting the energy saving obligations (1.5% pa from 2013 onwards); the industry fuel users are not included in this measure.
Other assumptions	
Emissions from non-energy use	Included in effort-sharing.
Non-greenhouse gas emissions	Assumed to fall in line with CO_2.

([a]) This directive also includes other fuels such as green electricity and hydrogen, but this is generally not reflected in the Primes scenario and we adopt a similar assumption.

([b]) UK data show that bioenergy is around 10% more expensive per unit of energy, therefore an increase in its contribution to 10% of total fuel would yield a maximum price increase of 10%*10%=1%.

([c]) Directorate-General for climate action: 15 Mar 2011 EU ETS phase 3 allowance auctions: Statement by Jos Delbeke, Director-General for Climate Action. This represents the share used by power generation.

Source: Primes reference scenario projections (European Commission, 2010c) and Cambridge Econometrics' own interpretation.

The energy and employment target scenario

In the energy and employment target scenario, three additional policy measures are introduced to augment the energy target scenario:

(a) revenues from EU ETS revenue actions are used to reduce labour costs (rather than income taxes) ([29]);

(b) employers' social contributions are cut further, using net revenues raised from social benefit cuts;

(c) country-wide increases to research and development (R&D) spending.

In the energy policy scenario, revenues raised from the EU ETS are used to reduce direct income tax. In this scenario, revenues are instead used to reduce employers' social security contribution.

This scenario and the energy target scenario are revenue neutral, meaning that there is no net impact on government budgets; they represent a shift in net tax revenues rather than an increase or decrease. The maximum reduction in employers' social contributions considered feasible in the scenario was 10 percentage points, which still represents a substantial shift; while if, for example, the rates of employers' social security contributions are already low in certain countries, then the room for further reductions is consequently small.

Gradual year-on-year reductions in the tax wedge between 2012 and 2015 are introduced to smooth the rate of policy introduction. For example, instead of a 10 percentage point reduction in employers' social security contribution in Belgium throughout 2012-20, we now have 2.5 percentage point reduction in 2012, 5 percentage point reduction in 2013, 7.5 in 2014 and a 10 in 2015-20.

The absolute size of the cut depends on the gap in meeting target and baseline social security contributions. If, for example, the rates are already low in some countries, then the reduction is necessarily relatively small since rates cannot fall below zero. Details of modelled changes in this scenario are provided below in Table A4.2. In the energy and employment target scenario, a further per annum increase in GDP growth above baseline levels of 0.5 percentage points from 2012 to 2015 is introduced into the model.

([29]) The *Roadmap for moving to a competitive low-carbon economy* (European Commission, 2010a) shows that using revenues from the auctioning of ETS allowances and CO_2 taxation to reduce labour cost would have positive impacts on employment.

Table A4.2 **Detailed breakdown of assumed Member States policies in the employment policy scenario, percentage point change from baseline**

	Employer's social security contribution	Benefit rates	Direct income tax rates	R&D investment
Austria	-10.0	-16.4	0.91	10
Belgium	-10.0	-27.3	0.63	11
Bulgaria	-22.0	-1.4	0.03	12
Cyprus	-10.0	-5.4	0.30	13
Czech Republic	-10.0	-28.6	0.37	14
Denmark	-0.1	-8.8	0.31	15
Estonia	-10.0	-7.9	0.53	16
Finland	-10.0	-9.3	0.16	17
France	-25.0	-5.0	0.66	18
Germany	-10.0	-0.6	0.25	19
Greece	-20.0	-9.8	0.05	20
Hungary	-30.0	-8.0	1.59	21
Iceland	-1.5	-14.1	0.30	22
Ireland	-6.5	-11.9	0.83	23
Italy	-30.0	-16.0	1.07	24
Latvia	-10.0	-8.3	0.44	25
Lithuania	-10.0	-21.7	0.35	26
Luxembourg	-10.0	-9.6	0.10	27
Malta	-7.5	-3.9	0.03	28
Netherlands	-1.5	-9.2	0.22	29
Norway	-10.0	0.0	0.00	30
Poland	-14.0	0.0	0.00	31
Portugal	-15.0	0.0	0.00	32
Romania	-15.0	0.0	0.00	33
Slovakia	-20.0	0.0	0.00	34
Slovenia	-10.0	0.0	0.00	35
Spain	-23.0	0.0	0.00	36
Sweden	-10.0	0.0	0.00	37
Switzerland	-4.0	0.0	0.00	38
UK	-10.0	0.0	0.00	39

Source: E3ME, Cambridge Econometrics.

Table A4.3 **Assessment of the policy options for meeting the employment**

Policies for meeting employment targets	Carbon impact	Energy impact	Jobs impact	Feasibility to model	Comment
Labour market policies					
Increase retirement age	Low	Low	High	Feasible	Labour supply will be increased but it might result in a lower employment rate
Policies targeted at vulnerable groups	Low	Low	Medium	Unfeasible	Not feasible using E3ME
Increasing jobs with flexible work hours	Medium	Medium	Medium	Unfeasible	Not feasible using E3ME
Reduce taxes for low wage earners	Low	Low	Medium	Unfeasible	Taxes for different socioeconomic groups are not available in the E3ME model
Reduce the barriers to return to the labour market	Low	Medium	Medium	Unfeasible	Not feasible using E3ME
Active labour market policies (ALMP)	Low	Low	Medium	Maybe	Difficult to model and capture impact using E3ME
Reduce the level of social benefit payments (i.e. unemployment benefits)	Low	Low	Low	Feasible	Modelled in energy and employment target scenario
Employment protection legislation	Low	Low	Medium	Unfeasible	Not feasible using E3ME and ambiguous jobs effect
Skills policies					
Provide training focusing on older and young workers	Low	Low	Medium	Maybe	Difficult to model and capture impact using E3ME
Improve quality of education (tertiary education system)	Low	Low	Medium	Maybe	Difficult to model and capture impact using E3ME
Reduce school drop-out rates, provide career guidance/ vocational training/lifelong learning programmes	Low	Low	Medium	Maybe	Difficult to model and capture impact using E3ME
Improving public sector productivity	Medium	Medium	Medium	Maybe	Ambiguous jobs effect
Economic policies					
Eco-tax policy (tax wedge: labour tax or consumption tax)	Low	Low	Low	Feasible	Modelled in energy and employment target scenario
Raising R&D financing (up to 3% of GDP in the EU is another EU 2020 goal)	Medium	Medium	Low	Feasible	Modelled in energy and employment target scenario
Other policies					
Renewable energy investment programme	Low	Medium	Medium	Feasible	Modelled in all sustainable energy scenarios
Energy efficiency improvement programme	Low	Low	Medium	Feasible	Modelled in all sustainable energy scenarios

NB: Key to colour band:

Impact	Low	Medium	High
Feasibility	Feasible	Maybe	Unfeasible

Source: Ahlo, 2011; European Commission, 2011b.

ANNEX 5.
Detailed model outputs

Table A5.1 **Baseline employment by broad industry 2012-20 (average annual growth rate, %)**

	BE	DK	DE	EL	ES	FR	IE	IT	LUX	NL	AT	PT	FI	SE	UK
Agriculture	-0.9	-2.4	-0.4	-1.0	-0.6	-0.5	1.1	-2.2	-1.0	-0.6	-0.5	-0.7	-0.4	-1.9	-0.6
Extraction industries	0.0	-0.8	-2.7	0.8	-0.3	0.3	-3.0	-1.7	0.0	-1.7	-0.7	0.0	0.5	2.9	-2.0
Basic manufacturing	-0.7	-0.2	-0.4	1.0	-0.1	0.0	-0.1	-0.1	0.4	-0.6	0.0	-0.6	-0.1	0.1	0.0
Engineering and transport equipment	-1.1	0.0	-0.3	0.5	0.4	0.0	0.1	0.2	-0.9	0.3	-0.4	0.9	0.2	0.7	-0.3
Utilities	-1.6	-0.2	-0.2	0.7	1.6	0.3	0.9	-1.6	-0.7	0.4	-2.3	0.4	-1.2	1.2	-0.7
Construction	0.7	1.8	0.0	-0.7	-1.0	1.0	3.0	-0.3	-0.2	0.8	1.1	0.6	0.2	1.0	0.7
Distribution and retail	0.5	0.6	-0.2	1.5	1.5	1.0	0.9	0.5	0.6	1.2	0.2	2.0	0.9	0.6	0.6
Transport and communications	0.9	0.4	-0.4	-0.6	1.2	-0.2	0.4	0.6	0.9	-0.5	0.4	-0.4	1.2	0.5	0.4
Business services	1.8	1.5	0.2	1.3	1.5	2.0	1.2	2.2	1.8	0.6	1.3	1.1	0.4	0.9	1.1
Public services	1.2	0.3	-0.2	0.9	0.1	0.4	0.6	0.3	0.5	0.5	0.3	-0.5	0.0	0.5	0.3

	CZ	EE	CY	LV	LT	HU	MT	PL	SI	SK	BG	RO	NO	CH	IS
Agriculture	-1.0	-1.2	-1.5	-1.5	-1.0	0.1	-1.9	-1.0	-2.4	-2.2	-1.1	-1.0	-1.6	-1.0	0.5
Extraction industries	-0.4	-3.0	0.0	-4.2	-0.7	-2.3	-1.4	-4.3	-0.6	-0.5	0.4	-1.8	-0.6	0.3	0.0
Basic manufacturing	-0.3	1.1	0.1	2.0	0.0	0.8	-1.0	-0.8	-0.2	0.1	-2.4	0.2	-0.8	1.1	0.0
Engineering and transport equipment	0.0	0.1	0.6	1.7	0.3	0.3	-0.5	-0.6	1.5	0.0	-0.3	0.4	-0.2	0.4	1.3
Utilities	0.5	-0.1	-0.4	-2.5	-2.0	0.0	-0.4	-3.0	-0.4	0.5	0.8	-0.4	0.6	0.3	-2.7
Construction	0.3	1.7	2.8	1.5	0.7	0.3	0.3	0.9	0.4	2.0	0.0	0.5	1.0	0.1	0.3
Distribution and retail	0.5	0.6	2.7	1.2	0.6	-0.2	0.7	0.7	0.8	0.8	0.6	1.0	1.0	1.5	-0.5
Transport and communications	-0.1	-0.2	1.5	0.9	0.6	0.1	-0.5	1.3	0.6	-0.6	-0.3	1.9	0.3	1.1	1.2
Business services	1.2	1.7	2.1	2.2	2.1	1.4	1.2	1.0	0.3	1.7	0.9	1.4	3.1	1.2	-0.2
Public services	0.7	0.3	0.7	-0.2	0.8	0.0	0.5	-0.2	0.5	1.2	0.7	0.4	1.3	1.0	0.6

Source: E3ME, Cambridge Econometrics.

Table A5.2 **Energy target scenario, employment by broad industry 2012-20 (average annual growth rate, %)**

	BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FI	SE	UK
Agriculture	-0.9	-2.4	-0.3	-1.0	-0.6	-0.5	1.1	-2.2	-1.0	-0.6	-0.5	-0.7	-0.4	-1.9	-0.6
Extraction industries	0.0	-0.8	-2.7	0.8	-0.3	0.3	-3.0	-1.7	0.0	-1.7	-0.7	0.0	0.5	2.9	-2.0
Basic manufacturing	-0.6	-0.2	-0.4	1.0	0.0	0.1	-0.1	-0.1	0.5	-0.5	0.1	-0.5	-0.1	0.1	0.0
Engineering and transport equipment	-1.0	0.1	-0.3	0.5	0.4	0.1	0.1	0.3	-0.8	0.4	-0.5	1.0	0.2	0.7	-0.3
Utilities	-1.8	-0.4	-0.3	0.4	1.5	0.1	0.6	-1.7	-0.9	0.5	-2.4	0.3	-1.3	1.1	-0.9
Construction	0.8	1.9	0.1	-0.6	-0.9	1.0	3.1	-0.2	-0.1	0.8	1.1	0.8	0.1	1.1	0.8
Distribution and retail	0.5	0.6	-0.2	1.5	1.6	1.0	0.9	0.5	0.6	1.2	0.2	2.0	0.9	0.6	0.6
Transport and communications	1.0	0.4	-0.4	-0.6	1.2	-0.2	0.4	0.7	0.9	-0.5	0.4	-0.4	1.2	0.5	0.5
Business services	1.9	1.6	0.2	1.3	1.5	2.1	1.2	2.2	1.8	0.6	1.2	1.1	0.4	0.9	1.1
Public services	1.2	0.3	-0.2	0.9	0.1	0.4	0.6	0.3	0.5	0.5	0.3	-0.5	0.0	0.5	0.3

	CZ	EE	CY	LV	LT	HU	MT	PL	SI	SK	BG	RO	NO	CH	IS
Agriculture	-1.0	-1.1	-1.5	-1.5	-1.0	0.1	-1.9	-1.0	-2.4	-2.2	-1.1	-1.0	-1.6	-1.0	0.6
Extraction Industries	-0.4	-3.0	0.0	-4.2	-0.7	-2.3	-1.4	-4.3	-0.6	-0.5	0.4	-1.8	-0.6	0.3	0.0
Basic manufacturing	-0.3	1.2	0.1	2.0	0.2	0.8	-1.0	-0.8	-0.2	0.2	-2.4	0.3	-0.8	1.2	0.2
Engineering and transport equipment	0.0	0.1	0.6	1.8	0.4	0.3	-0.5	-0.7	1.6	0.2	-0.3	0.6	-0.1	0.4	1.2
Utilities	0.4	-0.4	-0.7	-2.6	-2.0	-0.1	-0.6	-3.2	-0.5	0.5	0.2	-0.5	-0.7	-0.7	-2.9
Construction	0.4	1.8	2.9	1.5	1.0	0.3	0.4	1.0	0.5	2.3	0.0	0.5	1.1	0.2	0.3
Distribution and retail	0.5	0.6	2.7	1.2	0.6	-0.1	0.7	0.8	0.8	0.8	0.7	1.0	1.0	1.5	-0.5
Transport and communications	0.0	-0.1	1.5	0.9	0.6	0.1	-0.4	1.5	0.6	-0.5	-0.3	1.9	0.4	1.2	1.3
Business services	1.2	1.7	2.1	2.2	2.1	1.4	1.3	0.9	0.4	1.8	1.0	1.4	3.1	1.2	-0.1
Public services	0.7	0.3	0.8	-0.2	0.8	0.0	0.5	-0.2	0.5	1.2	0.7	0.4	1.3	1.0	0.6

Source: E3ME, Cambridge Econometrics.

Table A5.3 **Energy and employment target scenario, employment by broad industry 2012-20 (average annual growth rate, %)**

	BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FI	SE	UK
Agriculture	-0.7	-2.4	0.9	0.0	1.2	0.8	1.1	1.1	-0.9	-0.5	-0.1	0.5	0.8	-1.7	1.1
Extraction industries	0.0	-0.8	-2.7	0.8	-0.3	0.3	-3.0	-1.7	0.0	-1.7	-0.7	0.0	0.5	2.9	-2.0
Basic manufacturing	-0.2	0.0	0.1	1.5	1.0	0.9	0.5	1.6	1.1	-0.4	1.8	-0.4	0.5	1.4	2.0
Engineering and transport equipment	-0.7	0.0	0.0	0.3	-0.4	2.7	0.7	1.5	-0.8	0.7	0.9	2.0	1.2	1.2	1.4
Utilities	-1.5	0.0	0.3	0.5	1.4	0.5	1.1	-1.4	-0.8	1.1	-1.8	0.7	-0.7	1.9	-0.2
Construction	2.5	1.5	0.9	-0.8	-0.2	1.0	4.1	0.6	5.2	1.8	1.6	4.1	1.0	2.1	1.7
Distribution and retail	0.5	1.0	0.2	2.1	2.3	1.4	1.1	1.2	1.0	1.6	0.6	2.2	1.6	1.3	0.9
Transport and communications	1.5	3.0	0.5	0.5	2.6	-0.1	0.7	1.5	2.3	-0.2	0.6	-0.2	0.9	0.9	3.2
Business services	2.4	2.0	0.9	1.9	1.6	2.7	1.5	3.0	2.3	0.9	1.1	2.4	1.3	1.4	2.3
Public services	3.0	0.4	-0.1	0.9	0.7	0.5	0.6	0.7	0.6	0.5	0.5	-0.4	0.0	0.6	0.3

	CZ	EE	CY	LV	LT	HU	MT	PL	SI	SK	BG	RO	NO	CH	IS
Agriculture	-0.4	-0.2	-0.4	0.3	-0.7	1.7	-1.7	0.0	-1.7	-1.9	2.0	-1.0	-1.6	-1.0	0.3
Extraction industries	-0.4	-3.0	0.0	-4.2	-0.7	-2.3	-1.4	-4.3	-0.6	-0.5	0.4	-1.8	-0.6	0.3	0.0
Basic manufacturing	0.7	1.6	1.2	2.4	0.9	1.7	-0.7	0.2	0.4	1.1	-1.8	1.3	-0.3	0.9	0.3
Engineering and transport equipment	0.7	0.9	1.8	2.1	0.4	2.9	-0.2	-0.4	1.9	1.2	0.4	1.2	-0.8	1.1	0.6
Utilities	0.6	0.4	-0.1	-2.6	-2.0	0.2	-0.4	-3.0	-0.1	0.6	0.6	-0.3	-0.8	-0.5	-2.6
Construction	1.2	2.4	3.9	2.4	1.7	0.3	1.2	1.9	2.0	3.3	3.3	1.5	2.1	1.0	0.3
Distribution and retail	0.6	1.2	3.2	1.3	0.9	0.6	1.2	1.1	1.3	1.9	0.8	1.4	1.5	1.9	0.8
Transport and communications	1.1	1.5	2.2	1.1	1.0	0.5	0.3	2.6	1.2	-0.1	0.4	2.1	0.5	1.1	1.3
Business services	1.9	2.2	3.0	2.2	2.4	2.6	1.5	1.1	1.0	2.4	1.7	2.6	4.1	1.6	2.0
Public services	0.9	0.5	1.0	0.0	1.0	0.4	0.6	-0.2	0.6	2.0	0.7	1.1	1.3	1.1	0.6

Source: E3ME, Cambridge Econometrics.

Table A5.4 **Employment rate in 2020 under the different scenarios (%)**

	Baseline	Energy target scenario	Energy and employment target scenario	Targets ([a])
Austria	76	76	79	77-78
Belgium	71	72	77	73.2
Bulgaria	67	67	74	76
Cyprus	76	76	79	75-77
Czech Republic	76	77	80	75
Denmark	79	79	81	80
Estonia	79	79	83	76
Finland	78	78	82	78
France	71	71	75	75
Germany	78	78	81	77
Greece	61	61	64	70
Hungary	65	65	71	75
Iceland	83	83	86	n/a
Ireland	68	68	69	69-71
Italy	62	63	68	67-69
Latvia	76	76	78	73
Lithuania	74	74	77	72.8
Luxembourg	72	72	81	73
Malta	65	66	68	62.9
Netherlands	80	80	82	80
Norway	82	82	84	n/a
Poland	66	66	69	71
Portugal	72	72	77	75
Romania	68	68	71	70
Slovakia	70	70	75	72
Slovenia	72	73	76	75
Spain	64	64	69	74
Sweden	82	82	85	80
Switzerland	84	85	87	n/a
UK	75	75	80	75 ([b])
EU-27	71	71	75	73.7-74 ([c])
# EU-27 countries to meet the target	11	11	22	

([a]) As set by Member States in their national reform programmes in April 2011.

([b]) There is no explicit target for the UK and therefore the benchmark rate of 75% is assumed.

([c]) This figure is based on the European Commission's own estimate of the aggregate EU employment target derived by summing and weighting the national targets.

NB: The EU 2020 employment target is calculated by dividing the number of employed aged 20-64 by the total population aged 20-64. The indicator is based on the EU labour force survey. As data are based on the national accounts measure, the employment rates in scenarios are calculated after correcting this discrepancy.

Figures are highlighted in blue when the national targets are met.

Source: E3ME, Cambridge Econometrics.

Table A5.5 **EU-27+ employment by sector (% difference from baseline), 2020**

	Energy target scenario	Energy and employment target scenario
Agriculture	0.1	9.8
1. Agriculture, forestry and fishing	0.1	9.8
Extraction industries	0.0	0.0
2. Coal	0.0	0.0
3. Oil and gas	0.0	0.0
4. Other mining	0.0	0.0
Basic manufacturing	0.2	8.0
5. Food, drink and tobacco	0.1	6.7
6. Textiles, clothing and leather	0.1	7.2
7. Wood and paper	0.0	13.6
8. Printing and publishing	0.2	10.7
9. Manufactured fuels	-0.5	10.7
10. Pharmaceuticals	-0.1	6.8
11. Chemicals nes	0.1	5.3
12. Rubber and plastics	0.4	8.4
13. Non-metallic mineral products	0.5	5.8
14. Basic metals	1.1	15.3
15. Metal goods	0.3	5.0
Engineering and transport equipment	0.3	7.1
16. Mechanical engineering	0.4	10.3
17. Electronics	0.8	10.6
18. Electronic engineering and instruments	0.4	5.6
19. Motor vehicles	0.2	15.1
20. Other transport equipment	0.1	0.1
21. Manufacturing nes	-0.1	9.1
Utilities	-1.4	1.4
22. Electricity	-1.4	-0.6
23. Gas supply	-4.2	-2.8
24. Water supply	0.0	0.0
Construction	0.5	7.3
25. Construction	0.5	7.1
Distribution and retail	0.1	3.7
26. Distribution	0.1	3.3
27. Retailing	0.1	2.9
28. Hotels and catering	0.1	6.3
Transport and communications	0.2	8.3
29. Land transport and support services	0.2	10.9
30. Water transport	0.0	12.3
31. Air transport	0.7	6.0
32. Communications	0.1	1.8
Business services	0.2	5.8
33. Banking and finance	0.0	4.9
34. Insurance	0.0	3.2
35. Computing services	0.2	2.1
36. Professional services	0.2	8.0
37. Other business services	0.1	5.1
41. Miscellaneous services	-0.1	8.4
Public service	-0.1	1.7
38. Public administration and defence	0.0	3.4
39. Education	0.0	3.3
40. Health and social work	0.0	3.0

NB: nes = not elsewhere specified.
Source: E3ME, Cambridge Econometrics. Aggregated outputs by broad industry in Table 1.

ANNEX 6.
Sustainable energy policy context

Table A6.1 **National renewable energy promotion policies in the EU**

Country	Feed-in tariff	Renewable portfolio standard	Capital subsidies, grants, or rebates	Investment or other tax credits	Sales tax, energy tax, excise tax, or VAT reduction	Tradable renewable energy certificates	Energy production payments or tax credits	Net metering	Public investment, loans, or financing	Public competitive bidding
Austria	✓		✓	✓		✓			✓	
Belgium		✓	✓		✓	✓		✓		
Cyprus	✓		✓							
Czech Republic	✓		✓	✓	✓	✓		✓		
Denmark					✓	✓		✓	✓	✓
Estonia					✓					
Finland			✓		✓	✓	✓			
France	✓		✓	✓	✓	✓			✓	✓
Germany	✓		✓	✓	✓				✓	
Greece	✓		✓	✓						
Hungary	✓				✓	✓			✓	
Ireland	✓		✓	✓		✓				✓
Italy	✓	✓	✓	✓		✓		✓		
Latvia	✓							✓		✓
Lithuania	✓		✓	✓				✓		
Luxembourg	✓		✓	✓						
Malta	✓				✓					
Netherlands	✓		✓	✓		✓	✓			
Poland		✓	✓		✓				✓	✓
Portugal	✓		✓	✓	✓					
Romania					✓					
Slovak Republic	✓			✓					✓	
Slovenia	✓								✓	
Spain	✓		✓	✓					✓	
Sweden		✓	✓	✓	✓	✓	✓			
UK		✓	✓		✓	✓				

Source: Cedefop (based on Cambridge Econometrics estimates).

Table A6.2 **National energy efficiency promotion policies in the EU**

Country	Tax incentive for buildings refurbishment	Soft loans for building refurbishment	Energy audits	Strengthening of low-energy building codes	Subsidies for efficient appliances, heating, cooling and lighting	Public procurement measures	Tax incentives and disincentives for freight vehicles	Modal shift measures	Eco-driving
Austria	✓			✓	✓	✓		✓	✓
Belgium	✓	✓	✓	✓	✓		✓	✓	
Bulgaria			✓						
Cyprus	✓					✓			
Czech Republic		✓	✓						
Denmark				✓					
Estonia			✓	✓					
Finland	✓		✓			✓		✓	✓
France	✓	✓	✓	✓		✓	✓		
Germany		✓	✓		✓		✓		✓
Greece	✓		✓				✓		✓
Hungary			✓		✓		✓		
Ireland	✓			✓		✓	✓	✓	✓
Italy	✓								
Latvia			✓						
Lithuania			✓						
Luxembourg				✓	✓		✓		
Malta			✓		✓	✓		✓	
Netherlands				✓		✓	✓		✓
Poland			✓						
Portugal	✓	✓	✓		✓	✓	✓	✓	✓
Romania			✓		✓	✓			
Slovak Republic		✓	✓		✓		✓	✓	✓
Slovenia	✓	✓	✓		✓	✓		✓	✓
Spain	✓		✓		✓		✓	✓	✓
Sweden				✓			✓		✓
UK	✓	✓		✓			✓		✓

Source: European Commission (2009b).

ANNEX 7. Domain analysis

Employment estimates for each of the domains of interest, which do not map directly onto standard industrial classifications included in E3ME, were projected by combining existing forecasts of energy capacity development for wind power and solar thermal, and of projected energy savings potentials in buildings and road freight transport, with established megawatt-to-job conversion ratios. Comparing the employment projections across domains provides a view of the relative contribution of the domains to achieving high employment, sustainable energy objectives and highlights the scale of VET response that is likely to be required in the Member States.

The averaging technique adopted across each of the four domains has the advantage of providing a simple metric for comparing employment for different technologies. Annual employment for a given technology is calculated based on only two parameters: annual energy output (in megawatt) and the employment multiplier (jobs per megawatt). This simplicity enables a straightforward implementation of a jobs model without having to track the exact details of combining one-time employment activities with continued employment on a year-to-year basis, and the approach converges to the correct number of cumulative job-years after several years.

A drawback of this technique, however, is that it underestimates total employment for a technology that is growing rapidly (e.g. renewable energy technologies), while overestimating employment for a technology that is reducing capacity (Wei et al., 2010).

Comparative overview of employment projections in the domains

Comparing the employment projections across domains provides a view of the relative contribution of the domains to achieving high employment, sustainable energy objectives, and highlights the scale of VET response that is likely to be required.

Of the four domains, employment associated with the development of wind energy capacity is the most significant, with the 333 000 wind-related jobs projected by 2020 corresponding to more than the sum of employment related to the other domains put together. However, while total levels of employment in

2020 sustained by the EU markets for solar thermal is relatively small (84 000 jobs by 2020), these markets are expected to grow by over 28% per year from 2012 to 2020.

The outlook for employment related to energy savings potentials for low-carbon buildings is also relatively small, while growing fast, though the qualitative analysis suggests that training and skill needs are likely to be considerable as those employed in more traditional construction areas are required to adapt to changing regulations and materials. The picture for road freight transport is more mixed since, as well as energy efficiency measures, there are also likely to be modal shifts to altogether cleaner modes of transport. The aggregate results are presented in Table A7.1.

Table A7.1 **Estimated number of jobs in sustainable energy domains in the EU, 2012-20 (000s)**

	2012	2020	Change 2012-20	Growth (% per annum)
Wind energy	188	333	145	9.6
Solar thermal	26	84	69	28.2
Low-carbon buildings	43	69	58	20.0
Low-carbon road freight	107	118	10	1.3

Source: Calculated by Cambridge Econometrics and ICF GHK. A full breakdown of employment projections from 2012 to 2020 by domain and country, along with details of the calculation methods is provided below.

Wind power

This domain includes both on- and offshore wind generation. Literature on employment in this domain includes estimates of jobs per megawatt of average capacity. The UNEP (2008) report on green jobs contains a survey of such estimates split by manufacturing, construction and installation activities (CAPEX) and operations, maintenance and fuel processing (OPEX) activities ([30]). It follows that, on average, approximately 84% of jobs associated with wind power relate to CAPEX activities.

Multiplying these converter estimates by the forecasts of wind power electricity generation capacity, corresponding to the Directorate-General for Energy (Primes) baseline projections used in E3ME, creates an estimate of jobs projections of the average employment over the lifetime of a wind power

([30]) 1.47 jobs per megawatt of average capacity for CAPEX related jobs and 0.27 jobs per megawatt of average capacity for OPEX related jobs.

facility/installation, i.e. full time employment for one person over the lifetime of the facility.

Solar thermal

This domain refers specifically to solar thermal heating and cooling and excludes the more prevalent photovoltaic solar power generation. Since solar thermal systems do not generate electricity or steam they are not included in the Primes projections. Data on solar thermal capacity are relatively scarce; however, EurObserver produces a series of market reports on the solar thermal industry and, from these, capacity estimates by Member States for 2007-10 have been obtained ([31]). From 2010 onwards, annual growth rates over 2010-20 in projected capacity at Member States level are obtained from Energy Research Centre of the Netherlands and European Environment Agency (2011) ([32]).

The UNEP (2008) report on green jobs does not contain job-per-megawatt estimates for solar thermal power. Instead is uses material from Wei et al. (2010), which includes a survey of jobs per megawatt capacity estimates for solar thermal systems. We have applied the midpoint ([33]) of the surveyed jobs per megawatt capacity estimates to the capacity series provide in EurObserver.

Low-carbon public buildings

This domain includes work activities relating to energy savings in buildings construction and use of heating and electrical appliances. Statistics on the proportion of employment attributable to public buildings as a proportion of all buildings are not available.

For the purpose of calculating the overall estimates, the buildings sector, taken as a whole, includes:

(a) dwellings (excluding electricity for lighting and appliances),
(b) tertiary buildings (including electricity for lighting, fans and air-conditioning),
(c) office buildings in industry.

The *Study on the energy savings potentials in EU Member States* (European Commission and Fraunhofer Institute et al., 2009) provides estimates from 2010

([31]) EurObserver solar thermal barometer series (2008-11).

([32]) Calculated average annual growth for energy from solar thermal for 2010-20.

([33]) 0.27 jobs per megawatt average capacity for CAPEX related jobs and 0.53 jobs per megawatt average capacity for OPEX related jobs.

to 2020 for buildings (considering both electrical and heating needs) and for road freight transport, measured in gigawatt hours (GWh).

Taking the midpoint of the high policy intensity and low policy intensity scenarios offers a conservative estimate of the energy savings potential to be realised up to 2020, since the low policy intensity scenario is felt to be attainable with no additional action, and misses the EU 2020 objectives (European Commission, 2012b).

Multiplying these estimates of energy saving potential by estimates of jobs per unit of energy saving cited in Wei et al. (2010) ([34]) provides Member State projections of the average level of employment over the lifetime of the building i.e. full time employment for one person for a duration of one year (job-years).

Low-carbon road freight transport and logistics

Estimates of final energy savings potentials for road goods transport are included in the Fraunhofer Institute et al. (2009) projections. To estimate employment from these data, as with buildings, the midpoint of the high and the low policy intensity scenarios were multiplied by the estimate of full-time equivalent jobs per gigawatt hours of energy savings cited in Wei et al. (2010) ([35]). This provides projections by Member States of the average level of employment over the lifetime of the vehicle or facility, i.e. full time employment for one person for the duration of one year (job-years).

([34]) An average multiplier of 0.38 job-years per gigawatt hours is assumed. This figure is taken directly from ACEEE (2008), cited in Wei et al. (2010).

([35]) Ibid.

European Centre for the Development of Vocational Training

Skills for a low-carbon Europe

The role of VET in a sustainable energy scenario

Synthesis report

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This report provides an analysis of the labour market impacts of EU policy interventions designed to support the transition to a job-rich, low-carbon economy.

The approach taken is innovative as it combines quantitative (econometric modelling) and qualitative (case study) methods to investigate the expected impact of sustainable energy policies on employment and skills demand, while providing insights for the development of effective policies for VET activities that allow skills demands to be met.

This report claims that the climate and energy targets can be achieved at the same time as EU employment targets. However, to do so requires greater integration of climate and energy polices with measures to support employment and skills development across the EU. Recognising the complementarity of education and training policies to low-carbon strategies is essential to ensuring skills needs are met and that the transition process is not held back.

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