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Improving the Effectiveness of Green Local Development

THE ROLE AND IMPACT OF PUBLIC SECTOR-LED INITIATIVES IN RENEWABLE ENERGY

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Executive summary

Global renewable energy

This report presents a snapshot of the global renewable energy industry and investigates what this global industry can mean for local development. This industry is rapidly growing in response to countries' activities to reduce their carbon emissions. Three interlinked trends characterise the energy market:

- a move to renewable and low-carbon emission energy sources
- increasing development of distributed scale energy production and distribution systems
- the increased focus on energy efficiency to ensure that energy is used in the most productive way; therefore requiring a less or stable amount of energy to meet current or increased production needs.

Globally, renewable energy continued to grow strongly in 2012 in both OECD and non-OECD countries. The latest analysis by the International Energy Agency (2013) shows the following activity of the renewable technology sector:

- solar photovoltaic (PV) generation capacity has grown by an estimated 29-30 GW (42%) since 2010
- wind generation capacity both onshore and offshore has grown by 44-45 GW (19%)
- non-hydropower generation has risen by an estimated 142 TWh since 2010 (19%) and hydropower generation has increased by 108 TWh (3%)
- in total, non-hydropower generation capacity increased by 77 GW (19%) in 2011, while hydropower capacity expanded by 35 GW (3%) in the same year.

Countries are also developing renewable energy capacity at scale, with accelerated growth of the number of countries that have installed capacity above 100 MW expanding rapidly in all technologies.

This growth will need to continue if we are to stabilise global carbon emissions to 450 parts per million: renewable energy will need to account for 28% of global electricity generation by 2020 and 57% by 2050 (IEA, 2012). This increase will require contributions from all major countries. The IEA (2012) forecasts that by 2020 the largest proportion of global renewable electricity generation will come from the People's Republic of China (24%), followed by European OECD countries (19%), the United States (11%), Brazil (7%) and India (5%).

The renewable energy industry is now a significant sector in its own right with global investment in renewable generation capacity increasing by USD 230 billion in the years between 2001 and 2012. Public research and development activity in renewables is also increasing (almost back to the pre-global financial crisis peaks) as to is patenting activity in renewables.

Local benefits of renewable energy

The benefits of renewable energy at a global and national scale are evident; however, they are less so in particular local areas and regions. Many OECD governments see the renewable energy supply chain as a promising sector for the creation of valuable and stable jobs, particularly in regional and rural areas, since exploitation of major renewable energy sources is space-intensive and thus likely to develop primarily in these areas (OECD, 2012a). The deployment of renewable energy is therefore increasingly seen as a key development opportunity for rural regions and a way for governments to give substance to "green growth" claims. The main benefits can be summarised as follows:

- providing new job and business opportunities
- creating an opportunity for diversifying regional economies
- generating innovation in products, practices and policies in regions
- skills development and community capacity building
- affordable energy.

However, economic and workforce development opportunities are often constrained by similar challenges to other new economic activities in regional or rural areas, such as limited infrastructure and/or limited availability of the necessary competences to deal with new sectors or new technology.

Local governments and other institutions will be central agents in the success of the transition of regional areas to low-carbon economies. Local governments typically hold multiple roles as decision makers, planning authorities, managers of municipal assets, operators of local energy providers and role models for the public (ICLEI, 2013). Local governments also have a large degree of influence, if not control, over land-use policies, which means they can influence what industries localise where, and in some instances set and control the regulatory limits for extraction and discharge activities (UNEP, 2012).

The challenges for accessing these benefits are striking the right balance of public policy mix, private investment and community support, and this will look different in each region. The notion of the average region is virtually meaningless (OECD, 2011a).

The aim of this report is to provide evidence and advice on the impact of low carbon activities in local areas. The case studies presented from Australia, Brazil, China, Mongolia, Spain and the United Kingdom highlight four conclusions for renewable energy development at the local level. The results are not a "recipe" for local areas to implement, but provide some of the key elements to consider for local strategic planning for the transition to a low-carbon economy.

Green energy initiatives can drive job creation and new business opportunities if they are integrated into other local development activities.

Renewable energy development offers the opportunity for new jobs as well as new business opportunities for regional businesses. These activities, in turn, offer additional revenue (from taxation and service charges) to local and regional governments. It also adds diversity and dynamism to the local economy.

It is difficult to calculate the "net" job generation potential of renewable energy to regions because this will be different for each region and will depend on the existing composition of industry. Evidence does suggest that the depth of integration of renewable energy activities within the local region, particularly if these are supported by national or central governments, will determine the region's ability to generate additional employment to that associated with the construction and maintenance of renewable power plants.

Integration comes through the other activities that support renewable energy, including governance arrangements, networking and network support, and the creation and incubation of skills and training ecosystems.

Fostering green energy initiatives requires inclusive governance arrangements.

Governance arrangements put in place by jurisdictions have a major influence over the success or failure of renewable energy policies. To ensure the success of green initiatives, governance arrangements need to include local and regional authorities, academia, industry and civil society. Processes also need to be in place to ensure accountability to all local stakeholders and the highest standards of transparency should be adopted.

Public policy activity in various forms (grants, legislative moves to price carbon, tariffs and other assistance to support the uptake of green activities) is driving much of the uptake of renewable energy. Public policy that builds on national and local advantages in renewable resources, proximity to energy consumption and grids, can quickly accelerate into sustainable employment and economic activities. These activities can then develop further without the need for public subsides, but only if the activity is truly embedded in the local economy in which it sits.

SMEs can catalyse and customise green energy initiatives through innovation and embeddedness in local/regional networks.

Even small and well-established technologies require some degree of local customisation and innovation (ICLEI, 2013). These activities are likely be carried out by small and medium-sized enterprises (SMEs), as the market potential is not big enough to interest larger firms. These new business opportunities can be catalytic when supported by policy instruments that drive demand. Innovation can also occur in the public sector and the governance arrangements that enclose green initiatives.

Access to finance is an area of key policy intervention relevant to many SMEs and Public financial institutions (PFIs) can support these green initiatives by channelling funds. In fact, several national PFIs (in Argentina, Germany, Mexico, Norway, Slovenia, and Turkey) and supra-national ones (Nordic Investment Bank, European Bank for Reconstruction and Development, Multilateral Investment Fund) have specific funding instruments for SMEs to invest in renewable energy projects. The majority of these instruments take the form of direct credit lines.

What sets a region on a path to innovation is openness to new ideas of business and other organisations in the region, and their ability to source and absorb new ideas; in effect, a region’s ability to learn. This is also strongly related to the training and skills ecosystem present in the region. A region’s capacity to innovate relates to the stock and quality of human capital embodied in its workforce. In fact, it is hard to imagine a region engaging in a sustained path of technological upgrading without an abundant supply of skilled labour (OECD, 2011a).

Green energy initiatives need strong skills and training ecosystems at the local level to provide a robust base for workforce development.

The successful transition to a low-carbon economy will only be possible by ensuring that the labour force is able to transfer from areas of decreasing employment to other industries, and if adequate human capital exists to develop new industries that will grow as a result of climate change mitigation and adaptation activities. Skills development activities will play a major role in each of these transitions (Martinez-Fernandez et al., 2012).

It is likely that a low-carbon economy will have in aggregate, a neutral or slightly positive overall impact on the labour force in terms of total employment (Cedefop, 2013; OECD, 2012c; UNEP, 2011), but impacts will be spread unevenly across countries, regions and types of workers. Therefore, the move to green jobs must also accrue other benefits to regions apart from net job increases. Capacity building and skill development within the regional communities are also important benefits of green initiatives. This is a further impetus for training and skills development activities to be part of the policy suite for renewable energy if any jurisdictions are to obtain the maximum outcomes they seek for their efforts.

Introduction

This report aims to provide evidence on the impact and benefits of green initiatives in local and regional areas. In particular, public sector-led initiatives in the renewable energy sector are investigated by examining a number of case studies of green initiatives.

This report defines green initiatives as public sector-led activities that reduce carbon emissions in energy supplies along the entire spectrum from generation to end use consumption. These activities also include community education and engagement and support to firms and organisations to take up green opportunities.

Addressing challenges

The challenge of accessing the benefits of green energy initiatives are striking the right balance of public policy mix, private investment and community support, and this will look different in each region. The notion of the average region is virtually meaningless (OECD, 2011a).

Renewable energy policy has two areas of emphasis: energy security and climate change mitigation. The economic development (particularly job creation) objective is not essentially linked to the other renewable energy policy objectives. For example, most renewable energy projects are capital-intensive activities, and energy as a whole represents a small share of employment in regional economies. Small-scale installations typically source labour and equipment from international suppliers, so the impact at the community level in terms of job creation is rather limited (OECD, 2012a). Therefore, how they play out in individual regional areas varies both because each region is different but also because each renewable energy proposal will have a different view of its economic development role.

Focus of the report

This report investigates a number of current approaches to support the public sector's adaptation to the green economy in view of removing the barriers to the emergence and expansion of greener practices and activities in the private sector. These approaches demonstrate ways in which the public sector can improve the quality of advice and services offered to enterprises (e.g. market prospection), workers (e.g. skills assessment) and the civil society (e.g. communication) to stimulate the green economy within local labour markets.

Issues to be addressed will concentrate on the embeddedness of the projects, their innovation and technological component on the local economic development plans of the area, their impact on skills supply and demand, transition effects in the local skills and training ecosystems, and their connections with SMEs.

Recommendations are related to:

- facilitating the public sector's understanding of the green economy
- ensuring public institutions recognise the stakes and opportunities
- raising institutional employees' awareness of the role of the public sector (e.g. through procurement)
- providing local policy makers with tools to assess transferrable skills in the labour market
- advising on effective communication on the green market opportunities and regulations
- enhancing public sector capacity to act as brokers between the industry and the green economy
- informing on the key elements for managing the transition of industries to the green economy, particularly in relation to green energy.

This report is divided into three chapters. Chapter 1 provides an overview of recent trends in the global renewable energy sector and highlights the current policy settings and mechanisms and their underlying policy rationales for public policies initiatives for renewable energy. Chapter 2 then presents a number of case studies of green initiatives in local areas, highlights the intersection of global and local issues. Chapter 3 sets out the conclusions and policy recommendations.

Chapter 1

Green initiatives for a low carbon future

OECD countries have made significant commitments to reduce the emissions profile of their economies with the aim to avoid the impacts of climate change. The energy supply industries are one of the main areas that face an immense transition over the coming decades if emissions reduction targets are to be achieved.

The recent OECD report *Environmental Outlook to 2050: The Consequences of Inaction* (2012b), shows that 80% of carbon emissions are related to energy supplies. Further, if global carbon emissions are to stabilise at 450 parts per million (ppm), the level where there is a 50% chance of avoiding global average temperature increases of 2°C, then global emissions will need to peak in the next decade. The report also highlights that at the current rate of emissions generation, the business-as-usual baseline case shows carbon emissions at 675ppm by 2020 and global temperature increases of between 3-6°C. These temperature increases would be catastrophic for ecological and economic systems alike. The coming decade will therefore be a time of major transition in energy systems.

The transition of energy supply will involve the adoption of three interlinked trends:

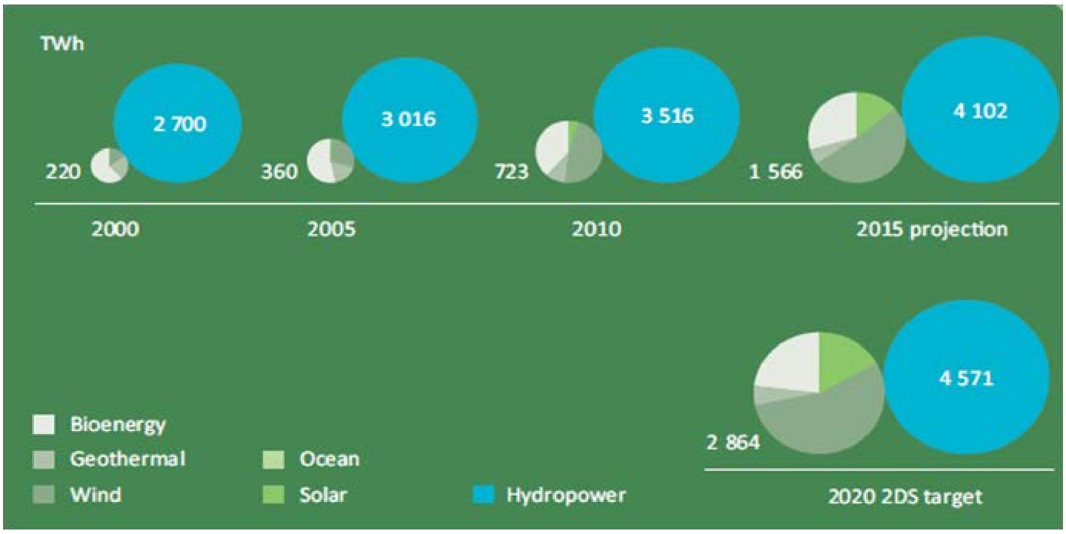
- a move to renewable and low-carbon emission energy sources and technologies
- increasing the development of distributed scale energy production and distribution systems
- the increased focus on energy efficiency to ensure that energy is used in the most productive way, and therefore requiring a less or a stable amount of energy to meet current or increased production needs.

Global uptake of renewable energy

Renewable energy plays a major role in emissions reduction in all of the scenarios for global emissions to stabilise at the 450ppm level. Renewable energy is forecast to make up 28% of electricity generation by 2020 and 57% by 2050 (IEA, 2012). Hydropower will make up the largest contribution of renewable energy by 2020 accounting for 17% of total electricity generation, followed by wind (6%), biomass and waste (3%), and solar (2%) (IEA, 2013).

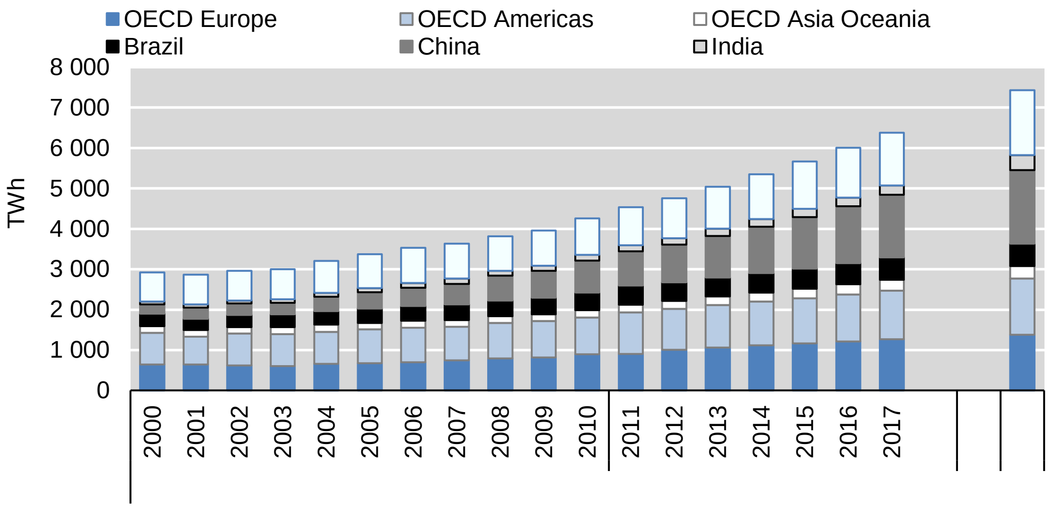
The transition to renewable sources of energy will contribute around 15% of global emissions reductions by 2020; this is the second-largest contribution after end-use fuel and electricity efficiency. In this scenario, the largest proportion of global renewable electricity generation in 2020 will come from China (24%), followed by Europe (19%), the United States (11%), Brazil (7%) and India (5%) (IEA, 2013).

Figure 1.1. **Global growth in renewables**



Source: International Energy Agency (2013), *Tracking Clean Energy Progress 2013*, OECD/IEA, www.iea.org/publications/TCEP_web.pdf.

Figure 1.2. **Renewable energy capacities current and forecast by region**



Note: Data for 2011-17 are MRMR projections. The last bar is the ETP 2DS objective.

Source: International Energy Agency (2013), *Tracking Clean Energy Progress 2013*, OECD/IEA, www.iea.org/publications/TCEP_web.pdf.

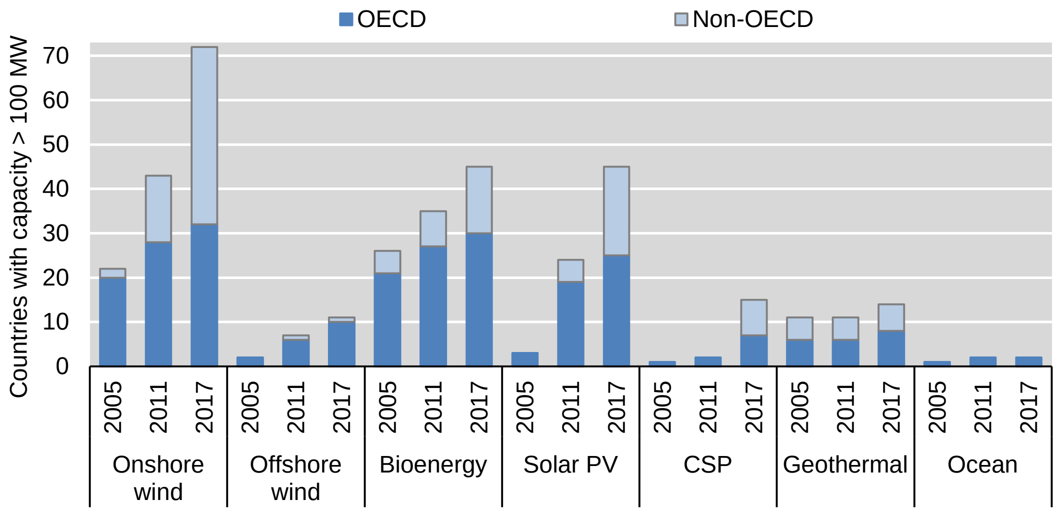
In 2011, non-OECD regions accounted for an estimated 2 410 TWh, or around 53%, of renewable electricity production, up from 45% in 2000 (IEA, 2013). The leaders in this increase in renewable capacity were Brazil, China and India. Renewable energy generation and the associated industries that surround them are no longer the preserve of developed countries. In fact, PFIs in Latin American countries have set up specific credit lines to SMEs to invest in renewable energy sources. For example: BICE in Argentina has allocated lines to fund up to 80% of the total investment project (solar, wind or hydroelectric), with a maximum of USD 10,000 and 2-years of maturity. This means that the development potential of the renewable industry is also being shared with many more countries.

Globally, renewable energy continued to grow strongly in 2012 in both OECD and non-OECD countries. The latest analysis by the International Energy Agency (IEA, 2013) shows the following activity of the renewable technology sector:

- solar photovoltaic (PV) generation capacity has grown by an estimated 29-30 GW (42%) since 2010
- wind generation capacity both onshore and offshore, has grown by 44-45 GW (19%)
- non-hydropower generation has risen by an estimated 142 TWh since 2010 (19%) and hydropower generation has increased by 108 TWh (3%)
- in total, over the past year non-hydropower generation capacity increased by 77 GW (19%) in 2011, while hydropower capacity expanded by 35 GW (3%) in the same year.

Countries are also developing renewable energy capacity at scale, with accelerated growth of the number of countries that have installed capacity above 100 MW expanding rapidly in all technologies, as shown in Figure 1.3.

Figure 1.3. **Countries with installed capacity above 100 MW by technology**



Note: CSP: concentrated solar power.

Source: International Energy Agency (2013), *Tracking Clean Energy Progress 2013*, OECD/IEA, www.iea.org/publications/TCEP_web.pdf.

Renewable market development

The increase in renewable energy means that the industry is now a significant sector in its own right and contributing to economic activity. The latest IEA figures show that investment in new renewable electricity capacity, including in emerging markets, has more than doubled over the last decade and is currently at the levels needed to put in place the amount of renewables required to meet the 450ppm target (IEA, 2013).

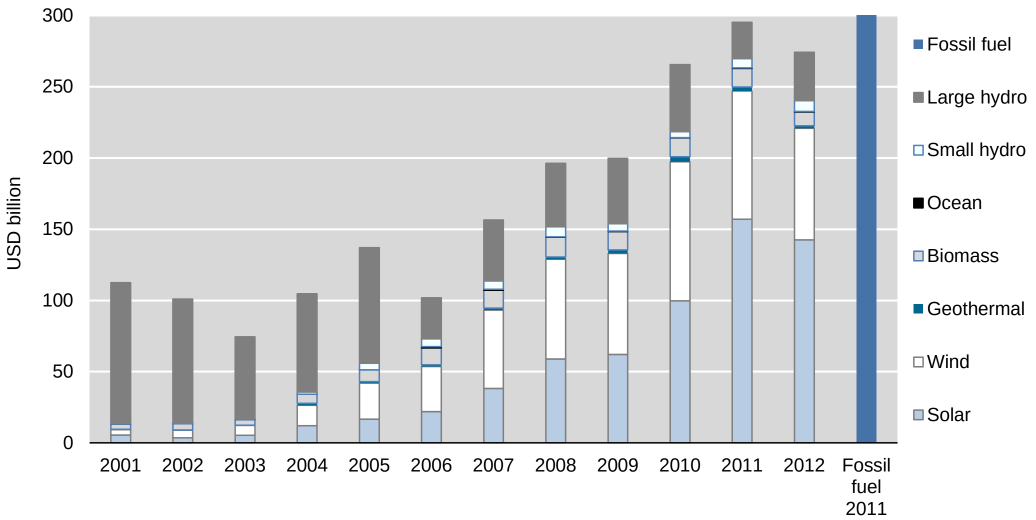
Global investment in new renewable energy capacity, excluding large hydropower capacity, increased by USD 230 billion between 2001 and 2012, reaching an estimated USD 240 billion in 2012 (+34% annually) (IEA, 2013). In 2012, investment reached USD 143 billion in solar, USD 78 billion in wind and USD 19 billion in other renewables. Investment is expanding in many emerging markets, sometimes supported by public financial institutions, including Brazil and other countries in Latin America and Asia, supported by rising electricity demand and good renewable energy sources in these countries. Figure 1.4 shows this growth in investment in these technologies over the past decade.

The trends in renewable energy investment show that investment has slowed in some technologies and regions recently; this is particularly evident in the solar PV market. In most cases, this slow down is attributed to the continued declining costs of technology as the technology matures and benefits from process innovation in manufacturing production (in solar PV, for example).

The changing policy dynamics are responding to these declining costs by reducing subsidies to match cost reductions in production to keep return on investment calculations at realistic levels. The economic recession experienced in many countries since 2008 has also lead to a decline in public subsidies to support renewable activities and this has also contributed to the slowdown in some countries. The slowdown in investment is also attributed to changes in government policy mixes supporting certain renewable energy technologies (IEA, 2011).

Figure 1.4. **Annual renewable capacity investments**

USD billions



Source: International Energy Agency (2013), *Tracking Clean Energy Progress 2013*, OECD/IEA, www.iea.org/publications/TCEP_web.pdf.

Current policy context for renewable energy support

The public sector plays a number of important roles in facilitating the low-carbon transition and diffusing the wider adoption of green practices. First, it leads by example by adopting these practices and in doing so providing learning-by-doing for other organisations in their jurisdiction. This reduces some of the implementation costs for other actors to follow. Government can also be a first customer and a less price sensitive one for new green products and services. In doing so, it funds the early deployment of these technologies and allows these products and services and the businesses that produce them to become viable to larger markets.

Governments also play an important role in emerging markets, particularly by:

- communicating the market opportunities emerging from moving towards a green economy;
- highlighting the adjustments needed for industry to comply with new policies and regulations;
- putting in place programmes and support schemes available for businesses to grow in the green economy;
- Public financial institutions, which fulfil a public policy mandate in fostering SMEs' access to finance, can provide direct and indirect support to green projects.

There are a number of PFIs that have specific credit line provisions for renewable energy projects. In particular, KfW in Germany offers programmes that provide particularly favourable refinancing schemes for municipal investment especially in structurally weak areas. These range from investments in infrastructure - including the development of industrial parks, road construction and sewerage networks - to investments in building refurbishment to improve energy efficiency and in the expansion of renewable energies. Also, Turkey, through TKB supports investment in projects at the local and national level that takes into consideration the improvement of energy efficiency and that are environmentally conscious (OECD CFE/SME, 2013).

Other initiatives, such as technical assistance or early "green" skills identification, could have a positive impact on businesses. However, the effectiveness of these initiatives depends on the administration's capacity to understand what is at stake, recognise the opportunities and transmit the right message.

Government support for the deployment of renewable energy comes in a range of policy types, including renewable energy generation and deployment targets, economic incentives (such as feed-in tariffs, tradable green certificates, tenders, tax incentives and grants) and measures to facilitate the integration of multiple and intermittent renewable energy generators into the electricity system (e.g. through increased power system flexibility and grid connectivity). These measures have been essential for the uptake of renewable energy to date.

The objective of public policy action is to remove market barriers to greater take up of renewable and low-carbon energy sources by the private sector, and also to address non-market barriers, specifically those related to the maturing of new technologies and the provision of infrastructure that has a public good, or non-exclusive characteristics that the private sector alone would not normally provide.

Table 1.1 provides a snapshot of the policy mix supporting renewable energy generation in a number of major countries (KPMG, 2013). The table shows that individual countries develop a range of policy mechanisms to support renewables, with most having some form of feed-in-tariff to support renewable energy generation; capital grants to support the construction of renewable power plants; concessional tax treatment for investments in renewable energy; and public financing either through loans or loan guarantees available to fund investments in renewable generation.

According to the IEA's *Renewable Energy Deployment Policy and Measures Database*,[1] 110 countries had some national renewable electricity policies in place at the end of 2012. The database also highlights changes and revisions to government policies for renewables in line with the aforementioned reasons.

The largest changes were in the category of economic incentives and mainly concentrated in markets where solar PV deployment had accelerated rapidly with the recent large cost reductions coming from mass production techniques now used in the manufacture of solar PV.

Many of the decreases in economic incentives were adjustments to feed-in tariffs (FITs) and the implementation of mechanisms for reducing FITs for future projects over time. Even in highly developed markets, such as Germany, there were significant policy changes.

Table 1.1. **Policy mix to support renewable generation in selected countries**

	Feed in tariff	Renewable Portfolio Standards/ Quota	Capital subsidies, grants, rebates	Investment or other tax credits	Sales tax, energy tax, excise tax or VAT reduction	Tradable RE certificates	Energy production payments or tax credits	Net metering	Public investment, loans, or financing	Public competitive bidding
Australia	(*)	✓	✓			✓			✓	
Brazil				✓					✓	✓
Bulgaria	✓		✓						✓	
Canada	(*)	(*)	✓	✓	✓			✓	✓	✓
China	✓	✓	✓	✓	✓		✓		✓	✓
France	✓		✓	✓	✓	✓			✓	✓
Germany	✓		✓	✓	✓			✓	✓	
Greece	✓		✓	✓				✓	✓	
Mexico				✓				✓	✓	✓
Netherlands			✓	✓	✓	✓	✓			
New Zealand			✓						✓	
Poland		✓	✓		✓	✓			✓	✓
Spain	✓		✓	✓	✓	✓			✓	
United Kingdom	✓	✓	✓		✓	✓			✓	
United States	(*)	(*)	✓	✓	(*)	(*)	✓	(*)	(*)	(*)

Source: KPMG (2013).

The challenge that remains for governments is to design policy mixes that achieve several goals at once: help renewables to compete; effectively match the pace of cost reductions for renewable technologies so as to avoid excessive policy costs; and maintain investor certainty and confidence, through transparent and predictable frameworks that reduce investment risk and cost, and increase the availability of finance. Many jurisdictions are also seeking employment and economic development opportunities as an outcome of support to renewable energies.

Role of government in renewables research, development and demonstration

Government intervention has always played a major role in encouraging research and development activities. The renewable energy industry is no different. In some respects, it may be more critical in the short term because renewable energy is competing essentially against a commodity – electricity. Other technological innovations are usually able to acquire some price premium against existing products. However, when renewable energy competes against the price of established electricity generation (coal-fired and gas, for example), even with the premium offered by renewable energy obligation and feed-in tariffs, return on investment can be uncompetitive in the early stages of deployment.

The emphasis for policy action in research and development (R&D) for renewables is the same as R&D activities within the economy as a whole. R&D activities have significant public good attributes, as well as non-exclusive characteristics that private sector investment alone would not normally provide. The renewable energy industry could also be described as an emerging industry, and therefore other non-market barriers also exist. This includes the development of associated services (finance, business and legal services), skills development and assessment frameworks for the workers, and the metrics and information about the merging industry for strategic planning and investment.

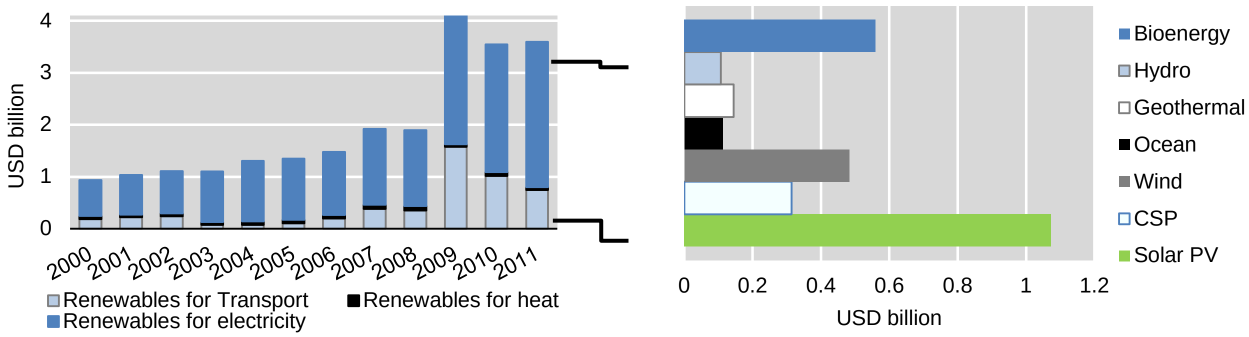
R&D comprises the creative work undertaken to develop new products, processes and applications, and to improve existing ones. The term covers basic research, applied research and experimental development. Demonstration is a fundamental part of the development of new technologies and is defined as a project involving an innovation operated at or near full scale in a realistic environment to aid policy or promote the use of innovation (OECD, 2012a) and to show the viability of its application to manufacturers and potential buyers.

The private sector will not fund these activities on its own. Industrial priorities for R&D focus on shorter term, incremental improvements designed to maximise returns on these investments. Evidence from a survey of a range of energy technology companies, from start-ups through multinational corporations, found that a large percentage of companies expected to make a return on their R&D within two to three years (Anadon et al., 2011).

There has been a rapid increase in OECD countries in the amount of funding directed towards R&D of renewables. As Figure 1.5 shows, the majority of this funding has been targeted at investments in renewables for electricity generation, which has grown by a multiple of three over the past decade. The largest amounts have been targeted at solar PV, followed by bioenergy.

Public R&D funding is also spent on renewables for transport and heat, with transport investments accelerating in the late 2000s as electric vehicles have grown in prominence. This growth in transport-related renewable investment is also mirrored in the rise in both electric vehicle and hybrid electric vehicle patenting activity. Similar increases in patents in other areas of renewable technology are also evident (OECD, 2011b).

Figure 1.5. **Public R&D spending on renewables**



Note: CSP: concentrated solar power.

Source: International Energy Agency (2013), *Tracking Clean Energy Progress 2013*, OECD/IEA, www.iea.org/publications/TCEP_web.pdf.

These investments in research, development and deployment (RD&D) have also started to pay off in terms of successful technologies. Of the top 14 innovations in photovoltaics over the past three decades in the United States, 13 were developed with government support, including 9 that were fully funded by the public sector (Jenkins et al., 2010). These results are also translating into financial returns. The US Department of Energy found that between 1978 and 2000, investment totaling USD 1 17.5 billion – primarily in RD&D for energy efficiency and fossil energy – provided a yield of USD 41 billion (Gallagher et al., 2006).

However, fostering innovation requires addressing the entire innovation chain. Expenditure in RD&D needs to be combined with financial support (such as venture capital, business networks, SMEs and start-up support, and entrepreneurial training) as well as policies that create demand for clean energy (such as public procurement, minimum energy performance standards and targets). Any of these policies implemented alone would be less effective and more expensive. The key challenge is to strike a balance between the various instruments.

The regional and local development potential of the renewable energy industry

For policy makers at sub-national levels, another important question of the low-carbon transition is: how will these changes play out in a specific geographical area?

Many OECD governments see the renewable energy supply chain as a promising sector for the creation of valuable and stable jobs, particularly in regional and rural areas, since exploitation of major renewable energy sources is space-intensive and thus likely to develop primarily in these areas (OECD, 2012a). The deployment of renewable energy is therefore increasingly seen as a key development opportunity for rural regions and a way for governments to give substance to “green growth” claims. However, economic and workforce development opportunities are often constrained by similar challenges to other new economic activities in regional or rural areas, such as limited infrastructure and/or limited availability of the necessary competences to deal with new sectors or new technology (OECD, 2012a).

Addressing these challenges and tapping regions’ endowment of renewable sources of energy will require improved learning capacity and the accumulation of competences in these areas.

Local governments and other institutions will be central agents in the success of the transition of regional areas to low-carbon economies (OECD, 2013a, 2013b, 2013c). Local governments typically hold multiple roles as decision makers, planning authorities, managers of municipal assets, operators of local energy providers and role models for the public (ICLEI, 2013). Local governments also have a large degree of influence, if not control, over land-use policies, which means they can influence what industries localise where, and in some instances set and control the regulatory limits for extraction and discharge activities (UNEP, 2012).

As drivers of change, local governments can encourage, enable, measure and regulate the local economy and inform debate on suitable energy options to help cities adapt to new technologies and changing energy requirements (OECD, 2013a, 2013b, 2013c). They also have the legislative power to make important decisions about energy efficiency and the deployment of renewable energy sources. Increasingly, these strategies are also being matched to economic development policies.

Local governments can support the establishment of related local renewable energy industries through the creation of cluster initiatives (two examples presented in this report, CIUDEN in Spain and the UK Biomass industry in the United Kingdom, show different levels of public involvement in cluster development). Clusters work by generating synergies between private and public actors, including research and educational institutions. This combination of infrastructure and interactions creates opportunities for learning and further specialised development.

Local governments can also stimulate green sectors through public procurement. Public procurement can act as a first and non-price sensitive customer for new green products and services. They can also work to create procurement guides and certification that allow other customers to also buy green without the added expense of the search and verification process.

Sub-national governments (local or regional) also design and manage many large public assets, such as government offices, schools and other community buildings, so they can influence how these assets are managed and ensure their procurement policies also encourage greening. They are also involved in the provision of water and waste services and act as key educators and informers to their local communities.

Findings from a recent OECD LEED project on climate change, employment and local development have shown that the public sector has little understanding of the green economy and the opportunities arising for the private sector (OECD, 2011a). The report also highlighted a lack of capacity within administrations to provide high-quality advice and services to the private sector about green economy developments.

There is limited evidence of the positive benefits of renewable energy projects for local areas, and what evidence is available is largely drawn from economic development theory and the theories of industrial specialisation and clustering (OECD, 2012a). From these limited cases, however, some evidence and trends can be drawn. The main benefits of renewable energy in local economies can be summarised as follows:

- providing new job and business opportunities
- creating opportunities for diversifying regional economies
- generating innovation in products, practices and policies in regions
- skills development and community capacity building
- affordable energy.

Chapter 2 investigates how these benefits play out in local and regional areas by examining a number of case studies of green initiatives.

Summary

Renewable energy is one of the key sources for global emissions reduction and recent data shows that the installation of renewable energy capacity is on track with scenarios for emissions reduction that see carbon emissions stabilising at 450 parts per million. Recent data also shows that the renewable energy sector is truly globalising and in the future, generation capacity will likely come from China, Brazil and India rather than Europe, North America or other OECD countries. This also means that competition for the employment and economic development associated with renewable energy is only going to increase. Investment in R&D for renewable energy is back to pre-global financial crisis levels, and there has also been an increase in patenting activity, particularly in solar photovoltaics, and electric and hybrid vehicles.

The momentum of the global renewable energy sector can be traced back to various public policy initiatives and incentives in key countries over the past decade. The rationale for public policy action in this area is well founded and supported by significant evidence of the role of government support for innovation and technology.

The role of public actors at the local and regional level is also established. These actors have important roles in land-use planning, building ownership and maintenance, and water and energy utility ownership and control. Local governments also play an important role in community engagement and capacity building in mitigation and climate change adaptation activities. They can also influence "green" markets through procurement policies. The next chapter examines in further detail the role local authorities and organisations play, and identifies benefits and challenges facing these communities.

Note

1. www.iea.org/policiesandmeasures/renewableenergy.

Chapter 2

Local cases of green initiatives

The current transition of economic activity based on fossil fuels to one based on low-carbon activities presents a unique challenge for public policy actors. The challenge emerges from the accruing of costs and benefits of the low-carbon transition. The costs of transitioning to low-carbon fuel, transport and production systems are immediate, yet the costs of inaction appear to be a long way into the future. There is also a high degree of uncertainty around which actions will prove the most successful in the long-term. These include uncertainties around technological choices and the irreversibility of these choices.

On the other hand, benefits are available in the early transition, through the development of first mover advantages in knowledge and industrial development. These advantages can result in significant growth opportunities in employment and firms.

The role of public policy in this context is two-fold – supporting the introduction of new technology and innovative practices that lead to the decarbonisation of economies; but also integrating these new technologies and business activities into regions and local areas to ensure that the outcomes of these large public sector initiatives are positive. The policy roles need to be incubating and integrating and involve co-operation amongst policy actors at different levels of jurisdiction (Martinez-Fernandez et al, 2013a, 2013b, 2013c).

In particular, the public sector can play three key roles. *First, public policy plays a role in effectively communicating the market opportunities emerging from moving towards a green economy.* New technologies are often unfamiliar to customers (Freeman and Soete, 1997) and technology development evolves through a series of “unknowns” – how and when technologies and business models will develop (Pavitt, 1991) and how they will change industrial composition and competitiveness (Tijssen, 2002) and who will benefit from any resulting economic development (Kassicieh et al., 2000).

Second, policy plays a key role in creating the environment for industry to comply with new regulations and incentives to take up green economy opportunities. Recent evidence shows that responding to regulation is a primary driver for current green economy activity (OECD, 2012a).

Third, public policy plays a role in the development and implementation of the programmes and support schemes available for businesses to grow in the green economy (David et al., 2009; OECD, 2011a).

This study analyses these roles on public initiatives that support the adoption of low-carbon energy sources, particularly renewable energy.

Context for action

There is no single policy instrument or mechanism that can achieve the changes required to decarbonise our economies, so the emphasis for governments is to have a mix of policies in place. The question then becomes what is the ideal mix of policies that each country needs to put into place to take advantage of its own characteristics (and even at lower levels of geographical aggregation – such as regional and local areas).

Traditionally, policy frameworks separate into a number of mechanisms:

- **Market-based instruments:** such as taxes, charges, tradable permits that can allow the selection of least cost methods first and thereby stimulate technological innovation. To work effectively, market-based mechanisms need a system of monitoring, enforcement and evaluation in place to ensure that the objectives of the instrument are met.
- **Regulatory policies:** such as norms, standards and abatement policies are the most prevalent forms of environmental management (UNEP, 2012) and responses to regulation currently represent the majority of activity towards decarbonisation. Again, for regulatory measures to be effective they need to be well designed, appropriate and flexible to change (e.g. strengthened) and industry needs to adapt to the regulation.
- **Information-based mechanisms:** such as eco-labelling, public disclosure of carbon intensity of business or use of renewable energy. These mechanisms offer governments another avenue to raise awareness and promote innovation and do so in a more ambitious way than regulations.

If we examine the range of policy options currently deployed to assist the development of renewable energy, they can be split into either direct or indirect policies. The direct policies include:

- grants
- economic incentives – such as feed-in tariffs
- favourable tax treatment (such as tax holidays or accelerated depreciation)
- non-tax incentives.

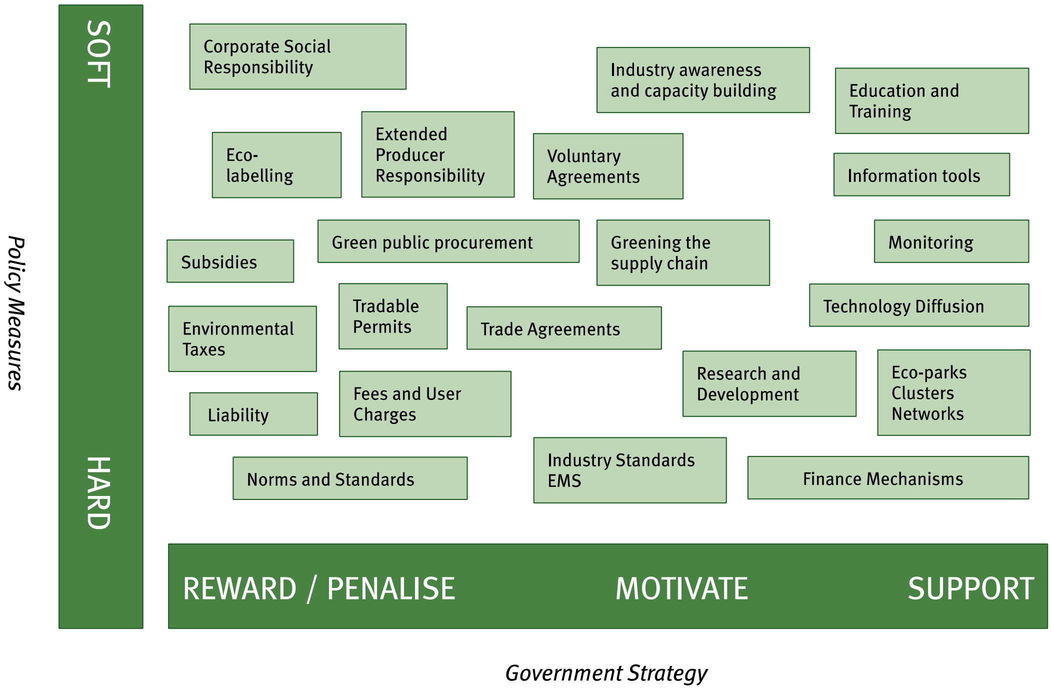
Indirect support from other policies is also beneficial for the renewable energy industry. Indirect support includes:

- carbon taxes and pricing
- cap and trade systems
- indirect taxes (energy tax, excise tax or value added tax).

Figure 2.1 plots all of these policy measures on a spectrum between hard and soft (regulatory versus non-regulatory) and whether they support renewable energy directly or indirectly, by penalising (pricing) carbon-intensive activities.

The IEA has created a database of renewable energy policies. The vast majority of policies are economic instruments, but beyond that there is a range of mechanisms employed by governments.

Figure 2.1. **Policy spectrum for renewables**



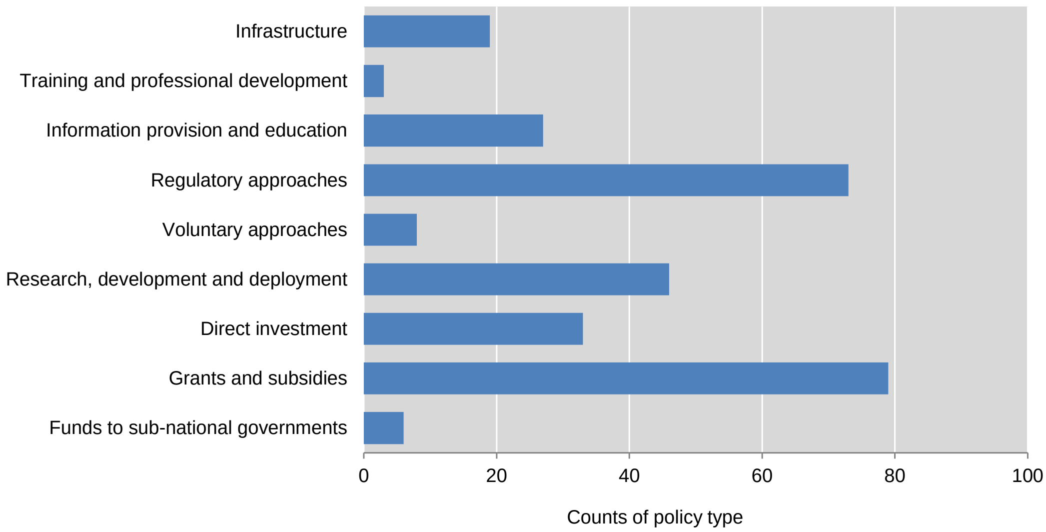
Source: Adapted from CSCP, WI and GTZ (2007).

Figure 2.2 shows the comparative frequency of these different policy measures. Regulatory approaches and grants and subsidies are prominent mechanisms, closely followed by research, development and deployment support. Voluntary approaches, infrastructure and the provision of funds to sub-national governments are only used in a small number of cases.

An area of great concern is the support for training and professional development activities; only three specific programmes targeting training and professional development were listed in the database. This figure may not pick up all activities, many grant programmes have educational components as well, but it does highlight the reduced priority of training and skills development in the eyes of policy makers for renewable energy.

The renewable energy sector will be one of the most effected sectors of "green growth" over the coming decades, with significant occupational changes (including many new occupations), therefore resulting changes in the skills and qualifications framework for these occupations (Cedefop, 2013). In order to avoid skills bottlenecks and to ensure the transition to low-carbon energy sources at minimal costs, further attention will need to be paid to skills development in this area (Martinez-Fernandez et al., 2013).

Figure 2.2. **Range of policy measures used by OECD member governments (2008-12)**



Note: Multiple policy types can be listed to a single adopted policy.

Source: IEA (2013), *IEA Renewable Energy Deployment Policy and Measures Database*.

The individual situation of each country, and further the region in which the large-scale renewable energy project is to be sited, will each have a different context and suite of policy support for the development. The following case studies provide the background context to cases of regionally focused renewable energy support to illustrate this difference.

Case studies

The following section presents seven short case studies of renewable energy initiatives in local areas. The case studies focus on the four themes identified in Chapter 1 as benefits of renewable energy initiatives for local areas:

- job creation and business opportunities
- diversifying regional economics
- greening innovation in products, practices and policies in regions
- skills development and community capacity.

As the case studies show, initiatives do not target just one of these areas, but a mix of them. Table 2.1 shows the coverage of each of case studies against each of these identified themes. In all cases, each initiative covers more than one theme. This increases the benefits that can flow from initiatives and also their embeddedness within the local economy and community, but it does add complexity to local authorities' ability to develop and then evaluate the results from these activities.

Table 2.1. **Themes of case studies**

Case study	Job creation and business opportunities	Diversifying regional economies	Greening innovation	Skills development and community capacity
Dezhou, China	X	X	X	
CIUDEN, Spain	X	X	X	X
Mongolia			X	X
Bertim and Porto Alegre, Brazil			X	X
Sao Paulo, Brazil	X		X	
Large Scale Solar, Australia	X	X	X	X
Biomass, Northern United Kingdom	X	X	X	X

Job creation and new business opportunities

Job creation and the generation of new business (and hence revenue opportunities for local governments) are the primary area of interest for regional authorities in investigating and supporting renewable energy opportunities. Renewable energy can also offer existing businesses, particularly those associated with primary production (agriculture, forestry), the ability to diversify their income streams (and also weather-proof them) by including renewable energy in their production activities.

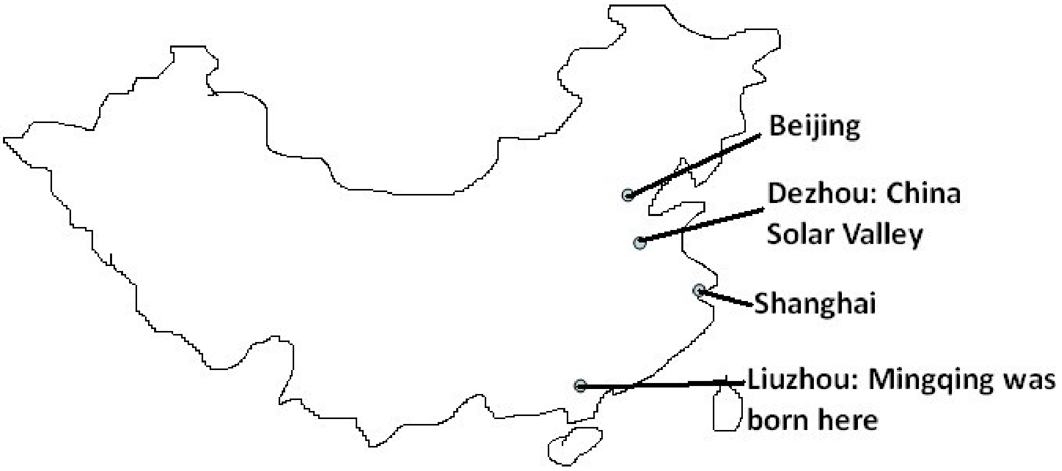
The net new job opportunities offered by renewable energy are mixed. In aggregate, it is clear that the renewable energy industry will grow significantly over the coming decades. However, job generation in individual regions will be influenced by how renewable energy activities are embedded within the region. If there are sufficient linkages to foster the appropriate skills and supply chain relationships, then regions can generate employment above and beyond that associated with the construction and maintenance of renewable power plants.

One region that put in place significant policy support to embed renewable energy generation within the region is Dezhou, China. The city has been able to grow from virtually no solar PV industry to being China’s solar city in just over 20 years.

Case study: Green economic development with renewable energy industries, city of Dezhou, China[1]

In the late 1990s, the city of Dezhou was lagging behind its regional counterparts in terms of economic development. Dezhou is located between Beijing-Tianjin Metropolitan Economy Zone and the Jiao Dong Peninsular Coastal Economy belt. It is classified as a third-tier city with no harbour or airport, but the city is a transport hub at the intersection of a number of highways and speed railways, including the high-speed rail between Beijing and Shanghai (see Figure 2.3 for the location of Dezhou in relation to Beijing and Shanghai). The location of Dezhou also means that the city receives the second highest amount of solar irradiation in China, some 2 666 hours per year.

Figure 2.3. **Map of the People's Republic of China showing the location of Dezhou**



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: www.greenpeace.org.

In 1997, the municipality and local government of Dezhou drafted a Development Plan for the Dezhou Economic Development Zone to attract investment to the region. The aim was to cluster solar research and development, manufacturing and education activities. The region was able to attract investment activity in solar energy by implementing supportive policies for land use, taxation and availability of finance. In doing so, it was able to build on its relatively small base of local solar industry.

In August 2005, the Dezhou local government proposed branding the city as China's Solar City. The government developed a new solar industry promotion plan to implement further measures to encourage the development of solar industry. Incentives were negotiated on a case-by-case basis. Foreign companies setting up in the zone received a two-year tax waiver, followed by a further three years at a lower tax rate. Companies that were classified as high technology received a 50% tax rebate, and low-interest loans were made available to firms with patented technologies.

These supply side incentive programmes were matched by demand-side programmes including:

- "Million Roof project" to encourage the installation of solar PV and thermal technologies in residences and businesses. New buildings were required to install solar equipment on their buildings. Grants and finance were also available for the retrofitting of existing buildings with solar equipment.
- "5555 Photovoltaic Demonstration Project" which installed or replaced conventional lights with solar lights at 50 traffic junctions, 5 main roads, 5 residential districts, including providing street and landscape lighting in 5 scenic areas.

Dezhou now has over 120 solar companies generating annual turnover of USD 3.46 billion, has matured its solar technology innovation system with strong links between industry, educational and research institutions. The annual growth rate of the solar industry in Dezhou was over 30% between 2006 and 2012. Around 5 300 jobs will be created in the PV industry and about 3 200 jobs in the solar thermal industry.

Diversifying regional economies

As mentioned earlier, it is difficult for policy makers to know the "net" job creation capacity of renewable energy to a region when authorities are considering policy support. However, in regions where significant job losses are expected with the decarbonising of the economy, the impetus to support renewable and low carbon energy sources is stronger. This is evident in the CIUDEN case study in the El Bierzo district in Spain. This region has historical legacies in agriculture and a specific concentration in the coal mining industry. The concentration of coal mining also provides an opportunity for the area to investigate carbon capture and storage (CCS) technologies alongside renewable energy sources. CCS technologies enable the capture of CO^2 from fuel combustion or industrial processes, its transportation, and its storage underground, in depleted oil and gas fields and deep saline formations. CCS can play a role in the global transition to a sustainable low-carbon economy, in both power generation and industry, but to date CCS projects have not been achieved at large-scale.

The macroeconomic environment has a strong influence on the success or failure of regional developments. As the case of CIUDEN shows, even with significant investments and multi-jurisdictional involvement in the initiative, ultimately factors beyond the scope and control of the region (namely the financial crisis) impacted on the success of the project. The case of Mongolia presents the opposite side of macroeconomic impacts, a case for positive force for green initiatives.

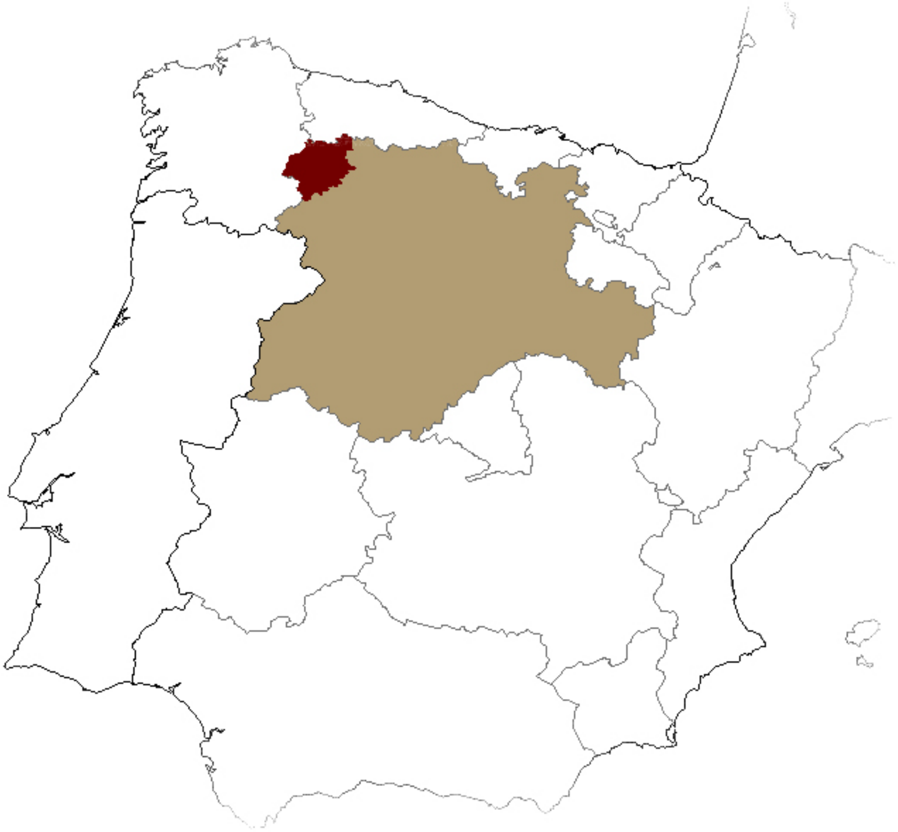
Case study: Energy independence from external and carbon-intensive energy supplies and local economic development: CIUDEN, Spain

An increasing awareness of the dangers of global warming, coupled with rising criticism of the economic and social cost of coal subsidies, have forced successive Spanish governments to reconsider their coal policies. The "*Ciudad de la Energía Foundation*" (CIUDEN) was born out of these considerations, to be based at the heart of El Bierzo and aimed at facilitating its transition into a green, "low-carbon" economy through a manifold approach involving a large-scale Carbon Capture and Storage (CCS) project, the creation of a National Energy Museum, investment in renewable energy sources, and co-operation with academia in order to create a local technological and research cluster. Of these four aspects, the CCS project has been, by a significant margin, the most important, however the focus of this case study is on the renewable energy and knowledge and community capacity building aspects of CIUDEN.

The El Bierzo district, located in the León province within the Castilla and León region in northwestern Spain (Figure 2.4), comprises 38 municipalities, with a total population of 134 571 in 2012, almost half of it in Ponferrada, the district capital. The El Bierzo district has strong cultural ties with the neighboring Galice region to the west, and shares a strong coal-mining heritage with the Asturias region to the north.

Although the El Bierzo district has been historically related to the agricultural and mining sectors, currently the tertiary sector clearly predominates, both in terms of economic activity and employment. In 2008, almost 70% of all registered companies were in the tertiary sector. Prior to the current economic crisis, the construction sector also had a very significant weight in the El Bierzo district, even bigger than in the rest of Spain. For these reasons, despite the presence of capital-intensive extractive industries in the El Bierzo district, such as coal mines and slate quarries, the average size of registered companies is particularly small, with a strong proportion of self-employed workers. In 2012, out of over 32 000 enterprises in the León province, only 20 employed more than 200 employees each.

Figure 2.4. **Location of El Bierzo district of Castilla and León**



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Successive local, regional and national governments of various political signs have been acutely aware of the dependency of the El Bierzo district on its coal sector and of the necessity to offer economic alternatives. Consequently, several initiatives have been encouraged to create alternative job sources, with a special emphasis on green jobs. For instance, a particular effort was made to support job creation in the wind power industry. Since the late 1990s, two major factories were opened in this sector: Coiper 2000, producing wind turbine towers, and LM Glasfiber, producing wind turbine blades. In order to offer more direct support to green job creation, and to further diversify the economy of the El Bierzo district, the national government decided to create CIUDEN.

Operating model

CIUDEN was created in 2006 as a public sector foundation under the common supervision of the Spanish national Ministries for Industry, Science and Innovation, and Environment, and in close co-operation with the Spanish Centre for Technological Industrial Development (CDTI) and the Centre for Energy, Environment and Technology

Research (CIEMAT). Local and regional authorities, however, were not directly represented on its Steering Committee. Its foundational aims were to promote research, development and innovation in the fields of energy and the environment, and to contribute to the economic development in the El Bierzo district.

The main priorities were the creation and management of an Advanced CO_2 Capture and Storage Technologies Research Centre, the construction of a National Energy Museum (Ene.Museo) and local development activities relating to renewable energy, energy efficiency and the environment.

Carbon Capture and Storage activities

CIUDEN's heavy involvement in CCS was driven by the local coal mining and coal-based power generation legacy. Its efforts in the field of CCS technologies started by planning and building a CO_2 Capture Technical Development Centre (es.CO2) in Cubillos del Sil, in close vicinity to ENDESA's Compostilla II power station. It occupies an industrial site of 64 500 m² and currently employs 50 people, including researchers, technicians and administrative staff. Its planning and construction, from 2006 to 2012, demanded a total investment of EUR 128.4 million, involved more than 150 companies and an average of 200 workers on site daily, with up to 450 workers on site at the peak of the project. The es.CO2 comprises two separate boilers: a 20 MWth pulverized coal (PC) boiler and a 30 MWth circulating fluidized bed (CFB) boiler. These were complemented with a fuel preparation unit, a flue gas cleaning unit, a CO_2 capture and purification unit, a biomass gasifier and a distributed control system. This centre was aimed at studying oxycombustion processes, in which the fuel is burned in the boilers with pure oxygen, rather than air, in order to produce CO_2-rich flue gasses, from which the CO_2 may be more easily separated. It also has the additional advantage of significantly reducing the generation of nitrogen oxides (NOx) in the combustion. A CO_2 transport experimental rig was also built on the same site, in order to test materials, devices and methods for the transport of CO_2 from capture to storage sites, as well as a test site for CO_2 injection in soils (PISCO2) to study the potential environmental impact of CO_2 leakages in CO_2 underground storage sites.

Simultaneously to the development of the es.CO2, a geological survey was launched in order to identify suitable CO_2 storage sites in Spain. Among these, a saline aquifer near Hontomin, in the province of Burgos, was selected as the site of a CO_2 storage technical development plant. The Hontomin site is distant from the El Bierzo district and consequently falls outside of the scope of this study.

In 2009, the efforts of CIUDEN in the field of CO_2 capture and storage were integrated in the broader Compostilla OxyCFB300 project, in partnership with ENDESA and Foster Wheeler OY, and co-funded by the European Commission under the European Energy Programme for Recovery (EEPR). Within the OxyCFB300 project, the construction of CIUDEN's experimental facilities in Cubillos del Sil and Hontomin were to serve as a first phase to be followed by the construction of a 300 MWe demonstration plant in the Compostilla power station, with an oxycombustion CFB boiler scaled up from the 30 MWth boiler of es.CO2, complemented by corresponding CO_2 storage facilities in Hontomin, and CO_2 transport facilities linking the two sites. However, as we will see later, a highly adverse economic conjuncture has so far held the partners from confirming their commitment to this second phase.

Other low carbon activities

With its current facilities, CIUDEN takes part in eight further EU-funded projects. The ECCSEL project, funded under the EU's 7th Framework Programme for Research and Development (FP7), seeks to link and improve CCS experimental facilities across Europe. Other projects funded under the FP7 include the Flexiburn CFB, MACPLUS, RELCOM and O2GEN projects, all relating to the combustion technologies used in CIUDEN's facilities, and the R&Dialogue project, aiming to establish a dialogue between researchers and civil society on ways to achieve a low-carbon economy.

With its biomass gasifier, CIUDEN participates in the BRISK project, also funded under FP7, and the DOTGe project, funded through the European Regional Development Fund (ERDF). Another major activity of CIUDEN has been the creation of a National Energy Museum using the rich industrial heritage of the El Bierzo district. In particular, it was decided to locate the museum in and around the buildings of two disaffected power stations in the Compostilla site. The museum is thus to have three parts: *Ene.térmica*, in the building of an early power station which operated from 1920 to 1971; *Ene.central*, in the facilities of the Compostilla I power station, which operated from 1949 to 1974 before being superseded by the current Compostilla II power station; and *Ene.parque*, an open air area linking both buildings.

Ene.térmica was inaugurated in July 2011, and was one of the 2012 Laureates of the EU Prizes for Cultural Heritage/Europa Nostra Awards. The completion of Ene.central has long been delayed by disputes with the building contractors since 2012, but is now set to occur by 2014, although presumably with a much-reduced content due to budgetary constraints.

Besides these two main lines of action, CIUDEN has also carried out several smaller scale projects directly aimed at carrying out territorial development activities in the El Bierzo district. It has been particularly active in the area of environmental restoration and in the use of biomass as a renewable energy source. In 2009, it opened CIUDEN Vivero, a nursery providing vocational training in environmental restoration and gardening, claiming, to date, the creation of over 50 jobs for an investment of EUR 2 570 000 through occupational training programmes run by the Ministry of Environment. It also runs experimental poplar and willow plantations for biomass production, supports the replacement of old fossil fuel heating boilers with fuel-efficient biomass boilers, has provided energy audits for 15 municipalities and runs a small photovoltaic plant.

Capacity building and community empowerment: Agreements with local universities

Since 2007, CIUDEN has a standing framework agreement with the University of León to develop a technological cluster on its Ponferrada campus, as mandated by the founding statutes of CIUDEN. Under this framework agreement, a specific agreement for the creation of a CCS Technology and Territorial Development Institute was signed in November 2011. According to this specific agreement, this institute should focus on teaching, research, knowledge and technology transfer, and the dissemination of scientific and technical knowledge. However, neither the framework agreement nor this specific agreement appears to have found a concrete implementation yet.

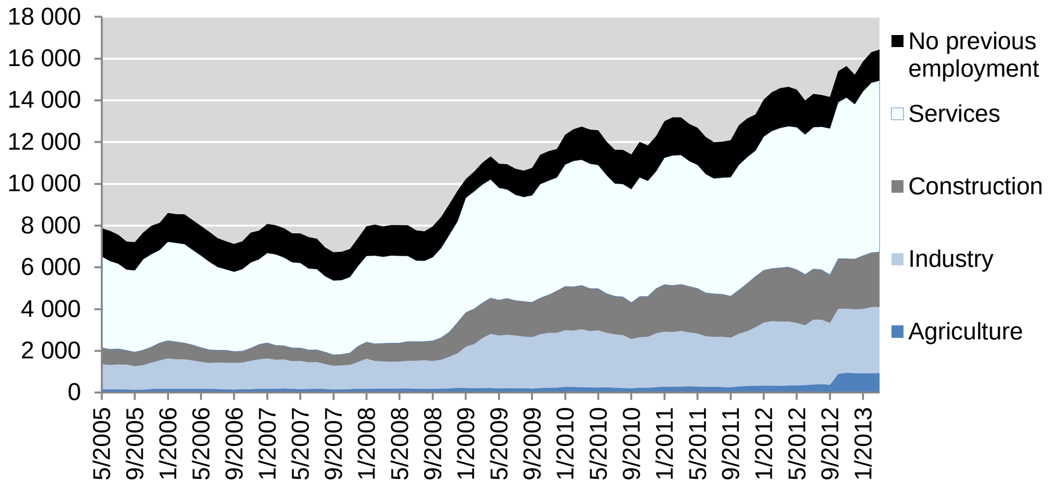
Finally, from 2011 to 2012, together with the Spanish National Distance-Learning University (UNED), CIUDEN also supported a Sustainability Territorial Observatory (OTN) analysing economic, social and environmental issues in northwestern Spain.

From its conception, one of CIUDEN's major aims has been to generate green jobs in the El Bierzo district through each of its programmes. The es.CO_2 has aimed to generate highly qualified scientific and technical jobs and to contribute to vocational training through the establishment of a technological cluster around the Compostilla site. The co-operation with the University of León to introduce these subjects on its Ponferrada campus should further strengthen the development of this technological cluster. The National Energy Museum was also projected to contribute to green job creation by increasing the attractiveness of the El Bierzo district as a tourism destination. For this purpose, the integration of the museum with other "eco-tourism" attractions in the El Bierzo district and its co-operation with local hospitality establishments were an important focus. Finally, CIUDEN Vivero and the environmental restoration of coal mining waste tips also generated green jobs by supporting vocational training and employment in environmental management and restoration, forestry and gardening.

Job creation impacts

Unfortunately, the creation of CIUDEN has coincided with a global downturn that has had a devastating impact on the Spanish economy, its job market and public sector budgets. Consequently, CIUDEN has had to face increasing challenges with diminishing resources in a politically turbulent environment. The evolution of employment in the El Bierzo district must be considered in the light of this negative context. Figure 2.5 shows the increasing unemployment in the El Bierzo district from 2005 to 2013. The general stagnation in electric power demand in Spain during this period, and regulatory uncertainty regarding the Spanish coal policy, had a direct impact in the El Bierzo district through much lower power generation in the Compostilla II and Anllares power stations, and proportionally decreasing coal production in the El Bierzo district.

Figure 2.5. **Registered unemployment in the El Bierzo district May 2006 to March 2013**



Source: Servicio Publico de Empleo Estatal.

Decreased employment in the local coal industry played an important role in this job destruction, but the green sector has also suffered, with the closure of both the Coiper 2000 and LM Glasfiber factories, which at their zenith employed nearly as many workers as the local coal mines. The ailing local economy has been unable to generate new jobs to balance these job losses. Not only has the number of new contracts steadily decreased on a year-to-year basis, but the remainder has been increasingly seasonal, with an ever-increasing relative weight of service sector summer jobs and agricultural sector harvest season jobs. Since 2008, the number of enterprises in the León province has been in steady decline.

This difficult context has clearly outweighed any positive impact of CIUDEN in the local employment market. While the construction of the es.CO_2 and of the National Energy Museum have doubtlessly helped maintain a certain number of construction and industrial jobs at the height of the downturn, these facilities are now nearing completion. Employment within CIUDEN itself has been hit by a redundancy plan in December 2012, and many of its projects are affected by budget cuts. The original aim to establish a technological cluster around the es.CO_2 has not yet been achieved and CIUDEN's flagship project struggles as the economic viability of CCS falters.

Case study: Mongolia's path to a low-carbon innovation economy

Mongolia has experienced very rapid economic growth over the past five years due to a mining boom. Foreign direct investment (FDI) and international trade from the mining boom have fuelled steep increases in national income, sector-specific labour productivity, and price inflation. Labour markets reflect the economic restructuring and skills mismatch frequently associated with rapid transitions.

For Mongolia, interest in environmental issues cannot wait until economic prosperity is achieved. Both dust and water scarcity are significant and potentially destabilising environmental dangers at this time. Progressive desertification is recognised as creating enormous challenges to meet the country's demand for water. Mongolian statistics reflect strong concern. Fifteen years ago, 78.2% of Mongolia's total territory was considered affected by desertification. Land area "severely affected" by desertification is now calculated as 11 times greater than it was 16 years ago, and the "very severely affected" area 7 times greater (Mandakh et al., 1998). The 2011 surface water inventories indicated 551 rivers, 483 lakes and 1 587 springs have run dry. These figures can be contrasted with, for example, inventory calculation that now suggests 6 646 rivers and 10 557 springs remain. Vulnerable areas are expanding rapidly as the desert grows northward. At the same time, about 12% of total cropland is now irrigated. The estimated increase in demand for water for processing by the new and future extractive activity has not been calculated.

The Ministry of Nature, Environment and Tourism (MNET) and the Mongolian National Chamber of Commerce and Industry (MNCCI) have drafted and submitted goals for developing a greener economy in Mongolia to the state government. The main goals for 2020 focus on 20% improvements in:

- energy efficiency
- renewable energy capacity
- greenhouse gas emissions
- investment in environmental conservation

- public investment in “green procurement” by local and state government.

On the path to an economy based on knowledge-intensive service provision, one key role the government can play is to encourage nascent centers of innovation through magnet infrastructure as well as collaboration platforms in skill ecosystems. These centers are logically in potentially high-growth, knowledge-intensive industries that address the special challenges of the country. Mongolia, for example, may be well situated to develop alternative energy, and water and air remediation technologies.

Some innovation capacity, particularly with respect to a transition to a low-carbon economy, is already in the country. Moving toward a sustainable development path has led to initiation of some alternative energy production. The national goals call for renewable energy to account for 3-5% of total energy use by 2010, rising to between 20 and 25% by the year 2020. A number of public-private partnerships in the past few years have brought new technologies and new markets to regional centers as well as Ulaan Baatar. While these initial steps are largely public sector driven, they are often designed with the idea in mind of having a broad impact across a number of sectors, and provide encouragement for moving more quickly toward the sustainability goals promulgated by the state government.

In June 2013, Mongolia’s first wind farm began production in a mountainous area Tuv aimag, in the centre of Mongolia. A total of 15 turbines are expected to cover the annual electricity demand of 100 000 local households, with an installed capacity of 68.5 MW. The electricity generated is equivalent to what would be produced by 150 000 tonnes of coal, with a CO_2 offset of about 180 tonnes. The wind farm was constructed in partnership with private companies, the European Bank for Reconstruction and Development, and the Netherlands Development Finance Company.

Solar power has also been recently expanded. Roughly 100 000 nomadic herder households (about 70%) gained access to portable home systems as a result of a project entitled “Renewable Energy and rural Electricity Access” (REAP) financed by a USD 13 million, multi-donor trust fund administered by the World Bank, building on government initiatives as described in World Bank (2012). During the project’s implementation from 2008 to 2012, 50 sales and service centres were created across Mongolia. The centres partnered with an existing network of village administers located in 342 villages. Herders purchase the solar home systems at a 50% subsidy and can also purchase other small electrical home appliances at the sales and service centres.

A public-private partnership composed of two Russian companies, Sibtermo LLC and Amore International LLC, in conjunction with the Second Thermal Power Plant (TTP2) of Ulaan Baatar is establishing a manufacturing complex to produce semi-coked coal briquettes in Ulaan Baatar, as described in Zoljargal (2013). The goal is to replace 25% of raw coal consumption in the city; production was expected to begin in September 2013. Amore International already has a number of ongoing projects with TTP2 upgrading generation facilities.

In 2011, the first electric power plant to be constructed independently by Mongolian engineers began operation. According to Mongolian Economy (2011), the project used technology and consulting services of GEA, a German company, to install a zero-waste water-cooling system. The Ukhaa Hudag power plant is designed to meet the demand from a local mine as well as a nearby town (the Tsogtsetsil soum). Even at its eventual maximal capacity, the power plant is fairly small – 15 MW. It is, however, an important milestone in Mongolia’s bid for sustainable development in that it uses a novel combination of existing technologies optimised for the harsh conditions of the Gobi region. The total cost of the power station is approximately USD 45 million, with an additional USD 10 million used to build a power sub-station and power grid.

These projects demonstrate a potential both for a low-carbon future and for the development of an innovation base to the economy in line with the particular concerns Mongolia faces. Acceleration of skill development through conscientious integration and inter-weaving of the multiple topics addressed by development agendas would be useful.

Generating innovation in products, practices and policies in regions

In hosting renewable energy, local areas become places where new technologies are tested, including new policies and support mechanisms to help these technologies establish. Clusters of renewable energy actors in a region can transform the skills ecosystem of the region by creating specialised pools of knowledge and labour competence.

Even the most basic technologies will require some degree of local customisation and this will most likely be carried out by SMEs. On the other hand, SMEs that are active in finding and exploiting business opportunity niches can thrive as valuable suppliers and customers. These new business opportunities can be catalytic when supported by policy instruments that drive demand. The case of solar hot water heaters in Sao Paulo provides clear evidence of this. Innovation can also occur in the public sector and the governance arrangements that enclose green initiatives. The case study from Brazil shows innovative public participatory processes in Betim and Porto Alegre.

Policy mechanisms at the national level can have significant impacts on the local communities where major infrastructure investments are placed. This, in turn, can be catalytic for further development if these initial investments are linked into the existing economy through supply chain and labour force links.

Another case study presents a programme from Australia for large-scale solar PV and solar thermal power plants. This programme was part of the multi-billion dollar package that introduced carbon pricing into Australia. A range of supply side measures were introduced in addition to the carbon price.

Case study: Participatory processes with stakeholders for local renewables in Betim and Porto Alegre, Brazil[2]

Bertim (part of the urban metropolitan area of the state capital of Minas Gerais) and Porto Alegre (the state capital of Rio Grande do Sul) have established renewable energy and energy efficiency reference centres (CRER) tasked with providing renewable energy and energy efficiency services and education to their local communities. The centres (established in 2006 and 2009 respectively) also attempt to act as catalysts for action in other local communities.

Both CRER have established stakeholder groups that are responsible for overseeing the activities of the centre, promoting and disseminating the activities of the centre, submitting proposals for actions and grants to be carried out by the centre in partnership with other groups. The stakeholders include technical and political representatives from relevant local and state government agencies (including those with responsibilities for the following services: water and sewage, housing, waste collection, environment, public works, planning and transport), representatives from electricity providers, private industry, trade unions, professional associations and representatives from research and educational institutions.

The stakeholder groups provide wider buy-in of the CRER’s activities by a large group of relevant institutions, ensures that all of the centres’ activities are exposed to scrutiny by the relevant agencies so they can be created in a way that achieves effective change. The stakeholder group also offers the opportunity for knowledge transfer and collective learning on renewable energy and energy efficiency activities by a large group of relevant institutions within the local areas.

Specific activities that the stakeholder group has achieved include drafting and approval of the use of solar heaters in Betim; enabling regulation for sustainable energy laws in Porto Alegre; and a seminar and series of debates on energy efficiency and renewable energy in both cities in 2010.

Case study: Local government regulation ordinances and laws to promote renewable energy in Sao Paulo, Brazil[3]

Sao Paulo already has one of the smallest carbon footprints of any major global city. Over 90% of the city’s electricity supply is sourced from hydro-electricity plants; however, with electricity demand steadily increasing with the continued growth of the city and a declining number of sites suitable for hydro-electricity, energy security has become an issue for the city.

The Solar Ordinance of Sao Paulo was approved in July 2007 and requires new residential, commercial and industrial buildings to install solar hot water (SHW) to cover at least 40% of the energy used for heating water. An estimated 40% of the city’s electricity consumption is attributed to heating water. A contributor to the approval of the regulation was a national campaign by the Brazilian Association for the Solar Thermal Industry, Solar Cities. The campaign, in 2005, lobbied for the inclusion of solar technology into local building codes and provided training sessions for engineers, architects and representatives of local government on the application of solar technologies.

The regulation has stimulated market demand as well as innovation in renewable energy hot water heaters. This, in turn, has resulted in both energy savings to a wide group of stakeholders, including reduced production costs, which means the payback period for a SHW system has decreased from three years to two years. The local government has also made significant savings by deferring or avoiding the additional cost of new electricity generation and distribution systems. These savings are valued at USD 400 million between 2007 and 2015. Key lessons learnt from the introduction of the regulation include:

- setting realistic yet innovative targets
- highly specific (one technology, solar, and one function, water heating)
- congruence with national policies – the regulation fit within the national energy framework
- certification of equipment to ensure minimum performance standards.

Case study: Complementary measures for a national carbon pricing mechanism: Solar Flagships programme, Australia

The Solar Flagships programme was part of the Clean Energy Initiative and introduced in tandem with the Australian government's Carbon Pollution Reduction Scheme (CPRS), Australia's first national attempt to price carbon emissions. The CPRS proposed a cap and trade emissions trading scheme with a -5% to -25% 2020 target range and covering 75% of Australian industry. The scheme was internationally linked through the Carbon Development Mechanism (CDM), which at the time was proposed to commence 1 July 2011.

- The Clean Energy Initiative was an AUD 4.5 billion package to support the research, development and demonstration of low-emission energy technologies. In addition to the Solar Flagships programme, there was:
  - A Carbon Capture and Storage Flagship programme to support the construction and demonstration of large-scale integrated carbon capture and storage projects in Australia.
  - An Australian Centre for Renewable Energy: promoting the development, commercialisation and deployment of renewable energy technologies.

Each of these programmes was expected to leverage other funding from the private sector and relevant state governments.

Subsequently, the Australian government introduced a fixed carbon price in July 2012. The price was fixed and indexed to the consumer price index for the first five years, before transitioning to a floating price that would be linked to the EU carbon market in 2016/17. The Australian government has recently changed. An election platform of the incoming government is to rescind the carbon price and associated legislative packages. At the time of writing this paper, the new parliament had not yet met, so no further detail on when and if these changes may happen, is available.

The objective of the Solar Flagships programme was "to provide the foundation for large-scale, grid-connected, solar power to play a significant role in Australia's electricity supply and operate in a competitive electricity market, with the aim of up to 1 000 MW of solar" (Australian Government, 2013). Other objectives included:

- develop the solar industry in Australia
- encourage regional development
- provide research infrastructure
- develop Australia's IP in solar power generation
- develop and share technical and economic knowledge from the programme.

The Solar Flagships programme is a grant-based funding source for the construction and operation of large-scale, grid-connected solar power stations in Australia. The programme and the first round of grants were announced in the 2009-10 federal budget. The programme included AUD 1.5 billion of public funding that would be used to leverage significant private and state government funding into large-scale solar projects.

The objective of government funding was to invest in projects in order to pull clean energy technologies at the early stage of the transition to a low-carbon economy, through the initial period of capital constraint. The first round of funding sought to identify two large-scale solar projects, one solar thermal project and one photovoltaic. The programme's strategy was to support commercially proven technologies (i.e. technologies that could be demonstrated in operation). The programme was split into two funding rounds. The first targeted up to 400 MW of solar, with one solar PV project and one solar thermal project. The second round (which was ultimately cancelled) targeted a further 600 MW of solar generation capacity.

The projects had to be large scale (any definition of large scale) but could be split across up to five different sites in the case of the PV plant, and have up to 15% hybridisation in the case of the solar thermal plant. The plants also needed to be grid connected and required the endorsement of the relevant state or territory governments. In terms of funding requirements, the Commonwealth funding to the successful proponent was to be awarded through taxable capital grants. Applicants needed to seek 2 for 1 funding for the project and were expected to access other government (state government) funding sources. Each project had an Educational Infrastructure Fund component (to support university research and training activities) and this funding was subject to separate legislative and funding requirements. It was anticipated that the round one project would be selected in 2010, to be fully operational by 2015.

Two highlights from the project include:

- **Solar Dawn project:** AUD 1 billion, 250 MW project in Queensland to build Australia's first solar thermal project and largest planned solar development. It won and lost both state and federal government funding and could not make financial close.
- **AGL and First Solar PV project:** AGL in partnership with Solar PV manufacturer First Solar has been revealed as the winner of the re-tendered round one SFP in the PV category. The cost of the 159 MW project at AUD 2.80 per watt is barely cheaper than a large residential solar system. Projects are to be developed in 2012-13 with construction complete in 2015. One hundred fifty direct construction jobs in Broken Hill and 300 in Nyngan.

Skills development and building community capacity

Job and new industry creation are major benefits available from renewable energy industries. In fact, the renewable energy industry is one of a number of industries that will receive strong *positive* employment growth as a result of increasing moves to low-carbon activities. The UNEP estimates that 20.4 million jobs will be created in renewable energy industries (wind, solar, biofuels). Cedefop identified further sectors, such as renewable energy, energy efficiency (particularly in buildings, new and old), transport, primary manufacturing and recycling sectors (Cedefop, 2010, 2012).

Job creation is only one side of the story. As the CUIDEN case study highlights, significant job destruction can be associated with the global move to lower carbon emission sources, and the impacts of these jobs losses are much larger when concentrated at a local level.

The low-carbon transition discussions initially highlighted the job creation potential of the low-carbon economy. This motivation is still strong with the reality of recession and austerity in many countries making the idea of green employment growth a welcome antidote to the high unemployment rates.

On the whole, there now seems to be agreement that a low-carbon economy will have in aggregate, a neutral or slightly positive overall impact on the labour force in terms of total employment (Cedefop, 2013; OECD, 2012c; UNEP, 2011), but impacts will be spread unevenly across countries, regions and types of workers; the effects will particularly be felt at the local level.

Therefore, in the move to green jobs other benefits also need to accrue to regions apart from net job increases. Capacity building and skill development within the regional communities are also important benefits of green initiatives.

Skills or competencies are inherently individual qualities. The OECD Skills Strategy defines skills as “bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning” (OECD, 2012b). In line with this, Cedefop defines green skills[4] as “the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society” (Cedefop, 2012).

The successful transition to a low-carbon economy will only be possible by ensuring the labour force is able to transfer from areas of decreasing employment to other industries, and if adequate human capital exists to develop new industries that will grow as a result of climate change mitigation and adaptation activities. Skills development activities will play a major role in each of these transitions (OECD, 2012c).

Skills development itself is becoming explicitly important for socio-economic development more broadly. People without adequate skills have a greater chance of experiencing economic disadvantage, a higher likelihood of unemployment and dependency on social benefits (OECD, 2012b). Conversely, even moderate improvements in skill levels have a significant pay-off for the economy in the long term (OECD, 2010). Green skills are important for the successful transition to a low-carbon economy, but also to ensure that we maximise the potential of our human capital.

In developing countries, the socio-economic impacts from skills development have the potential for even more dramatic impacts. Asian countries in the post-global financial crisis era are looking at increasing the knowledge intensity of their labour force and the sophistication of their domestic markets. As these countries move towards higher levels of services activity within their economies, the skills and competencies of the labour force must also transition. These economies can benefit by embedding the greening of the skills of the labour force in this wider upgrading of skills.

A further risk in not understanding and addressing green skills needs and the labour force gaps that may ensue is skills bottlenecks. This is where economic activity is stalled because of the unavailability of the correct range of skills, or the availability of these skills but at a cost that is too high to make their use viable.

Skills shortages, gaps and bottlenecks

Skills can be difficult to define and measure at an aggregate level because they are a socially constructed concept, intangible and often unobservable. A key distinction is whether skills are deemed to lie in the person or the job (Cedefop 2012), and in consequence, whether skills shortages or deficiencies should focus on those within people or those that are measured through volumes of jobs.

Skills shortages are defined as “a situation in which the demand for a particular type of skill exceeds the supply of available people with that skill” (Cedefop, 2012). This is marked by the absence of a sufficient number of appropriately qualified people to undertake particular roles when and where employers need them. Skills shortages may be caused by a shortage of applicants with the relevant knowledge, personal qualities, qualifications or experience or by low pay and unattractive working conditions, which may deter suitable recruits from applying. Skills gaps are defined as a situation in which the level of skills of the currently employed is less that that required to perform the job adequately or when the type of skill does not match the requirements of the job.

Skills shortages and gaps are a major impediment of many emerging industries. In a low-carbon economy, these bottlenecks can lead to increased costs to climate change mitigation and adaptation. These additional costs can diminish support for these actions and if they defer action on climate change, they can lead to greater costs in the long term.

Training facilities and knowledge infrastructure

Training facilities are important in creating the skilled capability needed to implement resource-efficient strategies in enterprises. Hands-on training (including quality management, resource accounting, production monitoring, etc.) provides both the sector and individual business with the skills needed to implement change. Governments can promote effective training initiatives by establishing them within government institutions or by funding external agencies such as industry groups or cleaner production centres (Unido, 2013). The best programmes will facilitate industry-initiated activity.

Industry clubs or associations are a useful means of promoting resource-efficient practices. Governments can provide grants and other incentives to these associations to develop practical management tools for promoting resource efficiency, specific to SMEs and the issues and operations of a particular industry or sector (ADB & IGES, 2008)

A region’s capacity to innovate, its resilience to shocks and the efficiency with which it delivers services, all relate to the stock and quality of human capital embodied in its workforce. In fact, it is hard to imagine a region engaging in a sustained path of technological upgrading without an abundant supply of skilled labour (OECD, 2011a).

Several rural regions have developed specific institutions, organisms and authorities to deal with the deployment of renewable energies in reaction to large investment and top-down national policies. The next case study shows how concentrations of individual low-carbon power plants can start to develop some of this specialised training and skills systems.

Case study: Biomass industry in the North of the United Kingdom

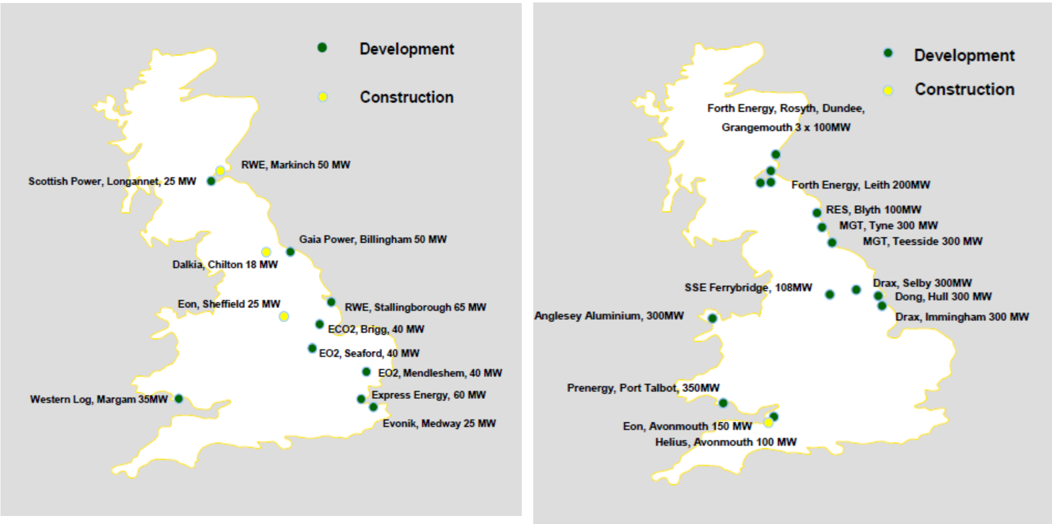
Bioenergy, by its very nature, is distributed locally, as the economics of the energy production depend on the close proximity of the energy supply feed stocks and the power plant. For this reason, bioenergy is considered a versatile form of low-carbon and renewable energy, and it can contribute to electricity generation, heat generation and transport fuels.

The UK government released a bioenergy strategy in 2012 (DECC, 2012); it outlines the role of bioenergy in assisting the United Kingdom to achieve its 2050 carbon emissions reduction targets. In 2007, biomass energy made up 3% of the total UK energy supply, and was forecast to increase to over 30% by 2020, although this figure has been significantly revised in the latest government documents (in 2011) to 8-11% by 2020. Most bioenergy (65%) is used in the form of solid (forest) biomass and biogas (from landfill) in power generation, followed by biofuels in surface transport (18%), the remainder is used in buildings, industry and agriculture.

Renewable electricity generation in the United Kingdom has received public support through the Renewables Obligation and the Renewables Transport Fuel Obligation, and specific biomass energy technologies have received preferential treatment (Korrhaliller, 2010). In recent years there has been a growing concern about bioenergy, specifically whether it results in low emissions energy when a lifecycle assessment viewpoint is taken, and also how bioenergy feed stocks interrelate with food production and food security issues (CCC, 2011).

Figure 2.6 shows the medium (right) and large (left) sized biomass power plants either under development or construction in the United Kingdom. The latest figures from the UK Biomass Energy Centre list 20 operational biomass plants (with a capacity of 2 MW or above), providing a total of 1.1 GW installed capacity and a further 28 in planning (Biomass Energy Centre, 2013). Although it is unlikely that all power plants in the development phase will proceed through to construction, there is a large cluster of these developments in the North of England and into Scotland.

Figure 2.6. **Biomass plants in the United Kingdom**



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: Korrhaliller (2010), "The UK's biomass energy development path," International Institute for Environment and Development, United Kingdom, updated from Bonsall (2010).

A number of these power plants have received public grants towards the start-up capital costs, including the Tees Valley biomass power plant (GBP 12 million grant from the Bio-energy Capital Grants Scheme (Korrhaliller, 2010). In the past there have been a large number of grant schemes open to bioenergy projects, as the biomass industry is so diverse when all of the different fuel stocks and processes methods are considered. Korrhaliller (2010) highlighted that industry found the range and different eligibility and application criteria confusing, and the *ad hoc* basis of grant funding (available one year but withdrawn subsequently) meant that industry could not adequately plan to include grant applications.

Despite the rapid increase in industrial activity in the bioenergy sector, one of the main barriers to the future development of the sector is co-ordination across the supply chain, networking fuel growers together with generators and end users (Korrhaliller, 2010). Some assistance in developing these links has been provided through the Biomass Infrastructure Scheme. Wider public awareness of the industry has been an important objective of the Biomass Energy Centre.

The bioenergy industry also has at least two recognised industry networks. One commissioned study (Northwoods, 2008) highlights the concentration of bioenergy activities in the North of England and the resultant impact not only in energy production (and therefore value to the economy), but also in the development of specialised training and educational services that were starting to develop as a result of the concentration of bioenergy industry in the region.

Summary

This chapter presented seven case studies of green initiatives that are having positive impacts in local areas. Each of the initiatives shows the multidimensional impacts available from these activities, particularly across the four areas of interest in this paper:

- job creation and business opportunities
- diversifying regional economics
- greening innovation in products, practices and policies in regions
- skills development and community capacity.

Each of the case studies presented has been different in terms of policy breadth, investment and objective, yet they also share some common challenges and lessons. The cases show that public green initiatives are capable of generating significant change – both in terms of lowering carbon emissions through shifting to renewable energy sources and in terms of generating new business and employment opportunities.

The cases also show that when a participatory approach is taken these initiatives can have knowledge and community building effects. This, in turn, helps further embed the initiatives in the local areas whilst also building capacity within the local population to take on further climate change mitigation and adaptation actions.

The cases also show the importance of training and educational institutional investments that need to be made hand in hand with renewable energy investments. These investments ensure that the local population is able to upskill in relevant areas, and therefore in a position to participate in any employment and entrepreneurial opportunities that result from green initiatives happening in their local area. This is particularly important in areas where these initiatives are being used to diversify the economy, because it is unlikely that these skills will be available in the existing labour force, and the renewable energy sector will move to import these skills from outside the area if there is no source of local skills.

Finally, these cases have also shown that even with the best of intentions and actions to deeply embed activities in the local economy, the wider macroeconomic impacts of national and global economies will sometimes counteract these efforts. Wider macroeconomic shocks mean that local activities require public support for longer periods of time than initially expected if they are to overcome these down turns and still make a return on the investments made in these green initiatives.

Notes

1. This case study draws on ICLEI Local Government for Sustainability/IRENA (2013a).
2. This case study draws on ICLEI Local Government for Sustainability (2010).
3. This case study draws on ICLEI Local Government for Sustainability/IRENA (2013b).
4. The starting point for identifying “green skills” is always the job (or the occupation) involved in a green (economic) activity in its strict sense (Cedefop, 2012).

Chapter 3

Conclusions and policy recommendations

This report has presented a snapshot of the global renewable industry and its impacts and effects at local and regional levels. The industry is rapidly growing in response to countries' activities to reduce their carbon emissions. This growth will need to continue if we are to stabilise global carbon emissions to 450 parts per million – renewable energy will need to account for 28% of global electricity generation by 2020 and 57% by 2050 (IEA, 2012).

This increase in global renewable energy generation will require a contribution from all major countries ; the IEA (2012) forecasts that by 2020 that the largest proportion of global renewable electricity generation will come from China (24%), followed by European OECD countries (19%), the United States (11%), Brazil (7%) and India (5%).

The renewable energy industry is now a significant sector in its own right with global investment in renewable generation capacity increasing by USD 230 billion in the years between 2001 and 2012. Public research and development activity in renewables is also increasing (almost back to the pre-global financial crisis peaks), as is patenting activity in renewables.

The benefits of renewable energy at a global and national scale are evident; they are less so in particular local areas and regions. Many OECD governments see the renewable energy supply chain as a promising sector for the creation of valuable and stable jobs, particularly in regional and rural areas, since exploitation of major renewable energy sources is space-intensive and thus likely to develop primarily in these areas (OECD, 2012a). The deployment of renewable energy is therefore increasingly seen as a key development opportunity for rural regions and a way for governments to give substance to "green growth" claims. However, economic and workforce development opportunities are often constrained by similar challenges to other new economic activities in regional or rural areas, such as limited infrastructure and/or limited availability of the necessary competences to deal with new sectors or new technology.

Local governments and other institutions will be central agents in the success of the transition of regional areas to low-carbon economies. Local governments typically hold multiple roles as decision makers, planning authorities, managers of municipal assets, operators of local energy providers and role models for the public (ICLEI, 2013). Local governments also have a large degree of influence, if not control, over land-use policies, which means they can influence what industries localise where, and in some instances set and control the regulatory limits for extraction and discharge activities (UNEP, 2011).

The challenges of accessing these benefits are striking the right balance of public policy mix, private investment and community support, and this will look different in each region. The notion of the average region is virtually meaningless (OECD, 2011a).

The aim of this report was to provide information and evidence to assist regional policy makers with the types of activities that can have positive impacts in their regions and the inherent challenges as these activities will then need to be customised to individual region's contexts. The case studies presented highlight four conclusions for renewable energy development in regions.

Job generation and new business opportunities

The Development renewable energy and other low carbon technologies offers the opportunity for new jobs, and also new business opportunities for regional businesses. Renewable energy can also offer existing businesses, particularly those associated with primary production (agriculture, forestry), the ability to diversify the income streams (and also weather-proof them) by including renewable energy in their production activities.

These activities, in turn, offer additional revenue (from taxation and service charges) to local and regional governments. It also adds diversity and dynamism to the local economy.

It is difficult to calculate the "net" job generation potential of renewable energy to regions because this will be different for each region and depends on the existing composition of industry. Evidence does suggest that the depth of integration of renewable energy activities within the local region, particularly if they are supported by national or central governments, will determine the ability of the region to generate additional employment to that associated with the construction and maintenance of renewable power plants.

Integration comes through the other activities that support renewable energy, including governance arrangements, networking and network support, and the creation and incubation of skills and training ecosystems.

Governance arrangements

The CIUDEN case study and the public participatory case for Brazil show how the governance arrangements put in place by jurisdictions have a major influence over the success or failure of renewable energy policies.

In CIUDEN, the project effectively involved six different administrative layers: the individual town councils, the El Bierzo district council, the León County Council, the regional government of Castilla and León, the Spanish national government and the EU; however, the Spanish central government was the only one to be represented in the governance of CIUDEN through its Steering Committee. Consequently, the lack of integration of local actors meant that some local and regional authorities might have felt insufficiently involved in the decisions of its management and therefore felt less ownership of the process.

This is contrasted with the experience of Betim and Porto Alegre, where a participatory process was implemented from the initial creation of the initiative for a renewable energy centre, and the success of the centre is credited to the active involvement of the multiple and relevant stakeholders. To ensure the success of these initiatives, it would be advisable to involve local and regional authorities, academia, industry and civil society more closely in the governance of CIUDEN, if necessary through direct seats on its Steering Committee. To further ensure its accountability to all of the local stakeholders, the highest standards of transparency should be adopted.

Innovation and embedded networks

A region's capacity to innovate, its resilience to shocks and the efficiency with which it delivers services, all relate to the stock and quality of human capital embodied in its workforce. In fact, it is hard to imagine a region engaging in a sustained path of technological upgrading without an abundant supply of skilled labour (OECD, 2011a).

Even small and well-established technologies require some degree of local customisation and this will most likely be carried out by the small and medium-sized enterprises (SMEs), as the market potential is not big enough to interest larger firms. These new business opportunities can be catalytic when supported by policy instruments that drive demand. The case studies of solar hot water heaters in Sao Paulo and solar PV in Dezhou showed two examples of this.

Innovation can also occur in the public sector and the governance arrangements that enclose green initiatives. The case study from Brazil shows innovative public participatory processes in Betim and Porto Alegre. Also some Public financial institutions acknowledge the importance of funding and provide specific lines for SMEs to adopt and carry one renewable energy projects.

What sets a region on a path to innovation is its openness to new ideas of business and other organisations in the region, and its ability to source and absorb new ideas; in effect, a region's ability to learn. This is also strongly related to the training and skills ecosystem present in the region.

Skills and training ecosystems

The successful transition to a low-carbon economy will only be possible by ensuring the labour force is able to transfer from areas of decreasing employment to other industries, and if adequate human capital exists to develop new industries that will grow as a result of climate change mitigation and adaptation activities. Skills development activities will play a major role in each of these transitions (OECD, 2012c).

It is likely that a low-carbon economy will have in aggregate, a neutral or slightly positive overall impact of the labour force in terms of total employment (Cedefop, 2013; OECD, 2012c; UNEP, 2011), but impacts will be spread unevenly across countries, regions and types of workers. Therefore, in the move to green jobs, other benefits also need to accrue to regions apart from net job increases. Capacity building and skill development within the regional communities are also important benefits of green initiatives.

It is worrying that in the IEA *Policy Database of Renewable Energy Deployment Policies* for 110 countries, that since 2008 only 3 policies specifically mention training and professional development as policy targets. This could be an under-reporting with much training activity happening in education policies, but alternatively it could also show underinvestment in the training and capacity building required to support greener industries. This is a further impetus for training and skills development activities to be part of the policy suite for renewable energy if any jurisdictions are to obtain the maximum outcomes they seek for their activities.

References

Asian Development Bank (2012) *Country Partnership Strategy: Mongolia 2012-2016*, Asian Development Bank, available at: www.adb.org/documents/mongolia-country-partnership- strategy-2012-2016 (accessed 13 August 2013).

Anadon, L., et al. (2011), "Transforming U.S. energy innovation", Policy Brief, Energy Technology Innovation Policy Research Group, Belfer Center for Social and International Affairs, Harvard Kennedy School, Cambridge, MA.

APPA (2011), *Estudio del impacto macroeconomico de las energias renovables*. Australian Government (2013), "Solar Flagships Program: Guidance for applicants", Commonwealth of Australia, Canberra, www.ret.gov.au/energy/Documents/sfp/Solar%20Flagships%20Information%20Guide%20for%20Applicants.pdf.

Biomass Energy Centre (2013), website, www.biomassenergycentre.org.uk.

Bradshaw, T. and E. Blakely (2002), *Planning Local Economic Development: Theory and Practice*, Sage, New York.

CCC (Committee on Climate Change) (2011), *Bioenergy Review*, Committee on Climate Change, London.

Cedefop (2013), *Skills for a Low Carbon Europe: The Role of VET in a Sustainable Energy Scenario*, European Commission, Luxembourg.

Cedefop (2012), *Green Skills and Environmental Awareness in Vocational Education and Training*, European Commission, Luxembourg.

Cedefop (2010), *Skills of Green Jobs: European Synthesis Report*, European Commission, Luxembourg.

David, P., C. Huang, L. Soete and A. van Zon (2009), "Towards a global science and technology policy agenda for sustainable development", *Policy Brief*, No. 4, United Nations University.

DECC (2012) *UK Bioenergy Strategy*, UK Government, London

ENDESA (2011), *Declaracion medioambiental UPT Compostilla*, Europa Nostra, www.europanostra.org/awards/77/?pagename=projects&id=77.

Freeman, C. and L. Soete (1997), *The Economics of Industrial Innovation*, Continuum, London.

Fundacion CIUDEN, es.CO2 Press kit.

Fundacion CIUDEN, "An ambitious plan", Fundación Ciudad de la Energía, Compostilla, www.ciuden.es/index.php/en/tecnologias/proyectos.

Fundacion CIUDEN, "Ciuden vivero", Fundación Ciudad de la Energía, Compostilla, www.ciuden.es/index.php/es/fundacion/component/content/article/9-desarrollo-territorial/35-ciuden-vivero-2.

Fundacion CIUDEN, www.enemuseo.org/index.php/en/el-museo.

Fundacion CIUDEN, PISCO2 brochure.

Fundacion CIUDEN, Statutes.

Fundacion CIUDEN (2013), "CIUDEN's patronage approves the works of storage in Hontonmín and the restart of Ene.Museum's building", 20 February, Fundación Ciudad de la Energía, Compostilla, http://ciuden.es/index.php/en/comunicacion/noticia?catid=0&id=695.

Gallagher, Kelly S., John P. Holdren and Ambuj D. Sagar (2006), "Energy-technology innovation", *Annual Review of Environment and Resources*, Vol. 31, November.

ICLEI Local Government for Sustainability/IRENA (2013a), "Local government regulation ordinances and laws to promote renewable energy", *City in Focus Sao Paulo, Brazil*, www.iclei.orf

ICLEI Local Government for Sustainability/IRENA (2013b), "Green economic development with renewable energy industries", *City in Focus Dezhou, China*, www.iclei.orf

ICLEI Local Government for Sustainability (2010), "Case study 113, Betim and Porto Alegre, Brazil", 20 July, www.iclei.orf

IDAE, "Plan de Energias Renovables 2011-2014".

International Energy Agency (IEA) (2013), *Tracking Progress to a Clean Energy Future*, OECD/IEA, Paris.

IEA (2011), *Renewable Energy: Policy Considerations for Deploying Renewables*, OECD/IEA, Paris.

IEA, *Renewable Energy Deployment Policy and Measures Database*.

Jenkins, Jesse et al. (2010), "Where good technologies come from: Case studies in American innovation", Breakthrough Institute, December.

Kassicieh, S., B.A. Kirchhoff, S.T. Walsh and P.J. Mcwhorter (2000), "The role of small firms in the transfer of disruptive technologies", *Technovation*, No. 22, pp. 667-674.

Korrhaliller, S. (2010), "The UK's biomass energy development path", International Institute for Environment and Development, United Kingdom.

KPMG (2012), "Taxes and incentives for renewable energy", KPMG International, June, www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/taxes-incentives-renewable-energy-2012.pdf.

Mandakh, N., D. Dash and A. Khaulenbek (1998), *Biological Resources of Mongolia, National Report 1998*, Edited by Tsogtbaatar,J. (2007), pp.63-73.

Martinez-Fernandez, C., S.A. Sharpe, H. Bruyninckx and A. Konig (2013a), "Green growth in the Benelux: Indicators of local transition to a low-carbon economy in cross-border regions", *OECD Local Economic and Employment Development (LEED) Working Papers*, No. 2013/09, OECD Publishing, http://dx.doi.org/10.1787/5k453xgh72ls-en.

Martinez-Fernandez, C., S. Sharpe, M. Munch Andersen, R. Genoff and K. Rovsing Kristiansen (2013b), “Measuring the potential for local green growth: An analysis of the Greater Copenhagen Area”, *OECD Local Economic and Employment Development (LEED) Working Papers*, No. 2013/01, OECD Publishing, http://dx.doi.org/10.1787/5k4dhp0xzg26-en.

Martinez-Fernandez, C., S.A. Sharpe and B. Haack (2013c), “Green growth in the Brandenburg, Berlin: An analysis of the regional growth core Schönefelder Kreuz”, *OECD Local Economic and Employment Development (LEED) Working Papers*, No. 2013/11, OECD Publishing.

Martinez-Fernandez, C., C. Hinojosa and G. Miranda (2010), “Greening jobs and skills: Labour market implications of addressing climate change”, *OECD Local Economic and Employment Development (LEED) Working Papers*, No. 2010/02, OECD Publishing, http://dx.doi.org/10.1787/5kmbjgl8sd0r-en.

McCann, P. and A. Rodríguez-Pose (2011), “Why and when development policy should be place-based”, in OECD (2011), *OECD Regional Outlook 2011: Building Resilient Regions for Stronger Economies*, OECD Publishing, http://dx.doi.org/10.1787/9789264120983-16-en.

Mongolian Economy (2011), “No water waste for the Ukhaa Hudag electric power plant”, Progressive Techology, Science and Technology Section, 2 December, available at: http://mongolianeconomy.mn/en/p/1376 (accessed 15 August 2013).

Northwoods (2008), “An economic evaluation of current and proppective value to the NE of England from biomass related business activities”, study for the Forestry Commission.

Observatorio Territorial del Noroeste, Desarrollo rural para el Bierzo: Economia.

OECD CFE/SME(2013)8 “The role of Public Financial Institutions in fostering access to finance for SMEs”, (2013).

OECD (2012a), *Linking Renewable Energy to Rural Development*, OECD Green Growth Studies, OECD Publishing, http://dx.doi.org/10.1787/9789264180444-en.

OECD (2012b), *Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, http://dx.doi.org/10.1787/9789264122246-en.

OECD (2012c), “The jobs potential of a shift towards a low-carbon economy”, *OECD Green Growth Papers*, No. 2012/01, OECD Publishing, http://dx.doi.org/10.1787/5k9h3630320v-en.

OECD (2011a), *OECD Regional Outlook: Building Resilient Regions for Stronger Economies*, OECD Publishing, http://dx.doi.org/10.1787/9789264120983-en.

OECD (2011b),*Green Growth Strategy*, OECD Publishing.

OECD (2010), *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*, PISA, OECD Publishing, http://dx.doi.org/10.1787/9789264077485-en.

OECD/IEA (2004), *Prospects for CO2 Capture and Storage*, Energy Technology Analysis, OECD Publishing, http://dx.doi.org/10.1787/9789264108820-en.

Pavitt, K. (1991), “What makes basic research economically useful?”, *Research Policy*, No. 20, pp. 109-119.

Reuters Point Carbon (2013), "EU carbon price collapse may advance CCS law", 26 April.

Spanish Ministry of Industry, Secretary of State for Energy.

Tait, Nikki (2011), "Opposition to Spanish coal subsidies grows", *Financial Times*, 15 February.

Tijssen, R.J.W. (2002), "Science dependence of technologies: Evidence from inventions and their inventors", *Research Policy*, No. 31, pp. 509-526.

UNEP (2012), *Tourism and the Green Economy*, UNEP, Geneva.

UNEP (2011), "Modelling global green investment scenarios: Supporting the transition to a global green economy", in UNEP (2011), *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*, available at: www.unep.org/greeneconomy.

Union Fenosa (2011), "Gas natural. Declaracion mediambiental – Central termica de Anllares".

World Bank (2012), "Solar power lights up future for Mongolian herders", Feature Story, 20 September, available at: www.worldbank.org/en/news/feature/2012/09/20/solar-power-lights-up-future-for-mongolian-herders (accessed 15 August 2013).

Zoljargal, M. (2013), "Semi-coked briquettes to reduce raw coal consumption by 25 percent", *UB Post*, 15 April, available at: http://ubpost.mongolnews.mn/?p=3654 (accessed on 11 August 2013).

Annex A

Local Energy Context: Spain and the Bierzo district

Spain, as a country largely dependent from energy imports, has a long-time interest in alternatives to its oil and gas imports. The most evident is its investment in renewable energy sources (RES). It has also added an increasingly important share of solar and wind power since the 1980s to a traditionally large share of hydropower into its energy mix. Several large-scale public initiatives, most notably the Almeria Solar Platform, have successfully contributed to this development.

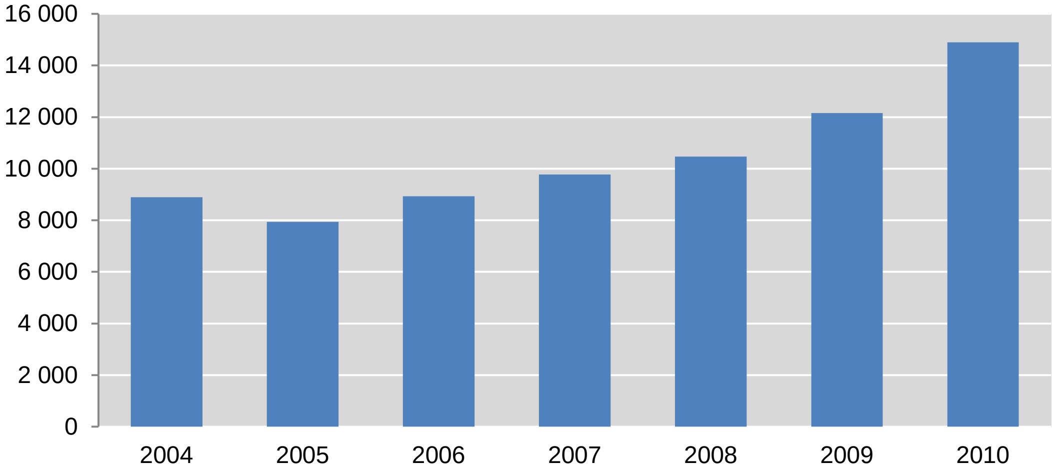
However, Spain's quest for alternatives has not been limited to RES. Despite strong economic and environmental criticism, it has also supported, through significant public subsidies and regulation, the exploitation of its indigenous coal resources. These coal resources are geographically concentrated in five provinces: Asturias, León, Coruña, Teruel and Cordoba.

Of these, the first two are the most dependent on their coal mines, and consequently on the public subsidies. In particular, in the northwestern province of León, in the region of Castilla and León, the coal mines are concentrated in the district of El Bierzo, shown in Figure 2.4, which consequently displays a significant historical dependency on the coal mining sector. Moreover, the local availability of coal in El Bierzo has also encouraged an historical investment in coal-fuelled electricity generation, which further increases the dependency on this sector.

Local context: Spain and the El Bierzo district

A comparatively high share of RES in its energy mix particularly characterises the Spanish energy market. In 2010, RES provided 33.3% of the gross electricity consumption in Spain and 11.3% of its primary energy consumption. Among the energy obtained from RES, 24.4% came from hydropower (both large- and small-scale), 25.2% from wind power, 6.7% from solar power (both photovoltaic and solar thermal) and 42.5% from biomass (including biogas and biofuels).[1] This reflects highly favourable environmental conditions, such as strong solar radiation, a mountainous geography suitable for hydropower and large areas of low population density available for wind power and biomass production. However, it also reflects a long-standing consensus on the need to reduce Spain's dependency on imported energy sources. The Spanish government has thus put several mechanisms in place to encourage the use of RES, including both direct subsidies and feed-in tariffs. In the period from 2004 to 2010, this resulted in a rapid growth in the use of RES, as is apparent in Figure A1.1.

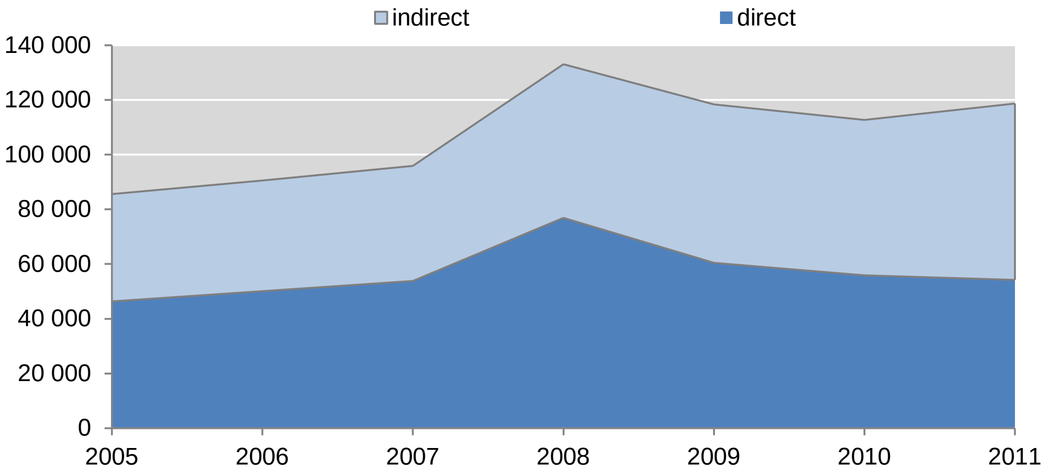
Figure A1.1. **Primary energy production from renewable energy sources in kTOE (tonnes of oil equivalent)**



Source: IDAE Plan de energias renovables 2011-2020.

At the same time, these policies also provoked a surge of "green jobs" in the renewable energy sector. By 2008, an estimated 133 028 direct and indirect jobs across Spain depended on the renewable energy sector (APPA, 2011). However, these policies also came at a significant cost to both utilities and the public treasury. As the general worldwide economic situation worsened from 2007, the financial burden of these policies quickly increased. Subsequent cuts in public funding and feed-in tariffs have had a significant effect on the renewable energy sector, with the number of direct and indirect jobs generated by the sector decreasing to 118 657 in 2011, as shown in Figure A1.2.

Figure A1.2. **Direct and indirect jobs in the renewable energy sector**



Source: APPA. Estudio del impacto macroeconomico de las ER. 2011.

Despite the environmental impact of coal extraction and burning, similar policies have also been in place to support indigenous coal use. Local coal mines receive direct subsidies under the "Coal Plan", while at the same time local utilities are under a legal obligation to buy set quantities of indigenous coal at regulated prices. Moreover, from

2006 to 2012, the national government bought significant quantities of coal to build up a "Strategic Coal Reserve". Already before the start of the financial crisis in 2007, these measures attracted considerable criticism both in Spain and abroad, and the pressure against them has increased under the current fiscal difficulties (Tait, 2011).

In 2011, a gross total of 2 643 622 metric tonnes of coal, representing over 30% of the Spanish coal production and concentrated in the higher coal grades (bituminous coal and anthracite), was extracted in the León province (Spanish Ministry of Industry, Secretary of State for Energy), with almost two-thirds of all coal mining jobs in León located in the El Bierzo district and neighboring Villablino, working for five coal-mining companies.[2] Fuelled by the local coal production, the first coal-fired power plant in the district was built as early as 1919, and the El Bierzo district is also the site of the Compostilla II (ENDESA, 2011) and Anllares (Union Fenosa, 2011) coal-burning power stations, with a generation capacity of, respectively, 1 200 and 365.2 MWe. These power stations are owned, respectively, by ENDESA and Gas Natural Fenosa.

Notes

1. IDAE. Plan de Energias Renovables 2011-2020.
2. Alto Bierzo SA, Carbones Arlanza SA, Hijos de Baldomero García SA, Coto Minero Cantábrico SA and Unión Minera del Norte SA, according to the Instituto para la Reestructuración de la Minería del Carbón.

Annex B

Note on contributors

Carmen Avellaner de Santos is a green energy policy consultant with a long career in the fields of energy, environment, research and development.

In particular, Carmen has worked in the European Economic and Social Committee and in various Directorates-General of the European Commission, handling an important project portfolio in the field of renewable energies, energy efficiency and international cooperation. She has also worked for the Regulation & Public Affairs department of Deloitte, represented the CIUDEN Foundation before the European institutions and coordinated the international relations of the Spanish National Energy Museum. She has recently joined INRA, the French National Institute for Agronomical Research, as European Affairs Officer.

She holds a Master's Degree in Economics and Management from Complutense University in Madrid (Spain) and another Master's Degree in Public Management from Solvay Business School in Brussels (Belgium).

Merritt Hughes holds a MS in Agricultural Economics from the University of Massachusetts, Amherst and has published in a number of academic journals such as *Journal of Regional Science* and *Networks*. She has served as agricultural economist at the United States Department of Agriculture over a period of eight years, specializing in issues relating to climate change, regional development and finance. Merritt Hughes is also an independent filmmaker, producing documentaries on a variety of topics. Merritt Hughes is currently serving as a consultant on projects related to green development strategies in Asia for OECD LEED while completing a PhD in public policy at the University of Massachusetts, Boston. She is a US citizen though has lived outside the US much of her life.

Dr. Cristina Martinez-Fernandez is a Senior Policy Analyst on Employment and Skills, Green Growth and Southeast Asia at the Organisation for Economic Co-operation and Development (OECD), Local Economic and Employment Development (LEED) Programme. She works on issues related to the challenges of skills and training systems for SMEs, entrepreneurial and innovation activities; industrial policy, climate change and the transformation of labour markets into the low-carbon economy; and the challenges of demographic change and an ageing society for skills and employment development. Cristina also manages the OECD/LEED initiative on Employment and Skills Strategies in Southeast Asia (ESSSA). Before joining the OECD she was an Associate Professor at the Urban Research Centre, University of Western Sydney in Australia where she led the Urban and Regional Dynamics Program, which analyses industry change, urban performance and socio-economic development within the frameworks of innovation, globalisation and the knowledge economy.

Dr. Samantha Sharpe is Principal Research Fellow at the Institute for Sustainable Futures, University of Technology Sydney. Her research focuses on regional economic development, innovation and technology development within firms, and science-based commercialisation of technology. Science and technology policy, particularly in the areas of green technology and economic development policy, are of ongoing research interest. Outcomes of this research are policy development and industry advice around the support of innovative activity in places, the incubation of new technology, and the role public policy can play in the "green economy" in establishing emerging markets for environmental technologies and services, particularly in energy efficiency and renewable energy.

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