Measuring the Potential of Local Green Growth – An Analysis of Greater Copenhagen

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Copenhagen Capacity is the Danish Capital Region's official organisation for investment promotion, business development, cluster development, and better framework conditions for international talents. Its mission is to grow business capacities in Copenhagen and to strengthen the Region's international competitiveness.

ISSN 2079-4797 (PDF)OECD Local Economic and Employment Development (LEED) Working Paper Series. This report is part of a series of working papers from the OECD Local Economic and Employment Development (LEED) Programme. The LEED Programme identifies, analyses and disseminates innovative ideas for local development, governance and the social economy. Governments from OECD member and non-member economies look to LEED and work through it to generate innovative guidance on policies to support employment creation and economic development through locally based initiatives.

FOREWORD

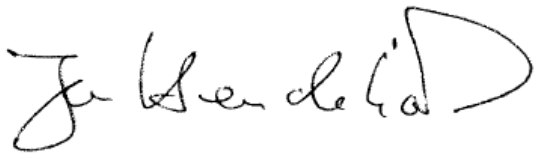
This study is a key element of the OECD LEED's work on green growth, as it shows that local institutions can foster private sector development, particularly that of Small and Medium Sized Enterprises (SMEs), in order to help them seize the opportunities offered by the green transition. The study helps us better understand how to achieve a transition to economic growth that is environmentally sustainable. It establishes the importance of addressing this challenge at all levels of government - global, national, regional and local.

Indicators are a primary catalyst for transition, because they measure both progress and delay, while providing comparisons across countries. It is important to have local as well as national indicators, since this is where many of the green adjustments take place. However, what needs to be measured is not necessarily the same at the national level as at the local level and indicators may need to be adjusted accordingly.

The Copenhagen case is the first OECD local-level green indicators study to be undertaken. It identifies the drivers of progress for Copenhagen's clean-tech firms, and it shows how these can become a magnet that attracts investment to the country. The Copenhagen Cleantech Cluster (CCC) is a key contributor towards the green transition of Denmark. However, despite strong growth within the companies that are part of the cluster, the clean-tech industry is at the centre of intense global competition, and strategic choices will be vital to its continued development. This report provides guidance designed to assist with making these decisions; highlighting those areas where further efforts by both the private and public sectors need to be concentrated.

This report emphasises the significant role that local institutions have to play in implementing national agendas for the transition to a green growth economy and the push for change. Progress measurements therefore need to take account of both ends of the 'national-local' continuum.

The Copenhagen green dashboard shows the usefulness of measuring progress as an analytical strategic tool for development. As the City of Copenhagen and the Capital Region demonstrate, much can be achieved through co-operation between national and local stakeholders.



Jan Hendeliowitz

Chair of the OECD LEED Directing Committee

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Dr Cristina Martinez-Fernandez directed the 'Measuring the Potential of Green Growth: Towards a Local Transition to a Low-Carbon Economy' project in collaboration with partners and experts from Denmark, the Netherlands, Luxembourg, Germany and Chile. This report presents results and policy recommendations from the analysis of Greater Copenhagen. The report has been prepared in collaboration with Dr Samantha Sharpe of University Technology Sydney and Dr Maj Munch Andersen of Technical University of Denmark, with chapter contributions from: Mr Rodin Genoff and Ms Alicia Hanton of Rodin Genoff and Associates; Mr Klaus Rovsing Kristiansen, Mr Kim Bek and Mr Thomas Baagø Rasmussen of Copenhagen Capacity, Mr Michael Johansen of Copenhagen Cleantech Cluster.

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TABLE OF CONTENTS

Tables

Figures

Boxes

EXECUTIVE SUMMARY

The need to address the threats and impacts of climate change, combined with the aftermath of the global financial crisis, has led to critical rethinking of our economic growth model and our consumption and production practices. The low-carbon economy, or more specifically, growing the economy in an (environmentally) sustainable way, involves promoting growth and development while reducing pollution and greenhouse gas emissions, minimising waste and the inefficient use of natural resources, maintaining biodiversity, and strengthening energy security.

Transition to a sustainable low-carbon economy requires further 'decoupling' of environmental impacts from economic growth, and greening of consumption and production patterns, while reducing poverty and improving health and job prospects. We are only at the early stages of understanding green growth transitions at the international, national and local levels. Indicators will be a key tool in understanding this transition, as they are vitally important in measuring progress, providing comparisons and understanding what is working well and what is lagging. Indicator development, particularly at the local level, is in the formative stages, and has an underlying tension between measuring past performance and guiding future directions.

There are two main reasons why monitoring and understanding progress towards green(er) growth needs to be tracked at all levels: national; international; and *local*:

1. The impacts of climate change will be variable at a local level;

2. The enactment and impacts of policies to mitigate climate change, such as pricing carbon, switching to less carbon intensive energy supply and production, and appropriating the opportunities presented by a transition to a low carbon economy (including the creation of both new employment and industries) will be distributed differently across regions and localities. This will be especially evident in labour markets.

Cities are playing an increasingly important role in the lives of the world's populations; they can also play a significant role in reducing global carbon emissions. People living in cities have lower direct per capita emissions but higher per capita GDP. Copenhagen exemplifies this, with its residents producing half the per capita emissions compared to the OECD average[1]. This report explores Copenhagen's journey towards a low carbon future, discussing trajectories and potential lessons for other cities looking to make the same transition.

The Copenhagen example is not alone nor was it the first in Denmark. In fact, numerous Danish municipalities have developed various types of climate or sustainability strategies and several green cross-municipal networks exist or have existed, including networks specifically designed to promote green growth. Copenhagen's progress to date has resulted from a unique combination of elements including: the specific institutional, cultural and resource capacities of the city; the installation of the

1 OECD (2011) Factbook Economic, Environmental and Social Statistics

district heating system; the drive for energy security through renewable energy (particularly the wind industry); and the tradition of collaboration and consensus-building within the political system.

These elements include long term and immediate actions by a range of public and private actors. This environment has delivered Copenhagen, and Denmark's clean-tech firms significant first mover advantages in green industries and technologies, and acted as a magnet for attracting investment to the city and country.

This report also presents, for the first time a local 'green growth' indicator framework. This indicator framework was developed from the OECD 'green growth' strategy at the national level, but modified to highlight issues of transition that are most relevant for local areas. The Copenhagen report is the first trialling of this approach, along with an indicator visualisation tool – or dashboard. The dashboard allows easy assessment of the progress of a particular local area in a number of indicator variables.

The dashboard for Copenhagen shows the city has already made considerable progress towards a low carbon future. Also, equally important, the dashboard shows that Copenhagen has significant resources available to measure this progress, with all variables in the local green growth indicator framework reporting data. In some areas this measurement and associated data sources are emerging, including areas such as environmental goods and services and green skills and knowledge. Comparative data sources at the national and international level on these variables are also limited, which makes progress difficult to contextualise.

The difficulty in measuring the value and size of the environmental goods and services market is not just restricted to local levels – similar data gaps exist at the national level as well. The problem is in part one of the definition (i.e. how are green industries defined) and partly, how is the 'green' element isolated from a wider impact of greening and an increasing focus on resource efficiency that is happening across the entire economy? It is in these areas that we are really at the frontier of defining and measuring 'green' industrial activity. The green growth indicator work undertaken at the global level will need to balance the tensions of using a framework that all local areas can adopt, against continuing to offer the opportunity for the leading cities to measure their ongoing progress in a meaningful way.

As the dashboard shows, Copenhagen is progressing well in green transition. This, however, does not mean that Copenhagen's transition to a low carbon economy is complete. Although the Cleantech Cluster is well established within Copenhagen, further resources and investment will be needed to ensure that social and economic benefits are maximised. Benefits include: innovative and globally competitive firms; skilled employment in environmental goods and services; and assisting Denmark to remain one of the global leaders in environmental and clean energy industries. The clean-tech industry is now the focus of serious global competition, with many other regions able to invest significantly more than the resources available to Copenhagen. Strategic investment choices will be essential. The following recommendations are proposed for: (1) fostering green innovation and the continuing competitiveness of the clean-tech industry; and, (2) financing innovation and facilitating knowledge-intensive green activities.

1. Invest in capacity for greening jobs, skills and entrepreneurship

A transition to a low-carbon economy will not be possible without accompanying labour market measures for workforce skill upgrading. At the same time, and as labour markets are ageing and shrinking, those that are not able to develop 21st century skills are at a higher risk of being left behind and not able to benefit from the new opportunities that green growth offers. A first step in this process is identifying metrics and collecting data that can inform future activities.

While there are several pathways to adjust the workforce to low-carbon economic activities, Copenhagen can take advantage of the existing clean-tech companies to strengthen research co-operation with universities and/or increase their involvement with the cluster's activities.

At the same time that formal university-business collaborations are established, other forms of green skills development can be facilitated through informal knowledge intensive activities. Universities, training institutions, trade unions and business organizations can introduce specific instruments related to green entrepreneurship, encouraging new entrepreneurs to interact with the clean-tech companies through dedicated networking events as a way to stimulate innovation and new business alliances.

Local institutions can help with this focus towards developing green skills by focusing on environmental policies and procedures in order to keep local demand for green development ahead of the international curve. Green public procurement, for example, can be a significant instrument for the local Small and Medium Sized Enterprises (SMEs) providing products and services, influencing the knowledge and skills of their employees to compete for public contracting.

2. Accelerate the transfer and diffusion of new knowledge and technology

Knowledge diffusion is as critical a process as knowledge development. In order for Copenhagen to maximise the impact of its clean technology, leadership diffusion around innovation needs to be as important an outcome as development of technology.

Developing a technology and knowledge transfer and diffusion strategy in partnership with other Danish agencies and knowledge institutions that build on Business to Business (B2B) connections and investment opportunities arising from the Copenhagen Cleantech Cluster will accelerate diffusion.

A further focus on strengthening the capacity of local SMEs to participate in the cluster, for example through their participation in projects with larger Danish and overseas multinational companies and knowledge institutions will expand cluster membership, but also enhance the clean tech capacity of the SMEs. Projects that enable SMEs to access or procure IP or production licences and the like (commercially or through partnership arrangements), can contribute to building SMEs green credentials in the market place but also increase the dynamism (and therefore longevity) of the cluster.

3. Foster 'disruptive' innovation

The Copenhagen Cleantech Cluster could be described as a mature cluster, with specialised institutions and knowledge service providers in place. Copenhagen can take advantage of the mature development stage of the region in green technology and practice to develop more radical green innovations. Copenhagen has unique opportunities to experiment with advanced green solutions within smart modes of organising production and consumption and technical infrastructures in a liveable city.

These novel solutions should be visibly demonstrated and highlighted in the city, contributing to the development of further green Copenhagen symbols such as the well-established bicycle use and the more novel harbour swimming basins. Such initiatives may attract the interest of early stage investors and venture capital to seed new green technologies of the future. Such new projects will reinforce Copenhagen's brand and international standing as a laboratory for new green products and services, and a test-bed for disruptive innovation as it displaces conventional production and distribution means grounded in 20th Century economic and technology paradigms. Such an initiative will also strengthen the interest of financial markets in CCC's companies and the projects in which they are participating.

4. Enhance financing of innovation and attracting foreign direct investment

Denmark and its companies' R&D and investment opportunities require sound, forward looking financial institutions in order to activate future investment opportunities, including the country's long term ability to attract foreign direct investment (FDI). Danish energy and clean-tech companies receive significant investment from Denmark and the Nordic region's financial institutions.

To enhance the financing of innovation, Danish financial institutions can provide further technical support to the CCC with wider participation in the cluster meetings and by assisting new and smaller companies with their innovations.

To attract more FDI, local institutions, and particularly Copenhagen's Investment Agency, should further strengthen the networking infrastructure developed for the Cleantech Cluster by providing specialised, knowledge intensive services that reach both mature innovative firms and the start-ups entering the market. The knowledge intensive activities that CCC facilitates can act as an 'innovation milieu' for firms searching to co-locate to be within the proximity of new knowledge generation.

5. Strengthen cross-sector linkages to connect global and local firms

Place and community space are important for connecting and mobilising activities between core clean-tech companies and other industries and services such as engineering and smart integration manufacturing companies, finance and marketing, and scientific companies. Generating and reinforcing such connections will allow clean-tech firms to maximise the competitive advantages the cluster offers.

Copenhagen City should, through its membership of the C40 group of cities, and the CCC through ICN, fully exploit the opportunities for international collaboration, and support smart city initiatives that bring together Danish and partnering overseas companies in the strong growth and emerging markets.

6. Develop a bottom–up, next generation governance architecture

Build on Copenhagen Cleantech Cluster's success and develop a governance structure that builds investment opportunities for clean-tech companies from the bottom up. This includes the formulation of a responsive and integrated platform that maximises triple helix partnerships between governments, businesses and universities in the delivery of state of the art and investment driven projects.

Copenhagen Cleantech Cluster's next generation architecture would include a dynamic market driven framework and programmes to support companies within the cluster and those suppliers and customers with whom they interact commercially, which may not see themselves as green growth companies, but which are nonetheless an indispensible part of the broader eco/industrial ecology of the Cleantech Cluster.

7. Develop a people driven investment agenda

Copenhagen is a liveable city and is ranked as one of most sustainable cities in the world. Copenhagen's governance architecture has been effective in marshalling the resources and knowledge of the entire community, and in the process formulating practical pathways to implement integrated green growth projects.

The Capital Region of Denmark, Copenhagen City and the CCC should work more closely together with the business community to forecast future investment plans (including, for example:

infrastructure; building and construction; urban development; transport; and in key clusters such as information and communication technology (ICT) and life sciences) to spin off complementary projects that can build a strong, vibrant and sustainable community. The social and economic benefits to the community of maintaining investment in these activities needs to be brought to the fore. The links with ensuring growth of the liveable aspects of Copenhagen need to be underlined so citizens and investors have a common interest in success.

8. Facilitate knowledge-intensive green activities for the Cleantech Cluster

CCC is a key facilitator of knowledge exchange in the clean-tech area. The design of specific knowledge intensive green activities that can function as intellectual services for the firms will maximise the transfer and uptake of new ideas, technology or production processes. These vital points of interaction and collaboration between companies underscore the strength of CCC. The exchange of each piece of information, through an initiative such as a cluster forum (including, for example, companies ranging from software, engineering and satellite navigation, all working across different disciplines to develop new clean-tech solutions) directly adds to the repository of the CCC's knowledge.

Boost the high innovative capacity of CCC and build on the already above-average degree of knowledge co-operation and exchange between companies, as well as between companies and knowledge institutions, through specifically designed green interactive activities.

9. Stimulate education, research and exchange programmes

Copenhagen Capacity has developed the International Cleantech Network (ICN) in partnership with the Colorado Cleantech Cluster in the United States with the aim of ultimately linking together 15 other clean-tech clusters globally, especially in the emerging markets of Brazil, China and Russia. This gives Danish companies global reach, in a manner that would, for many smaller companies, simply be impossible to achieve on their own. In fact, the ICN also acts as a point of dissemination for Danish green know-how to the rest of the world, while ensuring that CCC is kept abreast of global clean-tech trends, business and investment opportunities. The CCC should strengthen collaboration arrangements through the ICN to expand its research and university exchange programme.

In particular, this would see greater co-operation between businesses, universities and knowledge institutions involved through the ICN, which can support commercialisation, and research and development (R&D) activities of member clusters into target markets, and thus reinforce the CCC's commercial footprint in international clean-tech projects.

10. Investing in indicators data collection at the local level while co-ordinating with national agendas

This study has demonstrated the complexities of measuring green growth at the local level. Even if only a few indicators are collected, the benefits for the analysis of the local economy cannot be overestimated. The process of discussing and thinking about what the indicators and the green dashboard mean for Copenhagen introduces a focused dialogue between different stakeholders and actors from policy makers to business people, academics and researchers. It is through such discussions that innovative thinking and solutions can be developed, as well as inspiration for new projects and initiatives for green growth.

The final recommendation for Copenhagen and its local institutions is to continue working with the local indicator framework, developing and refining lists of indicators and data collection

methodologies. Data collection also needs to be accompanied by on-going reporting, and Copenhagen should also resource this reporting, through tools such as the dashboard, or similar.

The dashboard itself is an instrument for policy and strategic dialogue, and it should be regarded as an evolving instrument that takes different forms as the policy dialogue in Greater Copenhagen advances towards greening the economy.

Local institutions have a significant role to play in implementing national agendas for the transition to a green growth economy. Measuring progress needs to have the two sides of the 'national-local' pipe so that efforts can leverage the investments made at both ends of the continuum. It is this dialogue that will bring policy coherence and sustainable trajectories to the communities of Greater Copenhagen.

The Copenhagen 'Local Green Transition' Dashboard

The dashboard (Figure 1) was developed from the starting point of the OECD national green growth indicators. Through workshops with Copenhagen stakeholders, there were three specific areas of the green growth indicator framework that spoke especially well for the understanding of local components of green transition:

- Resource efficiency, but extended to include waste efficiency and the level of recycling within the local area
- Knowledge intensity and green economy opportunities
- Policy responses to support green growth

Developing on these areas, and in partnership with other local areas in Germany, Luxembourg, Belgium, and Chile within the *Indicators for local transition to a low carbon economy* project, a refined set of indicators and data collection was developed. An iterative process between case study areas and the OECD was then pursued to develop these areas into a modified local level indicator framework. Considerations used to shape this framework included data availability, current and proposed policy activity, cross-border implications, and an assessment of the literature on green jobs and skills for data collection methods and options.

The modified local level indicator framework will be tested in each of the case study regions. The overall aim of the project is to be able to advise a wide sample of local stakeholders on what is important to measure at the local level. The results will then inform future OECD work on measuring transition to a low carbon economy in local areas.

The results of the exercise for Copenhagen can be summarised as follows:

Environmental and resource productivity: Copenhagen performs at least as well as the OECD average with respect to the following measures: per capita emissions, energy consumption, water consumption, regional waste collection, per capita recycling, and treatment of contaminated land.

Economic opportunities: Copenhagen performs better than the OECD average on R&D expenditure and employment, green patents, employment in environmental goods and services, and turnover of environmental goods and services business.

Policy responses: Show that Copenhagen can progress further. Local government policies and municipal strategies have a higher degree of 'greening' than policies for universities, job creation initiatives, support schemes for social assistance, including for the elderly population.

Green skills ecosystem: Copenhagen's green skills ecosystem can be further developed by reinforcing links of industry and research and universities, fostering green vocational education and training, and co-operating further with the private sector and trade unions to boost green skills development and training.

The dashboard is supplemented by further stakeholder evaluations on the progress of policy, and skills and training systems on equipping the local area for low-carbon transition. The local policy assessment (Figure 2) and skills ecosystem (Figure 3) were derived from a short questionnaire submitted to local policy and training stakeholders. These stakeholders were asked to assess the progress of various policy and skills development mechanisms in encouraging local transitions to low carbon economy.

The bars in the charts for each of the indexes represent the average answers on a five-point scale. These results are subjective, but together with the other elements of the indicator framework can offer a richer picture of the current status of local transitions. If these questionnaires are conducted at frequent intervals, transition progress will also be evident.

Figure 0.1. Greater Copenhagen's Dashboard

Figure 0.2. Copenhagen - Local policy assessment for green growth

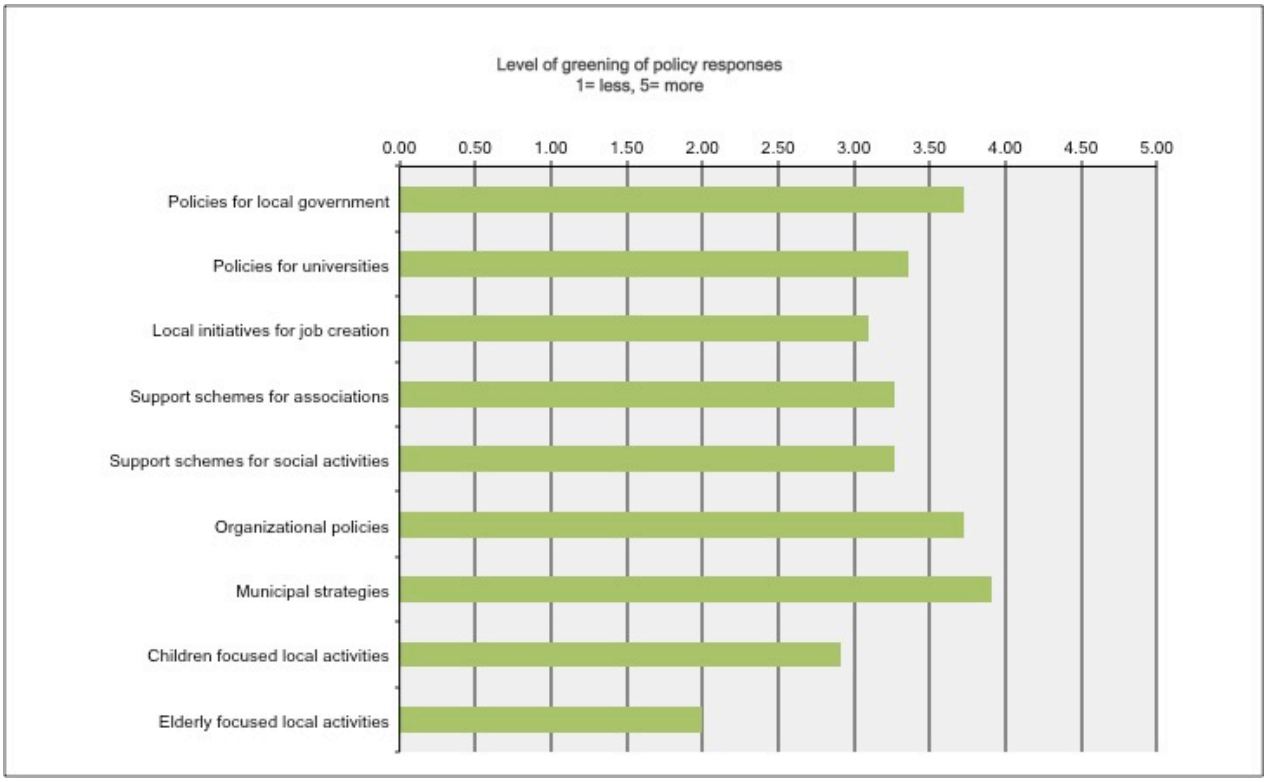
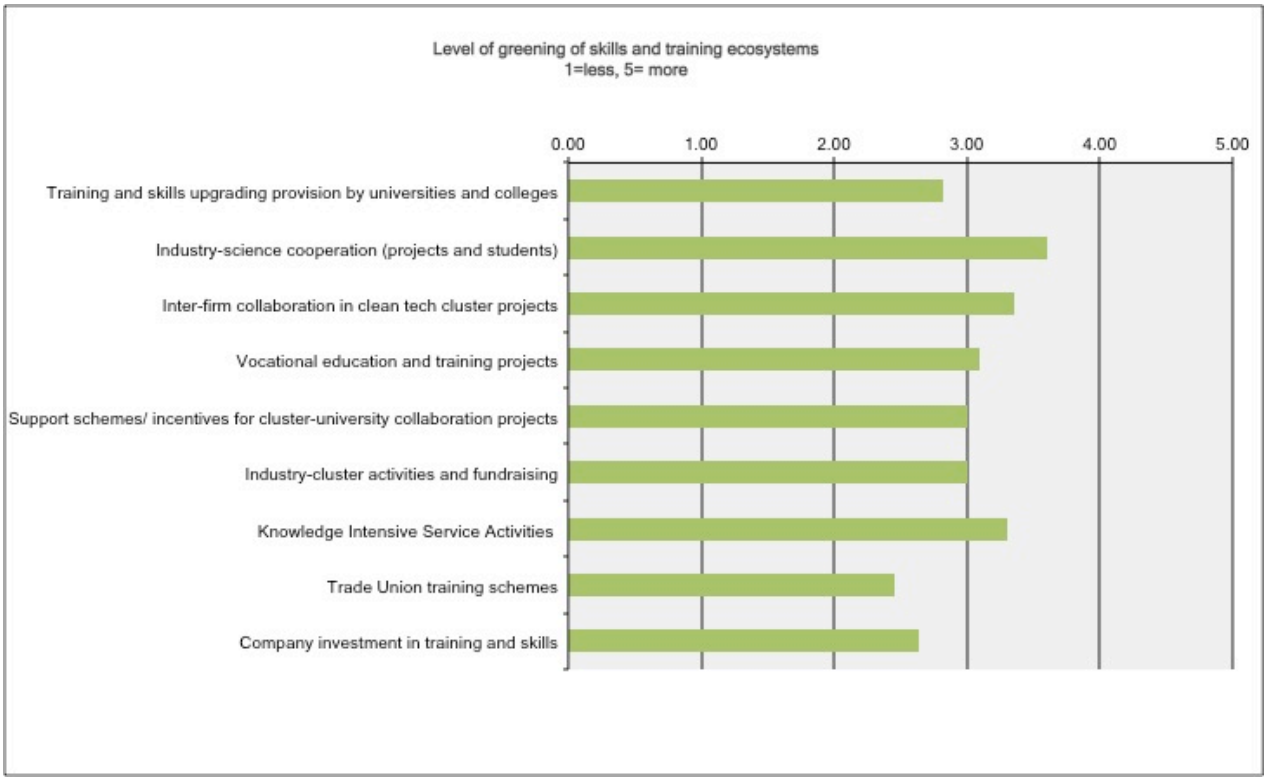


Figure 0.3. Copenhagen - Skills ecosystem assessment for green growth



CHAPTER 1

TOWARDS A LOCAL TRANSITION TO A LOW CARBON ECONOMY

As the need to address the impacts of climate change becomes more urgent and the subsequent green momentum continues to gather pace, individual governments and companies are transitioning to a low-carbon economy. This transition to a low-carbon economic and industrial future is taking place in a highly uncertain and competitive marketplace. With many countries and cities seeking to give their own domestic companies a head start as closer attention is paid to this low carbon transition, indicators are becoming increasingly important as a mechanism to inform the development of programmes designed to generate green economic growth.

The green transition and its challenges

Global warming and the emergence of the green economy have supplied added pressure to OECD economies to de-carbonise their economic activities. This, together with the global financial crisis, have led to critical rethinking of our economic growth model and our consumption and production practices. The recent OECD Environmental Outlook 2050 (OECD 2012) describes the fundamental demographic and economic forces that will shape the globe in the four decades to 2050:

- An additional 2 billion people will need to be accommodated, with rising living standards across all countries and a quadrupling of global GDP.

- Increasing life expectancy will mean that for some countries over one quarter of their population will be aged over 65 years, for other countries, particularly developing countries, young populations and workforces will be a competitive advantage. By 2050, the majority (70%) of people will be living in cities, placing greater emphasis on the need for solutions to air pollution, traffic congestion, and the management of water, waste and energy in urban environments.

Responding to climate change is a challenging paradox – for the majority of people the costs of inaction on climate change appear to be a long way into the future, yet the costs of action need to start being paid for now. There is also a high degree of uncertainty around which actions in the long-term will prove most successful. With all of these risks, businesses and governments at all levels find it difficult to act. These uncertainties include technological choices and the irreversibility of these choices.

The role of public policy is essential in the green economy transition, as public policy can provide the incentives and increased certainty for others to act. Business understands this; at the recent UN Sustainability Conference in Rio de Janeiro, Brazil, the World Business Council for Sustainable Development (WBCSD) put forward the following statement in their policy document to the Forum:

> Since the 80s, the notion spread that less government intervention is better for business and economic growth. Yet the resulting deregulated world, with its weak financial and multilateral governance, has a mixed record of progress. It also accumulates economic distress, social tensions and increased environmental risks. It deals badly with the magnitude, depth and urgency of our systemic challenges. Letting the "invisible hand" of the market sort out winners and losers in a vacuum of externalities, with a blind eye to the growing social inequality and the overuse of discounted natural resources, quashes the business case for the main beneficiaries to give up their power and initiate the changes. It only breeds the pursuit of business-as-usual, and resistance to change, except in the case of a close and direct crisis.
>
> In the current financial context, greener technologies and sustainable, inclusive business solutions are at a disadvantage when tested for short term returns. Their business case will not happen at scale and speed unless governments introduce measures to lower their barriers of entry and raise the costs, or remove the licence to operate stranded assets and harmful practices.
>
> Markets are merely man made. Changing Pace is about innovating better rules for markets, and overcoming mind-sets and dilemmas about shared authority and leadership. Governments and business must pull vigorously in unison to boost sustainable business solutions with smart policy solutions. (WBCSD, 2012, Changing Pace: Public Policy Options to scale and accelerate towards Vision 2050, Executive Summary pp.9-10)

All levels of government need to be involved in creating certainty and incentives – it cannot be solely the role of international and national institutions to act, as the pace of action will be too divergent. The difficulty in reaching consensus and action is that they rely on the very cautionary approaches by policy leaders at the national and international levels, as demonstrated at the recent Rio+20 conference agreements:

> Countries reaffirm the commitments they have made to phase out harmful and inefficient fossil fuel subsidies that encourage wasteful consumption and undermine sustainable development. We invite others to consider rationalising inefficient fossil fuel subsidies by removing market distortions, including restructuring taxation and phasing out harmful subsidies, where they exist, to reflect their environmental impacts, with such policies taking fully into account the specific needs and conditions of developing countries, with the aim of minimising the possible adverse impacts on their development and in a manner that protects the poor and the affected communities. (Text of the final declaration issued by the world community at the conclusion of the Rio+20 Sustainable Development Summit recently in Rio de Janeiro, Brazil, 2012)

This cautionary approach should not persuade other jurisdictions to also hold back. Multiple policy levers will be required to deal with all the complexity and highly specific variables necessary to create change over so many jurisdictions and countries.

Some benefits available now

There are widespread benefits in an early transition to a low carbon economy that are immediately available, and through current activities. These benefits have been purely speculative until recently. However, we are now starting to obtain substantive evidence of the positive industrial dynamics that can be achieved (Kammen, Kapadia and Fripp 2004; Pearce and Stilwell 2008; IEA 2009). The analysis of 13 independent reports and studies carried out by Kammen, Kapadia and Fripp (2004), on the economic and employment impacts of the increased clean energy in Europe and the United States showed that increasing the use and production of renewable energy had a positive impact on employment. The UNEP (2008) estimates that with an increasing move to renewable energy these industries will create 20.4 million jobs net by 2020. Another study shows the value of Environmental Goods and Services (EGS) has almost doubled from $548 billion in 2004 to a forecast of over $800 billion by 2015 (Selwyn and Leverett, 2006).

These figures are starting to turn the perception of climate change policy action from that of a ‘job killer’ to a ‘job creator' (Martinez-Fernandez et al 2010). Significant investments, despite the on-going financial crisis and economic downturn, continue to be made in encouraging green growth.

Encouraging Green growth and the need for indicators of transition

Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. To do this it must act as a catalyst for investment and innovation, which will underpin sustained growth and give rise to new economic opportunities (OECD 2011a).

The OECD Green Growth Strategy, delivered at the 2011 OECD Ministerial Council Meeting, conceives green growth as way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss, and unsustainable natural resource use (OECD Green Growth Strategy 2011[2]).

[2] www.oecd.org/greengrowth

Achieving greener growth will involve capitalising on opportunities to develop new green industries, jobs and technologies, as well as managing the transition for greening the more traditional sectors and the associated employment and distributional effects. It will require adopting new technologies, developing new products and supporting new patterns of demand from households, companies and governments.

However, there is very limited information regarding how progress can be made when standards and measures are uncertain and based on traditional measures of economic activity. While efforts at the national level are progressing, and many initiatives can be found at the local level, there are a significant number of inconsistencies, and a lack of agreement concerning the indicators needed to analyse, amongst other questions: How do local economies, firms, clusters and regional ecosystems adjust to low-carbon activities? How are local labour markets making the transition? How do firms re-structure their organisation and production processes? How do skills, education and training systems adapt to the development of new areas of growth?

The need for measurable indicators has been well established within the framework of the strategy, targeting four areas of analysis (see Figure 1 below):

- Changes in productivity in the use of environmental assets and natural resources;
- Natural asset base;
- Environmental dimensions of quality of life;
- Policy responses and economic opportunities.

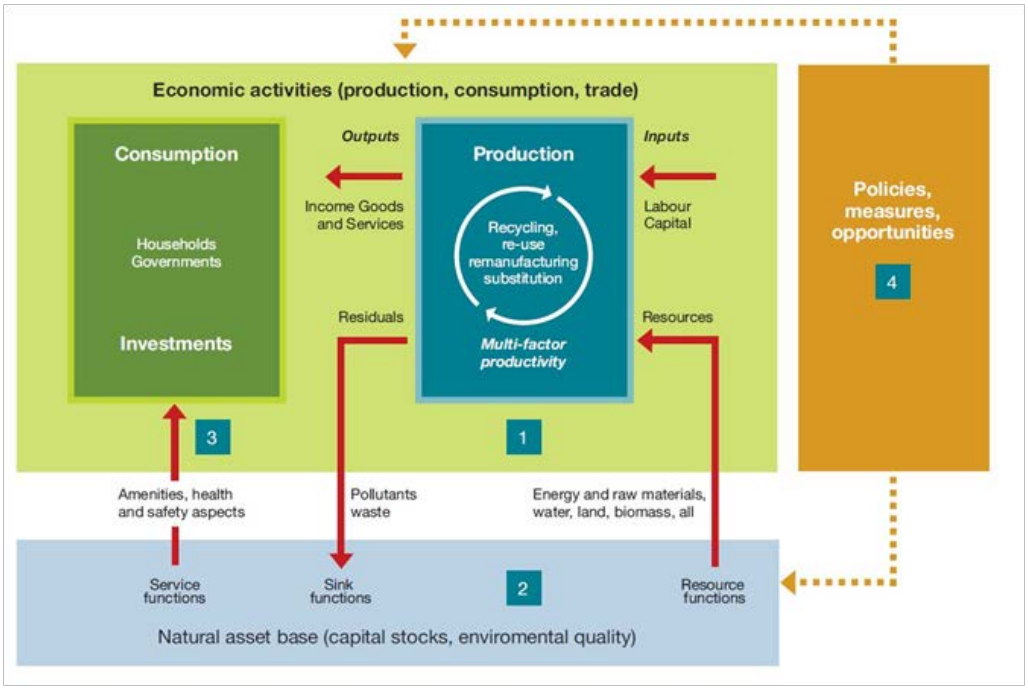
This monitoring will be essential for policymakers at national levels to create and implement green growth strategies. The progress towards green growth will not be equally distributed within countries, therefore it is also important that progress be monitored at the **local and regional levels**.

The central tenet of the green growth framework is the recognition of natural capital as a factor of production and its role in enhancing well-being (OECD 2011b). This provides a new dimension for understanding growth and is a counterpoint to how economic activity has been measured and understood throughout much of the modern era, with gross domestic product (GDP) being the central metric for understanding economic performance. The weakness with the GDP approach is that it fails to account for depletion of the stocks of natural assets in the current production and consumption regimes, and how these natural stocks are just as important and relevant to current and future growth as capital and labour stocks.

Natural capital stocks include natural resource stocks (both renewable and non-renewable), land, and ecosystems (as shown in Figure 1.1.). Alongside recognition of the natural asset base within the economic model, the indicator framework also includes an understanding of policies and measures that can provide a balance between the factors of economic activity. Public policy is needed to provide incentives and market structures, which will allow trade-offs between production, consumption and the natural asset base to be made over longer periods of time, as well as the encouragement and incubation of innovations that provide for a more efficient, less burdensome use of our natural capital in the future.

The green growth framework understands growth not only through the prism of economic activities of production consumption and trade, but also through the inter-relationships of these activities with our natural asset base and the public policy measures and mechanisms available to our governments.

Figure 1.1. OECD Framework for Green Growth Indicators



Source: OECD Green Growth Strategy (2011a)

Box 1.1. OECD's framework for thinking about green growth

- Economic growth is conventionally thought of as the process through which workers, machinery and equipment, materials and new ideas and technologies contribute to producing goods and services that are increasingly valuable for individuals and society. A framework for thinking about green growth builds on this with four additional elements:

- Capturing the importance of changes in the comprehensive wealth of an economy. This means attention to all types of capital: natural (e.g. ecosystems); human (e.g. education and skills); physical (e.g. machinery and equipment); and the intangible assets, which are so crucial to human progress, such as ideas and innovation. Captured within this are some important aspects of growth, including the nature of trade-offs, which arise at the frontier of production possibilities. For example, substituting environmental assets in production or consumption is not necessarily a smooth process; critical thresholds can be crossed after which assets that are renewable cease to be so (e.g. fisheries or soil), or assets that are non renewable are depleted to a point where substitution with other inputs or goods and services becomes impossible (e.g. climate or biodiversity), potentially short-circuiting growth in well-being. This introduces uncertainties regarding thresholds, irreversible outcomes and discontinuities, all of which complicate policy design.

- Incorporating the dual role played by natural capital in this process. Natural capital contributes to production by providing crucial inputs, some of which are renewable but others of which are not. It also influences individual and social welfare in various ways, via the effects the environment has on health, through its amenity value and through provision of ecosystem services.

- Acknowledging that investment in natural capital is an area in which public policy intervention is vital, due to market incentives being either weak or non-existent. This is largely because the contribution of natural capital to production is often not priced and the contribution of natural capital to individual welfare is not appropriately valued. The lack of proper valuation and market incentives or signals can affect behaviour and truncate the foresight of households and firms in ways that set the economy on trajectories that are unsustainable (or conversely, which miss growth opportunities), or that are not necessarily maximising well-being. This means that in many cases, better management of natural capital (e.g. via proper valuation of pollution) will be consistent with higher GDP and a lower environmental impact of economic activities. A clear example is when an inefficient energy mix (involving excessive use of fossil fuels) is improved upon by eliminating harmful fossil fuel subsidies.

- Recognition that innovation is needed to attenuate trade-offs that arise between investing in (depleting) natural capital and raising consumption or investing in other forms of capital. Indeed, once resource productivity is raised and inefficiency eliminated, a “frontier” is reached along which these trade-offs become more pronounced. Through innovation, the frontier at which trade-offs start to bind can be pushed outwards; essentially greening growth.

Source: OECD Towards Green Growth, 2011a

The OECD has identified seven main sources of green growth (OECD 2011b):

- Productivity enhancements through greater efficiencies of resource use;
- Innovation in addressing environmental problems spurred by policies and frameworks encouraging conditions for innovation;
- New markets from the demand for ‘green’ technologies, goods and services, and the job growth opportunities these new markets will bring;
- Confidence from investors with greater predictability and policy stability;

- Stability of macro-economic conditions and reducing the price volatility around resource costs;
- Resolution of resource bottlenecks (including human capital resources) that can make new investments more costly;
- Resolving imbalances in natural systems that will reduce the risks of more profound and abrupt changes to the natural environment through climate change.

The transformation of industries will have a large impact on regional and local ecosystems for employment creation, development of skills and green entrepreneurship. However, although there are significant upsides for some local areas and regions, for others the positive effects of the low-carbon transition will be outweighed by negative job losses. A solid empirical foundation by which to understand how the low carbon transition will unfold at the regional and local level is still lacking. The *"Indicators of local transition to a low carbon economy"* project is part of an effort to provide more empirical evidence at the local level.

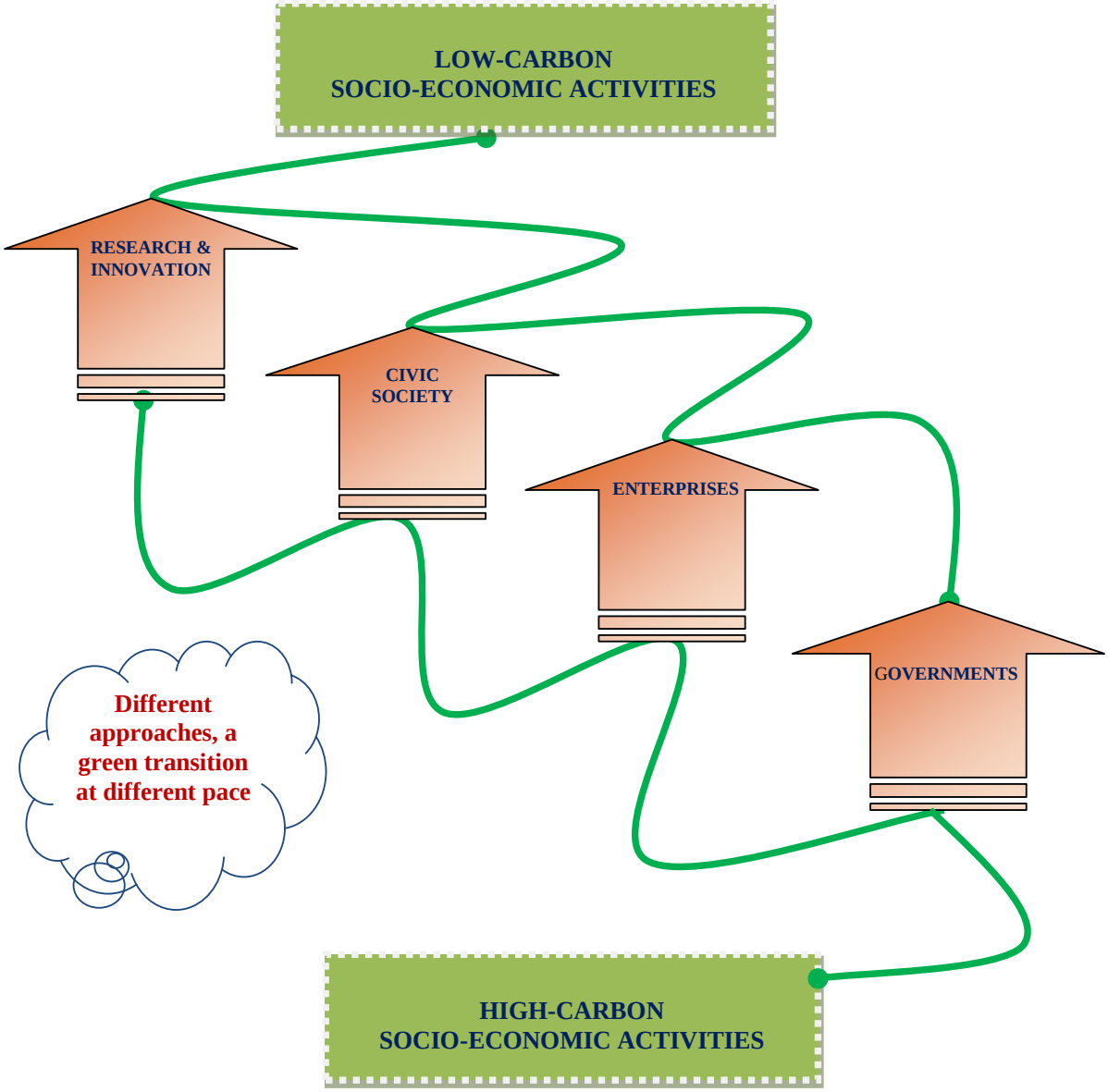
The identification of indicators is therefore imperative in order to measure economic progress towards low-carbon activities in such a way that policies, strategies and programmes can be periodically informed by data that is solid and comparable yet relevant to the local area, industry clusters and regional ecosystems under analysis.

Differential pace of transition

The 'transition' from a high-carbon to a low-carbon economy is taking place in different environments and at a varying pace, as the Rio+20 conference clearly shows: efforts led by researchers and innovation, by the civic society (NGOs, Trade Unions, community groups), the corporate world (large firms and SMEs), and governments are happening at different levels and not necessarily along the same pathways, although the goal is the same.

Figure 1.2 exemplifies the multiple paths and pace of transition, as well as the different actors and drivers involved. We have already seen earlier in this chapter the differential pace of government action at the various levels of jurisdiction, and the challenges for businesses operating within the uncertainties and risks of low carbon transition. There are, however, two other actors in this transition: civil society; and frontier research and innovation activity.

Figure 1.2. Transition pathways to a low-carbon economy



Community driven action to combat climate change has a long history, well exemplified by the first Rio conference on Sustainable Development, Rio+10, Rio+20 and all other sustainable development conferences where NGOs, trade unions and community groups have been active - if not within the negotiation table, then in the streets as the negotiations took place. Social symbolism is also happening at the global level: the Earth Hour on first of April 2012 was marked by the lights being switched off in cities in 147 countries across the world. This demonstration of global solidarity began a mere five years ago, when the lights were first switched off at Sydney's iconic Opera House, creating momentum for the rest of the city to follow suit.

Across the other side of the world, Germany has introduced one of the most significant energy policies witnessed in living memory - a programme to shut down all of Germany's nuclear reactors - in the wake of the Japanese tsunami that caused a catastrophe at the Fukushima nuclear plant. This decision will result in Germany spending around €200 billion on renewable energy sources. In fact, the German government had initially planned to shut down its reactors by 2032. Such is the momentum and demand by the community for a green economy that this decision has been brought forward by ten years to 2022 (see *Financial Times*, 27 March 2012).

Such policy decisions have significant implications for investment and future research and development. For instance, two of Germany's largest energy companies, E.ON and RWE, are now withdrawing from plans to build nuclear reactors in the UK. Instead, the funds earmarked for these nuclear plants will be invested in wind farms, including off the UK coast. This shift means these energy companies will concentrate on renewable energy so that within the next five years E.ON and RWE will have approximately 25% of all their energy investments in hydro and wind power (see OSW, Centre for Eastern Studies, 4 April 2012). This also means that these companies can now position themselves as leaders in one of the world's fastest growing knowledge intensive markets.

Different pace but interconnected pathways

As this green momentum continues to gather pace, individual governments and companies continue to activate green mandates and green projects. From the planning and building of green cities in the Middle East and China to countries such as New Zealand and Australia being the latest to sign up to the group of nations with Emission Trading Schemes. This change is taking place in a highly charged and competitive marketplace - companies competing against other companies. Wind energy companies such as Germany's Siemens, Denmark's Vestas, China's Suzlon and the United States' General Electric are currently battling for supremacy in the global economy.

Countries are also competing head to head as they attempt to give their own domestic companies a head start in an emerging and lucrative marketplace of the future. During the global financial crisis of 2008, the United States introduced a $US80 billion green stimulus package only to have China introduce a $US217 billion green package of its own. The European Union in turn responded with its own green stimulus package of around €23 billion. Such programmes over the past four years have acted as an accelerant for the creation of new products and services and have sped up, for example, the introduction of electric vehicles and new fuel cell and battery technologies.

As the world goes green, business and the community are demanding to know how to measure this progress towards becoming more sustainable. Indicators are becoming increasingly important. They form part of the evidence-based framework at the centre of formulating sound policy, which can then inform practical programmes to meet the community's aspirations for a greener world.

Local dynamics of green growth

There are two main reasons why monitoring and understanding progress towards green growth needs to be tracked at both the national/ international level and the local level:

i. The impacts of climate change will be variable at a local level;

ii. The impacts of responding to climate change, such as carbon pricing, switching to less carbon intensive energy supply and production, and appropriating the opportunities presented by a transition to a low carbon economy (including both the creation of new employment and industries) will be distributed differently across regions. This will be especially evident in labour markets.

For example, the transition to a green economy will not necessarily mean job losses, but there are some barriers that need to be overcome in order to ensure a successful transition. The need to align local and national strategies towards green growth, build strong partnerships, identify transferable skills, better target up-skilling programmes, support green entrepreneurship, and leverage the role of public authorities in supporting green growth activities are some of the issues that need to be addressed (Miranda et al, 2012).

Therefore, whilst national and international responses are required for carbon emissions mitigation, it is at the local and regional levels that strategies for dealing with the impacts of mitigation action will be required. Of the sources of growth, four have local dynamics that are directly relevant to this project:

- Productivity enhancements through efficient resource use;
- Innovation in addressing environmental problems;
- New markets and employment opportunities from green technologies, products and services; and
- Resolution of resource bottlenecks, including human capital development (e.g. skills and training).

Despite their limited capacities to respond to climate change, especially the mitigation component, with the majority of the effective policy levers existing at the national level in most countries, local authorities do have policy levers available in procurement and energy efficiency activities within their own buildings and urban environments. Local government can encourage the adoption of green skills through promotion of sustainability and triple bottom line reporting, and sustainable practices in the building and construction industry.

Denmark's green transition and the role of Copenhagen

Green growth ranks high on Denmark's policy agenda, with targets and plans in place to reduce the use of fossil fuels and GHG production while also investing heavily in green technologies. Denmark as a nation has few natural resources, but relies to a large extent on its human resources for its competitiveness[3]. Denmark is a small welfare economy dominated by small and medium sized enterprises, with few multinational companies.

However, the country is among the world's innovation leaders, being consistently ranked at the very top of the World Bank's *Knowledge Economy Index* (World Bank, 2010); and in the top four countries in the European Union's *Innovation Scoreboard* (EU, 2012). The country's high innovation capacity is attributed in part to its strong focus on human resources and learning, a widespread culture of dialogue, participation and co-operation, a flexible labour market, well-functioning infrastructures and administration, and a high uptake of ICT (Lundvall, 1998). Box 1.1 shows the relevant rankings for Copenhagen and Denmark relating to green growth. It can be seen that Denmark is very competitive in many of these rankings.

Denmark has strengths in design and research and development, and its export base includes, aside from agriculture, elaborately transformed manufactured products and services such as Bang and Olufsen's high tech consumer electrical products, life sciences companies such as LifeStraw, windmills, LEGO and similar products that have achieved international recognition.

3 This had led Waldemar Schmidt and Claire Macarthy to observe in a Danish Limited *Global by Design* (2006): that "...Denmark has vast amounts of the only natural resource that really matters in the world – people ...[they] discovered pretty early on that they had to develop their people resources if they were to prosper".

Box 1.2. Copenhagen and Denmark rankings related to green growth 2011-2012

Denmark

- 3rd in EU27 'eco-innovation scoreboard' 2011
- Relative clean-tech ranking no.1 (WWF 2012).
- Absolute clean-tech ranking no. 6 (WWF 2012)
- The world's best conditions for clean-tech start-ups (Cleantech group & WWF)
- 4th in EMAS registered companies (EU's environmental management system) 2010
- Number 1 on OECD's list of happiest countries in the world (Better Life Index)

Copenhagen

- European Green Capital Award 2014 (European Environment Commission)
- The Green Building Award 2012 (the UN City in Copenhagen)
- Sustainability Award 2012 (for the Hilton Copenhagen Airport)
- 2nd in The Copenhagenize Index (after Amsterdam) as the most bicycle friendly big city in the world.
- Bike City Copenhagen, the first city to have been awarded the UCI Bike City label by the International Cycling Union.
- 3rd in quality of life rankings for the world's major cities (Monocle)
- Copenhagen is in the top 25 of the most competitive cities in the world (EIU)
- The easiest place to do business in Europe (The World Bank)
- 3rd in human capital in the World (EIU)

Source:http://www.visitcopenhagen.com/media/leisure-news/news/news/prestigious-titles-and-rankings-to-copenhagen and http://copenhagenize.eu/index/, WWF 2012, EIO, 2011

As was the case with many countries after the 1970's oil shock, Denmark sought to improve its energy security by reducing dependence on imported oil. Following massive civil resistance, Denmark was one of the few countries to reject nuclear power as the alternative to fossil fuels and instead early on developed ambitious goals to move towards renewable energy generation and enhanced energy efficiency.

This early 'low-carbon' policy attention (although this title only recently came to be used) set Denmark onto a green path earlier than most other countries, with subsequent positive effects for the local industry. As a result, Denmark has become a world leader in windmill production and also contains several world leading producers of energy efficiency technologies. Overflows to other green policy areas and technologies such as water, air cleaning, waste incineration and recycling technologies have also occurred,

ensuring Denmark is strongly competitive in these areas (EIO Country Profile Denmark 2010, 2011; Andersen 2012).

Denmark's climate change policy to 2050 is set to accelerate investment in projects within these other areas. A recent parliamentary agreement will see Denmark generating 50% of its electricity supply from wind power by 2020 (Jamet 2012). The government has also set out an ambitious three-track strategy, which will encourage major investment in new technologies. The Climate Change Policy is discussed in further detail in the following chapter.

Denmark has made significant progress in reducing emissions and setting ambitious targets for future activities. There are risks associated with this strategy for a small country – namely, that emissions reduction will be much more costly for Denmark. The bulk of Denmark's emissions reductions can be achieved at lower marginal cost outside of the country (OECD 2012).

On the other hand, these regulations and targets can also stimulate new industries and the market for new technologies. These benefits, if captured domestically, can outweigh the higher costs of abatement activity. Monitoring to ensure these benefits are generated and captured is essential. Today, Denmark's early mover advantage in green technologies is threatened by rising competition from a number of other countries, as the green growth agenda catches on globally at a rapid pace (EIO Country Profile Denmark 2010, 2011; Andersen 2012; Cleantech Group and WWF/Knowles, 2012; WWF 2012).

This includes competition from low cost economies, with recent strong green growth policies being developed in countries such as China, India and South Korea. Globalisation is threatening even the Danish green flagship, the wind turbine industry, which is experiencing falling returns. Part of the solution to this problem is outsourcing, which in turn means that green jobs are leaving the country. However, the country is also trying to seize the new opportunities for green growth available in growing emerging markets around the world, where the demand for green technologies is booming. Overall, Denmark has a solid base in clean-tech and upholds a strong policy commitment to continue its green growth path, seeing this as an essential means of economic recovery and a basis for the competitiveness of Danish companies in the future.

Copenhagen: A global leader in clean-tech

Cities are playing an increasingly important role in the lives of global populations; they can also play a significant role in reducing global emissions. People living in cities have lower per capital emissions but higher per capita GDP (Hoornweg et al 2011). Copenhagen exemplifies this, with its residents having half the per capita emissions compared to the rest of the country (OECD 2012).

Copenhagen ranks as one of the greenest and most liveable cities in the world in the same way that Denmark ranks among the top countries in various green innovation indexes (EIO 2010, 2011; Cleantech Group and WWF/Knowles 2012; WWF 2012). A component of the city's green growth policy lies in the creation of the Copenhagen Cleantech Cluster (CCC), and the Capital Region of Denmark, comprised of more than 600 companies, many of which are global leaders in their field.

Denmark's green policy agenda is a narrative that is both top down and bottom up, as governments alone cannot undertake the transformation of an economy. Such change relies on collaboration and partnerships between central and local government, business, and the community, which reflects democratic and participatory processes at work, together with the driver of investment, which underscores green job creation.

Report overview

This report is divided into six chapters. The first chapters after this introduction (Chapters 2-4) discuss the local experience of transitioning to a low carbon economy. Chapter Two examines the governance structures of the City of Copenhagen and the Capital Region of Denmark, and their role in encouraging public and private sector action towards low carbon transition. Chapter Three focuses on transformations in industry, specifically Copenhagen's Cleantech Cluster, and the important role it plays in fostering the FDI, innovation, and cluster building that underscore Copenhagen's place as a global climate change leader. The chapter outlines why clusters are so important to the development of the knowledge intensive green industries of the future.

Chapter Four discusses labour market impacts and dynamics of transition, including strategies to reach Small and Medium Sized Enterprises (SMEs) and to develop a green skills and training ecosystem.

The second aim of this study is to test the suitability and adaptability of the OECD green growth framework in understanding this transition, and to provide a mechanism that will enable monitoring and reporting on progress to a low carbon future. Chapter Five discusses the green growth dashboard for Greater Copenhagen. Conclusions and recommendations for future policy and monitoring activities are presented in the final chapter.

CHAPTER 2

GREATER COPENHAGEN'S PATHWAY TO A LOW CARBON ECONOMY

This chapter explores Copenhagen city's pathway to a low carbon economy and some of the city's dynamic green growth projects that have received international attention and acted as inspiration for other cities around the world. Copenhagen was not the first city to adopt a green agenda but its systems and institutions, such as participative governance architectures, have enabled the city to make rapid progress in key policy areas. A number of these policies and programs are now at a mature stage of evolution and can offer guidance and examples to other city regions investigating their low carbon pathway.

Greater Copenhagen's pathway to a low-carbon economy

The challenges climate change has brought are global, but their effects are felt in different ways at the local level. 'Local' here is taken to mean areas that are smaller than regions, and which usually imply commuting areas to work; an area encompassing where people both work and live (Martinez-Fernandez et al, 2012). Local areas are the object of local development agencies and local institutions e.g. councils (Blakely and Leigh 2010). Much environmental policy is formulated or implemented at the local level and becomes embedded in long lasting, highly costly technical infrastructures (within energy, waste, water and transport). The local utilities are the key to the management and innovation of these infrastructures, in interaction with a range of stakeholders. The urban structures of cities impact significantly on consumption patterns and sustainable lifestyles.

The city of Copenhagen is home to 30% of Denmark's population. The Capital Region of Denmark (including outlying areas) accounts for more than 36% of Denmark's gross domestic product (GDP)[4]. Copenhagen is also the current centre of clean-tech activities in Denmark, with a strong partnership between the city's administration and the private sector. Figure 2.1 shows the Greater Copenhagen region.

Figure 2.1. Greater Copenhagen region

Source: Statistics Denmark, figures for 2010

The City of Copenhagen has formulated an ambitious plan to become the world's first carbon neutral capital by 2025. It has also developed a targeted green growth strategy that seeks to capture the economic gains from this policy by setting up initiatives to encourage new eco-innovations and investments.

Copenhagen plans to achieve carbon neutrality by, amongst other processes, ensuring:

- A carbon neutral district heating system;
- Electricity production based on wind and biomass;
- Separating plastic from waste to increase recycling;
- 20% more passengers in public transport and new fuels in vehicles;

[4] Statistics Denmark, figures for 2010

- Increasing active transport – bicycling and walking;
- Improved energy efficiency in buildings;
- Ongoing support for behavioural and social change programmes in households and businesses.

Energy security through diversification of the energy mix and focus on renewable sources

These goals are important complementary local goals to the national policies (discussed in Chapter 1) in that they are key enablers of sustainable living in ways that national policies cannot hope to be. The process towards these goals has taken time, and in Copenhagen's case this has been intergenerational.

In analysing Copenhagen's low carbon transition, some proponents identify its beginning as being in the post-war era, when district heating was gradually rolled out across Denmark's municipalities. The system of district heating has been a major factor in decoupling economic growth from carbon dioxide (CO_2) emission in Denmark. The first parts of the system were built in the 1920s but have been added to since then; now 1500km of double-piped network covers 98% of the demand for heating in municipal Copenhagen (Copenhagen Energy Ltd, 2009).

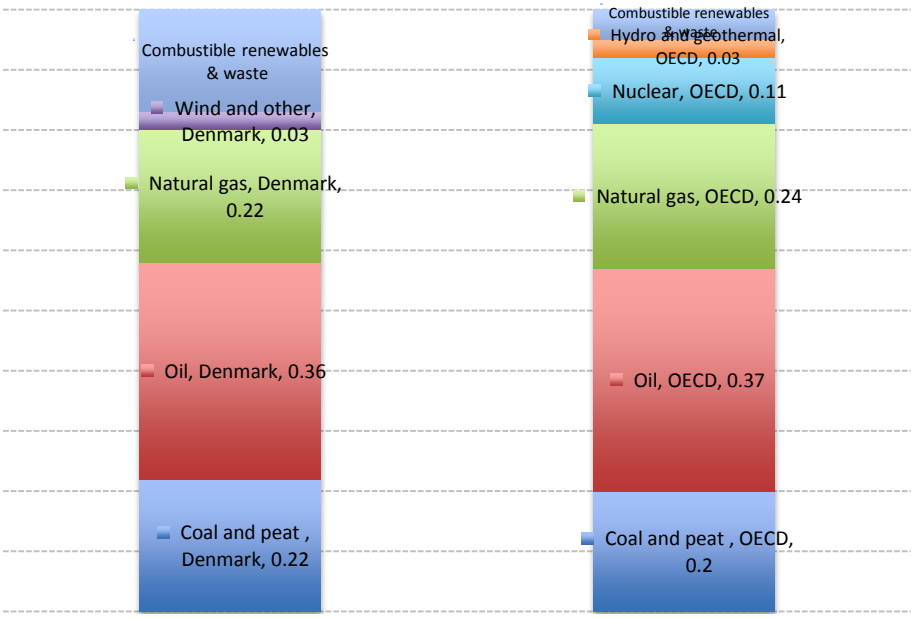
The oil crisis in the 1970s provided a major impetus for green policy action at both national and local levels. The oil crisis of 1973 hit Denmark heavily, as Denmark was among the OECD countries which were most dependent on imported oil for their energy supply. More than 90% of all energy supply was imported oil. As a consequence, Denmark developed a new energy policy to ensure its security of supply. The new strategy was based on diversified and increased use of renewable energy rather than nuclear power, as well as energy savings.

A broad array of policy initiatives in Denmark were launched throughout the 1970s and 1980s, including a focus on combined electricity and heat production, municipal heat planning, and the establishment of a wide natural gas grid. Furthermore, support for renewable energy, research and development of new environmentally friendly energy technologies, as well as ambitious use of green taxes and a focus on improving the efficiency of the building mass through building regulations.

In combination with oil and gas production from the North Sea these policies meant that Denmark went from being a huge importer of oil in 1973 to being more than self-sufficient in energy from 1997 onwards. In particular, since 1990 the energy composition changed significantly with an increase in the consumption of natural gas and renewable energy and a decrease chiefly in coal consumption. The current composition of Denmark's energy mix in comparison with the OECD average is shown in Figure 2.2.

The consumption of renewable energy has increased over a number of years and now accounts for 19% of total gross energy consumption. Denmark's government plans for the country to be using 100% renewable energy by 2050, thus allowing for continued energy self-sufficiency to coincide with the depletion of the remaining Danish fossil fuel reserves (Source: Danish Energy Agency 2011).

Figure 2.2. Denmark's energy mix compared with OECD



Note: Wind & Other refers to other renewable (such as solar) where they exist in the energy supply.
Source: IEA (2011) Energy Balances of OECD countries. OECD figures as a share of total primary energy supply.

The global success of the Danish wind industry

The Danish windmill success story is the most well-known example of green growth resulting from these policy efforts. This case has gained much attention and has been much researched. How is it possible that a small country could become world leaders in a radically new green technology? The story is even more interesting, because the Danish R&D into wind turbines was much less developed than that of competing countries. The initial R&D expenditure in Denmark have been calculated at approximately 47 M EUR until 1990, whereas R&D expenditure in Germany during the same time period was 227 M EUR. In the United States, early R&D expenditure has been calculated as more than 20 times as high as the Danish R&D expenditure (Neij and Andersen 2012).

The explanation offered by innovation researchers is, in short, that the Danish policy approach was more systemic than the competitors' approach. Policy support for windmills grew in the 1970s, but the government supported not only the development of the turbine itself, but also the process of market formation. Already in 1979, the Danish R&D programmes were combined with investment and production subsidies (for example, feed-in-tariffs).

Because the subsidies were open to all market actors, smaller actors, such as farmers and small and medium sized enterprises also benefited from the subsidies. The involvement of these actors in the innovation process turned out to be essential. The development of a home market in Denmark was supported by wind resource mapping, grid connection regulation, guidelines and regulation on municipal planning (permits), and information activities.

In 1978, the Test Station for Wind Turbines was established at the Risø National Laboratory (40 kms east of Copenhagen), and from 1979 the Energy Agency authorised Risø to issue type-approvals for wind turbines. In this way, a fruitful triple-helix interaction was established between industry, policy and research. The Risø National Laboratory provided manufacturers with essential technical and scientific support. Around the Risø centre, a culture of networking and co-operation rather than competition evolved between the entrepreneurs, owners (users) and researchers, in contrast to the competitive protective environment in other countries. The Test centre came to function as a centre for interaction and knowledge transfer (Neij and Andersen 2012; Karnøe and Garud 2012).

The world famous windmill test centre of Risø forms part of what is now known as the Copenhagen Cleantech Park (which is situated 40 km out of Copenhagen) and is a part of the Copenhagen Cleantech Cluster. However, today the main Danish industrial windmill hub is not around Copenhagen but rather in Mid Jutland. There, Aarhus, the next biggest Danish town, calls itself the world capital of windmills.

Today, the Danish windmill industry is threatened somewhat by cost-effective competition from India and China. The process of licensing the production of foreign-developed wind turbines resulted in the introduction of somewhat older and smaller wind turbines, due to the required utilisation of domestically manufactured units. On the other hand, the development of domestically manufactured units has allowed the use of local labour assets and the production of wind turbines at a low cost. The domestic production also provided cost reductions related to logistics and transaction costs. Taken all in all, the massive and aggressive policy structure of India and China has actually allowed for an impressive increase in domestically produced wind turbines over the last ten years (Neij and Andersen 2012).

Focus on human resources and liveability

Denmark's major development of its human resources has put people at the centre of the transition to a low carbon economy. Denmark has a strong tradition of urban planning, with an emphasis on developing liveable cities. This is a contributing reason for why Copenhagen consistently ranks as one of the most liveable cities in the Monocle magazine index. Since 2007, Copenhagen has been ranked within the top three most liveable cities, with the latest figures ranking Copenhagen as the third "Most Liveable City" for 2011. Monocle basis its index on metrics such as those listed in Table 2.1.

Table 2.1. Monocle Liveable City's Index

1.	Population	5.	Medical care	9.	Culture
2.	International flights	6.	Tolerance	10.	Architecture
3.	Crime	7.	Public Transport	11.	Environment
4.	State education	8.	Media	12.	Access to nature

Source: Monocle (2011)

A key part of being a liveable city, certainly in the case of Copenhagen, is the role of bicycling. Copenhagen has become one of the most bike and pedestrian friendly capital cities in the world. Since 1962, Danish architect Jan Gehl, a globally renowned urban planner, has documented in *Cities for People* (2010) that Copenhagen's city area being devoted to pedestrian and 'city life' grew by a factor of seven, resulting in a "remarkable new urban pattern; (where) many more people walk and stay in the city". And, as Florida has aptly observed in his book *The Great Reset* (2010), regions that are more productive and efficient are those in which people spend time thinking rather than stuck in traffic.

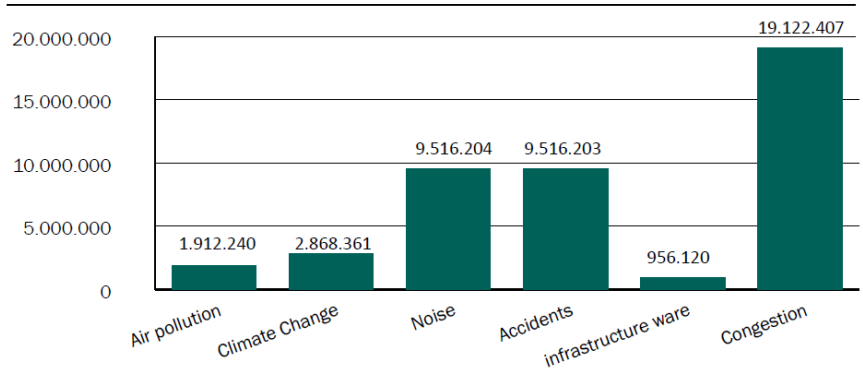
The City of Copenhagen has, as do many other Danish towns, a long tradition for cycling policies, investing in dedicated cycle lanes and bridges. Copenhagen City has 346 km of dedicated cycling tracks

and 48,000 bicycle parking spaces throughout the city. 35% of Copenhagen residents cycle to work or education regularly (City of Copenhagen 2010). Around 55 % of all school children in Copenhagen cycle to school on a regular basis. Currently, more than 1.2 million km are covered by cyclists in Copenhagen every day (Copenhagen Bicycle Account 2011). Copenhagen has developed a new dedicated bicycling strategy, aiming by 2015 to have 50% of its citizens commuting by bicycle on a daily basis, as a contribution to the city's climate strategy. This means a population the size of the entire city of Roskilde (approximately 55,000 people) would have to start cycling. The most innovative policy initiative to facilitate this goal is to build 'cycle super highways' for fast, long distance bike commuting, with few or no traffic lights. An 11 mile-long cycle superhighway between Copenhagen and Albertslund, a western suburb, is the first of 26 routes scheduled to be built, which are designed to encourage more people to commute to and from Copenhagen by bicycle. For the superhighway project, Copenhagen and 21 local governments teamed up to ensure that there were contiguous, standardised bike routes into the capital, across distances of up to 14 miles.

Another measure is that stoplight signals have been adjusted so that 'green waves' at primary traffic routes now favour the cyclists' 20 km/h and not the car speed. As many as 93% of cyclists think Copenhagen is either a very good, good or satisfactory city in which to cycle (Copenhagen Bicycle Account 2011). The cycle-friendly fame of Copenhagen has led to other city cycling initiative adopters such as New York naming their biking lanes 'Copenhagen lanes'.

The cycling strategy also has significant economic gains for the city. Figure 2.3 shows the estimated avoided costs (in $US) in shifting from vehicles to bicycles within the city, with the largest value to the city coming from reduced impacts of congestion.

Figure 2.3. Estimated avoided external costs (in US $) of the shift from vehicle to bicycle in Copenhagen



Source: Wiking M., (2011)

There are several world leading Danish architects and consultants making rapidly growing businesses within the areas of urban bicycle planning and communication. Most of these are situated in Copenhagen, such as Gehl Architects, Gottlieb Paludan, and Public Architects; the consultants COWI, and Atkins; and communications companies Aros Kommunikation, and Kofoed & Co. These entrepreneurs have joined forces with bicycle NGOs and six local authorities to create the 'Cycling Embassy of Denmark', which aims to promote cycling, and communicate cycling solutions and Danish know-how internationally[5]. The embassy is hosted at the Danish Bicycle Association, located in Copenhagen.

5 (see http://www.cycling-embassy.dk/)

There is no bicycle production left in Denmark itself, except for a small production of cargo bikes and some bicycle parts. However, there are 267 bicycle shops and 22 wholesale bicycle dealers, who design and sell bicycles. These firms generate 650 jobs and a total estimated annual turnover of DKK 1.3billion (Copenhagen Bike Account 2011), and the market is growing.

Still more Danish companies offer facilities for bike commuting (such as bike parking, showers and changing rooms, company paid bikes either for commuting or to be used on the business compound, company paid bike servicing at bike stores, and free participation in leisure biking races etc.), as a means to attract and nurse good employees. Participating in leisure bike racing has become very popular, among both men and women, often with company teams making up a large part of the participants. This is expanding across into triathlons, which are becoming one of the fastest rising sports in Denmark.

The last five years has seen a marked change in the bike market, as Copenhageners shift from buying standard bicycles to increasingly buying more 'sporty' bikes or fully fledged racing bikes. It has become trendy to commute on a sporty bike rather than a car, integrating exercise, transport and socialising, as colleagues team up and cycle together. The more expensive bicycles make bike commuting faster and altogether more fun, as well as offering new possibilities for long distance bike commuting. Indeed, the distances ridden are increasing.

Thus, despite the economic recession, the market for expensive bikes continues to rise. Additionally, many families with children purchase cargo bikes as a cheap alternative to cars for local transport within Copenhagen, so this market is rising as a result of the recession.[6] Cargo bikes are also increasingly used by gardeners, coffee shop owners and other small businesses.

The *Copenhagen Bicycle Account* is a detailed assessment of cycling development in Copenhagen. For the City of Copenhagen, the *Bicycle Account* is a vital planning tool with which to improve bicycle policy making. The *Bicycle Account* has been published bi-annually since 1995, and while it is mainly targeted at Copenhageners, it is starting to attract interest from abroad, thus illustrating the importance of indicators within policy making.[7]

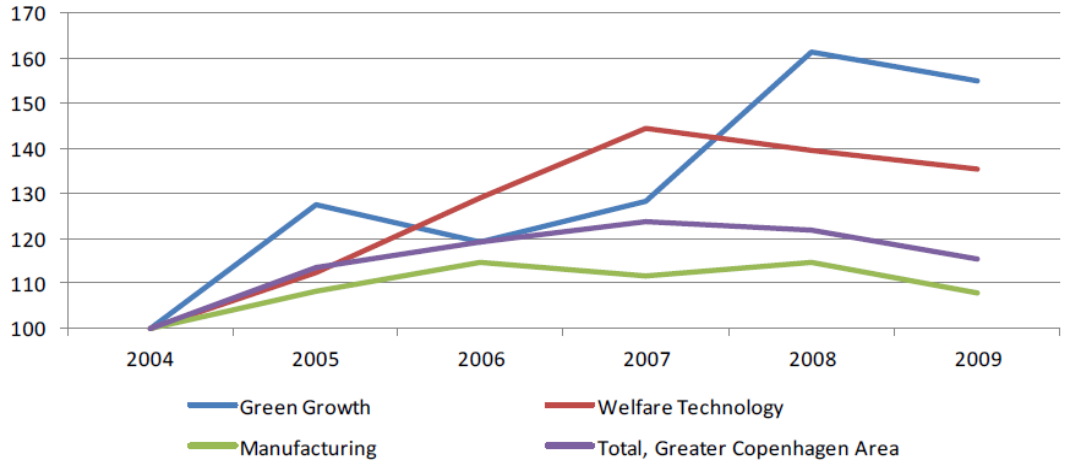
Greening the whole economy

The economic benefits of a green growth economy are also evident in the industrial growth figures for Copenhagen. Figures 2.4 and 2.5 show how 'green turnover' and exports have grown dramatically over the past five years in the Greater Copenhagen region to a point where they now outperform other key sectors of the economy including: welfare technology (35%); manufacturing (8%); and ICT. In fact, green growth has increased 55% during this period, while green technology exports grew by 77%.

6 According to Mark Johnsen, Byman Cykler, and Byman Sport, Copenhagen.

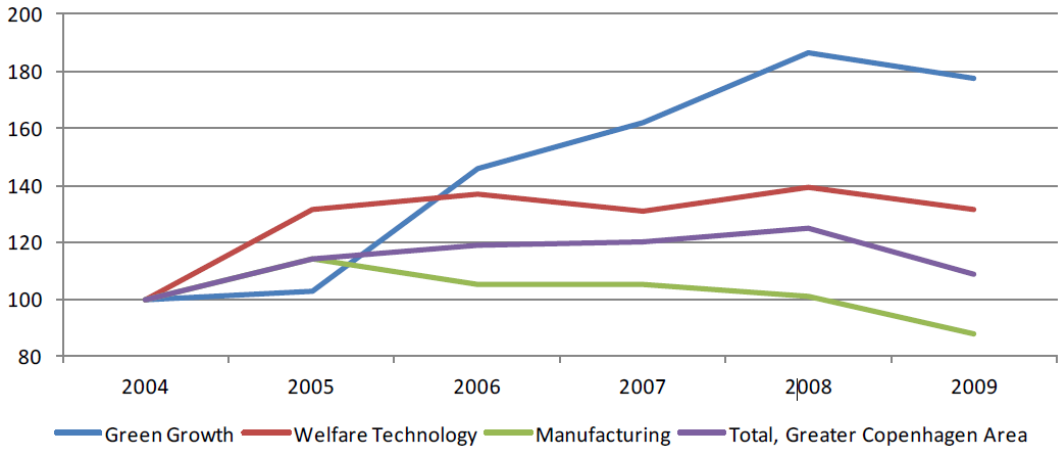
7 The Account is based on telephone interviews with 1,025 randomly selected Copenhagen residents as well as data from the DTU Transport Survey of Transport Behaviour. The Account deals with city cycling conditions, new initiatives, and the way in which the Copenhageners themselves perceive cycling facilities.

Figure 2.4. Growth rates of turnover in key industries compared to the Greater Copenhagen Area



Source: DAMVAD (2011), Green growth in Copenhagen. Green growth is defined using the Berkeley Roundtable on the International Economy and the OECD definition of environmental goods and services, which includes products, services and technologies for environmental protection and resource management.

Figure 2.5. Export growth on key sectors compared to the Greater Copenhagen area



Source: DAMVAD (2011), Green Growth in Copenhagen. Green growth is defined using the Berkeley Roundtable on the International Economy and the OECD definition of environmental goods and services, which includes products, services and technologies for environmental protection and resource management.

As illustrated in Table 2.2, green technologies generate revenue for Copenhagen, but also provide the city with a strategic 'green advantage' in one of the fastest growing industries in the world.

Table2.2. Growth in turnover in the Capital Region

Turnover	2004	2005	2006	2007	2008	2009
Green Technology	100	127	119	128	162	155
Welfare Technology	100	112	129	145	139	135
Manufacturing	100	108	115	111	115	108
ICT	100	105	108	129	135	130

1. 2004 is reference year.

Source: Wiking M., (2011), Copenhagen – Beyond Green, The socioeconomic benefits of being a green city.

Copenhagen: green through participatory processes

Copenhagen has a strong emphasis on collaborative and integrative governance processes involving community, business, government and universities. This triple helix approach has evolved over many years of co-operation and requires a commitment to collaboration processes and inter-sector solutions.

Figure 2.4 outlines some of the governance elements involved in Greater Copenhagen's pathway to a low carbon economy. In reality, this is not a simple hub-and-spoke configuration, as each of these enablers contributes to the whole. And each has empowered the city to develop the competitive advantages required to attract foreign direct investment (FDI), and anchored new export markets.

Copenhagen's governance architecture galvanises partnerships, which is at the heart of Greater Copenhagen municipal co-operation. This enables them to partner closely together across all areas affecting the city: from welfare and housing, to energy, waste management, economic development and attracting FDI. The latter is unique from most cities in the world and is symbolic of an integrated, future-orientated governance structure.

Greater Copenhagen also interfaces with the regional authorities (Denmark has five regions administered by the national government, with one of those being the Copenhagen region – the capital region of Denmark), such as the Væksthus ('Growth house'), which provides extension services to local business. They also have strong project and planning based partnerships with universities, business and national government departments.

Copenhagen hosts the two largest utilities in Denmark: DONG Energy; and Copenhagen Energi. While DONG Energy is the leading actor within energy supply and energy efficiency initiatives, Copenhagen Energy plays a central integrative role in innovation of resource efficiency in energy, waste and water.

Copenhagen Energy supports the Copenhagen climate goal of becoming a CO2-neutral capital by 2025 by focusing on development and testing of future greener supply solutions through an active partnership with not only the municipality, but also with businesses and developers. On the energy side, they work to establish smart energy systems. A foundation of this is the district heating (Copenhagen has 98% supported district heating), which is produced by combined heat and power plants based on biomass and waste. This CHPDH (combined heat and power district heating) is an important power source and a core Danish competence and export product. This system is now being complemented by the introduction of a novel district cooling system in Copenhagen.

On the water side, which is gaining much attention lately due to increasing problems with cloudbursts and flooding in the region, most likely caused by climate change; work is underway to develop an integrated strategy on secondary water and initiating local solutions for utilising rainwater. Copenhagen Energy has, for example, been a pioneer in facilitating household emerging rainwater recycling technologies; a source that is still prohibited by many Danish municipalities. Maintaining drinking water of a high quality based solely on groundwater usage is a also core priority, and the high quality of the groundwater in the region is illustrated by the fact that this water is only 'simple' cleaned.

In recent years, Copenhagen Energy has established 'delay' basins to ensure that the water quality in Copenhagen harbour is clean enough for swimming. A number of swim basins have been established in Copenhagen harbour, which have become very popular. These basins contribute greatly to the ambience that creates a liveable city in the summer time, and have become an important symbol of the cleanliness of Copenhagen, of which Copenhageners take great pride. This was very evident in the summer of 2012, when the harbour basins had to be closed because flooding caused sewage water to overflow and pollute the harbour water, with Copenhageners demonstrating their awareness and concern about their water.

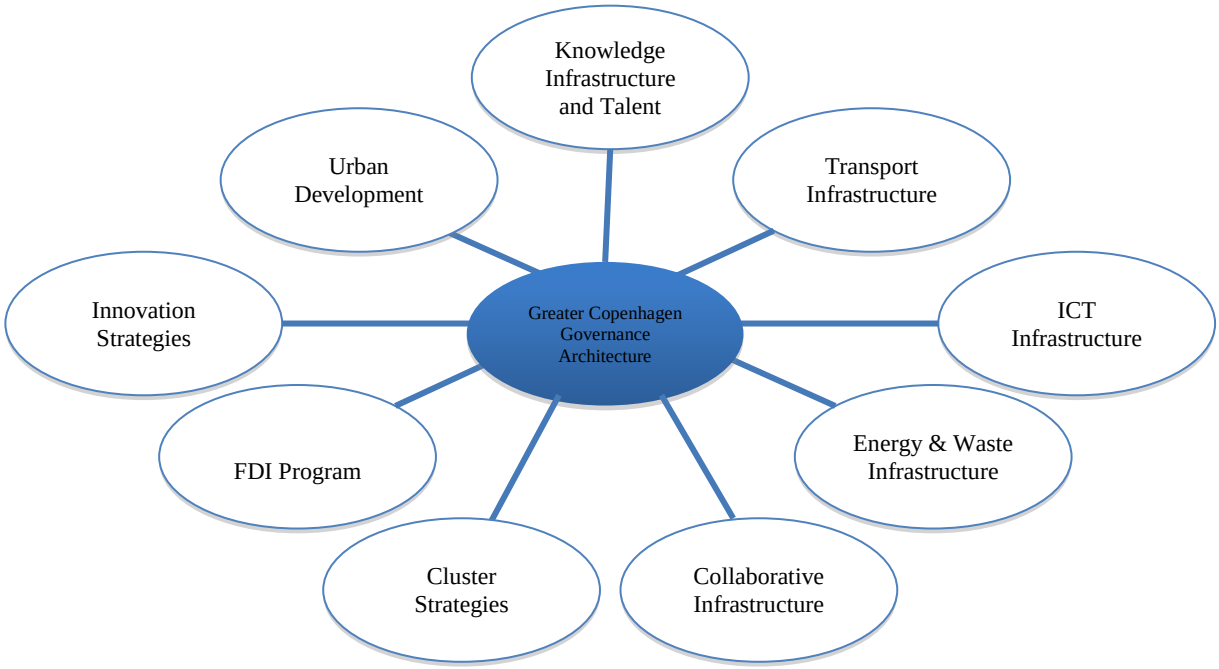
Copenhagen Energy has also participated in sending delegations to countries such as Brazil and China, and hosting visits from foreign guests. They have also contributed to the Copenhagen Municipality's pamphlet on 'Green solutions', which is used to inform foreign partners.[8] For example:

> In the green district of Nordhavn, Copenhagen Energy is working to introduce smart energy supplies, combining a range of power solutions, i.e. how fluctuating power generation from wind turbines can be integrated with district heating, cogeneration, heat pumps, geothermal heating, and cooling, etc. They do this in partnership with the City of Copenhagen, CPH City & Port, DONG Energy, and the Climate, Housing and Department of Energy. They have also identified a number of projects they work together to realise, such as heat storage, district cooling, low temperature heating, etc. (information sourced from Jörgen Edström, Strategy & Development, Copenhagen Energy 2012).

Hence, the utilities can function both as catalysts for new, and preservers of old, eco-innovations. However, with the growing policy emphasis on local green growth, they are increasingly taking on an enabling role. Realising their importance in this role, an agreement from 2006 committed the Danish electricity, natural gas and oil networks and distributing companies to achieve specific energy saving targets, including carrying out energy efficiency campaigns, with the purpose of influencing consumer behaviour. The utilities are today core actors in energy efficiency activities and innovation, being responsible for more than 50% of the annual energy savings (Danish Energy Agency 2011).

8 Information provided by Jörgen Edström, Strategy & Development, Copenhagen Energy,

Figure 2.6. Greater Copenhagen's green growth enablers



Box 2.1. Copenhagen Energy Ltd.

Copenhagen Energy Ltd is one of Denmark's leading utilities, employing 700 people and with a turnover in 2011 of approximately 4 billion DKK. Copenhagen Energy was created 150 years ago. The various energy suppliers in Copenhagen have gradually been fused together, thus creating the largest Danish multi-utility, with five supply species under the same roof**.** The utility ensures that the capital's citizens have town gas, heat and water - and get rid of their waste. In addition, it makes sure that 17 other municipalities in the metropolitan region have clean drinking water. Since 2005, Copenhagen Energy was broadened into a number of independent companies owned by the City of Copenhagen. Electricity was separated out into the company DONG Energy, also located in Copenhagen, and the largest utility in Denmark as well as the leading actor within energy supply and energy efficiency initiatives. This extraction was done with the aim of professionalising and streamlining the operations.

Source : http://www.ke.dk/portal/page/portal/Om_KE/Forsidethe

Copenhagen's triple helix approach (government, industry and research) is dynamic in its ability to marshal people, organisations and resources. For instance, in Table 2.3 a continuum of partnerships is outlined. While many traditional triple helix governance architectures usually undertake partnership activities related to 'co-ordinating', and the more successful ones undertaking 'co-operating', the Greater Copenhagen governance architecture can be defined as 'collaborating'. Modifying an individual organisation's activities in order to collaborate and thus achieve joint goals is a quantum leap – and in Greater Copenhagen's case, one that has been transformative. The progression of this integrated approach is outlined in Table 2.3.

Table 2.3. A continuum of public-private partnerships/ triple helix approach

Type	Function
Networking	Exchanging information
Co-ordinating	Modifying activities for a common purpose
Co-operating	Modifying activities and sharing resources for a common purpose
Collaborating	Making compromises and committing jointly to achieving a goal

Source: Rodin Genoff & Associates (2009)

Copenhagen seeks, as do several other Danish cities such as Aarhus and Vejle, to adopt a 'smart' approach to urban planning as a new way of meeting the sustainability challenges; seeking to mobilise consumers, institutions and companies in innovative partnerships by advanced used of ICT. This smart thinking seeks to optimise the interaction and integration of existing technical infrastructures and digital solutions. Smart communication via ICT is seen as a link between green technologies, public institutions, private companies and the drive of the consumers towards more sustainable consumption patterns[9].

The green district of Nordhavn

More radical green urban planning solutions are presently being sought and developed in the city district of Nordhavn. Nordhavn will be transformed from a post-industrial wasteland to an attractive and sustainable carbon neutral city district. The development will also create affordable homes for 2,500 people and jobs for 7,000 workers. A number of partners (the City of Copenhagen, Copenhagen City & Port, Copenhagen Energy, DONG Energy and the Climate, Housing and Department of Energy and architects) are working to introduce smart energy supplies that combine a range of power solutions, for example, determining how fluctuating power generation from wind turbines can be integrated with district heating, cogeneration, heat pumps, geothermal heating, solar energy, and district cooling with heat stores in a single energy system. At the same time, it is intended that all new buildings will be constructed to have low-energy consumption.

Nordhavn is intended to become a lighthouse project for Copenhagen, demonstrating future sustainable energy systems and other green solutions that will position Copenhagen as a centre of green growth and a display window for green technologies[10].

Regional Industrial Symbiosis Centre of Kalundborg

The Industrial Symbiosis of the city of Kalundborg, ca. 100 km west of Copenhagen, is a world famous and pioneering eco-industrial park promoting the principles of 'industrial symbiosis'. In an Industrial Symbiosis, companies in a region collaborate to utilise each other's residues. This unique metabolism of materials helps to mitigate unnecessary uptakes of virgin materials and minimises loss of resources, as well as reducing the costs of production, supplemented by an environmental benefit. Kalundborg Symbiosis consists of 9 partners, including the municipality, and features more than 30 bi- or trilateral relations, where one industry benefits from collaborating with another. Today, the calculated emissions saved from the Symbiosis are more than 272,500 tons of CO2 annually. Additionally, it has been possible to put a price on the particular waste stream as defined by the market. The recycling becomes cost-effective because of the geographic proximity, thus offering novel synergistic opportunities. In Kalundborg, the surplus heat from a 150/620 MW coal-fired power plant is used to heat the community

9 www.stateofgreen.com/en/press

10 http://www.stateofgreen.com/en/Profiles/City-of-Copenhagen/Solutions/Sustainable-energy-in-North-Harbour

and other companies. 5,000 local homes are heated, in addition to a nearby fish farm, whose sludge is then sold as a fertiliser. Steam from the power plant is sold to Novo Nordisk, a pharmaceutical company, and NovoZymes, an enzyme manufacturer, in addition to a Statoil plant. This reuse of heat reduces the amount of thermal pollution discharged to a nearby fjord. A by-product from the power plant's sulfur dioxide scrubber contains gypsum, which is sold to a wallboard manufacturer, thereby reducing the amount of open-pit mining needed for gypsum extraction. Furthermore, fly ash and clinker from the power plant is utilised for road building and cement production.

The symbiosis network, however, was not planned but has evolved gradually since 1972, starting with collaborative projects between the municipality and a refinery. Gradually, the number of partners and synergies increased. By the end of the 1980s, the partners realised that they had effectively 'self-organised' into what is probably the best-known example of Industrial Symbiosis in the world[11].

The green growth effects of the centre have not been calculated, but are both direct and indirect. The centre has been involved in system exports to the internationally recognised similar examples of Kwinana Industrial Park in Australia and the NISP initiative in the UK, as well as a number of eco-industrial parks in China. Eco-innovation continues. The Kalundborg Symbiosis currently has 10-12 projects in development in conjunction with regional companies. Two of the partners of the symbioses, DONG Energy and Asnæs power plant, are involved in the major 'KINEC' project, focusing on the transition to green energy. The centre functions as a source of inspiration and education, and the international and national interest remain very high.

Within the period of April 2011 to June 2012 the following visits have occurred:

- 11 major foreign delegations, with businesses and government representatives (including from France, Japan, China, the USA, Finland, Korea, and Israel);

- Seven major Danish delegations from ministries and universities, as well as researchers from foreign universities.9 team visits by Danish and international students, high schools and elementary schools.[12]

The industrial port and the tourist industry in Kalundborg perceive the Kalundborg Symbiosis as an asset, as it attracts thousands of visitors every year. In 2012 alone, more than 14 cruises, with 2-3,000 guests from each, have agreed to dock at the port of Kalundborg due not only to its deep waters but also because the green attractions are being emphasised as an incentive for visiting Kalundborg. Investors have also decided to invest in a new hotel in Kalundborg due to the many activities related to the Industrial Symbiosis.

The symbiosis is important for attracting and maintaining industrial production in the region, which is high for Danish standards. Novo Nordisk, the world's largest pharmaceutical producer of insulin, declared in 2010 that if one of its products becomes a major seller, and provided that guarantees were given for a sustained and transformed green steam production, this would lead to an expansion of Novo Nordisk production activities, leading to an increase in energy needs in Kalundborg by 2020 equivalent to 270% of today's (2010) consumption. This demonstrates how production in a high wage country like Denmark still does not deter new production as long as resources are cost efficient and green.

11 http://en.wikipedia.org/wiki/Kalundborg (accessed 20 August 2012).

12 Information supplied by Mette Skovbjerg and Johnny Madsen, August 2012, the secretariat of the Regional Symbiosis Centre of Kalundborg.

The Kalundborg Symbiosis illustrates the significance of regional green growth initiatives. It is here that systemic innovations, which allow for more circular and resource efficient competitive ways of organising production and consumption, may be realised. However, this is only if local public and private partners manage to collaborate. The still very limited planned implementation of similar systems worldwide illustrates the challenges to achieve this and the need for further attention at the local policy and administrative level in order to achieve a transition to a green economy.

Climate strategies at city and regional level

The national climate goals of Denmark have set up an ambitious framework to 2050 (see Box 2.2).

Box 2.2. National climate goals

- CO2-emissions must be reduced by 40% by 2020 compared to the level in 1990
- Reduce energy consumption in new buildings by 75% by 2020
- Supply of electricity and heat must be provided by renewable energy by 2035
- Independence of fossil fuels by 2050

The City of Copenhagen's climate strategy, launched in 2009, declared the ambition of becoming the first carbon neutral city in the world by 2025. In 2012, a new updated strategy has been launched setting up steps and goals outlining how the city intends to achieve this ambitious goal. Specific success criteria have been formulated already for 2015 and measurable targets set up for 2025.

The strategy's overall aim is to make the Capital Region of Denmark the most climate-prepared and energy-efficient region in Denmark, based on regional and municipal co-operation. The strategy also aims to strengthen the region's ability to proactively address climate challenges and thereby gain a strong position in the international competition between metropolitan regions around green growth and development (Climate Strategy for the Capital Region of Denmark 2012).

The capital region is already well prepared when it comes to climate adaptation and climate prevention. All 29 municipalities in the region have prepared local climate plans and 26 municipalities have joined the Denmark Society for Nature Conservation Climate Municipality initiative. Many local authorities are well advanced, having undertaken energy renovations of their buildings as well as strengthening efforts to reduce CO2 emissions from the region's 12 hospitals and other major institutions (Climate Strategy Copenhagen 2012).

Public-private collaborations and inter-municipal and regional co-operation are seen as essential for the contribution to innovative solutions, a strengthening of green industrial competitiveness, and green growth. This regional agenda is not aimed at replacing local efforts but rather supplementing, supporting and inspiring local environmental initiatives.

The strategy calls on the municipalities to co-operate around five specific areas, which are outlined further below in Box 2.4. The five areas are:

- A region prepared for climate change;
- Environmentally friendly transport;
- Reorganisation of energy systems away from fossil fuels;
- Energy efficient buildings; and
- Climate friendly and green procurement.

Whether environmentally friendly public procurement programmes or empowering the city's citizens to actively change their carbon footprint, together they chart the course for a new round of transformative projects, such as those initiated through public private partnerships, which ultimately share both the risks and rewards, for a positive investment in the future.

Box 2.3. Copenhagen Climate Change Plan 2012

Energy consumption

- Improvement of building structures and conditions including the development and testing of a new financial model to support energy savings.
- Establish procedures and guidelines for energy efficient buildings in Copenhagen supported by targeted funds for increased climate retrofitting. A model for energy savings in commercial and service companies will be developed, tested and implemented.

Increase the dissemination of solar cells

- Establish an organisation of interested stakeholders to ensure that the accumulated knowledge and experience in energy efficient buildings is shared and disseminated to interested parties.
- Creation of lighthouse projects in new low energy construction and energy retrofitting. A green growth partnership will be set up to contribute to the construction of private lighthouse buildings.
- Development of Copenhagen as a SMART city. A digital infrastructure will be laid down for public data on electricity and heat consumption, and the opportunities for flexible energy consumption improved.

Energy production

- Establishment of 100 wind turbines before 2025.
- Creation of flexible electricity and heat supply with multiple sources of energy that can supplement each other, including heat generation and biomass.
- By 2025, Copenhagen will have a carbon neutral heating supply, based primarily on biomass, waste and geothermal energy.
- Waste is to be seen as a resource and a new, high-tech waste treatment centre will be set up which would eventually include the sorting of waste, preparation for recycling, biogasification and incineration.
- Prevention, separation and recycling of plastics will be done by establishing three new collection streams to ensure that the hard plastic, metal and small electronics are sorted for recycling.

Mobility

- Development of bicycle connections to and from Copenhagen, with the majority of the PLUSnet comprising cycle tracks with three lanes.
- Partnerships to promote and improve cycling conditions, so the bike will be the preferred mode of transport to work.
- More passengers in public transport, which should be run by non-fossil fuels.
- Vehicles should to a large extent be driven using non-fossil fuels.

Box 2.4. The Climate Strategy for the Capital Region of Denmark, 2012

1. A region prepared for climate changes

Consequences of climate changes, including extreme weather conditions and rising sea levels, will be at the forefront of urban planning.

Initiative 1.1: The KLIKOVAND initiative (climate, municipalities and water) will ensure that municipalities and supply companies are able to implement an efficient and economic adaptation to climate changes.

Initiative 1.2: A detailed risk-map will map the consequences of the climate changes expected to influence the Region, primarily the increased amount and concentration of precipitation.

Initiative 1.3: Perceive wetlands as a resource: analysis of where surplus water can both be deposited and function as a recreation area at the same time.

2. Environmentally friendly transport

Efforts will improve public transportation and biking lanes to reduce the number of cars on the roads and subsequent CO_2 emissions. Efforts will also seek to get more people choosing an electric car.

Initiative 2.1: Climate friendly buses: implement common specifications on the use of bio fuel, and other technologies such as electric or hybrid buses.

Initiative 2.2: Promote car-pooling / ridesharing to reduce the number of cars on the roads. This campaign is currently running in another part of Denmark, and if successful will be transferred to the Capital Region of Denmark.

3. Re-organisation of the energy system to be non-fossil fuelled

Support the development of new technologies to reduce the reliance on fossil fuels in order to reach the goals of both the City of Copenhagen and Denmark.

4. Energy-efficient buildings

Put energy-efficiency at the forefront of building developments within the municipalities and the region. These efforts will lead by example and help develop new building solutions and inspire citizens to act.

Initiative 4.1: Reduction of energy consumption in public buildings: Analyses show that most investments in this area will make returns within a few years.

Initiative 4.2: Energy upgrading renovations of private houses: A common strategy will be developed to make it possible to undertake renovations of private houses.

5. Climate-friendly consumption and purchases.

The municipalities and regions can positively influence the climate, by ensuring that their own purchases and consumptions are climate-friendly.

Initiative 5.1: Promote climate-friendly public purchases: Develop 'best practice' approaches in green purchasing.

Initiative 5.2: Provide simple and practical advice for private companies and citizens regarding how they can reduce their climate-footprint through consumption and purchasing.

Source: Copenhagen Climate Change Plan (2012)

Summary

The Copenhagen example is not alone, nor was it the first in Denmark. In fact, numerous Danish municipalities have developed various types of climate or sustainability strategies, and several green cross-municipal networks exist or have existed, including networks specifically designed to promote green growth. Among Danish local authorities there is a high expectation and a strong interest in integrating city and regional development with environmental sustainability, liveable cities and green growth.

This chapter discussed how Copenhagen's pathway to a low carbon economy has stemmed from its investment in:

- Partnerships and effective governance structures that can marshal the resources to create the prerequisites that will allow a vibrant green industry of the future to flourish; and

- Creating a smart city that can attract and retain talent.

CHAPTER 3

COPENHAGEN CLEANTECH CLUSTER

The Copenhagen Cleantech Cluster is one of the premier clean-tech clusters in the world. The cluster includes companies from renewable energy, waste and energy production, energy storage and infrastructure, and grid connection. Many of these companies are global leaders in their field. This chapter examines the evolution of the cluster, identifying the key institutions and their governance arrangements. The cluster has been responsible for the development of specific attributes and resources, each of which are discussed below. The chapter also provides a critical assessment of the impact of the cluster in terms of innovation, research and development activity, export activity turnover, and employment in Copenhagen.

Introduction

Clean technology industries have a long history in Denmark; many of them based in Copenhagen where there are some 610 clean-tech companies (Oxford Research 2012).

The activities of these companies are deeply embedded in Denmark's knowledge intensive industries. They can be found in industries such as architecture; design and engineering; electronics; ICT, and software and artificial intelligence; all of which are located in the very heart of Copenhagen. They also expand into the regions like Mid Jutland, with its centre for the wind energy industry, or Aalborg University in North Denmark with its expertise in software programming and complex data management. Many of these companies are global leaders in clean-tech development.

In the previous chapter it was discussed the Danish cultural, political and legislative drivers that have underpinned Denmark's clean-tech development. Greater Copenhagen's Cleantech Cluster cannot be studied in isolation from these particular Danish characteristics. At the most fundamental level, industry clusters are more than just the sum of their parts. In the case of Copenhagen's Cleantech Cluster, its internal dynamism is propelled by:

- Regulatory regimes that encourage innovation;
- Supportive industry and clean-tech policy environments;
- Highly specialised and technically sophisticated companies in the forefront of their respective fields;
- Talent that is fostered by well resourced knowledge infrastructure and globally connected centres of excellence;
- Strong social and community cohesion that can mobilise and marshal the energy and resources of industry and the community; and, perhaps most importantly
- Changes in behaviour and the solidarity required for the community as a whole to move forward together and in step with each other.

These socio-economic conditions allow Denmark and, in particular Greater Copenhagen, to fast-track the commercialisation of clean-tech products and services, despite having only a relatively small venture capital market.

Copenhagen is seen as a test bed for the trialling of new products and services. The success of clean technology industries in the Nordic countries is also supported by the *Sustainable Asset Management Index* of the Dow Jones based in Zurich, which has now developed its own Nordic Index to support the future growth and development of clean-tech opportunities.

This chapter begins with an overview of the development of Greater Copenhagen's Cleantech Cluster (CCC). The chapter then explores the dynamics of the CCC and the wider contribution it makes to the economy. This is followed by a summary of the CCC's programme, its strategic priorities, how it plans to support entry into global markets and, in the process, not only ensure a return on investment (ROI) but also undertake transformative projects that enable them to market the very best of Copenhagen's clean-tech industry to the rest of the world.

Development of the Copenhagen Cleantech Cluster

The establishment of the Copenhagen Cleantech Cluster must be viewed within the wider international trend of the greening of the economy, perhaps one of the most profound pervasive changes of the modern economy (Andersen 2012). Today, green growth is high on the worldwide political agenda, receiving targeted investment funding and widespread policy support. But this is a very new agenda. International efforts elsewhere show the potential of clean-tech clusters even as a local development strategy where capacity can be strengthened by public policies, including investment in centres of research excellence and specialised testing facilities, creation of spaces for innovation exchange, and the introduction of a green strategy and eco-city approach (Potter et al, 2012). Dedicated local strategies and initiatives can support the emergence and expansion of clean-tech cluster activity that will enhance economic development capacity in the region while contributing to national green growth objectives.

Traditionally, the environment has been considered a burden to business rather than a business opportunity. In contrast, the environment and renewable energy has been high on the policy agenda for decades in Denmark. However, it has taken a long time, in Denmark as well as elsewhere in the world, to realise the economic potentials of the environmental efforts. In reality, there has been a very slow realisation of the green growth potential among both business and policymakers; it has taken 60 to 70 years for clean-tech, or 'eco-innovation', which focuses on the wider greening of technologies and services, to become recognised as a driver of economic development (Andersen 2012).

This is partly due to historical lock-in, partly to considerable organisational and institutional failures in the market. However, once the greening of the economy began to take root in the 1990s, the rate of green business development has been relatively fast, and recently with a pace that has surprised many. The mainstream consolidation of the green growth agenda in the second half of the 2000s came very suddenly, but it illustrates the presence of strong multiplier effects on green economic change (Andersen 2012).

The greening of the Danish economy in modern times can be divided into three major periods. The first period is the long regulatory or reactive phase, where firms started to engage in green R&D, forced to do so by policy making and under influence by green NGOs. This period starts with the emergence of environmental policies in the 1940s and 1950s, which were strongly reinforced in the 1970s due to the energy crisis and the rise of energy policies (as described in the previous chapter,) and further in the 1980s due to escalating environmental problems and rising green NGO movements. This led to a growing market within the traditional clean-tech sector and energy technologies, primarily renewable energy technologies, but little occurred on the business side where firms had reactive or even obstructive strategies towards environmental issues.

The second period starts around 1990. In the beginning of the 1990s, the first shift among businesses could be seen, as pioneering firms began searching for green profit opportunities more generally, starting very small but gaining in volume in the 2000s; propelled by both preventive and supportive policy measures (e.g. support for environmental management systems, eco-labelling, investments in clean technologies etc.). At the end of the 1990s, Denmark was among the initial pioneering countries seeking to formulate some of the first green growth policies in the world by the Ministry of Trade and Industry (Andersen 1999)[13].

Interestingly, the green growth agenda was originally picked up at local policy levels. The first green growth initiative in Denmark was 'Green City Denmark Ltd', which existed from 1994-2006, consisting of

[13] This 'Green industrial development strategy' was never implemented, however, due to a change of government in 2001 leading to a markedly lower policy emphasis on environmental issues, see Andersen /DTI 1999.

a network of four municipalities and two regional authorities in Mid Jutland, as well as a number of companies and knowledge institutions, in all 250 members, half of which were companies. Green City Denmark Ltd was initiated by the Danish Ministry of Business and Industry in co-operation with the Ministry of the Environment and Energy, the aim being to establish a visible showcase for Danish environmental technology and know-how. At the end of the 1990s, the network sought to expand into a national network and other municipalities, including Copenhagen, joined via the so-called 'Eco-link' initiative. Green City Denmark undertook numerous activities, organised around a series of working groups.

The first half of the 2000s is an intermezzo in the Danish greening trend, as a new government placed very low emphasis on environmental policies for a number of years, with negative impacts for the clean-tech sector and wider greening of the Danish economy, and for the Green City Denmark initiative, which died out.

The third period starts in the latter half of the 2000s, around 2006-2009, where the green growth agenda rapidly gained stronger policy momentum and became much more mainstream and internationally recognised, including within Denmark. The greening of the economy is becoming apparent, particularly in the affluent economies (Andersen 2012), see also (UNEP/ILO/ITUC 2008; Wagner 2008, 2010; UNEP 2011; United Nations 2011; Frondel, Horbach and Rennings 2005, European Commission 2006, Johnstone 2007; OECD 2008, 2009, 2010, 2011).

In Denmark, the government changed its policy during this period and started to embrace the green growth agenda, preparing for Copenhagen to host the much awaited COP15 (the UN's Conferences of the Parties) in December 2009. Copenhagen became a focal point for combating climate change, and promoting green energy solutions. This attention helped galvanise and strengthen the City's efforts to support a more co-ordinated approach to clean-tech initiatives. The establishment of the Copenhagen Cleantech Cluster (CCC) in 2009 is representative of a new era of more deliberate and ambitious green growth policy making and branding. The new Danish government from 2011 has reinforced this policy line, formulating stronger green growth policies than ever before seen in Denmark.

The rise of the green economy, termed by many a revolutionary or paradigmatic change, is due to long running co-evolutionary changes at the bottom (in knowledge, technologies, organisations) and the top (the institutional setting, not the least of which are policy rationales) (Andersen 2012). Four major international political events have been milestones in the greening of the economy. The first was the UN Brundtland Report (*Our Common Future*) from 1987, which firmly placed environmental sustainability in the international policy arena. The second was the influential UN Rio Conference in 1992, which reinforced the sustainability agenda and, for the first time, incorporated the business perspective and business representatives, leading to the creation of the World Business Council for Sustainable Development in 1995. The third was the entry of pioneering ministries of industry and innovation, and the development by the OECD of new green innovation strategies from the mid 1990s,widening in the latter half of the 2000s. The fourth was the new alliance between energy policy, climate policy and security policy that occurred partly in the lead up to the UN COP15 meeting in 2009, creating a new, very powerful agenda. Environmental sustainability moved from peripheral to central policies via ministries of state and economics (Andersen 2009, 2012).

The actual creation of CCC took place as a partner driven project comprised of eleven core partners ranging from universities, technical advisors, an industry association, a business council, business links, and an entrepreneur organisation within Copenhagen City. Together these partner organisations developed a five-year partnership agreement to provide a range of services on behalf of the cluster, and to fulfil an ambitious charter. This included creating a cluster organisation with a strategy for attracting FDI. It is for this reason that the investment promotion agency Copenhagen Capacity (CopCap), which has a strong

track record in attracting FDI and building investment driven partnerships, was chosen to lead the CCC. In fact, these practical and tangible results led CopCap to receive recognition from UNCTAD as the best green investment promotion agency for establishing a clean-tech cluster.

Thus, the CCC's primary aim became the development and promotion of Danish clean-tech companies, organisations, joint ventures, and R&D activities. Its vision is to attract global investors to Greater Copenhagen by developing one of the world's leading clean-tech clusters. Today, CCC is considered the leading local green growth initiative in Denmark, anchored in the Copenhagen area, but with ambitions for covering all of Denmark.

At the same time, several other local green initiatives co-exist within as well as across Danish municipalities or regional authorities, several with a green growth emphasis, such as Gate 21 and Carbon 20, further details on both are provided in Box 3.1.

Recently, the national 'State of Green Consortium' was established as the official green brand for Denmark. These local and national initiatives illustrate the current strong Danish emphasis on green growth. Please refer to the boxes below for more information on these initiatives. The Copenhagen Cleantech Cluster co-operates with these initiatives, but to some degree they also compete for attention and resources.

Box 3.1. Local Green Initiatives

Gate 21

Gate 21 is a non-profit partnership established in 2009 between municipalities, private companies and research institutions working together to create a sustainable society and green growth. Through innovative partnerships, Gate 21's 48 partners (municipalities, companies and research institutions) develop ambitious solutions to local climate and energy challenges through public-private projects. The Gate 21 Secretariat helps the partner group with the development, financing and management of its projects. It states:

In 2012, Gate 21 engaged in six projects:

- Formula M, which develops sustainable travel behavior in six municipalities.
- Plan C, which develops new energy renovation methods in municipal and general construction.
- PV Boost, which installs and monitors solar systems in municipal buildings. Participating municipalities have covered 20% of the cost.
- CO2-neutral city lighting, which develops street lighting run on solar and wind energy.
- Carbon 20, which co-operates with 100 companies to lower their CO2 emissions by 20%.
- Energy Øresund, which develops new methods for delivering renewable energy across the Øresund.

Gate 21 brings the green industry closer to the municipalities. The municipal market is an increasingly important driver of green growth, and Gate 21's projects use municipalities as a laboratory for the development of innovative solutions.

Source: http://www.gate21.dk/OmGate21/

Carbon 20

Carbon 20 seeks to strengthen the collaboration between municipalities and businesses to find new ways to reduce emissions of CO2 and other greenhouse gases. The project is supported by EU LIFE funds and runs between 2011-2013.

Carbon 20 aims more specifically to:

- Engage at least 100 companies to work diligently with CO2 reductions. The goal is to achieve a total reduction of 20% by the end of the project in 2013.
- Develop models, tools and guidelines for how municipalities and companies collaborate on climate action in companies.
- Illuminate climate interfaces between municipalities and industry. The aim is to better support local climate initiatives in enterprises, also in connection with spatial planning, transport, energy, building maintenance, renovation and public procurement.

Source: www.carbon20.dk

State of Green

'State of Green Consortium' was established in 2011 as a public-private partnership, to become the organisation behind the official green brand for Denmark. It states:

'Denmark has decided to lead the transition to a green growth economy and will be independent of fossil fuels by 2050 as the first country in the world. As the official green brand for Denmark, State of Green gathers all leading players in the fields of energy, climate, water and environment and fosters relations with international stakeholders interested in learning from the Danish experience. State of Green is your gateway to learn more about the ambitious Danish plan and the innovative solutions which are essential to make it happen'.

Source: www.stateofgreen.com

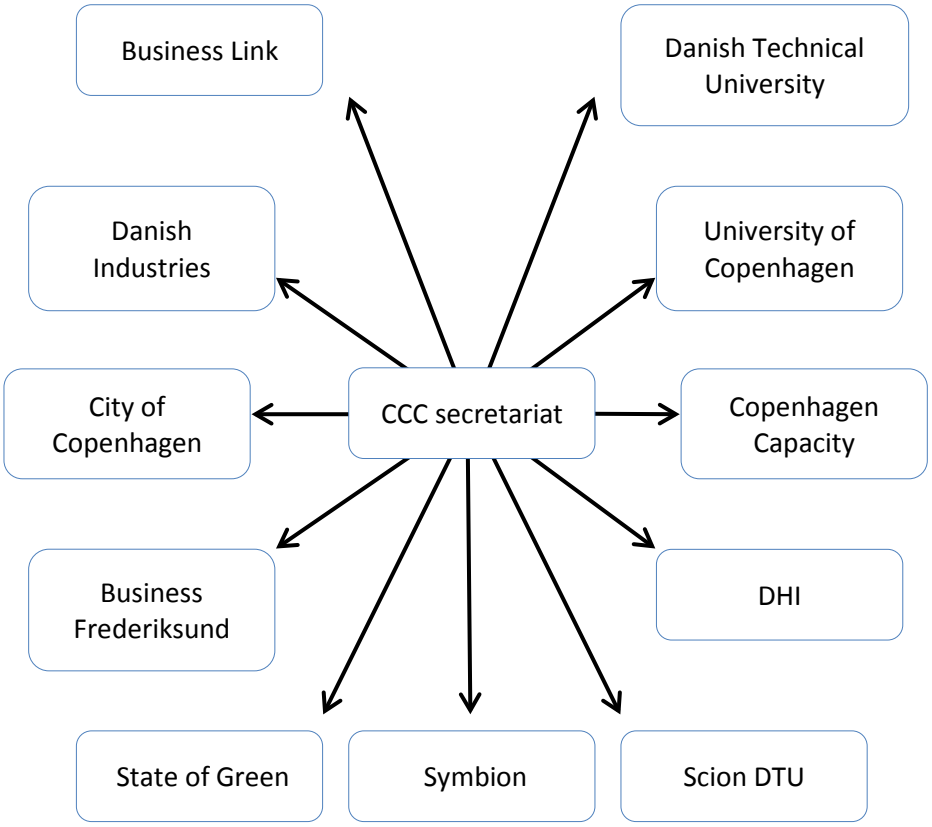
The CCC was initiated through a European Union supported project. Its budget (see Box 3.2) supported the largest project ever undertaken in Denmark using Structural Funds (the Danish Ministry of Research, Innovation and Higher Education 2011).

From the very outset, the partners of the CCC acknowledged that collaborating with global companies and international investors was essential to developing a globally orientated and investment driven cluster. Such global collaborations and investment projects are important because they support the acceleration of new research and development. This results in the rapid transfer and diffusion of ideas, knowledge and capabilities within CCC and its members.

Box 3.2. The funding and governance architecture of the Copenhagen Cleantech Cluster

Established in 2009 by Danish clean-tech companies, research institutions and public organisations, CCC was Denmark's largest ever European Union Structural Funds project. With a budget of €20 million over five years, financing is split 50% from the European Union (EU), 25% from Region Zealand and the Capital Region of Denmark and 25% from the founding partner organisations.

CCC is a consortium based on the triple helix model of university-industry-government interactions, key to innovation in knowledge-based societies (Etkowitz 2002). CopCap is one of eleven founding partners, responsible for the overall co-ordination and facilitation of the cluster, reporting to a board of directors comprised of twelve key stakeholders. The secretariat manages the interface between directors, executive partners, members and stakeholders.



Being a 'project', CCC would not be able to develop new activities and apply for new funding. Consequently, CCC has been established as an association with its own Board of Directors, company registration and the like, making it more operational and able to develop new initiatives. CCC has been able to launch new activities and expand the budget through strategic memberships by Siemens, DONG Energy and the City of Copenhagen, as well as project financing from the Danish Industry Foundation. This is part of a process making the association of CCC a sustainable and self-supporting cluster organisation ready to continue the work of developing and promoting the cluster once the initial project funding runs out in 2014.

Source : Copenhagen Cleantech Cluster (2012)

Today the CCC (as shown in Box 3.3.) has 610 members, with a combined turnover of €30 million.

Box 3.3. Snapshot of the Copenhagen Cleantech Cluster

Copenhagen Cleantech Cluster operates in an environment consisting of 610 clean-tech companies:

- In total, the companies employ a staff of 78,000 and roughly 34,000 of these are working directly with clean-tech-related activities, particularly industries related to environment and energy.
- The companies generate a combined turnover of about €30 billion, of which at least approximately €12 billion is directly related to clean-tech activities.
- The main sectors are energy efficiency, renewable energy, water and wastewater treatment, as well as waste and recycling.

Source: Copenhagen Cleantech Cluster (2012)

The dynamics of Copenhagen's Cleantech Cluster

The dynamics of the CCC stem from its vision "to be a highly connected international cluster" and to "establish [a] real working relationship with leading clean-tech clusters around the world" [14].

The CCC has a global market orientation, with many of its companies providing goods and services in global markets, but companies are also deeply connected to the broader industrial fabric and ecosystem extending from Greater Copenhagen right across Denmark, through to those global companies with which it has joint ventures, intellectual property (IP) and other commercial arrangements.

Figure 3.1 summarises the 56 individual industrial, research and commercial activities that define or go into making the CCC. In summary, the CCC is divided into two major activities: environment; and energy.

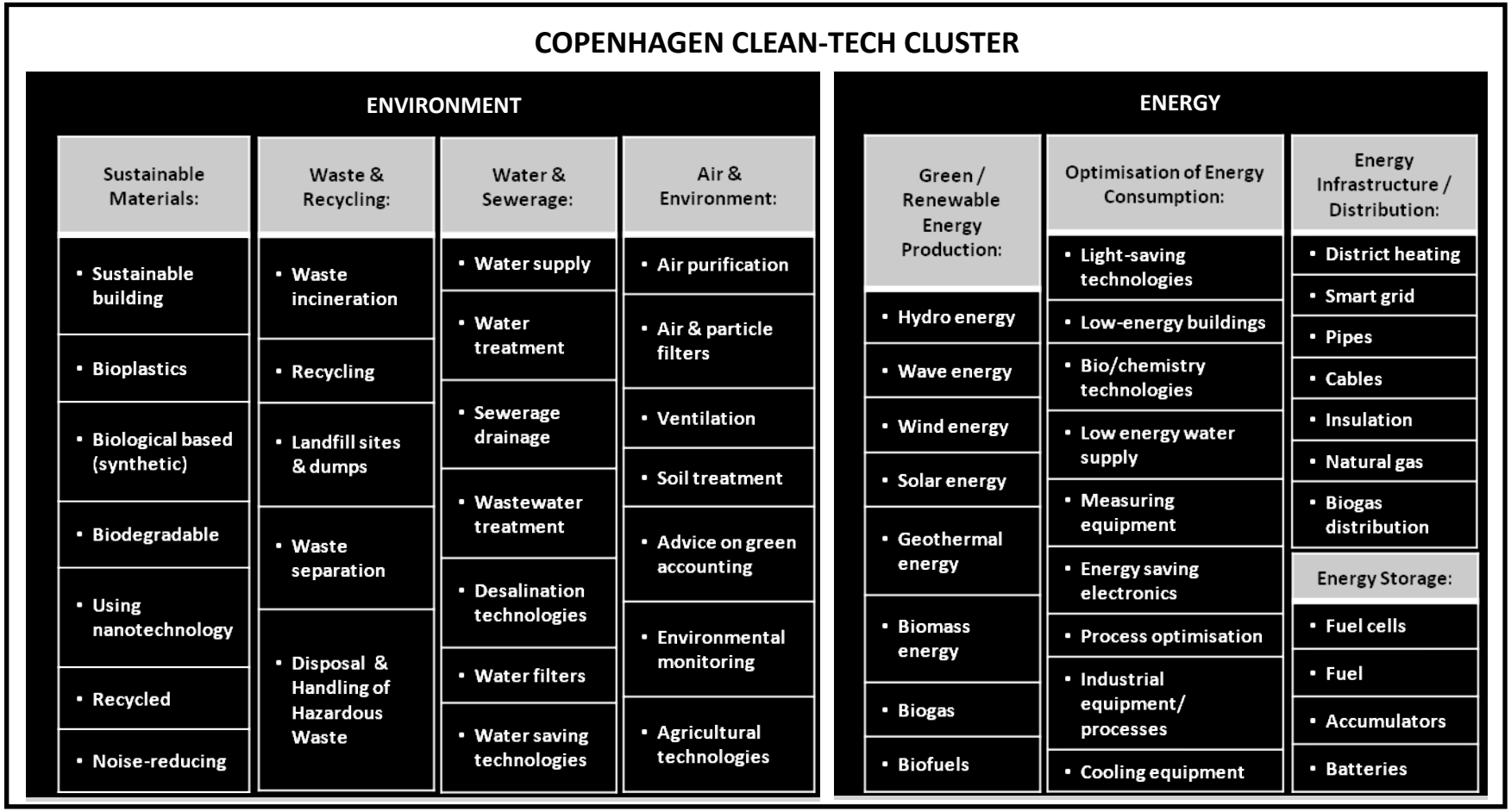
The environmental side of the cluster includes four themes: sustainable materials (including sustainable building materials and bio-plastics); waste and recycling (including for example recycling and waste separation technologies, and handling and disposal of hazardous waste); water and sewage (including water supplies and water saving technologies); and air and environment (including air purification, monitoring and advice on green accounting).

On the energy side of the cluster, the four themes are: green and renewable generation technologies; firms associated with optimising energy consumption (including energy efficiency and production optimisation technologies); energy infrastructure and distribution (including smart grid technologies); and energy storage technologies (for example batteries and fuel cells).

The activities outlined in Figure 3.1 enhance the activities of the CCC from its internal capacities and capabilities to its external connections and linkages. Inside the CCC we will find some of Denmark's leading companies like DONG Energy or leading wind energy manufacturer Siemens. Just as important are the 'external' companies, such as intelligent engineering or software companies, and finance firms such as venture capitalists are also part of the cluster. This is one of the underlying strengths of the CCC; being part of an intelligent ecosystem that can put the 'tech' into 'clean'.

14 Copenhagen Cleantech Cluster website, http://www.cphclean-tech.com/

Figure 3.1. Industrial, research and commercial activities in Copenhagen Cleantech Cluster



Source: Copenhagen Cleantech Cluster (2012)

Mapping the Cleantech Cluster

At its centre are the activities defined by the CCC. Framing this core group, and helping to define its underlying investment, technology and market trajectory are:

- Economic regulatory and knowledge infrastructure;
- Support services and smart solutions;
- Selected customers and markets.

Critical investment, technical, technological, research, partnership and joint venture arrangements exist between the core CCC and the smart services and smart solutions summarised in the chart *i.e.*:

- Intelligent engineering
- Systems integration
- Finance and marketing
- Scientific
- Creative Industries

To put this into perspective, we will explore the example of the *smart grid* and how some of these elements come into play.

The smart grid is all about energy optimisation; peaks and flows. But one can consider a more unusual example. At the heart of the smart grid is data management and, in turn, data visualisation, to support everyone from engineers to maintenance crews on the ground, to the customer themselves. Thus, without the expertise found in animation and software programming companies, who deliver data visualisation to manage the process itself, the smart grid is unable to live up to its reputation of in fact being 'smart'. Similarly, a more readily recognisable and very important example is the contribution intelligent engineering and systems integration make to the CCC.

Whether energy companies from DONG to Siemens or those specialised in measuring, testing and monitoring equipment design or manufacturing, these companies bring together intelligent capacities and capabilities from right across Denmark, including from the original equipment manufacturers (OEMs) and robotics and automation companies in Mid Jutland, to the ICT software and artificial intelligence companies of Northern Denmark.

Another example is Denmark's transport, storage and logistics sector. Maersk, Denmark's global shipping and logistics company, creates sophisticated demand for cutting edge technology and technical solutions in transport, storage and logistics, as well as satellite tracking technologies, in highly competitive global markets. Such demand acts as a spur to knowledge formation and investment in technologies of the future through powerful overflow effects.

These very same Danish sub-suppliers can then apply this knowledge to provide smart solutions across related or complementary clean-tech projects. With Maersk now at the global forefront to advocate for carbon offsets in the shipping industry it is almost certain that the solutions it seeks will be supported by companies in the CCC.

In turn, Denmark's agricultural sector has, over the past 50 years, driven a quiet revolution of its own in the development of new systems technologies in arenas such as its piggery sector. From unique farm based solutions, to waste, waste water and environmental solutions found across the supply chain, these advances have led to the creation of major export markets in plant and equipment, and systems technologies and processes. It is for this reason that agriculture features as one of the 56 industry sectors comprising the CCC, as shown in Annex C.

Another defining feature, and one that is often overlooked, is Copenhagen's media, marketing, public relations (PR), film and animation sectors, and the contribution they make to the global success of the CCC. As Denmark's brand is green, these companies help to give the CCC its visibility in the global marketplace. They also provide vital enablers from e-marketing platforms and solutions found in the digital media to the framing of export development strategies as CCC companies compete against the best in the world.

Copenhagen Cleantech Cluster: Growing, competitive and dynamic

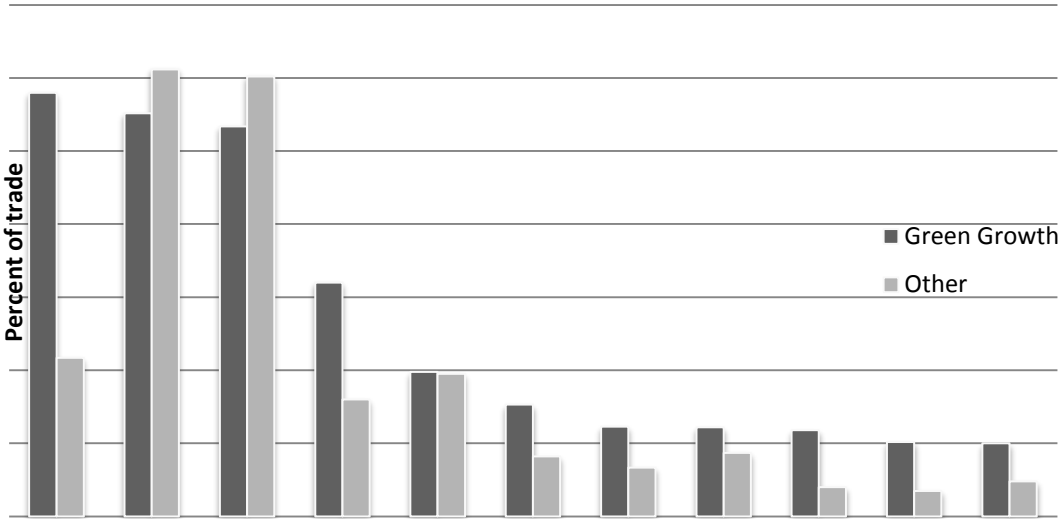
Green growth is growing at a steady pace and outperforming other traditional sectors of the economy including: welfare technology, manufacturing, and ICT. According to DAMVAD (2011), "despite the financial crisis, productivity in the [green] sector amounts to 8% per year" compared to 1.1% for the rest of Denmark over the past twenty years. Recent studies (Oxford Research 2012) have supported such conclusions, showing increases in exports, company turnover, R&D investment, and flourishing human talent as well as the importance of promoting business opportunities for innovation and collaboration, which have contributed to strengthen CCC's competitiveness and growth in the global clean-tech market.

In the following section of this chapter is a snapshot of the CCC's profile regarding its prospects for export growth, and the contribution it makes to R&D and wealth creation through the creation of powerful partnerships between companies and the institutions with which they collaborate.

Export growth

DAMVAD, in its report *Green Growth in Copenhagen* (2011), provides a detailed account of green growth within the Greater Copenhagen area. Figure 3.2 illustrates the extent to which green growth is driving Danish exports, particularly to Brazil, Russia, India and China (BRIC), which have some of the fastest growing economies in the world. Overall growth in green exports in Denmark has increased by 20% between 2004 and 2009.

Figure 3.2. Exports of Danish green growth outside the European Union, 2010



Source: DAMVAD (2011) author calculation of international trade of goods based on DAMVAD Trade Model

A survey for the CCC conducted by Oxford Research (2011) reported that in the period 2010 to 2011, 31% of the clean-tech companies have increased their exports of clean-tech products or services, with only 4% indicating decreasing markets for exports.

Growth spurs new product development

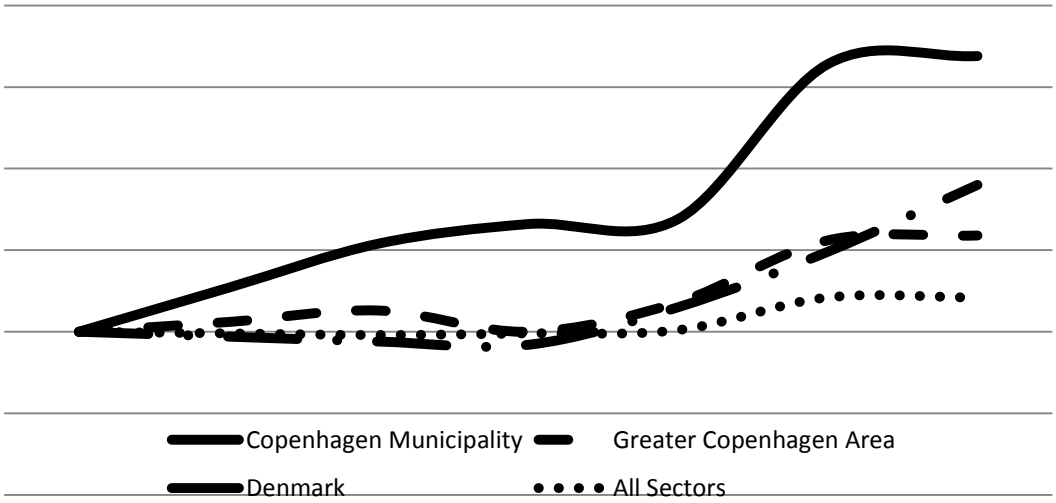
Oxford Research (2011) also highlighted that at an individual company level, 51% of the clean-tech companies have experienced an increase in turnover related to clean-tech in the past year, while only 9% of the clean-tech sector have experienced a decrease in turnover.

The survey went on to report: "60% of the companies have launched a new product, a new process, or a new service within the last year. Most of the new solutions have been launched within energy efficiency and renewable energy" (Oxford Research 2011).

Research and Development

DAMVAD (2011) in turn reported the Greater Copenhagen area has experienced the greatest growth in R&D investments within the green sector as compared to other locations and other sectors (see Figure 3.3).

Figure 3.3. Growth in R&D investments within the green sector by location compared to R&D investments in all sectors

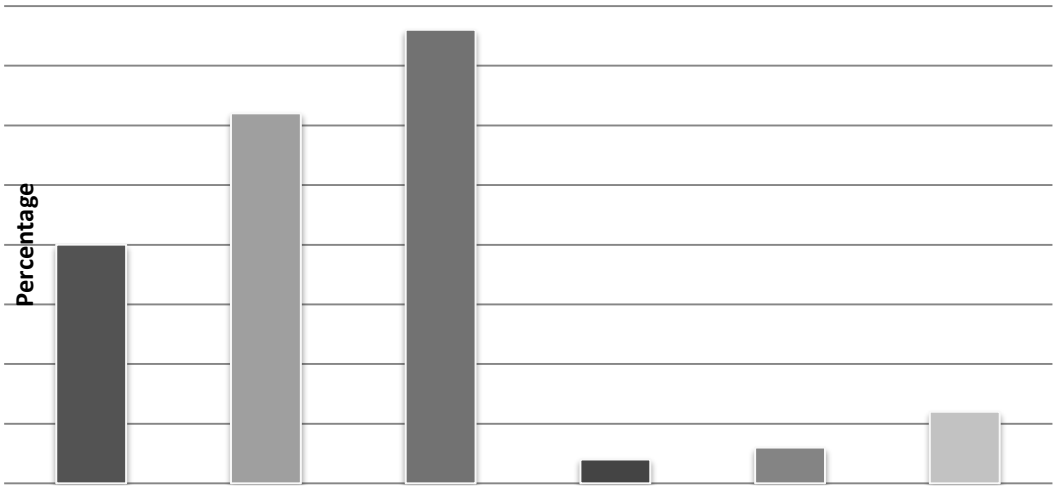


Source: DAMVAD (2011) authors' calculation based on Statistics Denmark

A related study by Oxford Research (2011), suggested that a strong level of investment in R&D has enabled the CCC accelerate to the forefront of innovative clean-tech solutions. As illustrated in Figure 3.4, R&D is a key driver for the industry as its companies attempt to break into new export markets.

This drive is reflected through the clean-tech companies reporting a 51% increase in their investment into research and development between 2010 and 2011. This is a dramatic increase given the effects of the global financial crisis, and reflects robust market conditions and profitable R&D opportunities in a rapidly expanding industry.

Figure 3.4. R&D budget for clean-tech activities

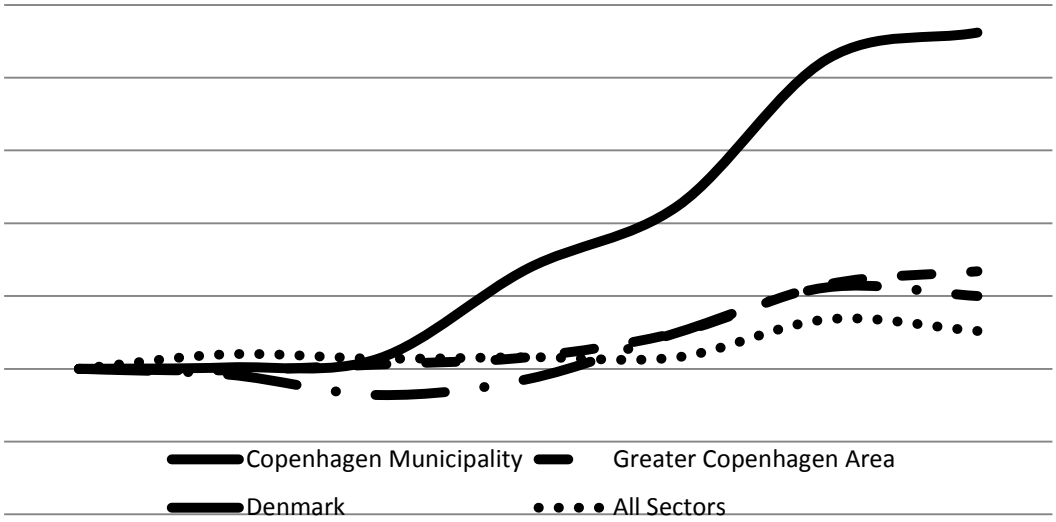


Source: Oxford Research (2011)

DAMVAD (2011) also highlights the Greater Copenhagen area as having experienced the greatest growth in R&D employees within the green sector when compared to other locations and

other sectors (see Figure 3.5). With a strong concentration of universities and globally orientated companies, Greater Copenhagen has attracted and retained its talent, proving to be an employment hub of choice for R&D companies and knowledge institutions.

Figure 3.5. Growth in R&D employees within the green sector by location compared to R&D employees in all sectors



Source: DAMVAD (2011)

Meantime Oxford Research (2011) concludes that from an overall green employment perspective in Greater Copenhagen; "44% of the clean-tech companies surveyed have experienced growth in employment linked to clean-tech activities over the past year. Only 9% have seen a reduction in the number of employees involved in clean-tech activities."

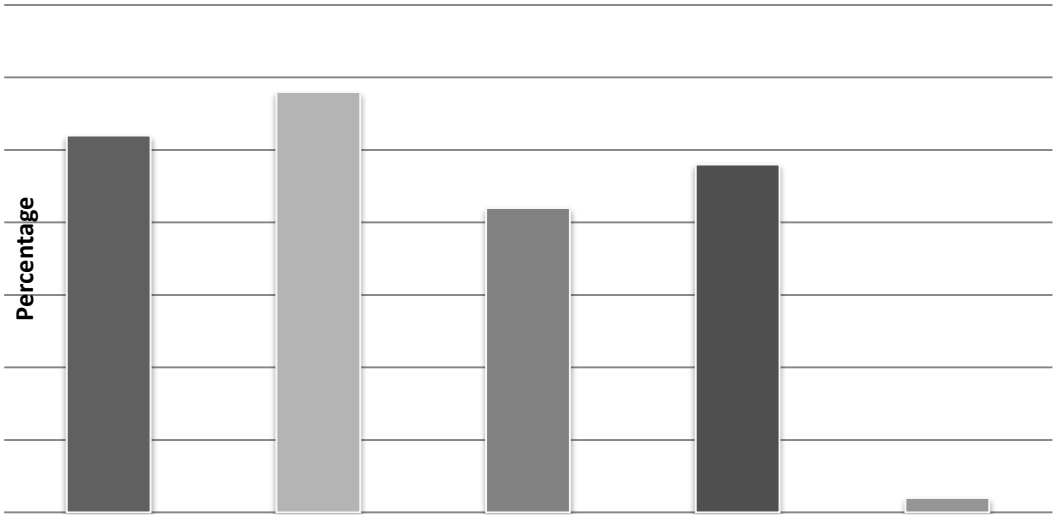
Partnering for success

Copenhagen clean-tech companies collaborate through a close-knit network of partnerships between companies and the knowledge institutions of which they are a part. In this respect, the Cluster is ideally located, with its members being in close proximity to each other; whether individually or collectively, they can take full advantage of capitalising on these close relationships between members and even key account customers. This heightened level of collaboration is revealed through the Oxford Research survey (2011), which concludes:

> The data reveals that 76% of the companies have co-operated with knowledge and/or research institutions and 61% of the companies have co-operated with other companies within the last year (Oxford Research 2011).

From the Oxford Research survey, the clean-tech cluster in Copenhagen is regarded as a relatively strong cluster, with 55% of the companies co-operating with a knowledge institution. The level of co-operation in the CCC is further enhanced, with approximately a quarter (26%) of all companies indicating they have engaged in a high degree of co-operation with knowledge institutions (seen below in Figure 3.6).

Figure 3.6. Degree of co-operation with knowledge institutions

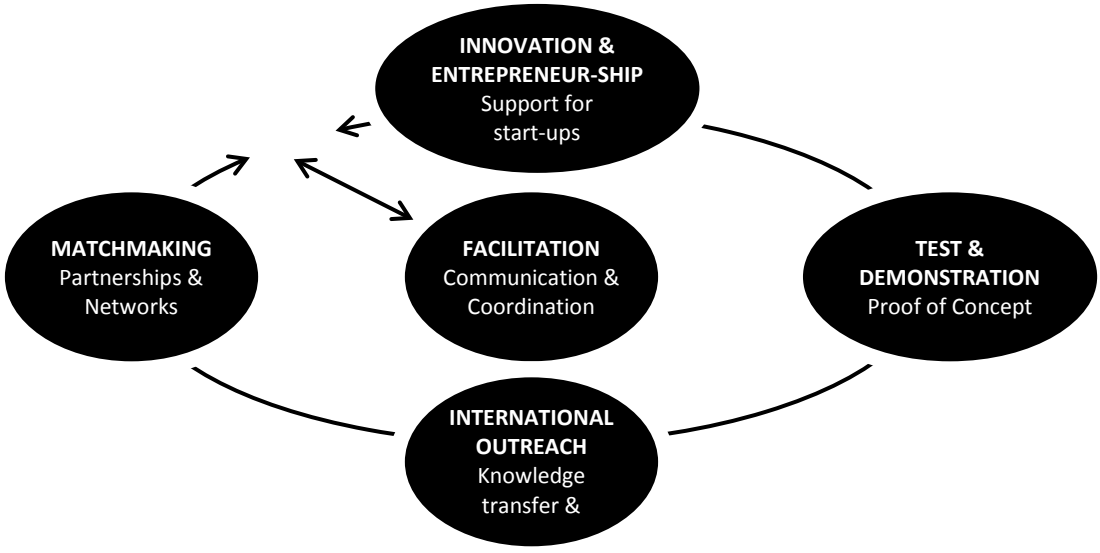


Source: Oxford Research (2011) Questionnaire

Putting clean-tech clusters to work: Overview of the CCC programme

With ambitious targets for job creation, foreign investment, research collaborations and international cluster partnering, CCC carries out projects in five focus areas: facilitation; matchmaking; test and demonstration; innovation and entrepreneurship; and international outreach (see Figure 3.7).

Figure 3.7. CCC's five focus areas



Source: Copenhagen Cleantech Cluster (2012)

The five areas are briefly described below in Box 3.4.

Box 3.4. Five Focus Areas of Copenhagen Cleantech Cluster

- **Facilitation:** Copenhagen Cleantech Cluster operates a 'One Stop Shop' where interested parties can gain an overview and access to the Cleantech Cluster. The One Stop Shop is the knowledge centre that ties all the projects and partners together. The centre ensures that the cluster's stakeholders have access to relevant information, advice, materials and activities. The One Stop Shop co-ordinates initiatives and stakeholders, and generates analyses that identify new opportunities, challenges and needs within the clean-tech sector.

- **Matchmaking:** Introducing the right people and projects to each other is a cornerstone of Copenhagen Cleantech Cluster. The cluster facilitates matchmaking between research institutions and companies, and builds vital networks between stakeholders. Analysis has shown that these networks foster a company's ability to be more innovative and productive, thus companies in networks and clusters are more likely to be successful compared to those outside a cluster.

- **Innovation & entrepreneurship:** Bringing new solutions to the global market is vital to the Copenhagen Cleantech Cluster. This requires the creation of a supportive environment and the right conditions in which new business ventures can thrive. One example is the Cleantech Accelerator programme, which supports start-ups to fast track their access to knowledge, skills and potential partners. The programme helps companies identify customer value and product differentiation. It relies on providing the start-up with relevant knowledge and an overview of the market, together with access to business modelling and assistance in managing scarce resources. And finally, start-ups are assisted in establishing a strong clean-tech network as well as in testing their products.

- Another example of support for new initiatives is the *gap funding initiative,* which provides a bridge between a promising research project and the process of commercialisation. As such, the funding is earmarked for university research projects, and allows researchers from the University of Copenhagen and DTU to apply for additional funding to further develop promising research projects until these are ready to be adopted by industry, as a spin-off, spin-out, or as a new start-up company.

- **Test & demonstration:** CCC provides access to testing and demonstration facilities for new clean-tech technologies and products, from initial idea to full-scale demonstration. These projects range from the construction of Copenhagen Cleantech Park to Risø DTU, where full-scale commercial demonstration plants and new technologies can be displayed and tested. The main objective is to create infrastructure for testing and demonstration that is attractive to both foreign and national clean-tech companies alike.

- **International outreach:** Copenhagen Cleantech Cluster (CCC) has a global focus and is already a central player in the international clean-tech field. The international outreach supports collaboration with cutting-edge clusters, their members abroad, and research institutions abroad. CCC is engaged in two large international projects, the International Cleantech Network (ICN) and Complex Cleantech Solutions (CCS).

Source: Copenhagen Cleantech Cluster (2012)

The ICN is a proactive network of visionary and leading clean-tech clusters around the world, sharing a collaborative platform to provide each cluster with the best opportunities for their cluster members (companies, universities/research institutions and local authorities).

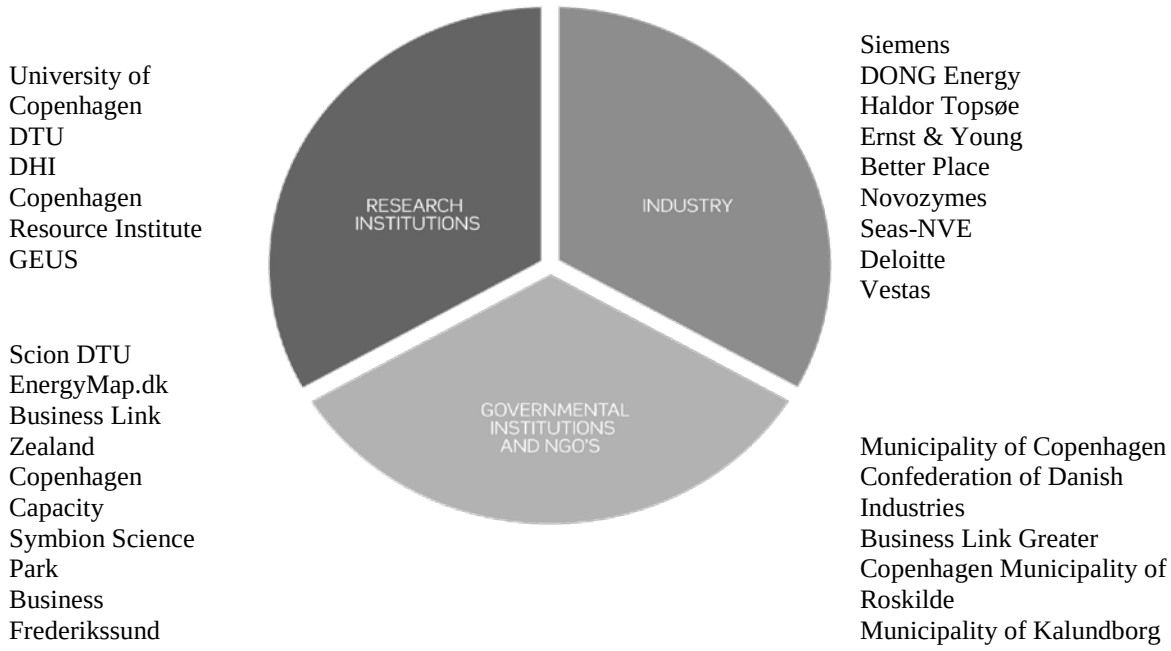
ICN currently has 10 partners, from Europe, North America and Asia. In 2011, CCC initiated an innovation platform for 'Smart Cities', and in March 2012 hosted 'Open Smart City 2012', where ICN members and other international clean-tech players met to discuss the smart city of the future, with the aim of creating cross-regional green growth. ICN operates in a flexible manner. Some activities, like the smart city conference, are common for all members, but clusters can also meet bilaterally or in groupings, often with a concrete focus of developing new business opportunities. In the coming years, another 5 new clusters may join ICN, should they meet the high standards of active

participation set for its members: The member clusters must demonstrate their leading position, should adopt a triple-helix architecture, and must focus on concrete activities, not just marketing efforts.

Complex Cleantech Solutions (CCS) has a technology focus, initiating joint business projects that deliver integrated green solutions globally, via the CCC network. Such projects are geared to combine the best aspects of a wide range of technologies to deal with the low-carbon challenge. In this manner, CCS also helps Danish clean-tech companies gain markets, knowledge and business opportunities. The CCS has separate funding of around 1½ million EUR over three years (Copenhagen Cleantech Cluster website, *www.cphclean-tech.com/home/services*).

As with all triple helix collaborations, there are industrial entities, government institutions and research organisations participating. In each of these areas there are multiple participants representing the full geography of relationships from city, country and international markets and institutions. In the industrial area, firms represent production, design and business service aspects of industry. Figure 3.8 below illustrates the central actors involved in CCC activities.

Figure 3.8. CCC - Examples of member companies and affiliated organisations



Source: Copenhagen Cleantech Cluster (2012)

Copenhagen Capacity and the Copenhagen Cleantech Cluster

The Copenhagen Cleantech Cluster`s most important task is to bring key clean-tech players together. The matchmaking activity consists of Business-to-Business networks and Research-to-Business programmes. The matchmaking working group and four-person investor-targeting team focuses research efforts on four sources of data to identify potential foreign investors and partners:

i. Existing cluster members;

ii. A "Scout Network" of lawyers, consultants and representative organisations of foreign companies in Denmark;

iii. CopCap offices and agents based in five target foreign markets - China, Germany, India, the United Kingdom and the US; and

iv. The International Cleantech Network and other clusters such as the European Cluster Consortium.

The CopCap investor-targeting team and its CCC partners are able to engage with potential investors through face-to-face meetings, presentations of opportunities, matchmaking events at industry fairs and conferences, business days in target markets, and business missions for visiting companies and officials.

CopCap and CCC network members have combined their outreach skills, sector knowledge and technical expertise to produce investment propositions for their clients. Thus, with a business and results orientated investment team, clear goals, targeted activities and funding, CCC has reaped quick successes in its first two years and as a member of the Global Cleantech Cluster Association, it is now regularly cited as one of the world's leading clean-tech clusters. It has, for example:

- Attracted five new foreign companies, representing 230 high-skilled, high-paying jobs in smart grids, electric vehicles, biofuels, water and energy efficiency;

- CCC has also sourced gap funding for the world's first interoperability test centre for electric cars; and

- Mapped the Danish smart grid, water and waste sectors, thus providing further relevant materials for the FDI attraction effort.

From the City of Copenhagen's perspective, the key role played by CopCap in building the cluster through domestic and international partnering is important in meeting the city's long term objectives to turn Copenhagen into the world's first carbon-neutral capital. By 2014, CCC has targeted 1,000 new jobs; 25 foreign investors; 30 new research and innovation collaborations; and work with 15 international clean-tech clusters. In 2014, the EU grant will expire, meaning CCC partners will be responsible for the full cost of the platform, based, in part, on its service-oriented formula. From that point onwards, CCC members will contribute according to the benefits and returns that the cluster provides.

Future growth trajectories: Global clean-tech business opportunities

Through continuous involvement with clean-tech companies, research institutions and governmental bodies, the Copenhagen Cleantech Cluster have identified the following particular opportunities in the clean-tech sector (see Table 3.1).

Table 3.1. Opportunities in the clean-tech sector

Industry	Opportunities
Wind energy	Expand business with the world's leading wind energy companies, suppliers and contractors. The Danish wind industry accounts for approximately one third of the world market.
Biomass, bio fuels and biogas	Utilise the regional competencies within biotechnology, chemistry, agricultural science and engineering to commercialise technology and R&D.
Smart grid	Develop opportunities and integrate solutions in a well-developed smart grid infrastructure.
Electric vehicles	Become part of developing the future of transportation by testing and demonstrating technology in a progressive market.
Green buildings and smart homes	Grow this market globally. The Danish private and public sectors are early adopters and key markets.
Fuel cells and hydrogen	Expand partnerships with established networks, a vigilant R&D environment as well as an array of emerging companies and suppliers on the forefront of fuel cell technology.
Water, air, waste. and advanced materials	Respond to the strong demand for more efficient use of resources in many traditional industries.

Source: Copenhagen Cleantech Cluster homepage[15]

Summary

Established in 2009, the Cleantech Cluster has, in a relatively short space of time, earned an international reputation for delivering results, and in the process supported Danish companies to break into global clean-tech markets.

CCC's key success factor can be found in its governance architecture, which nurtures collaboration and partnership building between its members. The CCC is not only 'bursting' with talent, the proximity of its companies to each other, when coupled with the partnership programmes the cluster has to offer, has resulted in 76% of its members having co-operated with a knowledge institution, while 61% of its companies have partnered on projects between themselves.

In turn, productivity growth as we know it is a critical benchmark when measuring the performance of any economy. In the case of the green economy, green productivity growth has increased by a dramatic 8% per year compared to 1.1% for the rest of Denmark over the past twenty years.

The collaboration environment of the cluster allows the development of trust and knowledge sharing so that companies and the knowledge institutions with which they co-operate can undertake truly transformative projects, such as attracting five new foreign companies to Copenhagen, resulting in 230 highly-skilled, highly-paid jobs in smart grids, electric vehicles, biofuels, water and energy efficiency.

The cluster's companies continue to grow and invest in new export markets, R&D, and highly skilled employees; all in the aftermath of the global financial crisis, where tight lending and credit conditions continue to weigh heavily on the broader economy.

15 www.copcap.com/content/us/doing_business/industries/clean-tech/business_opportunities_in_copenhagen

CHAPTER 4

GREEN JOBS PATHWAYS

One of the most critical dimensions of green growth for local areas is understanding the impact on local labour market dynamics. Green growth opportunities that are net positive at the national level can be completely different when examined at the local level – each region needs to be able to identify their local situation for greener jobs and skills. This chapter discusses possible labour market impacts of the transition to a low carbon economy. Identifying and categorising green jobs and skills is very much an emerging area for both data collection and policy, and the answers to the number and location of green jobs, or required combinations of necessary skills are not easily available. The importance of understanding local labour market impacts means that considerable intellectual and data investments need to be made to allow policy makers the best chance of minimising any negative impacts of forthcoming changes.

Introduction

The transition to a low-carbon economy has profound implications for labour markets. The dynamics of the Cleantech Cluster are creating a demand for new ideas and new skills across the entire economy in what has been coined by the Danish government as 'Denmark, The State of Green'. However, efforts towards green growth have a history of more than 30 years and, according to Tapscott & Williams (2012), Denmark has managed to grow its economy by almost 80% whilst maintaining the same level of energy consumption since 1980. Over the same period, Denmark changed from being an economy that was entirely dependent on energy imports to becoming a net exporter of both electricity and energy technology (Tapscott & Williams 2012).

In fact, a nation's or region's technology trajectory comes from the dynamics of those industries it already has (Storper 1995; Kenney & von Burg 1999; Genoff & Green 1998; Genoff & Sheather 2010). In this respect, the wind industry that was born of Denmark's rich industrial heritage in Jutland is now known the world over. Another example are the smart city solutions provided by Copenhagen's leading design, planning and architectural companies, which are grounded in a long history of creativity and innovation. Together these regional and city dynamics combine to create a new generation of skilled jobs and investment drivers that built competences for the transition.

Whilst individual employment classifications remain the same, such as machinists, engineers, or architects, understanding 'exactly what they do' is of vital importance to understanding the breadth and depth of the green jobs being generated. As discussed in this chapter, although many companies and their staff are undertaking green related projects, they do not necessarily see themselves as a part of the green economy. And nor are their efforts captured by the official statistics, as there is no specific agreement on what constitutes green jobs. Despite these definitional challenges, there is nonetheless a strong emerging consensus around the core attributes of what constitutes a green job.

This chapter discusses some aspects of the *Sixth Wave* of the green economic and industrial revolution, and how it is transforming what we do and how we do it across a myriad of occupations. Then discussed is how traditional occupations are being greened and, in the process, new employment opportunities being created and what pathways towards these can be found in Denmark. Finally, how Denmark is creating this new generation of green jobs is discussed. The final section summarises the key strategies being implemented by Greater Copenhagen and the Copenhagen Cleantech Cluster (CCC) to foster the growth of green jobs and green skills.

The Sixth Wave: Green Jobs

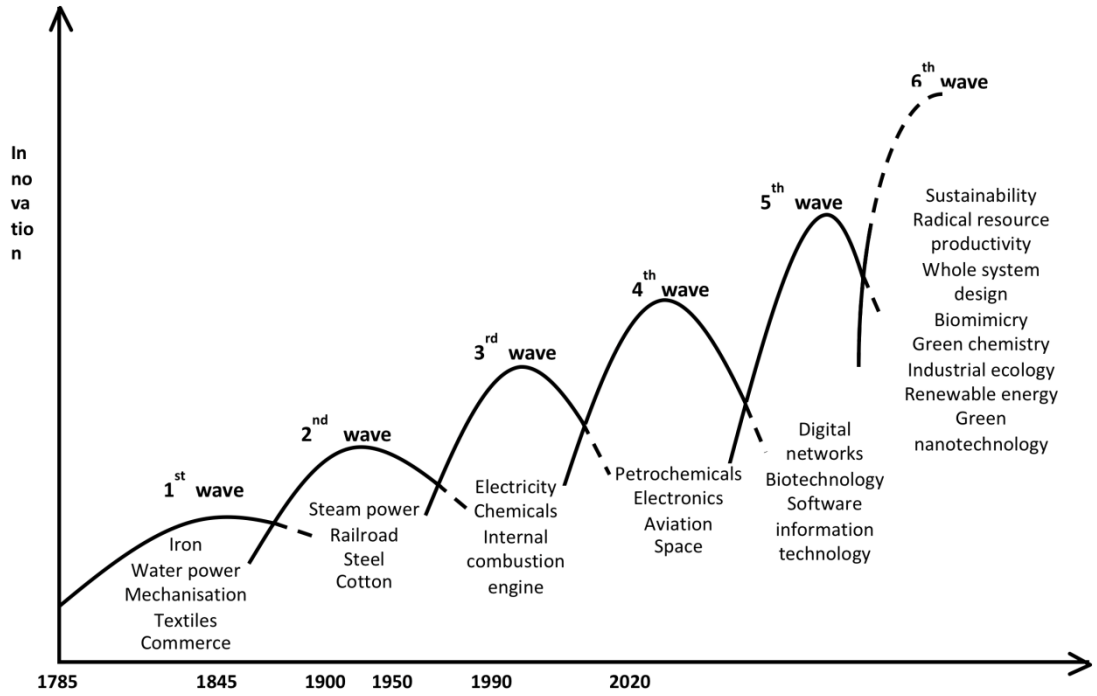
The authors of *Factor Five: Transforming the Global Economy through 80% Improvements in Resource Productivity* (Weizsacker 2009) have built on the innovation waves originally developed by the Russian economist Nikolai Kondriev in 1925, to describe the sixth or 21st century innovation wave as being green. Kondriev's 'long waves' (average 50 years) approach has been used to analyse paradigmatic technology changes in economic activity in recent centuries, for example the invention of the steam engine, petrochemicals and the more recent micro-electronics changes. Many of these breakthrough technologies are shown in the wave analogy in Figure 4.1.

The next wave of paradigmatic technology change is predicted to centre on how we use resources in the future, particularly how we increase the efficiency and intensity of resource use. This is based on the need to de-couple economic growth from the exploitation of the planet's natural resources. Weizsacker (2009)[16] has further speculated on what some of the components of the next forthcoming wave of sustainable technology development are, including:

[16] Other authors have also suggested similar frameworks including Rifkin (2011) in *The Third Industrial Revolution* – the main focus is on the increasing economic value of innovation in resource efficiency, recycling and decarbonising energy systems.

- Sustainability and radical resource productivity;
- Whole system design including biomimicry;
- Green chemistry;
- Industrial ecology;
- Renewable energy;
- Green nanotechnology.

Figure 4.1. CCC - Examples of member companies and affiliated organisations



Source: Von Weizsacker (2009)

James Bradfield Moody in his book *The Sixth Wave* (2012) expands upon the insights offered by Von Weizsacker. For Moody, this sixth wave originates in profound new advances in ICT and digital technologies grounded in Moore's law; where computing power doubles every 18 months. As outlined in the OECD report *Towards Green Growth*, this rapid diffusion of ICT has underpinned the green economy and its accompanying greening of skills (see Box 4.1. below).

Box 4.1. Fostering green growth – the ICT experience

If green innovation is to lead to a substantial acceleration in economic growth and the creation of new firms, jobs and industries, green technologies and innovation will need to become widespread throughout society. One recent example of this process is the rapid diffusion of ICT over the past decades, which is typically regarded as having led to a new technological revolution, contributing to productivity and employment growth. The example of this technology may prove instructive in better understanding the possible impacts of green technologies on the economy, and the conditions under which technologies become effective in substantially enhancing economic performance.

A few elements from the experience with ICT may be particularly relevant for the current debate:

- [The] experience with ICT suggests that much of the impacts and job creation resulting from new technology are not in the production or manufacturing of the technology, but in its application throughout the economy. While some countries benefitted from having an ICT-producing sector, most gained from ICT via its application throughout the economy, notably in the services sector. If this experience provides any guidance for a possible green revolution, it suggests that growth will result more from the application and diffusion of green technologies, including the associated services, than from the production of the technology, which tends to be highly concentrated.

- [In turn], the impacts of ICT were heavily dependent on complementary changes in work practices, skills and organisations, which in turn rely heavily on the flexibility of labour and product markets. If this provides any guidance to the current context, it suggests that green innovation is more likely to have positive impacts in economies that have well-functioning product and labour markets.

Source : OECD (2011a)

It is this exponential growth in computing capacity and capability that has enabled software engineers to, for example put the 'smart' into the smart grid. In other words, this growth provided the ability to integrate and synthesise enormous volumes of data, which would have been impossible only a decade earlier.

Moody (2012) concludes that such transformational changes in technology mean the sixth wave will result in a radical shift from resource dependence to resource efficiency, where 'waste will be a source of opportunity and nature a source of inspiration'.

Making the transition to green work of the future: greening jobs and skills

Green jobs can be found in activities that foster economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies (OECD 2011a). For Copenhagen's Cleantech Cluster, these are activities which develop (including consultancy and research), produce or implement new or improved processes or products that:

- Increase renewable energy or sustainable materials production;
- Reduce the use of natural resources by exploiting the resources or energy more efficiently;
- Reduce the harm caused by fossil fuels;
- Reduce pollution problems through products, processes and consultation;
- (Copenhagen Cleantech Cluster 2012).

While there is no common universally agreed definition of green jobs, there is a strong and emerging consensus on how to view green jobs. For instance, the International Labour Organisation (ILO) has been active in promoting the green jobs agenda and has developed the following definition of its own:

> Jobs are green when they help reduce negative environmental impact ultimately leading to environmentally, economically and socially sustainable enterprises and economies. More precisely green jobs are decent jobs that:
>
> - Reduce consumption of energy and raw materials;
> - Limit greenhouse gas emissions;
> - Minimise waste and pollution;
> - Protect and restore ecosystems
>
> (International Labour Organisation 2012).

The term 'green job' is, however, limited to analysing the labour force effects of the transition to a low carbon economy. There will in fact be many types of green jobs, each with different dimensions of skill and vulnerability and each responsive to different combinations of policy action.

At the broader level, there are two sources of positive employment effects forecast from increased policy action (regulation) to address climate change (OECD LEED 2010):

i. Climate change regulation will lead to the expansion of Environmental Goods and Services (EGS); and

ii. Production association with EGS industries is more labour intensive than other traditional industries where labour will be replaced. This may be explained by the emerging nature of some of these industries, which means they have not reached the stage of incremental innovation that increases the efficiency of inputs to outputs that other, more traditional industries have established.

A recent UNEP study (2011) highlights four labour market impacts, two positive and two negative:

iii. Additional jobs will be created which produce new products and services in response to climate change regulation;

iv. Some employment will be substituted – for example employment shifting from fossil fuel energy generation to renewable;

v. Some jobs will be eliminated without substitution as regulation decreases the costs of production;

vi. Many existing jobs will be transformed, refined and updated as day-to-day skills and work methods are upgraded.

Whether the number of new jobs created will outnumber those lost is undecided. Recent studies (Wei et al 2010) note that new jobs created in response to the need for new activities or the shifting of current activities to be less carbon intensive (for example through increased renewable energy generation) will require more labour than that required for the ceased activities. However, whether

this is a short term or long term phenomenon will depend on the development of these emerging industries. The labour-rich requirement may in fact be due to these new products and services being in the emerging phase of their technology lifecycle and therefore likely to experience efficiency gains (more output for the same or less input, including labour) as they develop. This would make this labour intensity a short-term phenomenon. Some authors (Fankhauser et al 2008) argue that this has already started to happen with the wind industry. This continued uncertainty again highlights the on-going need for monitoring.

The economic transition to a greener economy is significantly underpinned by the skills that human resources will need to learn to undertake new tasks or to transform the way of producing goods and services. The International Labour Organisation's (ILO) study on skills for green jobs (2011) points to five major challenges of skills development for green jobs: (1) shortage of qualified teachers and trainers in newly emerging green vocational fields that can take on the role of diffusing up-to-date environmental knowledge; (2) lack of co-ordination between different levels of government and inadequate resources planning for implementation at the sectoral level; (3) development of active labour market policies for workers in transition from 'brown jobs' to 'green jobs'; (4) update of training and qualification systems as a whole to respond to the occupational change driven by greening of the economy – in particular technical and vocational education and training (TVET) can lag behind if measures are not adopted; and (5) develop systems of anticipation of skills needs and labour market information for green jobs that can inform both the public and the private sector.

A new OECD report analysing the jobs potential of a shift towards a low-carbon economy (OECD 2012) suggests that policy makers need to focus on three main policy challenges: (1) fostering a smooth reallocation of workers from losing to winning firms; (2) ensuring that workers obtain the new mix of skills required for cleaner production; and (3) developing synergies between green growth and employment quality and growth. These synergies may precede good policy design as they are not inherent to green growth per se. Labour market and skills policies have therefore an important role to play in the green transition, in particular for reducing the insecurity due to job displacement, fostering eco-innovation through education and training, and making the tax and benefit system more supportive of employment.

In line with this, a new CEDEFOP study reveals an uncertain and fragmented picture of both policy co-ordination and stakeholders' co-operation towards the development of the green economy and its implication for skills and training activities (CEDEFOP 2012). Uncertainty about environmental regulations and policies makes it difficult to anticipate skill needs; multiple entry routes and insufficient recognition of skills acquired through non-formal or informal learning tend to deter workers from transferring to green jobs; learning providers are not sufficiently active in anticipating demand and are discouraged by uncertain and diverse employer needs. In these circumstances, especially at the local level, policymakers, the social partners and training providers need to work closely together to ensure a consistent policy framework that can promote future investment in the green economy.

Policy design indicators for green jobs are starting to be developed. In OECD LEED (2010) there is an initial set of criteria and indicators that reference industry, production method, value chain position, awareness of the organisation, occupational profile, job quality and green workload (see Figure C.3 in the annex for details of these criteria).

However, understanding how green related jobs are generated requires greater understanding of sectoral industry dynamics and drivers both in manufacturing and service sectors. One of these key drivers can be found in the financial markets, for example, emissions trading experts or brokers dealing exclusively in socially responsible investments (SRIs). Just a decade ago, these very same financial experts may have been brokers working on the floor of any number of stock exchanges found in major cities around the world. Today whether in Wall Street or in the heart of Copenhagen, they generate the financial instruments required to put new energy or green infrastructure projects to

work. Between them, they have an expert understanding of the political and financial drivers of green growth and where new green business and investment opportunities can be activated.

Such financial experts can be seen at work in Denmark's Danske Bank. For example, they provided the expertise to allow Danske Bank to increase its investment in assets under management in order to meet the Bank's SRI policy, from DKK 506 billion in 2009 to DKK 596 billion in 2011 (Danske Bank 2011). Danske Bank in 2009 was awarded the GreenBiz award for the Group's work with "green sourcing and environmental supplier screening" by the Purchasing Panel, which was appointed by the Danish Ministry of the Environment. In 2010, the bank was highlighted in the FTSE4 Good Sustainability Index for its work on "its environmental impact as well as on social and ethical issues related to our business" (Danske Bank 2010).

Although this example shows that a new type of job has been created in the financial services sector, this vitally important activity is unlikely to appear on the radar of official statistics. Some studies argue that the nature of green jobs is indeed dependent on their occupational profile (OECD 2010, p.26):

> This [a green job] refers to the nature or purpose of the job, irrespective of the sector it is performed in. Almost any occupation can be considered green as long as it contributes to reducing harmful impacts of human activity on the environment, either directly or indirectly. As a result, occupations ranging from managers, to sales workers to labourers can all at some point be considered as being green.

Such transitions, whether blue or white collar to green collar jobs, are taking place across many parts of the economy. Nidumolu, Prahalad, and Rangaswami (2011), writing in the *Harvard Business Review's* special issue *Greening Your Business Profitably* capture this process at work (see Annex C.2). They describe how green growth influences change in the workplace and fuels demand for new competencies. There are five stages of this process.

Stage one refers to the importance of compliance (the regulatory framework) in driving innovation and workplace change. Unlike most other developed economies, Denmark has been driving a sustainability and regulatory agenda for over a generation, which has underpinned its place as a clean-tech leader, and in the process created the requisite skills base to keep them at the forefront of a new generation of clean-tech R&D and know-how.

These changes are in turn driven through the supply chain from one company to the next, increasing efficiencies to life cycle assessments as summarised in stage two. The process at this stage accelerates the uptake and diffusion of new clean-tech production processes, technology and knowledge. At this point we also witness the greater involvement of the knowledge institutions as they begin to collaborate more closely with early clean-tech adopters and leaders.

This momentum builds into stage three, where new products and services are developed and in the process create demand for new green workplace competencies and even entirely new occupations. This is the point where companies and their management either have to adapt or perish. Agile companies will embrace the development of new competencies and new work roles.

Those that survive stage three and the process of creative destruction can transition to stage four in order to formulate new business models that can ultimately transform the very basis of competition itself. Whether through new models of collaboration or by adopting business strategies that combine digital or physical infrastructure, these new companies are the future green innovators. This operating environment is complemented by skills formation as new courses and curriculum are developed to support the training and investment needs of the private sector.

Finally, stage five signals the creation of next practice platforms', which lead companies to "question through the sustainability lens the dominant logic behind business today" in orderto develop

the "knowledge of how renewable and non-renewable resources affect business ecosystems and industries" (Nidumolu, Prahalad & Rangaswami 2011). Given the R&D expenditure and ability to be leaders in global clean-tech markets it can be suggested that this final stage is where many of Copenhagen's clean-tech and related companies can now be found.

An important point to underline regarding the dynamics at work of Copenhagen's Cleantech Cluster is the high level of collaboration between companies and the knowledge institutions (Oxford Research 2011), which reinforces Nidumolu, Prahalad, and Rangaswami's (2011) conclusions that..."Few innovations, be they to comply with regulations or to create a new line of products, can be developed in today's world unless companies form alliances with other businesses, nongovernmental organisations, and governments. Success often depends on executives' ability to create new mechanisms for developing products, distributing them and sharing revenue".

Denmark's approach to creating green jobs: an investment driven process

The policy and market drivers for green growth in Denmark are regulatory, urban, energy, transport, waste and water management, innovation and clean-tech cluster policies and programmes. As noted previously, these policy regimes and approaches have been deeply embedded in Denmark's knowledge institutions, from the Danish Technology University, to the research and development companies, which are global leaders in developing energy solutions.

Together these activities have generated an internal green labour market over time. As research by DAMVAD illustrates, such initiatives have created a labour market, with a green jobs ripple or multiplier effect across the entire economy (this is discussed in more detail below). These green growth externalities have been supported internally, for example by the widespread uptake of environment standards such as ISO 14001. In 2000, Denmark ranked second in Europe, after Sweden, for the number of companies with ISO 14001 and environmental related certifications, demonstrating the benefits of first mover advantages in the green growth sector, as companies complied with government regulations (John Ulhoi 2004). Together, such initiatives have propelled Denmark to the very top of the clean-tech global rankings and it is viewed as a solid testing ground in which global companies can trial new green technologies, which additionally acts as a magnet for foreign direct investment.

Investment in Denmark is driving green growth and the green jobs have followed in its wake. It is this green investment driven dynamic that has led to two interesting outcomes:

- Formulation of pioneering green economic, innovation, urban development, infrastructure, transport and energy plans and legislative programmes, which in the Greater Copenhagen Region are being integrated into a smart city strategy; but

- Without formulating detailed green labour market architecture.

The system also consists of an effective labour market structure that offers guidance, and a job or education to anyone who is unemployed (The Danish Ministry of Employment 2012). The Ministry of Employment also has the overall responsibility for measures in relation to all groups of unemployed persons, i.e. both unemployed persons on social assistance, as well as unemployed persons receiving unemployment benefits. Overall, the Ministry's programmes do not target specific sectors or types of occupations, but rather aim to build a strong and flexible labour force, reinforcing the OECD's (2011) recommendations that labour market policies should focus on creating market driven labour policies that are conducive to creating the conditions favourable for employment growth and not the protection of jobs exposed to structural adjustment pressures.

Policy should also provide the necessary scope for both workers and firms to be able to adjust quickly to changes brought about by the greening of the economy, including the ability to maximise new business and employment opportunities. That is, the workforce should be assisted to move from

jobs in declining industries to jobs in expanding industries. Thus, labour market policy settings should be adjusted to meet new skills and training requirements as underlying industry conditions change (OECD 2011a). These approaches are generally in keeping with Danish labour market and educational policies. This can be seen in the broad labour market and job strategy framework developed by the OECD, which is highlighted in Box 4.2.

Box 4.2. Labour market and skills policies

The OECD *Reassessed Jobs Strategy (RJS)* (2006) provides a useful framework for identifying policies that can reconcile the vigorous process of 'creative destruction' required to achieve green growth with a high level of employment and shared prosperity. One of the guiding principles of the *RJS*, which is particularly relevant, is that a carefully designed package of labour market, social protection and skills development policies can ensure that the labour market is both dynamic – continuously redeploying labour from declining to growing industries and firms - and inclusive. There are three policy areas that should be given priority in order to promote a *smooth* and *just* transition:

- A strong skill development system, and active labour market programmes, which facilitate a quick re-integration of jobseekers into employment, are key supply-side policy elements for reinforcing the structurally adaptive capacity of labour markets.
- On the demand side, moderate employment protection and strong product market competition are important supports for vigorous job creation as environmental policies and eco-innovation create new green competitive niches.
- Policies that increase the adaptive capacity of labour markets need to be combined with flanking measures, such as unemployment insurance and in-work benefits, which ensure that dynamism is not achieved at the cost of excessive insecurity or inequality for workers and their families.

Source : OECD (2011a)

Danish green skills activities

Denmark has a national system for Initial Vocational Education and Training (IVET), Continuous Vocational Education and Training (CVET) and also tertiary vocational education. As discussed above, the key policy focus is on ensuring that training reflects the needs of economic development – both when restructuring is about greening the economy, or related to the ongoing processes of structural adjustment. However, this is where Denmark's labour market and education and training systems diverge from other EU member countries such as the United Kingdom, and especially from other countries such as Singapore or the United States.

Remuneration and working conditions are typically laid down by collective agreements negotiated between trade unions and employers' organisations – a system of labour market regulation that is often referred to as the Danish Model. This uniquely Danish system is characterised by the fact that the social partners (employers, trade unions, government and the education sector) determine the rules of the game, as collectively they are in the best position to understand changes in underlying labour market conditions. And because they are on the ground, it is believed that together they are the most effective means to formulate quick and practical solutions, and adapt to new challenges. These organisations are therefore strategically and formally involved in the ongoing process of developing the further education system.

The European Centre for the Development of Vocational Training (Cedefop 2011) recently analysed the IVET and CVET efforts in relation to green skills. Its report on Denmark concludes "that no overall skills response strategy has to date been developed as part of a coherent policy response to climate change and environmental degradation". This may seem like a somewhat disappointing

observation. However, the report also concludes that "the long term green focus in Danish policy is already reflected in the educational sector. Various IVET, CVET, and tertiary programmes have over the years been adjusted to match the demand for skills and knowledge related to green technologies and aligned to the ongoing restructuring" (Cedefop 2011). This has led to the formulation of competency-based goals for specific VET qualifications in IVET as well as CVET. Examples of these are: energy generation and the reuse of energy; waste management; construction; facility management; transportation; and agriculture.

In the meantime, new programmes have been implemented in VET, CVET, and in tertiary vocational education. These relatively new qualifications at the upper secondary VET level have been developed to comply with the increased focus on energy reduction and energy efficiency, and to exploit technologies that can be used to optimise and monitor energy consumption. Examples are cooling and building service technicians.

In addition to technical skills, individuals are encouraged to attain a number of generic competencies relating to management, planning, and communication. Universities are also increasingly offering courses, which address the climate and energy challenge, from monitoring and analysing climate impacts to the development of energy efficient solutions. Further nurturing of green skills is likely to be supported in the future. For instance, within the last year an initiative focused around kindergartens and elementary schools has been launched, which will support courses that increase environmental awareness and skills (The Danish Ministry of Children and Education 2012).

Denmark's climate change consensus underpins green jobs growth and investment

In Denmark, there is political consensus that actions need to be taken to deal with issues of climate change extending across different layers of administration, from the national and regional level to the city level, as evidenced by the multiple policy documents addressing climate change issues. There is also a general agreement that the climate change challenge in economic terms is a double-edged sword presenting both costs and opportunities (Jamet 2012).

This consensus has translated into politicians being open to supporting environmental legislation, which has as its objective maintaining Denmark's position at the forefront of international policy and programme implementation. There is also a willingness to promote environmental regulations that are in advance of international agreements and protocols.

Significantly, this consensus also underpins investor confidence, which is grounded in the knowledge that governments are committed to a long term legislative and green policy trajectory. This legislative certainty has boosted business' confidence, which in turn has translated into significant investment outcomes. For example, in a survey of 57 leading Danish companies working in the green technology sector, three in four companies indicated that they have developed new technologies, products and services in response to Denmark's environmental legislation (Innovationsnetværket for Miljøteknologi 2012). This has resulted in some of these Danish companies experiencing first mover advantages in the green industries of the future, and in the process attracting foreign direct investment into Denmark.

Therefore, in Denmark it is found a self-reinforcing two pronged strategy: one addresses the issues of climate change; while the second focuses on business development and investment attraction. In this respect, policy is framed around a combination of push and pull incentives. For instance, tariffs could be raised on climate-unfriendly energy sources (push). In turn, this could be combined with subsidies that favour consumers who use more environmentally friendly products or subsidies for innovation in climate solutions (pull). However, this policy framework does not focus exclusively on development of specific types of green jobs. Rather, it aims to move society in a more climate and environmentally friendly direction while at the same time creating demand for new clean-tech solutions.

Denmark's approach can be witnessed in the new government's policy platform, which sets out a national climate change policy with ambitious new targets regarding CO_2 emission and use of renewable energy (The Danish Government 2011). In many respects, the centrepiece of the government's platform is green growth supported by a broad coalition of parties in the parliament (The Danish Ministry of Climate, Energy and Building 2012). The Danish government's headline targets for 2020 include:

- More than 35% renewable energy in final energy consumption;
- Approximately 50% of electricity consumption to be supplied by wind power;
- 76% reduction in gross energy consumption in relation to 2010 usage;
- 34% reduction in greenhouse gas emissions in relation to 1990 levels.

Specific initiatives in the government's climate change plan include:

- A more energy efficient Denmark;
- Increasing energy generated through wind power;
- Developing next generation new energy technologies;
- Dramatically expanding the use of renewable energy in industry, buildings and transport;
- Increasing bioenergy in Danish energy supply; and
- Rolling out smart grids across Denmark

(The Danish Ministry of Climate, Energy and Building 2012b).

The Danish government estimates that by 2020 these initiatives will lead to new investments in energy and energy efficiency totalling some 12 billion to 20 billion Euros. This investment will in turn lead to the creation of around 700 jobs in 2012 and a further 4,000 job in 2013. From 2014 to 2020, the government estimates an additional 6,000 to 8,000 jobs will be added to the green growth sector (The Danish Ministry of Climate, Energy and Building 2012b).

Complementing these national initiatives are the climate change policies and local initiatives being developed by the City of Copenhagen. As outlined earlier in this report, the City of Copenhagen is launching a new climate plan. The primary focus of this plan is to achieve the ambitious goal of becoming the first carbon neutral capital in the world by 2025.

On its journey to becoming the first carbon neutral capital in the world, the City of Copenhagen forecasts that new investments generated from this transition could create between 28,500 and 35,000 new jobs (City of Copenhagen 2012), although these additional jobs are unlikely to be net positive in total.

The Capital Region of Denmark is supporting these initiatives by launching a climate strategy that extends these benefits to the broader region (The Capital Region of Denmark 2012). Its strategy and accompanying governance architecture (as discussed in Chapter Two) focus more on encouraging different actors (municipalities, businesses, knowledge institutions and the like) to co-operate more effectively in order to meet the challenges of climate change. While specific investment and job creation scenarios have not been modelled in this plan, the Capital Region of Denmark does outline a number of case studies that point to the employment benefits arising from its climate strategy.

Copenhagen Cleantech Cluster: Dynamics of green growth job creation

The green growth activities and programmes undertaken by the Copenhagen Cleantech Cluster are viewed by both the Capital Region of Denmark and the City of Copenhagen as an important and integrated part of their efforts to enhance environmental outcomes as well as create growth and new jobs.

The CCC estimates that the approximately 600 clean-tech companies in the Region Zealand and the Capital Region of Denmark employ some 78,000 people (Copenhagen Cleantech Cluster 2012). However, it should not be overlooked that many of these companies operate across several markets at any one time. Hence, not all employees that work in these companies work exclusively on clean-tech activities. In this regard, CCC's (2012) research suggests that the total number of people employed in companies undertaking clean-tech activities is around 34,000. Of these people, some 31,000 are employed in the Capital Region. An accompanying report prepared by DAMVAD estimates that the number of people employed in the Greater Copenhagen area is around 25,000 people (DAMVAD 2011).

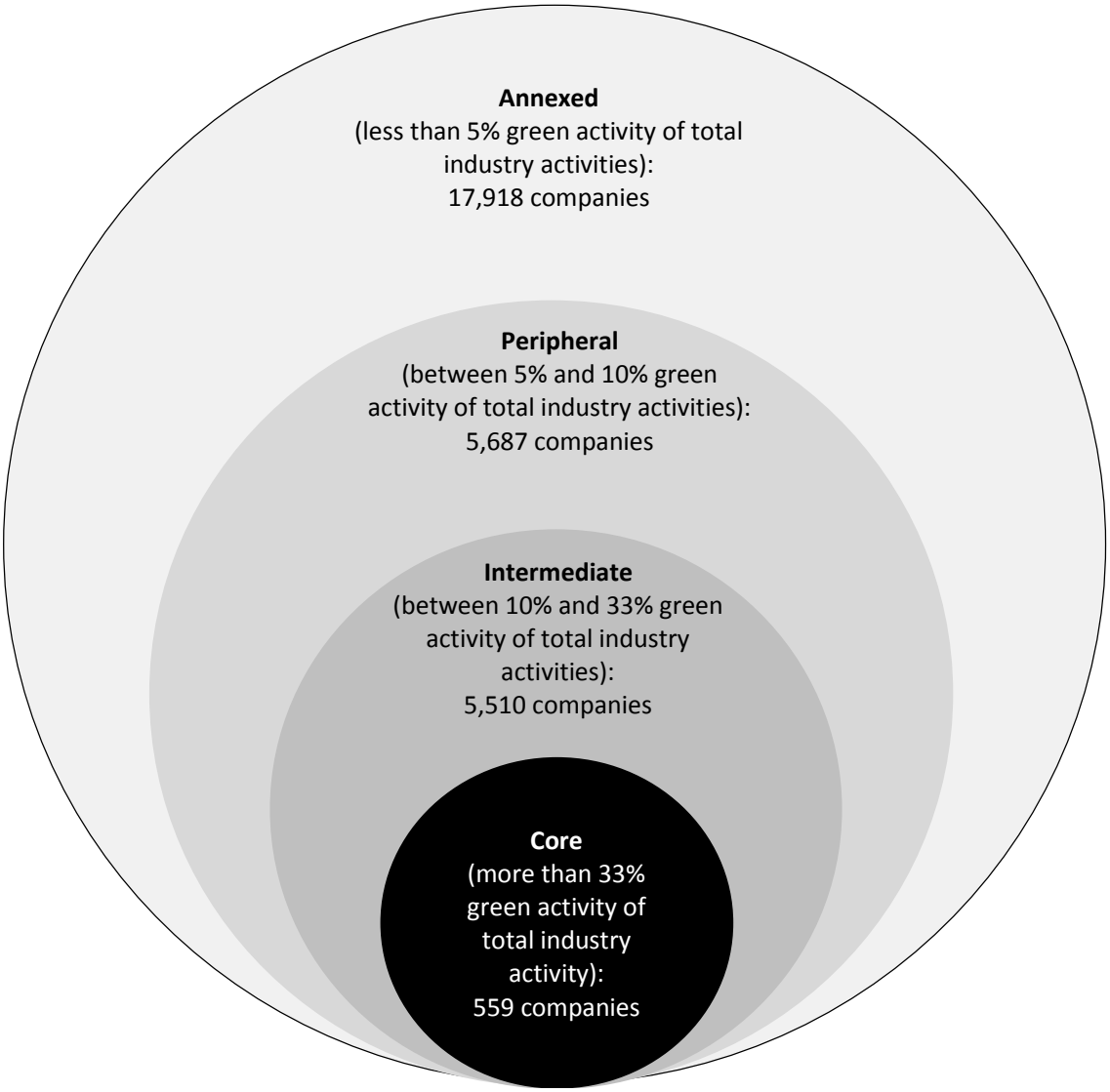
As outlined in Chapter Three, 44% of these clean-tech related companies experienced employment growth in 2010, and only 9% experienced a decline. This growth reflects the new technology trajectories described earlier in the chapter, which can be seen reflected in Greater Copenhagen, where green growth is driving new business and investment opportunities and, in the process, generating demand for both new jobs and different types of jobs.

The intersection of clean-tech companies with those that are either the Cluster's suppliers or customers can be seen in the clean-tech cluster map illustrated in Figure 3.3 in Chapter Three. The key point to note in this diagram is that green growth is not only being experienced by clean-tech companies, but also by those companies that constitute part of their broader market and innovative milieu. DAMVAD goes on to measure the broader contribution such companies make to green growth. They break up these companies into the following green growth categories and groups (DAMVAD 2011):

- The core group of companies belong to industries where it can be seen that more than one third, or 33%, of the industry activities are related to green growth;
- The intermediate group of companies belong to industries where between one third (33%) and one tenth (10%) of the industry's activities are related to green growth;
- The peripheral group of companies belong to industries where it is noted that between one tenth (10%) and one twentieth (5%) of the industry activities are related to green growth;
- The annexed group of companies belong to industries where it was found that less than one twentieth (5%) of the industry activities are related to green growth.

The contribution to green growth by the broader economy is summarised in Figure 4.2. DAMVAD's research shows how vitally important green growth is as a driver of investment and job creation across the wider economy.

Figure 4.2. Number of green growth companies in the Greater Copenhagen Area, 2010



Source: DAMVAD (2011)

From DAMVAD's research we see just how far demand for green growth solutions extends beyond core green activity companies. This is just one of the reasons why the Danish government has focussed on incorporating the green skills agenda into its existing mainstream education and training framework. This enables the tailoring of existing policy to reflect the greening of the economy and, in the process, include companies across the broad spectrum of the economy. The Danish government's strategy is focused around getting the message out to all companies, not just those working exclusively in green growth sectors of the economy.

The impact that green growth demand will have on occupations and skills profiles is summarised in the OECD's *Labour Markets in the Transition to Green Growth: Challenges and Policy*. Using examples from the recycling and waste management, and ICT sectors, as illustrated in the following Table 4.2, the OECD outlines how green growth will generate demand for a new generation of:

- Automotive engineers;
- Freight forwarders;
- Fuel cell engineers;
- Logistics analysts/engineers/managers;
- Supply chain managers; and
- Transportation engineers and planners.

Each of these occupations require medium to high level competencies and usually tertiary or university qualifications. Although students may have enrolled to undertake traditional engineering jobs, it will be found over time that more and more of these workers will find themselves working within green related projects. Some may even end up working wholly on green projects.

A similar trend is emerging for ICT workers. With the new demands that will be created by the smart cities of the future, ICT technicians, electrical engineers and software programmers will no doubt find themselves in the middle of a myriad of transformative green growth projects.

Table 4.1. Skills profile of green/greening occupations: illustrative examples (OECD countries)

Sector	Occupations	Growth prospects	Skill profile
Recycling and waste management	Waste sorting and reception	Long-established	Low qualification (minimal on-the-job training)
	Recycling and waste technician/waste recycling operator	Vocational qualification	Low – medium qualifications depending on country
	Hazardous waste management	Growing demand in medium term due to tighter regulations	Medium and high level
	Sustainable design manager, recycling and reclamation engineer, co-ordinator of recycling activities, regulatory programme compliance officer	Rising longer term demand from other sectors	Medium to high level skills to address organisational sustainability issues and embed sustainability principles into product design and production techniques
	Railroad conductors, locomotive engineers, truck and bus drivers	Greening existing occupations	Topping up existing skills
	Automotive engineers, freight forwarders, fuel cell engineers, logistics analysts/ engineers/ managers, supply chain managers, transportation engineers and planners	Reorganisation and re-engineering of existing (and new) transportation systems	Medium and high level skills combined with sector specific pre-existing medium-high competencies
ICT	Smart grid and building specialists, database administrators	"Smart" ICT applications and changes in business model for billing and customer relations	Medium to high

Source: OECD (2011b)

Summary

This chapter has outlined how the sixth wave of innovation can continue to transform the economy as we now know it and how Denmark's response to these changes has been unique in global terms. Denmark has both reacted to the changes by rising to the sustainability challenge, and at the same time charted its own course as that of a leader in climate change.

Perhaps paradoxically, rather than conclude that the absence of a separate strategy for green jobs and skills is an indicator that Denmark is lagging behind, it should be seen as a strength. With its long term focus and commitment to environmental and climate issues, Denmark has integrated this focus into the mainstream educational and vocational system, thereby setting the foundations for green skills development at different levels of education. By educating future craftsmen, engineers or researchers, most of Denmark's educational institutions are providing education that will in turn support the nation's green transition.

Similarly, the Danish Ministry of Employment does not have a specific policy framework for an economy-wide programme with which to develop the green jobs market. Rather, its focus is on ensuring an efficient and well functioning labour market, which in turn enables companies to move unencumbered into new markets, including the green economy. Together with regulation, policy, and a political consensus of commitment to tackle environmental and climate issues, can provide the environment in which green jobs and companies can flourish.

A specific plan for greening jobs and skills, however, can accelerate the transition to low-carbon economic activities by focusing on planning skills development for all companies.

CHAPTER 5

GREATER COPENHAGEN'S DASHBOARD FOR A TRANSITION TO A LOW-CARBON ECONOMY

We are only at the initial stages of understanding green growth transitions at the international, national and local levels. One of the tools that will be invaluable in understanding this transition is indicators. Indicators are vitally important for measuring progress, providing comparisons and understanding what is working well and what is lagging. Indicator development, particularly in the formative stages, also has a dual role involving measuring past performance (looking backwards) and guiding future directions. At these types indicators can cause tensions, as past performance will not always reflect the sentiment of current activity. With this limitation in mind, this chapter provides a local indicator framework and an assessment for Copenhagen City.

At the OECD Ministerial Council meeting in June 2009, Ministers acknowledged that green and growth can go hand-in-hand, and they therefore asked the OECD to develop a green growth strategy. As a part of this strategy, a monitoring framework was established to track how nations are progressing on their low carbon transition.

This framework was developed based on the understanding that the measurement variables of economic growth and development that have been used in the past would no longer be adequate to describe or understand the transition of green growth. The framework allows progress towards green growth to be measured using internationally comparable data, embedded in a conceptual framework that is able to be communicated to a wide audience of policy makers and the public at large (OECD 2011b).

These indicators represent a starting point in understanding green growth at the national level, and they will be further elaborated as new data becomes available and concepts evolve. It is important to recognise that no single indicator will be effective in capturing progress towards green growth, and not all the indicators presented are measurable today. The OECD framework contains 25 separate indicators, arranged into five themes. An outline of the indicator framework is shown in Table 5.1. The five themes covered include: the environment and resource productivity of the economy; the natural asset base; the environmental dimensions of quality of life; economic opportunities and policy responses; and context indicators covering the socio-economic characteristics of growth.

Table 5.1. OECD Indicator groups and themes

Indicator groups	Topics covered
1. The environmental and resource productivity of the economy	• Carbon and energy productivity • Resource productivity: materials, nutrients, water • Multi-factor productivity
2. The natural asset base	• Renewable stocks: water, forests, fish, resources • Non-renewable stocks: mineral resources • Biodiversity and ecosystems
3. The environmental dimensions of quality of life	• Environmental health and risks • Environmental services and amenities
4. Economic opportunities and policy responses	• Technology and innovation • Environmental goods and services • International financial flows • Prices and transfers • Skills and training • Regulations and management approaches
5. Socio-economic context and characteristics of growth	• Economic growth and structure • Productivity and trade • Labour markets, education and income • Socio-demographic patterns

In creating this indicator framework, the OECD made a conscious effort to be pragmatic, acknowledging that this is an emerging area, and that analysis of green growth will be imperfect until this indicator framework and the data sources upon which it relies mature. However, it is important to attempt to identify and test which areas will work, and to investigate what data is available with which to assess the current situation.

Copenhagen and the Green Growth Indicator framework

The previous chapters have outlined the progress of Copenhagen towards lowering their carbon emissions and also developing the economic opportunities that are arising from resource efficiency. Throughout this report, significant evidence has demonstrated the impact of the green growth ambitions of the city, and the effect that a small geographical area, can have on the emissions profile, labour market and innovation dynamics in that city. In the case of Copenhagen, these impacts are also felt across the whole nation of Denmark.

The progress of Copenhagen is clear, but the question remains how do we consider Copenhagen's activities in comparison with our metropolitan cities? What are the lessons that other local areas can learn from Copenhagen, and what are the critical markers or transition and how effective has policy responses been in encouraging this transition? To make this assessment required indicators with suitable variables at the local level.

A first step in identifying locally suitable indicators is to test how useable the framework developed at the national level is to describe activities at the local level. Does the framework increasing understanding of the transition at the local level, and if so in what areas? And if not, what

are the important missing elements and how might we start to fill the gaps, whether with proxies or suggestions for further data collection in the future?

Differences between national and local indicator frameworks

Three factors summarise the differences in context between the national and local situations for green growth. These factors need to be considered in designing the local indicators.

First, each area will have a different baseline. Green growth indicators must begin from a baseline. If we are to accurately assess green growth then this baseline will need to incorporate what is already present in an area. Every area has an array of existing production structures (its production function), including the labour force and capital stock (machinery, built environment etc) and well as stocks of renewable and non-renewable natural resources. These existing activities and assets will shape the trajectory of the local area's pathway to a low carbon future.

In the introduction to this report, the OECD definition of green growth was outlined. This definition acknowledges that green growth has several dimensions, and the opportunities for growth will occur through varying sources including:

- New opportunities emerging from new markets and activities;
- Net growth emerging from greening activities across the entire economy;
- Growth that takes into account the environmental impacts and externalities of our current production and consumption activities.
- Local indicators of green growth will differ from the national level in three areas:
  - Composition of stocks at a defined level of geography;
  - Available policy levers and jurisdictions;
  - Data availability.

Local trajectories will be unique for each area because of the different compositions of stocks and activities. However, at the national level, the aggregation of these activities masks some of the winners and losers of the transition to greener growth. This makes understanding and communicating local pathways to a low carbon economy a different, but no less important, task than at the national level.

Second, the policy responses available to local policy makers to direct the transition pathway are more curtailed than at the national level, for example, most local authorities do not have significant taxation revenue raising powers. However, policy makers at the local level have the ability to interact closely with their citizens, and can influence policy that has a direct impact on the daily way of life, for example through waste, recycling, and active and public transport options. Therefore, the same set of economic opportunities and available policy responses that exist at the national indicator level will not be suitable at the local level.

Finally, data on all the measurement variables are not available at the local level. This is where proxies and other future data collection exercises will need to fill important gaps.

Method for identifying local indicators

The method of designing a local indicator set for local green growth transition was a two-step process. The first step was to make an assessment of the relevance of the national OECD Green Growth Indicator framework and the relevance of the individual variables in describing Copenhagen's transition to a low carbon economy. This assessment was completed in collaboration with local Copenhagen research partners and was informed by the before mention three constraints on local trajectories, namely

- Different baselines of productive and knowledge activities and stocks of renewable and non-renewable assets;
- The policy reach of the local area and;
- The availability of data.

Table 5.1 shows an assessment of the variables within the OECD Green Growth Indicator framework by relevance to Copenhagen's transition to a low carbon economy. Each variable is rated Low, Medium or High in terms of its ability to contribute to the green growth assessment at the local level.

Table 5.2. Copenhagen's green growth indicators & the local transition

Environmental and resource productivity	Measurement variables	Relevance to local transition
	Co2 productivity	**H**
	Energy productivity	**H**
	Material productivity (non-energy)	L
	Water productivity	**H**
	Multi-factor productivity	M
Natural asset base		
Renewable stock	Freshwater resources	L
	Forest resources	L
	Fish resources	L
Non-renewable stocks	Mineral resources	L
Biodiversity and ecosystems	Land resources - land use state and changes	**H**
	Soil resources - agricultural land affected by soil erosion	L
	Wildlife resources - endangered species	M
Environmental quality of life		
Environmental health	Environmentally induced health problems - exposure to air pollution	M
and risks	Exposure to natural or industrial related losses	M
	Connection to sewage treatment	**H**
	Connection to safe drinking water	**H**
Economic opportunities and policy responses		
Innovation	Renewable energy R&D	**H**
	Environmental technologies R&D	**H**
	All purpose R&D	**H**
Patents important to GG	Environmentally related patents	**H**
	All patents	M
Environmental goods	Gross value add of EGS	M
and services	Employment in EGS	M
International financial flows	Official development assistance	L
The socio-economic context and characteristics of growth		
Economic growth, productivity and competitiveness	GDP growth	M
	Net disposable income	M
	Labour productivity	M
	Trade weighted unit labour costs	M
Labour markets, education and income	Labour force participation	M
	Unemployment rates	**H**
	Population growth	**H**
	Life expectancy	M
	Income inequality	M
	Educational attainment	**H**

1. High (H), Medium (M), Low (L)

The highly rated variables are in labour market characteristics and dynamics (unemployment rates, educational attainment, labour force training and skills development), resource productivity (energy, water and carbon productivity) and the knowledge intensity of the city, which is linked to its ability to embrace green economy opportunities (innovation and patenting activity, size and growth of the environmental goods and services industry). The effectiveness of policy responses in encouraging these green economy opportunities and ensuring the net economic benefit is captured for Copenhagen is also seen as an important measurement variable.

The lower rated variables are not considered of lower importance in green growth, but of lower relevance to understanding green growth at the local level, due to the three reasons mentioned earlier (composition of stocks, availability of policy levers, and data availability). For example, indicators for natural assets resources such as forests and fisheries are not applicable to most regions as they do not have these resources (particularly urban ones), regions either do not have the capacity to effectively measure resources within their jurisdiction, or do not have the ability through their policy remit to influence how these natural stocks are used or depleted.

This assessment was then use to inform the second phase of the development of the local indicator set: selecting suitable local variables. Workshops with Copenhagen stakeholders determined that there were three specific areas of the green growth indicator framework which were especially meaningful for understanding local components of green transition:

- Resource efficiency, but extended to include waste efficiency and the level of recycling within the local area;
- Knowledge intensity and green economy opportunities; and
- Policy responses to support green growth.

Three of the five headline themes of the OECD national framework were kept in the local indicators set. The headline theme of environmental and resource productivity remains in the local framework, although the variables are modified to per capita rather than productivity based measures to align with the availability of local data sources. The natural asset base and environmental quality of life measures whilst seen as very relevant for the national level; at the local level presented data collection (particularly in being able to collect meaningful local data) and policy jurisdiction issues (limited local policy reach in these areas).

The economic opportunities and policy responses themes was considered the most relevant for understanding the local situation and was expanded to include economic opportunity measures, policy responses but also skills and training measures. The socio-economic context indicators also remain, as import indicators of the local context for interpreting the previous variables. These were modified to take advantage of likely local data sources. The five theme areas of the local indicator framework are each explained in further detail below.

1. *Environmental and resource productivity:* This captures the headline resources' productivity figures for the local area.
2. *Economic opportunities:* This examines the capacity of the local areas to act on the low carbon opportunities. It includes measures of research and knowledge intensity, students and learning, and the value and number of jobs associated with the green economy.
3. *Skills and training ecosystems:* Skills and training systems can be very path dependent and will require significant momentum and time to change. This item captures the progress of green skills development in the local areas and the patterns of change in the skills and training ecosystems that will manage this progress.

4. *The socio-economic context:* This describes the social and industrial characteristics of the area under investigation. As noted earlier, local trajectories towards a low carbon economy will be strongly shaped by the existing industrial and human capital, therefore, it is important to show indicators within this context.

5. *Policy responses:* Each local jurisdiction has different policy levers available to them, but additionally, each jurisdiction has a different pattern of policy action and learning. Green policy is a new area of knowledge and policy development for many local and regional governments; they need to build not only political consensus for action, but also internal capability and capacity of policy design, implementation and evaluation. Theme 4 captures the progress of local policy actors in green policy making.

Specific variables and data for the first four themes were identified and developed from existing data sources. Data collection for the fifth theme – policy responses was collected through a survey of stakeholders,

Considerations used to shape this framework included data availability, current and proposed policy activity, cross-border implications and an assessment of the literature on green jobs and skills for data collection methods and options.

In many cases the variables were the same measurement variables used in other forms of regional development (productivity, employment, business start-up and survival), innovation (R&D spend, R&D employees, patents) and resource efficiency (energy, water and waste per capita). Data collection for these variables was easier because the concepts were established and data collection against these variables was already happening, if not at the specific local level then at the regional or national level.

Similar issues also exist when analysing the skills dimensions of the green growth transition. It is clear that such a major change in industrial processes and activities will also have a resulting impact on the knowledge and skills that employees require – but currently we do not yet have a metrics and data available that can characterise the evolution of so-called 'green' skills.

Where indicators and data sources were more difficult to identify and collect were in areas where the indicators are not well-established and/ or already being collected. This included areas such as eco-innovation, green jobs and investment and green knowledge and skills. Some data sources existed for climate change mitigation related technology patents and turnover and employment associated with environmental goods and services (DAMVAD 2011, EIO 2011).

One noticeable gap in the emerging variables for economic opportunities of the low carbon economy is an indicator of the prevalence of green tech and/ or resource efficiency knowledge and skills within the labour force. A measure of students (in both university and vocational training) studying environmental-related subjects is proposed as an initial proxy for measure green skills. Measuring the number of student studying these subjects year on year will allow a picture of the skills capacity in this area within the labour force to be built up over time. Further measurement variables will be required to gain a more sophisticated understanding of the greening of skills and occupation, but the identification of this variable was seen as a first step.

A collaborative process between the five case study areas participating in the OECD LEED Local Indicators for a Low Carbon Economy project agreed on the final variables for the local indicator set, bearing in mind that the variables had to be suitable to a range of local areas across OECD member countries.

Table 5.3 shows the data collection for Copenhagen against the local indicators set. Comparisons are then made with corresponding OECD, EU or national averages depending on data availability.

Table 5.3. Data table for Copenhagen dashboard

Socio-economic context	Copenhagen data	Unit	Source
Entrepreneurship rate	130 new firms in 2011	Firms	http://www.ebst.dk/publikationer/ivaerksaettere/ivaerksaetterindex_2011/978-87-92518-69-9.pdf
Firm survival rate	72.30% in 2011	%	http://www.ebst.dk/publikationer/ivaerksaettere/ivaerksaetterindex_2011/978-87-92518-69-9.pdf
Employment creation	68,000 less out of 958,235 workforce in second quarter 2011	Persons in capital region	Statistics Denmark http://www.regionh.dk/NR/rdonlyres/E7C13EC2-D8C7-4CE8-8AA4-E8D46A0A066B/0/Erhvervsanalyse_2011.pdf
Productivity	DKK 375000 (2010), 355000 (2009)	DKK/per capita	Statistics Denmark
Educational attainment	49% (2011)	Persons aged 25-34	Regional Konkurrenceevneredegørelse 2011. Erhvervs- og byggestyrelsen.
Income per worker	DKK 309.296 per year (2010)	DKK/ employee	http://www.statistikbanken.dk/statbank5a/default.asp?w=1525

Environmental and resource productivity	Copenhagen data	Unit	Source	Comparison	Source
Per capita emissions	4.7	tonnes/per capita Copenhagen City (2011)	CCC Climate Change Plan (2011) http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2012/07/Section-1-Local-contribution-to-climate-change_Copenhagen.pdf	Compared to OECD average 10.36137828 tonnes , 6.11 tonnes for Denmark (Measurement year for both 2008)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Energy consumption	0,4828 PJ per 1 Billion DKK	DDKoutput/PJ National level (2010)	Data on gross energy consumption (846 PJ in 2010) seems only available on national level. Danish GDP in 2010: 1754648 M DKK	Compared with OECD average $6(US) (Measurement year for both 2008)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Water consumption	41.3	kL/per capita/year Copenhagen City (2010)	Approx. 108L per day per capita – Source: DAMVAD based on data from Copenhagen Energy and Statistics Denmark. Calculated an annual figure in KL for comparison.	Danish average 130kL (2010) Compared with OECD average 870kL/annum (2009)	Danish average - Source: DAMVAD based on data from Copenhagen Energy and Statistics Denmark. OECD average: OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Municipal waste collection	403	kg/per capita Copenhagen City (2010)	Calculated per capita Veksebo (2010) from http://www.plastic-zero.com/media/20281/action_1-2_copenhagen_final.pdf	Compared with OECD 540kg/per capital (2009) and 830kg/capita Denmark (2009)	Denmark source Eurostat http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Municipal_waste_generated_by_country_in_1995,_2002_and_2009,_sorted_by_2009_level_(kg_per_capita).PNG&filetimestamp=20110708152012 OECD average Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Recycling per capita	23.61%	% Municipal waste recycled Copenhagen City (2008)	European Green City Index (2008)	Denmark 23% municipal waste recycled (2009) EU 40% of municipal waste recycled (2009)	Source: Eurostat 2009 http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-19032010-AP/EN/8-19032010-AP-EN.PDF
Treatment of contaminated land	1	Binary 1= yes, 0=no	http://www.regionh.dk/menu/Miljoe/Jordforurening/Offentligindsatsi2012/	1	Binary 1= yes, 0=no

Economic opportunities		Unit	Source	Comparison	Source
R&D employment	24.10526316	Per 1000 employees Greater Copenhagen region (2011)	http://www.regionh.dk/NR/rdonlyres/E7C13EC2-D8C7-4CE8-8AA4-E8D46A0A066B/0/Erhvervsanalyse_2011.pdf	Compared with 6.3 EU27 average (2010) and Denmark 12.3 (2010)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - ©OECD 2011
Educational Attainment of the workforce (All post secondary school education)	44.3	% of work force	Statistics Denmark 2011	43.63% (Denmark, 2011) 31% (OECD Average – derived from 35 of 41 member countries 2011)	Source: Denmark figures - http://www.dst.dk/en/Statistik/emner.aspx OECD figures - Education at a Glance 2012: OECD Indicators
Students in environmental subjects		% of work force National level, (2008)	No local data sources – National figures use	0.006% Denmark (2008)	http://www.kemin.dk/da-DK/KlimaogEnergipolitik/danmark/uddannelseforskningudviklingogdemonstration/grønne-uddannelser-og-arbejdsmarkeder/Sider/Forside.aspx plus author calculations
All purpose R&D	4%	regional GDP Greater Copenhagen region (2010)	http://www.ebst.dk/publikationer/RU/regional_konkurrenceevneredegoerelse_2010/kap05.htm	Compared with 2.33 OECD average (2010), 3.03 Denmark (2010)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Triadic patent applications for climate change mitigation technologies	0.000680042	per million Greater Copenhagen Region (2010)	OECD Regions at a Glance 2011	Compared with OECD 0.000992 (2010)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
All patents	Used national level	per mill population, National level (2009)	Used national level	Compared with OECD average 37.3, Denmark 50.56 (2009)	OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011
Turnover of EGS industries	50,992	DKK million Copenhagen City (2009)	DAMVAD (2011) Green Growth in Copenhagen	153,745 (million DKK) Denmark (2009)	DAMVAD (2011) Green Growth in Copenhagen
Employment in EGS	24,674	persons Copenhagen City (2009)	DAMVAD (2011) Green Growth in Copenhagen	76,076 (employees) Denmark (2009)	DAMVAD (2011) Green Growth in Copenhagen
Foreign Direct Investment	1	Binary 1= yes, 0=no	Copenhagen Capacity, internal data 2012	1	Binary 1= yes, 0=no

Dashboard for data visualisation

To analyse this data presented in the indicator framework, and to provide a point of comparison across the four case study regions within the whole project, a 'dashboard' data visualisation tool is developed. The dashboard takes the indicators one step further and helps the information to be summarised and communicated. The dashboard tool has been used in numerous global indicator programmes, including the UN Commission for Sustainable Development and the Sustainable Development Index (SDI) in the USA. Out of the 23 indicators developed by the OECD monitoring framework, the local indicators framework focuses on 14 indicators (six for environment and resource productivity and eight on economic opportunities).

At this stage a dashboard has only been created for environmental and resource productivity and green economic opportunities as these will be the main points of comparisons across the five case studies. After initial feedback on the dashboard tool with stakeholders and policy makers, the tool may also be extended to cover the socio-economic context and policy response. These themes will require further though as to how they can ranked using the dashboard tool, particularly in areas where an OECD average is lacking.

In the interim, the socio-economic variables are just reported in the tables of Figure 5.2 and to further assess the progress of policy responses for low carbon economy support and green skills and training a small survey of local stakeholders (representing government, business, trade unions, higher education institutions etc.) was completed. For Copenhagen, these data were validated in a workshop held in the city in October 2011.

The dashboard shows that Copenhagen has already made considerable progress towards a low carbon future. For the majority of data variables where data is available, the dashboard shows that Copenhagen is ahead of both national (Danish) and OECD averages. In some important areas relating to green growth employment and value of turnover there are still not consistent data sources available that will provide an assessment at the local level in comparison with national and international levels. It is hoped that these data sources will emerge over the coming years.

The results of the exercise for Copenhagen can be summarised as follows:

Environmental and resource productivity: Copenhagen performs at least as well as the OECD average with respect to the following measures: per capita emissions, energy consumption, water consumption, regional waste collection, per capita recycling, and treatment of contaminated land.

Economic opportunities: Copenhagen performs better than the OECD average on R&D expenditure and employment, green patents, employment in environmental goods and services, and turnover of environmental goods and services business.

Policy responses: Show that Copenhagen can progress further. Local government policies and municipal strategies have a higher degree of 'greening' than policies for universities, job creation initiatives, support schemes for social assistance, including for the elderly population.

Green skills ecosystem: Copenhagen's green skills ecosystem can be further developed by reinforcing links of industry and research and universities, fostering green vocational education and training, and co-operating further with the private sector and trade unions to boost green skills development and training.

The difficulty in measuring the value and size of the environmental goods and services market is not just restricted to local levels; in fact, similar data gaps exist at the national level as well (OECD 2011b). The problem is partly one of definition (i.e. how are green industries defined) and secondly one of determination - how is the 'green' element isolated from the wider impact of greening and increased focus on resource

efficiency that is happening across the entire economy? It is in these areas that we are really at the frontier of defining and measuring green industrial activity.

As noted the local policy assessment and skills ecosystem were derived from a short questionnaire submitted to local policy and training stakeholders. These stakeholders were asked to assess the progress of various policy and skills development mechanisms in encouraging local transitions to a low carbon economy.

The bars in the charts for each of the index represent the average answers on a five-point scale. These results are subjective, but together with the other elements of the indicator framework can offer a richer picture of the current status of local transitions. If these questionnaires are conducted at frequent intervals, progress in transition will also be evident.

As the Dashboard shows, Copenhagen is progressing well on the green transition. The green growth indicators working at the global level will need to balance the tensions of using a framework that all local areas can adopt, whilst still offering the chance for the leading cities to measure their ongoing progress in a meaningful way.

However, when we look to the policy and training indexes, we can see that while Copenhagen is perceived to be progressing well, there is still room for improvement. These results come from stakeholders who are deeply involved in the city, and it is probably true to say that it is critical reflections from inside the green policy and skills community in Copenhagen that will drive future progress, rather than external forces.

Figure 5.1. Copenhagen dashboard

Figure 5.2. Local policy assessment for green growth, n=11

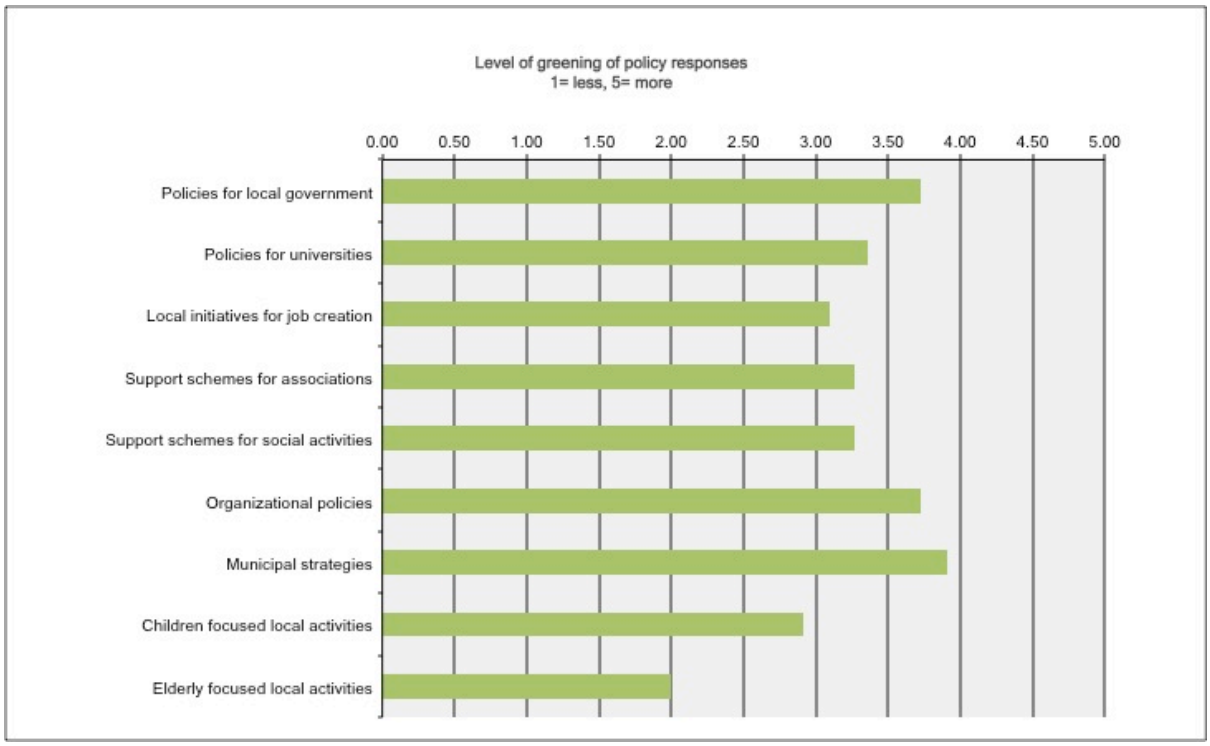
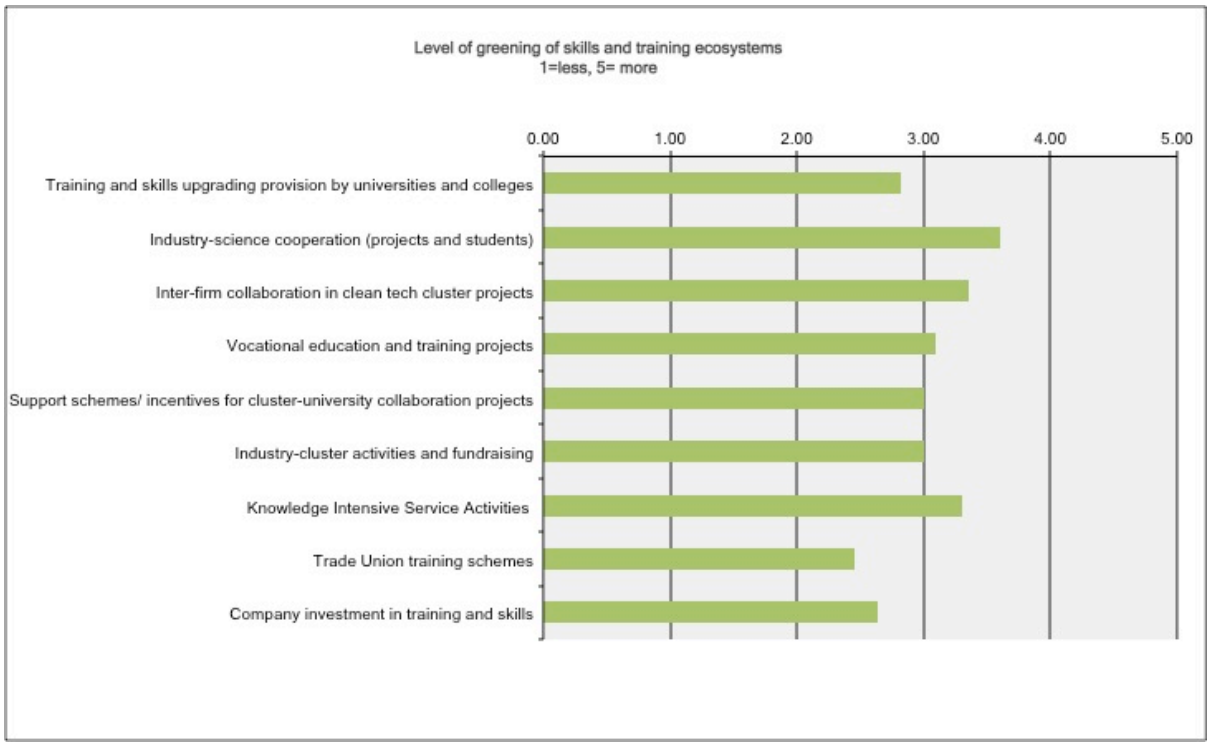


Figure 5.3. Local skills ecosystem assessment for green growth, n=11



CHAPTER 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

Copenhagen began its transition to a low carbon economy many years ago, long before the current international focus on green growth. Copenhagen was not the first Danish city to adopt these green growth practices, but the progress made to date puts Copenhagen ahead of many cities around the globe in terms of green growth. The greening of Copenhagen rests on a long Danish tradition of advanced urban planning, as well as an early mover advantage within renewable and efficient energy technologies. It is therefore appropriate that Copenhagen is the first case study in the *Indicators of local transition to a low carbon economy project* because, as this report has demonstrated, Copenhagen has many lessons to offer other cities and local areas seeking to begin or expand their low carbon transition.

Copenhagen's progress to date also benefits from a series of favourable conditions, including: the rich institutional, cultural and resource capacities of the city; the installation of the district heating system; the drive for energy security through renewable energy (particularly the wind industry); and the tradition of collaboration and consensus building within the political system. This environment has delivered Copenhagen and its clean-tech firms significant first mover advantages in green industries and technologies, and acted as a magnet for attracting investment in the country.

This, however, does not mean that Copenhagen's transition to a low carbon economy is complete. Although the Cleantech Cluster is well established within Copenhagen, further resources and investment will be needed to ensure that the social and economic benefits are maximised. The clean-tech industry is now the focus of intense global competition, with many other cities able to invest significantly more than the resources available to Copenhagen, strategic investments will be essential.

As the Cleantech Cluster approaches maturity, attention should turn to evaluating the depth of cluster links and infrastructure, and ensuring that new knowledge, people and firms are brought into the cluster. This will avoid knowledge stagnation and lock-in, where clusters become inward rather than outward looking, and static rather than dynamic.

The following recommendations are proposed for: (1) fostering green innovation and the continuing competitiveness of the clean-tech industry; and, (2) financing innovation and facilitating knowledge-intensive green activities.

1. Invest in capacity for greening jobs, skills and entrepreneurship

A transition to a low-carbon economy will not be possible without accompanying labour market measures for workforce skill upgrading. At the same time, and as labour markets are ageing and shrinking, those that are not able to develop 21st century skills are at a higher risk of being left behind and not able to benefit from the new opportunities that green growth offers.

While there are several pathways to adjust the workforce to low-carbon economic activities, Copenhagen can take advantage of the existing clean-tech companies to strengthen research co-operation with universities and/or increase their involvement with the cluster's activities.

At the same time that formal university-business collaborations are established, other forms of green skills development can be facilitated through informal knowledge intensive activities. Universities, training institutions, trade unions and business organisations can introduce specific instruments related to green entrepreneurship, encouraging new entrepreneurs to interact with the clean-tech companies through dedicated networking events as a way to stimulate innovation and new business alliances.

Local institutions can help with this impetus towards developing green skills by focusing on environmental policies and procedures in order to keep local demand for green development ahead of the international curve. Green public procurement, for example, can be a significant instrument for the local Small and Medium Sized Enterprises (SMEs) providing products and services, influencing the knowledge and skills of their employees to compete for public contracting.

2. Accelerate the transfer and diffusion of new knowledge and technology

Knowledge diffusion is as critical a process as knowledge development. In order for Copenhagen to maximise the impact of its clean technology, leadership diffusion around innovation needs to be as important an outcome as development of technology.

Developing a technology and knowledge transfer and diffusion strategy in partnership with other Danish agencies and knowledge institutions that build on Business to Business (B2B) connections and investment opportunities arising from the Copenhagen Cleantech Cluster will accelerate diffusion.

A further focus on strengthening the capacity of local SMEs to participate in the cluster, for example through their participation in projects with larger Danish and overseas multinational companies and knowledge institutions, will expand cluster membership, but also enhance the clean-tech capacity of the SMEs. Projects that enable SMEs to access or procure IP or production licences and the like (commercially or through partnership arrangements), can contribute to building SMEs' green credentials in the market–place, but also increase the dynamism (and therefore longevity) of the cluster.

3. Foster 'disruptive' innovation

The Copenhagen Cleantech Cluster could be described as a mature cluster, with specialised institutions and knowledge service providers in place. Copenhagen can take advantage of the mature development stage of the region in green technology and practice to develop more radical green innovations. Copenhagen has unique opportunities to experiment with advanced green solutions within smart modes of organising production, and consumption and technical infrastructures in a liveable city.

These novel solutions should be visibly demonstrated and highlighted in the city, contributing to the development of further green Copenhagen symbols, such as the well-established bicycle use, and the more novel harbour swimming basins. Such initiatives may attract the interest of early stage investors and venture capitals to seed new green technologies of the future. Such new projects will reinforce Copenhagen's brand and international standing as a laboratory for new green products and services, and a test-bed for disruptive innovation as it displaces conventional production and distribution means grounded in 20th Century economic and technology paradigms. Such an initiative will also strengthen the interest of financial markets in CCC's companies and the projects in which they are participating.

4. Enhance financing of innovation and attracting foreign direct investment

Denmark and its companies' R&D and investment opportunities require sound, forward looking financial institutions in order to activate future investment opportunities, including the country's long term ability to attract foreign direct investment (FDI). Danish energy and clean-tech companies receive significant investment from Denmark and the Nordic region's financial institutions.

To enhance the financing of innovation, Danish financial institutions can provide further technical support to the CCC, with wider participation in the cluster meetings and by assisting new and smaller companies with their innovations. Danish energy and clean-tech companies receive significant investment from Denmark's and the Nordic region's financial institutions. For example, the Nordic Investment Bank (NIB) can underwrite the development of catalyst technologies for energy efficient processes used for removing harmful emissions, production of clean fuels and power generation.

NIB has also developed a wide portfolio of loan programmes to support clean-tech and renewable energy projects from Denmark to Poland and the Black Sea Region. Such financial sector initiatives already directly support Danish companies to fast track state-of-the-art clean-tech solutions in vital European and Russian export markets that in turn springboard into accompanying export markets globally.

To attract more FDI, local institutions, and particularly Copenhagen's Investment Agency, should further strengthen the networking infrastructure developed for the Cleantech Cluster by providing specialised, knowledge intensive services that reach both mature innovative firms and the start-ups entering the market. The knowledge intensive activities that CCC facilitates can act as an 'innovation milieu' for firms searching to co-locate to be within the proximity of new knowledge generation.

5. Strengthen cross-sector linkages to connect global and local firms

Place and community space are important for connecting and mobilising activities between core clean-tech companies and other industries and services such as engineering and smart integration manufacturing companies, finance and marketing, and scientific companies. Generating and reinforcing such connections will allow clean-tech firms to maximise the competitive advantages the cluster offers.

Copenhagen City should, through its membership of the C40 group of cities, and the CCC through ICN, fully exploit the opportunities for international collaboration, and support smart city initiatives that bring together Danish and partnering overseas companies in the strong growth and emerging markets.

6. Develop a bottom–up, next generation governance architecture

Build on Copenhagen Cleantech Cluster's success and develop a governance structure that builds investment opportunities for clean-tech companies from the bottom up. This includes the formulation of a responsive and integrated platform that maximises triple helix partnerships between governments, businesses and universities in the delivery of state of the art and investment driven projects.

Copenhagen Cleantech Cluster's next generation architecture would include a dynamic market driven framework and programmes to support companies within the cluster and those suppliers and customers with whom they interact commercially, which may not see themselves as green growth companies, but which are nonetheless an indispensible part of the broader eco/industrial ecology of the Cleantech Cluster.

7. Develop a people driven investment agenda

Copenhagen is a liveable city and is ranked as one of most sustainable cities in the world. Copenhagen's governance architecture has been effective in marshalling the resources and knowledge of the entire

community, and in the process formulating practical pathways to implement integrated green growth projects.

The Capital Region of Denmark, Copenhagen City and the CCC should work more closely together with the business community to forecast future investment plans (including, for example: infrastructure; building and construction; urban development; transport; and in key clusters such as information and communication technology (ICT) and life sciences) to spin off complementary projects that can build a strong, vibrant and sustainable community. The social and economic benefits to the community of maintaining investment in these activities needs to be brought to the fore. The links with ensuring growth of the liveable aspects of Copenhagen need to be underlined so citizens and investors have a common interest in success.

8. Facilitate knowledge-intensive green activities for the Cleantech Cluster

CCC is a key facilitator of knowledge exchange in the clean-tech area. The design of specific knowledge intensive green activities that can function as intellectual services for the firms will maximise the transfer and uptake of new ideas, technology or production processes. These vital points of interaction and collaboration between companies underscore the strength of CCC. The exchange of each piece of information, through an initiative such as a cluster forum (including, for example, companies ranging from software, engineering and satellite navigation, all working across different disciplines to develop new clean-tech solutions), directly adds to the repository of the CCC's knowledge.

Boost the high innovative capacity of CCC and build on the already above-average degree of knowledge co-operation and exchange between companies, as well as between companies and knowledge institutions, through specifically designed green interactive activities.

9. Stimulate education, research and exchange programmes

Copenhagen Capacity has developed the International Cleantech Network (ICN) in partnership with the Colorado Cleantech Cluster in the United States, with the aim of ultimately linking together 15 other clean-tech clusters globally, especially in the emerging markets of Brazil, China and Russia. This gives Danish companies global reach, in a manner that would, for many smaller companies, simply be impossible to achieve on their own. In fact, the ICN also acts as a point of dissemination for Danish green know-how to the rest of the world, while ensuring that CCC is kept abreast of global clean-tech trends, business and investment opportunities. The CCC should strengthen collaboration arrangements through the ICN to expand its research and university exchange programme.

In particular, this would see greater co-operation between businesses, universities and knowledge institutions involved through the ICN, which can support commercialisation, and research and development (R&D) activities of member clusters into target markets and thus reinforces the CCC's commercial footprint in international clean-tech projects.

10. Invest in indicators data collection at the local level while co-ordinating with national agendas

This study has demonstrated the complexities of measuring green growth at the local level. Even if only a few indicators are collected, the benefits for the analysis of the local economy cannot be overestimated. The process of discussing and thinking about what the indicators and the green dashboard mean for Copenhagen introduces a focused dialogue between different stakeholders and actors from policy makers to business people, academics and researchers. It is through such discussions that innovative thinking and solutions can be developed, as well as inspiration for new projects and initiatives for green growth.

The final recommendation for Copenhagen and its local institutions is to continue working with the local indicator framework, developing and refining lists of indicators and data collection methodologies.

Data collection also needs to be accompanied by on-going reporting, and Copenhagen should also resource this reporting, through tools such as the dashboard, or similar.

Local institutions have a significant role to play in implementing national agendas for the transition to a green growth economy. Measuring progress needs to take account of both ends of the 'national-local' pipe, so that efforts can leverage the investments made at both ends of the continuum. It is this dialogue that will bring policy coherence and sustainable trajectories to the communities of Greater Copenhagen.

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ANNEX A

NOTE ON CONTRIBUTORS

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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.

Dr Maj Munch Andersen is Senior Scientist in the Department of Management Engineering, Technical University of Denmark. Maj undertakes research into innovation research at the firm, sector, value chain and national innovation system level from an evolutionary economic perspective. She has been a pioneer within eco-innovation research, writing the first Danish Ph.D. in eco-innovation in 1999, which was also one of the first Ph.D.s in this field in the world. She has been an important contributor to the development of the eco-innovation concept analytically as well as a policy issue. Apart from her scientific work Maj has worked four years with innovation policy within Danish Ministries. Maj developed the first Green Industrial Development Strategy for the Danish Ministry of Trade and Industry (1999-2001), which was among the earliest attempts internationally to develop green innovation policy. This work included work on eco-innovation indicators. She functions regularly as advisor on eco-innovation policy in Denmark as well as at the EU level.

Rodin Genoff is the Managing Director, Rodin Genoff & Associates, Sydney Australia, Rodin works with regional, industry and cluster strategies to achieve investment and employment outcomes and collaborations that lead to new global joint ventures between companies. His work includes working with companies globally, executive levels of government, and lecturing at a post graduate level in economics and public policy. Rodin has also written several books on manufacturing, innovation and industry cluster development. He has advised governments in Australia, New Zealand and Europe.

Klaus Rovsing Kristiansen, Master of Science (MSc) in the field of public administration and economics. Klaus Rovsing Kristiansen has 20 years of experience in analysing business development

focusing on themes like innovation, structural changes, globalisation and clusters. His experience stems from several key positions in media (Newsletter Monday Morgen), consultancy companies (Oxford Research, Brinkmann Kommunikation and the Danish Technological Institute) and central administration (The Danish Ministry for Economic and Business Affairs). Klaus Rovsing Kristiansen has been undertaking tasks in policy and strategy formulation, implementation, communication and evaluation. He has been working with individual companies, clusters and industries. With regards to geographical orientation he has been focusing on both city, regional, country as well as European level. He is responsible for the Analysis Team in Copenhagen Capacity, also conducting tasks for the Copenhagen Cleantech Cluster.

ANNEX B

SUMMARY NOTE COPENHAGEN WORKSHOP

Workshop of the OECD LEED Programme and Copenhagen Capacity

Measuring the potential of Green Growth

Copenhagen Marriot Hotel 12-14 October 2011

The OECD LEED Programme and the Copenhagen Investment Agency 'Copenhagen Capacity' held the first workshop of the project on Measuring the Potential of Green Growth: Indicators of Local Transition to Low-Carbon Economy in Copenhagen on 12-14 October 2011. The workshop was co-organised back-to-back with the Green Growth Leaders conference 'Take Lead'.

The meeting was organised as a dialogue of experts to discuss *Measuring the Potential of Green Growth in Copenhagen*. This comes at a time when the incoming Danish government has committed itself to making a transition to a "green economy".

The workshop was attended by about 50 people from international and national organisations: ILO, EC, GIZ, UNEP, Chile Ministry of Environment, African Development Bank, CEDEFOP, OECD ENV Directorate, Ministry of Environment, City of Copenhagen, Employment Region Greater Copenhagen & Zealand, the Danish National Labour Market Authority, the University of Copenhagen, other regional agencies and firms (SMEs and large) participated. Project Partners from Benelux (Deputy Secretary Luc Willems and Mr Hans Mooren) and Germany (Mayor Lutz Franzke and Carmen Struck, Chamber of Industry and Commerce) participated in the workshop (see agenda in Annex I).

The workshop focused on identifying those themes relevant for developing indicators to measure the *local* transition to a low-carbon economy in Greater Copenhagen and particularly the Copenhagen Cleantech Cluster. Discussions pointed to two groups of themes for consideration - industry (SMEs) and community:

Link with Industry (SMEs and value-chains)

- Radical innovation, with disruptive market potential driving the agenda – measuring collaboration with research labs, testing infrastructure for SMEs;
- Deployment of applications for commercialisation by local companies: measuring patenting, licensing;
- Linking green jobs and decent jobs: measuring job creation but also the job quality or 'decent' dimension;
- Retention of jobs and talent in green industries as important as creation of new jobs – monitoring the green component of jobs in the green industry;
- Skills and talent attraction needed for producing radical innovation + commercialisation – measuring skills;
- Need to focus on investment attraction (national and FDI) – measuring FDI; and
- Predictability for the market through clear policy signals – indicators of the socio-political context.

Link with Communities (regional/local level)

- Partnerships are key to push the green agenda – measuring triple helix connectivity (government/industry/academia) as strategic approach for green growth (consumers/ needs);
- Strong/visionary leadership;
- Coherence of green growth development agendas national-local – measuring policy alliances and connectivity;
- Measuring for social, financial, economic monitoring towards green growth;
- Measuring the local base renewable energy use, waste management, energy efficiency, mobility of people and goods, traffic congestion;
- Training and skills development ecosystem for green talent development in green and less green firms – measuring green training.

Mr **Rodin Genoff,** Director of *Rodin Genoff & Associates* acted as a 'rapporteur' for the meeting. The workshop focused on several topics, which have been summarised into four key issues arising from measuring green growth and implications this has for investment promotion, job creation and governance:

1. Measuring and understanding the potential of green growth and the dynamics of Copenhagen's Cleantech Cluster;
2. Investment attraction and promotion - job creation, fostering talent and the role of local agencies;
3. Local and regional dimension: putting governance to work;
4. Revised green growth Indicators.

Although not discussed separately, one of the primary issues arising from the workshop was the need to pass the test of relevance. The indicators need to be relevant in a way that they could be used to communicate the "green" story to business, political leaders and the broader community. This in particular was also one of the key issues identified by the 'Take Lead' VIP roundtable meetings of some of Denmark's largest companies and business leaders.

1. Measuring and understanding the potential of green growth and the dynamics of Copenhagen's Cleantech Cluster (CCC)

A major theme arising from the workshop were measurement limitations arising from the Eurostat definition of the green economy. This was particularly true of a number of "non green" industries that utilised green solutions to generate green efficiency dividends and productivity increases. Consequently their contribution to the greening of the economy was not captured. Hence inadequate signals were being sent to policy makers and investors as to the importance of these related industries.

Concerns were also expressed that the Eurostat definitions did not capture the dynamics of green growth and its full potential. For example, at the heart of the CCC are smart and systems integrating technologies. This cluster greatly benefits from being located in Copenhagen in close proximity to vital enablers from software developers and ICT companies to nano and bio technology companies. Sectors such as these needed to be included as part of the methodology.

While data and methodological limitations were acknowledged; OECD economic modelling capabilities nonetheless permit a broad range of factors to be modelled and analysed.

The challenge was to ensure that future growth scenarios and modelling are relevant to investors and SMEs in green industries. In addition, that the modelling was also relevant to those sectors of business that are not classified as being part of the green economy, but play important roles as suppliers or end customers. These related sectors are also important in terms of future employment growth and FDI attraction.

Participants also discussed the role of smart and intelligent industries enabling and spinning off investment opportunities within the green and wider economy. This process in turn supported the transition from "old industries" to new "green industries" and jobs of the future.

In this context, CCC companies are also characterised by radical innovation, with disruptive market potential across a broad range of industries. Its companies are highly collaborative with strong links to research and testing labs, and knowledge infrastructure.

2. Investment attraction and promotion - job creation, fostering talent and the role of local agencies

Participants discussed how the local level[17] was providing the strong/visionary leadership necessary for clusters and the green economy to thrive. Hence measuring the potential of green growth in Copenhagen is an important component to developing responsive investment attraction and promotion strategies for Copenhagen Capacity and the city as a whole.

Understanding the role of local agents and talent was seen as critical to the overall measuring and analytical architecture. Cities for example were seen as drivers of growth: trade, investment flows and migration exist between city 2 city; while companies undertake business 2 business, (also in a city/local area context). Concomitantly, talent was seen as a key prerequisite for a vibrant and competitive clean-tech sector. For example, Richard Florida has estimated that around 40% of Copenhagen's workforce is part of the creative class (Take Lead conference address, 2011), which is central to the underlying competiveness of clean-tech industries.

It was acknowledged that talent and knowledge were instrumental in both anchoring and attracting the FDI that underscores future green growth. For instance, public private partnerships were seen as important to securing future energy and transport projects, and the FDI to financially underwrite such investments.

With the government committing itself to transforming Denmark to a green economy, the issue of training and skills development is seen as crucial to informing the development of relevant indicators for this project. Especially skills and talent attraction needed for producing radical innovation and commercialization. This includes understanding the training and skills development ecosystem for green talent development in green and "less green" firms. As part of this process, developing green jobs criteria within a "decent" jobs framework as outlined by the ILO is needed.

Retention of jobs and talent in green industries was also seen as important as the creation of new jobs. Hence participants identified the need to monitor the green components of jobs in the green economy.

Finally, monitoring and tracking SRI, corporate reporting, and clean-tech stock exchange listings were also seen as important to understanding future growth and investment trends.

3. Local and regional dimension: putting governance to work

The theme of city and local/regional uniqueness emerged as one of the workshop's most important themes.

[17] Local level is defined as 'labour market areas' – it can refer to a city, town, sub-region, suburbs or in general to local commuting areas.

Participants acknowledged the real tensions – political, economic and definitional – of balancing the development of local measures and targets with EU and national ones. It was essential to find the right balance to ensure political ownership and participation at the local level, but the same time ensuring the integrity of national and EU policy settings and targets, and measurement tools.

It was crucial to tailor measurement tools to the unique economic and political conditions experienced at the local level - tools that were also informed by national and EU frameworks. It was agreed that the Eurostat architecture provided the common foundations across the EU and territories to undertake economic analysis and compare performance and industry structure between countries in the EU, and to develop broad policy settings. However the Eurostat architecture needed to be augmented by measures and industry definitions at the local level. The OECD through the work on indicators of green growth which this project contributes is currently addressing this issue.

The challenge facing the project is to integrate local indicators and political aspirations. This was a particularly vexing and difficult question for participants to address. The workshop acknowledged that there was more to this issue than just an economic or measuring dimension. There was also a political dimension that reflected broader community values. While in the case of the CCC, it has both a city and national dimension with strong global connections to other clean-tech clusters around the world. This added an additional layer of complexity to the project. These dimensions also have significant implications for the development of responsive and flexible governance architectures that promote investment attraction and skills and talent development.

This theme relates directly to the issues of unique national and local conditions. For example, the Danish government is planning to work across departments/sectors to integrate, embed and roll out green growth policies and programmes to optimise the transition processes to Denmark becoming a green economy. This process has the potential to broaden the suite of possible indicators as data is collated across various departments.

Governance issues are particularly important in the determination of policy predictability and transparency. Predictability through clear policy signals is critical to the efficient functioning of the market and securing investor confidence. It is also a prerequisite to attracting FDI. In turn partnerships emerging from responsive governance structures are key to implementing the green agenda. For example, triple helix (government/industry/academia) as a strategic approach to green growth.

4. Revised Regional Indicators

Five groups of indicators were proposed by Copenhagen Capacity for discussion:

1 - Foreign Direct Investment and Regional Attractiveness

Dialogue focused on the importance of indicators to support FDI and the development of regional attractiveness. Of particular importance was the development of a sound regulatory environment to underpin innovation and anchor FDI by having a predictable and transparent policy regime.

Indicators in this subgroup need to reflect the dynamics of cities and their unique characteristics.

In turn, existing Eurostat definitions could be used to model investment projections to create baseline forecasts.

2 - Creation of Green Jobs

Dialogue centred on ensuring that local green targets and the creation of green jobs are not at the expense of exporting brown jobs to developing countries. The development of green jobs indicators needed to ensure that they meet “decent jobs” criteria.

Given the dynamics of the green economy and clean-tech clusters, it was important to think across industries and interlinked labour markets. This is, a green economy skills base is required to unlock its internal labour market potential; however, it was also reliant on a broader talent pool related to design, venture capital, intelligent engineering, software development and the like.

Existing Eurostat definitions could be augmented to model green job and employment growth projections.

3 - Cluster Perspective

It was acknowledged that companies operating in clusters do better than companies not in clusters. Hence it was important to capture the intersectoral dynamics of growth when formulating relevant indicators.

Participants felt that this was a very useful way of comprehending and measuring the industry. It also provided a useful vehicle to develop foresight planning processes that captures future growth and technology trajectories. These in turn could be modelled. However the process itself needed to use the logic of business and the way they see the economy; whether from a risk management or investment perspective.

4 – Competiveness

Competiveness was not just about traditional indicators, land, labour, capital – but was seen in the context of city dynamics and clusters. In particular, utilising frameworks going beyond of traditional measures of economic development to support FDI and industry growth.

Participants recognised the role of Copenhagen's knowledge infrastructure in fostering investment and spinning off new high tech industries. This investment dynamic needed to be captured in the formulation of indicators that relate to how business makes its investment decisions.

They also acknowledged the importance of governance and institutional factors that support collaboration and underscore competitiveness.

5 -Intellectual Property, Job Types and Skills

Participants discussed the importance of sound institutional and legal frameworks required for the deployment of applications for commercialization by local companies ie patenting, licensing and IP. This was especially important when certain developing countries were flouting international protocols and legal agreements.

A key issue to arise from the dialogue was the need to maintain labour standards, decent jobs, and develop indicators that address such concerns. This was particularly important when "green collar" jobs are being split between production workers and knowledge workers. How this is conceptualised and measured may also be influenced by the transition from brown jobs to green jobs.

The OECD received the 'Copenhagen Manifesto of Sustainable Growth'. A report for measuring the potential of green growth in Greater Copenhagen is in preparation. Inputs by participants of this workshop (see Annex 2) are gratefully acknowledged.

ANNEX C.1

AGENDA

Wednesday 12 October 2011

Copenhagen Marriott Hotel, Kalvebod -1560 Copenhagen V

Facilitator	Rodin Genoff Industry strategist and Cluster Expert, OECD Consultant
Time	Agenda
8:30 am – 9:00 am	**Registration and coffee** **Registration for roundtable session** Venue: Copenhagen Marriott Kalvebod Brygge 5, DK-1560 Copenhagen V
9:00 am – 9:45 am	**Welcome and Opening** **Welcome** Ann Faber Ginness Research Manager, Copenhagen Capacity Dr. Cristina Martinez-Fernandez Senior Policy Analyst, OECD **Copenhagen Capacity: Leading Investments in new areas of growth** Kim Bek Director, Marketing and Intelligence, Copenhagen Capacity **The City of Copenhagen – Local green initiatives** Lars Lindholm Team leader, Green Growth
9:45 am – 10:30 am	**Project Presentation: Measuring the Potential of Green Growth** **Measuring the potential of green growth: Indicators of local transition to a low-carbon economy** Dr. Cristina Martinez-Fernandez Senior Policy Analyst, OECD **The Copenhagen Proposal: Measuring the potential of green growth in greater Copenhagen** Ann Faber Ginness Research Manager, Copenhagen Capacity Rodin Genoff Industry Strategist and Cluster Expert, OECD Consultant

Wednesday 12 October 2011

10:30 am – 11:00 am	**Coffee Break**
11:00 am – 12:00 pm	**Green Growth Initiatives in Denmark: Investment Promotion and Job Creation** **A Sector Overview (Copenhagen Cleantech Cluster)** Morten Larsen Chief Consultant, Oxford Research **The Ministry of Climate and Energy – Presentation** Jens Brandt Sørensen Ministry of Climate and Energy **Green jobs vs. greening jobs – Job quality** Martin Gasser Activity Manager, ILO (International Labour Organization) **Challenges for the green labour market** Robert Strauss Head of unit - Employment Analysis, European Commission
12:00 pm – 1:00 pm	**Lunch**
1:00 pm – 2:30 pm	**Company Presentations – Danish Cleantech Companies** **Inbicon** Charles Nielsen Director **Aquaporin** Oliver Geschke CTO / Ph.D. **Open Discussion** Questions and dialogue with company representatives

Wednesday 12 October 2011

2:30 pm – 2:45 pm	**Coffee break**		
2:45 pm – 3:00 pm	**Presentation of themes for Roundtables** **Introduction to roundtables** Ann Faber Ginness Research Manager, Copenhagen Capacity		
3:00 pm – 4:45 pm	**Roundtable Sessions** You will only be able to attend one of these sessions		
	Cleantech sectors and Industrial Attractiveness Cleantech clusters & Investment promotion	**Green Jobs and Talent Attraction** Job Creation, labour markets and skills	**Strategies for Green Growth & Regional Competitiveness** Recommendations for Policy making
	Discussion Chair: Kim Bek Copenhagen Capacity	*Discussion Chair:* Robert Strauss European Commission	*Discussion Chair:* Luc Willems Benelux – General Secretariat
	Tomonori Sudo African Development Bank	Dr. Cristina Martinez-Fernandez Senior Policy Analyst, OECD	Sina Johannes GIZ
	Martin Kristian Brauer DAMVAD	Martin Gasser ILO	Jenny Hawes-Hewitt Accenture
	Rodin Genoff OECD Consultant	Dr. Alwine Woischnik Ministry of Environment, Chile	
4:45 pm – 5:00 pm	**Wrap up and short briefing for the programme Thursday**		

Thursday 13 October 2011

8:30 am – 12:00 pm	**Site Visits for workshop participants** Departure: **Hotel Kong Arthur, Noerre Soegade 11, DK-1370 Copenhagen K.** Site Visits 1-3 are provided by State of Green Tours Site 4 is provided by DAC (Danish Architecture Centre) Site 5 is provided by Better place Field trip 6 is provided by Copenhagen Capacity 1. Avedøre combined Heat and Power Plant District Cooling Development Project "Kongens Nytorv" 2. Boat tour to Middelgrunden Off Shore Wind Farm 3. Copenhagen Harbour bath and visit to the sustainable buildings "8-tallet" designed by Bjarke Ingels, BIG 4. Copenhagen city tour by bike, habour and electrical bus 5. Better place Demonstration Centre 6. Boat trip – Copenhagen Sightseeing tour
12:30 pm – 5:00 pm	**Opening – Take Lead Conference** Venue: Copenhagen City Hall - Rådhuspladsen, DK-1599 Copenhagen V.
12:45 pm – 1:15 pm	**The good life** Bjarke Ingels Founding Partner, BIG
1:15 pm – 1:30 pm	**The Evidence of Green Growth** Professor John Zysman Professor, UC Berkeley
1:30 pm – 2:30 pm	**Re-taking the lead** Connie Hedegaard EU Commissioner for Climate Action Yvo de Boer Special Global Advisor, KMPG and Fmr. Executive Secretary of the United Nations Framework Convention on Climate Change
2:30 pm – 3:00 pm	**Break**

Thursday 13 October 2011

3:00 pm – 4:00 pm	**Green Growth Leaders** Q&A with Frank Jensen Lord Mayor of Copenhagen Flemming Borreskov CEO, Realdania Anders Eldrup CEO, Dong Energy Michael K. Rasmussen CMO, Velux Group Morten Albæk Senior Vice President, Vestas Wind Systems Erik Rasmussen CEO, Monday Morning
4:00 pm – 5:00 pm	**The Great Reset** Richard Florida Author and Thought Leader
5:00 pm – 8:00 pm	**Reception in the Ceremonial Hall** Copenhagen City Hall

Friday 14 October 2011

Copenhagen Marriott Hotel, Kalvebod -1560 Copenhagen V

9:00 am – 9:15 am	**Presentation of OECD Indicators:** **Towards green growth: Measuring progress** Dr. Ziga Zarnic OECD
9:15 am – 9:30 am	**The Copenhagen Green Agenda: Proposed Indicator Themes** **Danish perspectives on green growth indicators** Ann Faber Ginness Research Manager – Copenhagen Capacity
9:30 am – 10:15 am	**Open discussion – Danish indicators**
10:15 am – 10:30 am	**Coffee break**
10:30 am – 12:45 pm	**Panel Sessions (Open discussion)** **Panel discussions with insights from roundtables Wednesday** Rodin Genoff Industry Strategist and Cluster Expert, OECD Consultant
10:30 am – 11:05 am	**Panel 1** **Cleantech Sectors and Industrial Attractiveness** Facilitator: Kim Bek, Copenhagen Capacity Introduction: Key messages from roundtable session Wednesday **Panel Experts:** Tomonori Sudo, World Development Bank Dr. Ziga Zarnic, OECD Martin Kristian Brauer, DAMVAD
11:05 am – 11:40 am	**Panel 2** **Green Jobs and Talent Attraction** Facilitator: Robert Strauss, European Commission Introduction: Key messages from roundtable session Wednesday **Panel Experts:** Dr. Cristina Martinez-Fernandez, Senior Policy Analyst, OECD Martin Gasser, ILO Dr. Alwine Woischnick, Ministry of Environment, Chile

Friday 14 October 2011

11:40 am – 12:15 pm	**Panel 3** **Strategies for Green Growth and Regional Competitiveness** Facilitator: Luc Willems, Benelux – General Secretariat Introduction: Key messages from roundtable session Wednesday **Panel Experts:** Sina Johannes, GIZ Jenny Haws-Hewitt, Accenture
12:15 pm – 12:45 pm	**Key Insights from Panel Discussions** **Reflections on contributions from panel discussions** Rodin Genoff Industry strategist and Cluster expert, OECD Consultant
12:45 pm – 1:00 pm	**Closing Remarks** **Closing remarks and next steps** Ann Faber Ginness Research Manager, Copenhagen Capacity Dr. Cristina Martinez-Fernandez Senior Policy Analyst, OECD

ANNEX C.2

PARTICIPANT LIST

Last Name	First Name	Company/Organisation	Job Title
Bek	Kim	Copenhagen Capacity	Director, Marketing & Intelligence
Birkved	Morten	Technical University of Denmark	Assistant Professor
Birr-Pedersen	Katja	Dong Energy	Energy Economist
Bjørn	Anders	Technical University of Denmark	Research Assistant
Bjørndal	Frederik	Novozymes	Public Affairs Advisor
Brandt Sørensen	Jens	Ministry of Climate and Energy	Administrator
Brauer	Martin Kristian	DAMVAD	Senior Economist
Eaton	Derek	UNEP	Programme Officer
Faber Ginness	Ann	Copenhagen Capacity	Research Manager
Filtenborg Andersen	Jeanette	Copenhagen Capacity	Marketing Manager
Franceschini	Simone	Technical University of Denmark	PhD Candidate
Franzke	Lutz	Regional Growth Core “Schönefeld Cross”	Mayor
Gasser	Martin	International Training Centre of the ILO (ITC-ILO)	Activity Manager
Genoff	Rodin	Rodin Genoff Associates	OECD Consultant
Geschke	Oliver	Aquaporin	CTO/Ph.D
Grove	Arne	Norden	Director
Hawes Hewitt	Jenny	Accenture	Strategy Manager
Henriksen	Kristian	Danish Enterprise and Construction Agency - Division for Research and Analysis	Project Manager
Johannes	Sina	Sustainable Economic Development - GIZ	Technical Advisor
Larsen	Morten	Oxford Research	Chief Consultant
Lema	Adrian	Ministry of Climate and Energy	Climate Negotiator
Lema	Rasmus	University of Aalborg	Researcher
Lindholm	Lars	City of Copenhagen	Team Leader
Løbner Pedersen	Jacob	Employment Region Copenhagen & Zealand	Project Manager
Lomholt Svensson	Nikolaj	Ministry of Climate and Energy	Administrator
Lund Rants	Louise	DAMVAD	Consultant
Lund-Sørensen	Thøger	City of Copenhagen	Environment Economist
Madsen	Tone	Danish Energy Agency	Administrator

Last Name	First Name	Company/Organisation	Job Title
Mandix Sehestedt	Peter	Danish Energy Agency	Special Consultant
Martinez-Fernandez	Cristina	OECD LEED	Senior Policy Analyst
McQuaid	Ronald	Edingburgh Napier University - Employment Research institute	Director
Mooren	Hans	BENELUX	Policy Advisor
Munch Andersen	Maj	Technical University of Denmark	Senior Researcher
Nielsen	Charles	Dong Energy	Head of development
Ranieri	Antonio	CEDEFOP European Centre for the Development of Vocational Training	Senior Expert
Ruta	Philipp	ZukunftsAgentur Brandenburg	Head of Cleantech Unit
Spek	Stefan Ulrich	European Environment Agency	Project Manager - Environmental Economics and Policies
Strauss	Robert	European Commission	Head of Unit - Employment Strategy
Struck	Carmen	Chamber of Industry and Commerce	Management Consultant
Sudo	Tomonori	African Development Bank	Private Sector Specialist
Weidlich	Palle	Vaeksthus Greater Copenhagen	Consultant
Willems	Luc	BENELUX	Deputy Secretary-General
Wolschnik	Alwine	Ministry of Environment - Chile	Sustainability Coordinator
Zarnic	Ziga	OECD	Economist / Policy Analyst

ANNEX D.1

A THREE-TRACK APPROACH TO THE *ENERGY STRATEGY 2050*

Wisely, the government is concentrating its initial efforts on the elements of the Strategy that appear most promising with regard to establishing a cost-effective energy and transport system without fossil fuels. There is general recognition that the transition cannot happen at the same pace throughout the transport and energy systems, for a number of reasons, but primarily because of price differences and differences in technological maturity. The Strategy, therefore, has identified three parallel tracks along the transition to fossil fuel independence, with carefully developed initiatives in each track. The process can be summarised as follows:

Track one, the transition phase, is the process of converting to more efficient energy consumption and an energy supply based on renewable energy. This transition can start immediately as existing technologies are cost-effective with long operational life and decision-making processes. The activities involved will also contribute to realising short and medium-term objectives.

Track two, is the preparation and planning of the next phase of the transition, followed by the utilisation and integration of new solutions. It identifies the sectors in which there is a need to ensure the establishment of the framework before specific measures towards 2050 can be initiated.

Track three, the technology development phase, requires investment in research, development and demonstration of cost-effective energy technologies followed by large-scale demonstration and preparation for market. The final step will be market integration.

Source: The Danish Government (2011)

ANNEX D.2

SUSTAINABILITY CHALLENGES, COMPETENCIES AND OPPORTUNITIES

Stage 1 Viewing compliance as opportunity	Stage 2 Making value chains sustainable	Stage 3 Designing sustainable products and services	Stage 4 Developing new business models	Stage 5 Creating next-practice platforms
Central challenge To ensure that compliance with norms becomes an opportunity for innovation.	*Central challenge* To increase efficiencies throughout the value chain.	*Central challenge* To develop sustainable offerings or redesign existing ones to become eco-friendly.	*Central challenge* To find novel ways of delivering and capturing value, which will change the basis of competition.	*Central challenge* To question through the sustainability lens the dominant logic behind business today.
Competences needed • The ability to anticipate and shape regulations. • The skill to work with other companies, including rivals, to implement creative solutions.	*Competencies needed* • Expertise in techniques such as carbon management and life-cycle assessment. • The ability to redesign operations to use less energy and water, produce fewer emissions, and generate less waste. • The capacity to ensure that suppliers and retailers make their operations eco-friendly.	*Competencies needed* • The skills to know which products or services are most unfriendly to the environment. The ability to generate real public support for sustainable offerings and not be considered as "green washing." • The management know-how to scale both supplies of green materials and the manufacture of products.	*Competencies needed* • The capacity to understand what consumers want and to figure out different ways to meet those demands. • The ability to understand how partners can enhance the value of offerings.	*Competencies required* • Knowledge of how renewable and non-renewable resources affect business ecosystems and industries. • The expertise to synthesise business models, technologies and regulations in different industries.
Innovation opportunities • Using compliance to induce the company and its partners to experiment with sustainable technologies, materials and processes.	*Innovation opportunities* • Developing sustainable sources of raw materials and components. • Increasing the use of clean energy sources such as wind and solar power. • Finding innovative uses for returned products.	*Innovation opportunities* • Applying techniques such as biomimicry in product development. • Developing compact and eco-friendly packaging.	*Innovation opportunities* • Developing new delivery technologies that change value-chain relationships in significant ways. • Creating monetisation models that relate to services rather than products. • Devising business models that combine digital and physical infrastructures.	*Innovation opportunities* • Building business platforms that will enable customers and suppliers to manage energy in radically different ways. • Developing products that won't need water in categories traditionally associated with it, such as cleaning products. • Designing technologies that will allow industries to use the energy produced as a by-product.

ANNEX D.3

GREEN JOB CRITERIA

Industry	
Sector	The sector or industry refers to the fields of economic activity into which firms can be categorised. The sectors most often referred to as "green sectors", or the EGS sector, include renewable energy, building, transportation, recycling, food and agriculture, forestry and tourism. These sectors are usually the focal points of studies on green jobs not only because of the nature of the goods and services they are producing, but also because they tend to be labour intensive.
Product/service	This refers to the specific output of the businesses in the different industries or sectors. There are specific products and services that can be considered "green" due to the eco-innovative processes involved in their production. For instance, products/services aimed at reducing or limiting the negative impact of human activity on the environment (*e.g.* energy-efficient home appliances) or at improving the environment directly (*e.g.* waste recycling services). These might capture changes in human consumption habits as awareness for green products and services increase.
Organisation	
Production method	The production method refers to the environmental quality standards used by firms in their production process (*e.g.* ISO norms). Firms can set measures in place to reduce energy consumption and waste production and build environmentally friendly infrastructure for their production processes. This criterion allows for the classification of jobs in a firm that does not belong to a green sector but uses energy efficient techniques considered to be green.
Green awareness	Organisations have different levels of commitment to green and environmental issues (Connection Research 2009, p. 17). In some cases, the heads of firms are individuals that are deeply committed to the environmental cause and engage in associations, partnerships or community movements to protect the environment. Green awareness is also often reflected in the levels of corporate social responsibility of the organisation. This is often dependant on the history and structure of the organisation (Potts 2009).
Position in the value chain	The implication of a job in the green economy might vary along the value chain of the good or service being produced. A job in a company producing energy efficient automobiles might be considered to be green, but what about a job in the company producing the steering wheel for that specific car?
Job	
Occupational profile	This refers to the nature or purpose of the job, irrespective of the sector in which it is performed. Almost any occupation can be considered green as long as it contributes to reducing harmful impacts of human activity on the environment, either directly or indirectly. As a result, occupations ranging from managers, to sales workers to labourers can all at some point be considered as being green.
Required skills and abilities	Certain jobs require workers to possess certain specialised green skills and abilities. Determining whether a job can be considered as being green can in some cases be done based on the necessary skills and competences required to perform it.
Job decency	The UNEP and the ILO have both stressed the fact that “green jobs” need to be decent jobs, *i.e.* good jobs, which offer adequate wages, safe working conditions, job security, reasonable career prospects, and worker rights” (UNEP, ILO, ITUC, IOE, 2008a, p. 4). The Apollo Alliance has also taken up this dimension in its definition of green jobs stating that “if a job improves the environment; but doesn’t provide a family-supporting wage or a career ladder to move low-income workers into higher-skilled occupations, it is not a green-collar job”. Job decency is thus a key dimension of green jobs.
Green workload	Some workers may do some of their work in green areas and some of their work in traditional areas (Connection Research 2009, p. 17). In this case, it is important to adequately measure the part of the workload that is officially dedicated to green tasks in order to determine if the job can be considered as green.

Transitioning to a Low-Carbon Economy

OECD STUDY OF LOCAL INDICATORS TO A LOW-CARBON ECONOMY

The project on indicators of local transition to a low-carbon economy is an international effort to look at policy issues related to the:

- Indicators that can inform transition to low-carbon economic activities
- Barriers encountered by capturing data that is relevant at the local level
- Indicators for green skills production and utilisation in a particular local area.

The project examines the transition from high carbon economic activities to low carbon economic activities and which indictors can be used to monitor the transition at the local level. In particular the role of green skills and training ecosystem at the local level is analysed.
Participant countries: Denmark, Benelux (The Netherlands, Belgium, Luxembourg), Germany, Chile. The project is supported by the European Commission, DG Employment, Social Affairs and Inclusion.

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