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EU-China Low Carbon Cities Joint Study

A study prepared by Chinese and European experts for the IUC programme

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1 Introduction

1.1 Reason for the Study

China is taking ambitious steps to reduce greenhouse gas (GHG) emissions and leads the world in terms of the rate it is reducing its carbon intensity (emissions per unit of Gross Domestic Product – GDP). China's President Xi Jinping has recently announced that China will aim to hit peak emissions before 2030 and for carbon neutrality by 2060[1].

At the same time, improving quality of life for Chinese citizens and transitioning its industrial sector from low to high value remain key priorities. Low carbon and climate-resilient urban investments are institutionally more complex than conventional urban investments and may entail higher upfront costs. Consequently, the financing and funding decision-making processes and arrangements will generally be more sophisticated than existing systems. Traditional economic evaluation of low carbon interventions puts a premium on reducing GHG emissions, however considering the co-benefits (economic, environmental and social) of low carbon infrastructure and policy and considering the associated added value tips the balance and creates a strong economic argument for 'sustainable development'. In the context of Chinese cities, air quality is a particularly significant issue, which of course can be mitigated through action to mitigate climate change issues.

No more are these decisions important than in cities where key infrastructure and policy decisions made by local government can lock cities in to long-term GHG emissions, or, avoid that scenario. Urban areas in China account for approximately 75% of the national primary energy demand and 85% of the national commercial energy demand with the high level of urban migration set to further increase that contribution. Secondary industry is the major source of GHG emissions in most Chinese cities, however private transportation is still growing rapidly in order to meet the needs of people and in a traditional development model, the overall demand for energy will rise with improving quality of life.

As Chinese cities build new capacity, transition their industries, and improve the quality of their urban environments, key decisions need to be made based on forward-thinking evaluation criteria. Having been through industrial decline and transition and having advanced their low carbon economies, European cities are excellent case studies for Chinese (and other) cities to learn from. Several Chinese cities already have higher per capita GHG emissions than their European counterparts. If Chinese cities can successfully learn from the European experience, they can 'short-cut' on their transition to low carbon, sustainable cities. This could have huge benefits in terms of Chinese cities competing in modern industry, encouraging inward investment, and creating vibrant and high-quality urban environments for the citizens.

This study aims to compare the key enabling factors and policy frameworks in place for Chinese and European cities in transitioning to low carbon. Furthermore, the study assesses a small sample of Chinese and European cities to determine if Chinese urban and industrial policy objectives are matched by European city solutions which have already been implemented successfully.

[1] President Xi made this announcement when speaking via videoconference to the UN General Assembly in New York on 22.09.2020.

1.2 China's institutional mechanism and policy framework for low carbon development

1.2.1 Chinese initiatives to promote an economic transformation and green, low carbon development

The principal contradiction in Chinese society has changed from one between low productivity and growing material/cultural needs of people to one between people's growing needs for a better life and uneven and inadequate development. In terms of economic growth and transformation, the Chinese Government is trying to shift from high speed development to high quality development. With this aim, the approach focuses on:

1. adhering politically to the principle of improving quality and benefit;
2. deepening the structural reform of the supply side;
3. promoting reforms of quality and efficiency and improving productivity; and,
4. establishing an industrial system in which real economy, scientific and technological innovation, modern finance and human resources can develop together.

In this process, green development should be promoted in an all-encompassing way, built on a system considering production, life scale, technology, and finance. This will require solving the environmental problems faced by China and building an environmental governance system that is led by the government which requires enterprises to act as the responsible entities, with the participation of social associations and the public. This should include strengthening the protection of the ecological system and a market-oriented and diversified ecological compensation mechanism. This system should be backed by reforms to the ecological environment supervision system by establishing a state-owned natural resource assets management framework with associated regulators. While the Chinese public should feel the obligation and responsibility of protecting all natural resources, it is crucial that the Chinese Government take responsibilityy as a supervisor of administrative law enforcement on all types of pollution in urban and rural areas alike.

The general trend is that, in accordance with the concept of respecting and protecting nature, China will implement a basic national policy to save resources and protect the environment. This will promote green development, the circular economy and low carbon development more consciously and integrate the development of an 'ecological civilization' into all processes of economic, political, cultural and social development.

1.2.2 The background and significance of developing low carbon region and city pilots in China

In 2014, the '*National Plan to deal with Climate Change'* (2014-2020), issued by the National Development and Reform Commission (NDRC), mentioned policies to support 'Low Carbon Pilots' along with an associated evaluation index system. The plan allocated a batch of provinces, cities and towns to be transitioned to low carbon. Similarly, a series of urban districts, parks and communities with typical demonstrative significance were identified as pilot low carbon areas. A series of technologies and products with good emission reduction potential were also designated to be tested and promoted including projects for carbon capture, utilization and storage.

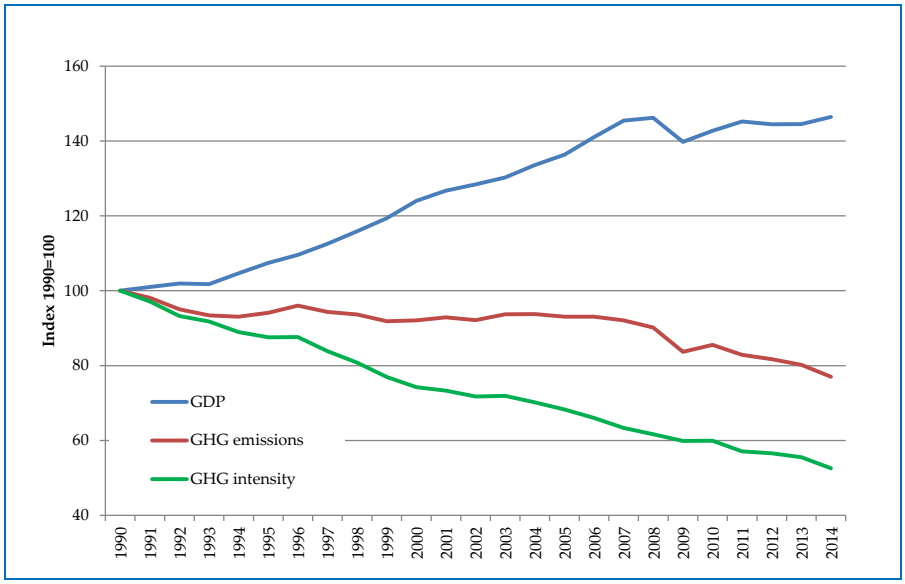
In 2016, the '*13th Five-Year Greenhouse Gas Emission Control Plan'* explicitly requested that China should further build on the Low Carbon Pilots, expanding the portfolio of low carbon cities to 100 and adding 80 parks as well. 20 national low carbon industrial demonstration parks were also established, and the plan also called for the creation of 1,000 new low carbon community pilots and to nominate 100 national low carbon demonstration communities.

1.3 Europe's institutional mechanism and policy framework for low carbon development

1.3.1 Decarbonisation of Europe's economy

Over the past 25 years, the EU has successfully decoupled economic growth from GHG emissions. During the 1990-2014 period, the EU's combined GDP grew by 46%, while total GHG emissions[2] decreased by 23%, meaning the EU's GHG emission intensity decreased by almost half between 1990 and 2014 (see Figure 1 below).[3] This achievement has been built upon the collective efforts of the European Commission, the EU member states and the actions of sub-national and local governments to engage in an ambitious climate change agenda. This multi-level governance approach has paid dividends by engaging all echelons of the public sector in Europe to commit to engage in direct and facilitating actions to lower GHG emissions and build low carbon economies.

Figure 1: Decoupling of the EU's economic growth and GHG emissions 1990 – 2014[2]



European climate policy has been evolving since 1990 with some significant advances since the initial Kyoto Protocol agreement in 1997. Soon after Kyoto, the *European Climate Change Programme (ECCP)* was launched, providing the first comprehensive suite of policies and instruments with the aim of reducing GHG emissions. Subsequently, the *European Emissions Trading Scheme (ETS)* was adopted, with national caps for emissions from power and industry sectors in each member state. The *Renewable Energy and Energy Efficiency Directives* were also introduced at the EU level to mandate member states to reduce demand for and generate cleaner energy. More recently, these suites of policies have been formalised with the *EU Climate and Energy Package for 2020*[4] (with the aim of reducing emissions by 20% from 1990 levels) and 2030[5] (with the aim of reducing emissions by 40% from 1990 levels). In December 2019, the Commission launched the European Green Deal, a new and ambitious approach to

[2] excluding LULUCF but including international aviation

[3] REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL Climate action progress report, including the report on the functioning of the European carbon market and the report on the review of Directive 2009/31/EC on the geological storage of carbon dioxide (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0576)

[4] Published in 2008

[5] Published in 2014 (note the level of ambition will be revised on account of the EU Green Deal)

shifting Europe to a clean economy, aiming at net zero GHG emissions by 2050 and ensuring a just transition for all[6].

1.3.2 Decarbonising European cities' economies

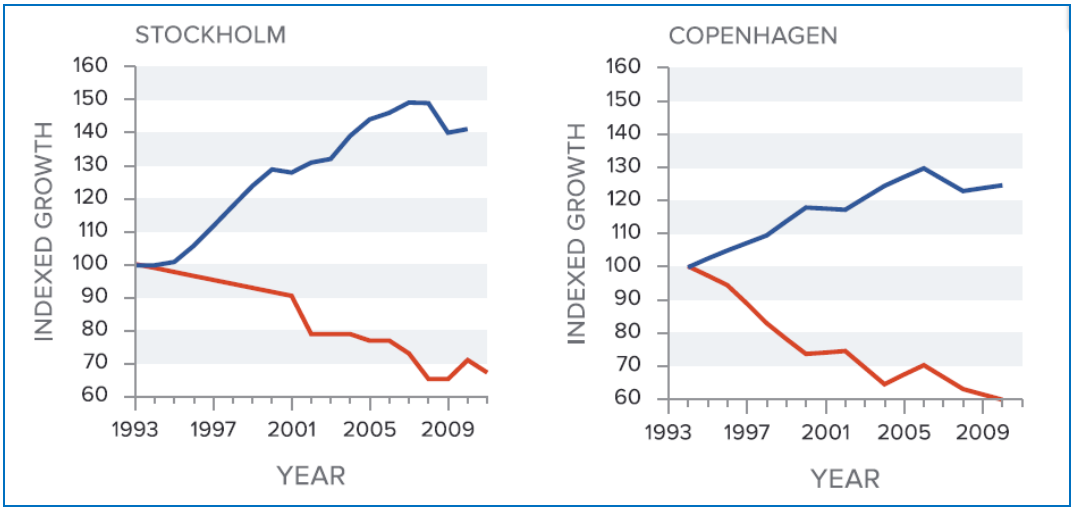
While EU cities and communities have necessarily been adopting related policies and measures passed down from European and national-level legislation, they have also taken it upon themselves to independently implement and advocate for ambitious climate action. This movement has been largely driven by the EU Covenant of Mayors (EU CoM) initiative, a policy framework which encourages cities to commit to significant GHG emission reductions and plan detailed policies and measures to achieve those goals. Launched in 2008, the EU CoM now has over 7,000 signatory cities and communities. The minimal level of ambition for members is to align with the EU-wide climate change targets:

i. original signatories committed to reduce emissions by at least 20% reduction by 2020 compared to their baseline year,
ii. subsequently (since 2016) new signatories now pledge at least a 40% reduction by 2030.

The huge success of the EU CoM initiative in recruiting so many cities and communities is largely credited to the existence of a broad multi-level governance approach to supporting signatories. *Covenant Supporters* and *Covenant Coordinators* have been established throughout Europe to provide financial and technical support to cities and communities to respond to the requirements. The collective impact of the Covenant signatories is projected to make up the equivalent of 31% of the EU's total GHG emission reduction target for 2020 (compared to 2005) and so is highly significant at the EU level in terms of achieving the EU-wide GHG emissions reduction target.

During this time, GDP across Europe has continued to grow. While there has been little analysis on a city-by-city basis to determine the exact rate of decreasing carbon intensity (i.e. tonnes of CO_2e per € GDP), it is clear that the trend has been a decarbonising economy in most EU cities. For more progressive cities, such as Stockholm and Copenhagen, specific research has been carried out and demonstrated that their economies are rapidly decarbonising (see Figure 2). It is noteworthy that these cities also rank highly in terms of quality of life.

Figure 2: Indexed economic and GHG emission growth for the cities of Copenhagen and Stockholm[7]



[6] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[7] Source: https://newclimateeconomy.report/2014/wp-content/uploads/sites/2/2014/08/NCE-cities-web.pdf

2 The economic case for low carbon development for cities

2.1 Financing low carbon action in cities

Urban development is becoming more inefficient, unsustainable, and carbon-intensive in many parts of the world. In developing regions, the share of urban trips by private vehicles is increasing and urban spatial expansion is outstripping urban population growth. A transition to low carbon, climate-resilient cities will require both a shift in the way that existing streams of finance are allocated and a substantial increase in the total quantity of urban infrastructure investment. Innovation, learning and scaling of financing instruments, governance structures and financial architecture are therefore needed.

This chapter outlines how cities can enhance fundamental financial capabilities and systemically mainstream climate commitments into financial decision-making, sharing views on the opportunities and challenges of a growing industry that has the potential to strengthen economic growth and secure greater energy independence, while reducing the impacts of climate change.

Transitioning to a low carbon economy presents both a significant opportunity and an enormous challenge. An opportunity is that the commercialization of low carbon solutions, including clean energy technologies, can further catalyze an important emerging market and support the transformation of the global energy sector. Simultaneously, this transition presents an enormous challenge given the significant capital required to transform economies that have been reliant on an energy system that has been largely fossil-fuel based. This challenge is even greater when we consider the requirement to make investments today for benefits that will materialize well into the future. A successful transition will require close coordination between policy, technology and capital, with partnership between the public and private sector at the core. At the same time, partnerships with countries around the world are also crucial.

Low carbon and climate-resilient urban investments are institutionally more complex than conventional urban investments and may entail higher upfront costs. Consequently, the financing and funding decision-making processes and arrangements will generally be more sophisticated than existing systems. Domestic public finance has traditionally been a significant source of infrastructure investment, but public budgets are often insufficient for larger and more complex infrastructure projects, particularly in the context of limited own-source revenues, austerity or competing priorities. At the local level this is particularly true, and governments may also be constrained from near-term infrastructure investment by the need to pay attention to fiscal sustainability, which is necessary to ensure long-term access to private finance. International public finance is also an important source of infrastructure investment, but it is not sufficient to fill the financing gap.

There is therefore a need to use this finance strategically to develop an enabling environment for low carbon, climate-resilient investment in urban areas. This could be through:

- supporting the design of climate-sensitive policy frameworks and institutional arrangements;
- building local capacities to plan and deliver climate-compatible infrastructure;
- supporting early entrants in key markets, such as renewable energy technologies or energy-efficient appliances; and
- crowding in private investment through reducing project risk.

Development and climate finance can also be used to promote inclusive decision-making processes and equitable project outcomes, thereby addressing some of the drivers of climate vulnerability. Private investors could be drawn to sustainable urban infrastructure projects where a sufficient return on investment is forecast based on project income flows or low-risk government debt repayments. Bankability and creditworthiness are therefore prerequisites to attracting private finance. Commercial

banks, investment companies, pension funds, insurance companies and sovereign wealth funds manage many assets, much of which could be steered into sustainable urban infrastructure. It is important to recognise that these different investor types will have different risk-return expectations and investment horizons, and to identify and structure projects appropriately for these different sources of finance.

2.2 Economic benefits of Chinese cities' transition to low carbon economies

China stands to benefit significantly by transforming its pattern of economic development towards low carbon growth pathways. Such a transformation will allow it to capitalise on new growth opportunities as a supplier that can help satisfy the increasing global demand for low carbon technologies. There are other substantial and immediate economic benefits to be gained from improving energy and resource efficiency levels. As described in previous chapters, China has already adopted rigorous policies to realise those benefits: these are important tools for kick-starting a low carbon economy. Growing industrialisation and urbanisation together with China's coal-based energy structure impose tremendous pressure on its resources and environment. China's growing dependence on oil imports raises uncertainties for economic development and worsens energy security. With global economic imbalances causing financial crises, the pattern of economic growth in China is facing unprecedented challenges. The transition to a low carbon economy is therefore an imperative, not an option.

China continues to experience a rapid demographic shift from rural to urban areas. The scale of infrastructure development is unprecedented and creates both risks (of locking in a high-emissions future) and enormous opportunities if planning can be appropriately reformed. Energy efficient buildings will play a key role, as well low carbon transport within urban areas as well as links with the countryside.

Quality of life will improve during this process, but lifestyles will also change in important ways – from where people live to the way they travel. Through education and via the fiscal system, an early step will be to encourage consumers to purchase lower carbon, sustainable goods.

A low carbon shift would dramatically improve long-term returns on investment. By acting now, Chinese cities can avoid sinking financial resources into inappropriate, polluting capital stock. A failure to invest in advanced technologies, equipment, and infrastructure would mean two things:

i. either China would be 'locked in' to decades of energy intensive pollution, or
ii. these old-fashioned investments would have to be expensively scrapped before the end of their normal economic lifetimes.

By building policy and institutional frameworks with incentives and support for energy conservation, the development and introduction of green technologies and better urban development, coupled with penalties for carbon-intensive energy use, China could reap many additional benefits. It could achieve energy security and create a more sustainable and prosperous new developmental model. There are also significant co-benefits: cleaner air, and a healthier environment, reduced health costs, improved quality of life etc.

China, however, also faces challenges in the transition to a low carbon economy. Despite unprecedented growth in clean energy sectors in China, its manufacturing sector remains dominated by heavy industry. Its exports tend to trade primarily on China's role as a low-cost manufacturer. It remains a developing economy, with low per capita income. Regional variation in capacity and income levels is considerable. It is critical to understand the current constraints to overcome them. Cities must choose from a variety of possible actions to promote low carbon development.

For Chinese cities, abatement options could be considered in at least four key emission-intensive sectors: industry, energy generation, buildings, and transport. The analysis could be extended to cover

other potentially important sectors, such as municipal services (solid waste, water, and wastewater), as well as actions with important co-benefits, such as those related to air pollution.

More generally, the prioritisation of abatement technologies or interventions at a city level should be holistically assessed, considering the costs per tonne of GHGs saved and other economic, environmental and social benefits. A framework such as the EU's Covenant of Mayors can help cities compile, plan and implement these policies and measures in a consistent and transparent way, allowing for monitoring performance indicators and progress and the exchange of ideas and best practice between cities. The consistency and transparency in this kind of approach can help to expedite the uptake and replication of successful polices/projects and ensure cities get recognition for their accomplishments.

3 EU Policy Framework: Sustainable Energy and Climate Actions Plans (SECAPs)

3.1 The EU Covenant of Mayors for Climate and Energy

The EU Covenant of Mayors (EU CoM) is an alliance of cities, towns and communities voluntarily committed to implementing EU climate and energy objectives at a local level. The initiative was launched in 2008 with the ambition to mobilise local governments to achieving and exceeding EU climate targets. The initiative now has over 10,000 signatory cities, towns and communities across 53 countries. The EU CoM is open to all local authorities democratically constituted with/by elected representatives, whatever their size.

Signatories commit to reducing GHG emissions by at least 40% by 2030 (previously 20% by 2020)[8] to demonstrate at least as much ambition as the EU's Nationally Determined Contribution (NDC) GHG emission reduction target and thereby contribute in a meaningful way to the objectives of the Paris Agreement. Furthermore, signatories agree to develop an approach to understand local climate risks and vulnerabilities, develop related climate adaption plans and consider how to ensure long-term access to secure and sustainable energy.

3.2 The Global Covenant of Mayors for Climate and Energy

The Global Covenant of Mayors for Climate & Energy (GCoM) is a merger between the European Union's Covenant of Mayors and the Compact of Mayors, to create the world's largest initiative for cities and local governments to voluntarily commit to reduce GHG emissions and cooperate on sub-national efforts, develop local low carbon economies and to aggregate and demonstrate the global impact of local action in reducing GHG emissions.

The GCoM provides value to cities by encouraging international cooperation and knowledge sharing, building capacity within local governments to act on climate change and signposting access to finance to implement local climate action. Cities benefit from being a part of a multi-level governance community with a common vision to transition to low carbon, sustainable communities. Meanwhile, the EU CoM platforms and marketing materials provide cities with the political recognition and publicity they desire.

3.3 Sustainable Energy and Climate Action Plan – the Process

3.3.1 Overview

EU CoM signatories commit to adopting an integrated approach to climate change mitigation and adaptation. They are required to develop, a Sustainable Energy and Climate Action Plan (SECAP) with the

[8] The commitments for Covenant signatories are linked to the EU's climate and energy policy framework: the 2020 climate and energy package for signatories who have joined between 2008 and 2015 and the 2030 climate and energy framework as well as the EU Strategy on Adaptation to Climate Change for signatories joining after 2015.

aims of cutting carbon dioxide (CO_2) emissions by at least 40% by 2030 (formerly 20% by 2020) and increasing resilience to the effects of climate change. Members of the EU CoM commit to submitting a SECAP, detailing the key actions they plan to undertake to reduce their 'community-wide' GHG emissions and manage their climate vulnerabilities. The SECAP is also required to have a 'Baseline Emission Inventory' (BEI) to establish the starting point against which GHG emission reduction targets and mitigation actions can be monitored. A Climate Risks and Vulnerability Assessment is also required to map the key risks for the city. The adaptation strategy can be part of the SECAP or developed in a separate planning document.

Effective SECAPs require the allocation of dedicated resources from the municipality (or whoever is coordinating the process) as well as high-level political support. The commitment letter is signed by the local government's mayor (or equivalent) with the expressed support of the municipal council. For the SECAP to be effectively devised and implemented, the involvement of multiple municipal departments and external stakeholders is vital (see Section 4.2 below for more detail).

3.3.2 Climate Change Mitigation

The EU CoM has a focus on reducing GHG emissions not only from the operations of the local government and publicly owned buildings/infrastructure, but also the wider community (i.e. all GHG emissions arising from activity within the geographical boundary). Thus, the aim of the initiative is to engage with local business and industry and citizenry/residents to develop a suite of policies and actions which can reduce emissions across all sectors.

- Energy efficiency in buildings (public, residential, commercial and industrial);
- Low carbon forms of transport;
- Local renewable/low carbon electricity production;
- Local district heating (and cooling);
- Land use planning (i.e. sustainable urban development);
- Public procurement (i.e. encourage markets to offer energy efficient products/services); and,
- Working with citizens and stakeholders (i.e. behavioural changes.

The suite of policies and actions to be included in the SECAP should be developed with a broad stakeholder group to encourage a wide array of interventions and to engage the various groups to commit to the process. The policy and actions developed should contain not only information about anticipated GHG savings, but also energy and cost savings, capital costs and sources of finance and other co-benefits (e.g. improvements in air quality, improved human health etc.) where possible.

3.3.3 Climate Change Adaptation

As well as developing a plan to reduce GHG emissions, the EU CoM now requires that signatories undertake a climate Risk and Vulnerability Assessment and subsequently develop an adaptation plan to address the key risks posed to the city from climate change. These plans can be integrated with the mitigation portion of the SECAP or as a stand-alone exercise.

3.4 Monitoring process

Once EU CoM signatories have developed and submitted a SECAP report (due within 2 years of commitment), there is a requirement to report on the progress of the key actions on a biannual basis to monitor progress towards the stated objectives. Every 4 years, signatories are also expected to provide an updated GHG inventory (known as a 'Monitoring Emission Inventory' or MEI) to demonstrate overall progress towards GHG emission reduction targets.

3.5 EU CoM Support Mechanisms

Multi-Level Governance

One of the key successes of the EU CoM has been the emergence of a large array of stakeholders at all levels of government and society to assist signatories in making their low carbon aspirations a reality. Some of the key players of this 'multi-level governance' arrangement are:

- Provinces/States and Regions (which play a coordination role in the initiative);
- Energy agencies;
- Associations of local authorities;
- National and European financial institutions (which have launched funding and technical assistance schemes supporting SECAP implementation and the development of related bankable investment programmes);
- Academic bodies and universities also play a considerable role in assisting municipalities with the development of their SEAP and emission inventory.

In countries where the EU CoM has been particularly successful (e.g. Spain and Italy), many these organisations' roles in the Covenant are formalised as either 'Covenant Coordinators' or 'Covenant Supporters' (described in the following sections). In those countries, the number of signatories is significantly higher than those without Coordinators/Supporters (cities and communities in Italy and Spain make up approximately 75% of Covenant signatories due to the strong presence of Covenant Coordinators). This demonstrates the value of regional cooperation in coordinating and encouraging participation of local municipalities.

Covenant Coordinators

EU CoM 'Covenant Coordinators' are national or territorial public authorities (provinces, regions, ministries, national energy agencies, metropolitan areas, groupings of local authorities etc.) who offer strategic guidance, technical and financial support to signatories, as well as assisting in recruitment of new signatories. For example, Covenant Coordinators can support signatories in developing their BEIs (and MEIs), Climate Risk and Vulnerability Assessments and in compiling and implementing their SECAPs. This resource has been particularly successful in the EU in raising the participation of local governments for the EU CoM, and the number of Coordinators in EU countries is linked to the number of signatories (i.e. in Italy and Spain).

Covenant Supporters

EU Covenant Supporters are non-government organisations (NGOs) which provide thematic expertise to signatories at international, national and/or regional/local levels (e.g. city networks, energy agencies, thematic agencies etc.). Supporters provide thematic expertise and capacity-building to signatories (i.e. scientific, regulatory, legislative and financial advice) and use their advocacy, communication and networks to promote the EU CoM initiative and support the commitments of their signatories.

Joint SECAPs

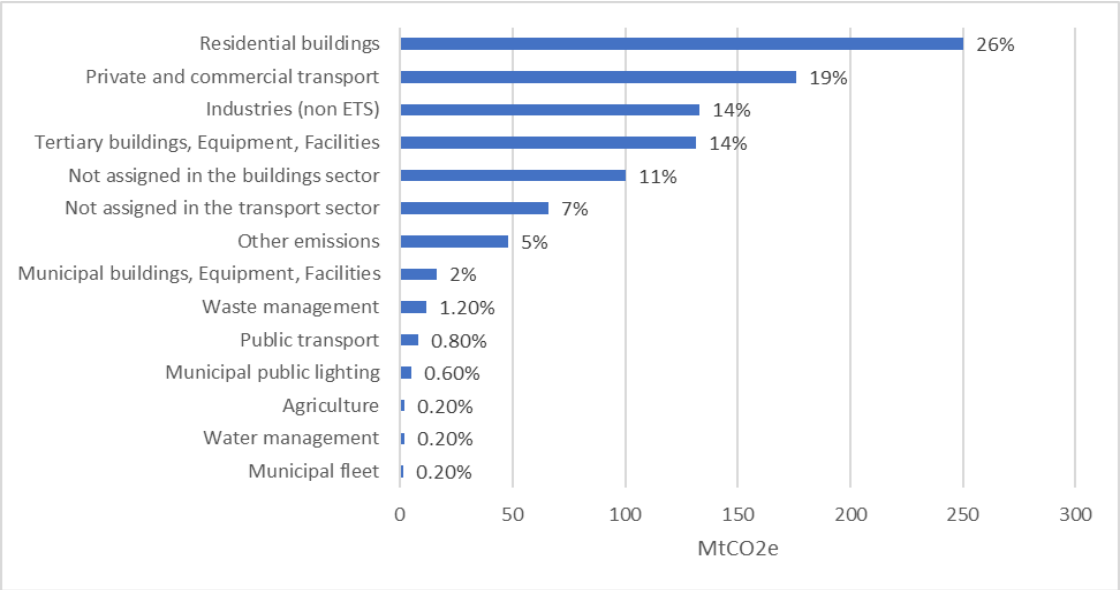
There is an option for EU CoM signatories to group together with neighbouring local authorities and produce a joint SECAP. This approach can ease the burden of developing a SECAP independently, but also offer the opportunity for cooperating on trans-boundary issues such as transport, local energy production, waste management etc. Joint SECAPs create a common vision amongst local authorities and share the effort of preparing emission inventories, assessing climate change impacts and defining actions to be implemented individually and jointly in the territory. In terms of implementation, an economy of scale can also be achieved, reducing costs and enhancing procurement power.

3.6 Collective Impact of EU CoM[9]

The EU CoM currently has over 10,000 signatories, alongside 200 Supporters and 222 Coordinators, representing 53 countries and a combined population of over 250 million inhabitants. The total baseline emissions for EU CoM members was 951 $MtCO_2e$ when last assessed in 2017. Most emissions arise from the building (67%) and transport (26%) sectors. A more detailed breakdown of emission sources from the EU CoM signatories is provided in Figure 3, below.

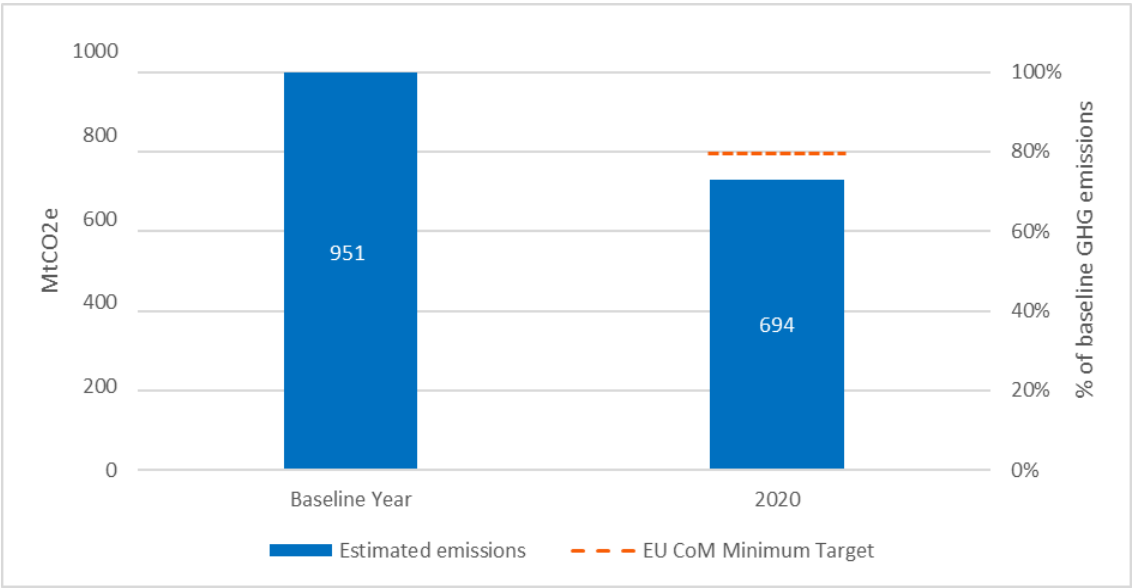
[9] Figures from this section are taken from the *'Covenant of Mayors in figures: 8-year assessment'*

Figure 3: A breakdown of the baseline GHG emission sources by sub-sector for EU CoM signatories[10]



The voluntary commitments put forward by Covenant signatories for 2020 were more ambitious than the EU-level GHG emissions reduction target (see Figure 4), with an overall commitment of 27% reduction compared to total baseline emissions (i.e. an additional 7 %age points higher than the minimum target required by 2020 - 20%). This makes up the equivalent of 31% of the EU's total GHG emission reduction target for 2020 (compared to 2005) and so is highly significant at the EU level.

Figure 4: Baseline emissions, EU CoM minimum target and actual anticipated emissions reductions from EU CoM signatories[11]



[10] Figures taken from the 'Covenant of Mayors in figures: 8-year assessment'
[11] Figures taken from the 'Covenant of Mayors in figures: 8-year assessment'

3.7 SECAPs Enabling Low Carbon Economies

In the context of a 'Low Carbon Economy' the SECAP process provides the evidence to support the GHG emissions trend analysis and determine the rate of decoupling from economic growth. By providing a regular, harmonized approach to assessing city-scale GHG emissions, low carbon economies can be assessed in a consistent manor at the city level. While detailed assessments of the relationship between GHG emissions and GDP growth are not currently commonplace amongst EU cities, there is a growing appetite from cities to demonstrate their ability to improve the livability of a city by showing economic growth alongside environmental improvement and reduced emissions.

In the EU, local governments which have SECAPs in place are more frequently at an advantage when it comes to funding competitions, which can stipulate that climate action plans should be in place. In addition to this, access to climate change specific financing also requires that due diligence has been carried out and 'bankable' projects developed, a requirement similarly supported by the SECAP process. For example, to participate in some of the calls of the EU's Horizon 2020 program, it is essential for the participating cities to have a validated SECAP to be eligible, and the plan has to have been approved by the European Commission's Joint Research Centre (JRC) before the call deadline.

The economic attractiveness of the adoption of many of the low carbon options usually included in the SECAPs, provides a strong incentive for cities to explore the new governance and financing arrangements necessary to exploit these opportunities. In the process, they can create the enabling conditions and momentum for longer-term, transformative change. A first obvious prerequisite for low carbon investment in any city is the political commitment. Thus, the adoption of a SECAP for the city can be very useful to attract the attention of decision-makers, not only those working on environment and sustainability, but also in areas such as economic development that tend to feature more prominently at the heart of urban development policy making. So, having a SECAP in place can help to build broader commitment and consensus to adopting low carbon development strategies and to mainstream climate targets into urban policy. For this reason, several cities no longer see the SECAP process as a cost, but an investment into leveraging new forms of non-traditional finance to support the growth of a low carbon economy.

This initial public investment has an important role to play. Local governments are major energy users and investors in infrastructure and can therefore contribute substantially to climate change mitigation by investing directly in energy-efficient options. SECAPs can help the cities to highlight all the multiple ways in which investments in the low carbon economy could be further encouraged. Tax increment financing, prudential borrowing, and various forms of public-private partnership can emerge in many settings and many more cities could benefit from climate-friendly development assistance and development-friendly climate finance enabling policy framework. Although some of the measures identified in the SECAPs should be economically attractive enough to secure investments on commercial grounds, others would clearly benefit from policy support in various forms, particularly in the early stages of their deployment in a particular context.

3.8 Main sectors of intervention for local governments in the EU CoM

The EU supports a broad suite of policy mechanisms at the European level to improve energy efficiency, encourage renewable energy generation and reduce GHG emissions. This is further augmented by national governments of the EU-28 to implement EU policy nationally and develop related national policy. These policy frameworks have an inevitable impact on how local governments design their suites of policies and measures, taking advantage of top-down policy which will help reduce emissions in their territories (e.g. the 'Energy Performance of Buildings Directive' or the 'Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles'). In addition to this, a large proportion of policies and measures are developed independently at the local level.

The largest contribution to the overall estimated GHG emission reductions by 2020 is expected in the buildings sector (49%), followed by transport (23%). Figure 5, below, provides a breakdown of emissions savings from all EU CoM signatories at the sub-sector level. The chart demonstrates that a large proportion of the anticipated savings will arise from the transport and residential sectors.

Figure 6 provides a breakdown of the anticipated emission reduction by type and demonstrates that a large proportion of the focus is on 'awareness raising and training' (i.e. behaviours/lifestyles) of organisations and inhabitants to foster low-emission behaviours.

Figure 5: A breakdown of estimated GHG emission savings by sub-sector by 2020 for EU CoM signatories[12]

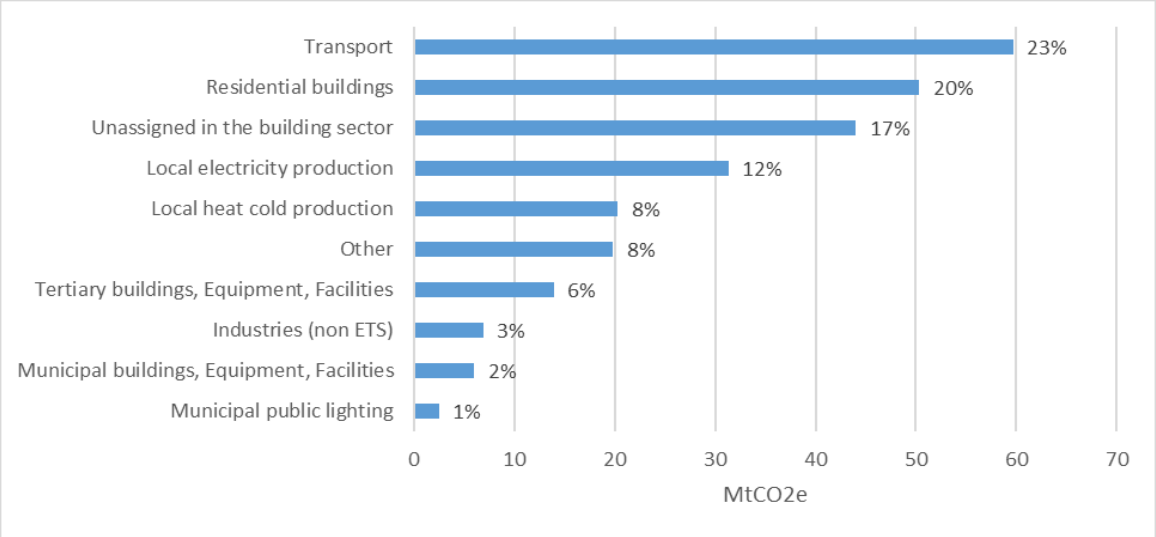
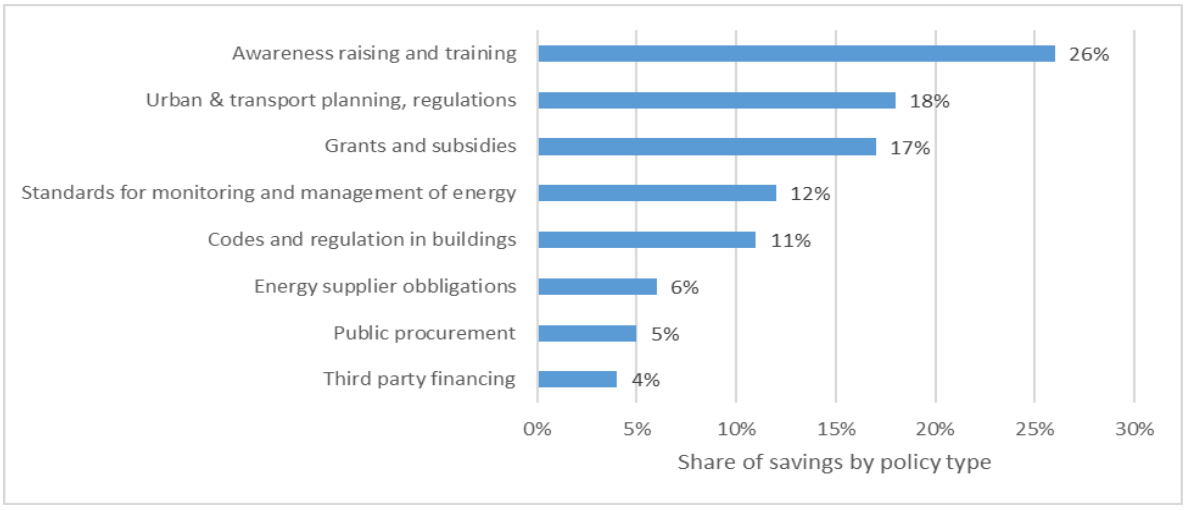


Figure 6: A breakdown of GHG emission savings by action type for EU CoM signatories[13]



[12] Figures taken from the 'Covenant of Mayors in figures: 8-year assessment'. N.B. The 'Unassigned in the building sector' typically compromises policies and measures which effect multiple sub-sectors within the building sector (e.g. building codes).

[13] Figures taken from the 'Covenant of Mayors in figures: 8-year assessment'

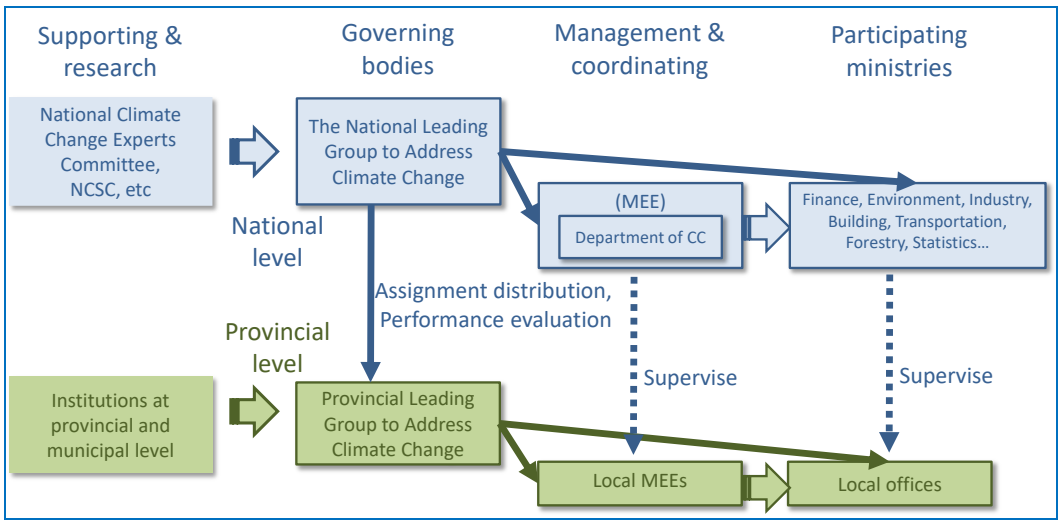
4 Chinese policy framework – The Low Carbon Cities programme

4.1 Governance for low carbon regions and cities

In 2007, the National Leading Group Dealing with Climate Change was set up, with the premier of the State Council as its head and 20 ministers as its members. The NDRC was assigned to set up the department to coordinate and supervise the relevant work. Following that, relevant government departments established functional organs and working mechanisms to deal with climate change work in their own fields. To coordinate the inter-ministry work, a liaison office was set up within National Leading Group Dealing with Climate Change in 2010, and the National Panel on Climate Change was adjusted and strengthened to ensure scientific decision-making.

All provinces, autonomous regions and municipalities directly under the central government have established their own leading groups and working organs to deal with climate change, and some sub-provincial or prefectural cities have also set up offices to tackle with climate change. Relevant departments under the State Council have founded supportive organs such as the National Center for Climate Strategy and International Cooperation of China, and the Research Center for Climate Change, and some universities and scientific institutions have set up their own climate change research organizations. In April 2018, the Department of Climate Change was adjusted from the NDRC to the newly formed Ministry of Ecology and Environment (MEE) during the reform of state institutions. Since then, over the past year, the provincial and city level climate change work has been adjusted to the responsibility of the local ecological and environment department or bureau in succession.

Figure 8: National and local governance structures for climate change (collected by NCSC)



In November 2009, when the State Council proposed China's goal of controlling GHG emissions in 2020, several provinces and cities took the initiative to implement the central government's decisions and deployments. Many regions issued policy proposals for developing low carbon industries, building low carbon cities and advocating low carbon lifestyles. Some provinces and cities independently applied to the NDRC to carry out low carbon pilot work. Since July 2010, China has launched the pilot work of low carbon provinces and low carbon cities and has approved three batches of 87 low carbon pilot areas.

4.2 China's Low Carbon Pilot Project

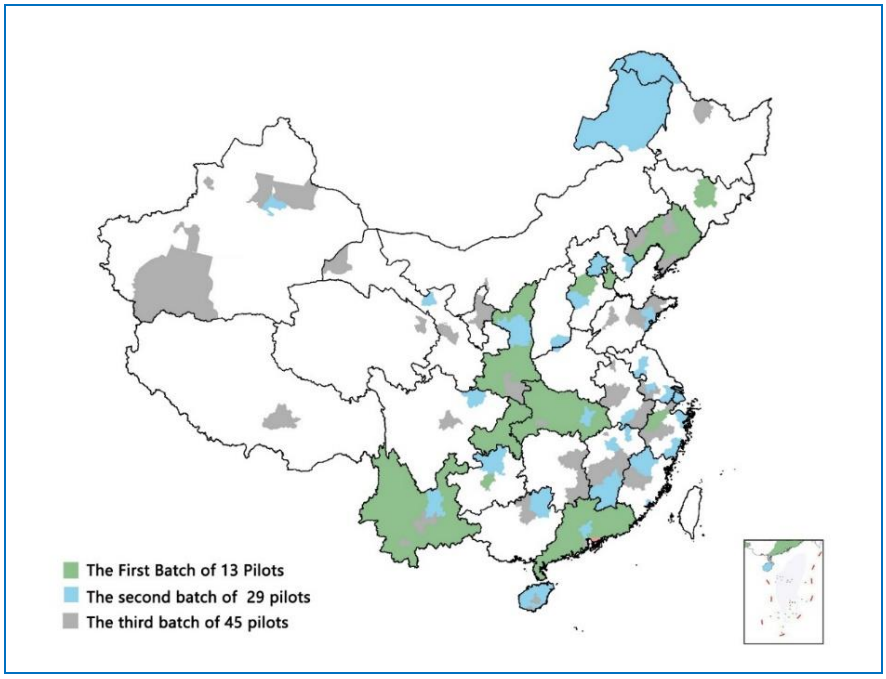
In 2010 the NDRC (China's top agency responsible for formulating and implementing national climate strategies) initiated national Low Carbon Pilot Programme, in which 5 provinces and 8 cities are involved. In 2012, the NDRC further expanded the low carbon pilot to 6 provinces and 36 cities.

With the purpose of exploring new development modes and pathways, providing experiences and demonstrating nationwide low carbon growth, the central government has put forward requirements for the pilots including:

- Work out plans for low carbon development;
- Explore low carbon green development models to fit local circumstances;
- Establish green, environmentally friendly and circular low carbon industry systems;
- Establish statistics and management systems for GHG emissions while establishing a system with goals and obligations to reduce emissions;
- Advocate a low carbon green lifestyle and consumption pattern.

After several years of exploration, the pilot provinces and cities have accumulated some good practices, but also found some deficiencies. In 2017, in order to promote China's low-carbon development and achieve greater results, the NDRC announced the 3rd batch of low carbon pilots, and added two requirements to the pilot: "actively explore and innovate experience and practices" and "improve the management capacity of low-carbon development". Currently, 6 provinces, 4 provincial-level municipalities, 69 prefecture-level cities, 4 county-level cities, 3 countries and 1 district have involved in this low carbon pilot scheme (Figure 9).

Figure 9: Geographical distribution of three batches of low carbon pilots (manufactured by NCSC)



Each pilot province or city formulates its own implementation plan to establish an accountability scheme for meeting the GHG emission controlling target. It strengthens the basic capacity building for the GHG emissions accounting and inventory preparation, and advocates for a green and low carbon lifestyle and consumption pattern. These efforts have yielded positive results in promoting nationwide green and low carbon development. The assessment of the fulfillment of carbon intensity targets during

the 12th FYP period showed that the decrease of carbon intensity in the pilot provinces and cities was significantly higher than the national average.

The focus of the work for pilot cities on low carbon development falls under 5 themes:

i. Exploring low carbon development by making a low carbon plan

A total of 33 pilot provinces and cities have made low carbon development plans, 22 of which have been published and 13 of which have been implemented. The pilot cities have incorporated low carbon development goals into their FYPs. During implementation of the plans, some pilots have defined targets and identified key working areas and high-profile projects. These pilots are actively exploring appropriate development patterns that take the local development status, emissions profile, natural environment and industry structure into account to maximize their effectiveness.

ii. Building low carbon development systems and policies in line with the national peaking target

28 pilot provinces and cities have proposed their peaking targets; 13 of which plan to achieve their emission goal by 2020 while 6 plan to attain the goal by 2025. Beijing, Shenzhen, Guangzhou, Wuhan, Zhenjiang, Guiyang, Jilin, Jinchang, Yan'an and Hainan have joined the "City Peaking Advancement Alliance", declaring their emission goal as well as their policies and action plans to achieve them. Based on deep research of peaking targets and implementation routes, the low carbon pilots have continued to promote scientific understanding and political consensus of the peaking target, strengthen low carbon development goals and enhance low carbon development systems and policy innovation in order to deliver a decisive shift in low carbon development.

iii. Promoting low carbon industrial systems through low carbon technology projects

Low carbon pilot projects have been pushing the service industry and other newly developed industries to upgrade compared to traditional industries by using low carbon technologies. By promoting low carbon development in industries such as energy, construction, transportation and other key sectors, the pilot projects help build a modern industrial sector, characterized by lower emissions. 29 pilot provinces and cities have set up special funds for low carbon development or energy saving and emissions reduction, providing financial support for low carbon technologies, projects and industries. Hainan province was the first to propose "low carbon manufacturing" as one of its main development goals and has highlighted low carbon manufacturing as one of the 12 key industries in its 13th FYP, making it important to promote economic growth under the new regulation. During the "Twelfth Five-Year Plan" (12^{th} FYP: 2011-2015), 9 pilots reached a higher reduction rate of carbon emission per unit of GDP compared with the country's average level, indicating the positive effect of low carbon economic transformation brought out by building a low carbon industry system.

iv. Continuing to strengthen the support system for low carbon development by building a management framework

All pilot cities and regions have started to develop their territorial GHG emission inventories. 10 pilots have built up GHG emissions statistics and accounting system for high-emission enterprises. 17 pilot cities have built their carbon emissions data management platforms to track carbon emissions for sub regions, key industries and main enterprises. A total of 41 pilot provinces and cities have set up climate change and low carbon development leading groups, 18 of which have set up dedicated departments. There are 29 pilot provinces and cities which have distributed targets and tasks for carbon emission intensity reduction to a district level, 22 of which have also evaluated and assessed the decomposition of targets to strengthen the transmission of target accountability and pressure on local governments.

v. Promoting public participation by encouraging a low carbon lifestyle

Pilot regions have built innovative low carbon communities. They promote the participation and buy in of the public by encouraging low carbon behaviours and popularizing low carbon as a “fashion” through a series of innovative activities including posting information on low carbon lifestyles, establishing low carbon community stations and piloting systems of carbon points, carbon coins, carbon credit cards and carbon generalized system of preferences (GSP). Carbon GSP quantifies and values the reduction in carbon emissions achieved by people's action. It also allocates corresponding 'carbon tokens' that can be used to purchase credits in the carbon market. There are 14 pilot provinces and municipalities that have carried out low carbon product certification to promote low carbon production and consumption. Some pilot provinces and cities have set up institutions such as research centers, low carbon development committees and councils and associations to encourage further public participation.

5 Main challenges faced by European cities in the low carbon transition

5.1 Financing mitigation policies and measures[14]

The significant success in encouraging EU cities, towns and communities to join the EU CoM and develop SECAPs has been unprecedented, thanks in part to a strong, multi-level governance approach to promoting and supporting the initiative. The key challenge for those signatories which have developed their SECAPs and proceeded to the implementation phase has been in identifying and securing sources of finance to execute the various policies and measures identified to reduce GHG emissions. There is a variety of finance options available at the local level, but there is a lack of awareness about those options, especially the more innovative and non-traditional equity and debt mechanisms (e.g. European-level investment funds and funding programmes; revolving funds; green bonds). Disseminating information on available sources of finance to cities has been a key challenge in the EU and many municipalities are still unaware of the sources of finance available to them. Municipalities typically rely primarily on public funds or traditional lending; however many cities do not have sufficient credit ratings to effectively utilise the latter.

In response to this issue, the EU CoM and its supporters have launched a variety of resources to raise awareness and change the way municipalities consider climate finance. For example, the EU CoM website contains information and links to details to guide cities through the financing landscape in Europe (see Figure 10 below) including detailed descriptions of the financing available, case studies where the various sources have been utilised and links to external websites and application information. This has been supplemented with a range of capacity-building training, delivered through the EU CoM Supporters network and other affiliates.

[14] Financing climate action (CoR)

Figure 10: Financial mapping to help cities in the EU Covenant of Mayors to access financing for policies and measures[15]

5.2 Effective governance structures and stakeholder buy-in

While the EU Covenant of Mayors process is typically run by municipalities' environmental and economic functions, the successful design and implementation of a SECAP relies on a broad group of municipal departments, external stakeholders and the citizenry. Thus, a specifically organised governance structure is key to enabling the process to be successful, as well as a dedicated resource to coordinate the work. If possible, the governance model should incorporate a 'triple helix' approach, engaging industry, academia and government to encourage knowledge-based innovation and economic development. A lack of coordination between these groups has proven to lead to ineffective or unimplementable policies and actions.

Within the municipality, multi-departmental and cross-sectoral participation is necessary (see Figure 10 below for a 'best-practice' example). For example, if considering a policy for high-density, transport-oriented development, representation from the environmental, transport, planning, economic and social welfare departments (or equivalents) would be beneficial for developing effective proposals, aligned with the independent mandates and organisational targets of each department. In some instances, convening under the banner of the SECAP has proven too narrow a topic to warrant significant cross-sectoral involvement, so consideration should be given to the internal branding and remit of the group (e.g. Sustainable City, Low Carbon Economy etc.). The governance structure should also be formalised with roles and responsibilities allocated.

In terms of external stakeholders, all members of society can play a role in addressing the energy and climate challenge with their local authorities, but clearly input needs to be controlled. Collectively, a broad stakeholder group[16] should define the overarching vision for a low carbon, economically healthy city. This type of broad consensus improves the quality, acceptance, effectiveness and legitimacy of the plan.

[15] https://www.covenantofmayors.eu/support/funding.html

[16] Suggested stakeholders from: local and regional energy agencies; financial partners (banks, private funds, ESCOs); institutional stakeholders (chambers of commerce, chambers of architects and engineers); energy suppliers/utilities; private/public transport companies; building companies/developers; business and industries; energy agencies;.

Stakeholder involvement not only assists in the stimulating behavioral changes of the individuals/groups of individuals but can also leverage independent commitments and/or contributions towards the associated goals. External stakeholders[17] also frequently identify policies or projects that were not known to the municipality. In some instances, local governments have forged strong relationships with the local private sector and encouraged businesses to make voluntary commitments towards reducing their GHG emissions locally (e.g. the city of Oxford, UK).

During the initial stakeholder engagement phase, it is key to identify if and where the SECAP can directly benefit the relevant organisations (e.g. bus companies can benefit from enhancements in public transport; fuel poverty NGOs can benefit from building energy efficiency etc.). This approach can encourage a deeper buy-in from stakeholders to proactively contribute to the process in the long-term.

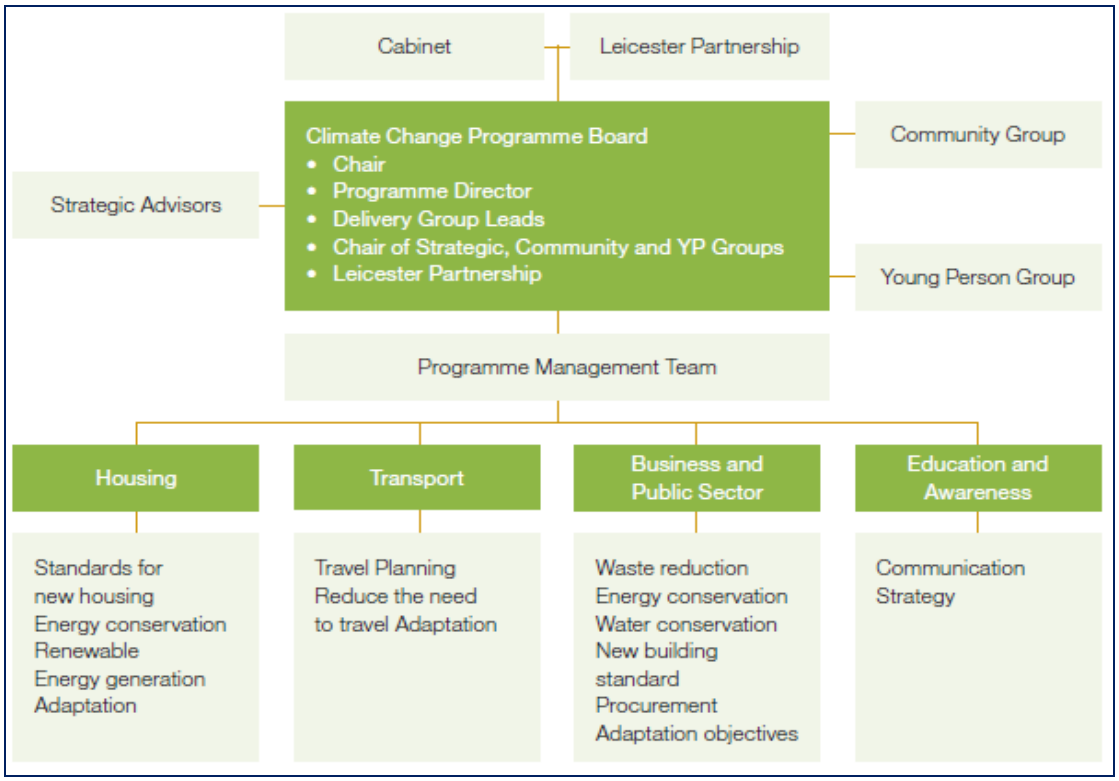
The more progressive cities in the EU are now considering climate change (and energy efficiency/independence) as a key consideration/category for infrastructure and investment decision-making. This development can assist cities in assessing the indirect costs of climate change (e.g. climate hazards and related infrastructure liabilities; health costs associated with air pollution; energy dependency) and make more informed decisions to create better economic strategies. Beyond the economic decisions, the other 'co-benefits' of climate action can also be considered (i.e. healthier citizens, more socially connected cities) to create more liveable, vibrant cities.

In order to support EU cities in creating effective governance structures and decision-making processes which support effective action on climate change, the EU CoM provides guidance and training. 'Support Structures' have also been created at the EU, national and regional levels to provide technical assistance, identify financial opportunities and train public officers.

Figure 11: An example of a best-practice administrative structure for the City of Leicester[18]

[17] NGOs and other civil society representatives; civil society (including students); universities; national/regional administrations and/or neighbouring municipalities

[18] Source: EU CoM Guidebook



5.3 Lack of Evidence on Cost of Climate Change and Economic Benefits of Climate Policy

The climate change narrative in the EU (and globally) has shifted from being primarily focused on environmental concerns, to focus more on economics and risk. Credit rating agencies are now assessing the vulnerability of cities and how they are managing climate risks and resilience in developing ratings and credit worthiness. These economic costs of climate change (sometimes referred to as the costs of inaction), are increasingly prominent in the climate policy debate. It is estimated that extreme climate events cost Europe €400 billion between 1980 and 2013[19]. The minimum cost of not adapting to climate change is estimated at €100 billion/year in 2020 and €250 billion/year in 2050 for the EU[20].

In order for cities to respond to this fiscal risk, it is becoming increasingly common for local governments to consider these costs when developing climate change mitigation and adaptation plans, but this practice is still not common. Developing and disseminating a better understanding of the costs of inaction in Europe is a key priority to assist cities in making informed decisions.

In addition to the potential risks and costs of climate change, there is also a growing body of evidence which supports the economic, environmental and social 'co-benefits' of climate action. For example, a policy to transition from private vehicle to public and active modes of transport can improve:

- **Social:**
  - Reduced respiratory diseases from air pollutants;
  - Reduced injury and mortality from road accidents;
  - Improved mobility of citizenry;
- **Economic:**
  - Increased productivity from healthy citizenry and reduced travel times;

[19] https://www.eea.europa.eu/highlights/climate-change-poses-increasingly-severe
[20] https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf

- Reduced health costs from air pollutants;
- Municipal revenues (e.g. congestion charges, public transport revenue, parking fees);

- **Environmental:**
  - Improved air quality (reduced PM, SO2, NOx and other pollutants);
  - Reduced noise;
  - Reduced congestion.

Numerous other co-benefits can arise from other climate change mitigation policies and measures, relating to improved energy security, alleviating fuel poverty, a more resource efficient economy etc. More generally, these aspects all contribute to improving the "liveability" and attractiveness of a city, encouraging more inward investment, immigration of businesses and inhabitants and improved tourism.

Despite the concept of co-benefits being widely accepted by the scientific community, there is a lack of quantified data to make economic decisions and therefore cities struggle to justify investment accordingly. A deeper understanding of this type of economics needs to be reached in order for these criteria to be accurately assessed as part of the decision-making process, especially as it relates to infrastructure investment.

6 Main challenges faced by Chinese cities in the low carbon transition

Low carbon development is a long-term, complex and systematic process with no end. With the advancement of related projects, some deep-rooted problems, contradictions and challenges have emerged. Firstly, there is no consensus on what makes an 'ambitious goal', and even after a goal has been set, plans have not been implemented effectively to peak emissions and there is insufficient motivation to promote institutional innovation.

There are also problems such as weak data baselines, poor building capacity, inertia in top-level policy design and a lack of fiscal policy. More research must be carried out to achieve consensus and make for greater breakthroughs. Further issues are summarised as follows:

1. **<u>The low carbon concept must be further understood and developed</u>**

In spite of the fact that green and low carbon concepts have become key elements of China's development in recent years, some pilot cities still consider low carbon as simply a part of energy conservation and emissions reduction and fail to understand the broader content of the low carbon concept. Local governments have failed to merge the low carbon concept into their regional economic and social development practices and/or failed to put the low carbon concept into local and urban planning processes. Private enterprises from pilot cities have not integrated the low carbon concept into their decision-making processes, showing the lack of social responsibility and asset management. Finally, there is a lack of public awareness of low carbon development, low carbon lifestyles and green consumption patterns.

2. **<u>Low carbon development goals must be strengthened to drive economic transformation</u>**

The '*12th FYP*' identified the carbon intensity reduction target as a mandatory index for the *National Plan for Economic and Social Development*, but there are still some pilot cities whose low carbon development goals do not reach the national level of ambition. Low carbon development goals are not clear and have not yet been included into the local economic and social development planning or the

annual plan. Low carbon targets are not advanced enough, which in turn makes it impossible to constrain local industries and other social and economic activities.

3. GHG emission targets should be optimized to drive green development

In early 2015 China proposed "to peak CO_2 emissions by 2030 and will try to peak as soon as possible", however some cities have not yet understood or recognized the relevance of the peaking target and their provincial or municipal strategic perspectives. The peaking target is regarded as a limit on local development thus cities lose motivation while others have not fully understood the strategic significance of the peaking target and have failed to promote scientific research to clarify the importance of developing a provincial or municipal peaking trajectory. A number of those cities which have proposed peaking targets based on preliminary studies still have issues such as a lack of robust data, poor understanding of the new normal of economic development and absence of social consensus. More ambitious cities have included a maximum emission target into their plans based on scientific research but have not yet put them into practice in different industries and different areas.

4. Understanding of low carbon systems needs to be strengthened

Although low carbon pilot projects in China have already set emissions limits on key construction projects, developed low carbon institutional mechanisms and green development patterns, they are still focused on promoting economic development and looking for policy and financial support. Several cities do not fully understand the requirements of the overall national plan or taken regional characteristics into consideration which has led to a failure to produce policies promoting low carbon development. Although some of the pilot cities have instigated research of low carbon systems and put forward plans for building new systems, they have given up easily when encountering problems or challenges rather than working to overcoming those obstacles. In addition, there are management and governance issues.

5. The quality of emissions data must be improved to provide a robust foundation

Although the nation has required pilot cities to develop GHG inventories, strengthen GHG emission statistical work and establish a sound statistics and accounting system, they have still failed in building such a system, And the emission data management is "Inaccurate". The data collection systems in some pilot cities are weak, resulting in non-transparent, inconsistent and incomparable data. There are also some problems in some pilot areas, such as imperfect basic statistical system, defective working mechanism, unstable organization and personnel, and inadequate funding guarantee.

6. Collaborative governance capacity needs to be improved

The functions of addressing climate change and emission reduction were transferred to MEE in 2018, and the requirements of enhancing the coordination between addressing climate change and environmental pollution prevention were more prominent. Addressing climate change involves a very wide range of content, which requires the department responsible for climate change (now is the ecology and environment system) to take the lead in coordination, with the cooperation of various relevant departments, and the full participation of local and industry. At present, the coordination mechanism at the department level and the relevant coordination mechanism needed to be established by the local government after the completion of institutional transfer are not perfect, and the exchange platform for emission control and pollution control work has not been established.

7 Main Instruments Available for Local Governments: Comparing Chinese and EU cities

7.1 EU suite of policies

The recent EU climate policy framework has been developed based on two specific time-horizons, 2020 for the Kyoto Protocol Second Commitment Period (2013 – 2020) and 2030 for the Paris Agreement (post 2020) and to reflect the increasing ambition within the EU to tackling climate change while increasing resilience and secure access to sustainable, low carbon energy. The European Commission is currently working towards the objectives of the 2030 Framework; however, the preceding 2020 Framework is still being actively monitored to determine if the targets will be achieved.

7.1.1 EU 2020 Framework[21]

The 2020 Framework is a set of binding legislation (enacted in 2009) to ensure the EU-28 meets its climate and energy targets up to the year 2020. The package sets three key targets:

1. 20% cut in GHG emissions (from 1990 levels)
2. 20% share for renewable energy
3. 20% improvement in energy efficiency

To meet these targets, the EU is taking action in all sectors and for all sources of GHG emissions:

- **Emissions trading system (ETS) -** the EU's key tool for cutting GHG emissions from large-scale facilities in the power and industry sectors, as well as the aviation sector. The ETS covers around 45% of the EU's GHG emissions. In 2020, the target is for the emissions from these sectors to be 21% lower than in 2005.
- **National emission reduction targets -** covers the sectors not in the ETS – accounting for some 55% of total EU emissions – such as housing, agriculture, waste and transport (excluding aviation). EU countries have taken on binding annual targets until 2020 for cutting emissions in these sectors (compared to 2005), under the "Effort-sharing decision".
- **Renewable energy – national targets -** EU member countries have also taken on binding national targets for raising the share of renewables in their energy consumption by 2020, under the Renewable Energy Directive. The target includes a 10% share of renewables in the transport sector.
- **Innovation and financing -** The EU supports the development of low carbon technologies for example through the NER300 programme (for renewable energy technologies and carbon capture and storage) and Horizon 2020 funding for research & innovation.
- **Energy efficiency -** Measures for increasing energy efficiency are set out in the 'Energy Efficiency Plan' and 'Energy Efficiency Directive'.

Central to this suite of action is the understanding in the EU that achieving the goals of the 2020 package will help increase energy security (reducing dependence on imported energy and contributing to achieving a European Energy Union), while creating jobs, advancing green growth to make Europe more competitive.

7.1.2 EU 2030 Framework[22]

The 2030 climate and energy framework set three more ambitious targets for the year 2030:

1. At least 40% cuts in GHG gas emissions (from 1990 levels)[23]

[21] Reference: https://ec.europa.eu/clima/policies/strategies/2020_en
[22] Reference: https://ec.europa.eu/clima/policies/strategies/2030_en

2. At least 32% share for renewable energy
3. At least 32.5% improvement in energy efficiency

It builds on the 2020 climate and energy package while considering the longer-term perspective for moving to a competitive low carbon economy in 2050. This additional ambition will require some enhancements to the existing EU mechanisms:

- **Emissions trading system (ETS) -** sectors would have to cut emissions by 43% (compared to 2005) – to this end, the ETS is to be reformed and strengthened.
- **National emission reduction targets -** non-ETS sectors would need to cut emissions by 30% (compared to 2005) – this needs to be translated into individual binding targets for Member States.
- **New governance system -** a transparent and dynamic governance process will be further developed to help deliver the Energy Union, including the 2030 climate and energy targets, in an efficient and coherent manner.

The continuation of the 2020 Framework approach helps ensure regulatory certainty for investors and coordinate EU countries' efforts. The framework helps drive progress towards a low carbon economy and build an energy system that ensures:

- affordable energy for all consumers;
- increases the security of the EU's energy supplies;
- reduces our dependence on energy imports;
- creates new opportunities for growth and jobs; and,
- environmental and health benefits (e.g. through reduced air pollution).

7.1.3 The European Green Deal

On December the 12th 2019, the European Commission presented the European Green Deal, a roadmap for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition 'just and inclusive for all'. As illustrated in Figure 7, the Green Deal provides a new roadmap with actions to transform the EU into a modern, resource-efficient and competitive economy where:

- there are no net emissions of greenhouse gases by 2050;
- economic growth is decoupled from resource use; and,
- no person and no place is left behind.

It outlines 1 trillion Euros of investments needed and financing tools available and explains how to ensure the just and inclusive transition. The Green Deal covers all sectors of the economy, notably transport, energy, agriculture, buildings and industries (such as steel, cement, ICT, textiles and chemicals).

[23] This target will be revised upwards with the introduction of the EU Green Deal

Figure 7: The various elements of the European Green Deal24

Achieving the ambitious targets that the European Commission has set out for mitigating and adapting to climate change and for protecting the environment under the Green Deal (and its associated actions and timeline) will only be possible with the involvement and efforts of all levels of government. Reaching this target will require action by all sectors of our economy, including:

- investing in environmentally friendly technologies;
- supporting industry to innovate;
- rolling out cleaner, cheaper and healthier forms of private and public transport;
- decarbonising the energy sector;
- ensuring buildings are more energy efficient; and,
- working with international partners to improve global environmental standards.

Cities, in particular, are crucial for effective climate action and for the Green Deal architecture. More than 70% of European citizens live in cities, and urban areas are responsible for most emissions and air pollution. However, cities are also indisputable pioneers with respect to innovation, climate ambition, resilience and sustainable development. They are also home to diverse and often vulnerable populations, such as refugees and migrants, low-income citizens, and others, who must be proactively included in climate policies and initiatives to ensure that the Green Deal leaves no one behind and is built on a strong 'European Social Pillar'. The EU will also provide financial support and technical assistance to help people, businesses and regions that are most affected by the move towards the green economy. This is called the Just Transition Mechanism and will help mobilise at least €100 billion over the period 2021-2027 in the most affected regions.

[24] Figure taken from the communication from the Commission to the European Parliament, COM (2019) 640 final

7.1.4 Instruments for Cities[25]

The EU offers a comprehensive suite of policies and mechanisms to reduce GHG emissions and encourage low carbon economies across its member states. In addition to these 'top-down' approaches to low carbon development, various initiatives, policies and funding streams have been introduced to enable 'bottom-up' action on climate change.

1. **The EU Covenant of Mayors** – as discussed previously is the main EU instrument for action on climate change from local government. Signatories commit to reducing GHG emissions at a level at least as ambitious as the EU-level commitments, currently a reduction of at least 40% by 2030 (previously 20% by 2020).
2. **Funding for cities under the European Structural and Investment Funds (ESIF)** – the European Regional Development Fund (ERDF) for 2014-2020 stipulates a mandatory minimum spending for the low carbon economy (20% of national ERDF resources in more developed regions, 15% in transition regions and 12% in less developed regions). The purpose of the funds is to invest in job creation and a sustainable and healthy European economy and environment. €40 billion from the ERDF and Cohesion Fund will be invested in the low carbon economy during 2014-2020. This will help Member States, regions, local government and cities to invest in energy efficiency, renewable energy, smart grids, sustainable transport and in research and innovation in these areas.
3. **URBACT 2014-2020 network** - URBACT is a European exchange and learning programme promoting sustainable urban development. It enables cities to work together to develop solutions to major urban challenges, reaffirming the role they play in facing increasingly complex societal changes. URBACT also helps cites to develop pragmatic solutions that are new and sustainable, and that integrate economic, social and environmental dimensions. Some 500 cities and regional authorities are already involved, and the number is growing. It is helping to advance climate change mitigation and adaptation actions as part of addressing urban challenges.
4. **The European Green Capital Award** - The European Green Capital Award (EGCA) recognises and rewards local efforts to improve the environment, the economy and the quality of life in cities. The EGCA is given each year to a city that is leading the way in environmentally friendly urban living and which can act as a role-model to inspire other cities.

7.2 China

7.2.1 Legal Framework for Low Carbon Development of Cities and Regions

The primary existing legal framework for regions is based on China's Carbon Emission Trading system. The NDRC took the lead to conduct the research on legislation and drafting of the associated Climate Change Law (2011) and solicited opinions widely from stakeholders in this regard. The legislation process for the new law and the Regulation on the Management of Carbon Emission Trading was developed. The governments of Shanxi, Qinghai, Shijiazhuang and Nanchang subsequently launched the regulations on climate change and low carbon development at the local level. Other relevant laws include:

- China improved capacity for resource utilization efficiency and promoting low carbon and cleanliness in the production process by enacting ***Clear Production Promoting Law*** (2002).
- In 2005, the Chinese government improved the management of renewable energy development and further explored the potential of non-fossil fuel resources by enacting the ***Renewable Energy Law*** and adopted amendments in 2009.

[25] Reference: https://ec.europa.eu/clima/policies/international/paris_protocol/cities_en

- In 2007, China introduced ***Energy Conservation Law*** to protect and improve the ecological environment, reduce carbon emissions and achieve sustainable development through detailed regulations on reducing energy consumption.
- In 2008, China adopted the ***Circular Economy Promotion Law*** to actively promote the development and utilization of resources, reduce GHG emissions while also enacting corresponding laws for air pollution, solid waste pollution and water pollution.
- In 2009, Chinese government demonstrated China's views, opinions and positions on climate change and improved corresponding laws and regulations through the ***Resolution on Making Responses to Climate Change*** enacted by National People's Congress.
- In 2019, MEE released the **Interim Regulations on the management of Carbon Emission Trading (Draft for comments)**, focusing on promoting the promulgation of the Regulations as soon as possible to lay a legal system foundation for the construction of carbon market.

7.2.2 Low Carbon Development System

In the field of addressing climate change at the regional level, the main systems are the Target Responsibility System and the Carbon Emission Trading System:

1. **Target Responsibility System - Building a target responsibility system for carbon intensity reduction**

China has adopted a decentralisation of CO_2 emissions per capita GDP reduction target in its 12th FYP Period (2011-2015), assigning targets to all provinces (including the autonomous regions and municipalities directly under the central government) and set up a target responsibility assessment system. In 2013 the NDRC, together with the relevant departments, formulated assessment measures and made a tentative assessment of the completion of the GHG emission control target, the implementation of tasks, measures and the basic work and capacity building undertaken at the provincial level.

2. **Carbon Emission Trading System - Carrying out carbon emission trading pilots**

In 2011 the NDRC selected seven provinces and cities (Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen) to carry out carbon emission trading pilots, exploring market-based mechanisms to control GHG emissions. The seven provinces strengthened the top-level design for carbon emission trading pilots, introducing local enactments and government regulations; establishing carbon emission measurement, report and verification systems; finalizing the allocation method for carbon emission quotas, trading rules and the mechanism for fulfilling responsibilities; and established carbon emission trading platforms and registration systems. Carbon emission trading markets that consist of complete institutional elements and local features have begun to take shape in these pilot provinces and cities. The local governments carried out work on monitoring and supervision over the carbon markets, the fulfilment of responsibilities and law enforcement.

In June 2013, the first carbon emission trading market was launched in Shenzhen. By the end of 2015 seven pilot carbon emission trading markets were launched, involving over 20 sectors and more than 2,600 key emission enterprises, with a total quota of 1.24 Gt CO_2e imposed each year. The enterprises involved in carbon emissions trading markets in Beijing, Tianjin, Shanghai, Guangdong and Shenzhen have completed two rounds of fulfilment of responsibility. The seven pilot carbon emissions trading markets have completed the trading of quota of around 67 Mt CO_2e, with an accumulated trading volume up to around RMB 2.3billion. As of September 2016, the seven pilot carbon markets covered nearly 3,000 key enterprises from more than 20 industries and traded 197 $MtCO_2e$, involving a total turnover of about RMB 4.52 billion. China's carbon market was officially launched on December 31, 2017.

8 Main sources of financing for local governments in the EU

Local governments need to raise sufficient resources or improve the efficacy of expenditure sufficiently to fill the urban infrastructure financing gap. In Europe, most public investments in infrastructure are carried out by local authorities. These investments give opportunities for the private sector to grow, while, at the same time, improving the living conditions for the general public. Financial competences are one of the most important elements of local government autonomy. The degree of local government autonomy is defined, mostly, through the functionality of the local government's financial system. It is built based on three main sources:

1. Local taxes on wealth, business' activity or incomes;
2. Tax on local services or payments from exploiters of services given by local government; and,
3. Grants from the highest levels of government (central/regional national government and European funds) and loans from capital funds.

Traditionally local taxes have been the main financial source in those countries where local authorities have more autonomy. On the contrary, state grants were the main source in centralized states where local taxes were much less important. Meanwhile, it is obvious that the increase of funds in the incomes from the central government for the local government leads to the increase of central monitoring on finances and local administration politics. The degree of local autonomy can be evaluated based on how much real freedom the local councils have to increase the incomes from these sources as well as to what degree they are allowed to spend the incomes where they consider it to be most useful.

In the EU, Public-Private Partnership (PPP) is brought forward as a solution for local authorities. One feature of a PPP project is that the private side of the cooperation finance the project. This is always more expensive (at least in Europe) compared to if the local authority would have borrowed the required funds themselves. This means that other efficiencies in the project have to out-weigh the higher costs of funds.

The quest for low-cost, low-risk financing has led to the trend that more and more EU countries explore the possibilities to set up Local Government Funding Agencies. The existing agencies work in a self-controlling way: for the agency to be successful in the capital markets, the local authorities (members or shareholders in the agency) must have good credit worthiness. The agencies have controls in place to supervise their members and act as soon as any deterioration is detected in one of the member's financial situation. These routines are crucial for the agency's rating and, hence, for their success in the capital markets. This is also an efficient brake mechanism against excessive borrowing on the side of the local authorities. A Local Government Funding Agency relieves central government from many aspects of the monitoring of local government. Finally, a market-based approach, with the checks and controls of an agency, tends to be more efficient than a system where central government controls local financing through borrowing restrictions.

9 Main sources of financing for local governments in China

In the Chinese context, financing a broadly categorised in 4 ways:

1. **The direct financing channel** is through the Chinese carbon market. China has huge carbon market potential, generating about a third of the world's emissions. However, as it relates to finance, China's carbon market system is still in the exploratory stage. Compared with the international carbon finance market, there are many problems, such as the imperfect carbon finance system; the imperfect carbon trading system; the lagging development of the intermediary market; and the lack of understanding of carbon finance among enterprises and

financial circles. By the end of 2015, the cumulative trading volume of CCER in the seven pilot carbon markets was about 36 $MtCO_2e$. As of August 2016, the NDRC had approved 5,074 'Chinese Clean Development Mechanism' (CCDM) projects, most of which were concentrated on renewable energy (3,733) and energy efficiency (632).

2. **The indirect way of financing** is 'Green Credit'. With the introduction of national and local green credit policy, banks play an important role in the implementation. Several publications have provided guidance on access to climate finance[26].

   Each bank has developed a management system and method for internal credit environment risk control. At the same time, commercial banks at all levels are actively exploring business opportunities related to green credit. They develop various types of financial products to take environmental responsibility and achieve corporate profits. For example:

   - Industrial Bank first promoted "energy efficiency loans" in 2006;
   - Bank of Communications formulated the "Green Credit Implementation Measures";
   - Industrial and Commercial Bank of China has summed up 90 green credit standards and 125 national industrial policy standards in the industry credit policy;
   - Agricultural Bank of China strengthened the linkage between the industry credit policy and the national industrial policy and implemented the "one vote veto system" for environmental protection;
   - Construction Bank formulated the "Working Plan for the Implementation of the China Banking Regulatory Commission's Green Credit Guidelines" to determine the green credit development strategy;
     China Merchants Bank formulated the "Measures for Promoting the Implementation of the Green Credit Plan" and the "Administrative Measures for the Classification of Green Credits for Public Loans".

3. Special funds for climate change are major finance resources in **innovative financing**. In August 2006, the State Council approved the establishment of CCDM, which is a policy fund managed in accordance with the social fund model to offer grants, compensate use and support national efforts to address climate change and achieve value-preservation. CCDM grantees support activities conducive to strengthening climate change capacity-building and raising public awareness of climate change. The main ways of carrying out the paid use business of the clean fund include the following three types:
   - Clean Development Entrustment Loan: loans granted by Chinese-funded banks entrusted by the Clean Fund for the provincial finance department in response to climate change, with a maturity of no more than three years and interest rates floating 15% above the PBOC's guiding interest rate.
   - Equity Investment: at the end of 2011, the clean fund invested in Shanghai Environmental Energy Exchange to actively promote the construction of the domestic carbon market in the future, and thus promote the development of certification, consulting, exhibition, finance and other related services in low carbon areas.

[26] 'Opinions on implementing environmental protection policies and regulations to prevent credit risks' (State Environmental Protection Administration, the People's Bank of China, and China Banking Regulatory Commission); 'Guiding Opinions of the People's Bank of China on Improving and Strengthening Financial Services in the Field of Energy Conservation and Environmental Protection' (People's Bank of China in 2007); 'Green Credit Reference' (China Banking Regulatory Commission in 2012); 'Green Credit Statistical System' (2012); 'Key Evaluation indicators for the implementation of Green Credit' (released in in 2014).

- Cash Management: the ability of banks and other partners to invest in energy conservation and emissions reduction through low carbon cash management and other means, meanwhile leveraging social funds to further support the development of low carbon economy.

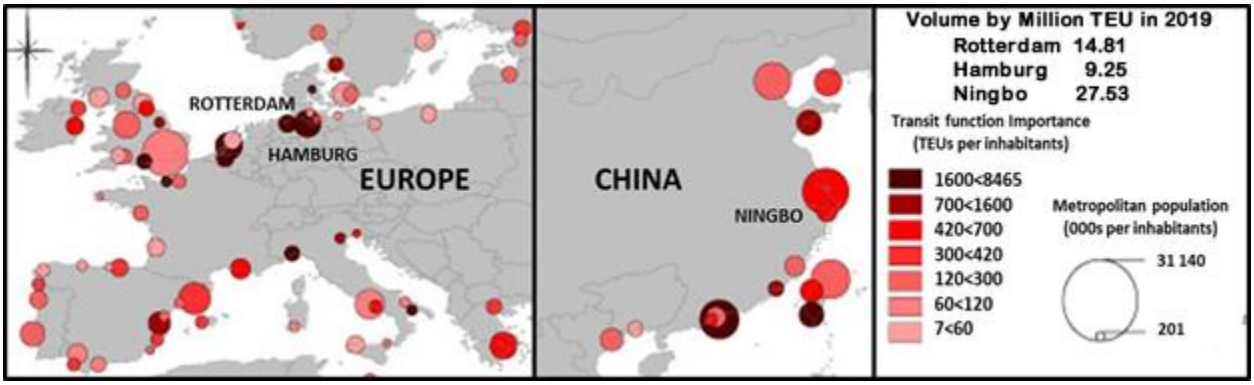
4. In recent years, China has introduced a series of **fiscal and taxation policies** for the direct purpose of promoting energy saving and reducing emissions, which has played an active and effective role in promoting the development of low carbon economy. The main manifestations are as follows:
    - Implementing special tax incentives for enterprises to save energy and reduce emissions and guiding enterprises to start sustainable development is the first move.
    - Establishing a tax policy to promote the development of renewable resources industry to encourage the use of renewable energy
    - Establishing the regulation mechanism of the tax on refined oil in line with the requirements of promoting environmental protection and energy saving and emission reduction.
    - Proposing a resource tax reform to increase the resource tax rate for high-carbon energy.

    In general, China's fiscal and taxation policies to promote the development of low carbon economy are not perfect, being scattered with a lack of systematization. There are few fiscal and taxation policies and minimal budget aimed at promoting the development of a low carbon economy.

10 Comparison of Port Cities

Port cities are highly strategic nodes for major trading regions in both Europe and China, especially in a world where more than 90% of trade volumes occur by sea. However, their roles are different for several reasons, such as the history of trade and urban settlements; the geographical layout; and the current level of regional integration and adoption of low carbon technologies. In this chapter, the cities of Ningbo in China and Hamburg and Rotterdam in Europe (see Figure 12) will be described together with an overview of their low carbon goals and activities. Various Good Practices and Key projects from the two European cities are presented.

Figure 12: City size of European and Asian port cities[27]



[27] Source: Picture from the paper "Port-city relationships in Europe and Asia" – Journal of International Logistic and Trade, C. Ducret, 2010 with data updated to 2019 from Port Economics.eu.

10.1 Chinese Port City: Ningbo

10.1.1 City Profile

Ningbo is an important port city on the southeast coast of China. It is also the largest port city in the world with a large traditional manufacturing sector. The foundation of development is solid, and its GDP ranks fifteenth in China. The land area of Ningbo is 9,816 square kilometers, the resident population is 8 million and the urbanization rate is 72%. It has the characteristics of a developed port industry, an active private economy and is opening to international markets. It is the south wing economic center of the Yangtze River Delta, an important material source base and an advanced manufacturing base in eastern China. In 2012, Ningbo was approved as the pilot in the second batch of Low Carbon Pilot Cities and actively implemented the ecological concept of “clear river and green mountains are worth piles of gold and silver”. The city adhered to the green cycle of low carbon development, adjusted its industrial structure, optimized the energy structure, improved the efficiency of the utilization of resources and energy and strengthened the control of the GHG emissions. These activities have already resulted in significant results in low carbon development.

Figure 13: Ningbo City and Port

Since 2010, Ningbo's economy has maintained openness and stability and its industrial structure has been continuously optimized. In 2017, the total GDP of the city was RMB 984.7 billion, up 7.8% from the previous year. The GDP per capita exceeded 10 thousand USD in 2010, 15 thousand USD in 2013, and 18 thousand USD in 2017. The added value of the third industry reached RMB 442.7 billion, accounting for 45% of GDP, nearly 5 percentage points higher than 2010, and its contribution to the whole economic growth reached 50%. The whole city's economic development benefited from opening to the outside world. In 2017, the total import and export of foreign trade was RMB 760.01 billion, 21.3% higher than the previous year. The foreign trade dependence was 77%, 43 percentage points higher than the national average, which has been deeply integrated into the global trade. The resident population in the city exceeded 8 million, increased by more than 120,000 over the previous year, 390,000 over 2010 and the average annual increase was 56,000. The urbanization rate exceeded 72%, was more than 4% higher than 2010, which was 13 % higher than the national average.

Figure 14: Economic growth in Ningbo since 2010[28]

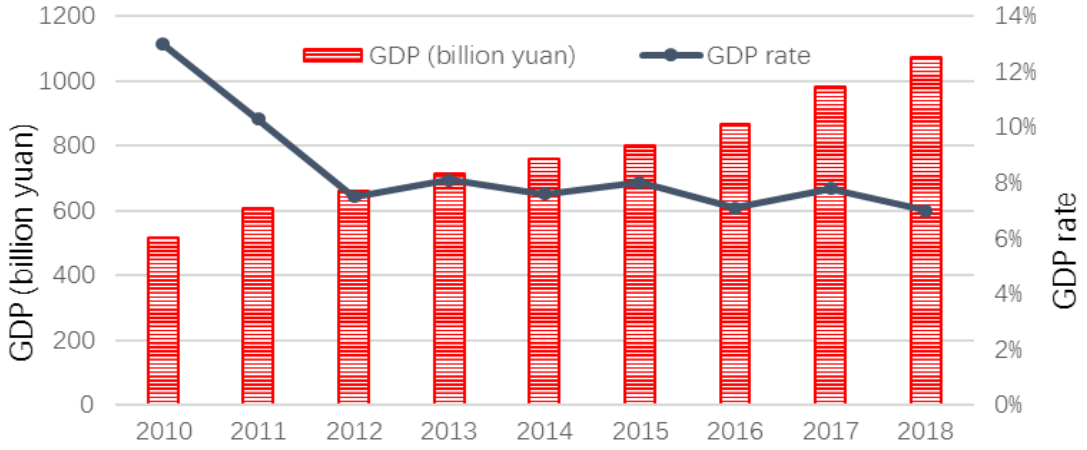
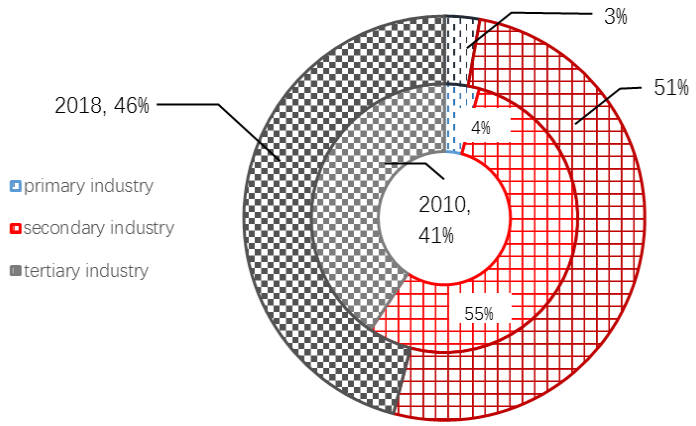


Figure 15: The change of industrial structure in Ningbo[29]



10.1.2 Low Carbon Activities

Since Ningbo has been selected as a Low Carbon Pilot City, the Ningbo Municipal Committee and the municipal government have attached great importance to the low carbon agenda and issued a series of policies and plans to promote the low carbon development of the whole city. On May 24, 2013, the Ningbo Municipal Committee issued the "Decision on Speeding up the Development of Ecological Civilization and Building a beautiful Ningbo", which transformed the pilot target of becoming a low carbon city into a major goal. The 13th FYP for the *National Economy and Social Development of Ningbo* has put green, low carbon development into its general goals. It is proposed that the total amount of energy and carbon emissions should be effectively controlled, and the green cycle of low carbon

[28] NCSC collected from Ningbo statistical yearbook
[29] NCSC collected from Ningbo statistical yearbook

development should be promoted. The "*Ningbo Low Carbon City Development Plan*" (2016-2020) reflects the specific actions being undertaken by the city.

Since the '11th Five-Year period', Ningbo continues to intensify efforts to promote energy conservation and emission reduction, develop its circular economy and implement green development. During the '12th Five-Year period', Ningbo upgraded the industrial transformation, optimized energy structure and further increased energy efficiency. The growth rate of carbon emissions in the city has slowed significantly. Carbon emissions from textile clothing and other traditional industries continued to decline while emissions from other industries remained stable, which suggested that the transition to a low carbon development in the city was remarkable. The focus of the efforts of Ningbo are to:

- Speed up the transformation of low carbon industry;
- Continuously promote energy structure optimization;
- Steadily improve the efficiency of energy utilization;
- Promote the development of green buildings;
- Build a low carbon transportation system; and,
- Popularize and promote the low carbon lifestyle.

10.1.3 Main problems and challenges faced

There are several key issues and challenges facing Ningbo to achieve its low carbon transition:

- There is still great uncertainty in the potential to realise the peak target;
- The adjustment of high carbon economic infrastructure is still very difficult;
- The system and mechanism for low carbon development needs to be improved;
- The popularization and application of low carbon technology needs some breakthrough;
- Urban transformation still faces many challenges.

As an old-fashioned foreign trade city and port city, the economy has obviously declined under the impact of the weak global economic recovery during economic restructuring and upgrading. There are therefore several economic issues which remain a barrier for sustainable, low carbon development:

- **A poor urban environment.** In the past few years, Ningbo has over-emphasized the importance of manufacturing, ports and resources but largely ignored the potential improvements to the urban environment. The lack of planning and investment in this matter is inhibiting the development of the city and has led to 'brain drain', with some of the highly skilled citizenry leaving the city.
- **Insufficient investment in technological innovation**. Technology investment is at a relatively low level all year round. In 2017, R&D spending in Ningbo accounted for only 2.35% of GDP while expenditure in other cities such as Xiamen, Wuhan, Hangzhou, Hefei, and Nanjing all exceeded 3%, with more than 4% in Shenzhen and 5% in Xi' an.
- **The development of a new economy is lagging.** The industrial transformation is slow, with high-tech emerging industries still at the initial stage of development. In 2017, the value-added of strategic emerging industries in Ningbo accounted for 26.7% of industrial added value. This is significantly behind the level of 50.8% in Suzhou (Jiangsu). Judging from its industrial energy intensity, most manufacturing industries are at the low end of the global value chain, with a short industrial chain and a low degree of intelligence. Industrial development depends mainly on the input of resource elements and low resource utilization efficiency has not changed. The investment intensity per unit area of various development zones in the city is 2.26 million RMB/mu, 8.9% lower than the average level in Zhejiang Province and 22.1% lower than Shanghai.

- **Lack of university resources.** Ningbo's colleges and universities resources are limited. There are only a few colleges and universities and there is no key university. There are many key high schools in Ningbo with excellent college entrance examination results. It is the homeland of national academicians, but the talents are seriously drained.

10.1.4 Low carbon policy objectives

For the City of Ningbo, the main policy objectives are:

1. **Explore the low carbon development model for coastal cities with heavy chemical industry:** As a major manufacturing industry, a low carbon industry structure is the top priority in achieving green development. Focusing on the decarbonization of the industrial structure, the greening of the energy structure and the efficiency of energy utilization. Ningbo should explore the low carbon development model for coastal heavy chemical industrial cities. This should be guided by the establishment of a climate change system and market-based mechanisms to nurture innovation, using intelligent monitoring systems as a means of construction.
2. **Promote industrial restructuring:** Ningbo should pursue "green GDP", speed up industrial transformation and upgrade and vigorously develop a more economical and efficient industrial and service economy. This should include concepts such as smart manufacturing, energy saving and environmental protection, new energy, cultural creativity, tourism and leisure, financial services and e-commerce.
3. **Build a green port and develop green traffic:** Large ships are one of the major air pollution sources in the port. The PM2.5 pollutants emitted by one medium-sized container ship in one day are equal to the daily emissions of 500,000 cars. For this, Ningbo proposed to create the "Green Silk Road," and actively promote the construction of low carbon ports, low carbon airports, low carbon logistics and intelligent distribution projects to accelerate green transformation in Zhoushan Port of Ningbo.
4. **Build a high-quality, green, low carbon city:** Focusing on building the center of the Dawan district, the hub of the large channel and the core of the urban area. Ningbo will build a sponge city, a garden city and a smart city and effectively raise the happiness index of the residents.
5. **Build higher education facilities focusing on the new economy, green and low carbon development and human resources:** Ningbo strives to create a higher education system that meets the requirements of the new economic development, connects with the sustainable green and low carbon development and gives full play on the cultural and historical advantages of this city.

10.2 EU Port City: Hamburg

10.2.1 City Profile

With a population of almost 1.8 million, Hamburg is the second largest city in Germany. Over 5 million people live in the Metropolitan Region of Hamburg. Green spaces, recreational areas and forest make up 16.5% of the metropolitan area. Nature reserves make up almost 9% of the urban area; areas of protected landscape cover a further 19%. At the same time, however, Hamburg is also an industrial city with Europe's third largest port and Germany's fifth largest airport.

The City of Hamburg is growing. Forecasts predict that up to 1.9 million people will be living in Hamburg by the mid-2030s. This presents Hamburg with very specific challenges in social and environmental policy. Traffic, industry and wealth are still accompanied by problems concerning air quality, noise, land use and carbon emissions. Other ongoing challenges faced by Hamburg include threats to social cohesion and the rise of rent levels and prices in general. Overall, the city has an integrated and participative planning strategy and a strong commitment towards a "green" vision. There are well

defined targets, excellent results, future plans and structured monitoring with respect to climate change.

There are 19 universities located in Hamburg, with about 100.589 university students in total. The city has also smaller private colleges, universities and special-purpose institutions, such as the Helmut Schmidt University and the International School of Hamburg.

Hamburg's heavy industry includes the making of steel, aluminum, copper and various large shipyards. Hamburg is also an important location of the civil aerospace industry and Airbus, which has an assembly plant in Finkenwerder, employs over 13.000 people. The Port of Hamburg on the river Elbe is Europe's second largest in terms of number of containers handled and is a good example of smart port for the future with improved infrastructure and digitalization. With the impending adjustment to the Elbe fairway, potential for growth will be enhanced. Through investments in infrastructure the Port of Hamburg counts among the cutting-edge hubs on the international sea trades. At the same time, companies are driving change in the port with the development of digital business models. At 136.5 million tons, in 2017 seaborne cargo throughput in Hamburg, comprising general and bulk cargoes, was stable at a high level.

The port handles the usual product mix of containers and bulk cargo (dry and liquid), both of which see a continuously steady increase in volume. Containers passing through it are expected to rise from 8 million in 2010 to 25 million in 2025, and total cargo handled from 121 million tons in 2010 to 296 million tons in 2025. The port is also an important node for the tourism industry as per year around 500 thousand cruise passengers arrive and leave from there.

10.2.2 Low carbon Activities

Strategy

Having been awarded the title of European Green Capital in 2011, Hamburg had set itself the goals of advancing its own environmental protection in a sustainable fashion and of conceptually developing its environmental policy. Since 1997 Hamburg has been active in climate policy. With the Hamburg Climate Action Plan 2007-2012, Hamburg defined qualitative as well as quantitative objectives, intensified its actions and bundled its activities in a central structure. Thus, climate action started to be a task for the whole city. As a follow-up program, the Master Plan Climate Action was approved in June 2013, and in December 2015 the Hamburg Senate adopted the Hamburg Climate Plan with a new resolution on cutting carbon emissions - aiming to reduce its CO_2 emissions by 40% by 2020 and by 80% by the year 2050. CO_2 emissions per person have been reduced by about 15% when compared to 1990, with annual energy savings of some 46.000 MWh, a major achievement for a big city. Hamburg's award as European Green Capital also enabled the city to position itself internationally as a city that offers a high quality of life and continues to be perceived as a "green", sustainable, environmentally conscious and innovative city. The city has successfully reconciled economic growth and sustainability and created jobs thanks to ingenious solutions and "green" technology. In addition to setting climate objectives, the Climate Plan 2015 describes a strategy that combines climate protection with adaptation to climate change, and that sets cross-sectoral objectives and measures, such as integrated, climate-friendly urban and district development, for the first time.

Highlights of climate protection measures include:

- Hamburg has set itself the goal of making the state administration largely carbon neutral by 2030 or, failing that, to compensate for its CO_2 emissions.
- Renovation concepts and roadmaps for city owned buildings has been drawn up by the end of 2017.

- Underground and suburban railway lines will be expanded, electric mobility promoted, and low-emission buses deployed. The proportion of electric cars in the fleets of public authorities will double to 50 % by 2020.
- The share of bicycle traffic in the transport sector will double to 25 % sometime in the 2020s.
- More educational work will be performed at schools and for adolescents in a bid to encourage younger generations to actively contribute to climate protection.

Energy Efficiency in Buildings

To achieve its own climate change mitigation targets, Hamburg is investing in energy rehabilitation and technology in city-owned buildings. The aim of the rehabilitation roadmaps is to reduce the final consumption of energy by 30% by 2030 and primary energy consumption by 80% by 2050 as compared with the consumption figures related to the actual buildings from 2008. A rehabilitation roadmap and energy management measures have already been drawn up for Hamburg's schools, set out in the School Construction Framework Plan.

The City was the first city in Germany to develop its own comprehensive Green Roof Strategy. The objective is to create 100 additional hectares of green roofs in the urban area by 2020. The aim is to virtually exhaust the potential for creating 44 hectares of green roof on new residential buildings, as well as 66 hectares on new commercial buildings over a five-year period. 20% of the new green areas are to be open to residents or employees as new productive and recreational areas in the form of sports grounds, parks or communal gardens. Green roofs can help provide greater thermal insulation in winter and shield buildings from heat in summer. This reduces energy costs and creates a pleasant climate on the top floor.

Renewable Energy

The energy transition is one of the central areas of activity for Hamburg. By 2050, 80% of Germany's electricity production is to be generated from renewable sources and Hamburg has set a goal for itself to make its energy supply more sustainable, climate-friendly and focused on the common good. For Hamburg, the energy transition is both an opportunity and an obligation. With 1.8 million inhabitants and a strong economy, the city needs considerable amounts of electricity and heat. For this reason, Hamburg must also contribute to achieving Germany's climate objectives. The city is pressing ahead with the transformation of its energy supply. In the process, Hamburg is focusing on three areas of key strategic importance in reducing energy consumption by achieving greater energy efficiency, introducing smart grids, and promoting more energy from renewable sources.

The power supply in Hamburg was privatised in the 1990s. Today, Hamburg has its own municipal electricity supplier once again. Since 2009, Hamburg Energie has been offering its customers climate-friendly, coal-free, nuclear-free energy as well as gas products with a high proportion of biogas. Serving more than 100.000 customers, Hamburg Energie is now one of the key suppliers in the city. In addition to commercial business, Hamburg Energie has also developed into an innovative energy generator, offering solutions in renewable energies and combined heat and power.

Transport

The city has achieved high environmental standards and good performance levels in terms of cycling and public transport indicators. Almost all citizens have access to optimal public transport within 300 meters of their given location. There is also a systematic structure for green areas which allow citizens easy accessibility.

Local public transport in Hamburg and the direct hinterland has been affiliated in a single public transport association: the "Hamburger Verkehrsverbund HVV" (Hamburg Transport Association), which

unites two metro systems, three bus companies and the regional trains of the national rail network. As a result of the expansion of the HVV to the adjacent Federal States Niedersachsen and Schleswig-Holstein, the demand on major railway routes to Hamburg has been significantly increased, and thus a large proportion of commuter traffic from the hinterland has been transferred to bus and rail networks. With the extension of the S3 line from Hamburg-Neugraben to Buxtehude and Stade, the Hamburger "S-Bahn" rapid transport company has, for the first time, commenced services reaching far into the Metropolitan Region of Hamburg. Since autumn 2006, only buses have been purchased which fulfil the "Euro 5" emissions class, not in force until 2009 (benefit: reduction of nitrogen monoxide emissions by over 70%). Since the end of 2007, voluntary retrofitting of over 300 buses in the "Euro 2" and "Euro 3" emissions classes with so-called closed filter systems has taken place (which results in a reduction of particle mass emissions by some 90%).

In the period 2003 to 2008, the "Hamburger Hochbahn AG" public transport company has provided development assistance for fuel cell buses. Hamburg's network of cycle lanes has a total length of 1,700 km. With a population of 1.7 million, this represents one metre per person. The everyday cycle route network links the most important centres of Hamburg's districts with one another and with the city centre. Hamburg's bicycle transport system comprises many bicycle parking areas as well as "Bike and Ride" facilities for more than 14,000 bicycles at rapid transit stations. For inhabitants in densely built-up districts, Hamburg provides private bicycle sheds that are installed in private and public premises. A cycling advisory council was set up and confers on Hamburg's strategy and measures for promoting bicycle traffic.

10.2.3 Good Practices and Key Projects in Hamburg

1) NEW 4.0 Project North German Energy Transition

Together with Schleswig Holstein, Hamburg is becoming a beacon for a sustainable energy economy in Germany. Starting in the second half of 2016, the two northern German federal states will jointly demonstrate how 70% of the region's energy needs can be met using renewable energy by 2025 through the North German Energy Transition (NEW 4.0) project. This will be achieved by intelligently coupling electricity generation with electricity storage and consumption.

More than 60 North German partners from industry and science have joined forces in the project funded by the federal government, forming an innovation alliance with the support of both federal states' governments. The model region, where around 700 companies in the renewable energy sector employ some 40,000 people, has extensive experience in this field. The goal of the project is to demonstrate that the entire region can be reliably and affordably supplied with power having a high share of renewable energy. By synchronising the fluctuating production from renewable energy sources with consumption (i.e. by intelligently connecting consumption and making it more flexible) the complete integration of renewable energies in the pilot region will become apparent.

2) Energy Bunker

In city-states such as Hamburg limited space is available for the use of renewable energy technologies. Hamburg's Energy Bunker (see Figure 15), which went into operation in 2013, is a highly innovative example of transition to decentralised energy supply through renewable energy. The former artillery bunker in Wilhelmsburg from World War II was transformed into a renewable local power plant featuring solar collectors and a large heat reservoir during the International Building Exhibition IBA Hamburg 2013. At present, 1.650 residential units in the vicinity are supplied with climate-friendly heat; in the future, the system is set to supply heat to 3.000 residential units. At the same time, the solar collectors generate electricity for around 1.500 households, which is fed into the grid. Even now, the overall project saves around 4.700 tons of carbon emissions each year.

Figure 16: The Energy Bunker in Hamburg

3) Green Procurement Guidelines

Having binding environmental criteria in the award process sends out an important signal to business and private individuals, encouraging them likewise to take greater account of the consequences of their purchasing decisions and to pay attention to each product's history. With its purchasing power (the city purchases goods, products and services to the sum of around €250 million each year), the city can help ensure that environmentally harmful products are purchased less frequently and that sustainable products achieve even greater acceptance in the market. This aspect has been fleshed out in the binding "Green Procurement Guidelines of the Free and Hanseatic City of Hamburg" (Environmental Guidelines), providing assistance. Public enterprises are also recommended to apply them when awarding contracts. In this way, criteria such as lifecycle costs, reparability and recyclability, packaging, climate impact and resource consumption can be taken into account in addition to price as a mandatory measure in the award decision. The new Environmental Guidelines also contain a negative list of products that the administration may no longer purchase or use in the future.

4) Eco-Partnership

Eco-Partnership involves 1.000 companies, responsible for around half of Hamburg's carbon emissions. Expenditure on energy is a major cost factor for many companies. The Eco-Partnership Hamburg provides information about specific actions companies can take that can lead to savings. The objective of the Eco-Partnership, an alliance between the City of Hamburg and Hamburg's economy, is to promote sustainable and resource-efficient economic activity. It acts as a central platform for environmental policy exchange between industry, politics and the civil service. The Eco-Partnership, established in 2003, is a voluntary alliance supported by the Chamber of Commerce, the Chamber of Crafts and Trades, the industrial association, the Unternehmensverband Hafen and the Ministry for Environment and Energy. The platform for information and networking is growing steadily. The Eco-Partnership paves the way for companies to improve efficiency and cut costs by offering numerous programmes and services. A great many of these activities benefit from financial support from the City of Hamburg, such as within the "Companies for Resource Protection" programme. Unlike other programmes, the Hamburg model offers a combination of financial, advisory and practical support. In the context of participation in the programme, Hamburg-based companies have so far invested in efficiency measures totalling some €367

million. Thanks to these investments, approximately 281.800 tons of carbon emissions are avoided each year, and 27.400 tons of material and 744.600 cubic metres of water are saved annually.

5) SmartPORT

As Hamburg's smart port, the Hamburg Port Authority (HPA) is driving sustainable economic growth and the greatest possible value for SmartPORT, an intelligent port management system which comprises a variety of different projects. One of its focus areas is the modelling and planning of logistical processes and traffic systems as well as the infrastructure of the port and its surrounding areas. The SmartPORT logistics project is about creating intelligent solutions for the flow of transport and goods in the Port of Hamburg, both from an economic and an environmental point of view. The latter are also the focus of SmartPORT energy, which was launched in 2012 together with the State Ministry of Urban Development and Environment and the State Ministry of Economic Affairs, Transport and Innovation. The project's goal was to reduce the port's dependence on conventionally generated energy using renewable energy in order to reduce emissions.

6) HafenCity

HafenCity is Europe's largest urban development project and is located in the Hamburg-Mitte district. It consists of the area of the Great Grasbrook, the northern part of the former Elbe island Grasbrook, and the warehouse district on the former Elbe island Kehrwieder and Wandrahm. It is bordered to the north, separated by the customs channel to Hamburg's city center, west and south by the Elbe and to the east, bounded by the upper harbor, Rothenburgsort. The district is full of rivers and streams and is surrounded by channels and has a total area of about 2.2 square-kilometers. HafenCity has 155 hectares in the area formerly belonging to the free port north of the Great Grasbrook. Residential units for up to 12,000 people are planned to be built on the site by around the mid-2020s, and jobs for up to 40,000 people, mainly in the office sector, should be created. It is the largest ongoing urban development project in Hamburg. Many companies operating in E-Commerce have moved into HafenCity or started there. In addition to cruise agents such as the CaptainTravel GmbH many start-up companies that have no direct connection to the port or ships can be found in HafenCity.

Figure 17: Hafencity

10.3 EU Port City: Rotterdam

10.3.1 City Profile

Rotterdam is a city of about 630.000 people strategically located in a low-lying delta on the North Sea in Holland, which is one of the reasons why it is often referred to as the 'Gateway' to Europe. The city has a set of ambitious long-range plans to become sustainable and well-prepared for the impacts that climate change will have on the city. The city suffered considerable damage during World War II, resulting in the rebuilding of most of the centre, and has developed a reputation for using cutting-edge, high-rise architecture both for residential and commercial buildings. Mainly thanks to its seaport, Rotterdam is a cornerstone of the Dutch economy.

Rotterdam has a well-equipped port infrastructure, multi-modal accessibility and considerable volumes of goods and passengers. The city historically developed its port-industrial complex with traditional port related activities. Since then, international services and international companies (head offices) have been pulled towards the city, thereby expanding the cluster. Innovation became a necessary ingredient for further development. As a result, the port cluster currently contains many of the regional knowledge institutes that operate internationally. These activities are particularly important for the competitive position of Rotterdam.

Like many cities, Rotterdam has shifted from an industrial to a service-based economy, focusing on logistics, transport and finance. Strong sectors are health, logistics and chemicals. The medical cluster concentrates around the Erasmus University Medical Centre Rotterdam (Erasmus MC), which is also one of the major hospitals of Rotterdam. The combination of high-end research, care and education provides jobs to approximately 12.000 employees. Because of its substantial size, the Erasmus MC is important for the economic development of the city, especially when linkages are maintained with other regional health institutes, government and the business community.

Finally, the developing creative sector leads to all sorts of applications and innovations for the other clusters but also the establishment of an increasing number of creative sector businesses. In particular, attention is being paid to the design cluster, including architecture, technical and graphical design, audio/visual and new media. There are some designated terrains and buildings for these companies and start-ups are stimulated.

In the last years five other sectors have been classified as particularly important for the international profile and position of the city. These are:

- Trade (example: Unilever, Hagemeyer)
- Water (example: Van Oord, Boskalis, Arcadis)
- Oil/Gas (example: E.ON, BP, Exxon, Tamoil)
- Port related business services (example: ING, Loyens & Loeff)
- Technical and Knowledge intensive business services (example: Deloitte, Ernst&Young, KPMG, PWC, Royal Haskonig, IBM).

10.3.2 Low carbon Activities

Strategy

In 2006, the Rotterdam Climate Initiative (RCI) was started. RCI is a cooperation programme of the Municipality of Rotterdam, the Rotterdam Port Authority, the Environmental Agency (DCMR) and the employers' and industry organisation Deltalinqs. The programme aims to create a mechanism through which the government, organisations, knowledge institutions and residents work together in relation to the most ambitious objectives in the field of climate in the Netherlands. This involves reducing CO_2 emissions by 50% by 2025 compared to 1990 levels.

In its comprehensive effort to tackle the causes and effects of climate change, the initiative considers the interrelationships of the environment, economy, climate, energy, water, and people. Industry, responsible for 85%of Rotterdam's GHG emissions, played a leading role in developing the RCI.

To facilitate a rapid transition to clean energy, Rotterdam's city government is striving to remove obstacles to sustainability. The Municipal Executive Committee, meanwhile, is trying to attract funding from the federal government and European Union, lobby for legislation and infrastructure funding, and create partnerships that advance sustainability. The city government is trying to serve as a role model by making its own operations sustainable, including the operation of its property and vehicles, and has adopted sustainable development guidelines and purchasing practices.

The city's clean energy and climate adaptation plans involve billions of euros in investment and management of the city's energy, water, land, raw materials, and waste. Implementation of the plans will impact air quality, public health, mobility and transport, and outdoor public spaces. The plans will also influence the city's biodiversity, building energy use, construction, and even demolition. The city's efforts are founded on extensive public outreach to engage all major segments of Rotterdam in its sustainability and climate-proofing campaign.

Since 2014, Rotterdam has also been an active participant in the 100 Resilient Cities (100RC) network and the city also belongs to C40 Cities and is a leader in the Connecting Delta Cities network inspired by the Clinton Climate Initiative. The goal of the Connecting Delta Cities network is to exchange knowledge about water management, climate adaptation, and sustainable development among cities globally.

The city is committed to strengthening environmental education and participation in sustainability activities. The city operates on the premise that sustainability must be a guiding principle in education and research. The city thus brings sustainability issues to the attention of its colleges and universities and encourages a greater focus on sustainability issues in higher education curricula.

The city has thus for years been planting more trees, bushes, and other vegetation in the city. The extra greenery makes the city more attractive, cools the city during heat waves, and provides a noise barrier between people and traffic. The city also has a subsidy program for green roofs and green facades and is supportive of urban farm initiatives that make the urban food chain more sustainable.

Energy Efficiency

Among other measures, Rotterdam replaced conventional traffic lights at 240 intersections with energy efficient LEDs, resulting in an energy saving of 60-70%. Rotterdam plans similar energy savings by lighting public spaces with LEDs. In fact, Rotterdam emits 29.8 tonnes of carbon per capita, one of the highest carbon intensities in the world (compared to the global average of about 4.6 tonnes per capita).

Renewable and Low Carbon Sources of Energy

Rotterdam's industries and incinerator generate enough waste heat for a million households. This city of 630.000 thus has substantial potential for district heating to share residual industrial heat with homes and businesses. A company known as the Heating Company of Rotterdam collects heat from industries in the port and shares it with homes and businesses. Use of waste heat eliminates the need to burn fossil fuels for heat and results in a significant reduction of GHGs, such as CO_2 and nitrogen oxides, thus improving local air quality and public health. Slightly less than 20% of Rotterdam's homes are now on district heating. The city is committed to getting 40% of its residents on district heat by 2020 and aspires to have 50% connected to district heating by 2035, but that will be very challenging. The use of district heating is integral to Rotterdam's plan to eventually phase out natural gas and reduce carbon emissions. Its district heating system already avoids the emission of 182,000 tonnes of CO_2 per year. To reduce

natural gas, the city wants to increase the use of electricity for domestic residential uses and to use more rooftop solar panels.

Transport

Rotterdam's public transport company, RET, currently uses clean renewable energy to power its trolleys and subways, and RET aspires to become the world's cleanest public transportation company. It plans to extend vehicles' range by capturing and reusing braking energy, a process known as recuperative braking.

Through its Power Surge Program, Rotterdam is also strongly encouraging the use of electric cars, which reduces noise, carbon emissions, and fine airborne particles that damage people's lungs. While the city is introducing its environmental zone, it is also encouraging demand for electric cars. Through Power Surge, the city already provides 2,000 charging stations for EVs and plans to add 2,000 more within the next two years. The city offered free parking permits for the first 1,000 electric cars to register for Power Surge. The city also has specific goals for increasing the use of public transport and bicycles and for reducing urban noise.

The city is also investing in bicycle paths and bicycle parking areas and encourages car sharing through its Greenwheels and teleworking programs. Rotterdam is also promoting the use of electric bicycles and scooters and pays owners of conventional scooters a fee for scrapping them. The city has a dozen public bicycle sheds with recharging stations for electric bicycles and scooters. Biodiesel fuels are being introduced for trucks and natural gas is being tried for inland ship traffic. Deltalinqs Energy Forum, a project of the city's main business association, is assessing the possibility of using hydrogen for vehicles at Port terminals and to fuel medium-sized, inner-city delivery vans.

10.3.3 Good Practices and Key Projects in Rotterdam

1) Port of Rotterdam Digitalization

The port of Rotterdam, Europe's largest port by cargo tonnage, aims at becoming the smartest port in the world. With more than 85% of all globally traded goods having travelled on a ship at least once during their lifecycle, ports play a key role in the global and local economy. It employs 90,000 people and contributes 10.5 billion euros, which is 3.3 % of Dutch GNP. Now the industry is embarking on its latest innovation journey, connected shipping. Much like the driverless car in the automotive world, connected ships operate autonomously and communicate with each other to avoid the risk of a collision. At the Port of Rotterdam, the goal is to host autonomous ships by 2025. The Port of Rotterdam Authority and IBM have joined forces on a multi-year digitization initiative to transform the port's operational environment using Internet of Things (IoT) technologies.

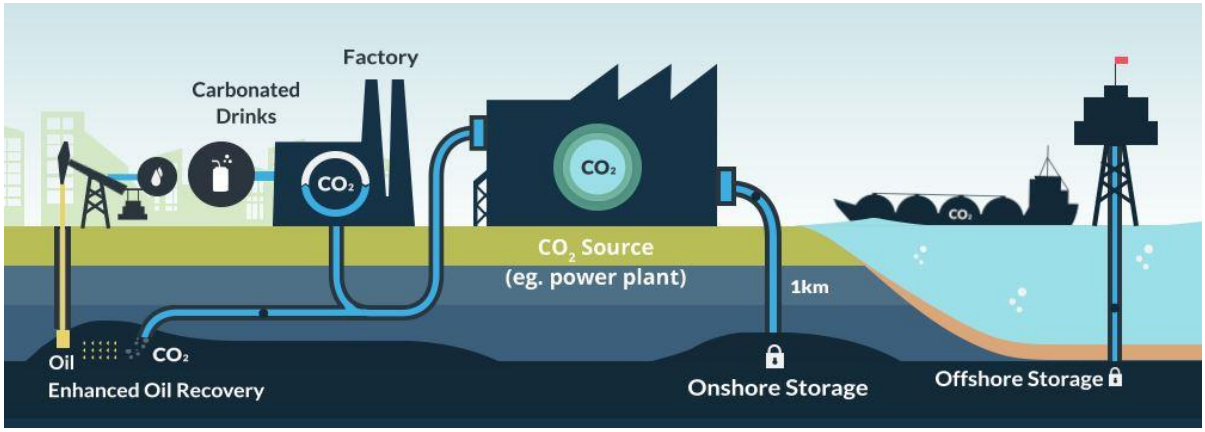
The initiative will also prepare the Port of Rotterdam's entire 42-kilometer site to host connected ships in the future. It begins with the development of a centralized dashboard application that will collect and process real-time data. The port expects the initiative will enable a new wave of safer and more efficient traffic management at the port. As the largest port in Europe, the Port of Rotterdam handles over 461 million tonnes of cargo and more than 140,000 vessels annually. Previously the port relied on traditional radio and radar communication between captains, pilots, terminal operators, tugboats and more to make key decision on port operations. Now, as the Port of Rotterdam begins its digital transformation, sensors are being installed across 42-kilometers of land and sea – spanning from the City of Rotterdam into the North Sea – along the Port's quay walls, mooring posts and roads. These sensors will gather multiple data streams including water (hydro) and weather (meteo) data about tides and currents, temperature, wind speed and direction, water levels, berth availability and visibility. This data will be analyzed by IBM's cloud-based IoT technologies and turned into information that the Port of Rotterdam can use to make decisions that reduce wait times, determine optimal times for ships to dock, load and

unload, and enable more ships into the available space. For example, the Port of Rotterdam will now be able to predict the best time based on water level to have a ship arrive and depart Rotterdam ensuring that the maximum amount of cargo is loaded on board. With the new initiative, Port of Rotterdam operators will also be able to view the operations of all the different parties at the same time, making that process more efficient. In fact, it is estimated that shipping companies and the port stand to save up to one hour in berthing time which can amount to about USD $80.000 in savings.

2) ROAD: Carbon Capture and Storage project (CCS)

Rotterdam's industrial sector is particularly CO_2 intensive, producing 88 percent of the city's CO_2 emissions in 2010. As a result, the city developed a plan to cut CO_2 emissions 50 percent below 1990 levels by 2025. The achievement of this ambitious goal, however, was predicated on the viability of an experimental and commercially unproven technology known as carbon capture and storage (CCS). The city's concentration of energy-intensive industry and the presence of empty oil and gas fields offshore in the North Sea is an ideal combination for a major CCS demonstration project. Thus, a consortium of 11 Rotterdam businesses is developing a regional CCS pipeline that will link energy-intensive industries producing CO_2 to potential offshore CO_2 storage facilities. Known as the Rotterdam Capture and Storage Demonstration Project (ROAD), it is one of the world's largest CCS demonstration efforts. Despite warnings from critics of the technology, city officials allowed two new coal plants to be built in the port of Rotterdam on the theory that their emissions would be captured and reinjected into depleted oil and gas fields beneath the North Sea.

Figure 18: Multiple industrial sources of CO_2 can use common transport and storage infrastructure in a CCS Hub or Cluster[30]



However, the technology proved costly and did not operate as planned. The city would have had to reduce its CO_2 emissions by 17.5 million tons a year to meet its CO_2 reduction goal. However, according to data from the Rotterdam port, the pilot CCS project was only designed to capture 1.4 million tons a year. The city, faced with the slow and uncertain roll-out of CCS technology, has abandoned its original CO_2 reduction commitment.

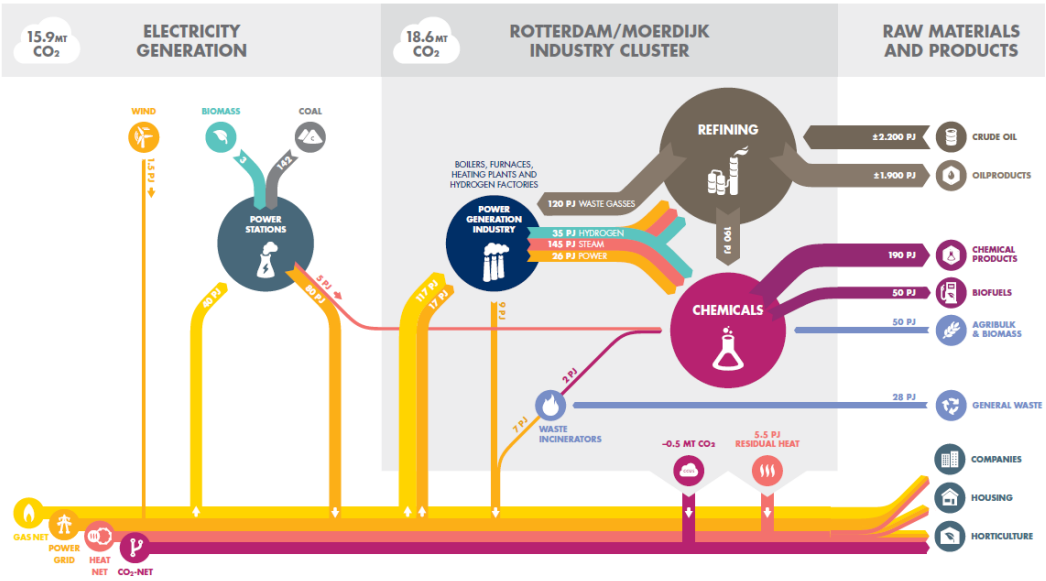
3) The Rotterdam Industry Cluster

The industry cluster in the port of Rotterdam is the engine for economic growth in the port and it is successful because the port offer companies an ideal location. By sharing infrastructure, logistics, energy and utilities, and by exchanging raw materials, products and residual and waste materials, companies in the cluster can operate more efficiently than if they were to run in standalone mode. This enables them

[30] Source: Global CCS Institute

to reduce their costs and strengthen their competitive position. The Rotterdam port industrial area consists of around 60 companies, including five oil refineries, 36 chemical companies, four waste processing companies and 14 other industrial companies. This industry cluster produces almost €13 billion of added value to the Netherlands and offers employment to some 75,000 people. The region imports raw materials and produces and supplies products with an annual energy content of more than 2,000 petajoules (PJ). Approximately 260 PJ are consumed in the production processes. Almost half of this energy input comes from the waste gases from the refineries, with an almost equal amount of natural gas coming from the gas network and an additional small amount of energy coming from general waste and electricity from the power grid. This energy consumption produces 18.6 megatons (MT) of CO2 emissions (2016). Since 2005, captured CO2 has been delivered to the greenhouse horticulture sector, and steam and heat networks have been operational for five years, allowing the reciprocal exchange of steam and the supply of residual heat to district heating networks (Source: Three steps toward a sustainable industry cluster, 2018).

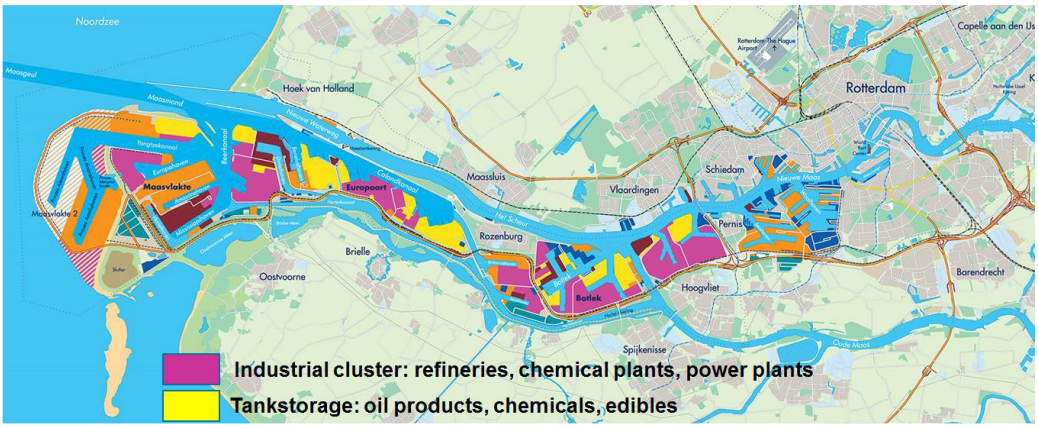
Figure 19: Energy Flows in the Rotterdam Industry Cluster31



Over the course of the years a high level of cost reduction, improved energy efficiency and emission reductions have already been achieved through means of cooperation. To provide direction and purpose to this cooperation, the Core Team of the Cluster has developed a vision for the 2030. According to this vision, in 2030, the Rotterdam Industry Cluster will continue to be leading in Europe and in addition to the large-scale production of chemical and refining products, the cluster will make an important contribution to the Western European energy transition, to sustainable mobility and to the production of bio-chemicals. Due to the proactive policy of all stakeholders, the cluster aims to emerge strengthened from the European consolidation of the fossil-based industries and will exploit the opportunities for growth provided by technological progress and the social focus on sustainability. After 2030, the cluster is required to engage in far-reaching decarbonisation to meet the European climate objective of an 80% - 95% CO_2 reduction by 2050 in relation to 1990.

Figure 20: The Rotterdam Industry Cluster facilities[32]

[31] Source: Three steps toward a sustainable industry cluster, 2018 - https://www.portofrotterdam.com/en/news-and-press-releases/climate-plans-for-the-rotterdam-moerdijk-industrial-cluster



When it comes to the use of new sustainable bio-based raw materials in the chemical industry, Rotterdam has a head start on other similar industry clusters in the world, because it already has a large bio-based cluster:

Figure 21: The Rotterdam Industry Cluster[33]

Throughput of Bio-based Raw Materials and Products	Production Capacity based on Bio-based Raw Materials
8 million tonnes/year of vegetable oils	4 vegetable oil refineries: 2.3 milion tonnes/year
3.5 million tonnes/year of biofuels	4 biofuel plants: 2.0 million tonnes/year
10 milion tonnes/year of agricultural bulk	2 bio-chemical plants: 5000.000 tonnes/year
1 million tonnes/year of lignocellulose biomass	3 biomas co-firing power plants
1.5 million tonnes/year of waste	1 biomass-fired power plant

These bio-based materials have a great deal of potential. Vegetable oils are increasingly used to produce oleochemicals, which creates opportunities for Rotterdam. In addition, there are business development projects involving bio-based chemicals conducted by consortia of companies together with the Port Authority. Four interesting platform molecules have been identified for the industry cluster. These molecules can be produced from new raw materials: carbon monoxide/syngas, bio-aromatics, glucose and ethanol from second generation biomass and household waste. Polymer recycling could become interesting for Rotterdam. Work is currently underway on a demonstration in Plant One for chemically recycling PET waste. Furthermore, processing ethane or LPG in European cracker units is of potential interest as a means of reducing the dependence of European cracker units on the price of oil. However, investments in the infrastructure required for this purpose are very costly.

4) The Heat Roundabout

Rotterdam's district heating will be part of a larger project called The Heat Roundabout that will also include the city, its port, and the other municipalities in South Holland, such as The Hague, Delft, Westland, and Leiden. The city is investigating the possibility of making the heating network more sustainable by integrating geothermal heat into the system.

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[32] Identifying and Developing European CCS Hubs Issue 1: April 2016, Zero Emission Platform

[33] Collaborating on a cluster in transition: Reinforcing the Rotterdam/Moerdijk Industry Cluster Action Plan, March 2016.

By 2020, 350.000 homes will be connected to district heating along with about 2,500 acres of greenhouses in Westland and Oostland north of the port. The cost of building the district heating infrastructure has been about three billion euros. However, the system will generate about twice as much in revenue from sales of the heat plus the value of the CO_2 reduction and other social benefits.

The greenhouses that receive district heat also utilize CO_2 piped separately to them to promote plant growth. They previously produced their own heat and CO_2 with natural gas-fired combined heat and power plants (CHP). Today, with the availability of district heating and the waste CO_2 distribution system, their heat and CO_2 requirements can be met without CHP plants.

District heating can also provide reliable cooling services. The cooling is created when customers use district heat to run absorption chillers and generate cool air. The city is currently investigating the feasibility of setting up a cooling network.

11 Comparison of cities facing industrial decline

This chapter draws together evidence from the city of Wuhan and two EU cities, Essen and Bilbao, which are experiencing huge change and transition from being industrial cities, through major decline in industrial manufacturing, to recovery. An overview of their low carbon goals and activities is presented as well as various Good Practices and Key projects from the two European cities.

11.1 Chinese Industrial City: Wuhan

11.1.1 City Profile

In recent years, Wuhan adopted the development of a green and low carbon city as its goal and regarded the national low carbon pilot city and the realization of a carbon emission peak as important elements of the construction of an ecological civilization. The city innovated the ideas, was pragmatic in practices and has achieved positive results in the low carbon development of the city.

Figure 22: Wuhan City

Wuhan has grasped the new economic opportunity by transforming and upgrading its heavy industry. The advantages of scientific, technological and academic resources are significant. Wuhan has the experience and foundation of a green transformation and the potential for development is huge.

Since 2000, the GDP of Wuhan has maintained a relatively rapid growth, from RMB 120.7 billion in 2000 to RMB 1,341 billion in 2017. The GDP growth showed an up and down trend with the highest growth rate of 15.6% in 2007. After 2007, it gradually decreased and became less than 10% since 2013. In 2017, the city's business attraction project '*No.1 Project*, *Introduction of Talents and Intelligent People's* was

implemented, resulting in the investment in fixed assets (which was over RMB 780 billion), growing by 11% and the GDP will continue to grow steadily in the future.

In the past 17 years, the average annual growth rate of registered population and permanent population in Wuhan was 0.8% and 1.8% respectively. In 2011, the city's permanent population exceeded 10 million for the first time. The urbanization rate of the urban city increases continuously, reaching 71.7% in 2016.

Since 2002, the per capita residential building area of urban residents in the city has shown "first increase and then decline", reaching the highest 51.83 square meters per person in 2011, but the index has declined in recent years.

The number of car owners in the city continued to increase. With the improvement of residents' income and the improvement of the quality of life, car ownership will keep increasing in the future.

In 2016, the high and new technology industry in Wuhan accounted for 64% of the total industrial output value and the high and new technology industry, modern service industry and other new kinetic energy occupied 60%. Wuhan's fiber optic cable capacity ranks the first in the world and the market share of optoelectronic devices is in the third place in the world. Wuhan has the second largest national biological industry base. Information technology, life and health, intelligent manufacturing have become the new industry base of this city and Wuhan gathers many new economic enterprises, which rebuilds the soul of Wuhan City.

Wuhan has 89 universities and colleges and more than 1 million college students. In 2017, the number of students who stayed in Wuhan after graduation reached 300,000. With the increasing scarcity of talent resources and the increasingly fierce competition for talents, the resource of college students in Wuhan has become a valuable asset for the development of the city, which makes Wuhan full of innovative vitality.

Wuhan has implemented a program of city partners and sent invitations to the talents in science and technologies at home and abroad to research and develop the leading core technologies of China and foreign countries. The technological results have helped progress local industry. The city also implemented the ‘Valley Plan’ to provide the best spaces for the city and make the best policies for the best supporting services. This will make the city become an innovative paradise and a home for business as soon as possible.

As the pilot area for carbon emission trading, low carbon society and the testing area of environment-friendly and resource-saving society, Wuhan has accumulated years of experience in green and low carbon development. It has a certain social basis, policy accumulation, and relatively strong public participation.

11.1.2 Low Carbon Activities

Strategy

In September 2015, at the first Sino-US Climate Smart/Low Carbon City Summit, Wuhan joined the Alliance of Peaking Pioneer Cities of China (APPC) and proposed to achieve the peak of carbon emissions in 2022. In 2017, on the basis of carrying out the peak forecast and the path of emission reduction, Wuhan officially issued the ‘*Notice of the Wuhan Municipal People's Government’s Action Plan of the Wuhan Carbon Emission Peak’* (2017 - 2022) (hereinafter referred to as" the Summit Plan").

The Summit Plan proposed the overall goal for carbon emissions in Wuhan. By 2022, the total carbon emissions in the city will reach its peak. The carbon dioxide emissions from the industrial (non-energy), construction, transportation, energy fields and the 14 regions of the city will be effectively controlled to

establish the industrial system, the energy system, the building system and the transport system based on the low carbon emissions.

In 2016, the evaluation of non-fossil energy consumption was added to the evaluation and review of the energy conservation of fixed assets investment projects, to master the non-fossil energy consumption of projects.

At present, a total of 33 enterprises in the city have been involved in carbon emissions trading.

Energy Efficiency

According to the *'Notice Hubei Provincial People's Government's Action Plan of Hubei Energy Saving and Emission Reduction'* in the 13th five-year period, the target of reducing energy consumption of GDP per unit area is 16% and the target of energy consumption increment control is 25 million tons standard coal. The target of reducing the energy consumption of Wuhan in the '13th FYP' was 17% per unit area and the target of energy consumption increment control is 7.15 million tons of standard coal.

According to the '*Comprehensive Work Plan for Energy Saving and Response to Climate Change in Wuhan during 12th Five-Year Period'*, the target for reducing energy consumption in Wuhan's '12th FYP' was 18% per unit area, and the target of reduced carbon dioxide emissions of the region's GDP was 19%.

During the period of 13th Five-Year period, Wuhan should implement the design and acceptance standards of green buildings in Hubei, energy saving design standards for low energy residential buildings and energy saving design standards for public buildings to ensure that the implementation rate of building energy saving standards will reach 100%.

Transport

During the "13th Five-Year" period, Wuhan will optimize green public transportation and build "Metro City". By 2020, the track traffic network system covering "three towns" and "new towns" will be basically formed. The total mileage of rail traffic will reach 400 kilometers, and the proportion of rail traffic accounted for more than 50% of public transport passengers. The optimization of the public transport network and the popularization of shared bicycles will also contribute to the rapid development of public transport. By 2020, public transport will account for more than 60% of motorized travel.

11.1.3 Main problems and challenge faced

At present, Wuhan is in the phase of construction and development. Rapid urbanization will be the main theme of the next development in Wuhan while urban construction, especially infrastructure, can lock-in future carbon emissions. According to the '*Trillion Times of Increase'* plan, GDP will break through 2 trillion by 2021, and the average annual growth rate of GDP will reach 10.3%. The trend of heavy industrialization in Wuhan has not changed and energy consumption and carbon emissions will continue to increase in the long-term.

There are a series of mainly economic issues which are bottlenecks to Wuhan's sustainable development aspirations:

- The traditional dominant industries in Wuhan have fallen sharply resulting in the investment will of enterprises generally declining. Although the emerging strategic industries of the city are accelerating, it is still difficult to offset the decline.
- The cost of innovation is high and the developments by private economy are insufficient.
- The pressure of environmental protection is heavy, and the cultural characteristics are not enough. The construction of smart city is still at the initial stage and the quality of the city is in urgent need of improvement.

- The degree of internationalization needs to be promoted, which is mainly reflected in the low grade of the financial centers, the small number of headquarters of multinational companies and the small proportion of foreigners and international organizations.
- Market mechanisms for reducing GHG emissions need to be further strengthened. In some large projects, there still are problems with high energy consumption and environmental pollution and the mechanism for pollution source prevention remains to be improved. Although the ecological compensation mechanism and the right of natural resources assets have been established, there is still a certain gap between its expectation and the actual effect.

11.1.4 Low carbon policy objectives

For the City of Wuhan, the main policy objectives are:

1. **Promote the green transformation of industry:** Wuhan should build a modern industrial system with clear hierarchy, prominent advantages and high ecological efficiency. To achieve this goal, a strong market environment and policy environment are needed. This will also force enterprises to speed up the pace of scientific and technological innovation and product upgrading and enhance their innovation ability as well as improving the technological level of enterprise green manufacturing.
2. **Encourage the market to transition to a green, low carbon economy:** Wuhan should promote the development of private economy and technological innovation. This could be achieved by improving the investment mechanism of green and low carbon development and the innovation ability of green enterprises (by promoting/enhancing total factor productivity through technological innovation). Associated positive externalities should be fully understood and promoted. Technical standards, emission tax, subsidies and other policy tools could be used to achieve these objectives.
3. **Develop green finance:** Wuhan plans to build a national carbon trading center and green financial system to support the low carbon transformation and development of real economy.
4. **Plan production life and urban construction according to environmental criteria:** environmental protection needs to be strengthened. Circular and low carbon economy approaches should be promoted from different levels such as: ecological industry, eco industrial park, ecological city and ecological watershed. Wuhan should vigorously publicize the concept of ecological civilization to let civil society participate in and supervise the formulation and implementation of green development policy and create a social atmosphere of green life and green consumption.

11.2 EU Industrial City: Essen

11.2.1 City Profile

The city of Essen is located in North-Rhine Westphalia, at the centre of the Ruhr Metropolis (also known as the Ruhr Area). It is an independent city in the administrative district of Düsseldorf. With around 582.624 inhabitants the city of Essen is the ninth largest city in Germany. The municipal area of 210 km² is divided into 9 districts, with 50 neighbourhoods. The density is 2.800 inhabitants/km2. Essen is the centre of the Ruhr metropolitan area which encompasses approximately 5.3 million people. Following London and Paris, this metropolitan area constitutes the third-largest agglomeration in Europe. The Council is the most important decision-making body in the city and is elected by the citizens for a term of 5 years.

Essen is an important industrial centre for German enterprises. Large corporations such as ThyssenKrupp AG, RWE AG (now partly innogy SE), Evonik Industries AG, Karstadt Warenhaus GmbH, Hochtief AG, Aldi Nord, Ista and E.ON have their headquarters here. The city is thus of particular

importance for the overall German economy. However, it is not only large companies which characterise Essen's economy. The sound mix of big firms, SMEs and an active craft sector helps to obtain a good economic climate. Between 2005 and 2015 the GDP increased from 18.7 billion Euros to 24.2 billion Euros. Over the same timescale, the GDP/worker increased from 61,833 Euros to 73,537 Euros. Nevertheless, the unemployment rate is at a high 13.0%. Essen offers a job opportunity for 233.360 people (almost exactly as many as 1981) in 12.808 companies. More than 80% of the city's working population are employed in administration, the service industries or commerce (tertiary sector, up from 57% in 1981).

Each year it attracts around 14.000 exhibitors and 1.4 million visitors from all over the world offering a wide range of cultural activities. In 2010 the city of Essen was appointed as European Capital of Culture 2010, representing the entire Ruhr Area. This title helped to change the external as well as the internal perception of the city from being a coal and steel city in decline into being a metropolis with European significance.

In addition, Essen plays an important role as educational location. In 2003, the University of Essen merged with the neighboring University of Duisburg, becoming the University Duisburg-Essen embracing about 43.000 students. Another university in Essen is the private FOM, a university of applied sciences with over 6,000 students and branches in 15 other major cities throughout Germany.

11.2.2 Low Carbon Activities

Strategy

Coal, steel and heavy industry all featured prominently in Essen's past, but now the reinvented Ruhr region hub is showing off its environmental credentials as 2017's European Green Capital. In fact, Essen was awarded the European Green Capital 2017 award by the European Commission for its "admirable efforts" to overcome its challenging industrial past and reinvent itself as a "green city." There is a very comprehensive relationship of the European Green Capital 2017 project with Essen's goal to establish the low carbon transition. This reaches from the involvement of stakeholders, to the realisation of pilot projects to reorganising city administration to tackle the challenges of shaping a sustainable city.

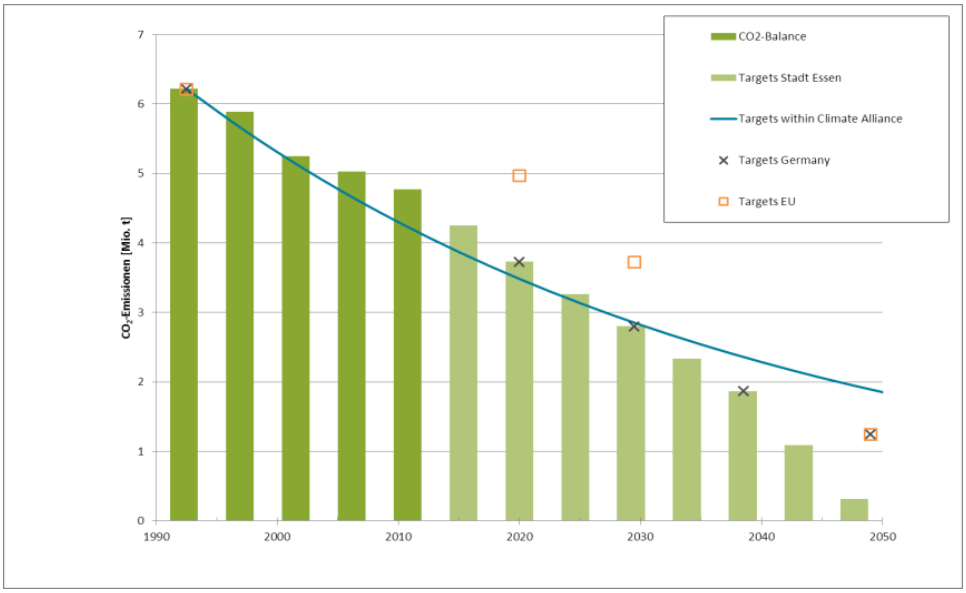
Essen's vision of the future is one of a prosperous, economically sustainable major city, which is resistant to climate change, and which offers its population opportunities to develop in a healthy environment. Essen promotes green infrastructure with high water quality and parks with high recreational value, innovative and environmentally friendly businesses (Green Economy), integrative education and sustainable mobility concepts. In the last decade, the strategies have been made more specific, particularly by the corporate objective of environmental protection, the urban development process "Essen urban development perspectives 2015+" (STEP 2015+), and the Integrated Energy and Climate Concept (IECC). In the overall process, the 133 measures currently contained in it will be pursued under the umbrella brand klima|werk|stadt|essen for a sustainable and climate-friendly urban development. Figure 22 shows the organisational structure of it.

The flagship project for networked, sustainable activities is the programme "Open space creates city space – ESSEN. New ways to the water". This aims at the development of open space structures and climate adaptation and is simultaneously a development programme for the long-term unemployed. The successful transformation story, from a city of coal and steel to the greenest city in North Rhine-Westphalia and a services and financial centre, is a role model of structural change for many cities in Europe.

Essen joined the EU CoM in 2010 with its "Integrated Energy and Climate Concept" (IEKK=SEAP) highlighting its ambitious climate and energy policy with concrete actions. The concept has been revised in 2013 and approved by the city council. The target will be reaching 40% emission reduction in 2020

compared to 1990 and 95% by 2050. The IEKK is not a static concept and will be dynamically developed in the future and supplemented by additional projects. In order to achieve the target of 40% reductions in emissions by 2020, around 670.000 tonnes of CO_2 per year must be saved.

Figure 23: CO_2 emission target in Essen[34]



Energy efficiency

Essen wishes to take a major step forward in reducing total energy consumption, through the total replacement of off-peak storage heating systems. The city's own buildings will have replaced off-peak storage heating systems by 2025. For privately owned buildings, the city is currently developing incentive programmes.

Renewable/low carbon sources of energy

The creation of an Energy Utilisation Plan allows the potential of cogeneration, of district and local heat networks, and in particular of waste heat recovery, can be consistently exploited by industry. The basis for this is analysis of the aerial thermography, which collected data using a crowdsourcing approach, and the electricity and heat deliveries from energy utility companies. The Energy Utilisation Plan also considers social, economic, urban-structural and ecological conditions.

Transport

Intelligent and flexible utilisation of the eco-mobility services provided by the environmental alliance with the local public transport system, which now includes car sharing, bike sharing, and electric cars and bikes, is hoped to become an expression of a climate culture put into practice by the population and businesses. Through the trend towards electromobility synergies can also be achieved for clean air and noise reduction policies.

In order to encourage cycling, the city and the RVR are aggressively expanding the cycle path network. The Ruhr fast cycleway will soon be a reality, a central East-to-West commuter connection running 101

[34] Application EGC 2017 – European Green Capital 2017 - https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/01_Application-EGC-2017_Climate-Change_ESSEN.pdf

km through the Ruhr Area. For the financing of climate protection projects, the creation of a revolving citizens' fund is planned. The target is to facilitate civic participation and open up capital for using renewable energies and other climate protection measures in Essen. This is a practical supplement to making municipal roof space available for private photovoltaic systems, as civil solar power systems. The control of the projects is monitored and analysed by SEAP in the context of a continuous improvement process.

11.2.3 Good Practices and Key Projects in Essen

1) Essen Climate Agency

In 2012 the Essen climate Agency was founded as a central and independent point of contact for consumers, companies, commerce, trades, associations and churches in order to network the city in the context of a new climate culture. The Essen Climate Agency sets trends and funds projects and organises events and campaigns. A range of consulting and services are organised in an energy expert partner system, supporting building owners in all phases of the renovation process, from initial analysis, through planning, financing, involvement of tenants, and implementation of renovation. The Climate Agency Essen, which is a project-financed institution of the Department of Environment of the City of Essen, is an independent point of contact for consumers. The agency has implemented a wide range of public-oriented measures for climate protection and local energy transition. Furthermore, it has initiated municipal networks in the fields of renewable energy, mobility and buildings.

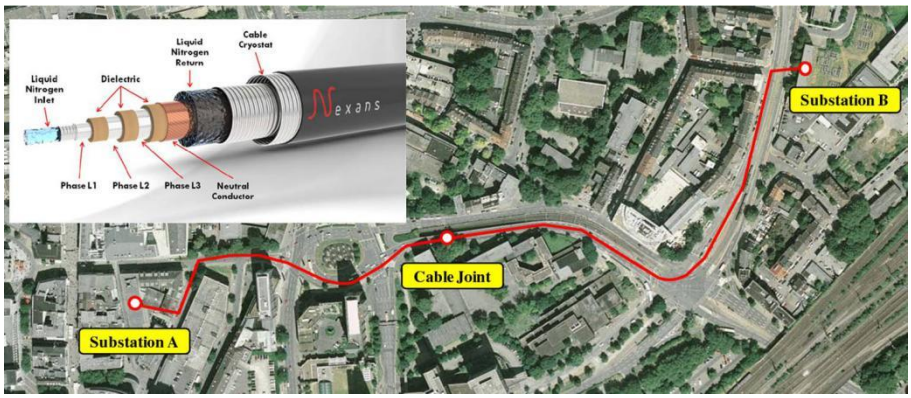
2) Brownfield development

The successful development of land and projects is due to the consolidation in Essen of groups, of companies like the RAG Group, renowned for their expertise in the profitable rehabilitation of industrial brown-field sites working also with politicians, municipalities, authorities and associations. On the basis of decades of experience with the real estate portfolios of mining companies and continuous research, these companies made a valuable contribution to structural change in North Rhine-Westphalia and the Saarland – from planning to use via treatment and implementation. The focus is on sustainable urban development, such as the protection of natural resources and ecological and with social responsibility being an integral part of all the activities as well as the protection of soil as a resource to active urban quarter development via renatur-ation. A list of sites and descriptions of the redevelopment is provided in Appendix I.

3) The Ampacity Super Conductor Project

The "AmpaCity" is a R&D project sponsored by the Federal Ministry of Economics and Technology (BMWi) given its special benefits and the prospects of superconductors for electricity distribution in the future. The total costs of the research project amount to some € 13.5 million, including the financial support provided by the federal government in the amount of approx. € 6.3 million. Project partners are RWE Deutschland AG, Nexans as manufacturer of cables and cable systems, the Karlsruhe Institute for Technology (KIT) and the project sponsor Jülich (PTJ). With this project Essen become model city for new superconductor link for electricity transmission and pioneer for a new chapter of inner-city electricity distribution for the future. The conventional 110.000-volt lines between two substations in Essen's city centre have been replaced by a modern 10.000-volt superconductor cable over a length of one kilometre.

Figure 24: Route for the installation of the superconductor cable system in the city of Essen.[35]



4) Ruhr fast cycleway

The development of foot and cycle paths on decommissioned freight train tracks from the coal and steel industries is a focus in the promotion of non-motorised transportation, particularly given how easy it is to cross these tracks. This objective is also served by the 101 km "Ruhr fast cycleway" which is a regional project intended to lead through the entire Ruhr Area, extending from the Rhine in Duisburg, via Essen, to Hamm. In Essen, the first 5 km of the Rhine Rail trail has already been completed as foot and cycle paths. The path track is simultaneously the green backbone of the city centre development strip, from the University district, through the Krupp Belt and Niederfeld Lake, up to the regional open space of the Emscher Landscape Park.

Figure 25: The Ruhr fast cycleway[36]

[35] M. Stemmle, F. Merschel, M. Noe, "Ampacity Project – Update on world's first superconducting cable and fault tolerance limiter installation in a German city center", 23rd International Conference on Electricity Distribution, 2015.

[36] Image via Metropole Ruhr, K. Lipsius, "Changing the way we act - The low carbon city: Concepts, frameworks and approaches", 2017.

11.3 EU Industrial City: Bilbao

11.3.1 City Profile

The municipality of Bilbao is the capital of the province of Biscay in the autonomous community of the Basque Country in Spain. Once a major industrial hub throughout northern Spain, Bilbao has had to deal with a declining population for the past two decades after an economic downturn led people to seek a new livelihood in other parts of the country or even Europe. Bilbao has 354.860 inhabitants and is the tenth most populated conurbation in Spain with a 35.865 € GDP per capita in 2012.

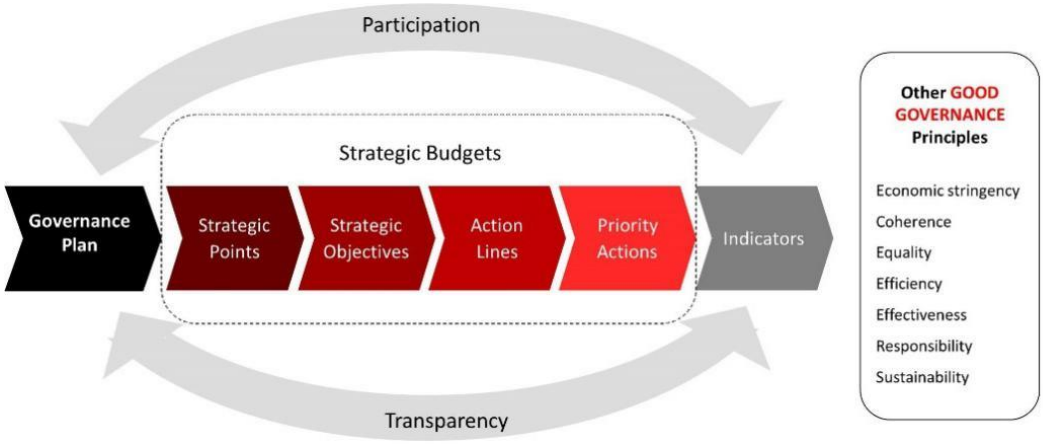
Bilbao is located between older industrialised regions and regions that are evolving new industrial structures. The city is divided into eight districts, which again are sub-divided into overall 39 neighbourhoods. This is particularly relevant as over the past decades, Bilbao's economy has found strength again. Today, the service sector (87.6%) dominates the local economy, whilst the industrial (6.9%), building (5.4%) and agricultural sectors (0.1%) have suffered losses in contributing to the city's annual Gross Value Added (2012). Yet, most of the service sector predominately relies on trade and repairs services (24%), followed by professional, scientific and technical services (18%) and education services (18%). Many of these activities are based on knowledge and are mainly located in the city centre. The number of gainfully employed in Bilbao ranges around 45.72% – a number which is still recovering from the industrial downturn from the 1980s onwards. The manufacturing and construction sector are still the second and third biggest employing sector (ca. 24.000 in total) after the commerce, transport and logistics services sector (ca. 34.000 in total). Bilbao's transformation has also led to more than 10.000 locals being employed in the tourism, hotel and catering services sector.

Bilbao has transitioned from a post-industrial city, to a city of services, culture, design and creativity. The metropolitan area of Bilbao has 953.152 inhabitants and has experienced an on-going social, economic, and aesthetic revitalisation process since the 1990s. The principal challenge was to transform the river into an axis for social and urban reintegration, and in turn, replace heavy industry with an emerging sector built on a network of design, technology and innovation centres.

In the beginning of 1980s, Bilbao witnessed industrial collapse. The situation turned gloomier with the city experiencing severe flooding in 1983. All these events led to Bilbao starting its transformation by bringing about a change in its approach and a strategic planning. The old industries gave way to new technologies, and today it stands as a city of services and culture. That the city was recognised in 2010 by the Lee Kuan Yew World City Prize, considered the Nobel for cities, is a testimony of Bilbao's ascendance to an international reference model from a failed city in 1980s. It is the symbol of a powerful social and economic driver to catalyse change, strengthen the urban fabric, inject vibrancy and improve the quality of life for its citizens.

Since 2008 Bilbao has been recognized as one of the most transparent city councils in Spain by the International Transparency Foundation. Bilbao City Council has demonstrated that high level of investment and high-quality service delivery can be maintained also in times of economic crisis/constraints through the adoption of a target-driven approach by linking the municipality budget directly to strategic objectives followed by strategic operations and a close monitoring, all of these with as much transparency as possible and fostering citizen participation.

Figure 26: Bilbao's Public Management Model and Good Governance Principles[37]



11.3.2 Low Carbon Activities

Strategy

Several departments are responsible for climate policy. Departments of Public Works and Services are in charge of lighting, cleaning and water management. Environmental planning, management and environmental regulations are under municipal jurisdiction. The Urban Development Department is responsible for building, renovation, management of grants and subsidies for modernisation, as well as the management of community incentives to introduce building owners to energy efficiency measures. The Transport Department is in charge of the promotion and encouragement of sustainable mobility within the city. The General Service Department is responsible for municipal public procurement.

In 2012, Bilbao signed the Covenant of Mayors and also elaborated its Sustainable Energy Action Plan (SEAP). The measures envisaged to prevent about 251.428 tonnes of CO_2e being released, which means a reduction of 30.8% by 2020, taking the base year (2005) as a reference. Within the SEAP, Bilbao developed measures in the following six areas: energy efficiency, renewable energy, sustainable mobility, waste, water and green zones. The main goals are to comply with the objectives set in the sustainable mobility plan, to renovate and modernise all privately-owned buildings in order to incorporate energy-efficiency solutions, to involve professionals and companies and urge them to inculcate the measures in their activities and projects and to create vigilant technological forums for sustainable renovation work.

To achieve these objectives, the plan includes investments amounting to a total of €809 million from 2011 to 2020. The investment is financed by the authorities of Bilbao, companies, families, and other regional, national, and European institutions. The areas receiving more funds are sustainable transportation (70%), energy efficiency (29%) and renewable energy sources (1%).

At the Basque regional level, the most recent plan is the "Climate Change Strategy for the Basque Country to 2050", which was issued in 2015. In line with international commitments the strategy contains three objectives:

(i) to reduce GHG emissions in the Basque Country by at least 40% in 2030 and by at least 80% in 2050, with respect to 2005;
(ii) to achieve 40% renewable energy consumption out of the final consumption by 2050; and,
(iii) to ensure the resilience of the Basque territory to climate change.

[37] Urban Planning Department of Bilbao

Bilbao was the first city with the Bidelek Smart Grid Project. The primary objective of this project has been the development of a more flexible, efficient and secure system, causing a qualitative improvement of the electric distribution grid and customer services. The functionalities of the system range from greater support to consumers through the new meters and traditional network of transformer stations, substations and MV power lines, to greater integration and coordination of the entire system with electric vehicles and distributed generation. The subway system for the city of Bilbao derives a significant amount of energy from renewable sources, which happens to be the first of its kind citywide subway anywhere in the world.

Energy efficiency

Bilbao is in a learning process regarding climate policies in the building sector. The main measure is to implement awareness-raising campaigns for energy efficiency in the private sector, including citizens, commercial stores and service providers. The Office of Climate Change in Bilbao is responsible for these campaigns. Urban modernisation in neighborhoods and privately-owned buildings is also actively encouraged. During the last few years, there has been strong advertising for the efficient renovation of buildings supported by financial and economic management. Furthermore, some pilot projects for renovation work have already been initiated. The main challenge regarding energy-efficient buildings is how the outcome of the projects is evaluated in terms of cost-benefit analysis. The awareness-raising concepts to motivate the private sector to carry out renovations represent another major challenge. Financial mechanisms for the community of property owners is one area that is holding back efforts to adapt to energy-saving methods of renovation.

Renewable/low carbon sources of energy

Bilbao is currently trying to enforce the production of renewable energy with different measures. Specifically, the following actions are being taken by hiring energy service companies:

1. Production of heat and power from solar thermal and photovoltaic systems on municipal sports centres.
2. Production of energy from photovoltaic systems at the new city hall.
3. Reduction of energy consumption of power systems for street parking meters by installing photovoltaic systems.
4. Promotion of renewable energy use in new municipal buildings to encourage the installation of solar thermal systems.

These measures are to be implemented to prevent GHG emissions and reduce fossil fuel consumption by using solar power.

Plans are at advanced stages to use the residual heat of industrial process of the Zabalgarbi Waste to Energy plant, to gain an HVAC urban network. The idea specifically, is to launch a pipe to provide heating and cooling to a zone of Bilbao, a few kilometers away, including living houses in the areas of Zorroza and Basurto and strategic centers in the district as the public Hospital in Basurto or the Headquarters of the Basque Public Television (EITB). Though expensive and complex, these projects have proved fundamental for the successful regeneration of Bilbao.

Transport

Regarding climate policy in the transport sector, Bilbao has already implemented a number of measures. Bilbao's local government has introduced a number of activities to encourage its citizens to switch to more sustainable modes of transport over the past few years. Within the city centre, most people get around on foot (64%), whilst others opt for public transport (24%) or private cars (12%). The municipality promotes efficient fuel consumption and the use of biofuels.

One project is the Biocar Life Project which demonstrates the sustainability of biofuels. Although there are some problems with the quality of biodiesel, the city has decided to persevere with them. However, hybrid buses could be a possible alternative in the future. Additionally, car sharing and car pooling, electric vehicles and bicycles both in the public and private sector are encouraged. For example, the City provides free parking spaces for electric cars (car sharing) in some underground car parks owned by the City Council and the possibility to buy affordable underground car parks. There are plans to create more pathways for pedestrians.

A plan for sustainable mobility is also currently being elaborated, but whose implementation depends on funding sources for the future. To develop climate policy in urban transport, there is potential to improve the general management of urban transport, as well as incorporate hybrid buses. With regard to bicycles, Bilbao's target is to promote cycling as a more sustainable and healthier means of transport through the Bilbon Bizi project. The target is to increase the number of people using the bicycle hire service. Bilbao aims to keep in line with EU, regional and state policies aiming to promote technological innovation and increase the share of renewable energy. With this in mind, the municipality plans to apply, adapt and improve the tools that enhance their implementation on both the administrational and service-related level as well as in the municipality's own residential buildings.

11.3.3 Good Practices and Key Projects in Bilbao

1) Abandoibarra renewal project

The flagship project of the urban transformation of Bilbao is Abandoibarra, developed on an obsolete and run-down port area. The riverside has been completely overhauled, doing away with the old railway track and building new green areas, hotels, shopping centres, residential apartments and the Guggenheim Museum. The riverside design, the bridges, the parks and gardens, the tram and the exhibits of urban art all go towards making this one of the most sophisticated areas in Europe.

3) Bilbao Metropoli 30

The Association "Bilbao Metropoli-30" is a Public Utility Entity recognized by the Basque Government that has been formed to carry out planning, research and promotion projects, headed towards the recuperation and revitalization of Metropolitan Bilbao. The Association for the Revitalization of Metropolitan Bilbao is an association of promotion and research, with full legal and patrimonial responsibility established in 1991. Its headquarters were established in Bilbao with the aim of carrying out investigation and promotion work for the revitalization of Metropolitan Bilbao, this last being mainly its territorial scope. Principally, Bilbao Metropoli 30 drives the implementation of the Strategic Plan for the Revitalization of the Metropolitan Bilbao.

The Association undertakes any type of actions derived from the Strategic Plan which are entrusted to its responsibility, and particularly, of those whose aim is the improvement of the external and internal image of Metropolitan Bilbao. Moreover, the association carries out study and research projects related to Metropolitan Bilbao, as well as other metropolis that, due to its circumstances, can provide useful knowledge fostering the cooperation between public sector and private sector with the aim of finding joint solutions to problems of mutual interest that affect Metropolitan Bilbao.

4) Bilbao Urban and Cities Design

Bilbao Urban Design & Cities is a spin-off project based in the experience gained during the award-winning Bilbao Metropolitan Urban Transformation. Bilbao Urban and Cities Design is a hub of Urban Strategy Thinkers who came across during the Bilbao Metropolitan Urban Transformation firmly believing that the enriching experience gained during that award-winning process may serve to inspire new urban solutions. Bilbao Urban Design & Cities gathers together professionals from different areas

such as urbanism, architecture, engineering, environment, energy efficiency and mobility, strongly engaged with more sustainable and efficient urban models and working in close collaboration with local governments to reimagine the city, rethink the urbanization processes and redesign better places to live, grow and work. Innovative urbanistic models that integrate in a long-term vision strategy to improve the quality of life of the citizens and attract new investors to compete internationally in the new World of Smart Cities are promoted.

5) NAVACEL

Navacel is a company of Bilbao with an extensive experience in the naval sector and representing an example of competitive repositioning thanks to the reconversion of the production towards new activities related to the renewable energy sector. Following the industrial crisis, the company has been able to use its broad experience in manufacturing maritime offshore equipment (like deck & cargo cranes, winches and other parts for companies that need equipment for offshore activities) to enter new segments of the market related to the renewable energies. Nowadays, in addition to traditional production, the company can produce towers and other products for onshore and offshore wind energy farms and pressure tanks to be used at thermo solar energy farms having well known international companies as clients and manufacturing capital equipment for offshore oil and gas industries, green industries like wind and solar energy, and handling and civil engineering companies.

6) City-Lab

Deusto Cities Lab is a team of transdisciplinary and cross-sectoral professionals based at the University of Deusto and focusing on the present and future of cities. Deusto Cities Lab develops research projects and learning programs related to models of governance, leadership styles and participation channels that foster levers of urban transformation such as collaboration, creativity, co-competitiveness, cohesion and compactness. The research activities are centred on cities, models, strategies and actions from all around the world that promote new habitats for human development. Deusto Cities Lab accompanies institutions, companies, social entities and citizens in the design, innovation and transformation of cities sharing experience and knowledge with professionals, experts and citizens. One of the innovative elements of the City Lab is its holistic approach to policy and governance evaluation. It is designed to address the smart city's specificities and its capacity to benefit from the active participation of citizens in assessing the public value of policy decisions and their sustainability over time. In doing so, the City Lab focuses the attention towards the performance measurement of multi-stakeholders co-design, co-production and social innovation processes related to public value generation and studying the processes by which public decisions are implemented, monitored and evaluated in relation to their capability to develop truly "blended" value services which are at the same time socially inclusive, environmentally friendly and economically sustainable.

12 Comparison of multi-level governance regions

The multi-level governance approach deployed for the EU CoM has clearly demonstrated that advancing governance of climate change across all levels of government and relevant stakeholders is crucial to avoid policy gaps between local action plans and national policy frameworks (vertical integration) and to encourage cross-scale learning between relevant departments or institutions in local and regional governments (horizontal dimension). Vertical and horizontal integration allows two-way benefits: locally-led (or bottom-up) where local initiatives influence national action and nationally-led (or top-down) where enabling frameworks empower local players. The most promising frameworks combine the two into hybrid models of policy dialogue where the lessons learnt are used to modify and fine-tune enabling frameworks and disseminated horizontally, achieving more efficient local

implementation of climate strategies. In this section, examples from Barcelona and Liverpool in Europe are compared with Jiangsu Province.

12.1 Chinses Region: Jiangsu Province

12.1.1 Province Profile

Jiangsu province is a wealthy, beautiful coastal province with developed science and education sectors, also famous for its manufacturing. It has always been a pioneer of reform and opening, with balanced economic and social development. However, in recent years, the bottleneck of resources and environment has become increasingly prominent, the comparative advantage of the manufacturing industry has weakened, relatively lagging Jiangsu behind as a new economy. The lack of top enterprises and entrepreneurs there have become the biggest problem for Jiangsu's economic transition.

Figure 27: Jiangsu Province

Since ancient times, Jiangsu Province has been a prosperous and rich cultural region in China, because of its location by the Yangtze River and being close to Shanghai. With its developed economy, science and education, and urban and rural social development level, Jiangsu Province has always been at the forefront of China's economic and social development:

- The amount GDP of Jiangsu province has always ranked second in the country's provincial administrative regions (after Guangdong Province), and the per capital gross is the first among the country's provincial-level administrative regions (excluding municipalities).
- Jiangsu province is a large manufacturing province, and its industrial output value and added value has ranked first in China for many years.
- The gap between urban and rural income, and regional development is smaller than other places in China and the whole province is very prosperous.
- Jiangsu's private economy has created 55 % of the province's GDP, nearly 60 % of taxes, 70 % of total social investment, nearly 70 % of enterprise research and development investment, and more than 80 % of new jobs. It provides important support of economic development, the main force of entrepreneurial innovation, the main channel for absorbing employment and the main source of social wealth in Jiangsu Province.
- Jiangsu has a long history, rich human resources and a splendid culture and art. It has a high level of science and education with 167 colleges and universities, ranked first in the country's provincial administrative regions. The regional innovation capability has been at the leading level in the country for 7 consecutive years, and the contribution rate of scientific and technological progress has exceeded 60% (the national average level in 2017 was 57.5%)

12.1.2 Low Carbon Activities

Jiangsu Province has a relatively advanced low carbon agenda and despite the high level of absolute emissions, the emissions per unit of GDP is relatively low. This is in spite of an ongoing process of rapid industrialization and urbanization. Jiangsu is part of China's emission trading system and transfers a large proportion of emissions under the name of Jiangsu Manufacturing. The emission profile of the province is largely driven by the industrial and coal combusting activities. The province has been relatively successful in decoupling economic growth and GHG emissions with the latter having entered a period of slow growth despite consistent economic growth.

Jiangsu is undertaking a number of specific low carbon development actions:

- Deepening a strategic low carbon reform of industry;
- Effectively promoting the optimization of energy generation and use;
- Strictly implementing an energy conservation review system;
- Promoting energy saving in key areas;
- Innovating in the construction of a low carbon cloud platform across the province;
- Promoting low carbon pilot demonstrations;
- Actively innovating low carbon working mechanisms; and,
- Developing its circular economy.

12.1.3 Main problems and challenge faced

In the past few years, Jiangsu Province has vigorously implemented an innovation-driven development strategy and made positive progress in transformation and upgrading, resulting in a new model for business emerging. However, on the whole, the development and transformation is still in a critical period of overcoming hurdles and the province is experiencing the pain of structural adjustment. Some key issues remain:

- Jiangsu Province is densely populated (779 people per square kilometer) and its high development intensity, small environmental capacity and limited resources and natural environment are increasingly strained for development. Its land resources are in short supply and per capital arable land has dropped from 1.03 mu at the beginning of the "12th FYP" period to 0.81 mu at the end of the "12th FYP" period. It is close to the "Cultivated Land Line" of 0.8 mu per capital as delineated by the UN Food Agriculture Organisation (FAO). Jiangsu Province also suffers from a lack of energy resources with over 80% of disposable energy imported.
- Jiangsu is a big manufacturing province, with its industrial output value and added value rank first for many years in China. However, its industrial level is wholly in the middle and low end of the industrial chain and value chain. Judging from the external economic environment, Jiangsu Province, as a major manufacturing province, is undergoing "double squeeze". Jumping to the high end of the industry, it faces the barriers of technology, standards, and other constraints from developed countries. The development of low-end and middle-end industries also faces fierce competition from low-cost countries. With the increasingly fierce international competition, some developed countries used their reputation in the international situation and arbitrarily adopted trade protection measures to implement green trade barriers against China in the name of environment. This will greatly limit the export of green products in Jiangsu and seriously hurt green foreign trade in Jiangsu.
- Jiangsu Province has difficulty in attracting and nurturing top enterprises and entrepreneur groups. On the potential of the growth-oriented enterprises facing the new economy, Jiangsu is weaker than Beijing, Shanghai, and Guangdong.

12.1.4 Low carbon policy objectives

In the next ten years, Jiangsu Province shoulders the heavy task of leading China's "transition and upgrading". From the pursuit of economic growth from quantity to quality, it will put emphasis on people's living status, focus more on the people's emotional state and the living environment, and focus on the influence of the industry in the world. Some key objectives are as follows:

1. **Let the ecological environment recover:** to overcome the insufficient capacity of resources and the environment, Jiangsu Province must rely on making a transformation on improving the efficiency of resource use, reducing resource consumption, reducing pollution emissions and protecting the ecological environment as part of its green, low carbon development. The ecological environment needs to be reclassified as "resources" and "assets" to allow the ecological environment to recover and to build a sustainable ecological environment.
2. **Develop a green and low carbon manufacturing sector:** the province must take measures to make the economic structures lighter, turn models green and improve quality. It needs to develop green manufacturing, build green factories and green parks, accelerate the recycling of factories and parks and support top and leading environmental protection enterprises.
3. **Gathering high-tech companies:** promoting comprehensive innovation centered on technological innovation and increased industrial added value is a priority. Jiangsu needs to cultivate a batch of technologies that are at an advanced level internationally made of industries that represent international standards and enterprises that are internationally competitive. It should accelerate the gathering of high-end elements and develop high-end industries and strive to form an economic system and development pattern that is led by innovation. Increased investment on green and low carbon technology research and development will be necessary.

12.2 EU Region: The Province of Barcelona

12.2.1 Province Profile

Barcelona, with more than 1.6 million inhabitants, is the capital of Catalonia and stands at the centre of a 2.500 km^2 metropolitan area with around 5 million people. The urban area accounts for 63.7% and 10.2% of the population of Catalonia and Spain, respectively. In terms of economic and transport infrastructure, the city boasts an international airport, the port, trade fair facilities, the Zona Franca free trade zone, and a major logistics platform all within an area of five kilometers. These facilities offer the potential of making the city a key logistics centre in the Mediterranean. Port activity registered 2.2 million TEUs and 47.5 million tonnes of freight transported in 2016, representing an annual increase of 14.5% and 3.5%, respectively.

Barcelona continues to develop its ability to attract businesses, employment, foreign investment and talent backed up by the city's strong international positioning. The city of Barcelona's Gross Domestic Product (GDP) was €42.200 per capita in 2015. In 2015, Catalonia generated a GDP of €214.927m, representing 19.9% of Spain's total. The same year, GDP per capita in Catalonia was 14% above that of the European Union. In 2015 the industrial sector generated 19.6% of Catalonia's total Gross Value Added, a %age that is above the European Union average (19.2%) and clearly higher than the rate for Spain (17%). Catalonia is the top region in Spain in terms of industrial development.

Catalonia is an area with a strong industrial base and is the fifth top region in Europe in terms of employment in high-tech industries, with 205.000 employees working in these activities in 2015, above other regions like Piedmont (Turin), Rhône-Alpes (Lyon) or Darmstadt (Frankfurt). Barcelona has a significant industrial sector accounting for 14.2% of all jobs in Catalonia, including competitive clusters. Outstanding examples are the chemical and pharmaceutical sectors, car production-with this being one of the leading manufacturing areas in Europe, food, paper and graphic arts and waste treatment.

12.2.2 Low Carbon Activities

Strategy

On the occasion of the Paris COP21 conference, the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change, and as part of the Citizens Commitment to Sustainability, Barcelona produced its Commitment to the Climate in which it made a commitment to reduce GHG emissions by 40% by the year 2030, compared to 2005 levels, and to increase urban green areas by 1.6km^2 as an adaptation measure.

The City Council and the general public established a 2015-2017 road map, with municipal and citizen projects aimed at achieving these objectives. Based on these two years of experience, the City Council now wishes to undertake a more powerful and structured response to this commitment. It therefore proposes uniting all the actions it is carrying out to counter climate change under a single plan that includes all its lines of action: The Climate Plan.

This plan also specifies all the international commitments undersigned by the City Council, including the Covenant of Mayors Sustainable Energy and Climate Action Plans.

The Climate Plan works on 4 major aspects: Mitigation: what to do about reducing emissions, Adaptation and resilience: how to be less vulnerable to climate change, Climate Justice: what to do about guaranteeing the rights of the most vulnerable people and Promoting citizen action: how to support projects undertaken by organizations and the general public.

As regards energy, for example, over recent years Barcelona has adopted new criteria as regards the promotion of urban projects – in the development of districts such as Vallbona, for example-, and has introduced technological and regulatory innovations which have had a significant impact on the sector, such as district heating and cooling networks or the thermal solar Bylaw, amongst others. Energy consumption went up from 15,664.78 GWh in 1999 to 16,782 GWh in 2012, despite the trend to reduce consumption per capita, with a drop-in energy consumption per resident from 10.60 MWh/year in 1999 to 10.35 MWh/year in 2012. As for GHG emissions, Barcelona released a total of 3,690,037 tonnes of CO_2 equivalent into the atmosphere in 2012, representing 2.28 tonnes of CO_2 equivalent per capita, considerably below the level of emissions for 1999, when 3.19 tonnes of CO_2 equivalent were given off.

Since the end of the 20th century, Barcelona is promoting initiatives to reduce the environmental impact derived from municipal activity; and it was in 2002, during a plenary session, that the City Council approved the PMEB (Barcelona Energy Improvement Plan for 2001-2010), a municipal action plan provided with a range of projects and measures aiming to increase energy efficiency improvement, to reduce GHGs, and to increase energy generation with sustainable sources.

In 2011 Barcelona approved its Energy, Climate Change and Environmental Quality Plan. This Plan, that uses 2008 as a baseline year, proposes a group of 108 measures to cope with all Barcelona's environmental target and commitments of the Covenant of Mayors. The Energy, Climate Change and Air Quality Plan of Barcelona is running with two parallel programs:

1. The Municipal Program deals with all the public services the City Council executes directly (i.e., public transport, public buildings, public energy generation, public lighting, etc.).
2. The City Program take care of those aspects that the City Council can promote but not directly execute (i.e. private mobility, private housing, etc.).

Catalonia has an Energy and Climate Change Plan 2012-2020, which demonstrates its leading approach towards clean energy. Its objectives complement the 2020 EU Strategy: The Plan will achieve a 25.3% emissions reduction from 2005 levels, a commitment to generate 20.1% of renewable energy sources of gross final energy consumption, and to achieve a 20.2% increase in energy efficiency by 2020. Actions

are focused predominantly on management of energy demand, energy efficiency and renewable energy. Energy efficiency is based on industrial, building and transportation sectors. The new Plan also promotes renewable energy, in particular wind, including marine wind, biomass and solar (thermal, photoelectric and thermoelectric).

Figure 28: Scenario for the Energy, Climate Change and Air Quality Plan of Barcelona in 2020[38]

RATIOS OF PECQ SCENARIOS			
Pecq-2020 Technology	**2008**	**Trend-2020**	**PECQ-2020**
Final energy consumption [Gwh/year]	17,001.78	21,826.93	20,148.08
CO_{2eq} emissions (Catalan mix) [t/year]	4,053,765.54	5,119,276.78	4,410,271.61
CO_{2eq} emissions (Spanish mix) [t/year]	5,733,150.57	5,784,227.50	5,063,398.23
NO_x emissions [t/year]	10,412.94	9,863.53	8,412.32
PM_{10} emissions [t/year]	743.77	619.95	470.13

The city has begun moving towards a more sustainable energy model by working to maximise power generation using local renewable resources, at the same time as reducing final energy consumption by applying energy saving measures and using resources more intelligently in all its activities and services. It wants to lead the way in energy policies, while prioritising and promoting a series of measures and actions designed to enable it to achieve the energy transition.

So, the city is committed to creating its own energy future by developing, at the same time, energy efficiency, clean, renewable production and the necessary collective change of chip to make that possible.

This change also involves rethinking funding solutions, designing new, appropriate governance models and understanding urban planning as a tool for moving towards a sustainable, low carbon future. With this in mind, and a medium- to long-term strategic perspective, the City Council is setting up the Energy Operator as an instrument that will enable it to develop comprehensive, efficient, coordinated energy policies that should ensure it achieves the city's energy transition, as well as implement all the measures envisaged within the framework of local energy planning, currently set out in the 2011-2020 Energy, Climate Change and Air Quality Plan.

12.2.3 Good Practices and Key Projects in Barcelona

1) Aggregated implementation and monitoring of SEAPs in the province

The provincial council since 2008 took over the role as coordinator and intermediary between the EU CoM and the 311 municipalities in the province. The province of Barcelona (5.347.403 inhabitants) consists of 311 municipalities ranging from very small scale, rural communities to large metropolitan cities such as Barcelona. The provincial council of Barcelona (DIBA) has been active promoting climate mitigation already before 2008, which is the year when it officially became the coordinator and intermediary between the EU CoM and the municipalities. In this function, the DIBA encourages the province's municipalities to join the EU CoM. In order to support them, the DIBA offers technical advice, such as the 29 organization of trainings and the development of a common methodology for the establishment of SEAPs. Furthermore, DIBA provides financial support by covering 100% of the costs for

[38] Energy, Climate Change and Air Quality Plan of Barcelona (2011-2020).

the establishment of SEAPs and providing funding tools for the implementation of measures from the plans. Typically, the parties involved in the establishment of SEAPs include:

- Technical staff from the municipality (who provide data and accompany the planning to later assume ownership of the SEAPs, and who typically come from the environmental department, but also the energy department and the city planning/architecture/municipal infrastructure are involved in the process);
- a consultant specialized on energy (paid by DIBA), and/or
- technical staff from DIBA as support. The consultant is also in charge of organizing the participation process. (however, the municipal staff interviewed commented that no participation by citizens took place, because of the absence of civil society organizations in their municipalities) (see below).

As of June 2020, 238 of the municipalities in the province (covering approx. 97% of the province's inhabitants) had joined the CoM. Another service the DIBA provides is the monitoring of the impact of the SEAPs. The success of the implementation of SEAPs in the province is not only confirmed by the high number of SEAPs but also by indicators such as the energy consumption in the province, which between 2005 and 2012 dropped in absolute terms (5%) as well as relative terms (11% per inhabitant). Most of this reduction was due to the transport sector. Furthermore, the reduction of emissions per inhabitant was calculated at 24%. When comparing municipalities who had joined the EU CoM with those who had not, the DIBA found that the energetic consumption of the municipalities who had joined the EU CoM was reduced by 8%, as opposed to 3% in those municipalities not part of the CoM. Likewise, municipalities being part of the EU CoM managed to increase the local production of renewable energy by 58%, as opposed to 31% in those municipalities not part of the EU CoM.

2) Barcelona Smart City Strategy

Barcelona's Smart City Strategy takes a holistic view of the various projects being developed throughout the city and uses technology as a transversal tool to manage the city's resources and services in a more efficient way. Barcelona's Smart City Strategy is currently formed by about 122 projects classified into 22 programmes that cover all areas of the city management, from Lighting, Water and Waste Management to Innovation and many others. For this reason, two of these 22 programmes are of extreme importance due to their transversal and horizontal nature, allowing for many vertical solutions to be integrated into them: The Telecommunications Network and the Urban Platform. The Urban Platform provides an IT architecture model of the city, which is replicable and open sourced.

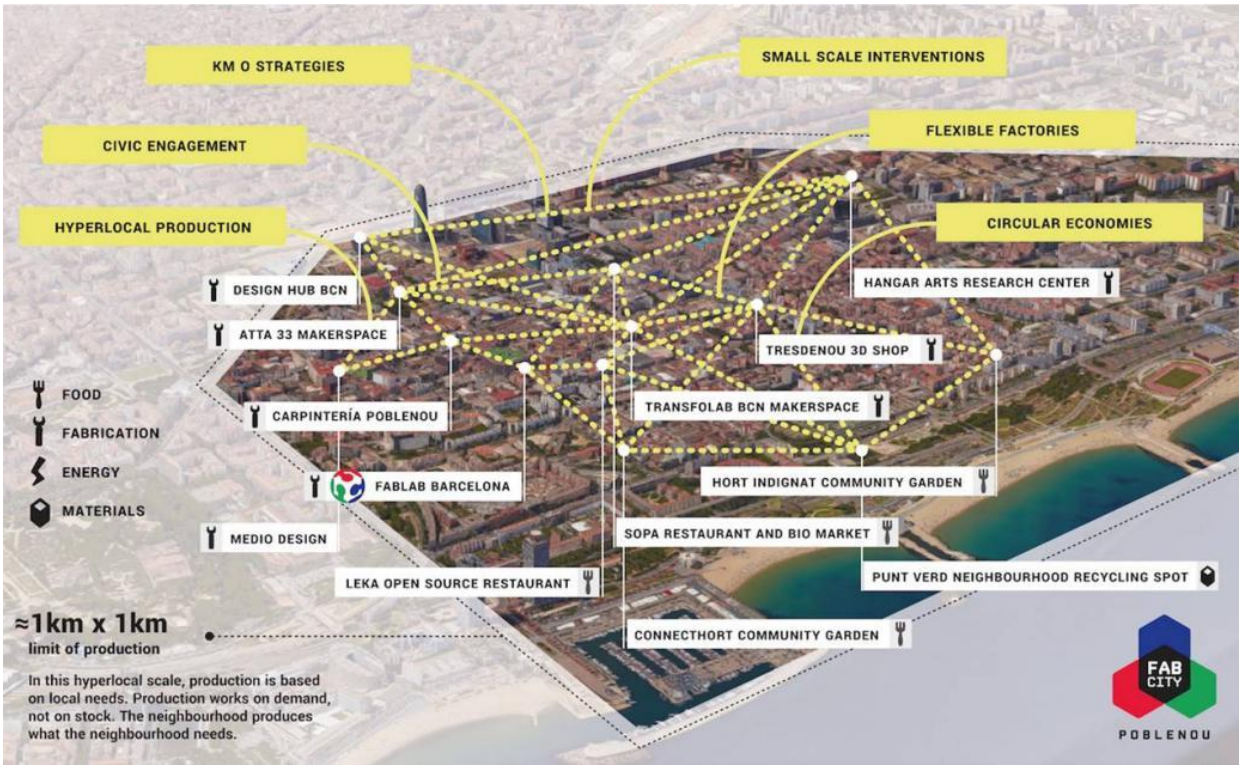
Many of the programmes included within the Smart City Strategy are aimed at reducing the negative impacts of the city on our environment. For example, the Self-Sufficient Buildings project monitors the energy within City Council's buildings, allowing us to know the building consumption in real time, detect deviations and correct them. This action is estimated to reduce 2.14 kg per year of NOx and 0.38 PM10 by 2015 from 2011 levels.

3) The Maker District Pilot Project

The Maker District pilot project in the neighbourhood of Poblenou is based on a prototype of a productive and scalable city, which aims to contribute to the city's reindustrialisation through activities and projects that promote interaction between local communities and citizen initiatives, while also being linked to a global and carbon free community. Poblenou's Maker District is based on an international perspective of the "fab city", the construction of a new model for cities that makes it possible to reduce their environmental and social footprint through the local production of food, energy and products, and the worldwide exchange of knowledge using the power of the Maker Movement and

the global fab-lab network. Barcelona is the world leader in this project. A Fab City is a new urban model for locally productive and globally connected self-sufficient cities that shifts how cities source and use materials is bringing back production to distributed and smaller scales. More production occurs inside the city, along with recycling materials and meeting local needs through local inventiveness.

Figure 29: The Maker District in Poblenou Neighborhood[39]



4) The Super Block programme

Whilst Barcelona has developed, the surface occupied by green spaces in the city has remained limited. Over the years traffic has increased, leaving less room for leisure and pedestrians. To reverse this trend and reduce the city's environmental impact, Barcelona has introduced the so-called 'superblocks' or 'filling the streets with life' programme. The superblocks programme is linked to the city's climate change commitments, as well as to its climate, urban mobility, green infrastructure, and biodiversity plans. Its aim is to free up space for green areas and recreation by reducing the amount of traffic and vehicles on certain streets. The programme began in 2014 with four pilot projects and will be extended throughout the city from 2017 onwards. Since the transport sector accounts for 28% of Barcelona's CO_2 emissions, the programme has the potential to significantly reduce the city's carbon footprint. At the same time, by building up the city's green spaces, Barcelona is able to address the urban heat island effect and create habitats that will encourage biodiversity.

5) Catalonia: a cluster and science parks hotspot

Barcelona's manufacturing and high-tech industry displays a strong tendency to cluster in order to ensure that international companies and investors can tap into the resources of a dynamic network of specialised partners and industry related suppliers, providers and associations. With 25 years of

[39] Image: Fab City Research Lab at IAAC – www.iaac.net

experience in cluster policy, Catalonia has attracted key international players such as Tci-network, the global cluster practitioners' network and the European Foundation for Cluster Excellence, as well as top-notch knowledge institutions. Catalonia's cluster policy is part of the Catalan multi-faceted, pro-business economic policy to promote Barcelona as a business location. The main goal is to bring together interconnected companies, research centres, universities and other relevant stakeholders sharing the same strategic challenges and providing the perfect environment to gather strategic sectorial knowledge, to connect companies locally and globally, and to develop collaborative projects with enough critical mass to compete in the globalised world. The constitution of Science Parks also ensure that international companies and investors can tap into the resources of a dynamic network of specialised partners and industry related suppliers, providers and associations. Currently, there are 29 clusters in Catalonia's Cluster Programme, home to 2,200 firms and more than 309,000 workers accounting for a turnover of 74 billion euros.

The Parc Tecnològic del Vallès (Science Park of El Vallès) is a new generation of business park especially established to cater for and incubate businesses and institutions that work in the field of the new technologies. The area of El Vallès has seen huge growth in the knowledge-based science and technology industries in recent years and this has coincided with the building of large communication infrastructures and a rapid urban development. The Parc Tecnològic del Vallès project was promoted by the Department of Industry, Trade and Tourism and by the Consortium of the Zona Franca of Barcelona and incorporates Catalan universities, research centres, financial organisations and local bodies as future shareholders of the corporation. The most important technological sectors are those of the Information Technologies (35%, with activities related to electronics, computing, software and telecommunications), followed by engineering -civil, product, processes and systems- with 17%. 63% of the partners are from Spain and 37% foreign.

12.3 EU Region: The Liverpool City Region

12.3.1 Region Profile

The Liverpool City Region, also referred as the wider LCR and situated in the North West of England, is an economic and political area of approximately 723.97 square kilometers, with a population of around 1.5 million. The city region, with a common geography shaped by the river Mersey and its maritime and industrial history, comprises the Core City of Liverpool and local authority districts of St Helens, Wirral, Knowsley, and Halton plus the adjacent areas of Warrington, Chester, Ellesmere Port and Neston (West Cheshire), and North Wales and West Lancashire. Within this area, Liverpool, Chester and Warrington are the three primary employment areas. The wider LCR has a simple polycentric structure and is an important driving force for the North of England's economy.

The Liverpool city-region is one of the areas of the UK (and England in particular) that has undergone significant socio-economic decline since the 1960s. The restructuring of the city's main industrial base, related mainly to the decline of its port function and related activities has created considerable socio-economic challenges ever since. The depth of the decline is illustrated by the fact that between the 1970s and the mid-1990s, Liverpool lost almost 200,000 jobs, which was a 53% decline in total employment. Clearly, such deep and rapid economic restructuring had a profound impact upon the city in a number of ways, including a rise in social deprivation, poverty, increased levels of crime, higher dependence of welfare benefits. In addition, the city suffered significant population loss due to economic out-migration, especially of younger people.

The city's economic fortunes rebounded somewhat in the late 1990s. This was due to a combination of factors including UK government policy which focused on improving the urban and socio-economic structure of the city using domestic as well as EU funds, aiming at shaping the socio-economic development of the region. These policies included the further development of Liverpool city centre and

further regeneration of the waterfront to help promote city-centre living and attract residents back into the heart of the city. In addition, the creation of business facilities on the southern periphery of the city (which was previously one of the most deprived in the UK), helped to attract private sector investment as well the creation of small firms in the area. The Maritime sector is a key sector, with some 1,700 firms employing around 28,000 employees. It is a diverse sector encompassing port operations (wet and dry docks), shipping services, professional services, distribution/logistics, marine engineering and specialised services. Activities are spread around the city region. The sector's growth aids complementary economic relationships across the city region.

In recent years, the Liverpool (and the LCR core) economy has been performing relatively well. Over the past ten years, the economy has grown by some 62% in economic value and business density has risen by 21%.28. The Maritime industry has re-established itself again, becoming increasingly reintegrated into the life of the City and its surrounding boroughs. Liverpool is the main UK port trading with USA and Ireland, and services ports in other parts of the world, including Asia. A fresh vision has been developed to create Liverpool 'SuperPort', integrating the core assets of the ports, airports, professional services and logistics operations to service regional, national and international markets.

Liverpool City Region has made significant steps to enhance its governance with the creation of the Combined Authority in 2014. The Combined Authority and its constituent councils enable decisions on economic growth and development to be taken in an open and transparent way on behalf of the entire city region. The Combined Authority was established to strategically lead work on transport, economic development, innovation, housing, employment and skills in the City Region to, in turn, support sustainable economic growth. More details on the Liverpool City Region Combined Authority are provided in Appendix I.

12.3.2 Low Carbon Activities

Strategy

LCR has identified the low carbon growth sector as being a key priority for job creation and economic growth. In 2005 Liverpool's GHG emissions totaled 3,172ktCO_2e based on its consumption of energy across the domestic, commercial, industrial and transport sectors and whilst evidence shows that there has been a reduction of 17% between 2005-2010 the City is reliant on importing energy with less than 1% coming from renewable sources or locally generated energy. Industrial and commercial use is responsible for circa 45% of emissions with transportation circa 18% and domestic 37%. Improving the energy efficiency of existing homes is a major local challenge and priority. Levels of fuel poverty in the City are higher than the national average and 61% of the city falls within the lowest 15% of national indices for multiple deprivation with levels of fuel poverty higher than the national average.

In 2012 LCR adopted the Sustainable Energy Action Plan identifying a range of energy and low carbon projects at different stages of delivery and setting out its ambition to transform itself into a low carbon economy in which future economic growth, the delivery of which remains of vital importance, is decoupled from the consumption of fossil fuels and their inevitable carbon CO_2 emissions. The target is to achieve a 35% CO_2 reduction by 2024. The SEAP created a baseline to inform decision-making. The baseline contains some compelling messages:

- In 2005 the City Region consumed over 37,000 GWh of energy.
- From this energy consumption a total of 11,500kt CO_2 equivalent (CO_2e) was emitted.
- In 2009, 23% of households in the City Region were in fuel poverty.
- Between 2005 and 2009 Liverpool City Region energy consumption has reduced by 19% and CO_2e by 16%.

The SEAP, together with another document adopted by LCR, the Low Carbon Economy Action Together, set out a co-ordinated programme to ensure the region is at the forefront of the transition to a low carbon economy. These documents recognise that the low carbon sector will draw heavily on the existing skills and business base, but will also require new skills and, in particular, up-skilling of existing workers. As is the situation nationally, a central challenge for the region is to create a labour market able to meet the anticipated demands of low carbon employers and investors. This not only impacts existing vocational and higher education training providers but also creates a requirement for in-work up-skilling so that existing jobs can be safeguarded through training.

To coordinate this skills development across Liverpool the LCR has also produced a standalone Low Carbon Skills for Growth Agreement. It evaluates the current and potential contribution of the low carbon sector, identifies the sector skills that are required by local businesses and the gaps that are creating barriers to sector growth, and commits to a number of actions that the LCR, and the city, should take to up-skill local workers and maximise potential within the sector.

Renewable/low carbon sources of energy

With over 4.4 GW of potential resource capacity identified for renewable and low carbon energy generation, the City Region has enormous potential to deliver a diverse range of commercial, community and micro-generation projects. The Liverpool City Region also provides a significant domestic market for energy projects and a real opportunity to cut carbon emissions in homes and workplaces, whilst also accommodating a mix of large, medium and small-scale energy generation schemes. In doing so, these projects have the potential to save money and create employment. The city region has a potential of energy capacity of 24MW from Biomass, 77MW from Waste, 299 MW from Microgeneration, 632 MW from Wind and 700 MW from tidal.

12.3.3 Good Practices and Key Projects in Liverpool City Region

1) Offshore wind projects at Liverpool Bay

Liverpool City Region is well placed to develop and take opportunities for low carbon and energy sector growth. Over £18bn is being invested by the private sector off the coast of the Liverpool City Region in some of the world's largest offshore wind projects and Liverpool's status as a Centre for Offshore Renewable Engineering (CORE) the city region is in a unique position to exploit, on and offshore, west coast low carbon and renewable growth opportunities.

Liverpool City Region represents an international success story in offshore wind energy, leading the way in new technologies, investment opportunities, infrastructure creation and supply chain development support. 56% of Europe's investment in offshore wind energy came to the UK in the past five years: £4.3 billion of that came to Liverpool City Region.

The Centre for Offshore Renewable Engineering has one of the largest concentrations of offshore wind assets in the world, with over 270 turbines in operation. It also boasts the first operational deployment of the world's largest wind turbines, the 8MW Mitsubishi Vestas V164. 32 V164 turbines came into operation in 2017 at DONG Energy's Burbo Bank windfarm extension. With ever-increasing investment in offshore wind energy supported by local R&D capability, a strong, existing supply chain, world class infrastructure and connectivity and a long-term vision for growth, Liverpool City Region will continue to lead the way in offshore wind energy.

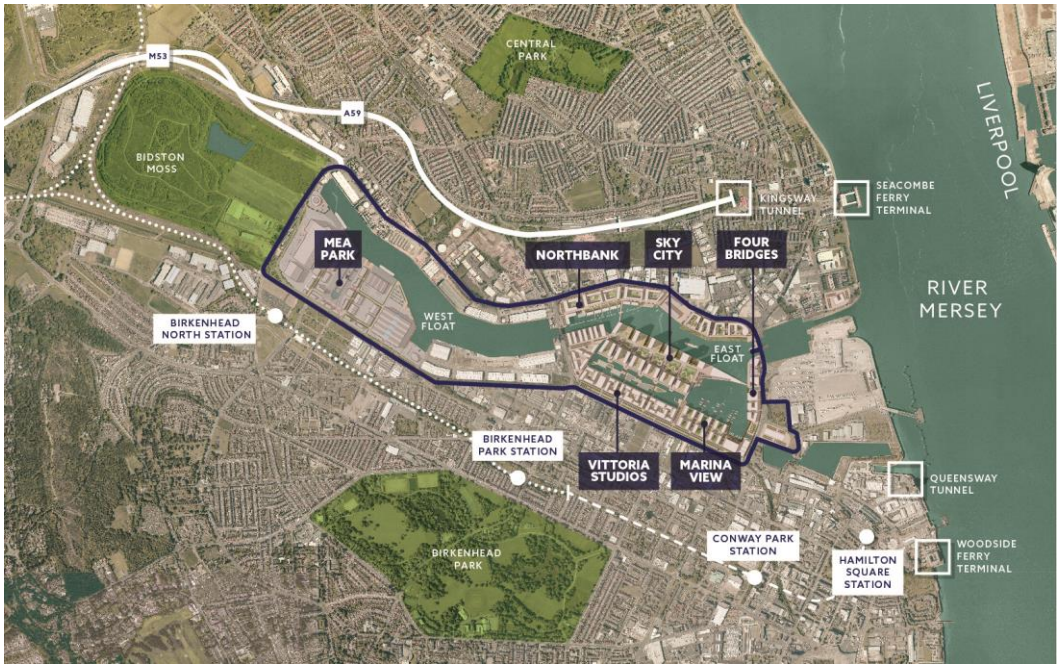
2) Green Infrastructure at Wirral Waters

Wirral Waters is a large-scale regeneration programme of national significance, in an area of high deprivation and inequality. The area, characterised by large tracts of derelict and underused land, needs investment for sustainable growth. The landscape strategy has been a fundamental strand of master

planning for the Wirral Waters project. The developer of Wirral Waters, Peel Group, has been working with partners including the Forestry Commission and Mersey Forest to create 'green infrastructure' that will help to act as a catalyst for economic growth, by improving the local environment. This includes; a community led programme of urban tree planting along important road routes; planting of biomass that can produce a crop in 3 – 5 years; design and implementation of new areas of woodland and other habitats and investment in green spaces, including the recently restored Birkenhead Park, as well as several smaller local parks and open spaces.

The focus has been on the delivery of a range of benefits, including climate change adaptation and mitigation benefits that will improve the quality of the area, leading to new investment. In terms of climate change adaptation, this Green Infrastructure provides: evaporative cooling and shading to the area; helps to attenuate flood events by reducing the rate and volume of water runoff; provides carbon storage and sequestration; filters air pollutants; provide a vegetated and permeable landscape through which species can migrate to new 'climate spaces' and provides a recreation and visitor resource for a more outdoor lifestyle and to promote more cycling and walking. Over the past few years there has been a great deal of work ongoing to develop a green infrastructure approach to embed the natural environment in decision making. This work has involved a wide range of organisations and has seen the rapid development of a range of policies, research projects, reports and tools, including the Green Infrastructure Valuation Toolkit - an easily accessible toolkit to enable valuation of social, environmental and economic benefits of Green Infrastructure.

Figure 30: Regeneration masterplan for Wirral Waters[40]



3) Alder Hey Children's Hospital

The newly built Alder Hey Hospital is set to be one of the most sustainable 24-hour hospitals ever built, with 60% of energy generated on site by ground source heat pumps, air source heat pumps and photovoltaic panels. Alder Hey NHS Trust took an ambitious architectural approach, featuring a central hub connecting three long 'fingers' (each topped with a green roof sloping down to ground level),

[40] Image from Wirral Waters - https://www.wirralwaters.co.uk/news/2018-will-big-year-wirral-waters/

acknowledging the importance of natural light and outdoor space, extending out into the surrounding Springfield Park, a vibrant green space for both patients and the public to use freely and securely, without the needs of either group being compromised.

Alder Hey is a prime example of putting the health, climate change and biodiversity together and of seeking good practice examples worldwide to develop a holistic, sustainable approach to building management and design. Since its completion in 2016, the hospital has won a host of building design awards, including; the Prime Minister's Better Public Building award at the British Construction Industry Awards, the 2016 Civic Voice Design Awards (winning both New Buildings category and the Overall Award), and the RIBA National Award and is looked to by others as a beacon of good practice with visitors worldwide coming to learn from the experience of this project.

Figure 31: Low carbon, sustainable building at Alder Hey Children's Hospital[41]

4) Cammell Laird

Cammell Laird has been at the heart of British manufacturing for the last two centuries and major investment in its port infrastructure and facilities are seeing it play a critical role in the region's offshore wind industry. From its Birkenhead site, on the River Mersey, it handles huge component parts for the construction of the windfarms in the Irish Sea, working with international partners such as RWE and DONG Energy. One of the best and most competitive heavy fabrication facilities in the engineering industry, Cammell Laird has one of the largest modular construction halls in Europe and with world-class facilities and the right engineering skills it provides services to offshore wind energy, maritime, civil nuclear, oil and gas and petrochemicals projects. Ship-building and refitting capabilities continue to be at the heart of Cammell Laird's work, winning contracts to construct the flight decks for the Royal Navy's new aircraft carrier and beating international competition to build a £200 million polar research ship, which will be equipped with on-board laboratory facilities and robotic technologies.

5) Clarke Energy

Liverpool City Region success story Clarke Energy was founded in 1989 and today employs more than 1,000 people in 17 countries from Algeria to New Zealand. It supplies, installs and maintains high

[41] Building Climate Resilience: Good Practice Case Studies in Liverpool City Region – 2017, Liverpool City Region Brussels Office

efficiency embedded power plants, with over 5,000MW of reference plants globally which can generate enough electricity to supply the equivalent of 13 million UK homes. Leading on low carbon and renewable power, with Liverpool City Region plants including Broadgreen Hospital and the University of Liverpool and a range of international projects, Clarke Energy is a key player in the low carbon economy. A regular winner of industry awards for its international success Clarke Energy is a holder of the Queen's Award for enterprise and in 2016, it was named Exporter of the Year Award at the North West Business Masters Awards, for a second year running.

13 Comparison of case studies from the EU and China – Synthesis

13.1 Overview

In reviewing the challenges and policy objectives of the Chinese cities and region profiled, it is clear that they face similar issues to those that the EU cities have been addressing over the last 30 years. By assessing the policies and measures which have been successful in the EU context, there is an opportunity to accelerate the successful transitions of Chinese cities (both those profiled in this study and others) to low carbon economies. Based on the similar themes of the challenges faced between EU and Chinese cities in the small subset analysed for this study, there is an indication that an extrapolation of this process to aggregate more Chinese policy challenges with successful EU solutions would be a valuable exercise.

The following sections present the proposed matching of policy objectives from the Chinese cities and region with the solutions presented by the EU case studies. The selections presented are not restricted to the categories described in Sections 11, 12 and 13 above so, for example, objectives from the 'port city' (Ningbo) are matched with solutions from EU cities which have faced 'industrial decline'.

Considering the small number of cities/regions profiled in this study, the relevance of EU city/region policies and measures to Chinese objectives is encouragingly high. This signifies that specific follow-up and city-to-city cooperation on the specific issues listed could provide great value to the Chinese local and regional governments and stakeholders in advancing their low carbon agendas.

13.2 Ningbo City – Policy Recommendations

The table below is to show EU city solutions and further policy recommendations towards Ningbo's specified needs on policy.

Policy Obj. #	Policy Objective	EU City Solution(s)	Broader Policy Considerations, Recommendations and Actions
1	***"Explore the low carbon development model for coastal cities with heavy chemical industry. "***	**Rotterdam**: Rotterdam Industry Cluster (including use of bio-based materials) **Rotterdam**: ROAD Carbon capture and storage project	Establish industry clusters to reduce CO_2 emissions and improve the production efficiency by energy transition and the application of innovative technologies. Expected results can be: • Improving in the effectiveness of operations, full use of renewable raw materials and energy sources, electrification reform on industry, CO_2 capture and storage (CCS), and the supply of CO_2, hydrogen and heat resources of third parties. • Establishing a leading platform for bio-refining: wide ranges of biomass and waste streams conversing into building blocks for bio-based chemicals and fuels. • Greening the mobility by reducing the CO_2 footprint of liquid fuels and by producing hydrogen. • The companies in the cluster can achieve above-average economic return with the port's excellent logistics facilities, non-traditional raw materials, optimal chain integration, new technologies and jointly investing in utilities and logistics infrastructure. • Due to the possible joint effort of the port authorities and regional, provincial and national governments, the industry cluster provides an excellent business atmosphere characterized by suitable local charges and clear goal-oriented laws and regulations, at the same time with sustainability revolution, financial support for investments in common infrastructure and logistics facilities, social incorporation of activities into the cluster, the presence of highly trained and motivated personnel, and the promotion of new economic activity. • Establishment of a Core Team to help with cooperation between the vocational education and the industrial job market under the policy of governments and financial aid to build a long-term project. • A concrete and specific policy agenda with the agreement of stakeholders is set to specify short and longer-term actions, quantify the contribution of the execution of these actions to the policy objectives set by companies and governments and identify the resources required to implement the actions. The development of this policy agenda is a key task for all involved parties.
2	***"Promote industrial restructuring.***	**Hamburg**: NEW 4.0 Project North German	• Enhancing the cooperation of industry, political support and the high-efficient administration. Statutory regulations are needed for convincing stakeholders to invest in environmental and climate protection projects; Voluntary measures, coupled with consultancy services, incentives and marketing

	”	Energy Transition **Hamburg**: Eco-Partnership	opportunities, can generate innovative solutions to environmental problems. Indeed, environmental policy also has to do with the ability to establish and promote technical innovations. • Promotion of large-scale projects to demonstrate how the full integration of renewable energies can be accomplished in areas characterized by pronounced, growing imbalances between production and consumption. This will require the comprehensive synchronization of (fluctuating) production and consumption. • To achieve this, an innovative approach for integrating and orchestrating all the stakeholders and components of the production, transport, distribution, storage, and consumption stages by means of intelligent network technologies are required. At the same time, the market-oriented system integration need be tested in the context of advanced market rules and regulatory conditions. • Regional and trans-regional partners, stakeholders from all industries and along the energy sector's entire value chain need to join forces in order to form an "innovation alliance" that aims to overcome the challenges of the energy transition based on integrated technological expertise. • Participating companies and organizations will have access to new market and export opportunities with innovations and solutions developed in the context of the project and to boost their competitiveness within a highly innovative growth market. With this alliance, the cities and the regions involved can strengthen their regional economies and create new industrial value chains, which will contribute to securing and creating jobs in the region, enabling to sharpen their profit as a leading innovation location for the energy sector in particular. • City government set a pilot with funding to operate R&D integrated projects in new low carbon technologies, concepts and infrastructure like the Carbon Capture and Storage, IoT for ports or Superconductor project.
3	***“Build a green port and develop green traffic.”***	**Rotterdam**: Port of Rotterdam Digitalization **Hamburg**: Smart PORT	In order to establish an industrial cluster in the Port Area, specific recommendations can be suggested for the local authority, regional and national policy makers and companies that are part of the port's industrial cluster. • Work out a De-carbonization Roadmap for the port area in collaboration with industry • Win support from government for becoming a flagship de-carbonization region • Optimize the port's business model • Continue to anticipate and prepare for future developments • Intensify strategic networking on the future role of the cluster in de-carbonising field • Identify low-risk, robust investments in line with de-carbonization

			• Push policy makers to ensure sufficient investment • Provide a clear vision and high certainty of de-carbonization in China • Increase the penalty of CO_2 emissions • Make plans for the phase-out of CO_2-intensive technologies Facilitating the access to best technologies and available innovations anywhere in the world for the establishment of a connected and low carbon port. Research is required in support of formulating policy for components of the industry cluster's transition: • The information provided of decision-making related to topics such as deep decarbonisation pathways, CO_2 abatement, electrification, power2gas, power2chemicals, bio-refining within the port or at source, • Acquisition strategies on the basis of profit or lacking flows or (end-)products, energy analyses and business-transcending infrastructure for commodities. • Programme Team set for managing these projects and hires the required expertise for this purpose. • Adoption of Smart technologies and policies like: Innovative Control Room and Software, Replacement of the on board produced electric potential energy, Environmental Discount in Port Usage fees, Plastic waste at the port instead of in the sea, Smart Port Infrastructure, Traffic Management System, Real time data processing
4	***"Build a high-quality, green, low carbon city."***	**Bilbao**: Urban and Cities Design **Hamburg**: HafenCity **Essen**: Brownfield Development **Essen**: Ruhr fast cycleway **Barcelona**: The Super Block programme	Actions for More Efficient Buildings: • Use a revolving fund model to finance greener buildings • Increase land value tax to promote compact urban development • Build public infrastructures (school, hospitals) involving citizens in every step of designed process. Action for De-carbonising Electricity Supply: • Issue municipal bonds to finance renewable energy and other low carbon infrastructure • Reform the feed-in tariff to stimulate private investment in renewable energy Actions for Low Carbon Transport: • Found an integrated municipal transport office to coordinate planning and financing issues • Introduce congestion pricing to encourage the use of public and non-motorised transport modes • Construction of cycling lanes to link residential areas to green space and commercial center

			• Build and enforce the use of pedestrian zones areas or Super Blocks concepts in downtown areas
5	***"Build higher education focusing on the new economy, green and low carbon development and human resources."***	**Bilbao**: City-Lab **Bilbao**: Metropoli 30	Implementing actions of technological innovation, diffusion and international cooperation: • Friendly policy is issued to encourage technological innovation and diffusion, through a combination of direct support, tax incentives, and institutional support. Public research-and-development institutions and testing platforms have a huge important role in systems supporting technological innovation. • Establish new research laboratories to carry out disruptive research, deliver pilot studies and projects, carry out trials, testing and certification. The lab will be open to businesses, universities and other research institutions, and will work to make up for the lack of common technology in the low carbon sector. • Push forward research projects and learning programs related to models of governance, leadership styles and participation channels that foster levers of urban transformation such as collaboration, creativity, co-competitiveness, cohesion and compactness. The research activities need to be centred on cities, models, strategies and actions from all around the world that promote new habitats for human sustainable development. The lab will accompany institutions, companies, social entities and citizens in the design, innovation and transformation of cities sharing experience and knowledge with professionals, experts and citizens. • Mechanism based on a 'circles of sustainability' to be used to assess climate change adaptation practice across the domains of ecology, economics, politics and culture. • Workshops presenting plans and strategies, challenges and actions faced by metropolitan areas to adapt to climate change. • Policies of promoting innovation should be implemented continuously, such as self-reliance programs and requirements for equipment in major projects to be sourced domestically, to promote localization. As soon as possible, these should be complemented by detailed rules for implementing plans to adjust and reinvigorate the equipment manufacturing industry, as well as risk compensation mechanisms for new domestically produced equipment. Projects should be covered by insurance companies in case of accidents. • The government should also implement preferential tax policies for technological innovation, and support efforts by companies to cooperate on research and the domestic production of key components.

13.3 Wuhan City – Policy Recommendations

The table below is to show EU city solutions and further policy recommendations towards Wuhan's specified needs on policy.

Policy Obj. #	Policy Objective	EU City Solution(s)	Broader Policy Considerations, Recommendations and Actions
1	***"Promote the green transformation of industry."***	**Hamburg**: NEW 4.0 Project North German Energy Transition	Constitution of a Green Energy Cluster enhance collaborations among companies and other agents to provide integrated and innovative solutions in the energy efficiency market, joining products and services from value chain and provide solutions in packages that comprise of products, facilities, maintenance and management. Several actions can be proposed: • Development of new packages or integrated solutions with high energy efficiency, competitive in the international market. • Identification of complements among companies and encouragement of collaborative projects. • Promotion of knowledge exchange for the implementation of innovation and new development. • Enhancement of access to public for investments in R&D and Innovation. • Promotion of business and professional exchange among associates. • Promotion of the participation of associates in the energy efficiency market through information on tenders, commercial contracts, etc. • Dissemination and promotion of products or services of energy efficiency offered by associates (training courses, participation in trade fairs, conventions, promotional campaigns, etc.) • Promotion and participation in training courses for professionals. • Prepare a package of services to improve partners of the clusters' energy conditions. • Support ambitious climate targets, a robust international framework agreement, and policies to drive low carbon and resilient outcomes
2	***"Encourage the market to transition to a green, low carbon economy"***	**Hamburg:** Eco-Partnership	Promote the constitution of an Eco-Partnership involving a large number of companies strongly responsible for carbon emissions in the city. Proposed activities and actions of the Eco-Partnership are: • Provide information about specific actions which companies can take to help with energy savings. • Local government ally with the city's economy. • Acting as a central platform for environmental policy exchange between industry, politics and the

			civil service. • Offer a combined platform of financial, technical, advisory and practical support. • Propose investment in projects with well-defined environmental and climate targets. • Propose a combination of technological (supply-side) innovation and behavioral (demand-side) adjustments. • Overcoming behavioral and managerial barriers, developing guidelines for a low carbon economy and market aiming at bringing energy efficiency and low carbon transformation to the attention of senior management. • Collaborate to create new financial instruments to drive low carbon investments, such as green bonds, trade in energy savings certificates and energy efficiency schemes and incentives. • Investors collaborating to engage companies on their climate performance Aiming to decarbonise a sectoral significant quantity of investment portfolios
3	***"Develop green finance."***	**Essen**: Climate Agency **Hamburg**: Green Procurement Guidelines	Establish a local energy agency that offers support and expertise to investors and consumers providing various services and activities: • Overall framework. This requires establishing framework with baselines and benchmarks—based on a globally or nationally recognized inventory methodology—to measure progress. Conducting a citywide carbon emissions inventory requires a consistent methodology, robust data collection, and transparency. • Knowledge of a city's history is critical to informing citizens and policy makers about the level and source of baseline emissions. • Develop a vision and set a low carbon target. This will require very detailed analysis of options and a top-down articulation of a long-term vision from the city's officials. Setting carbon emission targets at the city level would include four steps: determining the carbon reduction potential, including developing a city's carbon emission abatement cost curve; developing the carbon emission abatement scenarios; defining the carbon emission vision and target for the city; and dis aggregating the carbon emission target for the city, using quantifiable and monitorable indicators. • Implement a low carbon city action plan. A low carbon city strategy and implementation plan will need to be developed and organized into a balanced and ranked set of cross-sectoral and sectoral actions—with each activity fully costed and with financing identified. The low carbon city action plans should clearly address institutional integration. • Adopting Green Procurement and developing Guidelines to facilitate the introduction of

			environmental standards into technical specifications, procurement selection and award criteria, and contract performance clauses.
4	***"Plan production life and urban construction according to environmental criteria. "***	**Essen**: Brownfield development **Hamburg**: Energy Bunker **Bilbao**: Abandoibarra renewal Project **Bilbao**: Metropoli 30 **Bilbao**: Urban and Cities Design **Liverpool**: Wirral Waters	Consolidating companies with strong expertise in the profitable rehabilitation of industrial brown fields sites and collaborating also with local politicians, municipalities, authorities and associations: • Consider the requirements of the low carbon economy into urban planning and run demonstration projects. • Identify declined, in-equal areas of social and industrial to be recuperated and revitalized further • Include requirements for "low emissions, high efficiency" in urban planning and rural development planning, for example when determining zoning, industrial structure, public transport and land use. • Launch low carbon urban development projects in suitable areas of the city in the near future, using economic and incentives to achieve energy-saving in the transport and building fields. New areas should include low or zero-carbon communities, industrial zones or ecological cities. • Common standards of measuring low carbon development should be developed and agreed. • Low carbon development should be taken into consideration when choosing winners of high level ecological, environmental and liveable city competitions. This would be a departure from the current criteria, under which the victors might be environmentally friendly in some respects, but still have high carbon emissions overall. • Establishing a Public utility Entity to carry out plan, research and promotion projects headed towards the recuperation and revitalization of disused sites. • View exchanges meeting should be held , experts from different fields such as urbanisation, architecture, engineering, environment, energy efficiency and mobility, strongly engaged with more sustainable and efficient urban models work in close collaboration with local governments to make better city,

13.4 Jiangsu Province – Policy Recommendations

The table below is to show EU city solutions and further policy recommendations towards Jiangsu's specified needs on policy.

Policy Obj. #	Policy Objective	EU City Solution(s)	Broader Policy Considerations, Recommendations and Actions
1	***"Let the ecological environment recover."***	**Liverpool City Region**: Green Infrastructure at Wirral Waters **Essen**: Brownfield development	Implementing large-scale regeneration and profitable rehabilitation programme of national level, in areas of high deprivation and inequality or in industrial brown-field sites. Possible activities include: • Find an area characterized by large tracts of derelict and underused land in need of investment for sustainable growth. • Propose cultural and natural heritage areas and sites that can be representative of the development of traditional heavy industries in China. • Implement a community led programme of urban tree planting along important road routes; • Planting crop would be productive in 3 – 5 years; • Design new areas of woodland and other habitats, and investment in green spaces, including local parks and open spaces. • Delivery a range of benefits, including climate change adaptation and mitigation benefits that will improve the quality of the area, then attracting new investment. • Show the probable achievement of green infrastructure (e.g. evaporative cooling and shading to the area; helps to attenuate flood events by reducing the rate and volume of water runoff; provides carbon storage and sequestration; filters air pollutants; provide a vegetated and permeable landscape through which species can migrate to new 'climate spaces' and provides a recreation and visitor resource for a more outdoor lifestyle and to promote more cycling and walking). • Develop a green infrastructure approach to embed the natural environment in decision making, involving a wide range of organizations to act under policies, research projects, reports and tools, including accessible toolkit to enable valuation of social, environmental and economic benefits of Green Infrastructure.
2	***"Develop a green and low carbon***	**Liverpool**: Offshore wind project **Liverpool**: Cammell	• Found new financing products and investment vehicles for renewable energy and low carbon manufacturing sectors. • Identification of local companies aiming at the re-conversion of the production towards new

	manufacturing sector."	Laird **Bilbao**: Navacel	activities related to the renewable energy and low carbon sector. • Study on the possibility of offshore wind projects.
3	***"Gathering high-tech companies."***	**Catalonia**: High-tech industry cluster **Rotterdam**: Industry Cluster	• Create clusters in specific technological areas in order to detect synergies among partners and generate business opportunities developing strategies to encourage private and public R&D performers to locate in proximity to each other... • Promoting and developing a methodology to overcome barriers of technological, social, market and legal character for the realization of innovative projects in the field of low carbon technologies. • Improve the competitiveness of partners offering services to internationalize companies, develop innovative products, train their employees, find funds for their projects and position themselves in their sector. • Create a partnership based on reciprocal trust with the regional administration. • Promote innovation services including transfer of technology and know-how, business development, spin-offs, risk capital support services, consultancy services, patents centre, technological springboards networks. • Provide business services such as risk capital and consultancy to create an interface between science and industry. • Offer to researchers, entrepreneurs and society in general a setting equipped with powerful research support services, research staff, specialised technicians and agents to promote knowledge and technology transfer pointing to the creation of new companies. • Brings basic research and product development on low carbon technologies closer together, fostering a synergistic relationship between the public and private sectors in order to lead to joint ventures and mixed units of research.

14 Policy implications for the EU-China Low Carbon Cities Partnership

14.1 City-to-city cooperation on low carbon policies and measures

Based on the high level of relevance of policy objectives and related solutions between Chinese and EU cities/regions from the small number of cities and regions profiled, it is suggested that a broader partnership be considered. This could involve a compilation of low carbon policy objectives across all major (or a larger set of) Chinese cities, which could subsequently be matched to policy solutions on the EU side, from a broader pool of EU cities. Thematic 'working groups' could then be established where Chinese delegations made up of multiple cities wanting to address a specific issue (e.g. industrial redevelopment, urban mobility, energy efficiency) work with EU 'solution providers' to quickly advance policy design and implementation on the subject matter. This thematic approach to knowledge exchange would provide better economy of scale and efficiency compared to traditional 'one-on-one' city cooperation.

A 'menu' of low carbon policy issues/interventions could be developed/verified by Chinese cities and experts to categorise the highest priorities for policy cooperation, against which Chinese cities could each register their primary objectives. The best solutions/case studies from the EU could then be presented to their Chinese counterparts to help advance implementation of relevant policies and actions and expedite the low carbon transitions. As well as demonstrating technical feasibility and benefits of the interventions, focus should also be kept on the EU experience around financing the policy/project, return on investment etc.

It is envisaged that this could have multiple benefits on both sides:

- EU city and local clean technology businesses/industries can gain exposure to Chinese markets and vice versa;
- Chinese cities can accelerate policy and/or technological expertise related to the policy/intervention theme of interest;
- Chinese businesses/industries can gain exposure to new technologies and build expertise on developing technology as well as construction/installation, operation and management of low carbon technologies/infrastructure;
- Financers for low carbon interventions in Chinese cities can review evidence and gain confidence of the financial performance from case study projects in the EU;
- Foreign investors can be attracted in certain industries to form joint ventures with a domestic partner;
- International scientific and academic collaborations on specific research themes or projects can take place.

14.2 Policy framework for Chinese Low Carbon Cities Pilot Project

14.2.1 A Covenant of Mayors-like process

Some of the main challenges faced by Chinese cities in transitioning to low carbon in Section 6 were identified as "*weak data baselines*" and "*poor capacity building*" and it is specified that "*The quality of emissions data must be strengthened to provide a robust foundation to deliver results*". There is an obvious opportunity to use the EU Covenant of Mayors experience to help develop the Chinese Low Carbon Cities Pilot Project's effect and deepen the policy and data collection framework. In sharing experience on the development of the functions and associated platforms of the EU Covenant of Mayors and Chinese Low Carbon Cities Pilot Project, an 'economy of scale' solution could be developed to help

all Chinese cities build capacity and respond to the challenges of climate change in a more meaningful and efficient manner.

To support the implementation and validation of policies and measures to reduce GHG emissions amongst Chinese cities, some of the processes and frameworks utilised in the EU Covenant of Mayors could be implemented as part of the Chinese Low Carbon Cities Pilot Project. While various indicators are already being tracked by Chinese cities, a process more focussed on identifying emission-reducing interventions through stakeholder engagement and defining and prioritising action would be valuable.

Specifically, the process of estimating GHG emission reductions on a per policy basis and tracking the progress of implementation could be particularly valuable in building the evidence base to support and drive further action. This accounting for GHG emission reduction actions is useful in building momentum for further activity:

- Prioritisation of policy implementation based on cost-benefit;
- Validation of successful case studies;
- Accessing regional, national and international sources of climate finance;
- Providing profile and recognition for cities acting on climate change;
- Replication of successful case studies based on verified savings.

Furthermore, a website platform (much like the EU Covenant of Mayors website[42]) could be developed to raise the profile of Chinese cities efforts, both domestically and internationally, and to share knowledge and case studies between the cities. This kind of communications platform can raise cities' ambition to act on reducing GHG emissions by offering recognition and breeding healthy competition between politicians while facilitating a 'peer-to-peer' exchange between technical staff within the cities' administrations. For example, the EU Covenant of Mayors platform profiles the cities' targets and showcases their climate actions. It also provides profile for the Mayors, administrative details and the combined effort and impact of cities. This type of information can help build political support at both the city and programme level.

14.2.2 Multi-level governance

A further key challenge outlined in Section 6 is that, from the pilot cities involved in the Chinese Low Carbon Cities Pilot Project "*have not yet understood or recognized the relevance of the peaking target to their provincial or municipal strategic perspectives*". Enhancing this connected thinking between regional and local objectives strengthens cohesive policymaking while also creating economies of scale in the implementation of low carbon policies and measures.

National, provincial and local government can jointly participate in this multi-level governance effort. In particular, the upper levels of government can assist as follows:

- **National government** can work to support and raise the profiles of the efforts of provincial and municipal efforts to reduce GHG emissions. For example, compiling the collective impact of Chinese cities and how that impact can contribute to the Nationally Determined Contribution (NDC) can raise the profile of Chinese city actions in the international discourse.
- **Provincial governments** can support cities by setting province-wide GHG emission reduction targets and engaging their municipal constituents to be as or more ambitious with their targets. Economy of scale technical support can also be provided from the province to the municipalities in developing GHG emission inventories, identifying climate actions and identifying sources of finance. Provincial governments can also support/coordinate

[42] https://www.covenantofmayors.eu/en/

'transboundary' climate actions (for example on issues such as transport, waste management and renewable energy generation).

One of the key pillars of success in the EU Covenant of Mayors has been the availability of multiple layers of support and governance to assist large and small cities in building capacity and resources to make effective transitions to low carbon economies. By engaging regional governments, energy agencies, academia etc. (as described in Section 3.4) huge advances in the recruitment and technical capacity of municipalities have been achieved. By adapting this approach to the Chinese context, a lot of value could be provided to Chinese cities. In particular, the case studies in Italy and Spain should be evaluated to determine how their success was achieved.

Implementing a collaborative multi-level governance approach is a step-by-step process:

i. **Initiate the collaborative process**: this preliminary step serves to identify stakeholders and engage them in the process to develop a common vision, joint objectives, and expected results.
   - Identify the regional authority's needs
   - Identify key stakeholders
   - Identify their level of participation
   - Develop a common vision and objectives

ii. **Developing the multi-level governance model**: during this step, a more detailed analysis of the stakeholder engagement process and governance mechanisms will be carried out, in a joint manner, to define the most appropriate governance structures, decision-making processes, and operational methods to use.
   - Define the coordination and governance processes
   - Develop the engagement strategy
   - Define responsibilities and decision-making process
   - Define the evaluation process

iii. **Implementing the multi-level governance model**: in this step a governance system must be established, which requires good communication and the active involvement of all stakeholders throughout the entire process. A participatory evaluation and continuous improvement of the process is implemented.
   - Mobilise stakeholders and formalise their commitment
   - Evaluate and improve the MLG model

An authority can adapt this methodology at any time to suit its local circumstances. For instance, depending on the scope of the project, timeline and budget, the regional authority may decide to implement some activities in parallel.

14.2.3 Peaking road map

An urgent challenge raised in Section 6 is the implementation of peak targets. At present, some pilot areas have the phenomenon of "emphasizing slogans but neglecting implementation". The peak target can not be simply understood as an indicator to limit the development space of the region. The implementation of the peaking target needs to be combined with a peak GHG emissions road map and action plan. The implementation of the carbon emission peaking target is the main focus for Low Carbon Pilot cities and provinces in the near future. Local governments should focus on:

- defining a peaking target (considering the national target and their own commitments);
- develop and issue a peaking road map and action plan: They should also

- actively explore and improve the total GHG emission accountability (i.e. sectors covered);
- develop an assessment system and a system for monitoring progress;
- assess climate investment and financing opportunities;
- explore the establishment of a green and low-carbon industrial and energy system; and,
- explore intelligent, green and low-carbon new urbanization development modes and pathways.

Considering the rich successful experience of EU Covenant of Mayors and the good practices of EU on low-carbon transformation and total carbon emission reduction at city level, China and the EU can explore the possibility of cooperation in the following four aspects:

- Sharing advanced experiences and successful cases of low carbon development in European cities;
- Design low-carbon action plan projects to support local government to define peaking targets and road maps;
- Invite relevant experts of city level to participate in the preparation of peaking roadmaps;
- Organize relevant training activities and carry out local capacity-building in response to climate change.

14.3 Developing the Local Low Carbon Economy and Innovation

14.3.1 Promoting Entrepreneurships, Start-ups and Open Innovation

The following steps should be considered to help encourage the establishment of innovative clean technology companies to help advance the local low carbon economy:

- Realization of 'Fab Lab' and 'Maker Districts' as shared workshops where citizens can access digital fabrication equipment to design and make their own objects.
- Renew the framework for the commercialisation of research in order to develop joint principles and processes for universities regarding technology transfer and spin-offs. Support universities in establishing a model and clear rules concerning the use of research infrastructures for commercial purposes. Require all universities to establish a technology transfer strategy and action plan.
- Establish a demand- and success-driven support programme for incubators that allows the development of both public and private incubators
- Create a 3D printing field lab to supporting specific applications and processes on demand.
- Create a Connecting Hub with the following tasks: linking stakeholders, making them visible to the outside world, providing information on initiatives and support measures, collecting data to monitor the system, promoting the participation of start-ups and SMEs in public procurement and helping the ecosystem to learn fast.
- To assist entrepreneurs and start-ups, the Connecting Hubs can be the service window/information centre for existing knowledge and contacts with the business community and the knowledge world and serve as the way finder within the innovation eco system. Connecting Hubs play an important role in attracting start-ups and in providing market guidance. This way new activity can also be linked to the already existing clusters.
- Promote Local Enterprise Partnership (LEP) in order to make collective recommendations through the constitution of 'Low Carbon Committee' and 'Employment and Skills Committee', drawn from the public, private and third-sectors. The LEPs can act as an effective local co-ordinator to ensure that skills development is relevant to the most immediate and local demands from the low carbon sector. At its best, an approach such as this can foster strong links between

education and employment in a demand-led, locally-driven process, given strategic direction by effective LEP leadership.

- Stimulate the creation of "Club of Low Carbon" actors coordinated at government level and operating as a network of cities and villages for sustainable development and climate mitigation matters and involving universities, research institutes, financing institutes, companies, professional associations and unions.

14.3.2 Implementing Smart City Strategies and Projects

The following steps should be considered to help expedite cities' transition to 'Smart Cities':

- Adopt an agile institutional framework and governance mechanism (Smart City Agency) to ensure co-ordination and support throughout the lifetime of each project. The smart city agency will have to be agile and, ideally, independent from traditional city departments. It should, however, be accountable to a governance body on which the city institutions are represented.
- Appoint a smart city director with strategic vision as key to the success of smart city projects. A smart city director should be a project leader with cross-functional skills, capable of defining a long-term strategy. Rather than focusing on technology solutions, he will understand and analyse the city's needs and requirements. He will require appropriate authority to act efficiently, will have concrete objectives, and will be capable of bringing along those departments resisting innovation and change.
- Communicate effectively smart city project objectives and benefits establishing a dialogue with the local community is essential to ensure effective smart city services design and functionality. Digital media can help involve citizens in each step of the service lifetime and highlight tangible benefits that a smart city project will deliver.
- Promote technology investment in open and scalable systems trying to avoid relying on proprietary technologies tied to a single provider.
- Identify Standards-based solutions and synergies as an essential foundation for the long-term evolution of a smart city: e.g. a new smart lighting system can be an opportunity to deploy additional services that use the same light poles, such as air pollution monitoring, the provision of Wi-Fi or security cameras.
- Comply with privacy and security best practice, rather than defining new service-specific rules: To safeguard privacy and security, smart cities need to draw on industry best practice and comply with national laws. Local city managers should resist the temptation to define their own data privacy and security standards for services they launch and adopt in their own city.
- Make city data available to promote transparency and stimulate innovation: Cities generate a wealth of data related to transport, to the environment, health, demographics, and services accessibility. While protecting individuals' privacy, city managers should look to make data accessible to promote transparency and stimulate the creation of innovative services. Some cities already have portals that make data available in accessible formats.
- Explore new models of funding: Smart city projects require significant initial investment. Smart city managers should explore public private partnerships or alternative finance mechanisms, such as municipal bonds, development banks or vendor finance.

15 Final policy recommendations

On the basis of the reviews of the policy objectives of Chinese cities and the policy framework for cities in the EU and China, the study recommends the following next steps…

1. As a pilot case, explore partnerships between the EU and Chinese cities reviewed in this study on the specific Chinese city policy objectives and EU city solutions.

2. Based on the feedback from Chinese cities on the above, consider expanding the initiative to a more formal programme, developing thematic options for Chinese cities to prioritise in cooperation with specific cities/solutions in EU cities.
3. Review the EU Covenant of Mayors processes and resources to determine what elements could be valuable to implement as part of the Chinese Low Carbon Cities Pilot Project. For example, a workshop or workshops between the administrators of the EU CoM and the China Low Carbon Cities Pilot Project to exchange ideas and experiences should be organised. As an example, this should evaluate the benefit of categorising and tracking data on carbon-reducing policies and actions being developed by Chinese cities and providing a website/platform for Chinese cities to share their ambition and progress and gain recognition for their efforts domestically and internationally.
4. Consider how 'multi-level governance' could support Chinese cities in their transition to low carbon economies, based on the lessons learnt in the EU Covenant of Mayors. This could include exchanges between Chinese and European regional government and stakeholders as well as the evaluation of entities such as Covenant Supporters and Covenant Coordinators in the Chinese context.

Annex I – Additional Detail on Key Projects

The SmartPORT Philosophy of the Port of Hamburg

In 2014, the HPA and Hamburg University of Technology, Harburg, (TUHH), signed a grant agreement to establish the "smartPORT" junior professorship at the TUHH's Excellence Research Group, thereby creating links between research and practice. And together with the University of Hamburg, the HPA studies the use of Virtual Reality (VR) and Augmented Reality (AR). The introduction of the "Internet of Things" (IoT), a new stage of networking, is also being driven forward in cooperation with the University of Hamburg. The HPA has identified efficiency as perhaps the most important competitive factor for the Port of Hamburg. A connected port offers great potential to increase efficiency, especially if implemented together with strong business and science partners. Through intelligent networking, port operation becomes more efficient and allows for the Port of Hamburg's sustainable and resource-saving growth.

The Port of Hamburg

More than 20 pilot projects have been set up through the smartPORT initiative.

Innovative Control Room and Software

The PORT Monitor control station system provides, in real time and based on geo-referenced data, information on events and conditions in the Port of Hamburg's waterways as required by the Hamburg Vessel Traffic Service for the port and its approach on the Elbe. This information includes, for example, the current location and destinations of the vessels, current water level data, berths, bridge heights and even information on current construction sites. A control room software, Port Monitor, allows to keep all the stakeholders in the port of Hamburg up to date. Important information is therefore always accessible to all those involved on land and on the water. The new mobile net-work giganet 5G is currently being tested on a testing ground in the Port of Hamburg. The focus is on logistical applications in traffic and infrastructure control. The network is going to enable innovative control systems for container handling such as Virtual Reality applications. But it's not only about improving the bandwidth or speed. The goal is the possibility to run various applications with various requests concerning speed, reaction time, safety and capacity at the same time.

Replacement of the onboard produced electric potential energy

To reduce the emissions of the cruise industry while it's growing, the HPA started the construction of a shore side power system at the cruise terminal Altona in July 2014. By now, it is in regular operation. Besides, HPA also erected a land side infrastructure at the cruise terminal HafenCity to make the power supply of cruise ships possible at this location. By producing the electricity through LNG gas engines, 100% of the PM10 and SOx emissions as well as 80% of the NOx emissions can be saved. The use of LNG

reduces the emissions significantly, especially when compared to the combustion of conventional fuel. The basis of the calculation of the effectiveness of this measure is a scenario: In 2020, 0.5% and in 2025 5% of all ships entering the Port of Hamburg will be converted to be driven by LNG.

Environmental Discount in Port Usage fees

In order to achieve quicker success in controlling air pollution in the port, the HPA grants a discount in the port usage fees for the use of environmentally friendly port power. Cruise and container ships in overseas traffic can save up to 3,000 euros. With this, the HPA hopes to further convince users of the port to abandon the more favourable electricity generation systems while docked in port. Additional incentives for the use of environmentally friendly ships are provided by the HPA in the form of rebates for the use of tankers with a double hull, for the use of Liquefied Natural Gas (LNG), and of shore side power. Furthermore, "Blue Angel" and "Green Award" certifications are also rewarded for particularly environmentally or safe ships.

Plastic waste at the port instead of in the sea

Hamburg has created additional incentives to encourage ships to dispose of their waste at the port, and not at sea. In 2015, Hamburg passed a regulation that enables ships arriving at the Port of Hamburg to dispose of six times the amount of ship-generated waste at the port than before at no extra cost. As a result, Hamburg has created an incentive to put a stop to the illegal dumping of waste generated on board at sea. This regulation contributes to reducing the 20.000 cubic metres of waste that are thought to be dumped into the North Sea each year.

Smart Port Infrastructure

As an investment in smart port infrastructure, the HPA is embedding sensors and communicative capacities in the port's main tangible assets. This includes smart lighting, which illuminates only those areas necessary, based on motion detection, which saves energy costs. Sensors monitoring the use of assets (e.g. trucks, cranes, carriers, roads, etc.) and infrastructure (e.g. roads, parking lots, warehouse storage rooms, etc.) identify recurring underused capacity and allow for making adaptations to optimize utilization by e.g. relocating assets or rerouting goods flows. Smart storage systems with temperature, humidity, ventilation, and barometric pressure sensing ability in warehouses or containers can detect the needs of the cargo they contain and adjust these factors to increase product quality and decrease cargo damage. Cameras, opening sensors, and heat detection sensors along with alarm systems on the other prevent theft, and provide solid input for planning security improvements. The life-cycles of port assets and infrastructure are extended, and the likelihood of defects that influence normal port activity is drastically reduced due to smart maintenance systems. Smart maintenance systems track the usage and wear-and-tear of fixed assets, and can pre-emptively detect damages and malfunctions, saving tremendous costs on reparation, replacements, and mitigation in case of a breakdown. Finally, smart energy management is also a priority in moving towards a greener port, with Hamburg port accounting for over 40% of Hamburg's total energy consumption. As part of this plan, certain key infrastructure is equipped with smart meters that can monitor and control energy use by adjusting factors like temperature, pressure, electric drivers, etc. Smart energy efficiency systems should allow the port to save a yearly amount of 12 thousand tons CO_2.

Traffic Management System

Over 40.000 truck trips strongly impact Hamburg port and city daily. Managing this flow of traffic is an important task to keep the port attractive for business and the city attractive for its inhabitants. Starting in 2011 the Hamburg port authority placed 300 sensors on roads and bridges to track and manage the roadway traffic in the port. These provide the Port Road Management Center continuous updates on the

status of bridges (i.e. open/closed) and traffic throughout the port. This data allows the traffic management system to make efficient decisions on directing traffic flows to optimize routs, and therefore minimize congestion and transit time for all customers. Similarly, parking recommendations, which are made based on continuous parking space monitoring, allow all port visitors to find parking with ease. Mining of aggregated data over a longer time period then allows the Port Road Management Center to improve journey time predictions and plan future traffic infrastructure investments or modifications to further optimize traffic flow. Moreover, sensor-collected information on the conditions of the River Elbe, and the vessel traffic on port waters are continuously fed to the center, which can in turn share this information with all vessels to assure smooth sailing on its waters.

Brownfield development - successful development of disused land

Some details regarding the specific redevelopment sites are as follows:

- **The University District:** The University district is an example of high-quality development of a disused plot of city centre land. The new city centre district is around 13 ha in size and has been built on disused land formerly used by the railway, between the city centre and the university, and with its water features and expanses of grass will help improve the climate in the city centre. Starting from a green area 4 ha in size, a high-quality district is currently developing, combining housing (470 residential units) and commercial use, with 1,800 new jobs.
- **The Krupp Park**: On the former site of the Krupp cast steel factory, there stretches the 230 ha Krupp Belt. The expansion of the 12 ha Krupp Park North on a former industrial wasteland has created an attractive leisure area for the people of the district area of Altendorf, previously short on open space, and for the adjacent ThyssenKrupp district. In its final version, the total size of the Krupp Park comes to around 22 ha, with construction costs of around € 12.0 million. The lake in the Krupp Park is fed with rainwater from the roof surfaces of the ThyssenKrupp headquarters. The overflow of the lake leads to a tributary of the Emscher system. In this manner, the ecological conversion of the Emscher and its tributaries from former wastewater ditches into streams of clear water is supported by drainage ditches. The Krupp Park has a climate-balancing effect on the neighbouring, highly built-up areas of Essen city centre and the adjacent ThyssenKrupp district. The lawns generate cool air, which produces air exchange in the adjacent built-up areas. The wooded areas create a pleasant climate on hot days. The staged build-up of woodland, alternating with lawns and shrubbery, ensures that air pollutants are filtered out.
- **Zollverein World Heritage Site**: The Zollverein World Heritage Site is around 100 ha in size, and of exceptional importance. The tourism highlight of the Ruhr Area is a location for design and the creative industries, as well as cultural facilities such as the Ruhr Museum in the middle of Zollverein Park, and extensive industrial woodland. More than 25 years after its closure, the once largest colliery in Europe combines culture and dining, design and architecture, handicraft and the creative industry – as the only World Heritage Site of the Ruhr Area.
- On December 12th, 2001 the UNESCO World Heritage Committee declared the inscription of the Zollverein Coal Mine Industrial Complex in Essen on the World Heritage List as “representative of the development of traditional heavy industries in Europe” and especially praised the “architecture of the industrial complex in the Bauhaus style, which was for decades exemplary for modern industrial construction”. The overriding objective was the preservation of cultural and natural heritage sites of mankind, which have an outstanding universal value and are thus both unique and authentic but are simultaneously sensibly integrated into public life. Preservation through conversion has been the motto to the present day; variety characterises

the offerings, which combine history, culture, creativity, entertainment, gastronomy, and recreation.

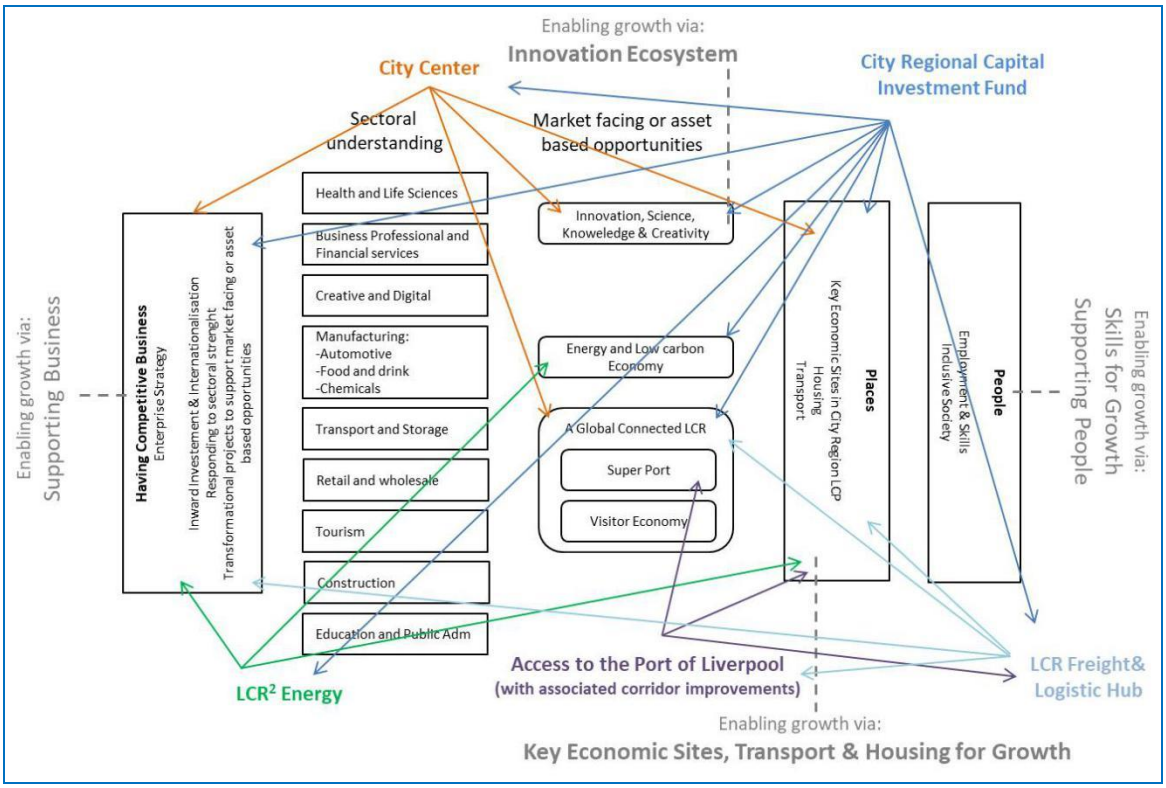
Further examples of former disused land areas that have been assigned new functions include the Weststadt office park (10 ha), the Thurmfeld development zone (5.5 ha) on the edge of the city centre, the M1 industrial estate (13.4 ha), the Econova business and industrial site (152 ha) and the residential development at the site of the Phoenix foundry in the Ruhr Valley (5.9 ha).

City Region Governance: The Combined Authority and the Local Enterprise Partnership

Liverpool City Region has made significant steps to enhance its governance with the creation of the Combined Authority in 2014. The Combined Authority and its constituent councils enable decisions on economic growth and development to be taken in an open and transparent way on behalf of the entire city region. The Combined Authority was established to strategically lead work on transport, economic development, innovation, housing, employment and skills in the City Region to, in turn, support sustainable economic growth. It enables the City Region to speak with one voice in a democratically accountable structure which can attract funding and devolved powers from the central Government. The Local Enterprise Partnership also ensures that the views of businesses are represented in strategic decision making. The combined authority of Liverpool City Region includes the local government districts of Liverpool, Halton, Knowsley, Sefton, St Helens and Wirral. Transport is a key focus of the Combined Authority, in recognition of the central role it plays in helping to grow the economy and in enabling and encouraging regeneration. In 2016 the Liverpool City Region agreed a Devolution Deal with Central Government which devolved further powers and funds. The agreement protects the integrity of local authorities in the Liverpool City Region and in 2017 the first Mayor was elected.

The Combined Authority marks the next step in a progressive process of devolution of funding, responsibilities and powers from central government to the Liverpool City Region. The Liverpool City Region will continue to have further devolution dialogue with the government in the future, including on health and social care integration. The devolution proposal and all levels of funding are subject to the Spending Review and ratification from the Liverpool City Region individual local authorities. This agreement is subject to the enactment of the necessary legislation, and to parliamentary approval of the secondary legislation implementing the provisions of this agreement. Liverpool City Region has the opportunity, through devolution, to ensure it is at the heart of the Northern Powerhouse, a proposal to boost economic growth in the North of England trough improvements to transport links, investments in science and innovation and devolution of powers. One of the tasks of the Authority is the transfer of significant powers for economic development, transport, housing and planning and employment and skills which will positively impact on the lives of all of residents and businesses. Devolution must deliver opportunities for all those residents and businesses, through creating more jobs, improving the skills and employment prospects of our residents and allow them a greater say over the future of their communities.

Liverpool City Region strategic priorities and programmes[43]

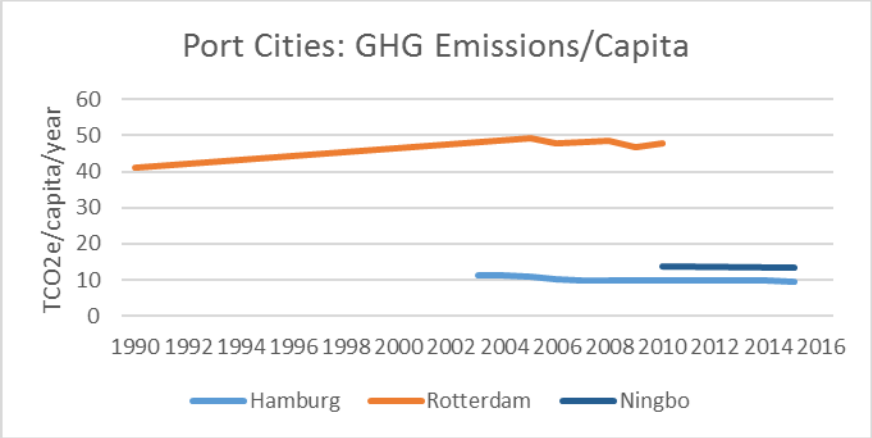


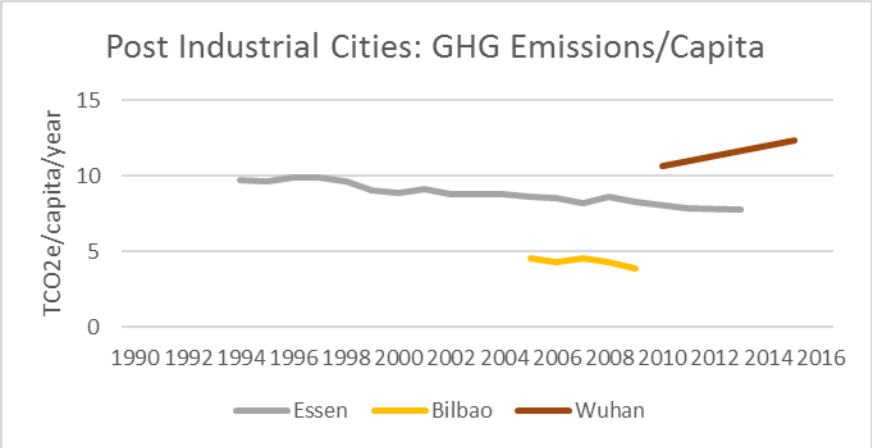
The Mayoral Combined Authority works very closely with the government for the benefit of the public. Since its birth, the Liverpool City Region Combined Authority has become the top-tier administrative body for the local governance of the city region. Through the combined authority, the six districts pool their responsibilities over strategic policy areas such as economic development, transport, employment and skills, tourism, culture, housing, and physical infrastructure. The region's economic development is also supported by the Liverpool City Region Local Enterprise Partnership (LEP), established in 2010 as the private sector-led board comprising political and business leaders from around the city region. The Liverpool City Region Mayor is also a member of the Local Enterprise Partnership (LEP), alongside the other members of the Combined Authority, recognising the importance of the private sector in delivering Liverpool City Region's growth strategies. The LEP consists of the board, which makes collective recommendations to the Combined Authority, and a series of sub-committees. There are two relevant committees: the 'Low Carbon Committee' and the 'Employment and Skills Committee', both of which are drawn from the public, private and third-sectors. The Low Carbon Committee works with a number of other committees, on the basis that low carbon is a theme that cuts across sectors, one of which is the development of skills for employment. The LEPs can act as an effective local co-ordinator to ensure that skills development is relevant to the most immediate and local demands from the low carbon sector. At its best, an approach such as this can foster strong links between education and employment in a demand-led, locally-driven process, given strategic direction by effective LEP leadership. Many firms lack confidence in the extent to which future government policy and funding will

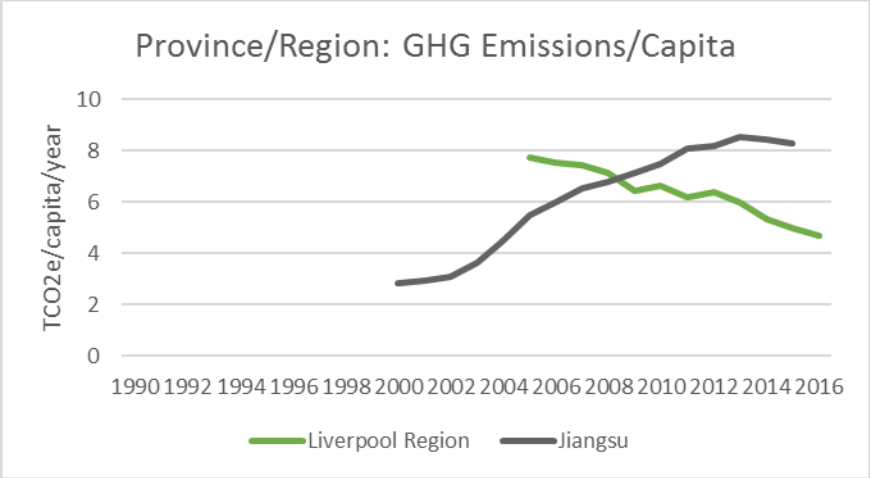
[43] Source: Liverpool Local Enterprise Partnership

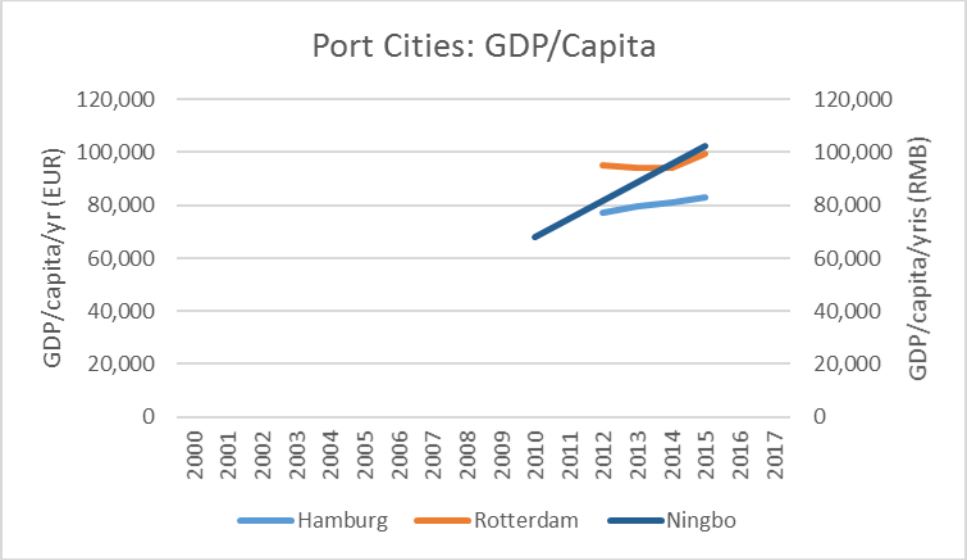
support investment in the low carbon sector. This constrains the development of skills programmes, which take a considerable length of time to create and put into effect. Another challenge is that the time horizon over which firms tend to demand new skills for the low carbon sector leaves insufficient time for the LEP to respond. Demands tend to be erratic and immediate, rather than consistent with an approach that looks five or ten years into the future. The two are linked: with consistency of government policy and funding, consistency of local demand for low carbon skills can be expected to follow. This would enable LEP to plan for the future and develop effective strategies for co-ordinating long-term plans for the supply of skills that meet local demand in the low carbon sector.

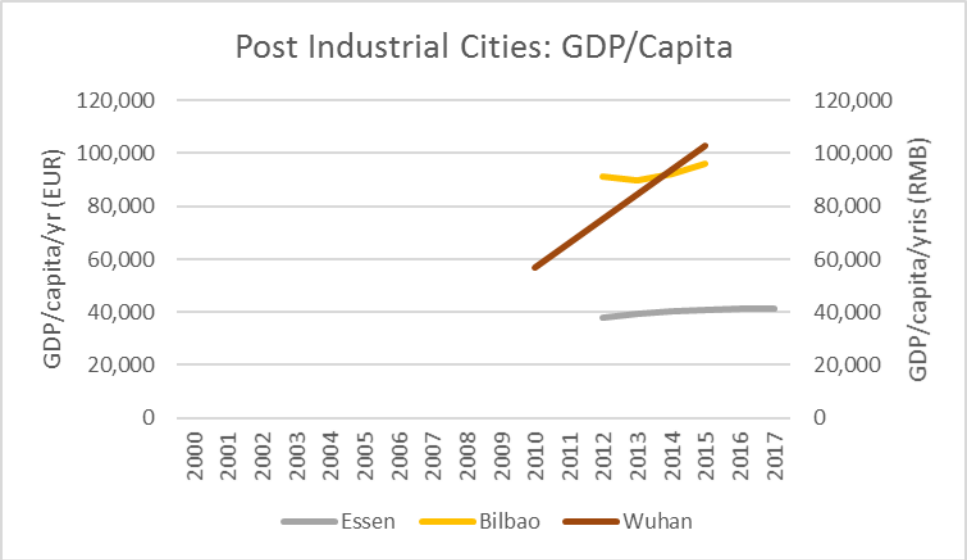
Annex II – Indicator Data for Cities

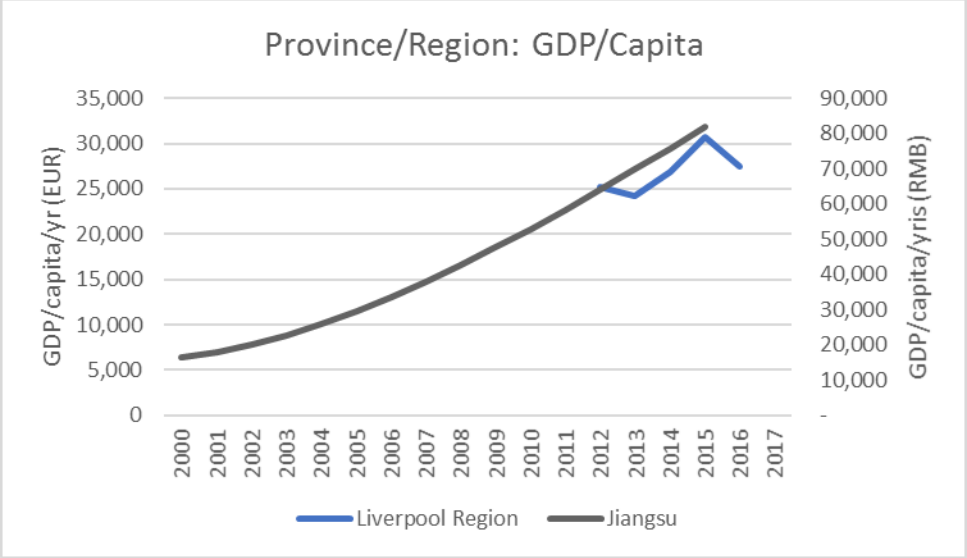


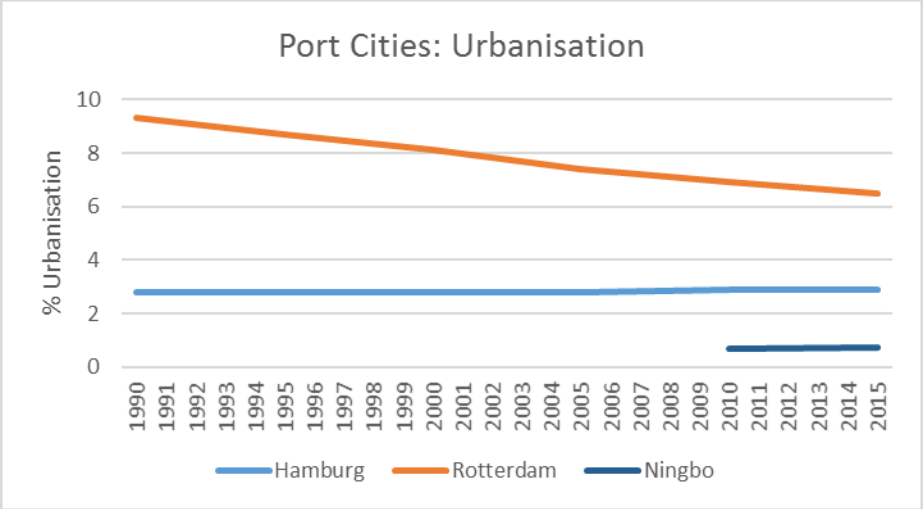


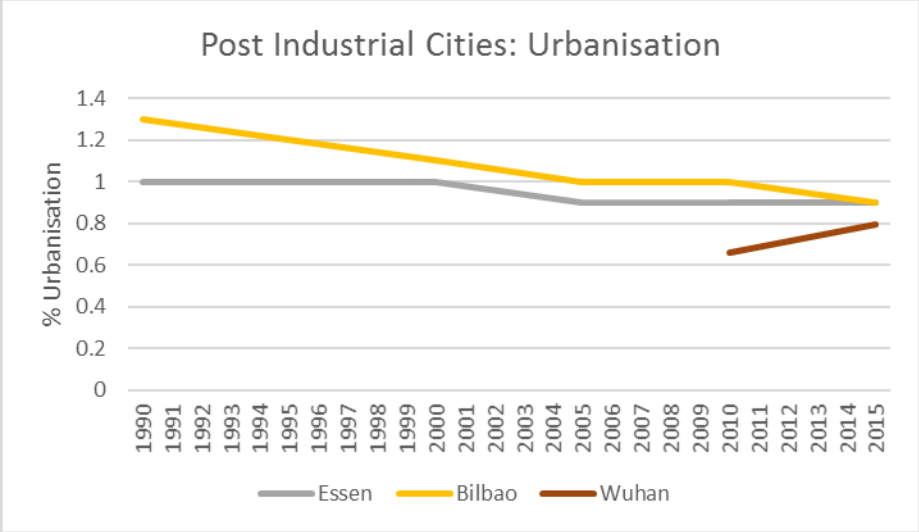


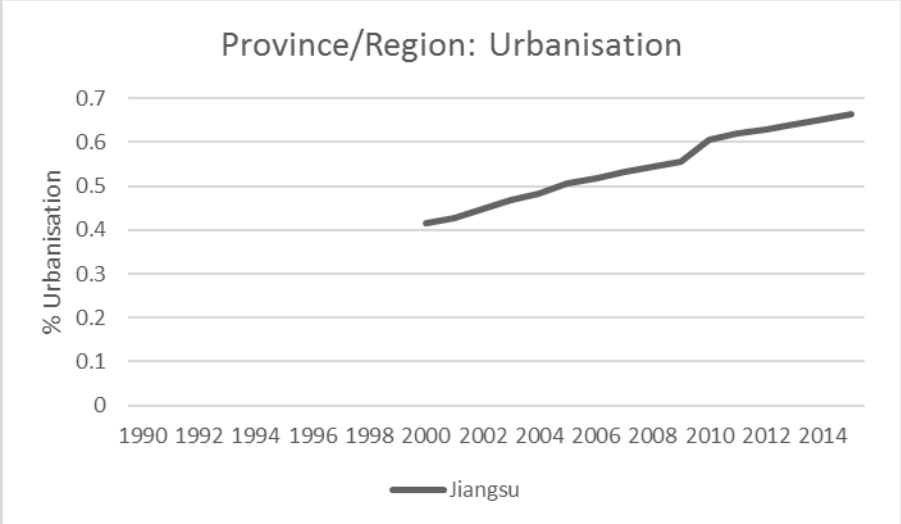

Port Cities: GDP/Capita
GDP/capita/yr (EUR)
GDP/capita/yris (RMB)
120,000
100,000
80,000
60,000
40,000
20,000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Hamburg
Rotterdam
Ningbo


Post Industrial Cities: GDP/Capita
GDP/capita/yr (EUR)
GDP/capita/yris (RMB)
120,000
100,000
80,000
60,000
40,000
20,000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Essen
Bilbao
Wuhan


Province/Region: GDP/Capita
GDP/capita/yr (EUR)
GDP/capita/yris (RMB)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Liverpool Region
Jiangsu


Port Cities: Urbanisation
% Urbanisation
10
8
6
4
2
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Hamburg
Rotterdam
Ningbo


Post Industrial Cities: Urbanisation
% Urbanisation
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Essen
Bilbao
Wuhan


Province/Region: Urbanisation
% Urbanisation
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Jiangsu