FROM SCENARIOS TO ACTION – FACILITATING A LOW CARBON PATHWAY FOR WUXI

NEEDS / POSSIBLE SOLUTIONS / MEASURES

LOW CARBON FUTURE CITIES

A Sino-German Cooperation on an Integrated Climate and Resource Proof Urban Development

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EXECUTIVE SUMMARY

The Sino-German project Low Carbon Future Cities (LCFC) aims to develop a cross-sectoral integrated low carbon strategy for its Chinese pilot city Wuxi, which is situated in Jiangsu Province about 130km away from Shanghai. The strategy primarily focuses on carbon mitigation but also considers links with the issues of resource efficiency and adaptation to climate change.

Wuxi city government has decided to pursue a proactive low carbon policy approach. By the end of the 12th Five-Year Plan period (2011-2015), it aims to reduce CO_2 emissions per unit GDP by 20%. This paper offers strategic examples of good practice and makes recommendations to Wuxi city government about the changes that key sectors can adopt in order to comply with its low carbon target and to achieve substantial greenhouse gas reduction until 2050. It focuses on four key sectors: power and heat generation, buildings, transport and industry.

The recommendations are based on in-depth status quo and scenario analyses by the LCFC team, which were used to pinpoint needs within and across the key sectors. As a next step, strategic approaches were identified to address these needs. Following that, the LCFC team selected examples of good practice that could foster the enforcement of the strategic approaches. Finally, the examples were translated into recommendations for concrete measures to implement, next steps to undertake and individuals/organizations to involve.

Most of the recommendations were achievable in the short term. They are, therefore, framed with suggestions for mid to long-term technological options for carbon mitigation, as well as with approaches for integrating resource efficiency and adaptation to climate change into a low carbon agenda. Furthermore, the report identifies key markets for low carbon development. Fig. 1 illustrates the relationship between needs and examples of good practice in an aggregated manner. The recommendations of the LCFC team can be summarised as follows:

CROSS-SECTORAL:

Wuxi city government has adopted a large array of ambitious low carbon targets. To facilitate their enforcement, the LCFC team recommends the creation of institutional structures, which **offer support and expertise to potential investors or consumers and systematically tap iness opportunities related to low carbon transformation**. Within this context, establishing a local energy agency that functions as a knowledge hub and dialogue platform for stakeholders could offer significant support to Wuxi's low carbon strategy.

POWER/HEAT GENERATION:

At present, Wuxi relies heavily on coal-fuelled power and heat generation, while renewable energy represents only a minor share of the power mix. Therefore, it is important for Wuxi to **improve its understanding of renewable energy potentials, remove bureaucratic barriers for renewable investments and create examples of successful integrated renewable energy projects,** which provide economic co-benefits with existing technical systems. In order to unlock Wuxi's renewable energy potential, the LCFC team recommends the development of a potential database and suggests that possible investors and political decision-makers should be presented with multi-functional online maps e.g. indicating the wind, hydro or solar potential of certain areas.

> "...This paper offers strategic examples of good practice and makes recommendations to Wuxi city government about the changes that key sectors can adopt in order to comply with its low carbon target."

BUILDINGS:

Building **standards need to be supported with incentives for investment** in efficient and sustainable construction. In order to ensure high quality and ultra-efficient buildings, **new manufacturing processes, such as Off-Site Manufacturing (OSM), need to be promoted**. Furthermore, buildings offer excellent conditions to **alleviate the impacts of climate change in urban centres**, e.g. through green roof

approaches. The LCFC team suggests that energy performance contracting schemes should be adopted as these can generate win-win situations for building owners. For the construction of new buildings, **quality assurance systems**, such as for OSM components, are key.

TRANSPORT:

Satisfying the increasing mobility needs of Wuxi's citizens, while ensuring a climate-friendly modal split, is the key challenge in the transport sector. Key recommendations are the **expansion of public transport services, the deployment of low carbon vehicles**, such as electric vehicles, as well as **flexible mobility concepts**, e.g. car sharing. With regard to freight transport, combining ship, rail and road transport through **trimodal harbour concepts** is an important option for Wuxi as it is located on the Taihu.

INDUSTRY:

This sector presents the greatest challenge for Wuxi as it is a major source of emissions and is highly diverse. In the short-term, **learning and knowledge sharing mechanisms for tapping energy saving potential** are crucial, e.g. through professionally coordinated local or regional resource and energy efficiency networks. For the mid to long-term, **more ambitious and costly technological measures** (e.g. direct iron reduction via hydrogen in the steel industry) will be needed to achieve substantial carbon mitigation. However, such steps generally need to be driven at national or provincial decision-making level.

In order to avoid trade-offs between Wuxi's low carbon strategy and resource efficiency and adaptation to climate change, both issues should be systematically integrated with mitigation aspects. With regards to resource efficiency, it is recommended that **regular resource checks of mitigation measures** should be conducted and that **cross-industrial resource utilisation** should be fostered. Adaptation does not yet occupy a prominent position on the local policy agenda. The LCFC team suggests that the topic should be institutionalised through a **new cross-sectoral leader group for adaptation** and that the knowledge base on climate-related risks and vulnerabilities should be strengthened.

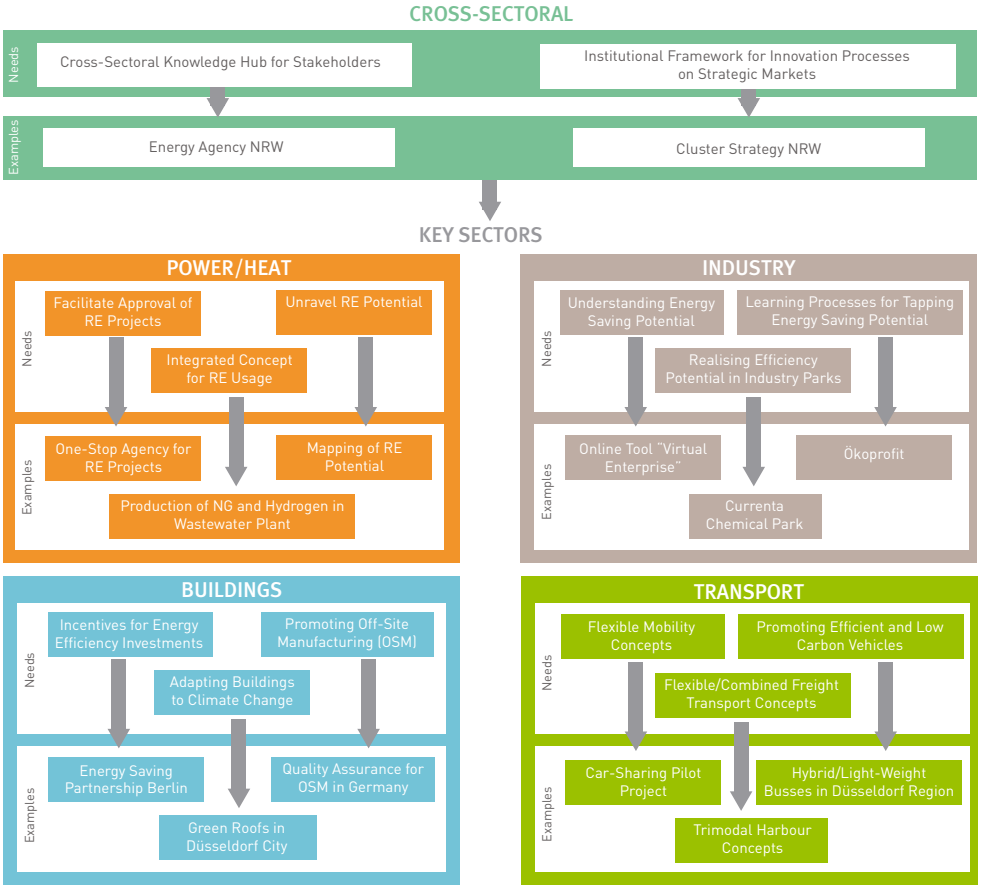

Fig. 1: Needs and Possible Solutions for Low Carbon Development in Wuxi

1 INTRODUCTION

Making low carbon development possible at local level in its urban centres is key to achieving an ambitious climate policy pathway in China over the coming decades. Against this background, the Sino-German project Low Carbon Future Cities (LCFC) aims to develop a cross-sectoral low carbon strategy for the city of Wuxi, which is situated on Lake Taihu in Jiangsu Province, about 130km away from Shanghai (see Fig. 2)." The strategy promotes an **integrated approach, combining greenhouse gas mitigation with resource efficiency and adaptation to climate change**. While the project focuses on mitigation aspects, links with the two other dimensions are systematically assessed when developing low carbon scenarios and measures.

Wuxi is a regional hotspot for energy-intensive industry operations, especially for steel, iron and chemical production. Nonetheless, the municipal government has decided to pursue a proactive low carbon policy approach and shift its economic structure towards the needs of a carbon-constrained future. This means strengthening its service-oriented businesses, while maintaining a strong core of highly modern and efficient industries. The city government has adopted a broad set of ambitious targets and initiatives; the major target is to **reduce CO_2 emissions per unit GDP by 20% by the end of the 12th Five-Year Plan period (2011-2015)**. This means that Wuxi's carbon intensity target is three percentage points more ambitious than the national target, despite its strong dependence on energy-intensive industries.

The rationale of this paper is to offer strategic examples of good practice and to make recommendations to Wuxi city government about the changes that key sectors can adopt in order to comply with its low carbon target.

> "…The rationale of this paper is to offer strategic examples of good practice and to make recommendations to Wuxi city government…."

The recommendations are based on in-depth scientific analyses which were undertaken earlier in the LCFC project, such as a greenhouse gas (GHG) inventory, an analysis of the institutional setting for low carbon policies and a low carbon scenario up to 2050 (named Extra Low Carbon Scenario). These are available on the LCFC website (www.lowcarbonfuture.net).

In combination with an intense dialogue with city representatives, these project milestones were used to identify challenges and needs for a low carbon strategy

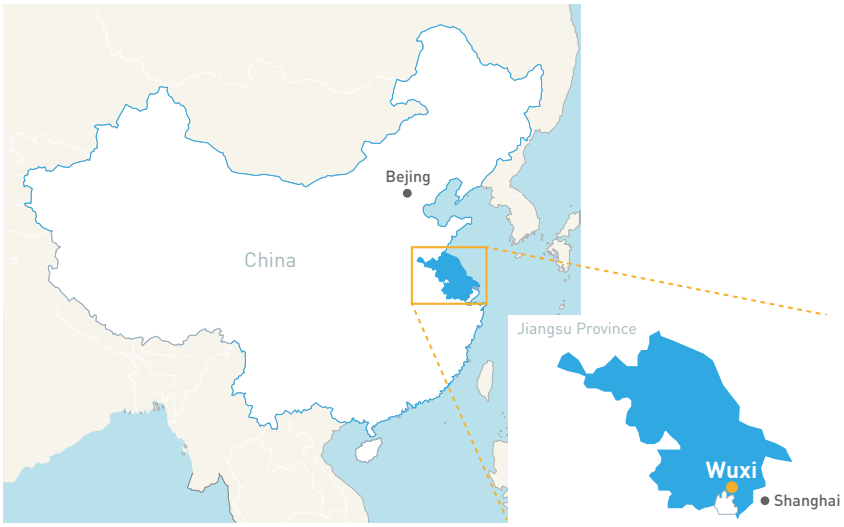

FIG. 2: MAP OF WUXI

across and within **four key sectors – power/heat generation, industry, buildings and transport**. As a next step, strategic approaches were formulated. Following that, examples of good practice that could help to achieve the strategic approach were selected from the Düsseldorf region (the German LCFC pilot region) as well as other parts of North Rhine-Westphalia. While most of the examples focus on carbon mitigation, some of them conceptually integrate the fields of adaptation to climate change and resource efficiency. At the end of the paper, the set of needs and examples is aggregated in strategic conclusions and recommendations.

"…In this paper, the LCFC team has chosen the approach of offering a limited number of concrete examples to Wuxi city government…"

In this paper, the LCFC team has chosen the approach of offering a limited number of concrete examples to Wuxi city government, instead of presenting a large selection of general measures. The first sub-section of the concluding chapter translates the examples into recommendations and measures for action and suggests organisations that should be involved in the process of implementing the recommendations. These recommendations mainly focus on the **short to mid-term**. In order to frame them within a longer-term perspective, the second sub-section of the conclusion illustrates the portfolio of low carbon-technologies – including **ambitious long-term options** - whose market introduction would be required in the Extra Low Carbon scenario. The third and the fourth sub-sections of the conclusion offer some more meta-oriented recommendations for **integrating adaptation to climate change and resource efficiency** into a low carbon strategy and on **potential key markets** for fostering low carbon development. Fig. 3 illustrates the overall strategic approach of the paper.

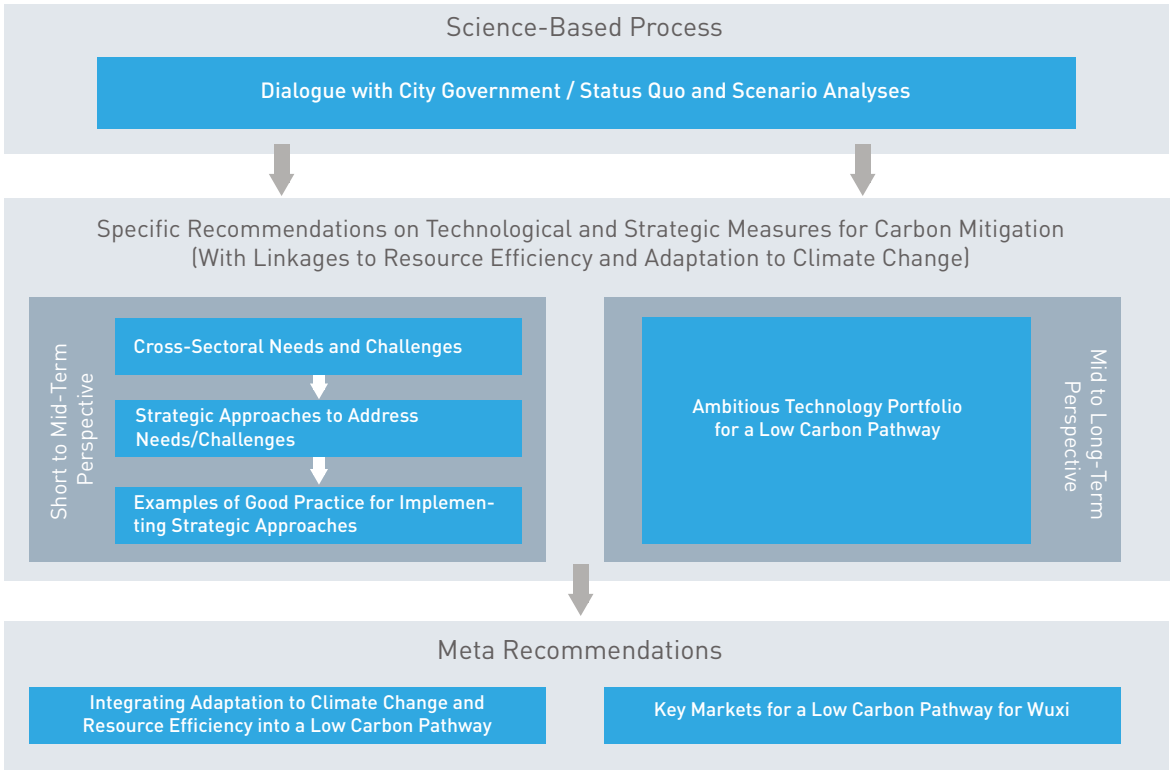

FIG. 3: OVERALL STRATEGIC APPROACH OF THE PAPER

2 HOTSPOTS AND FIELDS OF ACTION FOR WUXI'S LOW CARBON STRATEGY

The LCFC team has conducted a comprehensive analysis of the status quo of direct greenhouse gas emissions, resource efficiency and climate change in Wuxi. In the following section, the key outcomes of these analyses are briefly summarised.

2.1 STATUS QUO OF GREENHOUSE GAS EMISSIONS AND KEY SECTORS IN WUXI

Due to the high concentration of energy-intensive industries and increasing electricity demand, coal combustion is responsible for the bulk of Wuxi's carbon emissions. As shown in Fig. 4, the overall CO_2 emissions discharge of the energy sector as defined by the International Panel on Climate Change (IPCC), including emissions from fuel combustion (power and heat generation, petroleum refining etc.), manufacturing industries (not including process-related emissions), transport and the commercial and residential sector, total more than 70 million tonnes (according to the LCFC inventory, based mainly on Wuxi Municipal Bureau of Statistics 2010).

It should be noted that the inventory only covers direct emissions differerent from the low carbon scenario presented in section 3. Furthermore, the inventory needs to be considered as a rough estimate of Wuxi's CO_2 emissions due to significant gaps in local emission data. **Direct emissions from power/heat generation and industry represent about 90% of the overall discharge. Wuxi's CO_2 emissions amounted to 12 tonnes per capita in 2010**, whereas China's national average is about 6 tonnes per capita. This means that Wuxi's per capita CO_2 discharge was higher than that of Germany (10 tonnes/capita) in the same year (EIA 2013).

Power/heat generation and the industry sector represent by far the largest portion of Wuxi's current CO_2 emissions. Furthermore, the **transport sector and the residential buildings sector were also identified as key sectors.** While their current share in Wuxi's overall CO_2 emissions is quite limited, they are expected to develop dynamically in the future.

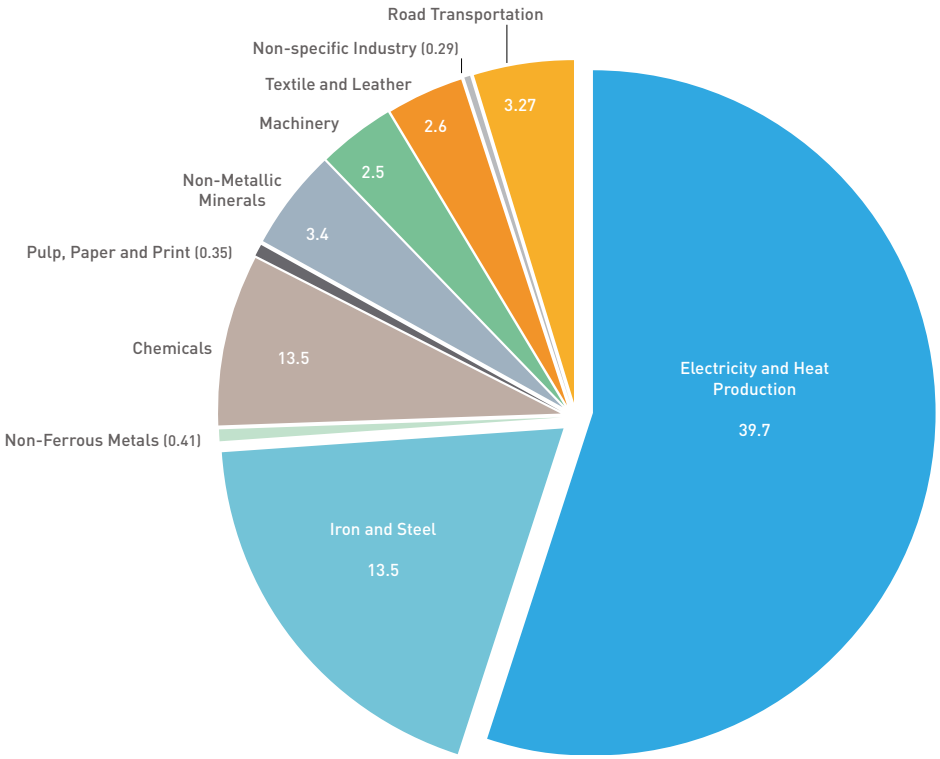

FIG. 4: WUXI'S TOTAL DIRECT CO_2 EMISSIONS (IN MILLION TONNES) IN THE IPCC-ENERGY SECTOR IN 2009

2.2 RESOURCE FLOWS AND VULNERABILITY TO CLIMATE CHANGE OF KEY SECTORS

The key sectors identified are not only highly relevant for CO_2 mitigation, but are also relevant for the two other problem dimensions of the LCFC project – resource efficiency and adaptation to climate change.

Material and water use were assessed as examples for the power/heat sector and the buildings sector. The analysis shows that for electricity production, Wuxi's largest emission source, material flows and water consumption for coal extraction and use dominate the picture. In a scenario up to 2050, which takes into account only existing policies (Current Policy Scenario), material flows related to power/heat generation will further increase due to Wuxi's growing demand for electricity in the coming decades. With regards to the building sector, a surge in local building stock is projected due to a steadily growing population and improved living standards. Therefore, erecting new buildings and demolishing old ones will cause significant material demand. In particular, the disposal of building materials is expected to have a significant impact on Wuxi's material flows.

Wuxi's vulnerability to climate change is predicted to increase in the coming decades. This assessment is based on past and projected climate parameters and combines the city's capacity to cope with climate change and its damage potential, e.g. negative impacts on infrastructure. Wuxi is most vulnerable to floods and heavy rainfalls. Although the intensity of both are not expected to change significantly, risks will increase due to the growing density of infrastructure in Wuxi's urban centre.

FOR INTERESTED READERS:

More details on the status quo and Current Policy Scenario of material flows and greenhouse gas emissions in Wuxi, as well as projections of the risks of and vulnerability to climate change are available in the LCFC report "Integrated Status Quo and Trends Assessment" (www.lowcarbonfuture.net).

2.3 WUXI'S CURRENT LOW CARBON POLICY APPROACH

Wuxi city government is a forerunner in the promotion of low carbon development in China and has adopted several policy documents to emphasise this role. One of the key documents is the 12th Five-Year Low Carbon City Construction Plan from 2011. This is a strategic document that sets out the city's low carbon strategy for different sectors. For the four key sectors identified in the LCFC project, the city's low carbon strategy focuses on the following aspects:

POWER AND HEAT

BUILDINGS

TRANSPORT

INDUSTRY

INDUSTRY:

The city government aims to reduce the local industries' carbon discharge by gradually phasing out energy-intensive enterprises, such as parts of chemical and textile production, and by accelerating the development of a less carbon-intensive service sector.

POWER/HEAT GENERATION:

To reduce Wuxi's reliance on coal-fuelled energy, the aim is to diversify the energy mix by stopping the further construction of coal-fired power plants and by increasing the use of natural gas. Furthermore, using renewables in power and heat generation (through both energy imports and local production) will be promoted. This is in line with efforts to develop a low carbon energy industry.

BUILDINGS:

The strategy aims to raise energy performance requirements for new buildings and to promote the use of renewable energy. Existing buildings, e.g. government office buildings, will be retrofitted with energy-efficient technologies. This process will be facilitated through piloting energy performance contracting.

TRANSPORT:

In order to reduce the transport sector's carbon emissions, the strategy focuses on water freight transport and public transport. The government is encouraging the sale and use of vehicles fuelled with renewable or alternative fuels for both road and water transport. Additionally, access to and usage of vehicles with high emissions in the city centre will be limited.

FOR INTERESTED READERS:

More details on Wuxi's current policy and institutional framework for low carbon development are available in the LCFC report "Institutional Analysis of Wuxi Low Carbon Development" (www.lowcarbonfuture.net).

3 A LOW CARBON PATHWAY FOR WUXI

"Wuxi's CO_2 emissions are assumed to peak at 100 million tonnes between 2020 and 2030."

A long-term strategy towards a low carbon future for Wuxi requires a vision of how the city could look in future. In which direction might Wuxi's economic structure evolve? How might the daily life of residents and entrepreneurs change?

The LCFC team has developed a **quantitative long-term low carbon scenario for Wuxi's key sectors** (Extra Low Carbon Scenario; ELCS) for the period up to 2050. The scenario is based on multiple assumptions made by the LCFC team and, therefore, it outlines only one possible pathway for Wuxi's future development up to 2050. The developments in the individual key sectors are described briefly in the following subsections.

From 2005 to 2010, Wuxi's GDP more than doubled with an annual growth rate of about 14%. The LCFC scenario assumes that in future decades **the rate of Wuxi's economic growth will gradually slow down, but Wuxi will nevertheless continue developing at a significant pace**.

The LCFC team assumes that **Wuxi will be a highly developed and prosperous city by 2050**, with modern urban infrastructures that meet the highest technical standards and offer good conditions for business and residential life. Wuxi's economic structure will be less dependent on energy-intensive industries but this change will be offset by the growth of more high-tech and service-oriented products, such as technologies that virtually connect physical items (e.g. through barcodes), sustainable energy technologies, software devices etc.

Fig. 5 shows that in the Extra Low Carbon Scenario (ELCS) **Wuxi's CO_2 emissions are assumed to peak at 100 milion tonnes between 2020 and 2030. The graph includes both direct and indirect emissions**. The latter comprise emissions from power and heat generation. Direct emissions reflect, for example, emissions from fuel combustion in industrial operations or vehicles.

The ELCS is compared to the Current Policy Scenario (CPS), which factors in only existing policies and targets. In the decades following 2020, the use of highly effective mitigation technologies, such as boosting the renewable energy supply (through both imports and domestic production), and behavioural changes, lead to a gradual decline in emissions in the ELCS to a level of 36 million tonnes by 2050. **Compared to 2010, this would be equivalent to a reduction of 56%**. The lion's share of Wuxi's greenhouse gas mitigation in the Extra Low Carbon Scenario is achieved in the local industry sector, whereas other sectors contribute smaller percentages.

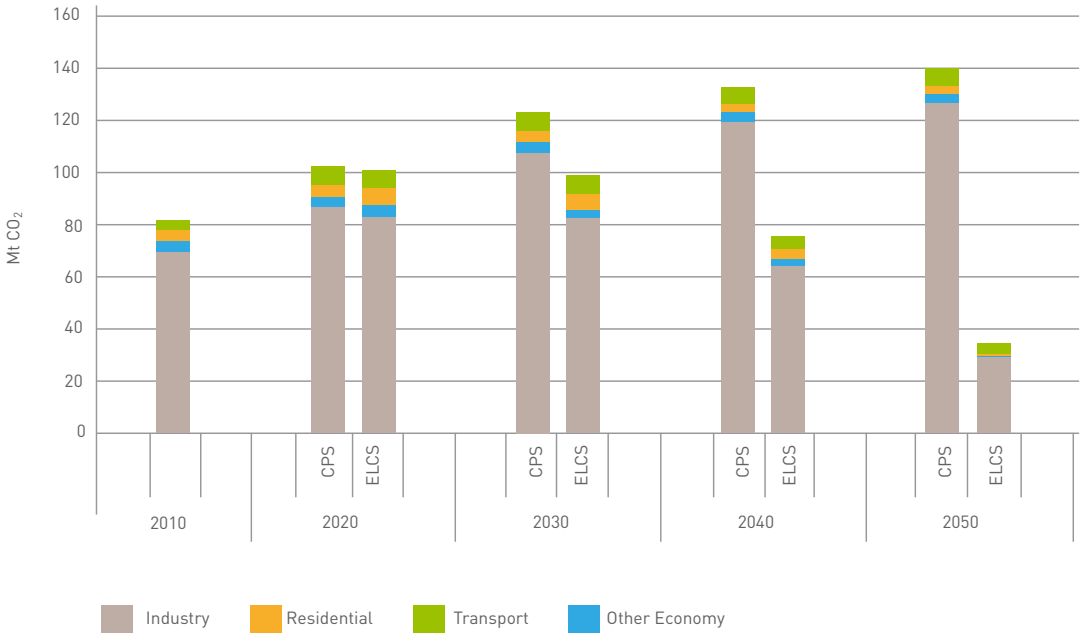

Fig. 5: Wuxi's Direct and Indirect CO_2 Emissions in the Current Policy Scenario (CPS) and the Extra Low Carbon Scenario (ELCS), 2010-2050

3.1 INDUSTRY SECTOR

Despite the proposed changes in Wuxi's economic structure, the LCFC low carbon scenario envisages that **Wuxi will remain an important industrial centre** within Jiangsu province and China, with production at a stable rate – or even showing slight growth. Although steel, chemicals and cement will be produced in lower volumes in future, the manufacture of these products will still be at the industrial heart of Wuxi.

However, local industries will have substantially modernised their infrastructures by the end of the scenario. **From 2030 to 2040, Wuxi's existing industrial plant fleet will be fully retrofitted and renewed with the best available technologies**, operating at the highest possible efficiency levels. Furthermore, the fuel used in Wuxi's industrial operations will increasingly shift from coal to natural gas.

Wuxi's steel and iron industry will face the most obvious technical changes within the industry sector. For example, direct iron reduction with hydrogen is projected to become a key mitigation technology, replacing coke and coal.

Overall, **the industry sector's CO_2 emissions will be reduced by 58% by 2050 compared to 2010**; direct CO_2 emissions from fuel use in the iron and steel industry will drop from about 11 million tonnes in 2008 to approximately 2.4 million tonnes in 2050.

"…Wuxi's steel and iron industry will face the most obvious technical changes…."

3.2 TRANSPORT

Along with rising living standards, more and more of Wuxi's citizens will purchase private cars. Private car ownership is predicted to rise sharply until 2025.

From 2030, **electric vehicles will become an increasingly important strategy** for reducing CO_2 emissions from Wuxi's growing transport sector.

The share of **non-motorised transport in Wuxi's modal split will significantly decline** in the coming decades. However, non-motorised transport is still expected to fulfil almost 50% of the mobility needs of residents in Wuxi by 2050. Therefore, bicycles etc. will still be a familiar sight on Wuxi's streets in 2050.

Despite strong growth until the mid-2020s, **it is assumed that the saturation rate of cars per capita will stay at the reasonably low level** of 30% per 100 inhabitants (in comparison, in industrialised countries such as Germany there are approximately 50 cars per 100 inhabitants). This means that Wuxi will maintain a healthy balance between privately owned motorised transport and non-motorised or public transport. Nonetheless, significant efforts will be needed to slow down the rapid growth of private car ownership.

In terms of public transport, **Wuxi's local subway system will become increasingly important**, offering a fast and reliable alternative to private car use.

The transport sector's direct and indirect CO_2 emissions will grow from 3.5 million tonnes in 2010 to 7.4 million tonnes in 2023 in line with the rising number of private vehicles. Afterwards, emissions decline slightly to 4.7 million tonnes by 2050.

"…electric vehicles will become an increasingly important strategy for reducing CO_2 emissions from Wuxi's growing transport sector."

3.3 BUILDINGS AND HOUSEHOLDS

From the present day until 2050, Wuxi will experience massive migration flows from rural areas to the urban centre of the city. Therefore, construction activities are likely to be concentrated in urban areas.

The living conditions of Wuxi's urban residents will improve greatly. **Most households will be equipped with modern electronic devices**. The efficiency level of these household devices will reflect the standard of best available technologies.

However, the growing number of electronic devices is predicted to lead to a significant increase in the energy demand of urban households: up to 6,000 GWh per year by the mid-2040s.

Low and ultra-low energy houses will be common in Wuxi by 2050. By this time, 70% of Wuxi's total buildings stock are projected to meet China's standard for ultra-low energy buildings as well as high standards for sustainability and quality. Furthermore, it is predicted that there will be only a moderate increase in the growth of the average floor space per resident. Overall, residential energy demand in Wuxi will be considerably lower compared to the same living conditions in less energy-efficient residential buildings.

Overall, **the building sector's CO_2 discharge (indirect emissions due to electricity consumption) will peak at 10 million tonnes in 2025** and decline to 1.8 million tonnes by 2050. Compared to 2010, this represents a decrease of 79% due to a higher share of renewable energy in electricity production.

"Low and ultra-low energy houses will be common in Wuxi by 2050."

3.4 POWER AND HEAT

It is envisaged that Wuxi's power demand will rise steeply from about 40 TWh in 2010 to about 120 TWh by 2050. This is mainly due to more electricity-intensive lifestyles (e.g. the increase of air conditioning in private households) and more electricity-intensive businesses.

However, by 2050, Wuxi's power and heat sector will be operated with a **significantly more diverse technological and fuel mix than today**. Wuxi is already in the process of replacing its inefficient coal-fired power plants with modern natural gas-fired power plants and combined heat and power (CHP) units.

Furthermore, **Wuxi will make more use of renewable energy sources**, such as solar, biomass (including waste products) and wind energy. Photovoltaic (PV) technology is of particular importance in promoting local renewable energy production in Wuxi. A growing number of PV modules will be installed on Wuxi's rooftops, enabling house owners to meet their own electricity demand.

Nonetheless, local renewable electricity plays a rather minor role in the LCFC scenario due to its limited potential. Instead, a large share of Wuxi's renewable energy will be supplied by **electricity imports from adjacent municipalities.** The share of imported electricity from renewable sources is expected to rise to around 75 TWh by 2050. Fig. 6 illustrates Wuxi's power supply from 1995 to 2050.

"...Wuxi will make more use of renewable energy sources...."

Indirect CO_2 emissions from the CHP heat and electricity consumption outlined above have been calculated according to the specific CO_2 emissions of Wuxi's power and heat plants. Today's CO_2 emissions from electricity imports are rated according to the figures of the East China grid. In the future (from 2030 onwards), Wuxi will only import electricity from renewable sources, which are counted as CO_2 neutral.

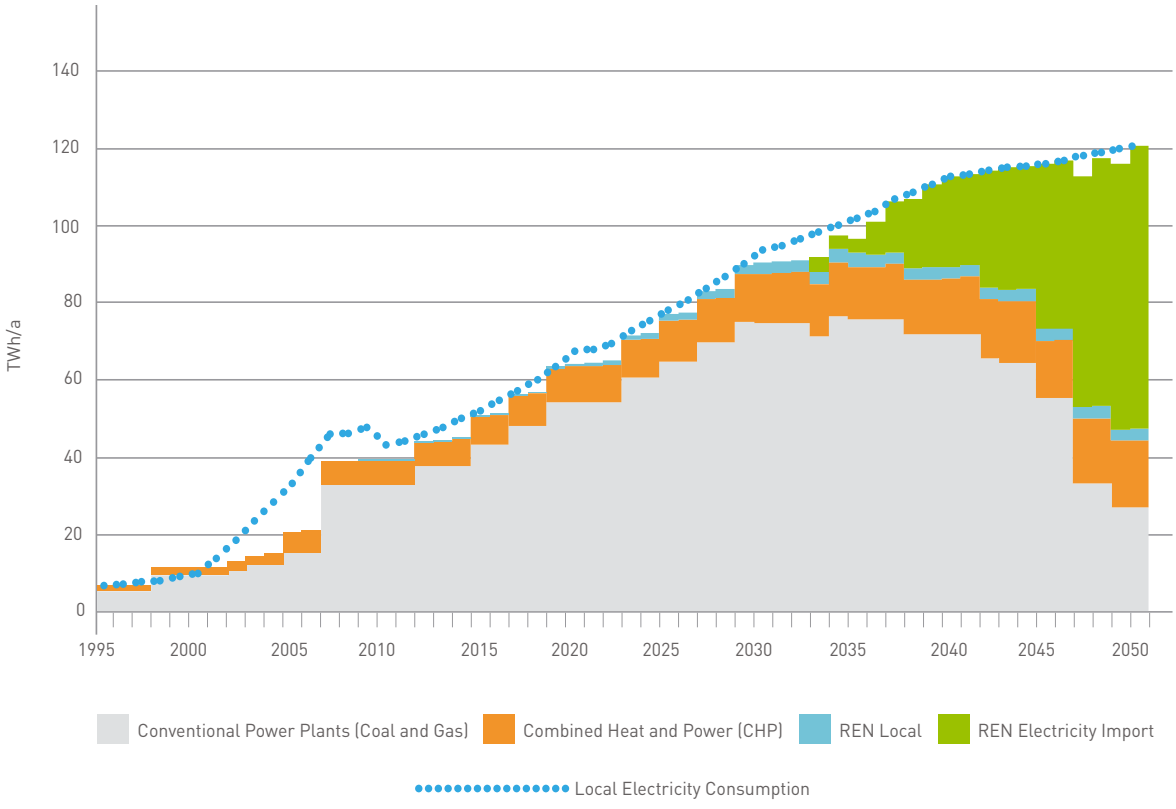

Fig. 6: Wuxi's electricity supply in the Extra Low Carbon Scenario, 1995-2050

3.5 RESOURCE USE AND ADAPTATION TO CLIMATE CHANGE IN A LOW CARBON WUXI

How does the 2050 Extra Low Carbon Scenario for Wuxi affect the city's material and resource flows as well as its vulnerability to climate change?

In the **power/heat sector**, decommissioning old coal-fired power plants and expanding electricity production from gas-fired plants and renewable imports significantly reduces the "ecological rucksack" of the power sector. The material footprint of Wuxi's power and heat sector in the Extra Low Carbon Scenario is about four times lower than in the Current Policy Scenario. This is due mainly to a switch from coal to natural gas and renewable energies – both have much lower material requirements than coal-fuelled power plants.

"…This shows that climate change may have a significant effect on energy demand and, consequently, on mitigation efforts."

In **the buildings sector**, a number of different factors affect material and resource requirements. Migration towards Wuxi's urban centre will cause a significant level of demolition waste in rural areas in the near future. In the urban centre, in turn, urban residential building stock will increase by 70% by 2050, in comparison to 2010 levels. Overall, these developments will create a total of 680 million tonnes of demolition waste and the input of over 750 million tonnes of construction materials. High levels of construction in the urban centre are projected to outweigh the declining number of new building projects in rural areas. Therefore, compared to 2010 levels, total material flows are projected to increase by about 9% by 2050.

The **links between adaptation to climate change and mitigation** of CO_2 emissions in Wuxi can be illustrated with an example from the building sector. Increasing summer heatwaves and rising living standards are projected to augment cooling energy demand. If no measures are taken with regard to energy efficiency improvements, increasing urbanisation and adaptation, the LCFC team estimates that the total energy costs for air-cooling will increase from nearly 500 million RMB/year in 2010 to nearly 900 million RMB/year in 2050. The increasing number of days where cooling is required would be responsible for about 13% of this increase in energy costs. This shows that climate change may have a significant effect on energy demand and, consequently, on mitigation efforts.

FOR INTERESTED READERS:

More detailed information on the LCFC Extra Low Carbon Scenario, further scenario pathways as well as their implications on resource efficiency and adaptation are available in the full report "Integrated City Strategy for CO_2 Emission Reduction, Resource Efficiency and Climate Resilience" (www.lowcarbonfuture.net).

4 FROM SCENARIO TO ACTION: CHALLENGES AND POSSIBLE MEASURES FOR LOW CARBON DEVELOPMENT IN WUXI

The identification of hot spots for GHG mitigation in Wuxi and the outline of a vision for a low carbon Wuxi by 2050 (as presented in the previous sections) clarify the scope of the challenge both across and within the identified key sectors.

As a Sino-German project, the Low Carbon Future Cities team aims to support Wuxi city government to face this challenge by offering examples of possible solutions from Germany, particularly from the German LCFC pilot region Düsseldorf. To ensure that the examples selected are relevant for Wuxi, the LCFC team has followed a **step-wise approach. Firstly**, based on completed scientific analyses of the project and intense dialogue with city representatives from Wuxi, **challenges and needs across and within the key sectors** have been identified. In a **second step**, the LCFC team has derived strategic approaches to address these challenges and needs. **Thirdly, examples of good practice**, which could help to implement the strategic approach if transferred to Wuxi, were selected based on experiences of the Wuppertal Institute in low carbon city projects in Germany and the Düsseldorf region. **Finally**, section 5.1 presents concrete recommendations for **measures and next steps to facilitate a transfer of the examples**. Fig. 7 illustrates the relationship between needs and examples in an aggregated and simplified way.

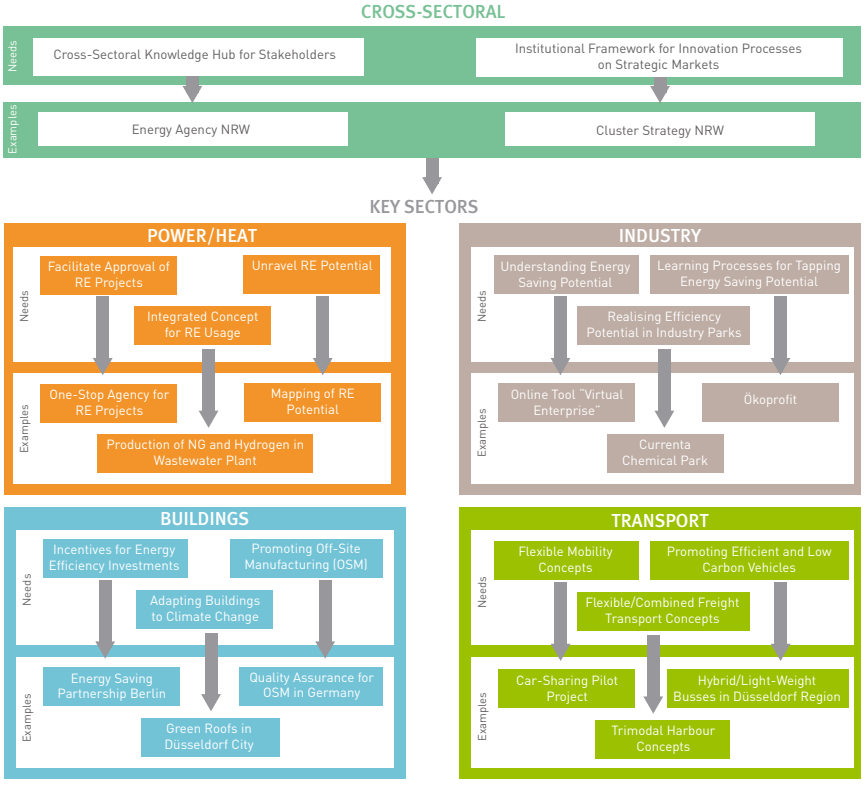

FIG. 7: NEEDS AND POSSIBLE SOLUTIONS FOR LOW CARBON DEVELOPMENT IN WUXI

FOR INTERESTED READERS:

Readers who would like further details about the examples are invited to get in touch with the LCFC team: daniel.vallentin@wupperinst.org or chun.xia@wupperinst.org

4.1 CROSS-SECTORAL NEEDS AND POSSIBLE EXAMPLES FOR ACTION

Challenges and Needs

In the absence of further ambitious mitigation measures and behavioural change, the LCFC Current Policy Scenario projects that Wuxi's CO_2 emissions will double by 2050, compared to 2010. While power/heat generation and energy-intensive industries are responsible for about 90% of Wuxi's CO_2 emissions, emissions from transport and buildings/households will also develop dynamically. This illustrates the need for coordinated action among all sectors and administrative bodies.

"Wuxi city government has published an overarching "Low Carbon City Construction Plan" and has established three cross-sectoral leader groups…"

Wuxi city government has published an overarching "Low Carbon City Construction Plan" and has established three cross-sectoral leader groups (low carbon construction, emission reduction, circular economy) under the auspices of the Mayor's office in order to make progress on a low-carbon track. Based on an exchange with Wuxi city representatives and experiences from North-Rhine Westphalia, strategic approaches and examples could help to further optimise cross-sectoral coordination and planning in addressing the needs outlined below.

Building a cross-sectoral energy knowledge hub for stakeholders:

Need: To increase support and advisory services for potential investors or consumers and institutionalised processes and mechanisms for knowledge sharing among stakeholders.

Strategic approach: A knowledge hub, which offers expertise and support to potential investors or consumers and functions as a dialogue platform between stakeholders from different sectors, could help to facilitate compliance with low carbon targets and to tap cross-sectoral synergies.

Example: Energy Agency of North Rhine-Westphalia

Institutional framework for fostering innovation processes for strategic markets:

Need: To foster the necessary framework for innovation and offer new business opportunities to support low carbon development. In order to tap innovation and business potential, the dialogue regarding future market opportunities between key stakeholders and the city government needs to be intensified.

Strategic approach: An institutional framework should be established, which brings together experts from different stages of the value chain for promising future markets and involves them in a continuous strategic process.

Example: Cluster strategy of NRW

GOOD PRACTICE EXAMPLE:

Energy Agency NRW

What is the project/programme all about? Background, objectives and highlights

Since the early 1980s, energy agencies have been playing an important role in Germany as service providers to investors or end users in the fields of renewable energy and energy efficiency. Energy agencies are organised at local, regional or state level. Their mission is to support stakeholders from business, politics or the local community in tapping potential for saving energy and costs; in doing so, they also help these stakeholders to reduce greenhouse gas emissions (German Association of Energy and Climate Protection Agencies 2013).

"The agency is committed to achieving significant GHG mitigation by encouraging investment in energy efficient technologies…"

The state of North Rhine-Westphalia has established an energy agency (EnergieAgentur.NRW) that functions as a strategic platform with broad competencies and expertise. Its work is organised in eight key areas: energy efficiency and renewable energies in enterprises and municipalities, efficient and solar buildings, power plant and grid technologies, biomass, alternative fuels, hydrogen and fuel cells, photovoltaic, climate protection and emission trading.

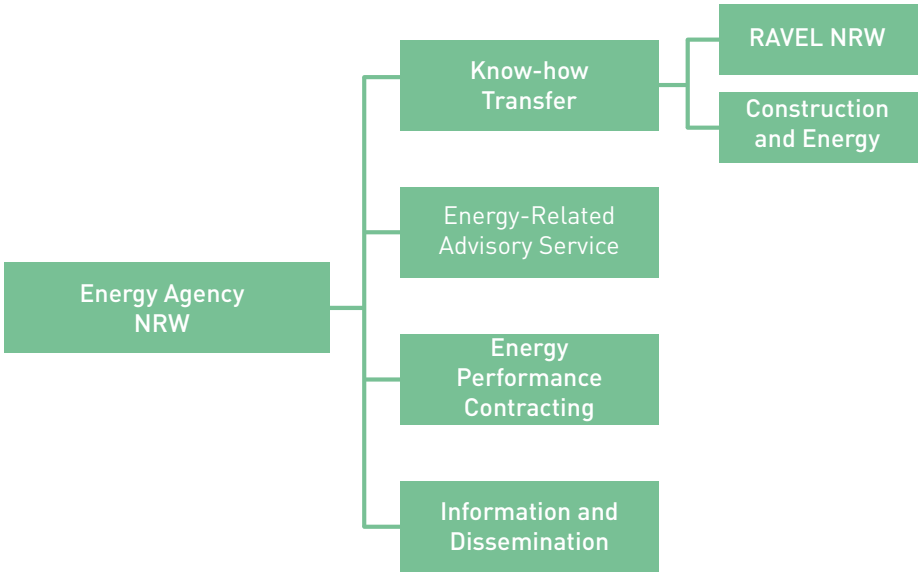

FIG. 8: THE ENERGY AGENCY NRW – ITS ORGANISATIONAL SET UP

Adapted from http://www.energieagentur.nrw.de/unternehmen/die-energieagentur-nrw-neutrale-anlaufstelle-in-allen-energiefragen-2333.asp

Within these key topics, the agency performs the following functions:

- coordinates **expert networks** with a focus on strategic future markets to facilitate collaboration and alliances between enterprises, universities and research institutes.
- offers **advice to enterprises and end users** on how to reduce energy consumption, e.g. by optimising production processes, and funds programmes that could be used for this purpose.
- offers **capacity-building tutorials** on energy efficiency and renewable energies for enterprises, municipalities, end users and other organizations and hosts a **web-based knowledge platform**.
- undertakes **information campaigns** on specific topics, e.g. heat pumps or biomass heating systems.

What are the important impacts of the project/programme (economic, environmental and social)?

The agency is committed to achieving **significant GHG mitigation by encouraging investment** in energy efficient technologies and supporting their implementation, both for large-scale industrial technologies and small devices. Furthermore, the energy agency's advisory services help to **reduce the energy bill** of industrial companies and private consumers and may stimulate dynamic innovation processes. By doing so, energy agencies help to **raise the acceptance of the transition to a low carbon model**. Initially, the energy agency may support investment in efficient technologies, which will lead to new material flows and disposal of old equipment. Overall, however, it contributes to an improvement of resource efficiency by reducing energy demand.

What are the important success factors?

The Energy Agency NRW is acting at state level in North Rhine-Westphalia, but there are numerous energy agencies in Germany that are based at community level; therefore, the concept is well suited for replication at city level.

The energy agency must be **well rooted in the administrative departments whose competencies/responsibilities are affected by the agency**. This includes bureaus and departments that deal with energy, buildings and industry.

Furthermore, the agency needs to be **officially authorised by the city government** to act as a platform for energy-related issues so that it has a mandate for bringing together relevant stakeholders.

The agency also needs to be **closely linked to practitioners**, especially entrepreneurs, in order to be able to address their needs and concerns.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

An **appropriate institutional setting** must be identified. This should provide the agency with a clear mandate and should not work at cross-purposes with the responsibilities/competencies of the municipal offices and departments involved. This could be achieved by placing the energy agency under the auspices of the municipal Development and Reform Commission.

Entrepreneurs and end users should perceive the agency as a support tool/mechanism, which addresses their needs and concerns and helps them to tap energy saving potential. To achieve this, it is recommended that the organizational structure of the energy agency encompasses an **advisory board, which systematically integrates the perspective of entrepreneurs** into the agency's strategic agenda.

"…the energy agency's institutional set up could be flexibly designed…"

Transferability to Wuxi:

It goes without saying that to create a new institution and embed it into the existing political setting of Wuxi is challenging. However, the energy agency's **institutional set up could be flexibly designed** according to the specifics of Wuxi's administrative system and available resources. Even in Germany, energy agencies in different settings have differing formal status and/or funding sources. For example, the Energy Agency NRW is fully owned and financed by the state, while the Energy Agency of Berlin is a private company (the state of Berlin holds 25% of the shares) and receives no public funding.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Official German website of Energy Agency NRW: **http://www.energieagentur.nrw.de**
English section of the official website of Energy Agency NRW: **http://www.energieagentur.nrw.de/themen/service-provider-of-the-state-of-nordrhein-westfalen-in-all-energy-matters-the-new-energyagencynrw-5289.asp**

GOOD PRACTICE EXAMPLE:
Cluster Strategy of NRW

What is the project/programme all about? Background, objectives and highlights

A low carbon transition requires processes and channels to stimulate innovation. In order to encourage such an environment, the state of North Rhine-Westphalia formed industry clusters to tap strategic future markets and to prepare itself for future economic, ecologic and social challenges.

The strategic clusters include the following industries: automotive, biotechnology, chemicals, food, energy, logistics, health and ICT (amongst others).

The clusters are managed by the responsible administrative units (e.g. ministries) and convene stakeholders from business, politics and academia. They serve as platforms for information, communication and collaboration to develop strategies and coordinate activities. Their work is organised in networks. For example, the Energy

Agency of North Rhine-Westphalia manages the energy cluster. Its networks are closely related to the focal topics of the energy agency, such as power plant technology, biomass and efficient and solar building concepts. The network for efficient and solar buildings consists of more than 600 actors from all stages of the building value chain, including architects, engineers, local council representatives and others, all of whom are organised into different working groups. As well as collaboration among stakeholders within one cluster, the state government facilitates cooperation and exchange between different clusters as it understands that the greatest potential for innovation exists when clusters cooperate.

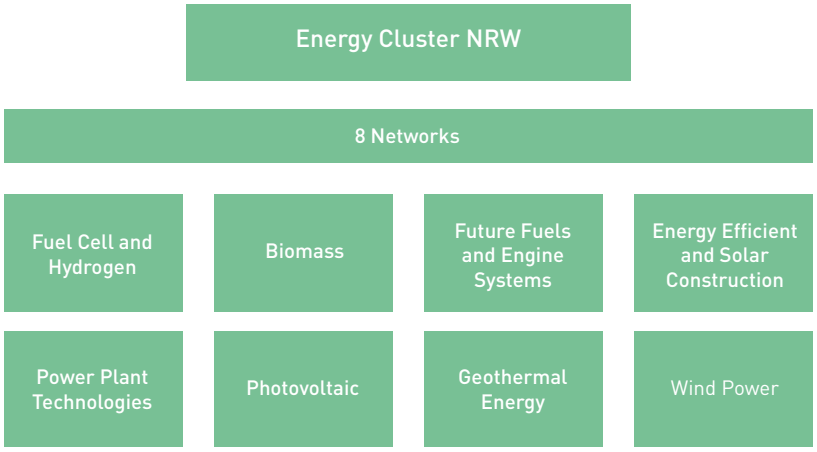

FIG. 9: SPECIALISED NETWORKS WITHIN THE ENERGY CLUSTER OF NRW

Adapted from: http://www.energieregion.nrw.de/energieregion/themen/ziele-und-aufgaben-12069.asp

What are the important impacts of the project/programme (economic, environmental and social)?

The markets covered by North Rhine-Westphalia's cluster strategy do not exclusively address low carbon activities. However, the cluster strategy offers an **excellent opportunity to integrate the idea of urban low carbon development into different economic fields and to develop sustainable industrial strategies**. By doing so, the cluster strategy helps to join forces and share expertise to develop pilot projects and strategies for future markets, facilitating the combination of environmental benefits with economic opportunities.

What are the important success factors?

The basic prerequisite for the cluster strategy is that decision-makers and stakeholders have to **perceive the need to collaborate and share knowledge** in order to prepare for future economic and environmental challenges. Therefore, the strategy requires a high degree of openness between the parties involved. Such openness and willingness to collaborate is more likely to be achieved when the top level of the local or regional government coordinates the process, while each cluster is managed by the responsible administrative bureau or department. **Effective and efficient management structures** need to be established to coordinate activities within and among clusters. Furthermore, **the benefits of the cluster approach for entrepreneurs should be clearly communicated** in order to increase their motivation to participate.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

In order to develop a consistent and ambitious cluster strategy, the responsibilities of the different offices/departments must be clearly defined. Furthermore, **close collaboration between the administrative units** involved is required, especially for tapping the potential between the clusters.

Transferability to Wuxi:

It should be possible to transfer the cluster strategy approach to Wuxi as it **can be integrated into the existing administrative setting** and does not require new institutions to be created. Instead, responsibilities for single clusters should be given to the departments/offices that already hold the main responsibility in the relevant areas. Furthermore, the cluster approach could be **organised within the process of developing Wuxi's Five-Year Plans** and provide systematic input.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

> **"…an excellent opportunity to integrate the idea of urban low carbon development into different economic fields and to develop sustainable industrial strategies…"**

Link for further information:

Official English website of NRW cluster strategy: **http://www.exzellenz.nrw.de/nocl/noth/?L=1**

Source: Shutterstock.com

4.2 NEEDS AND POSSIBLE EXAMPLES FOR ACTION IN WUXI'S POWER AND HEAT SECTOR

Challenges and Needs

At present, over 90% of Wuxi's primary energy demand is supplied by coal. In particular, **Wuxi's power and heat sector relies heavily on raw coal combustion and this is the city's major source of GHG emissions**. In 2009, the sector discharged nearly 40 million tonnes of CO_2 or about 55% of the GHG emissions of Wuxi's energy sector (which includes fuel combustion activities, manufacturing industries, transport and others). In turn, renewable energy accounts for only a minor share of Wuxi's electricity supply despite an increasing trend.

Wuxi city government has adopted several ambitious targets and measures to reduce the carbon discharge of the local power and heat sector, e.g. by shifting the power feedstock from coal to natural gas and promoting photovoltaic (installed capacity to reach 60 GW by 2015) and biogas (sites with a capacity of more than 4 million m3 to be opened by 2015) (see LCFC report "Institutional Analysis of Wuxi Low Carbon Development" at www.lowcarbon-future.net).

In order to accelerate the low carbon development of the power sector, the LCFC team has identified the following needs, measures and examples based on existing policies and from conversations with the city government.

Unravel renewable potential:

Need: To broaden the knowledge and understanding of local/regional renewable energy potential in order to expand and diversify Wuxi's renewable energy supply.

Strategic approach: The compilation and visualisation of data on renewable energy potential in broadly accessible, multifunctional mapping systems could be a valuable information tool for both the city government and potential investors.

Example: Mapping systems for renewable energy potential in German states such as Baden-Württemberg or North Rhine-Westphalia and cities such as Düsseldorf.

Facilitate approval of renewable energy projects:

Need: Renewable energy projects are currently slowed down by complex approval processes, involving authorities at several decision-making levels. The approval process is determined at the national level, but Wuxi city government could reduce the bureaucratic burden for potential investors through offering systematic support.

Strategic approach: A specialised

agency could support and guide investors through complex approval processes.

Example: Model of one-stop agencies, such as NRW.INVEST.

Integrated concept for renewable energy utilisation:

Need: In order to foster the deployment of renewable energies in Wuxi, innovative examples of best practice, which demonstrate their technical and economic viability, .need to be established.

Strategic approach: For this purpose, technologically concepts that combine renewable energy projects with other industrial processes and, thereby, generate economic co-benefits as well as synergies among sectors, seem to be well suited.

Example: Production of natural gas and hydrogen in a waste water treatment plant of the Emschergenossenschaft (EUWAK).

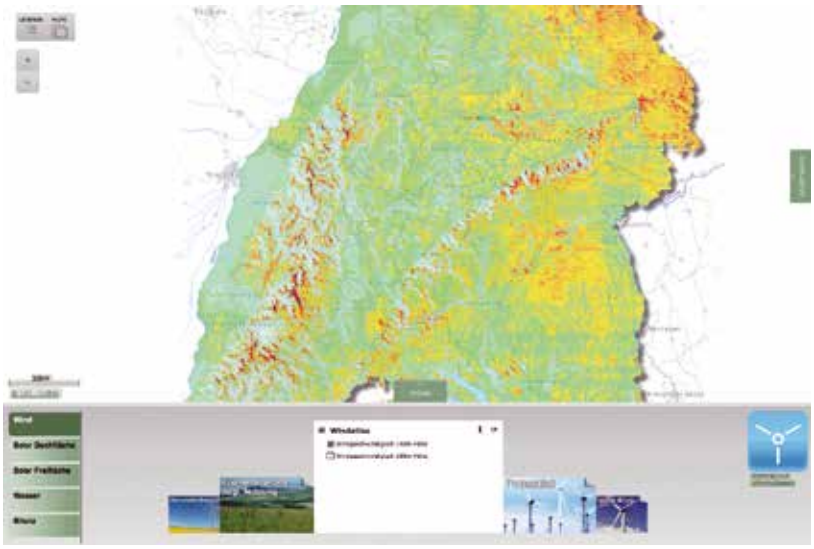

FIG. 10: INTERACTIVE MAP OF THE WIND ENERGY POTENTIAL OF BADEN-WÜRTTEMBERG

Source: http://rips-app.lubw.baden-wuerttemberg.de/maps/?lang=en&app=potenzialatlas

GOOD PRACTICE EXAMPLE:

Mapping of Renewable Energy Potential

What is the project/programme all about? Background, objectives and highlights

To expand the capacities of renewable power generation in Wuxi and the surrounding municipalities, comprehensive knowledge of the potential of available renewable energy sources is needed. In Germany, several states as well as municipalities have mapped their local renewable energy potential and quantified the resulting long-term CO_2 mitigation potential. At local level, these studies are generally an integral part of municipal climate concepts and provide the basis for concrete steps for CO_2 mitigation.

States such as North Rhine-Westphalia and Baden-Württemberg have published detailed GIS-based (Geographic Information System) maps of renewable energy potential and installed or planned power generation capacities. The maps are publicly available on websites; users may combine different parameters and generate maps according to their own needs. The potential atlas of Baden Württemberg offers maps for wind power, solar energy (both on rooftops and open areas) and hydropower. For wind power, mapping parameters include installed wind power capacities, wind velocities and power potential of all municipalities or districts in Baden-Württemberg.

At city level within the LCFC pilot region, Düsseldorf has developed a web-based cadastre of the solar potential of each rooftop within the administrative boundaries of the city. As a next step, the city of Düsseldorf, as well as the districts Rhein-Kreis Neuss and Kreis Mettmann, intend to elaborate a regional cadastre of solar roof potentials.

"...an important tool for informing decision-makers and potential investors..."

What are the important impacts of the project/programme (economic, environmental and social)?

Mapping the potential for renewable energy production within a certain region or municipality constitutes an **important tool for informing decision-makers and potential investors**. It offers insights about the economic viability of specific production sites and enables estimations to be made about the greenhouse gas mitigation impact of renewable power capacities. Furthermore, the maps indicate in which municipalities programmes or initiatives for **public acceptance** of new infrastructure are most needed. Therefore, renewable energy maps are an important knowledge basis for low carbon strategies.

What are the important success factors?

Detailed mapping of renewable energy potential requires a **comprehensive local and regional database**. In the process of compiling such a database, close collaboration between different responsible units at local level (e.g. the planning department and agricultural department) and at provincial level is inevitable. Therefore, a **cross-departmental committee**, which coordinates and oversees the data collection process, could be an important success factor.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The **systematic evaluation of available data sets and identification of data gaps** is a crucial first step at local level. Wuxi should, therefore, collect and evaluate local data. In addition, predictions are that Wuxi will depend heavily on imported renewable electricity from adjacent municipalities and for extensive import/export flows between different municipalities within the province. Therefore, in all probability, the geographic boundaries of the mapping system would have to reach beyond the boundaries of Wuxi. Therefore, **adjacent municipalities or even the wider province should be consulted** for collaboration.

Transferability to Wuxi:

Transferability is challenging in this case, as the process of data collection at local and inter-municipal level requires **involvement and collaboration of several departments**. At local level, close collaboration between government and research institutes is needed, such as the Development and Reform Commission (DRC), Bureau of Agriculture and Forestry, Urban Planning Bureau, grid company and Jiangnan University. They could form a **data committee under the auspices of the DRC** with Jiangnan University being responsible for managing the data and creating a comprehensive database. The data committee could also organise the collaboration with adjacent municipalities or at provincial level.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Map of renewable potential in Baden-Württemberg (German only): **http://rips-app.lubw.baden-wuerttemberg.de/maps/?lang=de&app=potenzialatlas**
NRW energy atlas (German only): **http://www.energieatlasnrw.de/site/nav2/Potenzialstudie.aspx?P=8**

GOOD PRACTICE EXAMPLE:
One-Stop Agency for Approval of Renewable Energy Projects

What is the project/programme all about? Background, objectives and highlights

In China, investment in renewable energy projects, such as installing PV modules on the rooftop of a building, require lengthy approval processes involving decision-making at several levels, including national level. The suggestion is for Wuxi city government to establish institutional structures and mechanisms to offer support and advice to investors. One possible option for such a scheme is a so-called one-stop agency. One-stop agencies have been established in several German municipalities and states in order to facilitate investment. They are administrative entities that guide investors through all stages of an investment process, including planning, application for approval, approval

procedure and project implementation. They contact the relevant authorities, submit the required documents and function as a 'bridge' between investors and the administrative system. One-stop agencies are constantly in touch with the relevant authorities and inform the investors about the present state of the process. They help to speed up the approval process and make it more transparent (Vallentin and Liu 2005). This type of institutional vehicle seems suited to facilitating low carbon investments at local level.

In North Rhine-Westphalia, the state-owned agency NRW.INVEST offers expertise on legal and tax-related issues to potential investors, as well as detailed information on the economic structure of target regions or knowledge clusters. NRW.INVEST moderates and supports investment projects through the full process from the first to the final stage. Of course, the assignment and organizational structure of a one-stop agency for low carbon energy projects in Wuxi would be different to NRW.INVEST. However, its basic function - offering expertise, guidance and support for investment and the related approval processes - seems to be transferrable. This type of one-stop agency could be an integral part of a newly established energy agency (see above). Alternatively, it might be located under the auspices of the local energy department.

What are the important impacts of the project/programme (economic, environmental and social)?

A one-stop agency could prove very useful for large-scale investment projects involving serious players in the market, as these types of investments require numerous approvals. Equally, the one-stop agency should **encourage and enable investors** with limited financial resources and experiences (e.g. private residents) to embark upon renewable energy investment projects. In this way one-stop agencies can encourage a broad range of investments.

What are the important success factors?

The introduction of one-stop agencies demands **a good awareness of the bureaucratic barriers to investment and the motivation to overcome these hurdles**. Most importantly, it requires intense collaboration between the relevant administrative entities and a service-oriented approach towards investors. Furthermore, the one-stop agency **needs to be approved and accepted at higher administrative levels**, namely at provincial and national level.

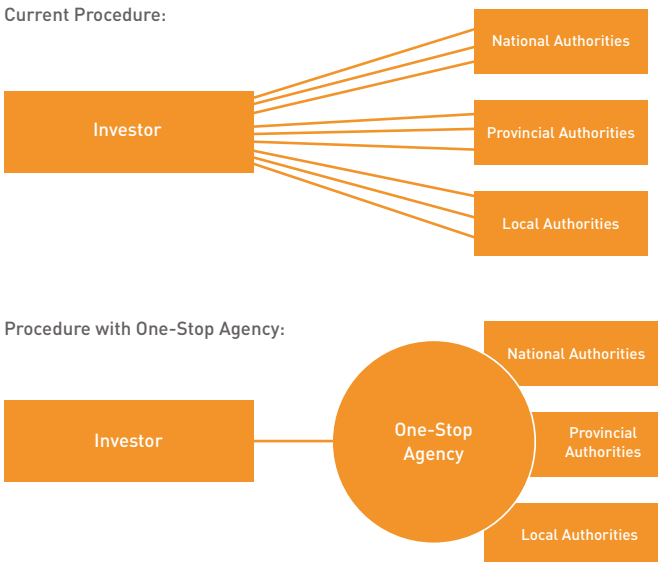

Fig. 11: One Stop Agency for Renewable Energy Projects – How It May Facilitate Approval Processes

Adapted from: Vallentin and Liu 2005

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

An **over-complex set of administrative responsibilities** for different renewable energy sources may hinder the establishment and effectiveness of a one-stop agency.

Transferability to Wuxi:

The function of a one-stop agency is **not to reform administrative procedures but to make them more transparent and tangible for investors**. Therefore, this scheme should be transferrable to Wuxi. The one-stop agency could, for example, be located within a newly established energy agency. Similar to the energy agency, it could either be fully government-controlled or a semi-governmental entity.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

"The introduction of one-stop agencies demands a good awareness of the bureaucratic barriers to investment and the motivation to overcome these hurdles"

Links for further information:

Official website of NRW.Invest (in English):
http://www.nrwinvest.com/

GOOD PRACTICE EXAMPLE:

Production of Natural Gas and Hydrogen in a Wastewater Treatment Plant (EUWAK)

What is the project/programme all about? Background, objectives and highlights

This project is an excellent example for demonstrating how renewable energy production may be integrated into other infrastructures and be combined with resource efficiency. The wastewater treatment plant in Bottrop (North Rhine-Westphalia), owned and operated by Emschergenossenschaft, is one of the largest plants of its kind in Germany. Every year, the treatment of sewage sludge generates between around 15 and 18 million m3 of biogas as a by-product (Innovation City Ruhr and Bottrop Innovation City, no year given). This biogas is used for different purposes. At the plant sites, it fuels three combined heat and power units, which supply a significant share of the auxiliary electricity and heat for the wastewater plant. Furthermore, the biogas is upgraded to the same quality level as natural gas and used, for example, for fuelling staff cars for business use. The remaining natural gas is converted to hydrogen and transformed into heat and power in a hydrogen engine, supplying an adjacent school and swimming pool. Though still at the pilot stage, the wastewater treatment plant is the first project which demonstrates the complete supply chain from hydrogen production through to its distribution to the end user. The plant has been running successfully since it started operation in 2008. In the same year, it received the Innovation Award of the International Water Association (IWA).

"…the project helps to replace fossil fuels with low-carbon feedstock, shortens the fuel supply chain and reduces the energy bill…"

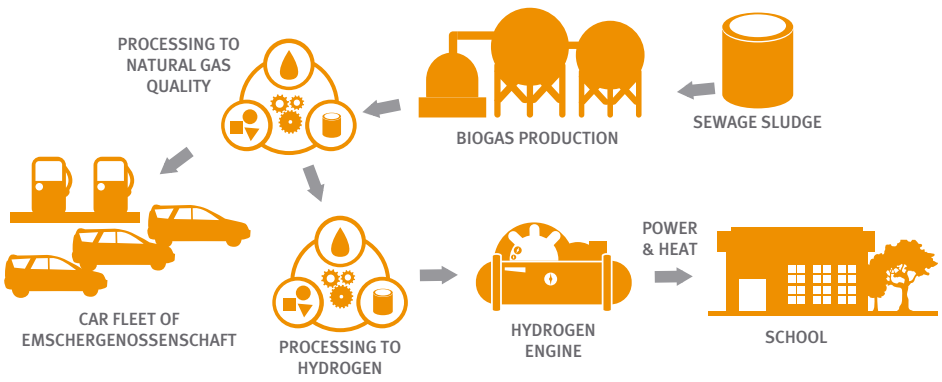

FIG. 12: GENERATING CO-BENEFITS – THE PRODUCTION OF NATURAL GAS AND HYDROGEN FROM BY-PRODUCTS OF A WASTEWATER TREATMENT PLANT

Adapted from http://www.h2-netzwerk-ruhr.de/Waste-water-treatment-plant.78.0.html?&L=1

What are the important impacts of the project/programme (economic, environmental and social)?

The EUWAK project is an excellent example of how resource efficiency and low carbon power/heat production can be combined by connecting different process cycles and making use of by-products. By doing so, the project helps to **replace fossil fuels with low-carbon feedstock, shortens the fuel supply chain and reduces the energy bill** of the wastewater treatment plant. Furthermore, the production of biogas avoids energy and logistic-intensive processes for disposing sewage sludge.

What are the important success factors?

Projects such as this, which generate energy as a by-product, should be **located near potential energy demand centres**, e.g. industrial parks or public buildings, in order to avoid long-distance transfers of energy and extensive infrastructure costs.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The demand for hydrogen depends heavily on the **availability of infrastructure** for its distribution. To increase both the production of hydrogen and its conversion into power or heat requires **significant infrastructure investments**.

Transferability to Wuxi:

The project approach seems to be well suited for Wuxi as the promotion of biogas is already an important focus of Wuxi's low carbon energy efforts. Integrating biogas generation into wastewater treatment processes and combining it with hydrogen production should **complement Wuxi's existing portfolio of biogas projects**. As a first step, it is recommended that the Economic & Information Commission consults competent research institutes to **conduct a feasibility study** in collaboration with wastewater treatment plant operators.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Project information on EUWAK by Emschergenossenschaft (in English):
http://www.eglv.de/en/waterportal/about-us/cooperative-ventures/euwak.html

Source: Shutterstock.com

4.3 NEEDS AND POSSIBLE EXAMPLES FOR ACTION IN WUXI'S BUILDING SECTOR

Challenges and Needs

Wuxi is a pioneer city in promoting energy-efficient buildings in Jiangsu Province. During the 11th Five-Year Plan period, the newly completed area of energy-efficient buildings in Wuxi reached 55.8 million m2. Within the same timeframe, **energy savings in buildings were estimated at 1.01 million tonnes of coal equivalent (32.24 million GJ), representing 13% of the total energy saving in Wuxi** (Wuxi Bureau of Construction 2012).

In order to increase resource efficiency in the building sector, the Wuxi government has issued several policies relating to the innovation of building materials. Nonetheless, Wuxi still faces various challenges in its quest to create a low carbon building sector. Based on its understanding of the Chinese situation and dialogue with city representatives, the LCFC team has derived the following needs, strategic approaches and examples.

Incentives for energy efficiency investments:

Need: To incentivise investment into energy-efficient and green building designs and/or technologies.

Strategic approach: Existing building codes and regulations should be complemented by efficiency incentive schemes and business models that offer win-win situations for building owners, such as energy performance contracting schemes.

Example: Energy Saving Partnership Berlin.

Promoting Off-Site Manufacturing (OSM):

Need: To secure the supply and use of high quality building materials to meet ambitious building standards.

Strategic approach: The broader market introduction of OSM may help to optimise construction processes and ensure high quality building elements.

Example: Promotion of and quality assurance procedures for OSM in Germany.

Adapting buildings to climate change:

Need: To design urban infrastructures in such a way that they help to adapt to present and future climate change, as climate change may notably affect the living quality

in urban centres such as Wuxi.

Strategic approach: Buildings are an integral part of urban infrastructure. Green roof concepts may help to reduce the urban heat island effect and alleviate air pollution.

Example: Green roofs in Düsseldorf City.

GOOD PRACTICE EXAMPLE:

Energy Saving Partnership Berlin

What is the project/programme all about? Background, objectives and highlights

In 2011, 60 energy performance contracting (EPC) projects were carried out in Wuxi with a focus on the industry sector (Xia-Bauer et al. 2013). However, as investors in the building sector lack any incentive to introduce efficiency measures over and above those required by the building code, effective models for EPC are crucial for this sector.

"The partnership has achieved an average annual CO_2 emission reduction of 60,484 tonnes and guaranteed annual energy cost savings of €2.5 million."

The Energy Saving Partnership Berlin represents an excellent example of energy saving contracting for public, commercial and industrial buildings. It was set up in 1996 by the Berlin Energy Agency (BEA) and Berlin's Senate Department for Urban Development.

An accredited private Energy Service Company (ESCO; contractor), which is selected through a tendering process, finances, plans, implements and manages energy saving measures for a client (e.g. a school). BEA acts as an independent "project manager" that coordinates and manages the whole process, such as tendering and contract negotiation.

The contractor guarantees the client a minimum level of energy savings (for retrofitting projects, ESCOs agree to achieve an annual average cost saving of 26%). The contractor's investment is refinanced through the guaranteed energy savings (Waldmann 2007). Any remaining savings are shared by the partners for the duration of the project according to an agreed ratio system. The client benefits from all cost savings once the contract has expired (City Instruments, no year given). Furthermore, the contractor is obliged to offer training sessions for the client and awareness-raising activities for users.

The partnership originally targets large building complexes. In order to make the partnership possible for smaller projects, building owners can combine several buildings to create "building pools" that reach a minimum annual energy bill of around €250,000.

What are the important impacts of the project/programme (economic, environmental and social)?

The partnership has achieved an **average annual CO_2 emission reduction of 60,484 tonnes and guaranteed annual energy cost savings of €2.5 million**. Thus, it has tapped both mitigation and resource efficiency potential in the building sector. As the project was not publicly funded, it also saved the municipal government more than €60 million in investment between 1996 and 2005.

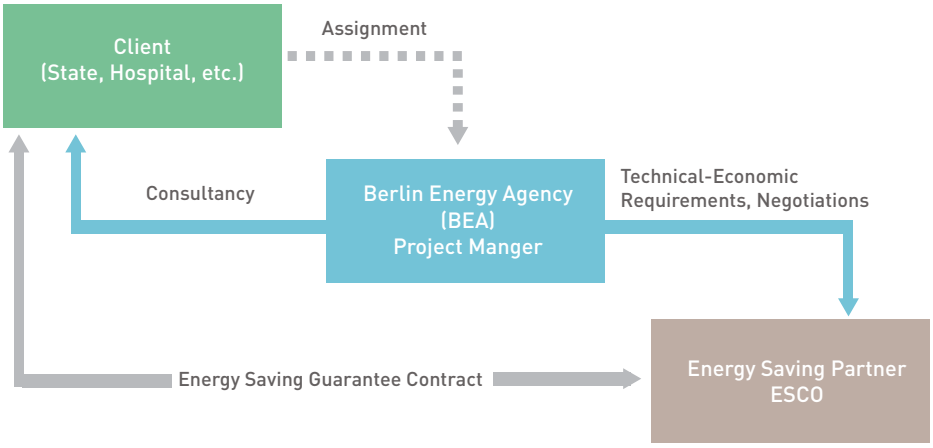

FIG. 13: ENERGY SAVING PARTNERSHIP BERLIN – INVOLVED PLAYERS AND THEIR ROLES

Adapted from: http://www.ecologic.eu/files/attachments/Projects/2358/prasentation_berger.pdf

What are the important success factors?

The success of the partnership was facilitated by the fact that BEA functions as an **independent manager** who coordinates the overall process. Furthermore, the **creation of "building pools" helps to lower transaction costs**; competition through a tendering process among ESCOs also encourages cost-effective solutions.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The programme requires a **competent agency**, which is capable of coordinating and monitoring the process as well as **competent ESCOs**, which can offer best-available technological solutions. On both counts, capacity-building and the creation of new institutions may be needed in China. Furthermore, as part of the tendering process clients are required to provide reliable baseline information about the relevant buildings, which would necessitate some preparatory action.

Transferability to Wuxi:

The approach seems to be well suited for transfer to Wuxi with **governmental office buildings as good potential starting points for forming building pools**. The programme would have to be initiated and overseen by the Wuxi Economic & Information Commission, which is responsible for all activities related to energy service provision, and the Construction Bureau, which is in charge of energy-efficiency building activities. They could be supported by a new energy agency. For the coordination and implementation of the project, competent service providers with sufficient experience from within and outside Wuxi could be used or, alternatively, international companies could be contracted should there be no suitable companies in Wuxi.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links or contacts for further information:

Project website of Berlin Energy Agency (in English): **http://www.berliner-e-agentur.de/en/projects/energy-saving-partnerships-berlin**

GOOD PRACTICE EXAMPLE:

Quality Assurance for Off-Site Manufacturing (OSM) in Germany

What is the project/programme all about? Background, objectives and highlights

Every year, China constructs 2 billion m2 of new buildings; in Wuxi, newly constructed floor space totalled 37 million m2 in 2012. In recognition of the huge energy and resource consumption and the quality issues associated with construction, the 12th Five-Year Plan of the Chinese government promotes Off-Site Manufacturing (OSM) in the construction sector. However, the development of OSM still faces various barriers in China, in particular a lack of both skilled workforce and stringent quality assurance systems.

In Germany, Off-Site Manufacturing (OSM) started in the 1920s and is widely perceived to deliver high-quality products through continuous innovation and transparent quality assurance processes. Both have significantly enhanced the acceptance of OSM. The German OSM quality assurance system involves a three-

> **"...the creation of "building pools" helps to lower transaction costs"**

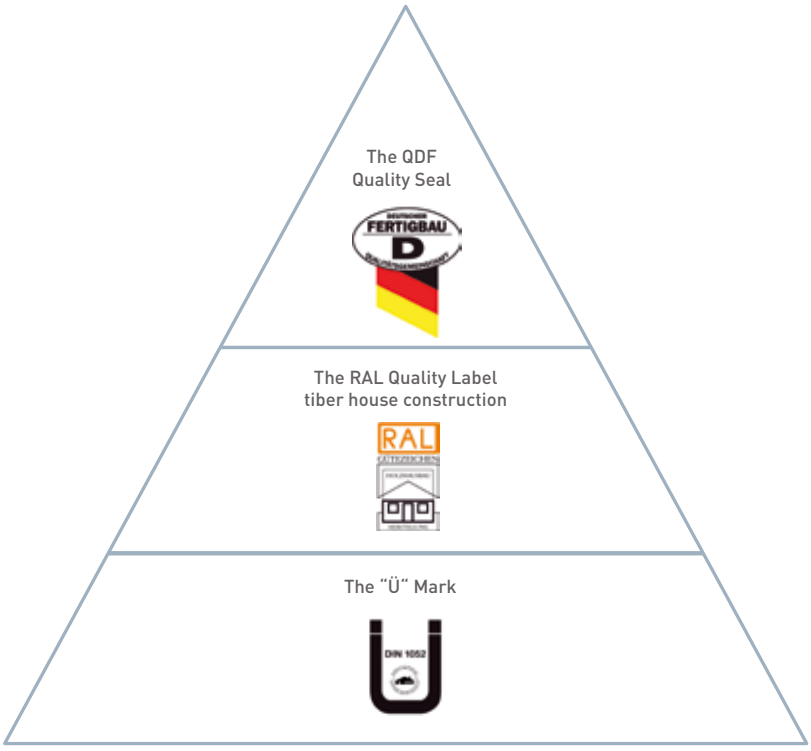

FIG. 14: DIFFERENT STAGES OF THE GERMAN QUALITY ASSURANCE SYSTEM FOR OSM

Adapted from: Deutscher Fertigbau e. V. (BDF) (2009). Satzung der Qualitätsgemeinschaft Deutscher Fertigbau XIII

stage approach with different labels (quality assurance marks), which are awarded by different industry associations.

The first stage is the basic label for all construction products (Ü-label), which confirms that the product fulfils the minimum requirements in compliance with the law. At the second stage, the Gütegemeinschaft Deutscher Fertigbau (GDF, Quality Association of German Off-Site Manufacturing) issues a label called "RAL", which ensures the quality of both manufacturing and the assembling processes. The quality is checked through regular and unannounced inspections by independent experts. Inspection of the factories takes place twice a year; construction sites are evaluated once a year. The third label is issued by the Bundesverband Deutscher Fertigbau (BDF, Federal Association of German Off-Site Manufacturing). It is called "QDF", which is based on wider criteria, including higher technical standards, energy efficiency, environmental protection etc. The QDF needs to be renewed every year.

"Wuxi city government could actively support the deployment of OSM in local construction projects and, at the same time, foster agenda setting for establishing an OSM quality assurance system at national level…."

This labelling and evaluation system ensures the high quality of OSM products. Furthermore, industry associations for OSM offer various training opportunities to professionals in order to enhance and update their knowledge in the OSM field. The content of these training sessions ranges from technological, economic and financial issues to legal aspects and marketing strategies.

What are the important impacts of the project/programme (economic, environmental and social)?

OSM offers **shorter construction duration**, increased **certainty about upfront costs and lower lifecycle costs**. From an environmental perspective, OSM leads to increased resource efficiency through **reduction in material and construction waste as well as energy and water consumption** (Tam et al 2007). Furthermore, it is well suited for the fabrication of low energy buildings and **alleviates air pollution and noise**.

What are the important success factors?

Stringent quality assurance is essential for the successful market deployment of OSM. Industry associations play an important role in Germany. In China, although the quality assurance system would most likely be developed by government agencies, the role of industry associations in providing information and training on OSM would need to be fully explored.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The **upfront costs of OSM** are still significantly higher than those of conventional construction. Therefore, a supportive policy framework with sufficient incentives for OSM investors is needed (Zhang and Skitmore 2012). Furthermore, a lack of know-how currently limits the development of OSM in China. Therefore, **capacity-building for governmental officers and actors on the supply chain** (ranging from construction companies to manufacturers of single pre-fabricated house components) is essential. China's construction sector suffers from **poorly skilled construction workers**, who are unable to install more sophisticated building designs. In addition, scaling up OSM requires standards and quality assurance systems for OSM construction. So far, the overall construction quality in China is low as building standards are often not enforced.

Transferability to Wuxi:

A 1:1 transfer of the German OSM quality assurance system to Wuxi would appear to be problematic because, initially, such a system should be established at the national level and, also, China does not yet have a network of industry associations that is as firmly established, experienced and capable as in Germany. However, led by the Construction Bureau, Wuxi city government could **actively support the deployment of OSM in local construction projects** and, at the same time, **foster agenda setting for establishing an OSM quality assurance system at national level**.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Official website of Bundesverband Deutscher Fertigbau (BDF; in English):
http://www.bdf-ev.de/english/index.html
Official website of Gütegemeinschaft Deutscher Fertigbau (GDF; German only):
http://www.guete-gemeinschaft.de/

Fig. 15: Green Roofs in Düsseldorf City

Source: http://www.duesseldorf.de/umweltamt/luft/stadtklima/dachbegruenung.shtml

GOOD PRACTICE EXAMPLE:

Green Roofs in Düsseldorf City

What is the project/programme all about? Background, objectives and highlights

Green roofs can contribute effectively to climate change adaptation in cities, e.g. by adapting to heavy precipitation or reducing the urban heat island effect. In addition, they facilitate the reduction of dust and smog levels, which are a salient issue in Chinese cities.

Several years ago, Wuxi city government acknowledged the potential for green roof systems but, to date, the concept has not taken off due to a lack of incentives for potential investors. Germany has a long tradition of promoting green roof systems, based on a comprehensive set of stimulating policy instruments and regulations at local level.

For example, since 2000 the city of Düsseldorf has spent €1.4 million to promote green roofs. As a consequence, there are now a total of 110 projects covering about 90,000 m2 of green roof area (Hack, 2011). Economic incentives are provided through different programmes. For instance, the city reimburses up to 50% of the investment cost, or a maximum of €25/m2 of the roof area if a green roof is combined with measures for heat insulation. Furthermore, to encourage these projects, buildings with green roofs are charged only 50% of the regular rainwater drainage charge and can also access a fund for environmental projects.

"...every square metre of green roof area filters about 0.2 kg of polluting gases or other substances from the air..."

In addition to financial incentives, the city administration of Düsseldorf has adopted regulatory instruments to promote green roof systems. For example, it is required to plant extensive green surfaces on all flat roofs and on new residential, mixed or commercial buildings with roof inclinations of up to 20 degrees.

Additionally, it is worth noting that the city also piloted the combination of green roof systems and PV modules: whereas cooling from green roof plants boosts the efficiency of PV modules, the panels shade the plants from excessive sun exposure and evaporation.

"...green roofs contribute both to greenhouse gas mitigation and adaptation to climate change..."

What are the important impacts of the project/programme (economic, environmental and social)?

Green roofs may significantly **improve the climate in built-up urban areas**, especially during summer time when temperatures in urban centres may be up to 10°C higher than in rural areas. Green roofs store rainwater, which evaporates more slowly and has a cooling effect. Furthermore, they bind CO_2 and air pollutants. Annually, every square metre of green roof area filters about 0.2 kg of polluting gases or other substances from the air (Department for Environment of Düsseldorf City, no year given). Consequently, **green roofs contribute both to greenhouse gas mitigation and adaptation to climate change**.

What are the important success factors?

Implementing green roofs in Düsseldorf has succeeded because of the f**ormulation and implementation of an appropriate combination of policies and measures**, including financial incentives, regulations, and information tools.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

In Wuxi, green roof construction is not yet mandatory and it involves **high upfront costs**. As a result, the development of green roofs in Wuxi is still at its initial stage. To accelerate the development, local government could initially consider **providing financial incentives for investors to commence obligatory construction of green roofs at new governmental office buildings or large-scale public buildings**.

Transferability to Wuxi:

It would appear that this technology could be transferred to Wuxi as it offers **co-benefits for existing and new buildings** requiring limited investment, provided that a supportive framework is in place. Furthermore, green roof programmes have been **demonstrated successfully in other Chinese cities**, such as Beijing. Here, more than 100,000 m2 of green roofs per annum have been constructed since 2005 (China Dialogue 2013).

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Article on green roofs in Düsseldorf (in English): **http://www.greenroofs.com/content/guest_features006.htm**
Official website of Department for Environment of Düsseldorf, green roof section: **http://www.duesseldorf.de/umweltamt/luft/stadtklima/dachbegruenung.shtml**

Source: Shutterstock.com

4.4 NEEDS AND POSSIBLE EXAMPLES FOR ACTION IN WUXI'S TRANSPORT SECTOR

Challenges and Needs

Since 2000, the number of private cars in Wuxi has increased twenty fold (from 20,000 to 400,000). This growth is evidence of the highly dynamic development of the sector and is projected to continue until the mid-2020s in the LCFC scenario.

In 2011, Wuxi was selected as a national pilot city for building a low carbon transport system. Therefore, the government has worked hard to improve the environmental performance of the transport sector. It has understood that the expansion of public transport and energy-efficient transport concepts – for people and freight - is key in limiting the sector's CO_2 emissions. For example, the city is currently building a subway network with the first two lines to be completed by 2015 and also plans to modernise the freight railway infrastructure. The LCFC team has summarised the needs for facilitating a low carbon pathway in Wuxi's transport sector, as well possible strategic approaches and examples for fostering such a development, as follows.

Flexible mobility concepts:

Need: To offer alternative and flexible concepts, which combine different modes of transport, to satisfy the increasing demand for mobility of Wuxi's citizens and stabilise car ownership at a moderate level.

Strategic approach: Although it does not seem to be compatible with the current growth in car ownership in Wuxi, car sharing could be a promising concept in the mid -term to limit the number of private vehicles.

Example: EU project "More Options for Energy-Efficient Mobility" for promoting car sharing in European cities.

Promoting efficient and low carbon vehicles:

Need: To quickly test and introduce efficient and low carbon vehicles to meet the growing mobility needs of Wuxi's citizens.

Strategic approach: Wuxi city government has already conducted demonstration or pilot projects for different types of low carbon vehicles, such as plug-in hybrid buses. Here, some exchange of experiences with comparable German demonstration projects might be useful to stimulate a learning process.

Example: Pilot project for hybrid or light-weight buses of Rheinbahn AG in Düsseldorf region is one possible option for an exchange of experiences.

Flexible and combined freight transport concepts:

Need: To find solutions to optimise freight flows as the volume of freight transport is predicted to grow significantly in the LCFC low carbon scenario.

Strategic approach: Concepts that enable the combination of different transport modes may help to reduce the environmental impact of freight transport and increase cost efficiency.

Example: Trimodal Freight Transport – Neuss – Düsseldorf Harbour (ND-Häfen GmbH).

Fig. 16: Car-Sharing is Easy – Booking the Car Online and Picking-It Up at the Parking Lot

Source: Car2Go

GOOD PRACTICE EXAMPLE:

Programme "More Options for Energy-Efficient Mobility"

What is the project/programme all about? Background, objectives and highlights

The European project "More Options for Energy-Efficient Mobility" (MOMO) is an interesting example of car sharing as an alternative mobility concept. It ran from October 2008 to September 2011 and was coordinated by the city of Bremen, which also functioned as one of the project's pilot cities. The project aimed to extend the number of car sharing users and establish car sharing services in more European cities. To achieve this, it used an integrated approach which encompassed several steps, such as optimising the integration of car sharing with other means of transport to raise its acceptance, identifying key target groups and developing car sharing models tailored to their needs, as well as conducting awareness campaigns. Furthermore, the project strived to optimise the management and environmental performance of car sharing fleets. Finally, car sharing services were introduced in selected cities, including Bremen.

In the course of the project, collaboration between car sharing providers and construction projects, hotels and student unions turned out to be particularly effective in attracting new car sharing users. For example, car sharing services are offered as an annex to the deed to all "new residents" (individuals/companies) in some parts of Bremen.

What are the important impacts of the project/programme (economic, environmental and social)?

During the project, around **4,000 people and nearly 600 companies joined the programme** (across all participating cities). The number of members of existing car

sharing providers that participated in the project increased by 95,000 (this increase may or may not have been influenced by the project). In Bremen, **car sharing meant that between 1,500 and 2,000 new parking places did not need to be built, saving around €30-50 million** (Glotz-Richter 2013).

Regarding environmental impacts, the programme helped to **reduce the emission discharge of car sharing vehicles by between 7 and 25g CO_2/km per vehicle and achieved a 10% reduction in fuel consumption** as a result of driver training sessions. Furthermore, car sharing reduces the need for parking places and, for example, **leaves more space for green areas**, which are important in balancing urban heat islands.

What are the important success factors?

Implementing car sharing involves **complex institutional and logistic challenges**, such as establishing an attractive and reliable vehicle fleet, the broad distribution of parking stations, a smooth booking system and good integration with public transport. However, the most important success factor is to **raise awareness** and convince potential users through **an attractive and tailor-made business model**.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

At present, the potential for car sharing in China tends to be neglected due to **different consumer habits and the importance of car ownership as status symbol**. The same arguments were voiced in opposition to car sharing in Germany for several years but eventually the situation has changed. In a recent survey among young urban people in Germany (20-29 years), around 40% stressed that driving a car is no longer "hip" and 45% even stated that people with large cars are unappealing. In response to this trend, car manufacturers like Mercedes and BMW have recognised the market potential of car sharing and have developed their own car sharing systems.

Transferability to Wuxi:

In general, the broad market introduction and acceptance of car sharing services in Wuxi will **require time and effort** as it counteracts the current trend towards increasing car ownership. Nonetheless, Wuxi Transport Bureau could conduct a **first feasibility study, followed by a pilot project combined with an awareness campaign**. This pilot could be set up in collaboration with experienced German car sharing providers, taxi companies or car manufacturers. For example, Shanghai started a car sharing pilot in collaboration with Dazhong Car Leasing (related to Volkswagen) in 2010. Overall, **an attractive fleet and good integration with public transport** would appear to be particularly important for promoting car sharing in China.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

> **"…the programme helped to reduce the emission discharge of car sharing vehicles by between 7 and 25g CO_2/km per vehicle and achieved a 10% reduction in fuel consumption…"**

Links for further information:

Project description of MOMO on website of Intelligent Energy Europe (in English):
http://www.eaci-projects.eu/iee/page/Page.jsp?op=project_detail&prid=1879
Downloads about MOMO project on Intelligent Energy Europe website (in English):
http://www.eaci-projects.eu/iee/page/Page.jsp?op=project_detail&prid=1879&side=downloadablefiles
Official project website of MOMO (in English): h**ttp://www.momo-cs.eu**

Fig. 17: Innovative Hybrid Busses of Rheinbahn AG in Düsseldorf Region

Source: Nikolas Borkelmans; http://www.bus-bild.de/name/einzelbild/number/43650/kategorie/deutschland~betriebe-staedte-d-e-f~dusseldorfrheinbahn.html

GOOD PRACTICE EXAMPLE:

Hybrid or Light-Weight Buses, Düsseldorf Region

What is the project/programme all about? Background, objectives and highlights

The Rheinbahn AG (corporation) provides public transport in Düsseldorf, Meerbusch and large parts of "Kreis Mettmann". Currently, it runs seven city railway routes, 11 city tram routes and 91 bus routes. Since 2009, the CO_2 intensity of the fleet has been continuously improved. 125 buses are equipped to EEV standards (Enhanced Environmentally Friendly Vehicle), which is below the EU standard (Euro-5-Norm). In addition to that, the fleet includes ten hybrid buses and 2 lightweight buses. Hybrid buses are powered by a combination of an electric motor and a diesel engine (WI 2013).

"...the company's annual CO_2 emissions could be reduced by 43,000 to 57,000 tonnes..."

Rheinbahn AG recently ordered two electric buses ("Solaris Urbino electric"), each with a 160 kW electric motor and 210 kWh batteries (Omnibusrevue 2013). They will be charged via a plug-in connection. Additionally, the buses will be retrofitted at a later date with an automatic recharging system. This system, which is installed on the roof of the bus, uses pantographs (similar to those used by trolleybuses.).

What are the important impacts of the project/programme (economic, environmental and social)?

The hybrid buses use so-called "regenerative braking" systems, which means that they store the electrical energy produced when braking. The battery is then used to feed the electric motor. This system can **reduce fuel consumption by about 20%**. Lightweight buses can even reduce their fuel use by up to 25%. If hybrid buses covered 10% of all the kilometres driven by Rheinbahn AG buses, the **company's annual CO_2 emissions could be reduced by 43,000 to 57,000 tonnes**. Air pollutants and fuel use would equally be reduced (WI 2013).

The **investment costs of hybrid buses (around €500,000 each) are about 50-100% higher than conventional buses**; lightweight buses cost around the same as conventional buses (€200,000 per bus). Due to fuel cost reductions, the latter offer significant economic advantages from the outset, while hybrid buses involve longer payback times.

What are the important success factors?

In Düsseldorf about 20% of the total CO_2 emissions derive from urban transport, mostly from private cars. Cities with relatively low distances between working places, residential areas, commercial centres and recreation areas have the best potential for expanding public transport. **Bus fleets can be highly efficient and are particularly well suited for hybrid systems due to their regular "stop-and-go" modes**. The Rheinbahn AG programme is supported scientifically by TÜV-Nord and the University of Aachen (RWTH) to further optimise the technologies and public transport systems (WI 2013). Here, an **exchange of experiences with Wuxi**, one of China's national pilot cities for low carbon transport, could be fruitful.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The main barrier to the deployment of hybrid buses is **high investment costs**. Therefore, financial support from the city administration and/or the willingness of the public transport company to accept higher upfront costs are crucial pre-requisites.

Transferability to Wuxi:

Being designated as a national pilot city for low carbon transport, Wuxi has already started, or plans to start, several ambitious pilot projects related to low carbon vehicles. These include testing hybrid buses. Therefore, the Rheinbahn AG project offers the **opportunity for mutual learning** with Wuxi's public transport company and the Transport Bureau about lessons learnt and next steps.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Official website of fuel cell and hydrogen network of Energy Agency NRW: **http://www.fuelcell-nrw.de/**

GOOD PRACTICE EXAMPLE:
Trimodal Freight Transport – Neuss-Düsseldorf Harbour (ND-Häfen GmbH)

What is the project/programme all about? Background, objectives and highlights

The harbours of Neuss and Düsseldorf (ND-harbours), both located in the Düsseldorf region, merged in 2003 and represent a successful example of how different modes of transport can be combined in the freight transport sector (trimodality), including rail, barges and trucks.

Due to trimodality the harbour is a key hub in the Rhine-Ruhr region. The terminals stretch over 500 hectares and have a handling capacity of 15.8 million tonnes (in 2011), of which 10 million tonnes are disembarked on the waterway. With the regular transportation of 7 barges and

"…positive impacts, including significantly lower fuel and resource use, resulting in lower carbon discharge…"

Fig. 18: Modern Harbours – Hubs for Combined Freight Transport Concepts

Source: http://www.nd-haefen.de/content/presse/presse_fotoarchiv.html

around 40 trains per week, the harbours are well connected to the seaports of Rotterdam, Antwerp, Hamburg and European destinations beyond.

The trimodality approach optimises the use and inter-linking of all three modes and aims to reduce road freight transport by shifting as much load as possible to water and rail transport. As a result, the trans-shipment of different kinds of goods, like bulk, piece, containers, liquid or heavy goods, and pre or post-carriage by rail or truck is possible. Through the synchromodal organization of hinterland transport, the optimal transport mode is chosen for each trip and can be altered at short notice in the case of unforeseeable problems (e.g. road construction).

"...the local Transport Bureau assesses the feasibility of a tri-modal port system and fosters its implementation..."

What are the important impacts of the project/programme (economic, environmental and social)?

Over the last few years, the connections and the rail and water handling capacity of ND-harbours increased by 16-17% (from 2011 to 2012). The modal shift from road freight transport to rail and water transport has several positive impacts, **including significantly lower fuel and resource use**, resulting in lower carbon discharge. For example, the emission discharge of rail transport is equal to only 20 to 25% of the emissions from trucks; water transport reduces CO_2 emissions by about 20% compared to road transport. However, **train freight transport** noise on inner-city connections is a negative environmental factor. With regards to economic issues, the Europe-wide bundling and optimisation of cargo transport flows at specific geographic corridors contributes to cost efficiency.

"Key factors for success include the optimal inter-connection of water, road and rail transport..."

What are the important success factors?

Over the last decades, inland ports have transformed from traditional transhipment and storing complexes to efficient multimodal freight centres. Key factors for success include the **optimal inter-connection of water, road and rail transport, sufficient terminal capacity for changing the transport mode/carrier** (for heavy-lift consignments) as well as **optimised logistic management and IT tools** for making the best possible use of free capacity. This means that port agencies need to offer complete logistic concepts and services, which are particularly attractive for export-oriented companies or customers. Building such an infrastructure requires **investment** as well as **political will and support**.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

Modern infrastructure, political backing as well as **funding** are crucial for the successful implementation of a tri-modal transport system. Furthermore, a **detailed and long-term planning process** with relevant stakeholders, expert planners for different transport modes (road, rail, harbour) and city departments is essential.

Transferability to Wuxi:

As Wuxi is a centre of the manufacturing industry and is located on the banks of Taihu, a tri-modal port system that optimises and combines transport flows would be highly appropriate. The suggestion, therefore, is that the **local Transport Bureau assesses the feasibility of a tri-modal port system and fosters its implementation**. This concept appears ripe for transferability as the idea of tri-modality is already included in Wuxi's 12th Five-Year Plan for transportation.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Information brochure on tri-modal port concepts (in English):
http://myservices.ect.nl/SiteCollectionDocuments/0457.1088%20Fast%20Forward%2052%20Winter%202011_WT.pdf
Official website of European gateway services (in English):
http://europeangatewayservices.com
Online tool for CO_2 calculation of freight transport modes (in English):
http://ecotransit.org

Source: Shutterstock.com

4.5 NEEDS AND POSSIBLE EXAMPLES FOR ACTION IN WUXI'S INDUSTRY SECTOR

Challenges and Needs

The manufacturing industry in Wuxi produces the second highest levels of GHG emissions (only power and heat production are higher). Accordingly, the per-capita emissions of Wuxi's industry are above the Chinese average. About half of the industry's CO_2 emissions currently derive from iron and steel production, representing about 18% of Wuxi's total industrial outputs. Other major industrial emitters are the chemical industry and cement production; the machinery industry (including electrical equipment) and the textile industry also produce considerable carbon emissions.

Wuxi city government has clearly formulated its intention to strengthen service-oriented and less carbon-intensive industries. Nonetheless, energy-intensive operations will remain an important backbone of Wuxi's economy, in part because most of the industrial plants are less than ten years old and are still at the beginning of their lifetime.

Needs, strategic approaches and examples for a low carbon pathway in the industry sector are summarised in the following paragraph. Due to the diversity of the industry sector, the strategic approaches and examples do not directly address the individual technologies that were identified as key in the Extra Low Carbon Scenario (see section 3.1). Instead, they focus on meta-measures, which can be initiated by the city government. However, further measures to induce the market penetration of key technologies, such as direct iron reduction with hydrogen, are needed. This, however, generally requires decision-making at national or provincial level.

Understanding energy saving potential:

Need: To actively disseminate information and knowledge about the potential for the companies involved to achieve energy savings and reduce costs. In most areas of industry, process optimisation and behavioural change offer good potential in this respect.

Strategic approach: Easily accessible, virtual information tools, which visualise the economic potential and benefits of process optimisation and behavioural change, can help to gently introduce entrepreneurs to energy saving – especially useful for companies that are reluctant to embrace

technological change or adopt positive environmental practices. This is particularly relevant for small or medium-size companies with limited resources and capacities.

Example: Energy Agency NRW's online tool "Virtual Enterprise".

Initiating learning processes for tapping energy saving potential:

Need: To initiate learning processes in order to support industrial companies from Wuxi to achieve their economic potential for energy saving and carbon mitigation.

Strategic approach: Such learning processes can be organised in local or regional networks of organizations, led and coordinated by a consulting company. The format may combine group workshops with individual advice.

Example: Ecoprofit – Local/Regional Resource and Efficiency Networks.

Realising energy efficiency potential in industrial parks:

Need: To identify the possibilities and processes for making use of synergies among different industrial processes to maximise the potential for energy-saving. This is particularly relevant as Wuxi increasingly clusters industry operations in specific industrial parks, e.g. chemical parks.

Strategic approach: Pilots of integrated climate protection programmes in industrial parks, which connect different processes and product cycles, may help to tap mitigation and energy saving potential.

Example: Currenta GmbH & Co. OHG - Integrated climate protection programme in the chemical industry.

"In addition to group workshops, the programme offers individual advice to the participating companies…"

GOOD PRACTICE EXAMPLE:

Ecoprofit – Local/Regional Resource and Energy Efficiency Networks

What is the project/programme all about? Background, objectives and highlights

The Ecoprofit programme was developed in the early 1990s. Its aim is to implement environmental measures and, as a result, to reduce overall costs at company level. To achieve this, the participating companies are grouped in local or regional networks in close collaboration with the relevant cities, counties or districts. The municipalities and companies involved, together with the state, commonly finance the network activities.

Companies within the regional network take part in ten monthly workshops within one year, which focus on environmentally relevant topics such as waste management and reduction, emissions from energy production and consumption, environmental controls, workplace improvement, legal aspects etc.

In addition to group workshops, the programme offers individual advice to the participating companies through five on-site visits. After an initial survey or baseline study and advice on legal or organizational aspects, new ideas for the company are developed in conjunction with the employees. Concrete measures with a clear timeline, responsibilities and costs are decided upon and the implementation is planned. In addition, a specific consulting day for energy reduction can be arranged.

For small-scale companies with less than 20 employees and no harmful combustion plants, a "slim ecoprofit" version is possible with fewer workshops. After the successful implementation of ecoprofit measures, an enterprise is publicly recognised as an "Ecoprofit Company".

What are the important impacts of the project/programme (economic, environmental and social)?

In 2012/2013, a network of 11 companies was formed in Düsseldorf. The network included small enterprises like a cargo company with 19 employees and large companies such as a car-manufacturing plant with several thousand employees. Overall, about 1,416 companies located in North Rhine-Westphalia have already participated in the programme since its inauguration and have **implemented more than 6,000 environmental measures** (as of June 2013, Ökoprofit NRW 2013). These measures led to an **annual CO_2 reduction of 218,000 tonnes and have reduced energy consumption by 583 million kWh per year**. Although investment of around €178 million was required, it is estimated that the measures have resulted in **annual cost savings of €59 million** (Ökoprofit NRW 2013). This shows that Ökoprofit improves the environmental and economic performance of participating companies, whilst also providing positive social impacts, such as better job security and improved protection for workforces.

What are the important success factors?

The most important success factor is the programme's **overall integrated approach** (individual consulting, collaborative workshops, training), in combination with **professionally moderated and interactive project implementation** (including innovation and learning). Furthermore, it is crucial that cost-effective measures are not solely focused on technology, but also on **internal processes and the organization of enterprises**. In addition, it is essential to develop the internal competencies and to systematically involve, motivate and educate employees.

Fig. 19: Ecoprofit in Düsseldorf – Combining the Reduction of Greenhouse Gas Emissions and Costs

Source: Stadtwerke Düsseldorf AG – Unternehmenskommunikation

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The basic idea of Ecoprofit has been disseminated not only in Germany and Europe, but also on a worldwide scale. Energy and resource efficiency networks have been introduced on other continents and also in China. This illustrates that the barriers for implementation in Wuxi are probably low. Since 2005, a total of **seven networks have been established in China**, e.g. the Changzhou Climate Protection Network and the Suzhou Resource and Energy Efficiency Network. If the Wuxi government would back and promote such a network approach, success is very likely.

> "These measures led to an annual CO_2 reduction of 218,000 tonnes and have reduced energy consumption by 583 million kWh per year…"

Transferability to Wuxi:

As mentioned above, several energy efficiency and resource efficiency networks have already proved to be successful in other Chinese cities, including adjacent cities such as Suzhou. For example, Arqum – one of the key consultants of the Ecoprofit programme – also operates the Suzhou efficiency network and has shown serious interest in becoming active in Wuxi. This indicates excellent transferability.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Official website of Ökoprofit (in English):
http://oekoprofit.com/about/

Fig. 20: Chempark in Dormagen, operate and managed by Currenta, North Rhine-Westphalia

Source: Currenta GmbH & Co. OHG

GOOD PRACTICE EXAMPLE:

Currenta GmbH & Co. OHG – Climate Protection Programme in the Chemical Industry

What is the project/programme all about? Background, objectives and highlights

Currenta Corp., a joint venture of the global chemical companies Bayer and Lanxess, manages and operates "Chempark", one of Europe's largest chemical parks. The park has sites in Leverkusen, Krefeld-Uerdingen and Dormagen, the latter being located in the Düsseldorf region. In total, more than 70 companies with about 45,000 employees are located at Chempark.

"These projects resulted in total CO_2 emissions reduction of 210,000 tonnes…"

In 2008, Currenta initiated a climate protection programme, entitled "Efficiency Class A++". Its target was to achieve a reduction of 200,000 tonnes of CO_2/annum within 4 years (2008-2012) and to reduce costs and resource use. Currenta followed a two-pronged approach, combining reduction in energy use with increased energy efficiency in energy production (Currenta 2013).

What are the important impacts of the project/programme (economic, environmental and social)?

Within four years, the climate protection plan led to the **initiation of more than 200 projects**, including new technologies in waste water treatment, energy efficiency improvements in buildings, combined heat and power of large-scale combustion plants, improved water circulation etc. These projects resulted in **total CO_2 emissions reduction of 210,000 tonnes**, which is 5% more than the target and equivalent to a reduction of about 17% of Currenta's total emissions (of 2008).

The modernisation of a thermal waste air incineration plant in Dormagen was the single project with the largest mitigation effect, avoiding about 30,000 tonnes of CO_2. Another successful measure is the **usage of heat from wastewater for generating steam**. The latter is then fed into the air incineration plant, avoiding a further 1,300 tonnes of CO_2. Furthermore, Currenta succeeded in **increasing the efficiency of the cooling infrastructure** at the park in Leverkusen, which reduced CO_2 emissions by 12,000 tonnes.

Despite recent technical optimisation, CHEMPARK is still one of NRW's largest energy consumers. As a follow-up to its climate protection programme, Currenta GmbH & Co. OHG is now aiming to **introduce an energy-management system**. As part of this process, energy flow and demand patterns within the whole chemical park will be analysed.

What are the important success factors?

Key to the success of the programme was the **active involvement and training of the employees** to optimise processes and save energy. Although Currenta considers the programme to be voluntary, it was introduced due to an increasingly strict legal framework and high cost pressure. Furthermore, the programme should help to overcome the negative public image of the chemical industry in terms of environmental impact.

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The chemical industry is one of Wuxi's key industries, with chemical operations being increasingly clustered in chemical parks. Hence, the approach of **saving energy through the systematic optimisation of the technical infrastructure of chemical parks** is highly relevant for Wuxi.

Transferability to Wuxi:

As previously mentioned the optimisation of industrial parks and realisation of energy efficiency potential through interlinking different processes is highly relevant for Wuxi and should be transferrable.

For example, the Economic & Information Commission could select **one industrial park as a demonstration project** for an integrated climate protection programme similar to the Currenta project.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links or contacts for further information:
News entry on Currenta website on outcomes of climate initiative (in German only): **http://www.currenta.de/aktuell/items/2013-04-15-currenta-uebertrifft-einsparziel-von-200000-t-co2-5437.html**
Section on environmental services on current website (in English): **http://www.currenta.com/environmental-services-cpp.html**
Pictures of industrial plants or mitigation measures at Currenta industrial parks (German only): **http://www.presse.currenta.de/currenta/currentanews.nsf/id/3B994AD78CF4C055C1257B4E0032B49E?Open&ccm=001**

GOOD PRACTICE EXAMPLE:

Online Tool "Virtual Enterprise"

What is the project/programme all about? Background, objectives and highlights

The mission of the Energy Agency NRW has been described in section 4.1 We will present one of the agency's initiatives for the industry sector here. To provide information about both the challenges faced by enterprises and their significant energy saving potential, the Energy Agency NRW has developed online platforms and an online tool called "virtual enterprise". The tool offers a very clear and well-designed virtual tour illustrating different areas or stages of industrial production processes, such as engine systems, lighting or construction materials. The user can access each area and receive information on the potential for energy saving and process optimisation, as well as good practice examples. Furthermore, helpful links and short films are offered for further information. Most importantly, the platform offers calculation tools so that each enterprise can assess its individual energy saving potential.

For more detailed information, there are specific webpages detailing efficiency potential for specific industry sectors, such as the metal and hardware industry. Furthermore, the energy agency offers individual advice to companies or matches them with relevant experts or organizations to further explore their individual needs and potential.

What are the important impacts of the project/programme (economic, environmental and social)?

The energy saving potential of the industry and commerce sector in NRW is estimated at about 5-20% and could significantly reduce the sector's energy bill. However, many companies have not yet exploited this potential due to a combination of organizational, economic, behavioural and communication-related barriers.

The virtual energy efficient enterprise offers an **easily accessible opportunity to quickly analyse whether efficiency measures could be an interesting and cost-effective approach for an enterprise**. After this first step, it is generally easier to convince management and colleagues within a company to take the next step and to analyse the potential in further detail. Overall, the information tools and consultancy services of the Energy Agency NRW are well accepted and used. However, it is hardly possible to quantify the direct environmental and economic impact of the initiative.

"The virtual energy efficient enterprise offers an easily accessible opportunity to quickly analyse whether efficiency measures could be an interesting and cost-effective approach for an enterprise…"

FIG. 21: DISCOVERING THE POTENTIAL OF ENERGY EFFICIENCY – THE ONLINE TOOL "VIRTUAL ENTERPRISE"

Source: http://www.energie-im-unternehmen.de/

"...The online tool is very easily accessible, user-friendly and offers a much lower threshold for first contact..."

What are the important success factors?

The online tool is very easily accessible, user-friendly and **offers a much lower threshold for first contact** than, for example, an individual meeting at the energy agency. Consequently, for enterprises with quite high internal resistance against modernisation or limited open mindedness regarding environmental/climate-related measures, this tool helps to introduce them gently to the topic. One important success factor is that the **information is presented by a trusted organization** such as the Energy Agency NRW; otherwise, the information could be influenced by business interests.

"...The most important challenge when publishing an online information tool is awareness..."

What are the barriers for implementation in China? What steps could be important to overcome these barriers?

The most important challenge when publishing an online information tool is awareness: it must become well known and accepted by the target market. To achieve this, an established and widely respected player needs to present it to the target group. Another important point is the **relevance, use and value of the information**. Clear and concrete information, which addresses the user's needs, is key. Therefore, the target group must be defined precisely and a **professional marketing and dissemination strategy**, which understands the user habits of the target group, is needed.

Transferability to Wuxi:

The idea of an online information tool for industrial energy efficiency is fairly easy to transfer compared to the other project examples given in this paper. However, as mentioned above, it requires a professional marketing and dissemination strategy to reach the target group. Furthermore, the tools need to be **adapted to Chinese user habits and the needs of Wuxi's industrial entrepreneurs**. For example, the development of such an online tool could be part of a newly founded energy agency. Alternatively, the **development of the tool could be outsourced to competent local research institutes**, such as Jiangnan University, with the full process to be overseen by the Wuxi Economic & Information Commission.

Suggestions for next steps to transfer the example to Wuxi are given in section 5.1.

Links for further information:

Overview of energy efficiency in companies on website of Energy Agency NRW (German only): **http://www.energieagentur.nrw.de/unternehmen/energieeffizienz-in-industriebetrieben-3722.asp**
Virtual tour to explore energy efficiency potential in companies (German only): **http://www.energie-im-unternehmen.de/**
Information on energy efficiency in iron and metal industry (German only): **http://www.energieagentur.nrw.de/unternehmen/energieeffizienz-in-der-eisen-und-metallwarenindustrie-3748.asp**

5 CONCLUSIONS: RECOMMENDATIONS AND FOLLOW-UP STEPS

The previous sections have presented a large number of good practice examples to address needs in the key sectors under consideration. Most examples are tools and mechanisms that may help to prepare Wuxi for the future challenges of a carbon-constrained world. However, these are only initial steps that can be implemented in the short term, contributing to a dynamic and innovative process. In order to embark upon a pathway as outlined in the LCFC Extra Low Carbon Scenario in section 3 further mid to long-term measures are needed, which will require a transformation of Wuxi's economy and society.

Therefore, this conclusive section firstly presents **recommendations and next steps deriving from the needs, strategic approaches and examples** discussed above. In a second sub-section, it shows which **technological options will be needed in the mid to long-term** to achieve development as outlined in the LCFC low carbon scenario. Following that, suggestions on how to strengthen the **integration of mitigation, adaptation to climate change and resource efficiency** are made in order to avoid trade-offs among these three problem dimensions and to create a resilient low carbon strategy. The implementation of such a strategy may be fostered through innovative business opportunities. Therefore, the conclusions end with a sub-section on **potential future key markets** whose further exploitation may be both a precondition and result of a local low carbon development in Wuxi.

5.1 FROM EXAMPLES TO ACTION: SHORT-TERM MEASURES

How to transfer the good practice examples from Germany to Wuxi? The following table translates the examples into possible measures for low carbon development in Wuxi, recommends next steps and suggests which stakeholders and decision-makers should be involved in, and responsible for, implementing these steps.

"...recommendations and next steps deriving from the needs, strategic approaches and examples..."

Need	Measure	Recommendations for Next Steps	Responsibilities and Stakeholders to be Involved (Administration, Business)
Cross-Sectoral Recommendations			
To build a cross-sectoral energy knowledge hub for stakeholders.	Establish a local energy agency that offers support and expertise to investors and consumers.	It is recommended that the Mayor's office creates a task force for setting up an energy agency.	The task force should be under the auspices of the Mayor's office, consisting of the implementation offices of existing cross-sectoral leader groups for low carbon development, including the Development and Reform Commission (DRC), the Economic & Information Commission (EIC) and the Environmental Protection Bureau. The Energy Agency NRW could be contacted for advice.
To create an institutional framework for fostering innovation processes for strategic markets.	Develop a cluster strategy for future key markets.	Identification of strategic key markets under the auspices of the Mayor's office and definition of clusters. Delegation of responsibilities and coordination of single clusters to specialised departments/bureaus. Integration of cluster strategy into the Five-Year Plan process.	The Mayor's office should lead the process with support of DRC. Specialised departments/ bureaus will take responsibility for single clusters. State government of North Rhine-Westphalia (NRW) could be contacted for advice.
Power and Heat Generation			
Unravel renewable potential.	Foster the development of an atlas of renewable energy potential.	Build a committee for collection of potential data consisting of local government authorities and science under auspices of the local DRC. Data to be assessed and compiled in a database. The committee should also organise exchange/collaboration with other municipalities or the provincial level.	The Data committee is headed by DRC. It includes the Bureau of Agriculture and Forestry, Urban Planning Bureau, the local grid company and Jiangnan University. Jiangnan University is responsible for developing and managing the database. Energy Agency NRW or state government of Baden-Württemberg could be contacted for advice.
Facilitate approval procedures of renewable energy projects.	Establish a one-stop agency for renewable energy projects.	It is recommended that the one-stop agency is located within a newly established energy agency. Therefore, a concept should be developed by the energy agency task force suggested above.	See task force for establishing an energy agency.
Realise integrated concepts for renewable energy utilisation.	Combining wastewater treatment processes with biogas production, which is used for electricity, hydrogen or natural gas production.	Develop a feasibility study for a demonstration project.	Economic & Information Commission, operators of wastewater plants, research institutes Emschergenossenschaft could be contacted for advice.

Need	Measure	Recommendations for Next Steps	Responsibilities and Stakeholders to be Involved (Administration, Business)
Buildings			
Provide incentives for energy efficiency investments.	Establish an energy saving partnership.	Identify governmental office buildings, which could form a first building pool. Identify competent Chinese or international service providers to coordinate the project and implement energy saving measures. Alternatively, the Economic & Information Commission, the Construction Bureau and/or a new energy agency could take this role.	Programme would have to be initiated by the Economic & Information Commission and the Construction Bureau; possibly with the support of a new energy agency. Competent service providers (either Chinese or international) for coordinating and implementing the project need to be contracted. Berlin Energy Agency could be contacted for advice.
Promoting Off-Site Manufacturing (OSM).	Promote OSM in Wuxi.	Encourage and support the deployment of OSM in local construction projects through a supportive policy framework with sufficient incentives for OSM investors. Enter into dialogue with construction companies and actors on the supply chain. Foster political agenda setting at national level for establishing OSM quality assurance systems.	Initiative should be headed by the Construction Bureau. Involve responsible entities at national level and construction companies as well as companies on the supply chain (e.g. manufacturers of single prefabricated house components) in dialogue process.
Adapting buildings to climate change.	Promote green roofs in Wuxi.	Realise examples of good practice on roofs of public buildings. Conduct public awareness campaign on the benefits of green roofs. Provide economic incentives for green roofs.	Programme should be under the auspices of the Construction Bureau in collaboration with the Bureau of Municipal Utility & Parks & Woods. Real estate owners should be invited to a dialogue. Düsseldorf city could be contacted for advice.
Transport			
Developing flexible mobility concepts.	Promoting car sharing in Wuxi.	Conduct a car sharing feasibility study followed by a pilot project with a limited fleet in collaboration with hotels or real-estate complexes. Exchange of experiences with car sharing project in Shanghai and German car-sharing providers.	Feasibility study should be led by the local Transport Bureau. Pilot project could be conducted in partnership with car manufacturers (e.g. Volkswagen), taxi companies, hotels, real-estate projects or international car-sharing providers.
Promoting efficient and low carbon vehicles.	Exchange of experiences on hybrid and light-weight buses with Düsseldorf region.	Wuxi government and the local public transport company are recommended to enter into an exchange of experience with Rheinbahn AG and Düsseldorf region.	Exchange should include the Transport Bureau, Wuxi transport company, Rheinbahn AG, technology suppliers and the involved municipalities from the Düsseldorf region.
Flexible and combined freight transport concepts.	Developing a strategy for a tri-modal harbour concept.	Wuxi government convenes a Task Force with relevant government departments and representatives of the different transport modes to provide a strategy to enable tri-modal freight transport in Wuxi.	It is suggested that the Task Force should be convened under the auspices of the Mayor's office with support of the Transport Bureau. Furthermore, it should include the port operators, representatives of all transport modes and experts from science.

Need	Measure	Recommendations for Next Steps	Responsibilities and Stakeholders to be Involved (Administration, Business)
Industry			
Understanding energy saving potential.	Develop an online tool for enterprises to understand their energy saving potential.	Development of the tool by a competent local research institute under the auspices of the city government. Professional marketing strategy helps to develop the tool according to the needs of the target group and to disseminate it.	Economic & Information Commission oversees and coordinates the process. Tool is developed by local research institutes, e.g. Jiangnan University. PR agency to be contracted for developing a marketing strategy.
Initiate learning processes for tapping energy saving potential.	Establish a first energy and resource efficiency network of interested companies in Wuxi.	Wuxi government consults the Suzhou efficiency network for an exchange of experiences and makes contact with Arqum, operator of the Suzhou network. Afterwards, a first pilot network to be established.	Economic and Information Commission to coordinate the process and conceptualise the pilot network. Relevant department and enterprises from Suzhou. Arqum as potential operator of the pilot network. Enterprises from Wuxi to learn about their needs and concerns.
Realise energy efficiency potential in industrial parks.	Designation of one industrial park as a pilot for an integrated climate protection programme.	Wuxi government designates one industrial park as a pilot and provides funding to the park operator for developing an integrated energy efficiency concept.	Economic and Information Commission designates an industrial park and coordinates the overall process. Industrial park operator develops an integrated concept for realising energy savings. Enterprises of the industrial park need to be involved in order to gain acceptance for the implementation of the concept.

5.2 GETTING ON TRACK: AMBITIOUS MID AND LONG-TERM TECHNOLOGICAL MEASURES FOR CARBON MITIGATION

The recommendations presented in the previous section are mostly measures that could be implemented in the short-term and involve either institutional schemes, which have proved successful, or technologies that are already mature and available. However, **in order to embark on a more climate-friendly path as outlined in the low carbon scenario, Wuxi must make more ambitious technological developments in the mid and long-term**.

Fig. 22 illustrates the range of possible mitigation technologies and at what point they would have to become part of the development process. Further details on the scenario are available online in the full report of work package 3 of the LCFC project (www.lowcarbonfuture.net).

The depicted technologies include **technologies that could be used instantly and technologies that require more time to be widely applied**. Therefore, the graph offers recommendations for the focus of future research, development and demonstration efforts. As some of the technologies, such as carbon capture and storage (CCS) for industrial operations, are not really part of the city government's responsibility, this applies at city, provincial and even national level. Particularly in the industry sector, investment-intensive new technologies, such as the deployment of electric arc furnaces for steel production or retrofitting of membrane processes in industrial plants, are needed and these developments involve significant changes in existing structures/interdependencies. To achieve this, support at higher decision-making levels would be needed. Other technologies, however, such as efficient household appliances or electric vehicles, can be fostered at local level through dissemination campaigns or pilot projects.

> "...Wuxi must make more ambitious technological developments in the mid and long-term..."

5.3 INTEGRATING ADAPTATION TO CLIMATE CHANGE AND RESOURCE EFFICIENCY

Wuxi's future low carbon strategy needs to be resilient, which means that carbon mitigation measures should avoid trade-offs with resource efficiency and adaptation to climate change. The examples presented illustrate that there are many inter-linkages with these two problem dimensions. Therefore, it is recommended that Wuxi city government considers resource efficiency and adaptation to climate change when further improving its future low carbon strategy in the future. It is **necessary to both integrate these dimensions into carbon mitigation strategies and to address them through specific measures**.

Currently, **adaptation to climate change** does not have a prominent position on the local policy agenda in Wuxi and other Chinese cities. Consequently, further analysis of the risks of climate change and resulting vulnerabilities are needed. As a first step, it is recommended to **establish a cross-sectoral leader group for adaptation** to ensure the institutionalisation of the topic. The leader group should conduct basic assessments, such as **risk-mapping**, to estimate how vulnerable Wuxi's economic key sectors and local business areas are to weather extremes. Furthermore, enterprises should be supported in conducting risk assessments for their specific businesses and be informed about possible measures to reduce risks. (Prognos AG and WI 2011).

With regard to **resource efficiency**, many of the city government's measures, such as the shift from coal combustion towards natural gas and renewable energy in the power/heat sector, are leading to a significant reduction in Wuxi's carbon emissions. In the future, it is recommended that **regular resource checks of mitigation measures** should be conducted to avoid negative resource-related impacts. Furthermore, cross-sectoral synergies offer significant potential to save resources, such as shared infrastructures in industrial parks or recycling of waste materials for usage in other sectors. Therefore, it is recommended that the city government **establishes a dialogue platform for cross-industrial resource utilization with the aim of setting up pilot projects and understanding knowledge gaps and need for further policies**.

> "It is necessary to both integrate these dimensions into carbon mitigation strategies and to address them through specific measures."

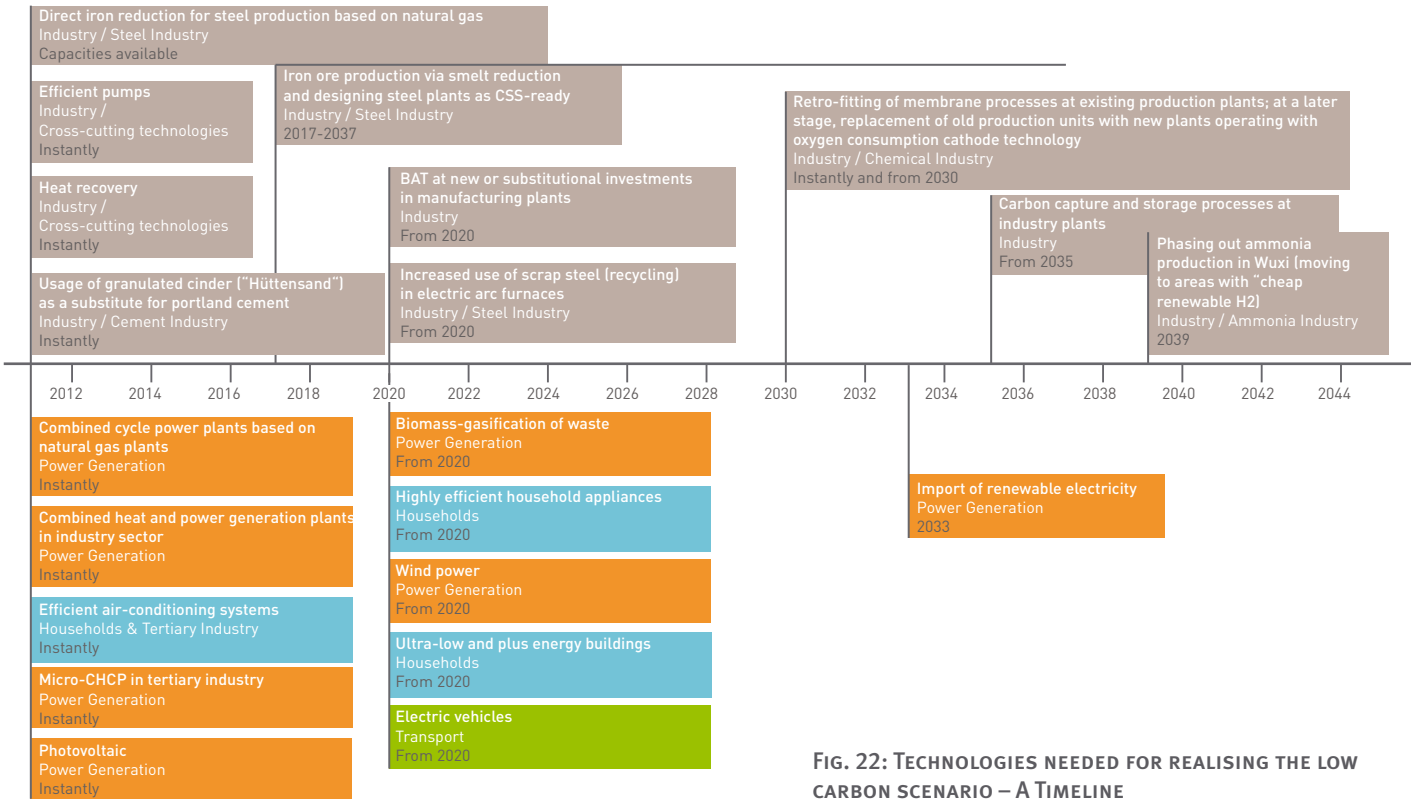

FIG. 22: TECHNOLOGIES NEEDED FOR REALISING THE LOW CARBON SCENARIO – A TIMELINE

5.4 LOW CARBON DEVELOPMENT AS A BUSINESS CASE

Dimensions of Low Carbon Entrepreneurship and Particularly Relevant Markets

Markets	Capacity	Technology	Finance	Institutions	Intermediation	Market Access
Services for energy system integration e.g. flexibilities and storage capacities for renewables		●	●	●	●	●
Energy Analyst and Energy Services e.g. energy contracting or optimisation of production		●	●	●	●	●
Urban Mining e.g. re-use/cycling of materials from dismantled buildings		●	●	●	●	●
Smart buildings e.g. centralised cooling systems; passive cooling etc.		●	●	●	●	●
Ecodesign services e.g. enable producers/architects to design cradle-to-cradle		●	●	●	●	●
International business consulting e.g. help SME to enter internatinal markets		●	●	●	●	●

Caption: yellow = potential hot spot; blue = potential strength; **grey** = rejected hot spot/strength

FIG. 23: KEY MARKETS FOR LOW CARBON DEVELOPMENT IN WUXI

"...Wuxi needs better mechanisms and structures for knowledge sharing, consultancy etc. to exploit future markets..."

FOR INTERESTED READERS:

Detailed information on Wuxi's key markets for low carbon entrepreneurship and possible business models can be found in the LCFC reports "Leverage Points for Low Carbon Entrepreneurship in Wuxi" and "How Entrepreneurship Can Drive Low Carbon Development" (www.lowcarbonfuture.net).

Business models for low carbon entrepreneurship may serve as a catalyst for a low carbon economy in Wuxi. Therefore, Wuxi's low carbon strategy should **systematically take into account the needs and capabilities of entrepreneurs**. Based on an analysis of Wuxi's economic landscape, the LCFC team has identified **key markets, which indicate promising business potential and could contribute to low carbon development**.

Fig. 23 indicates particularly relevant markets for low carbon development in Wuxi and evaluates their potential on six dimensions: capacity (e.g. creative thinking, will to take risks), technology (e.g. availability of technological solutions), institutions (e.g. policies, decision-making structures), finance (e.g. access to capital), intermediation (e.g. knowledge brokerage, representation of interests) and market access. The dimensions are either marked as potential hot spots, strengths or rejected strengths. Hot spots are those markets that are most relevant for yielding impact. Strengths can be used for addressing hotspots.

The illustration indicates that intermediation seems to be the most persistent weakness across all key markets in Wuxi. In turn, finance seems to be the clearest strength. This implies that **Wuxi needs better mechanisms and structures for knowledge sharing, consultancy etc. to exploit future markets**. The LCFC team recommends that this aspect, as well as the key markets, should be prominently addressed in future low carbon strategies. Furthermore, it is recommended that city-**planning and industrial policy should be aligned with low carbon strategies** in order to tap market potential. On the other hand, the **business community could pool its capacities and resources with sector-level and partnership approaches along the value chain** in order to facilitate learning and innovation.

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