中欧低碳技术与投资示范区

可行性调研报告

Feasibility Study on

EU-CHINA Low Carbon Technology and Investment Demonstration Zones

CIPA E3G

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Acknowledgement

In order to explore future EU-China cooperation on low carbon technology and investment, in June 2009, China International Investment Promotion Agency (CIIPA) entered into an agreement with Third Generation Environmentalism (E3G) to conduct a Low Carbon Technology and Investment Demonstration Zones (LCTIDZs) feasibility study. This is carried out under the framework of a series of 'two-way' investment memorandum of understandings signed between Investment Promotion Agency of the Ministry of Commerce (CIPA) and some EU member states. With valuable and dedicated support from CIPA, the feasibility study has now been successfully completed. It will hopefully provide a good foundation for future policy exchanges and collaborations between the relevant departments in China and the EU, and cooperation between businesses in both regions. We would like to thank all those who have contributed towards the preparation, implementation and report writing process of the feasibility study.

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Executive Summary

The increasingly significant impact of climate change on the environment, economic development and social stability has given the concept of the Low Carbon Economy (LCE) much greater prominence globally. Since its recent inception in Europe (more specifically the United Kingdom) LCE has been received by many European countries as a sustainable, science- and technology-based development model driven by growing demand for low carbon goods and services. The concept of 'low carbon' not only has implications for policy and technology, it can also lead to deeper structural economic and industrial changes and transformation of consumption patterns. With the recent experiences in low carbon related policy making and CO2 emissions reduction activities, LCE development in Europe has proved itself both as a 'carbon reduction' tool and as a strategic instrument that facilitates economic restructuring and increases international competitiveness.

China faces unique challenges in the process of energy saving and emissions reductions, in the development of renewable and alternative energy, and in the exploration of medium and long term low carbon development strategies. However, these challenges can also be viewed as opportunities especially in relation to 'low carbon economic growth' and 'low carbon technology innovation'. Given China's size and regional diversity there will not be a "one size fits all" national model for low carbon economic development. A variety of regional models are needed which can be developed from representative pilot initiatives and continuously improved on through experience.

EU-China Low Carbon Technology and Investment Demonstration Zones

Built on EU-China climate linkages as well as close trade and investment relations, the development of LCE provides new opportunities for a strategic cooperation on low carbon technology and investment between the two regions. EU-China low carbon technology and investment cooperation is needed at both the macro level (strategic relations) and micro level (the involvement and participation of the business community). These demonstration zones will provide a strong foundation for future EU-China LCE cooperation. One of the main benefits of these zones is to generate lessons and provide useful models for development, especially:

- A regional low carbon economic development model in the context of international cooperation and market competition.
- A strategic and innovative cooperation model for technology transfer and technology co-development between the EU and China.
- A new investment and financing model and investment cooperation strategy between governments, and between government, the business community and financial institutions to promote low carbon technology R&D, deployment and diffusion.

The underlying objectives of the EU-China Low Carbon Technology and Investment Demonstration Zones (LCTIDZs) are to explore China-specific low carbon technology development pathways and strategies as well as strengthen the substance and strategic importance of EU-China low carbon economic cooperation. This will allow the EU and China to look for new low carbon development opportunities and to accelerate a low carbon transition within an international framework.

Taking into consideration the existing local development conditions and future strategic development needs, a feasibility study on EU-China LCTIDZs was carried out in the following places:

- Energy production region: Pingliang City, Gansu Province
- Energy consumption region: Nanjing Yangtze River Development Zone, Jiangsu Province

Research & Development (R&D) and innovation are the supporting pillars of future low carbon economic development for both the energy production and energy consumption regions. In the face of globalisation, China has a unique position in low-carbon innovation built on its indigenous innovation capacity. Therefore, the feasibility study also includes a survey of China's low carbon R&D and innovation status and potential, taking Zhangjiang Hi-Tech Park in Shanghai as an example.

EU-China Low Carbon Technology and Investment Potential (I) – Energy Saving and Emissions Reduction in Energy Intensive Industries and Low Carbon Agriculture

China has not yet imposed GHG emissions reduction obligations and targets on its industries. Among the heavy industries surveyed – chemical, steel and power – enterprises would potentially regard a domestic CO2 emissions reduction target as part of the energy saving and emissions reduction target in the near future. At the same time, enterprises have, to varying degrees, recognised the importance of low carbon technology for future development. The survey also shows that existing measures adopted for environmental protection and energy saving purposes have already indirectly helped to reduce CO2 emissions and increase the reuse of CO2. However, low carbon technology use still faces several limitations:

- The imbalance between large CO2 emissions and small-scale CO2 utilisation and conversion.
- Limited understanding of the international development of low carbon technology by enterprises partly due to lack of information.
- Inadequate use of more advanced production processes and more efficient energy management to reduce CO2 emissions.
- The emphasis on 'hardware' (equipment) and neglect on 'software' (smart management) in energy saving and emissions reduction.

Low carbon technology therefore remains uncharted territory for most enterprises in China. This gap can be filled by policy guidance and support, international exchange and cooperation. Demand from industries will drive the development and deployment of low carbon technology, while the establishment of new low carbon industries will aid international cooperation.

The implications of LCE and technology for the agricultural sector are two-fold: GHG emissions reduction and climate change adaptation. However, the development and deployment of low carbon technology that is suitable to China's agricultural sector has yet to attract enough attention, especially in the context of international cooperation. There is therefore a huge potential for EU-China low carbon technology and investment cooperation in both the industrial and the agricultural sectors:

- **The integration of circular economy and LCE with the former being gradually upgraded to the latter** including integrated solutions for water shortage, pollution and CO_2 emissions.
- **Low carbon energy**: including the development and utilisation of renewable energy, and recycling of discharges from thermal power generation and the large-scale re-use of CO_2.
- **Energy transmission**: including the development and deployment of smart grids.
- **Low carbon industries**: non-conflicting energy saving, pollution control and CO_2 emissions reduction measures in heavy industries including steel, cement and chemical, and the establishment of low carbon production chains.
- **Low carbon agriculture and industrialisation of the agricultural sector**: including reducing the impact of climate change on agricultural production, and the application of low carbon concept and technology during the industrialisation of the agricultural sector.

EU-China Low Carbon Technology and Investment Potential (II) – Co-Development of Low Carbon Technology

Zhangjiang Hi-Tech Park and other similar hi-tech parks (in terms of R&D capacity and high degree of openness) have already incorporated the concepts of low carbon technology and low carbon economy into their investment promotion and technology capacity building policy and strategy. Low carbon technology R&D activities undertaken by multinationals, domestic enterprises and R&D institutions of various sizes in these parks will help to accelerate a low carbon transition in China.

The direction of R&D development in these parks is broadly in line with the international trend where huge investments are put into renewable energy and CO_2 capture technology. Taking into account the principles of 'In China, For China' and 'LCE with Chinese characteristics', clean coal and integrated coal resource use are the main focus of future low carbon technology development in China.

The market size of China creates favourable conditions for the acceleration of R&D, small-scale testing, large-scale demonstration and real-life modelling of low carbon technology. This will help to create a 'win-win' situation for EU-China low carbon co-development and cooperation. As the R&D capacity in China increases, a better market and policy environment will help to strengthen China's role in the international low carbon technology market.

EU-China Low Carbon Technology and Investment Potential (III) – Regional Economic Development and Transition

From the point of view of regional economic development and transition, different EU-China LCTIDZs will take different forms and substance in order to maximise their demonstration effects.

As the economic development of China's Eastern and coastal regions continues to evolve and upgrade, more and more resource-intensive enterprises and large investment projects are moving into the Western region. However, from an overall development perspective, the relocation of these 'three-high' (high energy consumption, high water consumption, and high emissions) industries will not solve the problems of coal-dominated energy structure and energy consumption in China. As China continues to industrialise and urbanise, the 'three-high' industries will remain a major force of development especially in resource-rich, but less developed regions. Therefore helping China's western region, such as Gansu Province, to move towards a LCE will be most effective for EU-China low carbon cooperation. This will help to build confidence in the pursuit of a sustainable development pathway in the western region (and avoid 'high carbon lock-in'), as well as transform and upgrade the 'three-high' industries through technology innovation and breakthrough. This will in turn strengthen EU-China climate change cooperation and increase their competitiveness in the development of LCE.

For the more prosperous Eastern region, including Nanjing Yangtze River Development Zone, there is a need to transform 'development zones' into 'high- and new-tech zones' for various reasons including limited land resources and economic structural change. Local governments are now less inclined to rely on resource-intensive industries for development; they have instead turned to the development of less land-intensive and high value-added advanced technology and service industries. Low carbon technology can provide a breakthrough for the future development of Nanjing Yangtze River Development Zone. This will facilitate industrial upgrade for its chemical and steel sectors and promote a regional development supported by the heavy industries and rational resource use. Low carbon technology development and investment in the Development Zone will be guided by three basic plans and strategies, namely 'Low Carbon Zone Planning', 'Low Carbon Industries Development Roadmap' and 'The Strategies for Low Carbon Technology Introduction and the Creation of Low-Carbon Investment Environment and Platform'. The establishment and development of an EU-China LCTIDZ will increase the competitiveness of Nanjing Yangtze River Development Zone and can provide a useful low carbon development reference for other places in the Eastern region that are also undergoing similar economic transition.

EU-China Low Carbon Technology and Investment – Recommendations for Cooperation

In order to facilitate a strategic and effective EU-China cooperation on LCE, the feasibility study makes the following recommendations:

- Development of 'low carbon coal power' and 'low carbon agriculture' in Pingliang City, Gansu Province.
- Development of 'low carbon chemical', 'low carbon steel' and 'low carbon technology R&D and services' in Nanjing Yangtze River Development Zone in Jiangsu Province.

To facilitate technology introduction and deployment, the demonstration zones can act as the test-beds for new modes and mechanisms of EU-China low carbon technology cooperation. These include:

- Low carbon technology information and experience exchange and policy dialogue
- Low carbon technology transfer, diffusion and co-development platform
- Low carbon technology R&D and diffusion fund

The prospects are promising for future EU-China cooperation in Pingliang City and Nanjing Yangtze River Development Zone in low carbon technology transfer, deployment and co-development. Specific examples of technology development and production process and equipment upgrades include:

For power, building material, chemical and steel sectors:

- Control of pollution caused by coal-burning, especially the emissions of CO_2
- CO_2 emissions reduction, capture, conversion and large-scale utilisation
- High efficiency generators
- Low CO_2 emissions steel-making technology
- Use of ultra-low temperature waste heat and pressure
- Energy system optimisation and management

For biogas use and environmental protection:

- High efficiency biogas engineering and equipment
- Large biogas power generation and large-scale utilisation projects
- Air purification and noise pollution reduction
- Bio-fuel equipment development and upgrading

EU-China LCTIDZs provide an innovative platform for EU-China cooperation on LCE. Cooperation in these zones will promote technology upgrade and development of new technologies in both China and the EU, which will in turn help to achieve their short and long term CO_2 emissions reduction targets. It will also allow the EU and China to work with the business community to build a new "Protect and Share" IPR regime that will enable the rapid and large-scale diffusion of low carbon technology. This will bring real economic benefits for both parties and create a strategic and effective EU-China cooperation on climate change.

Chapter 1 EU-China Low Carbon Economy Cooperation and China's Sustainable Development

1.1 Low Carbon Economy and Sustainable Development in China

The science of climate change is complex. But in recent years there has been growing confidence in the relationship between Greenhouse Gas (GHG) missions, especially carbon dioxide (CO2), and rising global temperatures. The increase in global temperature will have drastic humanitarian consequences including water scarcity, coastal flooding, food security and public health.

The increasingly significant impact of climate change on the environment, economic development and social stability has given the concept of Low Carbon Economy (LCE) greater prominence globally. Since its recent inception in Europe (more specifically the United Kingdom) LCE has been received by many European countries as a sustainable, science- and technology-based development model driven by growing demand for low carbon goods and services.

Broadly, LCE entails the reduction of GHG emissions and the development of an integrated system that combines different low-carbon elements, such as:

- The development and utilisation of low carbon energy
- The establishment of low carbon industries and related technology services sectors
- The adoption of low carbon consumption and lifestyle
- The development of low carbon knowledge and R&D
- Effective integration of low carbon market mechanisms and regulatory frameworks

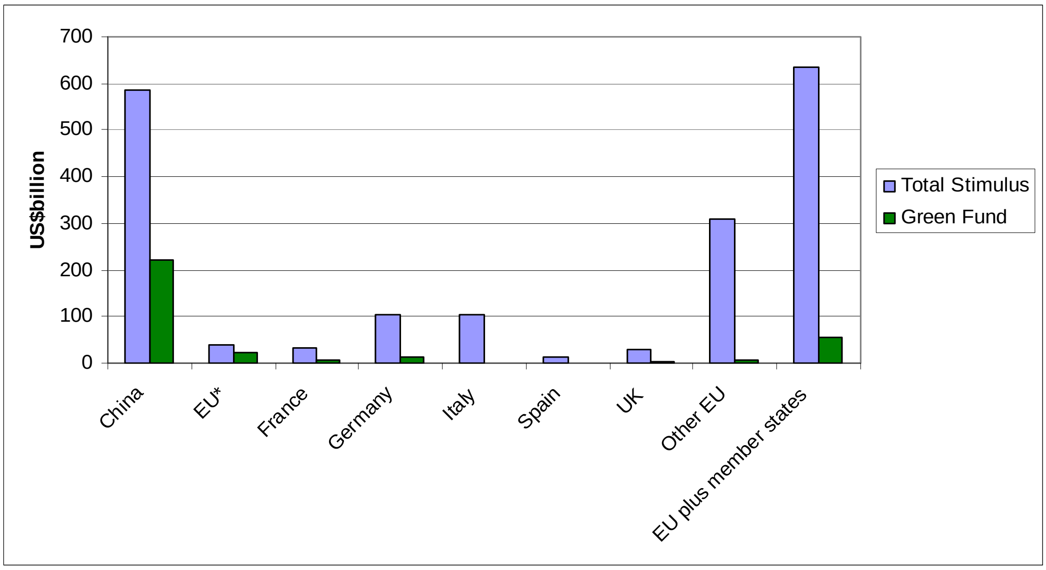
The concept of 'low carbon' has a bearing not only on policy direction and the technology used, but more importantly it can trigger a transformation of the economic and industrial structure and consumption pattern of a society. In the face of the global economic crisis many European countries have championed the transition to a LCE as the means to promote sustainable economic recovery and 'green' jobs creation. They also see it as a prerequisite to achieving economic, energy and climate security. With the recent experiences in low carbon related policy making and CO2 emissions reduction activities, LCE development in Europe has proved itself both as a carbon reduction tool and a strategic instrument that promotes economic restructuring and increases international competitiveness.

What does a LCE mean to China in the context of global economic development? Firstly, China's determination to develop a LCE is reflected in its various policies and investment strategies. At the same time, China already has the basis for the development of LCE, as reflected in the following areas:

- The concepts of 'circular economy' and 'resource saving and environmental friendly society' are closely related and complementary to the concept of LCE; there is no need for China to start from scratch.

- Sustainable development, innovation capacity building, and industrial transition and upgrade as part of the concept of a 'scientific outlook on development' provide diverse low carbon growth opportunities.
- China has made progress in energy saving, renewable energy and other targets under the 11^{th} Five-Year-Plan (FYP), which indirectly results in CO_2 emissions reduction. For example, if China achieves its energy intensity target of 20% by the end of the 11^{th} FYP, it will have avoided a total of 150 billion tonnes of CO_2 emissions. In addition, if China achieves its 15% target for renewable energy by 2020, it will become one of the world leaders in solar and wind energy.
- Under China's fiscal stimulus plan, a large amount of spending has been allocated for investment in energy efficient buildings, renewable energy, rail transportation, and electric vehicles (see Figure 1 below), which provide a strong basis for scaling up low carbon development and innovation.

Figure 1: Proportion of Green Spending under Stimulus Packages in China and the EU



Source: A Climate for Recovery, HSBC (2009)

<u>Existing Challenges and Opportunities in China</u>

China faces unique challenges in the process of energy saving and emissions reduction, in the development of renewable and alternative energy, and in the exploration of medium and long term low carbon development strategies – but these challenges can also be opportunities. For example:

- The context of the development of a LCE in China is different from that in the EU: In China, climate change needs to be addressed in conjunction with other equally pressing ecological and environmental problems. However, the adoption of scientific approaches to energy saving, pollution reduction (such as SO_2, NO_x) and CO_2 emissions reduction will encourage new breakthroughs in R&D and innovation. These will be the commanding characteristics of China's future climate change and environmental protection policies.

- China faces difficulties and challenges posed by a low carbon transformation that are different from industrialised EU countries: This is mainly reflected in its coal-dominated energy structure and its need for high rates of industrialisation and urbanisation. For example, around 70% of China's electricity comes from fossil fuels, which will remain the case in the medium term. In addition, China produces 48% of the world's cement and 35% of the world's steel to meet the needs of its ongoing rapid urbanisation. In the transition to a LCE, China needs to address not only the common challenges faced by industrialised countries in moving from a high carbon development to a low carbon development, but also the key issue of large-scale poverty alleviation. What is required is not a transition from a 'low income and low emission' to a 'high income and high emission' pathway, which would lock in high carbon development for decades to come. Instead, there are plenty of opportunities for China to 'leapfrog' old models of high carbon growth to become a 'high income and low emission' country.
- China's LCE development structure and institutional framework are also different from the US and European countries, especially EU Member States: China currently lacks a legally binding CO2 emissions reduction target and does not have a carbon trading mechanism. This means there is an urgent need for appropriate policy and institutional innovations.

Given China's size and regional diversity there will not be a "one size fits all" national model for low carbon economic development. A variety of regional models are needed which can be developed from representative pilot schemes and continuously improved on through experience. For example, it can:

- Strengthen the 'Go West Low Carbon Development Strategy' in poor regions in the West and North-West in China through more efficient use of traditional energy resources and vigorous development of renewable energy.
- Promote the development of advanced low carbon technology in the Eastern coastal areas and manufacturing bases, which can increase energy saving and emissions reduction, and the development of low carbon industrial production chains and clusters. It can also encourage the development of technology-based and innovative Small and Medium-sized Enterprises (SMEs).
- In large cities and urban agglomeration areas, relatively high levels of market openness and indigenous innovation capacity mean there is a great potential for foreign direct investment (FDI) and indigenous innovation to drive low carbon economic development.

1.2 Foundation and Implications of EU-China LCE Cooperation

In recent years, Europe has been taking important steps to foster leadership in promoting climate change policies and LCE development. The EU "Climate and Energy Package" agreed in December 2008 includes binding legislation to reduce EU emissions at least 20% below 1990 levels by 2020, rising to 30% as part of an ambitious international agreement. The

Package has profound implications for Europe's economy and future international cooperation on low carbon technology and investment. Highlights include:

- A commitment to generate 20% of its total energy from renewable energy by 2020; requiring an additional investment of €380-€420 billion in clean energy technologies over the period.
- European car efficiency legislation agreed alongside the package will limit average emissions to 95 gCO_2/km by 2020 (57 mpg).
- The EU agreed regulation governing the geological storage of carbon dioxide, requiring all new power plants to be carbon capture ready. The package also includes around €9 billion of European support to build a programme of up to 12 large-scale carbon capture and storage (CCS) demonstration power plants by 2015.
- CCS demonstration is the first stage of an EU Strategic Energy Technology Plan (SET-Plan) covering other major technologies such as biofuels, solar, nuclear and wind. Research platforms will also cover low carbon steel, cement, and construction and will be open to international cooperation. The EU has also recently agreed to set aside €50 million for the next phase of EU-China CCS cooperation and co-development.

Since December 2008 the EU has moved ahead with implementation of the Package and a range of supporting policies. For example:

- In March 2009 European leaders agreed additional green investments as part of a €200 billion EU Economic Recovery Package, building on the national stimulus packages agreed by individual Member States.
- The EU is in the process of agreeing a set of detailed efficiency standards for Energy Using Products ("Ecodesign Directive") and exploring ways to unlock market potential in green industries such as renewable energy and recycling ("Lead Market Initiative").
- The European Commission is expected to publish a communication on low carbon financing, which will identify further steps that Europe can take to drive investment in clean technologies.

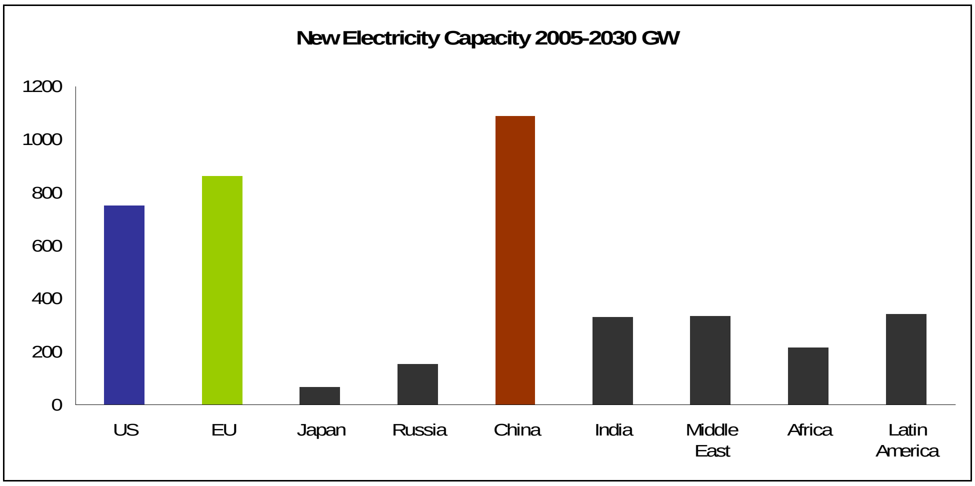
A Strategic EU-China Cooperation on Low Carbon Development

What does LCE cooperation mean for the EU-China strategic relationship? Firstly, the EU is the world's largest and most mature low carbon products market, while China is the world's fastest-growing low carbon products emerging market. The combined market size of the two economies can generate significant benefits of scale to drive down the cost and price of low-carbon products. EU-China market openness and integration will be crucial for accelerating the diffusion of low carbon goods, services and technologies.

Secondly, the EU is China's largest trading partner while China is the EU's second largest trading partner. At the same time, through the FDI from Europe to China, the EU has already become China's largest supplier of technology and the top destination for export of hi-tech products, which lays a solid foundation for broader and deeper EU-China low-carbon technology and investment cooperation in the near future.

Thirdly, in the next two decades, both China and the EU need to invest in large scale construction of low carbon infrastructure, especially in the power sector (see Figure 2). This means that China and the EU face common challenges and opportunities in avoiding high carbon lock-in in the development of the power and industrial sectors through the use of low carbon technology. The eventual convergence in energy and climate change policies, close trade and investment relations, and the common challenges in low carbon development thus provide a good foundation for EU-China LCE cooperation.

Figure 2: New Electricity Capacity in China and the EU Between 2005-2030



Source: IEA, 2006; Euroelectric 2007

In recent years, China and the EU have cooperated on launching and successfully implementing a series of energy and climate change related projects. Leaders from both sides have also given priority to LCE cooperation in recent high-level meetings. During a visit to Europe by Premier Wen Jiabao in January 2009, and at the recent EU-China High-Level Economic and Trade Dialogue in Brussels (7-8 May), the two sides discussed the importance of moving to a low carbon economy and agreed some initiatives such as the launch of the Europe-China Clean Energy Centre in Beijing.

In addressing the global economic crisis and the common challenges of energy and climate security, EU-China low carbon technology and investment cooperation is needed at both the macro level (EU-China strategic relations) and micro level (the involvement and participation of the business community). Closer and more strategic cooperation is needed to overcome existing barriers to a more effective and concerted global effort to address climate change.

<u>Obstacle 1 – Technology Barriers</u>

One of the biggest obstacles to a global low carbon transformation is the slow diffusion rate of low carbon technology due to prohibitive costs and IPR issues. Currently, only a handful of low cost and high efficiency R&D and innovative technologies exist because of conceptual, R&D capacity and market limitations. To overcome this, the EU-China strategic partnership on technology (including low carbon technology) needs to be improved and optimised. Being the world leader in low carbon technology R&D and deployment, the EU can benefit from a deepened technological engagement with China, especially in relation to the reduction of R&D and deployment costs and the acceleration of low carbon technology commercialisation. This will have a positive impact on the overall development of low carbon technology in Europe as well as in the global market. Low carbon technology also presents China with unique advantages. Although China still lags behind Europe in terms of conventional advanced (including low carbon) technologies and the development of the low carbon concept, it is catching up and even leading in some emerging low carbon technology fields such as electric vehicles, batteries and renewable energy.

Obstacle 2 – Investment Barriers

Another major obstacle to the development of LCE both in China and the EU is the lack of recognition of the role of the business sector. Large enterprises and SMEs have, in different ways and at different levels, contributed to CO2 emissions reduction and the development of low carbon technology. The role of enterprises in LCE development (especially in relation to technology, finance, markets and international cooperation), however, has not been fully reflected in EU-China strategic technology and investment cooperation.

To improve and optimise EU-China strategic low carbon technology cooperation, and in particular give a greater role to the business community, the following factors need to be taken into account when constructing cooperation platforms and mechanisms:

- Cooperation in industrial restructuring and development as part of the inter-governmental low carbon technology and investment cooperation strategy.
- Public-private partnership to achieve an integrated approach to regional development, improvement of the investment environment, and technological exchanges and cooperation.
- Public-private partnership to establish a ‘protect and share’ IPR regime that promotes low carbon technology diffusion and co-development.
- Public-private partnership to provide an international cooperation platform and to develop low carbon technology markets, especially for SMEs.

In the face of the global economic crisis, it is vital that the EU-China low carbon technology and investment strategic partnership is built on a mutually beneficial foundation. Low carbon technology R&D, deployment and diffusion can be facilitated through open market access and a fair and competitive market environment. This will help China and the EU to achieve ‘triple security’ – economic, energy and climate security. The improvement of the EU-China low carbon technology and investment strategic partnership and the greater role of the business community can create a future based on co-development and mutual aspirations for joint low-carbon growth opportunities.

Chapter 2 Feasibility Study on EU-China Low Carbon Technology and Investment Demonstration Zones

2.1 EU-China Low Carbon Technology and Investment Demonstration Zones

Low Carbon Technology and Investment Demonstration Zones (LCTIDZs) aim to provide a strong foundation for future EU-China LCE cooperation. To the participating areas, these demonstration zones are not only the means to increase energy efficiency and reduce emissions but are also a strategic response to the current economic crisis, through the development of regional low carbon economies and new low carbon industries.

The scale and definition of these demonstration zones vary and are determined by the development foundation and strategic needs of the different regions. For example, a demonstration can be established in an economic development or high-tech zone where the development of a low carbon industrial chain and industrial clusters can help to increase its international competitiveness. LCTIDZs can also take place in the context of regional economic transitions where integrated economic and industrial restructuring and upgrading can occur, such as at the city level.

One of the main benefits of these zones is to generate lessons and provide useful models for development. In particular, LCTIDZs can provide:

- A regional LCE development model in the context of international cooperation and market competition.
- A strategic and innovative cooperation model for technology transfer and technology co-development between the EU and China.
- A new investment and financing model and investment cooperation strategy between governments, and between government, the business community and financial institutions to promote low carbon technology R&D, deployment and diffusion.

The underlying objective of the EU-China LCTIDZs is to enable the EU and China to look for new low carbon development opportunities and to accelerate a low carbon transition within an international framework. This can be achieved through exploring China-specific low carbon technology development pathways and strategies, as well as strengthening the substance and strategic importance of EU-China LCE cooperation.

2.2 Low Carbon Technology: Scope and Coverage

Following the industrial and information revolutions, the problems of energy security and global warming now present a new global challenge – a challenge of ensuring 'harmonious' development that incorporates the concerns of climate change, environmental protection and economic growth. This can be pursued using a range of technologies for clean energy, resource recycling, energy saving, emissions reduction and environmental protection.
Main selection criteria for low carbon technology include:

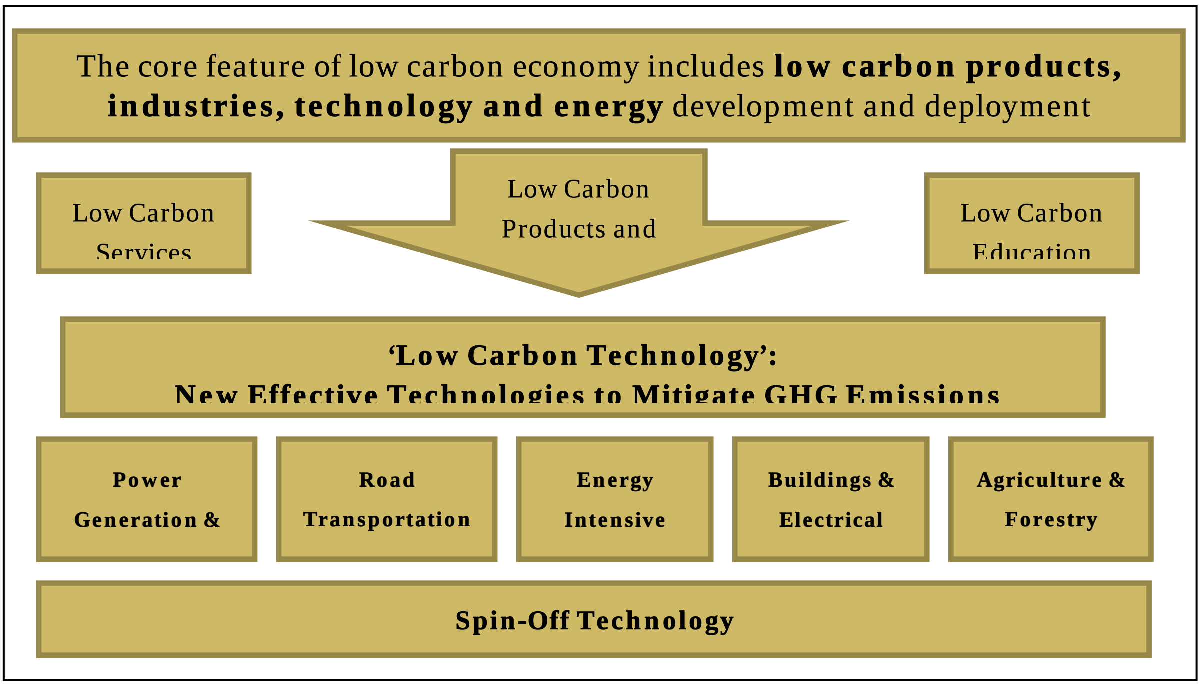
- CO2 emissions reduction potential
- Maturity of the technology
- Cost-effectiveness and efficiency

Low carbon technology includes new technology that relates to and promotes energy saving, effective use of coal, oil and gas resources, coal-bed methane exploration and development, renewable and new energy, carbon capture and storage (CCS), and effective mitigation of GHG emissions. The general direction of low carbon technology development includes:

- R&D of CO2 emissions reduction technology and reform of production processes in all domains
- Reduction in production costs for all types of new clean energy and CO2 emission mitigation technology
- Industrialisation and large scale utilisation of new technologies

Low carbon technology involves huge engineering undertakings in different sectors, domains and disciplines. It is currently the technology framework used to address climate change, and its application includes the power, transport, buildings, metallurgy, petrochemicals, and the automobiles sectors (see Figure 3).

Figure 3: Low Carbon Technology Framework



2.3 Low Carbon Technology: Development and Deployment

Rapid deployment and diffusion of low carbon technology is crucial to the development of a LCE. There remain some stereotypes and misunderstandings of low carbon technology in the early stages of LCE development. For example, it is commonly perceived that the low carbon problem is an energy problem, and that low carbon technology is equivalent to energy technology. It is true that low carbon issues are closely related to the energy problems; and the underlying premise of a low carbon transition is the simultaneous attainment of both energy and climate security through the effective use of energy and optimisation of the energy structure. However, the implications extend well beyond the energy sector. Wide application of low carbon technology and its beneficial impact and catalytic potential in industrial restructuring are crucial elements of a LCE transition. LCE not only signifies large-scale changes in production and consumption patterns but also denotes a diversified economic structure as well as transformational changes in the industrial structure and regulatory framework.

Major EU member states (especially the UK and Germany) regard the LCE transition as a 'new green industrial revolution', and view a LCE development strategy as a means to increase competitiveness and attract high value investment. To promote rapid development of low carbon technology on which its future industrial development will be built, the EU has introduced a series of low carbon projects. Table 1 below provides a list of programmes under the Strategic Energy Technology (SET) Plan introduced in 2007. The global transition to a LCE also has significant implications for China's medium and long term development strategy, especially its potential for developing low carbon technology and future engines of growth and competitiveness in the global market.

Table 1: EU Strategic Energy Technology (SET) Plan

Initiatives	Research Focus
European Wind Initiative	• Large turbines and large systems validation and demonstration (for both on- and off-shore application)
Solar Europe Initiative	• Large-scale demonstration for photovoltaic and concentrated solar power
European CO2 capture, transport and storage initiative	• Whole system requirements including efficiency, safety and public acceptance, to prove the viability of zero emission fossil fuel power plants at industrial scale
European electricity grid initiative	• Development of the smart electricity system including storage, and creation of a European Centre to implement a research programme for the European transmission network
Sustainable nuclear fission initiative	• Development of Generation-IV 'technologies
Bio-energy Europe Initiative	• 'Next generation' bio-fuels within the context of an overall bio-energy use strategy • The EU has set a non-mandatory target to replace 5.75% of road transport fuel with bio-fuels by 2010 (to be increased to 25% by 2030)
Joint Technology Initiative on Fuel Cells and Hydrogen	• Low cost, reliable and durable fuel cells and high capacity hydrogen storage • Target to increase the proportion of hydrogen cars among passenger cars in EU-27 to 1.5% by 2020 and 12% by 2030

2.4 EU-China Low Carbon Technology and Investment Demonstration Zones Feasibility Study

Taking into consideration the existing local development conditions and future strategic development needs, a feasibility study on EU-China LCTIDZs was carried out in the following places:

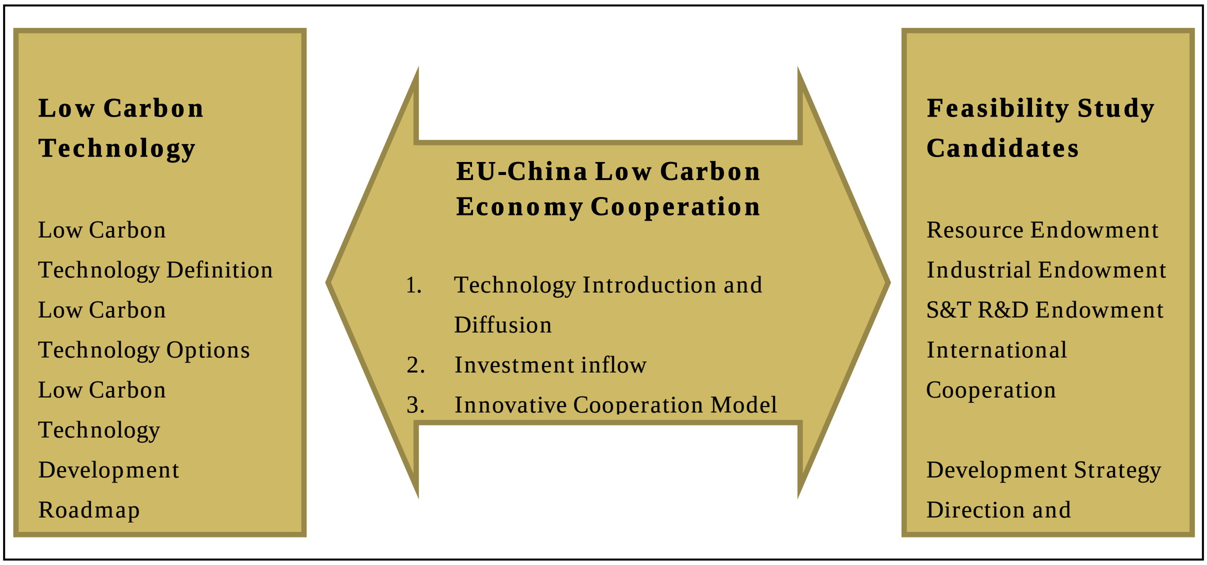
- Energy production region: Pingliang City, Gansu Province
- Energy consumption region: Zhongshan Science and Technology Park, Nanjing Yangtze River Development Zone, Jiangsu province.

Research & Development (R&D) and innovation are the supporting pillars of future LCE development for both the energy production and energy consumption regions. Therefore, the feasibility study also includes a survey of China's low carbon R&D and innovation status and potential in Zhangjiang High-Tech Park in Shanghai.

The feasibility study on EU-China LCTIDZs focused on the following main areas (also see Figure 4):

- The LCE development foundation of the candidate development zone/city in terms of industries, resources, R&D, policy and international cooperation.
- The LCE development strategy and aspiration of the candidate development zone/city.
- Technology choice and roadmap for future low carbon development suitable for the particular development zone/city built on its low carbon development foundation and aspiration.
- Analysis of low carbon technology development opportunities and obstacles including technology conditions and investment and international cooperation needs.
- The implications of low carbon technology and investment on GHG emissions, environment, climate and society, and strategic LCE development opportunities.

Figure 4: Feasibility Study Framework



The information gathered during the feasibility study can be divided into two main areas:

1) Low carbon technology and investment development conditions at the **regional level**, including:

- Local government's understanding and awareness of LCE and low carbon technology from a regional development perspective.
- The relevance of circular economy and the need for the development of a LCE from a regional development perspective.
- Technology orientation and platform for low carbon technology development and innovation in the international context.
- New models of cooperation and financing mechanisms for low carbon technology development and innovation in the international context.
- The role of international cooperation in low carbon technology development and innovation.

2) The low carbon technology needs at the **enterprise/agricultural production unit level**, including:

- Existing 'energy saving and emissions reduction' measures and their effectiveness.
- The development of the circular economy and the creation of industrial chains.
- On the basis of the above two measures ('energy saving and emissions reduction' measures and circular economy), the awareness, needs and initiatives for a low carbon transition.
- Similarly, on the basis of the above two measures, the potential for low carbon initiatives and CO2 emissions reduction.
- Low carbon technology R&D and potential.

Chapter 3 Low Carbon Technology in Practice – Energy Intensive Industries

3.1 China's Energy Intensive Industries

Production of solid waste, waste water and air pollutants from rapid industrialisation and urbanisation are causing serious environmental problems and exacerbating the threat to the well-being of our ecology and sustainable development. As a developing country in the process of rapid economic growth, China has become one of the largest emitters of CO2 in the world and its CO2 emissions continue to grow. The main reasons for China's high CO2 emissions are:

- Existing energy resource characteristics where primary energy consumption is dominated by coal.
- The dominance of energy intensive industries in China's economy – as China is still undergoing the industrialisation process, the secondary/industrial sector, dominated by energy intensive industries, accounts for a high proportion of its GDP in comparison to the tertiary/service sector. .
- In the industrial sector, especially among energy intensive industries, the problems of low energy conversion rates, low energy efficiency and the fragmented structure of the industries are prominent.

Between the 10^{th} FYP and 11^{th} FYP, economic restructuring has increased energy efficiency in China; between 1990 and 2005, the annual reduction of China's energy intensity per RMB10k GDP was 4.1%, which was equivalent to a saving of more than 800 million tonnes of coal and 1.8 billion tonnes of CO2 emissions reduction (WWF, Low Carbon Business Leadership Case Studies, 2009). Despite this achievement, China's energy intensive industries still face huge challenges in future energy intensity and GHG emissions reduction. In particular, apart from the high growth rate, the average technology level and energy efficiency level of China's energy intensive industries are still lagging behind those in industrialised countries (see Table 2).

Currently, low carbon development within the different industries has only just begun and there is still significant CO2 emissions reduction potential. It is estimated that by 2020 the carbon intensity (CO2 emissions per unit GDP) of China's energy intensive industries will be reduced by at least 30%, which could provide a basis for absolute CO2 emissions reduction efforts in the future (WWF, Low Carbon Business Leadership Case Studies, 2009). In order to reduce the technology gap between China and developed countries, and to find development opportunities in low carbon technology, there is a need and huge potential for Chinese and EU R&D institutions and companies to engage in technology cooperation in the sectors discussed below.. More importantly, EU-China low carbon technology cooperation is not only a matter of competition and mutual benefits. It will also have huge benefits in the global fight against climate change.

Table 2: A Comparison of China's Energy Intensity of Major Energy Intensive Products with International Best Standards

A Comparison of China's Energy Intensity of Major Energy Intensive Products with International Best Practice					
Projects	China			International Best Practices	2007 Energy Intensity Difference (+%)
	2000	**2005**	**2007**	**2007**	
Electricity consumption per tonne of coal produced /k Wh/t	30.9	26.7	24.0	17.0	41.2
Coal consumption per unit of electricity produced /gce/k Wh	363	343	333	299	11.4
Coal consumption per unit of electricity supplied /gce/k Wh	392	370	356	312	14.1
Energy consumption per tonne of steel /kgce/t (large and medium sized enterprises)	784	714	668	610	9.5
Energy consumption per tonne of cement/kgce/t	181	167	158	127	24.4
Energy consumption per tonne of ethylene /kgce/t	1125	1073	984	629	56.4
Energy consumption per tonne of ammonia /kgce/t	1699	1650	1553	1000	55.3

Source: National Bureau of Statistics of China, and China's coal industry association, China's Petrochemical industrial association, China's industrial association of metal products.

China currently has not imposed a GHG emissions reduction obligation or target on its energy intensive industries. Within this context, the feasibility study will focus on the power, cement, chemical and steel industries to understand:

- Existing 'energy saving and emissions reduction' measures and their effectiveness, as well as the limitations and technical barriers faced
- Low carbon development awareness and voluntary measures
- Low carbon transition and technology needs of industries

3.2 The Power Sector – Current 'Energy Saving and Emissions Reduction' Measures

As China's primary energy resource, coal will continue to be a major source of energy in China for a relatively long period of time. In line with the target of GDP quadrupling by 2020, China's total installed capacity will reach 900-950 GW with a generating capacity of 4.2 trillion kWh, of which fossil fuel will still account for around 70%. In the face of such rapid growth, the challenge of CO2 emissions reduction will be huge for China's power sector.

During the feasibility study, five power and coal companies of different sizes provided information about their production processes (see Table 3) and 'energy saving and emissions reduction' measures (see Table 4). Overall, these enterprises had upgraded and transformed their technology to meet their 'energy saving and emissions reduction' targets under the 11th FYP. The capital investment involved, especially by large companies, is colossal. For example, during the 11th FYP period, Huaneng (Pingliang) Power Company and Huamei Coal Group conducted more than 160 'energy saving and emissions reduction' projects, including unit desulphurisation and electro-mechanical system transformation respectively, resulting in a total investment of RMB 695 million. The annual saving of standard coal, SO2 emissions reduction and COD reduction was 180,000 tonnes, 6,000 tonnes and 3,000 tonnes respectively.

In the process of addressing 'energy saving and emissions reduction', companies not only invest in the upgrade of production process and in other 'hardware' transformation but are also increasingly paying attention to internal energy saving management systems. For example, Huaneng (Pingliang) Power Company has adopted the following measures in relation to its internal energy saving management:

- The adoption of long term and annual energy saving plans, and the introduction of energy saving indicators and departmental contractual commitments to achieve these targets.
- Reduction of energy use in non-production processes and optimisation of internal energy saving potential by reducing energy and coal use in the production units and during maintenance and standby period.

Table 3: Brief Introduction of Case Studies – Power Sector

Company Name	Coal Consumption	Equipment Status
Pingliang Power Company (China Huaneng Group)	Comprehensive energy consumption 2.27 million tce/year	Currently four 300MW units, two 600 MW super-critical (SC) units with air-cooling and desulphurisation within the 11th FYP
Huating Power Plant (Gansu Huaming Power Co Ltd)	Coal gangue consumption 1 Mta	Coal gangue power generator unit, with a 480 t/h circulating fluidised bed (CFB) boiler, a 135 MW reheat steam turbine and an air-cooled rotor & stator power generator. Two 600 MW units will be built in the second phase.
Nanjing Power Plant (China Huaneng Group)	Raw coal 2.8 million ta	Two 320 MW SC units, built during the 8th five years
Huarun Cogeneration Plant	Under construction	Two 600 MW SC units with desulphurisation & de-nitrification, coal consumption: 300 g/kWh, CHP cogeneration.
Huating Coal Power Co Ltd (Huating Coal Group)	Energy consumption per output value 7.7 tce/10kRMB	8 coal fields with 9 wells, a production of 20 Mta

Table 4: Existing 'Energy Saving and Emissions Reduction' Technologies and Techniques Used by Companies

Method and project	Efficiency of energy saving and emissions reduction	Savings (tce/year)	CO_2 emissions reduction (tonne /year)
Blower improvement using high-voltage & variable-frequency technique	Coal consumption reduction 19%	-	-
Improvement using variable-frequency technique	Power consumption reduction 50%	-	-
Resulphurisation SO_2	Emissions reduction 22.6 kta Flue dust reduction 817.8 ta	-	-
Plasma ignition	-	-	-
Start with half-slip parameter	Savings in power consumption of the power plant 120 kRMB/year	-	-
Improvement of high/low pressure heater/trap of unit	Savings in heat loss of steam/water 112.5 kRMB/year	375	1140
Wastewater recycling	Wastewater reduction 100 kt	25.7	-

- Improvement on energy saving and reduced consumption of non-renewable energy through unit operation mode optimisation.
- Establishment of a monitoring system, including online gaseous emissions and waste water monitoring.

The feasibility study shows that existing production processes and 'energy saving and emissions reduction' technologies are already oriented towards a low carbon transition:

- Adhering to the principle of 'big replacing small' by increasing the use of high parameters, high-capacity, water-saving and environmental friendly generators: new coal-fired plants are now using generators with capacity of 600 MW and above and even supercritical technology.
- Upgrading energy consuming equipment and water systems: deployment of energy saving products and new frequency control and computer control systems.
- Development of thermal power plants that make comprehensive use of coal gangue from industrial waste as fuel.

In addition, the feasibility study also found that 'energy saving and emissions reduction' measures have different effects on the firms. Energy saving measures have brought tangible economic benefits to the firms in the form of savings on energy costs. However, the investments in and the daily running cost of emissions reduction equipment and technology are formidable and may not be recoverable. For example, Huaneng (Pingliang) Power Plant has invested RMB 230 million on 4 sets of 30MW desulphurisation equipment, the energy consumption of which amounts to 1% of the firm's total annual energy use. This is considerable given that in 2008, the firm's energy saving target is 2% of its total energy consumed (in other words, energy consumption by the desulphurisation equipment amounted to half of the energy saving target).

China's power sector 'energy saving and emissions reduction' development process is different from Europe. While the latter adopts an integrated pollution prevention and control approach that emphasises coordinated management of major pollutants such as sulphur dioxide (SO2), nitrogen oxide (NOx) and CO2 and an overall production process emissions control system, the former targets individual pollutants and deals with them separately at different stages. For example, SO2, to be followed by NOx, is now the priority of China's regulatory regime, potentially followed by CO2 at some point in the future. The Chinese regulatory regime also tends to focus more on emissions control and treatment at the end of the production process, thus inhibiting the development of comprehensive pollution control technologies or systems and increasing deployment and operation costs for companies.

3.2.1 Extension of 'Energy Saving and Emissions Reduction' Technology – Examples of Low Carbon Technology in the Power Sector

Globally, advanced low carbon technologies in the power sector include carbon capture and storage (CCS), clean coal power generation and CO2 conversion and utilisation. In the context of China's low carbon development strategy, especially areas included in the feasibility study, the potential of these technologies must not be underestimated.

Clean Coal Power Generation

Clean coal power generation technology is part of the 'clean coal technologies' (CCT) that are used in power generation. It has a smaller environmental pollution impact, high power generation efficiency and does not occupy a large area of land. The core of the technology is to increase power generation efficiency and to limit post combustion emissions. At present, integrated gasification combined cycle (IGCC) and circulating fluidised bed combustion (CFBC) are representative of clean coal power generation technology.

Integrated Gasification Combined Cycle (IGCC)

IGCC power generation technology works on the basis of integrated combination of coal gasification and steam: coal is first turned into gas and any impurity is then removed from the gas, including 99% of hydrogen sulphide (H2S) and 100% of dust; solid fuel is turned into clean gaseous fuel that is then used to drive the gas turbine to generate power, combining gas and steam power generation. Its main advantages include:

- High combustion efficiency: current international level is 43%-46% and is expected to reach 50% by 2010.
- Good emissions reduction capacity: desulphurisation rate is more than 98%, same NOx emissions rate as natural gas, and reduced CO2 emissions.
- Strong fuel adaptability: unique adaptability to high-sulphur coal.

- Can be used to retrofit fuel combined cycle unit and old coal-fired power plants to increase combustion efficiency, reduce environmental impact and prolong the life of equipment.

IGCC is one of the best commercialised clean coal power generation technologies available in terms of efficiency and environmental impact. Following twenty years of experience in IGCC R&D, China now has a relatively good foundation for individual technologies used in IGCC such as gasifier, air separation unit (ASU), gas desulphurisation and heat recovery steam generator (HRSG). During the 8th FYP, Chine completed a joint 200MW and 400MW coal-water slurry pressurised gasification IGCC feasibility study with Texaco (US).

Internationally, second generation IGCC technology (where the initial temperature of the gas turbine reaches 1288°C and where the stand-alone capacity exceeds 400MW) is being commercialised. Currently, there are 30 IGCC plants that are built, under construction or to be constructed in the world. The Baggenum power plant in the Netherlands (253MW) has been in operation since 1994. IGCC demonstration projects have also made significant progress in the US, including the Wabash River power plant (as part of the coal gasification reconstruction project) that has a generation capacity of 262MW, energy supply efficiency rate of 38% and desulphurisation rate of more than 98%. Wabash River (262MW) and Tampa (260MW) IGCC plants in the US and Puertollano IGCC plant (300MW) in Spain have all entered the production demonstration stage since 1997. Currently, the largest IGCC plant (440MW) can be found in the US while, amongst those still in the planning phase, the biggest ones are a 900MW plant in Germany and 1 GW plant in Russia.

Circulating Fluidised Bed Combustion (CFBC)

Circulating fluidised bed combustion is a combustion technology in which fluidised beds suspend solid fuels on upward-blowing jets of air during the combustion process. The result is a turbulent mixing of gas and solids. Generally CFBC is structured by the boiler and the high temperature cyclone. The intra-furnace gas velocity is as high as 4 to 8 m/s. Coarse fluidising medium and char in the flue gas are collected by the high temperature cyclone, and are recycled to the boiler. Recycling maintains the bed height and increases the denitration efficiency.

CFBC is highly adaptable and is currently the world's most popular furnace for clean coal combustion. Its unique characteristics include:

- Clean combustion: desulphurisation rate reaches 80%-95%, and 50% reduction of NOx emission.
- Strong fuel adaptability: suitable for both medium and low sulphur coal.
- High combustion efficiency: can reach 95%-99%.
- Good load adaptability: load adjustment range of 30-100%.

The development of CFBC technology in China started in the 1980s and China now has the R&D, design and production capacity in relation to this technology. Currently, China has the ability to design and make CFBC furnaces with capacity of up to 75t/h. However, improvement is still needed in relation to the continuous running time, load, wear and tear, smoke leakage and desulphurisation of existing equipment.

CFBC is a mature technology that has been widely developed and is being commercialised at a large scale in developed countries. At present, boiler capacity can be found in the range of 50t/h, 100t/h, 400t/h, and the largest capacity so far of 900t/h in France (250MW power plant). ABB-CE is currently designing a CFBC boiler with a capacity of 1,500t/h. Globally, there are 300 CFBC boilers of 12MW and above, 4o% of which can be found in the US, 40% in Europe and the remaining 20% in Asia. The longest running time and the longest continuous operation time of CFBC boilers so far are 90,000 hours and 13 months respectively, with a load rate of more than 90%.

Both the IGCC and CFBC technologies have become the focus of technology development in the power sector and are deemed to be suitable for widespread deployment in China. The current challenge for the EU and China is to promote international cooperation, deployment and diffusion of advanced technology, and mutual gains for both governments and businesses through large scale production and commercialisation of these technologies.

3.3 The Cement Sector – Current 'Energy Saving and Emissions Reduction' Measures

Building construction is also a typical energy intensive industry. Cement production in China in 2008 was the largest in the world - 8 times more than India (second largest producer) and 17 times more than the US (third largest). According to the Information and Statistics Department of China's Building Material Federation, in 2007, China's cement industry consumed a total of 140 million tonnes of coal – equivalent to 73.4% of the total energy consumed in the building sector, 7.5% of the total energy consumed in the whole industrial sector and 5.4% of China's overall energy consumption. Compared to 2000, energy consumption of the cement industry grew by 95.9%, with a net increase of 70 million tonnes of coal and an annual growth rate of 10.2%.

Faced with the rapid growth in cement production and energy consumption, according to China Finance Net, the Chinese government has invested more than RMB 28 million in production process upgrading and energy saving in the cement sector since 2006 (RMB 26 million of this is especially set aside for low carbon projects). Through waste heat power generation and more than 40 other technology upgrade projects, the industry has saved RMB 104 million, which was equivalent to 4.4% of its annual sales revenue.

During the feasibility study, two cement companies of different sizes provided information about their production processes (see Table 5) and 'energy saving and emissions reduction' measures (see Table 6). One of these companies is Pingliang Qilianshan Cement Co. Ltd – a relatively large private-owned company. It has invested a large sum of money and technology on 'energy saving and emissions reduction' so far: RMB 2.82 million in 6 'energy saving and emissions reduction' projects in 2008, RMB 4.25 million in 4 technology upgrading projects and RMB 45 million on a waste heat power generation project in 2009. At the same time, technological improvements, such as the use of distributed control system (DCS) in its production line, has led to increased production efficiency. In relation to environmental protection, the company has invested RMB 26 million on 62 waste gas disposal equipment, waste gas online monitoring system, and WSZ-3 (land burial) type waste water integrated disposal facilities for secondary biological treatment.

Table 5: Brief Introduction of Case Studies – Cement Sector

Company Name	Energy Consumption (t ce/year)	Equipment Status
Pingliang Qilianshan Cement Co Ltd	116050	2.5 kt/d new dry-process clinker production line. 1 Mta High-grade cement
Kongtong Cement Co Ltd	31346	A 3.5x125 m rotary kiln and a 3.6x12 m vertical shaft kiln cement production line. 400 kta cement

Table 6: Existing 'Energy Saving and Emissions Reduction' Technologies and Techniques Used by Companies

Method and project	Efficiency of energy saving and pollution reduction	Savings (t ce/year)	CO_2 emissions reduction (tonne /year)
Low-voltage reactive power compensation	Power factor raised to 0.96 from 0.88	12	37
Improvement of raw mill circulation blower using frequency conversion	In the process of planning	-	-
Mill feeder of desulphuric gypsum	Consumes desulphuric gypsum 50 kta, saving 2 million RMB/year	375	1140
Waste heat recovery	Power generation 34675 k Wh	11.2 k	34k 21765 (SO_2)
Wet powder outlet	Waste heat recovery	-	-
Puls jet type bagfilter dust collector	Dust collection efficiency of 99.8%	-	-

3.3.1 Low Carbon Related Technologies in the Construction Sector and Their Future Development

The most representative low carbon technologies in the construction sector include:

New Dry-Process Cement Production Technology

The new dry-process cement production mainly involves suspension pre-heat and pre-decomposition technology and is widely used in the whole cement production process. It represents a modern, high-tech way of producing high quality cement. Its other advantages include high productivity, high energy saving, low emissions and large scale, automated production process.

Pure Low Temperature Waste Heat Power Generation Technology

Comprehensive use of waste heat from cement kilns to generate power has become a major technological solution to reduce energy consumption and CO2 emissions in the cement production process. This technology is used in conjunction with the new dry-process cement production technology and involves using waste heat emitted from both ends of the kiln to generate power. The resulting decrease in energy consumed for power generation provides a good economic return to investors. Whereas cement waste heat power generation is no longer a new technology internationally, it has just begun to gain ground and the technology continues to be developed and improved in China's cement sector.

In China, the rapid development of production and equipment technologies in the cement industry has created market demand for the deployment of pure low temperature waste heat power generation technology (used in conjunction with the new dry-process production system). The introduction of foreign technologies and domestic upgrading of cement production lines and power generation facilities have helped to improve the overall technology standard and deployment rate of the new waste heat power generation system (for example through further adaptation and upgrade of specific aspects of the new technology including the heat circulation system, circulation parameters and heat extraction method).

The deployment and diffusion of waste heat power generation technologies needs to take into consideration the overall impact on energy saving as there are instances where the one-sided pursuance of waste heat utilisation has resulted in waste of energy. One example is the conventional combustion boiler waste heat utilisation technology. It was designated as one of the major technology projects during the 8^{th} FYP and has been successfully deployed within China's cement industry. Currently this technology is still widely used in 1000t/d and above new dry-process production lines. Although this technology manages to recycle waste heat from the cement production process hence reducing energy use, it consumes a lot of energy and compared to large high-temperature high-pressure power generation, its coal consumption per unit is 40% higher. This makes it less economical and has a negative impact on the overall energy saving effort.

3.4 The Chemical Sector – 'Energy Saving and Emissions Reduction' Measures

For the chemical sector, energy is not only a form of fuel or power but also its raw material. Currently energy used as raw material in the chemical industry in China amounts to around 40% of total energy consumption, and more than 50% of the industry's total energy consumption comes from coal and coke. In addition, most energy is consumed (more than 43% of total consumption) in the production of energy intensive products such as ammonia, caustic soda, calcium carbide, phosphorus, carbon black and ethylene.

In 2007, the oil and chemical industries consumed 375 million tonnes of coal, equivalent to 15.2% of China's total energy consumption. The chemical industry alone consumed 250 million tonnes of coal, which was 10.1% of the national total energy consumption (see Table 7).

Due to the high per-unit energy consumption of chemical products, energy cost forms a large proportion of the overall production cost: for large ammonia producers that use natural gas as raw material, energy cost accounts for 75% of the production cost; for medium-sized ammonia producers that use coal and coke as raw materials, the proportion is 70%; and for small ammonia producers the figure is around 73%. As a result, energy saving measures are also important cost-saving measures for the chemical industry, and are vital for the future sustainable development of the industry.

Table 7: Energy Consumption of Energy Intensive Products in 2007

	Ammonia	Caustic Soda	Calcium Carbide	Phosphorus
Energy consumption (tce)	75 million	12 million	180,000	3.5 million
% of total energy consumption of the chemical industry	30%	4.8%	7.2%	1.4%

Source: China Petroleum and Chemical Industry Association

There are two large state-owned chemical companies in the survey areas. Their production processes and 'energy saving and emissions reduction' measures broadly reflect China's domestic situation and also the existing norms and technology standards. Investment in 'energy saving and emissions reduction' by these two companies is huge. For example, faced with the challenges of environmental protection, energy security and water shortage, investment in R&D and deployment of new energy saving and cost effective technologies has become an important strategy of Sinopec Yangzi Petrochemical Co Ltd. Its investment in 'energy saving and emissions reduction' technology has amounted to more than RMB 1 billion so far.

Table 8: Brief Introduction of Case Studies – Chemical Sector

Firms	Coal Consumption (/year)	Current Technology Situation
Nanjing Chemical Industry Co Ltd	500,000 tonnes and above CO_2 emissions around 20,000 tonnes per hour	Large state-owned chemical enterprise with more 200 chemical products in 7 product groups: chemical fertiliser, non-organic chemical raw materials, organic chemical raw materials, catalyst, chemical machinery, chemical building materials, and chemical fibre. It also carries out large-scale chemical engineering and machinery R&D, designing, manufacturing, construction and installation. Its main products include ammonia, sulphuric acid, hydrogen, and catalyst products; its annual ammonia and hydrogen production are 30 and 4 tonnes respectively.
Sinopec Yangzi Petrochemical Co Ltd	More than one million tonnes	It currently owns 43 large petrochemical production plants that are used to produce 8 million tonnes of processed crude oil, 650,000 tonnes of ethylene, and 1.4 million tonnes of aromatics per year. It produces more than 7 million tonnes of 44 different products annually under the 5 product groups of polyolefin plastics, polyester raw materials, rubber raw materials, basic organic chemical raw materials, and refined oil. Its products are used in light industry, textiles, electronics, food, automotive, aviation, modern agriculture and etc. It has an annual sales income of more than RMB 40billion.

Coal and coke are still the main energy source for China's chemical industry, accounting for more than 50% of its energy supply (China Chemical Industry Energy Saving Technology Association). Hence, the energy efficiency of China's chemical industry is relatively lower than that of counterparts in developed countries which use mainly oil and natural gas (15%). This energy saving potential in China's chemical industry represents a valuable opportunity for future EU-China technology cooperation.

The chemical companies within the survey areas currently have relatively comprehensive environmental protection and treatment facilities. These include strict targets for three major types of waste discharges (water, gas and residue) and the promotion of clean production processes that seek to incorporate both at-source control and tail-end treatment of discharges. At the same time, these companies are undertaking in-house R&D and working with outside research institutes to develop comprehensive waste treatment and management systems.

Table 9: Existing 'Energy Saving and Emissions Reduction' Technologies and Techniques Used by Companies

Method and project	Efficiency of energy saving and pollution reduction	Savings (t ce/year)	CO_2 emissions reduction (tonne/year)
Dual Pressure suppressing gas	Reduced coal consumption	100k	340k
Utilizing CO_2	Utilisation of CO2 to produce new and side products. A small amount of CO2 is used in food processing.		50k
PTA equipment improvement for energy saving	Saving coal	More than 200k	680k
Desulphurization renovation project	Desulphurization capacity: 1.5 millionM^3/h	-	-
NO_x renovation project	No statistical data	-	-
Sulphur recovery unit	Sulphur recovery: 134k(t/year)	-	-

Chemical industry clusters in the study areas also facilitate a low carbon transition. Firstly, the presence of large foreign chemical companies (such as Yangzi-BASF) has increased local competition and has helped to enhance the 'environmental social responsibility' awareness of domestic firms. Secondly, chemical industry clusters will drive large-scale low carbon technology (including waste water discharge and CO2 emissions automatic monitoring system, energy optimisation control, environmental protection facilities operation control, and real-time online alarm system) deployment in the region, and help to scale up collective 'energy saving and emissions reduction' efforts.

3.4.1 Low Carbon Technology and the Development of China's Coal-Based Chemical Sector

The development of LCE and low carbon technology is country-specific and is influenced by the geographical conditions, energy structure and resource environment. In China, where coal is the dominant energy source, the evolution of the chemical industry in terms of technology use and development pathway is inevitably different from industrialised countries that rely mainly on oil.

The key to ‘energy saving and emissions reduction’ in the coal-based chemical industry is the large-scale deployment of suitable technologies and development of industrial clusters. Firstly, the main technologies used involve coal gasification and the synthesis process. Secondly, process integration through the extension of the industrial chain will also increase resource and energy use efficiency. And thirdly, the development of industrial clusters in industrial parks will promote integrated treatment of waste and energy optimisation.

The following low carbon technology and development direction will be vital to the sustainable development of the coal-based chemical industry:

- Coal gasification technology
- Gas purification technology
- Pressure reduction synthesis system technology
- Energy system optimisation
- Co-generation, or steam turbine compression & extraction technology
- Methanol as raw material, an extension of industrial chain

3.5 The Steel Sector – ‘Energy Saving and Emissions Reduction’ Measures

Due to the dominance of coal in the energy structure and the large usage of limestone, China’s steel sector is the third largest source of CO2 emissions, after power and construction (cement). Energy consumption in the steel sector is also quite high: according to the statistics, in 2007, China’s steel sector consumed 478 million tonnes of coal (25.1% of the total industrial sector energy consumption and 18% of the national total energy consumption). Compared to 2000, energy consumption in the steel sector has grown by 269%, involving a net increase of 348 million tonnes of coal and annual growth rate of 20.5%. (WWF, Low Carbon Business Leadership Case Studies, 2009). The discharge of waste water, industrial dust and SO2 from the steel industry is 10%, 15% and 10% of the national total of industrial discharges respectively. In short, the steel industry is leading in energy consumption and pollutant discharge among Chinese industries (Beijing Lange Steel Information Research Centre).

The following provides an overview and background information on Nanjing Iron and Steel United Co Ltd (Nanjing Steel) including its ‘energy saving and emissions reduction’s reduction measures and its understanding of CO2 emissions reduction.

Existing ‘energy saving and emissions reduction’s reduction measures of Nanjing Steel include:

- Resource recycling – mainly focuses on ferrite resource recycling, energy recycling, water recycling, and solid waste recycling.

Table 10: Brief Introduction of Case Studies – Steel Sector

Company Name	Energy Consumption	Equipment Status
Nanjing Iron & Steel United Co Ltd	Coal consumption: 3 million t/year Comprehensive energy consumption per unit: 7.3 (tce/t)	The company has mining beneficiation, iron and steel smelting, steel rolling productions. It is located in Old and New Production districts. The New District has a modern wide plate production line and supporting facilities. The main equipment include： 2x55-hole coke oven and a 60-hole coke oven a 180m2 sintering machine a 360 m2 sintering machine, a 2000m3 BF a 2550m3 BF 2x120Tone Converter a Wide-slab caster and a wide plate (volume) mill The New District focuses on the following products: high-grade pipeline steel plate high-strength and grade shipbuilding plate low-alloy high-strength structural plate bridge plate boiler plate pressure vessel plate engineering machinery plate high-quality carbon structural steel automobile girder panel

- Zero-emissions from combustible gas during production process – coke oven gas and blast furnace gas utilisation rate of 99% and above; converter gas recovery and utilisation that reaches 100m^3/t steel and above; and zero emissions of combustible gas during basic production process.
- Environmental protection measures – RMB 120 million investment on sintering desulphurisation; the use of steel-making by-products and the use of urban waste for coking.
- In-house power generation – Nanjing Steel has invested RMB 1.18 billion on energy saving projects in the past three years, which includes converter gas recovery, blast furnace gas TRT (Top-gas-pressure Recovery Turbine), coke dry quenching waste heat recovery, furnace gas comprehensive utilisation and other heat recycling measures. The in-house power generation capacity of Nanjing Steel continues to increase and accounts for 43.4% of its overall energy consumption in 2007.

Table 11: Energy Consumption and Emission Reduction of Nanjing Steel

Energy Consumption		Emissions Redution	
Comprehensive energy consumption per tonne of steel in 2007	0.638 tce	Chemical oxygen demand (COD) per unit of steel (tonne) in 2007	0.24 kg/t
Decrease from 2006	0.092 tce	Decrease from 2006	0.2 kg/t
Percentage of decrease	12.60%	Percentage of decrease	41.67%
Comparable energy consumption per tonne of steel in 2007	0.581 tce	SO2 emission per tonne of steel in 2007	2.05 kg/t
Decrease from 2006	0.116 tce	Decrease from 2006	0.05 kg/t
Percentage of decrease	16.64%	Percentage of decrease	2.4%
Fresh water consumption per tonne of steel	6.68 tonnes		
Decrease from 2006	7.28 tonnes		
Percentage of decrease	52.15%		

It was discovered during the feasibility study that unlike other energy intensive industries in China, the steel industry has already recognised the urgency of the problem of CO2 emissions and China Steel Industry Association has even started discussions on CO2 measurement and emissions value. Steel companies are also focusing on low CO2 steel-making processes and CO2 recovery and utilisation. For example, Nanjing Steel is currently using urban waste for power generation, increasing the recycling rate of by-products and improving the recovery rate of scrap.

3.5.1 Extension of 'Energy Saving and Emissions Reduction' Measures – Examples of Low Carbon Technology in the Steel Sector

The results of the feasibility study show that companies within the steel sector have not developed in a homogeneous way. The Chinese steel industry is characterised by low concentration rate, huge technology and capacity gaps, and a large number of firms of different sizes and scale. This also means that there is a wide divergence in energy efficiency between Chinese steel producers and there is also a considerable potential for further 'energy saving and emissions reduction' efforts. For the steel industry, the two most viable low carbon technologies are currently dry coke quenching and low temperature waste heat power generation. In Europe where low carbon technology development is already well underway, its iron and steel industry is developing the 'ultra low CO2 steelmaking' (ULCOS) technology.

Dry Coke Quenching Technology

Environmentally sustainable development is an important issue in coke production today. With good plant design and disciplined operation, emissions can be cut to very low levels or eliminated altogether.

The CDQ technology features:

- Heat from red hot coke (around 1,000°C) discharged from a coke oven is recovered as steam or electric energy.
- The treatment by a closed system makes it possible to prevent atmospheric pollution caused by dust generation and dispersion that is inevitable when wet quenching is employed.
- The quality (strength) of coke is increased due to its gradual quenching method.
- CO_2 emissions can be reduced.
- Even for a medium to small-scale coke oven, a large-sized CDQ system can be installed without modifying the existing wet quenching car track.

Low Temperature Waste Heat Power Generation

Since the 1960s, low temperature waste heat power generation technology has been developed and widely deployed in industrialised countries. However, in China, this technology and the related processes have only been deployed since the beginning of this century, when resource use efficiency, environmental concerns and the introduction of circular economy became important issues for China's steel industry. The upgrading of the traditional sintering and basic oxygen furnace (BOF) steel-making processes, and the deployment of new production processes such as the electric arc furnace have also created demand and opportunity for the introduction of this new technology.

Although low temperature waste heat power generation is now common in the cement industry, its use in the steel, glass, ceramic and other sectors is still relatively limited and the potential is considerable. This technology recycles heat lower than 300°C-400°C from gas, waste steam, hot water and solid materials emitted during the production process to generate power, hence achieving 'co-generation of heat and power'. The use of recycled heat not only provides a valuable source of energy but also helps to reduce pollution.

Ultra Low CO2 Steelmaking (ULCOS)

The ULCOS programme was launched by a consortium of 48 European companies and organisations from 15 European countries led by ArcelorMittal. The aim of the ULCOS programme is to reduce CO_2 emissions of today's best route by at least 50% through R&D and deployment of breakthrough steel-making technologies. It covers the whole innovation chain from basic research to demonstration and to the final stage of commercialisation. Many advanced concepts have been introduced under the programme such as top gas recycling blast furnace, CCS and utilisation of hydrogen energy. The current main focus of ULCOS research is the new non-nitrogen furnace technology – top gas recycling blast furnace (TGRBF). The programme analyses the CO_2 emissions reduction potential of different technologies and makes a selection based on cost-benefit analysis and technology feasibility studies. The demonstration effects of the different technologies are also tested, and the programme aims ultimately to achieve large-scale industrial commercialisation of the new technologies.

The survey of technology use and level of China's energy intensive industries shows that existing measures adopted for environmental protection and energy saving purposes have already helped indirectly to reduce CO_2 emissions and increase the reuse of CO_2. However, the speed and scale of progress is inadequate to meet the increasingly urgent challenge of climate change.

As a conclusion, the feasibility study shows that within the energy intensive industries, companies have, to a varying degree, some understanding of the issue of CO_2 emissions and its solutions. Although there are currently no specific CO_2 emissions reduction targets, companies have recognised the importance of CO_2 emissions reduction in the context of energy consumption, production technology improvement and climate change. Significantly, companies are also showing great interest in the development of low carbon technologies, although their understanding of these technologies remains limited. Low carbon technology can play an important role in China's future sustainable development and in alleviating the global impacts of climate change.

Chapter 4 Low Carbon Technology in Practice – Agriculture

4.1 China's Agricultural Development and Climate Change

China is a large agricultural country and 60% of its population still resides in the countryside. Based on its 2020 economic development plans, the primary sector will still account for 13% of its GDP and employ 40% of its workforce by 2010. China's arable land and water resources are inadequate to support its large population: despite having 22% of the world's population, its arable and water resources only account for around 7% of the world total equating a very low level of natural resource per capita (Circular Economy and Sustainable Development, 2009). In addition, the distribution of its water resources is uneven. The Southern and the Yangtze regions have 54% of the population but 81% of the water resources, compared to the Western and Northern regions that have 46% of the population but only 19% of the water resources.

To reduce the pressure caused by resource scarcity and rapid population growth, in the 1970s, China adopted the practice of modern 'ecological' agriculture. Ecological agriculture refers to an integrated agro-ecosystem that emphasises material recycling within an ecosystem and regular energy conversion. After more than two decades of demonstrating and implementing various types and sizes of eco-agricultural projects, a unique eco-agriculture system has been established in China. The recent implementation of the circular economy policy and 'New Countryside Development' has further accelerated its development in China.

At the early stages of LCE development, low carbon technology R&D and deployment efforts mainly centred on the industrial sector. In contrast, the need for the development and deployment of low carbon technologies that are suitable to China's agricultural sector has yet to attract enough attention, especially in the context of international cooperation. This needs to be changed for the following reasons.

Firstly, the emissions of GHG including CO2 are closely related to the agricultural sector. Agriculture is one of the main sources of GHG: 1. methane and argon-nitrogen oxide emissions from animal husbandry; 2. methane emissions from rice fields; and 3. nitrous oxide emission from agricultural land. According to preliminary estimates, GHG emissions from the agricultural sector in China account for 17% of its total emission. On the other hand, agriculture, soil, crops and grassland also act as carbon sinks and help to regulate the climate.

Current eco-agriculture and circular economy measures are already helping China's agricultural sector to reduce GHG emissions by increasing soil carbon storage capacity and energy saving. These measures include:

- The dissemination of biogas use in the rural areas through the implementation of the Rural Sustainable Development and Promotion of Biogas Technology Plan.
- The increasing use of scientific approaches in soil fertility including soil testing and the use of organic fertiliser to reduce nitrous oxide emissions.

- The promotion of 'straw mulch tillage'-based protective farming in order to increase the organic carbon content of soil.
- The use of GHG emissions monitoring, carbon emissions reduction and absorption, and biomass technologies.

Secondly, global warming and extreme weather caused by the emissions and atmospheric concentration of CO2 will have serious negative impacts on the agricultural sector and the farming community. These impacts include increased instability in agricultural production, changes in geographical location of agricultural production, aggravated soil erosion and desertification and pests and disease infestation. Due to the recent extreme weather such as severe drought and floods, a drop in food supply within China has become a common occurrence. According to the latest research, China's agricultural productivity, primarily wheat, rice and corn, will drop by 5%-10% by 2030 due to climate change and will continue to get worse by 2050 (Greenpeace, Climate Change and Poverty: a Case Study of China, 2009). Another effect of climate change (through accentuated drought and floods cycles) is the continuing decrease of water resources in the Northern region and increase in the water volume in the Southern region. In response to this situation and to ease the pressure on food production, the Chinese government has introduced a series of measures including the 'South-to-North' water diversion project. However, this project has at the same time increased the pressure on energy supply and demand.

It is therefore clear that the development of LCE and technology is vital for the agricultural sector for two reasons: to help to reduce GHG emissions and to adapt to climate change. With this as the starting point, the feasibility study has carried out surveys in two agricultural counties in Pingliang City, Gansu Province, in order to understand the following:

- The current GHG emissions reduction measures and their effectiveness in the agricultural sector.
- Measures that increase the adaptability of the agricultural sector to climate change and reduce the impacts of climate change on the production of crops and other agricultural products.
- The potential for extension of, or transition from, a circular economy to a LCE.

4.2 GHG Emissions Mitigation Measures – Jingchuan County

Jingchuan County is a major agricultural county in Pingliang City with a total area of 1,409.3 km^2 and a population of 310,000. It also has 880,000 mu of arable land. As a traditionally agricultural county, Jingchuan's industrial sector is under-developed. Jingchuan County is, however, rich in natural resources. A coordinated development of its industries and natural resource environment should be promoted to establish mutually dependent and supportive industrial and agricultural sectors. For example, this can be achieved through industrialisation of its fruit and husbandry sectors with support from the government, the public and private investors. The construction of eight modern agricultural industrial zones scheduled for 2009 has already begun. These include fruit orchards (mainly apples) and large-scale animal feeding centres. Its modern agricultural industrial zones have managed to attract a large number of food and beverage processing companies and high-tech firms.

Investments so far include a 30 million broiler slaughter project, a 30,000 tonnes concentrated apple juice production line, and a 30,000 tonnes organic fertiliser project. Jingchuan County has organised 12 business events in the first half of 2009 and has so far attracted a total investment of RMB 300 million.

Jingchuan County's agricultural sector is currently undergoing the process of industrialisation. In relation to 'energy saving and emissions reduction', following the intensive industrialisation process, the deployment of renewable energy is now widely promoted among its rural households and the demand from its industries for large-scale use of renewable energy has also increased (see Table 12). Among the important measures that it has taken are:

Table 12: The Effectiveness of 'Energy Saving and Emissions Reduction' Measures

Modification Projects	**Biogas**	**Agricultural New Energy Saving Technologies**	**Organic Fertiliser**	**Central Heating**	**Waste Resources**
Introduction	A 8m^3 methane-generating pit can generate 300m^3 gas annually	Biogas, solar cookers, solar water heater	Better use of manure after fermentation	11 km of heating pipe has an annual heating capacity of 40,000 m^2	Fruit dregs produce 2,000 tonnes of pectin and 3,600 tonnes of insoluble dietary fibre
Aim of modification	Energy saving, clean rural village	Energy saving, carbon emissions reduction	Fertiliser substitution	Energy saving	Resource reuse
Energy saving and pollution reduction impacts	Annual saving of RMB 1,000	-	Reduction of fertiliser use of 50kg per mu	Shorter duration of land restoration	-
Reduced dust emissions	-	-	-	380 (tonnes)	-
Reduced coal use	-	23.1 (kg/household)	-	5,000 (tonnes)	-
Reduced CO2 emissions	-	6.9 (10,000 tonnes)	-	-	-
Reduced SO2 emissions	-	90.9 (tonnes)	-	300 (tonnes)	-
Reduced stalk burning	-	158 (kg)/ person	-	-	-
Reduced firewood	2,000 (kg)	24 (kg) / person	-	-	-

- Promotion of energy saving: this is achieved by making full use of currently available technology and continuing to improve energy saving projects such as integrated disposal of waste water, rural livestock and poultry manure treatment, urban waste treatment and so on.
- Widespread deployment of agricultural energy saving technologies: within the County, 7,990 biogas digesters, 5,840 solar cookers, and 5,578 meters^2 of solar water heaters have been built and deployed. Also 50 eco-village demonstration sites and 4,794 'livestock (manure waste) – biogas (organic fertiliser) – fruit (tree)' energy model households have been established.
- Implementation of design measurement standards for energy saving and active promotion of energy saving in buildings: including the use of central heating and various insulation measures.
- Developing the linkages between industries and waste recycling: this includes turning end waste products from biogas into high quality organic fertiliser for the orchards, and the recycling of 6,000 tonnes of fruit dregs.

4.3 Arid Agriculture – Chongxin County

Chongxin County is the smallest agricultural county in Pingliang City with a total area of 850 km^2 and a population of 94,000. It has more than 370,000 mu of arable land and 250,000 mu of wasteland that can be used for development purposes. Chongxin County has experienced rapid economic growth in recent years, and its success in arid agriculture has become an example for other places.

Arid agriculture is also known as rain-fed agriculture where the only source of water supply comes from the rain, so technologies that collect and store rain underground are fundamental. From 2003-2005, the 'all-film double-furrow sowing' technique was first tested in Chongxin County, and was subsequently piloted in other regions in Gansu Province. The use of this new technology resulted in a more than 35% and 30% increase in corn cultivation (compared to semi-membrane planting technique) and potato cultivation (compared to open-field planting) respectively. Its drought-resistant and high yield properties make it a tremendously valuable technology. Chongxin County has invested RMB 10.24 million on the promotion of arid agriculture technologies, including the deployment of the 'all-film' technique in 50,200 mu of arable land. Food production per capita remains above 600 kilograms with an annual growth rate of more than 50%. The unique characteristics and added-value of the 'all-film' technique include:

Agricultural Production Technology

The 'all-film' technique has increased the controllability and stability of arid agriculture production. The technique is also more effective in improving water harvest and crop productivity in semiarid areas.

Compared to common plastic film mulching, the new technology provides three different treatments to improve soil moisture:

- It changes semi-membrane coverage into double film coverage, which helps to retain more rain water and moisture from the soil.
- It uses groove ridge planting instead of mulch planting.
- It moves the sowing time to autumn (around October) and spring (March).

Agricultural Industry Structure

Widespread deployment of the 'all-film double-furrow sowing' technique will promote large-scale farming and agricultural sector industrialisation. It has transformed the agricultural sector in semi-arid areas. There are now regions that specialise in corn and potatoes production and a number of leading industries (based on corn, corn stalks (as feed) and the corresponding agricultural products processing industry). It will further promote modernisation and development of arid agriculture.

Ecological Sustainable Development

Large-scale deployment of the 'all-film' technique will enable the transition to an eco-agriculture through land use change and arable land remediation. For a long time, extensive farming has been carried out in arid areas to provide food for the growing population, and has caused serious ecological problems and soil erosion. The new 'all-film' technique increases the level of intensive farming and land productivity and promotes the move away from extensive farming. The widespread deployment of this technology promotes effective use of China's limited land resources as well as optimising the restoration of the ecological environment by encouraging the conversion of sloped land into forest and grassland and the co-development of farming and aquaculture industry.

It is vital to ensure that this new 'solution' does not create new environmental problems. For example, the use of a huge quantity of plastics in the deployment of 'all-film' technique will create the problem of white pollution if conventional plastics are used. To avoid this, biodegradable plastics can be used instead. China's achievement in the development of biodegradable plastics is discussed below.

4.4 From Circular Economy to Low Carbon Economy – Chongxin County

In recent years, the concepts of circular economy and comprehensive resource utilisation have been widely adopted in China's countryside. For example, the use of biogas, organic fertiliser and solar energy are becoming increasingly common in the rural areas. But there remains the challenge of how to promote their deployment on a large scale, namely moving from a 'household use' model to an 'industrialised' uptake in order to attain economic efficiency and progress towards sustainable development. On this basis, Chongxin County has been actively exploring a new 'green and circular' agricultural development model that combines arid agriculture and animal husbandry (see Figure 1), and has so far achieved some breakthroughs in the use of corn stalks as feed and standardisation of cattle ranching farms.

Corn Stalks Feed

Through technological development, Chongxin County has managed to increase its corn yield. There are currently six corn stalks feed processing operations in Chongxin County, helping it to launch its farming and animal husbandry industries and enhance the standard of beef-cattle feed.

Corn Stalks Conversion and Utilisation Technology

This technology uses machines to break down corn stalks completely, turn them into soft strips, compact them into bales, and finally turn them into coated silage, which can then be used as feed for cattle, sheep and other ruminants. By crushing corn stalks, it increases the feed's palatability and its rate of utilisation, and it is currently the preferred method of feed processing. This technology recycles agricultural waste as well as decreases the operation costs of animal husbandry.

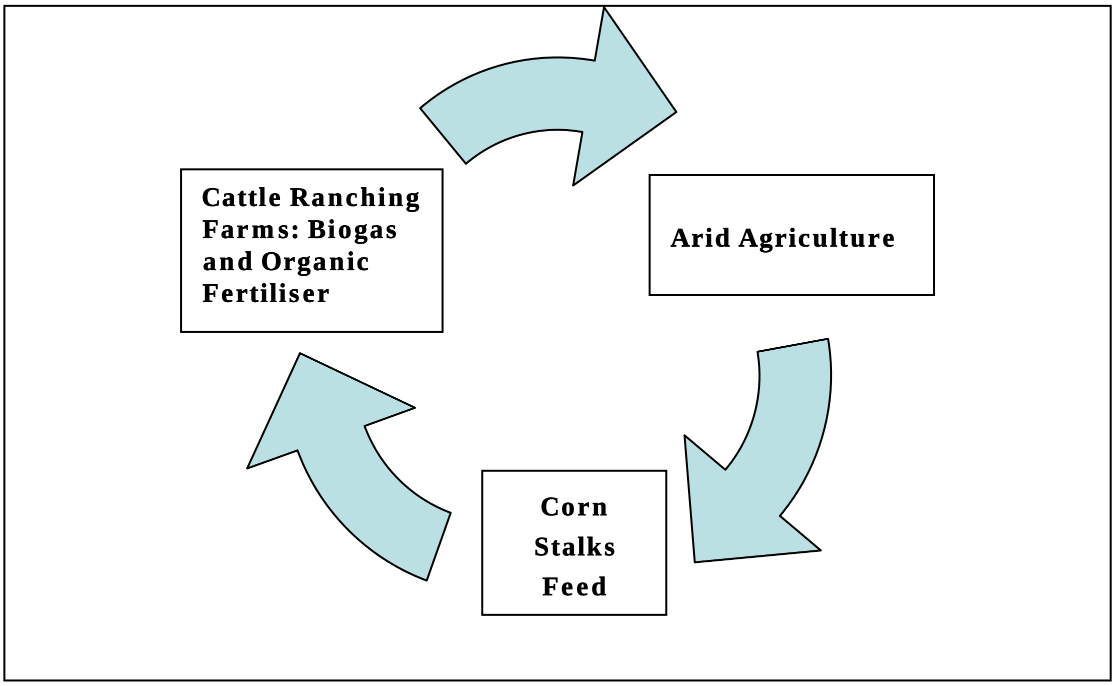
Standardisation of Cattle Ranching Farms

In Chongxin County, 60 mu of land in Yangjiagou Village in Huanghua Town has already been set aside for cattle ranching. A total of RMB 7.5 million will be invested in this project and 50 standard cattle sheds (with capacity of 1000 cattle each) will be built over two years. Centralised feeding and management, and comprehensive resource utilisation in these standardised cattle ranching farms have helped to solve the problems of environmental pollution and resource waste caused by fragmented cattle ranching operations. The scientific (large-scale, market oriented and highly effective) development and industrialisation of the cattle ranching sector in Huanghua Town have transformed the production and management of the animal husbandry industry by enhancing its concentration level. As a result, Chongxin County now has a cattle ranching capacity of 76,000 (cattle) and revenue from the industry amounts to 21% of the rural per capita net income.

4.5 Low Carbon Technology Development Potential and Opportunities

Successful experiences in Jingchuan and Chongxin counties show that the circular economy based on traditional, small-scale farming is being scaled up and industrialised. This provides the basis for future development of LCE and technology in the agricultural sector. As a result of this development, small-scale comprehensive resource and renewable energy utilisation are no longer adequate to meet the demand of large-scale production systems. The use of low carbon technology will hence help to promote sustainable industrialisation of the agricultural sector as well as overcome the demand bottleneck for large-scale comprehensive resource use. This also means that many European advanced low carbon technologies will become more widely applicable in China's agricultural sector. For example:

Figure 5: 'Green and Circular' Agricultural Development Model



Centralised Biogas Supply Engineering and Biogas Industry

Together with the rapid development of a more centralised animal husbandry sector, the development of a rural biogas industry also needs to be accelerated. It is foreseeable that as biogas use is specialised, commercialised and becomes more accessible, the demand for the following technologies will also increase: biogas purification and upgrade (to natural gas that contains 94%-98% methane), high concentration dry anaerobic fermentation, biogas fuel cells power generation, and biogas-powered engines. European countries already have successful innovation experiences in these domains: for example, Sweden will soon test the world's first biogas-powered train. The deployment of these technologies will have significant implications in China.

Solar-Powered Water Purification

Solar-powered water purification technology has been widely deployed in the Scandinavian countries. It is also becoming popular in developing countries such as Kenya and Nepal. The underlying principle of the technology is rather simple: water is purified by filters that use ultraviolet rays from the sun. Based on a five-year calculation, the purification cost of 1 litre of water using a conventional technology would cost 50 ore (7 cent USD) while it will only cost 2 ore with the solar-powered technology. Thus, the deployment of similar technology is highly viable among rural households and cattle ranching farmers in China.

Biodegradable Plastic

Biodegradable plastics are a representative low carbon technology and are currently made from corn starch. In light of the concern of energy security and the problem of serious white pollution in China, the promotion of the use of biodegradable plastics can further develop China's new eco-plastic industry. China currently has its own categories of plastic film biodegradable certification standards – GB/T20197. It follows the footsteps of the EU (EN13432), US (ASTM 6400) and Japan (JIS-K6950this) to become the world's fourth biodegradable plastics certification standards, and is also the first of its kind among developing countries. China also has its own degradable plastic products evaluation system. The development of the biodegradable plastic industry in China has kept pace with its counterparts in the US and EU, and many cost-effective technologies can also be found in China.

Chapter 5 Low Carbon Technology in Practice – Research and Development

5.1 Zhangjiang Hi-Tech Park – Low Carbon Concept and the Definition of 'Low Carbon Industries'

The research and development (R&D), deployment and diffusion of low carbon technology and products are the key to the development of a LCE. In order to understand China's current low carbon technology R&D capacity and potential, the feasibility study team has visited Zhangjiang Hi-Tech Park in Shanghai.

Zhangjiang Hi-Tech Park is situated in Pudong, Shanghai. It was established in 1992 and occupies an area of 25 km^2. It is also one of the earliest national level high tech parks approved by the Chinese government. In the 16 years since its inception, Zhangjiang has created its own unique 'hi-tech' development path by becoming the centre for the three major hi-tech industries of IC (integrated circuits), bio-medicine and software. The major advantages of Zhangjiang are the degree of openness Shanghai offers to foreign firms, its favourable policy environment and its success in attracting highly skilled professionals. So far Zhangjiang has managed to attract R&D institutions from many of the 'Fortune 500' multinationals: for example, seven of the 'Big Pharma' companies have set up R&D centres in Zhangjiang, making it the most 'pharmaceutical R&D' intensive area in the whole world. In recent years, following the increase in domestic R&D and innovation capacity, many Chinese state-owned and private-owned firms have also set up R&D centres in Zhangjiang.

In early 2009, Zhangjiang introduced its planning goals for the next 10 to 15 years. It will become an eco-industry model zone, a new low carbon industrial demonstration zone, an innovation centre and a leader in setting high technology standards. The feasibility study has set out to identify the low carbon concept and the definition of low carbon industries in Zhangjiang.

Zhangjiang's low carbon development involves setting up low carbon industry clusters that will help to drive its low carbon R&D sector, which in turn will help to expand its low carbon industries. Its two main focuses are new energy and energy efficiency and environmental protection technologies. It also plans to create a low carbon living environment through low carbon planning in the construction of infrastructure, social and natural environment. The low carbon elements of Zhangjiang in relation to its industries include:

- Overall industrial planning that aims to attract R&D- and innovation-based industries and firms, and to restrict energy and land intensive manufacturing industries.
- Decarbonising its existing bio-medical and IC industries and promoting 'zero emission' low carbon production chains, e.g. IC design R&D and services.
- Emphasising R&D and innovation of new energy technologies. In recent years, a number of domestic private R&D firms have moved into Zhangjiang and have grown rapidly. Their R&D focuses include:

- Solar energy: second generation thin-film technology and third generation high-performance solar cells and equipment – there are currently 20 solar energy R&D SMEs in Zhangjiang
- Hydrogen energy technology
- Wind power equipment
- Second generation bio-fuel, e.g. ethanol from straw
- Low carbon transportation, e.g. ultra-capacitor bus

According to 2006 statistics, zero and low carbon emissions industries, including the software, IC design and cultural and creative industries, accounted for 48.3% of the total added value of Zhangjiang, and is expected to grow to 52% and 70% by 2010 and 2020 respectively. As one of its new 'pillar' industries, the new energy sector is expected to grow rapidly during this period through the development of a new energy base and the establishment of a new energy fund in Zhangjiang.

Another advantageous attribute of Zhangjiang is its investment portfolio in advanced technologies, which is carried out by its management group – Zhangjiang Science and Technology Co Ltd and its subsidiary Haocheng Zhangjiang Hi-Tech Park Venture. Its investments are market oriented but are carried out in the context of the national policy (on science and technology) and its future hi-tech development needs. Investments in new energy and low carbon industries will be an important part of Zhangjiang's low carbon development strategy. These investments are vital, especially for the new energy sector, as the subsidies currently offered by the government are inadequate to cover all R&D and production costs. Its current major investment focuses are:

- LED use
- Wind power (in particular equipment manufacturing)
- Solar energy (thin-film batteries)
- Vehicle emission treatment equipment
- High- power fuel cells
- New materials
- Energy saving technologies and processes (energy management of large electricity users)

Despite the fact that investments in new energy and low carbon technologies have increased internationally, Chinese venture capital institutions still have reservations regarding investing in these new sectors due to the following reasons:

- Domestic and international policy uncertainty: Chinese venture capital institutions are following international discussions on climate change and energy closely. This is due to the fact that historically, China's domestic policy is very much influenced by the US and EU. To many investors, US climate change, energy and technology development policy are still far from clear; in addition, domestic and international policy on and market signals for new energy still need to be strengthened. As a result, it is still difficult for China to reconcile its strategic interests and the needs of its investment market.

- In relation to EU-China climate change cooperation, clean development mechanism (CDM) has been less than successful mainly because of its inconsistent market development and its potentially limited scale-up. At the same time, although the EU has introduced an energy and climate change package, there is still a disparity between policy and actual market conditions or demand. Hence, EU-China climate change and energy cooperation discussions at the policy level are yet to receive sufficient acceptance and support from Chinese investors.
- A lack of understanding of the concept of LCE among Chinese investors has until now limited large-scale investments; in the EU and US, investments in the new energy sector in the EU and US have become stagnant due to the global financial crisis.
- In China, investors are given a wide range of investment choices and most of the time would prefer other relatively 'safe' investments. For example, medical equipment is popular among investors due to the rapid development of the corresponding medicinal R&D and production sectors; in contrast, the new energy sector still lacks a clear investment policy and direction.

However, the feasibility study found that despite the cautious attitude, many multinationals and domestic private companies have already taken the first steps towards building a multi-disciplinary and competitive international low carbon market in China. This is illustrated below.

5.2 In China for China – International R&D Institutions

Zhangjiang is ready for the development of low carbon technology due its solid R&D foundation and favourable international R&D environment. The following gives an overview of the R&D activities of three major multinationals in China.

GE China Technology Centre (CTC)

GE CTC is one of GE's four (China, US, Germany and India) global R&D centres. Located in Zhangjiang Hi-Tech Park, it was opened in 2003. It is one of the largest independent foreign-funded R&D institutions and is also one of the very few commercial R&D centres that carry out basic scientific research in China. It has more than 1,400 employees at CTC, around 60 of which work in well equipped laboratories. CTC completes more than 100 research projects every year, one third of which are basic research projects. By the end of 2008, CTC had applied for more than 368 patents in China.

By adopting the 'In China For China' strategy, GE uses local talents for and incorporates local culture into its R&D activities, while its products and services target both the international and the domestic markets. In addition, GE will also expand its regional R&D capacity by extending its investments to the Western, Central and North-Eastern regions of China. China's Science and Technology Medium and Long Term Development Plan forms the basis of GE's sustainable development and low carbon development strategy in China, and guides its development of products and technologies that are suitable for the Chinese market (see Table 13).

Table 13: In China For China – Examples of R&D Focuses of GE CTC

Major Sectors and Areas of Focus under the National Long Term Planning	GE's R&D Projects
Energy	High efficiency energy, coal gasification and integrated gasification combined cycle (IGCC) CTL, Polygen, renewable energy, power grid control and security
Water	Water saving, water reuse, water recycling, desalination, zero discharge of waste water
Environment	Recycling, air/water quality monitoring
Manufacturing	Digital manufacturing, automation, functional materials and parts, organic light emitting diode (OLED)
Transportation	Basic infrastructure construction and maintenance, high efficiency and new energy vehicles
Information	Remote diagnostics, traffic information network, digital manufacturing
Urbanisation and urban development	Medical, environmental protection technologies, urban transport, electricity, security

In recent years, one of GE's most influential R&D strategies and activities is 'Ecomagination': in China, GE aims to help solve major environmental problems (while driving profitable growth for GE) by working with the government to promote China's industrial technology upgrade. GE has invested and will invest in the following 'Ecomagination' products:

- Clean coal IGCC technology
- LMS100 gas turbine, gas engine, GE9FA gas turbine, GEnx aircraft engine
- Wind power
- 'Green' lighting including variable power distribution system and lighting system
- Water treatment such as ultra-filtration membrane technology, wastewater reuse technology, rain water reuse technology, water desalination, water purification technology and reverse osmosis membrane technology
- CO_2 separation and capture technology

At the same time, CTC is also paying a close attention the future development of CCS technology in China, and maintains close communication and interaction within its global R&D network and with GE's R&D centre in Germany in relation to low carbon and renewable energy technologies.

Honeywell Technology Solutions Lab China (TSLC)

Honeywell is present in 13 countries in the Asia Pacific region and its headquarter for the region is set up in Shanghai Zhangiang Hi-Tech Park. Honeywell's manufacturing operations are primarily concentrated in Australia, China, India, Japan, South Korea, Singapore and Taiwan. Honeywell has already invested more than $500 million in China and has an annual turnover of more than $500 million. It employs nearly 1,000 researchers in China, about 700 of who work at Honeywell Technology Solutions Lab in Zhangjiang.

Honeywell's TSLC is already carrying out many low carbon development related R&D activities as part of its objective to "***build a safer and more secure, more comfortable and energy-efficient, and more innovative and efficient world***". Its specific R&D focuses include (see Table 14):

Table 14: Overview of Honeywell TSLC R&D Activities

Automatic control	Industrial control technology, products and services, residential / commercial buildings control
Aerospace	Products and services, small emission aircraft engines, airborne components
Specialty materials	Specialty chemicals, polymer, electronic materials, solar energy, solar energy substrate stent
Transportation system	Turbocharging system, biomass fuel

Dow Chemical (China) Co Ltd

Dow Chemical is the world's second largest chemical company, after DuPont Chemical (US), in terms of total output. It has 47,000 employees in 175 countries, and produces about 3,500 types of products in the sectors of transportation, medicine, and electronics. It has more than 5,000 employees in China and its R&D centre in Zhangjiang can be divided into three main components: basic R&D, commercial R&D and technical services. Its 500 scientists and engineers in Shanghai Dow Centre carry out experiments and research in more than 80 laboratories in areas such as buildings, energy, water treatment, electronic equipment and personal care (see Table 15).

Table 15: Overview of Shanghai Dow Centre's R&D Activities

Energy efficiency improvement	**Materials, building energy saving**
Water-saving	Recycling of sea water, brackish water, municipal water and treated water resources, reverse osmosis membrane
CO_2 emission reduction	CO_2 capture, wind power, automobile, solar cells, biomass materials
Solid waste reduction	Clean production

The concept of sustainable development has been integrated into Dow Chemical's products design, transportation, use and recovery, and has also been incorporated into the management and operation of the company (e.g. data compilation, company objectives). Dow Chemical has also introduced a sustainable development target. Between 2006 and 2015 it aims to reduce by 25% its total pollutants discharge, using 2005 as the baseline. It is also involved in the following 'energy saving and emissions reduction' activities in China:

- Training of industrial 'clean production' professionals
- Participating in the development of China's energy audit system
- Providing financial support to CO_2 emissions reduction activities in China's countryside (Shaanxi)

5.3 Shanghai Bi Ke Clean Energy Technology Co Ltd – A New EU-China Technology Cooperation Model

China Academy of Sciences (CAS) is China's largest and most influential R&D institution. It owns more than 100 specialised research institutes, six of which carry out important energy technology R&D and are distributed throughout the country (Beijing, Shanxi, Dalian and Guangzhou). The new Shanghai Clean Energy Technology Development Centre is recently built in Zhangjiang Hi-Tech Park, and is CAS's first energy-related R&D centre in Shanghai. It not only provides strong R&D support for the development of a new energy industry in Zhangjiang but also represents a strategic objective of CAS that aims to promote scientific and technological industrialisation in China.

In relation to CO_2 emissions reduction technologies, CAS's Shanghai Clean Energy Technology Development Centre currently focuses on two research areas:

- CO_2 capture: the most cost and energy effective way of capturing and the optimised use of CO_2
- Large-scale coal chemical polygeneration

Since its inception, Shanghai Clean Energy Technology Development Centre has become a 'bridge' between CAS and the business community. For example, the Centre is already cooperating with large enterprises such as Shanghai Electric (China's largest energy equipment manufacturing enterprise), Xinjiang Goldwind Science and Technology and Yanzhou Mining Group in the fields of thermal power, nuclear power and wind power. By integrating the different research outcomes and understanding the demand of the industry, it designs projects and provides specific technological solutions for enterprises.

In relation to international cooperation, CAS has entered into partnerships with multinationals such as BP, Shell, Samsung and GE. Its recent joint venture with BP, Shanghai Bi Ke Clean Energy Technology Co Ltd (CECC), is of particular interest. CECC is an innovative and multifunctional (technology, engineering, capital and market) business-R&D joint venture providing a commercial win-win model for international technology cooperation:

- It resolves development bottlenecks of energy technologies by creating an innovation value chain, and by exploring new development models and pathways that will help to internationalise China's energy technologies.
- It brings together the advantages of CAS and BP and promotes a 'win-win' situation in the following aspects:
    - The combination of 'coal conversion' technology R&D capacity (CAS) and the actual engineering and commercial application experiences (BP).

- The combination of actual investments in copyright and IPR (CAS) and international IPR management and operation (BP).
- The combination of technology and product R&D capacity (CAS) and market prediction and operation capacity (BP).

This strategic and innovative partnership will rapidly close the gap between China's R&D capacity and the market demand for new technologies. Internationalisation and industrialisation of low carbon technology in China will also help to accelerate the deployment and diffusion of these technologies in the global market.

5.4 Future Low Carbon R&D Trend in China

The feasibility study found that other hi-tech parks that are similar to Zhangjiang (in terms of R&D capacity and high degree of openness) have also already incorporated the concepts of 'low carbon technology' and 'low carbon economy' into their investment promotion and technology capacity building policy and strategy. Low carbon technology R&D activities and projects undertaken by multinationals, domestic firms, and research institutions of various sizes will help to accelerate a low carbon transition in China.

The direction of R&D development in Zhangjiang Hi-Tech Park is broadly in line with the international trend where huge investment is put into renewable energy and CO2 capture technology. At the same time, taking into account the principles of 'In China For China' and 'LCE with Chinese characteristics', clean coal and integrated coal resource use will become the main focuses of future low carbon technology development. This is because China uses substantial coal resources and only 10% of the existing coal supply is available for gasification, and this will remain the case for a long period of time. The development and deployment of low carbon technology will help firms to achieve technological breakthrough and increase their competitiveness. It will also allow firms to find new markets in existing sectors such as the coal-based chemical industry, or excel in the technology field.

China's market size creates the conditions for accelerating the processes of R&D, small-scale testing, large-scale demonstration and real-life modelling of low carbon technology. In other words, it shortens the innovation chain of low carbon technology. Enhanced international cooperation (such as the joint venture between CAS and BP) will also quicken the pace of development and commercialisation of new technologies. At the same time, just as in other countries, government policy and financial support are needed at the early stages of low carbon technology research and development, while market openness and competition are needed for technology transfer and diffusion. As the R&D capacity in China increases, a better market and policy environment will help strengthen China's role in the international low carbon technology market.

Chapter 6 Resource-Based Low Carbon Economy in Western China – Pingliang

6.1 Introduction

In light of Gansu Province's development need and resource endowment, the Chinese government has designated Gansu as the 'New Energy Resource Development Base'. Construction of new infrastructure, electricity grid and railway has been carried out to overcome the existing logistical problems and to fulfil the national energy strategy of 'From West to East' electricity transmission. Being an important coal and oil producer and due to its strategic location, Pingliang City is a key part of the national development strategy. Pingliang City has been selected as a demonstration zone for the EU-China low carbon technology and investment feasibility study due to its regional characteristics and development needs:

- It is situated in the poorer Northwest region of China – economic development is characteristically dominated by ***energy intensive, high emission and resource intensive*** industries.
- The needs and potential for ***economic development leapfrog*** – from a 'high carbon and low income' to a 'low carbon and high income' model.
- The presence of both large and small companies in the energy intensive sector – the demand for new technologies, industries and development pathways in the process of ***industrial restructuring and upgrading***.
- Agricultural population and economy – it suffers from adverse climate change effects and is in need of ***agricultural production and development adaptation to climate change***.
- From the perspective of international cooperation, g***overnment-to-government and business collaborations*** on low carbon technology will facilitate technology introduction and investment from European businesses in Pingliang City and the Gansu region.

In order to understand the foundation and potential of Pingliang City as a LCTIDZ, the feasibility study focuses on the following:

- Recent economic development trends and existing 'energy saving and emission reduction' measures
- Medium and long term development plan and strategy
- Current LCE development foundation
- The implications of EU-China LCTIDZ and the direction of cooperation

6.2 Overview of Pingliang City

Pingliang City is one of the major cities in Gansu Province. It is situated at the epicentre of and is 300 km away from the three major provincial cities of Xi'an, Lanzhou and Yinchuan. It is also the transportation hub of the three provinces of Shaanxi, Gansu and Ningxia. Pingliang City consists of six counties and one district (Jingchuan, Lingtai, Chongxin, Huating, Zhuanglang and Jingning Counties and Kongtong District), with a total land area of

11,000 km^2. Its total population is 22.8 million, 85% (19.3 million) of which reside in the countryside. Urbanisation has accelerated in recent years. By 2010 the urban population is forecast to increase to more than 2.5 million people, rising to 3.2 million people by 2020.

Pingliang City is rich in natural resources, mainly minerals, petroleum, and fruit-, vegetable- and livestock-based agriculture.

Coal Resources

Pingliang City is rich in coal resources, with estimated coal reserves of more than 65 billion tonnes scattered among the four counties and the district of Huating, Chongxin, Jingchuan, Lingtai and Kongtong. Huating has the largest coal mine in Gansu Province and its Hualong coal field is also one of the 13 large-scale national coal bases, with total (proven) coal reserves of 3.6 billion tonnes. Pingliang City's coal has the unique 'three high, three low' (high volatility, high chemical activity, high heat, low ash, low sulphur, and low phosphorus) features, which is ideal for use in power generation, coal gasification and coal-based chemical.

Oil resources

In 2008, the Northwest subsidiary of Sinopec successfully drilled a flowing well in Jingchuan County with a daily oil production of $36m^3$, which marks a breakthrough in Pingliang City region oil exploration. Early estimates put the oil reserve at 430 million tonnes.

Agriculture and Livestock Development

Pingliang City is a typical arid agricultural region; it is also Gansu Province's 'green' animal husbandry and fruit production base. At present, there are 1.6 million mu of orchards and economic forests which are dominated by high-quality apple orchards. It also has 974,000 cattle, ranking first among the rural regions of Gansu Province. In 2008, output from both its fruit and livestock production contributed to 22% of rural per capita income (total per capita income of the rural population was RMB 2,414).

6.2.1 Industrial Development in Pingliang City

Under the 11th FYP (2006-2010), Pingliang City aims to fully exploit its coal resources to promote its industrial development based on key industries such as coal power, chemical and construction. It emphasises the expansion of the industrial sector economic output, the upgrade of key traditional industries and the exploration of new industries development opportunities. In recent years, Pingliang City has been active in promoting investment by large enterprises in its coal-based power and chemical industries. Huating Coal, Huaneng (Pingliang) Power, and Pingliang Qilianshan Cement are now the backbone enterprises of Pingliang City.

By the end of 2008, the total industrial added value in Pingliang City reached RMB 6.41 billion, RMB 5.55 billion (87%) of which came from Pingliang City's 80 above-designated-size (ADS) enterprises, with the annual growth rate of more than 15%. In particular:

Table 16: Industrial Restructuring of Pingliang City's Key Industries under the 11th FYP

Industry	2000		2004		2010	
	Added Value	Percentage %	Added Value	Percentage %	Added Value	Percentage %
Coal Power	**2.30**	**36**	**16.6**	**72**	**57.3**	**84.3**
Construction	**1.25**	**19.6**	**0.92**	**4**	**3.1**	**4.5**
Electrical	0.51	8	0.56	2.4	1.6	2.3
Food processing	0.59	9.3	0.90	3.9	3.0	4.4
Others	1.73	27.1	4.02	17.4	3.0	4.4

- The industrial added value of its 36 coal power enterprises was RMB 4.45 billion, which accounted for more than 80% of the total industrial added value of ADS industries. The total coal production from these enterprises amounted to 20.14 million tonnes, accounting for 51% of Gansu Province's coal output and ranked first among the seven major coal-producing cities in the province. The coal in situ conversion rate was 28%.
- There are 4 power generation companies – 3 coal-fired power plants and one small-scale hydro plant – with a total installed capacity of 1.54 GW and annual maximum generating capacity of 11000 GWh. Their generating capacity in 2008 amounted to 9320 GWh, accounting for 13.5% of the province's total generating capacity. By the end of 2008, added value of the power sector in Pingliang City was RMB 1.78 billion, accounting for 32% of the industrial added value of ADS enterprises. Overall energy consumption in Pingliang City in 2008 was 1620 GWh, and energy consumption in the industrial sector alone was 1076 GWh, while the potential for electricity export from Pingliang City was 7700 GWh.

Although the coal power industry has grown rapidly during the 11th FYP, its transition from a resource-based development model to a modern industry -based development model has proceeded relatively slowly. The 'extensive' growth pattern of the coal power industry is prominent, which is reflected in its short industrial chain, low added value, relatively weak pulling effect, and low employment turnover, resulting in a waste of resources.

In terms of its development potential, the power sector in Pingliang City has entered the stage of large-scale and rapid construction. As the role of the power sector in Pingliang City's overall economic development becomes more important, the difficulties and problems it faces are also becoming more prominent. They include under-developed power infrastructure, lack of strong support from the electricity network, poor transmission of electricity, and relatively low standard of power grid equipment.

Energy Saving and Emissions Reduction Targets and Achievement

By the end of the 11^{th} FYP, energy consumption per RMB 10,000 GDP of Pingliang City is expected to decrease by 20%: a drop from 3.03 to 2.42 tce. In Pingliang City, Huaneng is the largest coal consumer among the 11 major (above 10,000 tonnes) users of coal, accounting for more than 60% of the industrial energy consumption. The 20-30 main users of coal in Pingliang City together account for 80% of its industrial energy consumption. In relation to 'energy saving and emissions reduction', Pingliang City has taken the following measures:

- Energy saving target agreements have been signed: between Pingliang City municipal government and seven key governmental departments, between the Municipal Economic Commission and 11 major energy-consuming enterprises, and by county- and district-level large enterprises and some towns and villages.
- Actively engaged in energy auditing within industries to look for energy saving potential. So far, energy auditing has been carried out in 4 major (above 10,000 tonnes) coal consumer enterprises.
- Carried out 10 major projects to promote energy saving in the industrial sector.
- Construction of urban central heating projects in Pingliang City: it plans to provide urban central heating by utilising waste heat from its power plants. When completed, it will provide central heating to 1 million m^2 of area, benefiting more than 10,000 households. The project will also allow the retirement of more than 240 small boilers that are obsolete, polluting and energy consuming, which will help to save around 120,000 tonnes of coal annually.
- Intensified efforts to eliminate obsolete production capacity.
- Comprehensive development and deployment of new energy resources (e.g. biogas, solar cookers, solar water heaters) under the 'New Countryside Development' programme.
- Accelerating industrial restructuring and the development of low energy-consuming industries: speeding up the development of coal-methanol and its downstream products.
- Actively promoting R&D and deployment of new energy saving technology and products.

By the end of 2008, energy consumption per RMB 10,000 GDP in Pingliang City has dropped to 2.672 tce, a drop of 11.82% from 2005 (3.03 tonnes). Energy consumption per added value (tonne of SCE/10,000 yuan) of ADS enterprises decreased from 7.04 tonnes in 2005 to 5.796 tonnes in 2008 (17.67% drop), saving around 540,000 tonnes of coal in total. In 2009, due to the global economic downturn, demand for coal-fired power and energy consumption per GDP dropped significantly: generating capacity was reduced by 21oo GWh, coal consumption dropped by 600,000 tonnes while industrial value added also decreased by 400 million RMB. Nevertheless, the prospect of achieving the 'energy saving and pollution reduction' target in 2010 remains challenging due to the impending increase in the generating capacity following improvement in the macroeconomic situation and the fact that two new coal mines are being opened to supply coal to the phase II of Pingliang Power Plant.

6.2.2 The Development of Agriculture and Animal Husbandry in Pingliang City

In recent years, Pingliang City has been actively promoting the building of large-scale cattle ranches. By the end of 2008, there were 72 small standardised cattle ranching areas with more than 36,000 beef-cattle and 7.5 million chickens.

Since 2003, the 'all-film double-furrow sowing' technique has been tested and used for corn cultivation in Pingliang City: 768,800 mu of land has since been cultivated using this technique, 46% (346,000 mu) of which consists of large-scale demonstration areas. This new technique is the most popular and rapidly promoted technique, and has also received the highest investment. The technology so far has achieved remarkable results and provides an effective agricultural development model in arid and semi-arid areas: 1. grain production level has been significantly increased; 2. farmers' income level is raised; and 3. the high-quality straw provides sufficient fodder for the animal husbandry sector which in turn helps to accelerate the development of that industry.

6.3 Pingliang City's Medium and Long Term Economic Development Strategy and Targets

The principal goal for Pingliang City under the 12th FYP is to strengthen and develop its four main industries of coal-based chemical, new building materials, agricultural products processing, and equipment manufacturing in order to achieve a 'giant leap' in its industrial economy. The integrated development of both coal-based and petroleum-based chemical industries will be emphasised, and the formation of an 'ecological energy system' based on clean coal, high-capacity thermal power and fine chemical will be promoted. A national chemical base will be also built in Longdong.

In relation to its agricultural sector, Pingliang City will strive to become an arid agriculture demonstration region by accelerating the promotion and deployment of the 'all-film double-furrow sowing' technique. It aims to further widen the deployment of the technique in 3-5 years to 2.6 million mu of land for not only corn and potatoes but also wheat, vegetables and fruits. Pingliang City will also promote comprehensive utilisation of straw and the development of straw-based energy technology, and create an 'arid agriculture - animal husbandry - green agriculture' circular development model. This will simultaneously boost agricultural development and rural income in less-developed regions.

Medium and Long Term Development Plan for Coal Power and Coal-based Chemical Industry:

- By 2015, the total coal production of Pingliang City will reach 50 million tonnes with the generating capacity of 10 GW. The production of methanol, dimethyl ether and other coal-based chemical products will reach 8.6 million tonnes, and the rate of coal in situ conversion will amount to 60%.
- By 2020, RMB 180 billion will be invested in more than 60 coal power generation and coal-based chemical construction projects. Coal production will reach 80 million tonnes, oil production will reach 5.5 million tonnes, and the total installed capacity of

thermal power will amount to more than 16 GW. The production of coal-based chemical products will reach 11 million tonnes and coal in situ conversion rate will be above 80%.

- The power sector will be dominated by large-scale power generation projects and the construction of power grids, focusing on combined heat and power generation and coal-to-electricity conversion. It also aims to increase the coal in situ conversion rate.
- Coal-based chemical projects will focus on the production of coal-methanol, dimethyl ether, formaldehyde, acetic acid, olefins and other products, extending the product chain to maximise added value potential of the resources. There will be three types of product chains:
    1. Methanol – olefins coal chemical industry
    2. Methanol – carbon – chemical industry chain
    3. Coal-ammonia – fine chemicals

Medium and Long Term Development Plan for New Building Materials Industry:

- By 2012, RMB 1.8 billion will be invested in at least 5 major projects in the building industry to develop new types of dry cement, special cement, bulk cement and other cement products. Support will be given to a large cement company to carry out dry-process cement production with daily cement production of 9,000 tonnes.
- A comprehensive restructuring of small- and medium-sized cement enterprises where the retirement of obsolete production will be accelerated via the 'large back small' and 'large lead small' initiatives. This will further increase production and the management concentration level of the cement industry.
- In order to promote clean production and circular economy, Pingliang City will actively help the building industry to move towards an energy saving, recycling-oriented and environmental friendly development by promoting the utilisation of coal gangue, fly ash, urban construction waste and other integrated resource use new technologies.

6.4 The Foundation for and Potential of LCE Development in Pingliang City

The feasibility study found that although Pingliang City has a relatively good foundation for low carbon development, it also faces real difficulties. Both of these nonetheless provide the basis for EU-China low carbon technology and investment cooperation because:

- There is a need to speed up the introduction of large-scale projects and enterprises (such as Huaneng Power International, Conch Cement Co and Sinopec), and to expand small businesses (because of the government's industrial policy and the need for economies of scale). The development pace of all industries and sectors will also need to be above the national average. At the same time, due to the increasing pressure on energy and resources use, there is a need to reduce energy and resource consumption as well as to increase the quality of their use.

- Although ‘energy saving and emissions reduction’ efforts have produced good results, there are still some outstanding issues that need to be addressed. The gap between the pressure to save energy and reduce emissions and their supporting policies on the one hand and rapid GDP growth on the other is becoming increasingly wide. The main difficulty lies in the increasing reliance on heavy industry, making inevitable an upward trend in energy consumption in the short term.
- Pingliang City is developing a circular economy and a foundation for comprehensive utilisation of waste. However, as the demand for recyclable resources continues to outstrip the supply (e.g. crucible stone coal and coal fly ash) , the potential for waste utilisation is also becoming smaller.
- Industrialisation and rapid development of the agricultural sector increases the demand for new technologies and products. It will, however, also accentuate the problems faced by the sector such as energy saving, environmental protection and CO2 emissions.
- From a planning point of view, Pingliang City already has a reasonably advanced development roadmap. However, more emphasis is needed in the extension and diversification of coal and coal-based chemical production chains, and also the development of new industries, businesses and products through the deployment of new technologies (including low carbon technologies).
- From a policy point of view, inadequate national and local support for low carbon development (especially for industrial energy saving, biogas utilisation of biogas and etc) offers an opportunity for international cooperation.

6.5 EU-China Low Carbon Development Cooperation Potential and Recommendations

Based on the discussions above, the urgent needs for low carbon technology and development in Pingliang City are reflected in the following:

- Enhancement of existing ‘energy efficiency and emission reduction’ and environmental protection efforts by businesses.
- The development of a coal-based chemical industry production chain.
- Rational, innovative and progressive development of Longdong national energy chemical base.
- The establishment of a modern arid agriculture demonstration area in the Western region.

Pingliang City has also carried out various circular economy pilot projects, which provide the basis for a gradual shift towards a LCE. In terms of technology, the following could be the focus of EU-China cooperation within the demonstration zone:

- Clean coal and low carbon power generation technologies
- Development of low carbon coal-based chemical industrial chain
- Low carbon and energy saving cement technologies
- Development of arid agriculture technologies
- Biogas industrialisation

The establishment of a EU-China LCTIDZ in Pingliang City will no doubt have implications on its long term development strategy. More importantly, the success of the zone will also have a positive demonstration effect on low carbon resource-based development for the North-Western and even North-Eastern regions of China. As the economic development of China's Eastern and coastal regions continues to evolve and upgrade, more resource-intensive enterprises and large investment projects are moving into the North-Western region. Many large cities are also actively promoting the reallocation and limited growth of the 'three-high' (high energy consumption, high water consumption and high emissions) industries as part of their 'energy saving and emission reduction' measures. However, from an overall development perspective, the relocation of these 'three-high' industries will not solve the problems of coal-dominated energy structure and energy consumption in China. In fact, as China continues to industrialise and urbanise, the 'three-high' industries will remain a major force of development especially in resource-rich, but less developed regions. In light of this, helping China's Western region, such as Gansu Province, to move towards a LCE will be highly meaningful and most effective for EU-China low carbon cooperation. This will help to build confidence in the pursuit of a sustainable development pathway in the Western region (and avoid 'high carbon lock-in'), as well as transforming and upgrading the 'three-high' industries through technology innovation and breakthrough.

Chapter 7 Low Carbon Economic Development of the 'Three-High' Industrial Base in Eastern Region – Nanjing Yangtze River Development Zone

7.1 Introduction

Since China's 'open door' policy, Jiangsu Province has become one of China's most important industrial (especially heavy industry) bases. Nanjing Yangtze River Development Zone, locally known as 'Dachang District' (which means 'big factory' district in Chinese), is one of the most representative regions in terms of its concentration of large enterprises and industries.

Following 20 years of development, the Development Zone has managed to establish large industrial clusters and attract a group of large enterprises. In recent years, the growth of industrial clusters, urbanisation and sustainable development have highlighted the urgent need for a more environmental and ecologically friendly development in the Development Zone.

For the more prosperous Eastern region of China, including the Development Zone, there is a need to transform 'development zones' into 'hi-tech zones' for various reasons including increasingly scarce land resources and economic structural change. Local governments are now less inclined to rely on resource-intensive industries for economic development; they have instead turned to the development of 'less land-intensive' and 'high value-added' advanced technology and service industries. But one of the main challenges they face is to find 'high-tech' industries that are compatible with local development needs. The Development Zone possesses unique attributes that allow for an industrial upgrade and overall regional development via low carbon technology. This can provide a new development direction and concept that can be replicated elsewhere.

In Nanjing Yangtze River Development Zone, the feasibility study focuses on two levels:

1. Energy intensive and high pollution industries/companies will be analysed on their:
   - Existing 'energy saving and emissions reduction' measures including investment and technology upgrade, and their future plans and needs.
   - Existing CO_2 emissions, and CO_2 utilisation methods and scale.
   - Needs for low carbon technology.
2. The Development Zone as a whole (including areas that have been built and areas that are under construction) will be evaluated on:
   - The understanding of low carbon concept, low carbon industries and low carbon technology within the Development Zone.
   - The relevance of the 'low carbon concept' in zone and industrial planning, technology and market development, and investment promotion.
   - The potential for a new development model driven by low carbon concepts, technology and industries that will increase the competitiveness of the Development Zone as well as provide high-tech services to large companies within the region.

7.2 Brief Introduction of Nanjing Yangtze River Development Zone

Situated along the Yangtze River in the northern part of Nanjing City, Nanjing Yangtze River Development Zone was established in 2002 . It has a total area of 82.6 km^2 and a population of 220,000. Built on its heavy industry base and the global development of the petrochemical industry, the Development Zone has managed to attract a few large investment projects in its chemical sector during the 10^{th} and 11^{th} FYP period. At the same time, the expansion of its chemical processing industries, including fine chemicals, polymer materials and pharmaceutical chemicals, has accelerated the process of chemical industry clustering, resulting in a long chemical industrial chain (crude oil processing – basic chemical raw materials – chemical intermediaries – fine chemicals and households chemical products), and making it the leading petrochemical base in China.

The Development Zone has a unique industrial structure and has managed to attract a group of large and 'super-large' petrochemical, steel and power companies. Super-large state-owned enterprises (SOEs) within the Development Zone include Yangzi Petrochemical Corporation, Nanjing Chemical Co Ltd, Nanjing Iron and Steel United Co Ltd, Nanjing Thermal Power Plant and Huaneng Nanjing Power Plant. Also situated within the Development Zone is Nanjing Chemical Industrial Park, which is one of the two national level petrochemical parks in China. It occupies an area of 40 km^2 and specialises in petrochemical, polymer materials and other oil processing related activities. In addition, a number of European companies such as BASF (Germany), BOC (UK), and DSM (Netherlands) are also situated in the Development Zone. In 2008, its GDP reached RMB 4.1 billion following an annual growth rate of 12.7%. Its industrial output in 2008 was nearly RMB 8.7 billion.

In recent years, the development of Zhongshan Science and Technology Park, which will occupy a total area of 40 km^2 has become a major focus of the New and High Technology Development Zone within Nanjing Yangtze River Development Zone. The construction of the first phase (occupying a land area of 1.2 km^2) of Zhongshan S&T Park has now almost finished. The second and third phases occupy 10.5 km^2 of the Park and are under construction. The Park aims to attract SMEs in the energy saving and environment, new materials, electronics and information, and machinery manufacturing sectors in order to increase the Park's added value and its technology and 'low-polluting' industries profile. At the same time, the Park will tap into local R&D capacity (e.g. Nanjing University and SouthEast University) and attract highly skilled professionals to build a technology R&D and demonstration hub.

7.3 Future Development Strategy of Nanjing Yangtze River Development Zone

According to the Nanjing City Urban Development Plan (2007-2030), the area north of Nanjing City on the north of Yangtze River will become a national level petrochemical industry base, an advanced manufacturing base in the Yangtze River Delta, and an important logistics industry base. In particular, the future development of Nanjing Yangtze River Development Zone will include:

1. The development of energy saving and environment sectors through the following:
   - Improving heat utilisation of its thermal power plants: power generation plants within the Dachang District include Huaneng Power (Nanjing), Nanjing Thermal Power Plant, Yangzi Petrochemical Power Plant, Yangzi-BASF Power Plant, Nanjing Chemical power plant, and Nanjing Steel power plant. The Development Zone will emphasise heat utilisation, optimise its regional heat distribution and improve 'cascade use' of energy in order to reduce energy consumption.
   - Building an environment industry base in Zhongshan S&T Park: in conjunction with the development of its service industry, the Park will aim to attract major environmental services companies and establish an environment industry cluster leading to the formation of a complete environment industrial chain covering environmental R&D, equipment manufacturing and services.
2. Developing an advanced manufacturing industry: promoting structural change and upgrade of products through technological progress.
3. Developing a modern logistics industry: building a modern logistics industry centre in the New City in Dachang District.

7.4 Low Carbon Technology Development Foundation and Potential of Nanjing Yangtze River Development Zone

China has not yet imposed GHG emissions reduction obligations and targets on its industries. As a result, low carbon development has not become a priority among companies. However, among the heavy industries surveyed – chemical, steel and power – companies would potentially regard a domestic CO2 emissions reduction target as part of the 'energy saving and emissions reduction' target in the near future. At the same time, companies have to varying degrees recognised the importance of low carbon technology for future development. Their existing 'energy saving and emissions reduction' measures have also partly incorporated elements of 'low carbon technology'. For example:

- Using CO2 to produce hydrogen
- CO2 capture and use in food processing
- Dry coke quenching
- CO2 absorption and conversion

But low carbon technology use still faces the following limitations:

- The imbalance between large CO2 emissions and small-scale CO2 utilisation and conversion.
- Limited understanding of the international development of low carbon technology by firms partly due to lack of information.
- Inadequate use of more advanced production processes and more efficient energy management to reduce CO2 emissions.
- The emphasis on 'hardware' (equipment) and neglect of 'software' (smart management) in energy saving and emissions reduction.

Low carbon technology remains uncharted territory for most firms in China. This gap can be filled by policy guidance and support and international exchanges and cooperation. In Nanjing Yangtze River Development Zone, its existing industrial foundation and demand from industries will drive the development and deployment of low carbon technology, the establishment of new low carbon industries and international cooperation.

There is therefore a huge potential for EU-China technology cooperation, especially with regards to:

- Technologies that improve comprehensive resource utilisation
- Combined heat and power (CHP) and combined cooling, heating and power (CCHP) technologies
- Development of low carbon production technologies
- Clean production and new generation environment technologies
- Energy optimisation and more advanced energy saving technologies

The industrial foundation and the future development potential, especially the establishment of Zhongshan S&T Park, of Nanjing Yangtze River Development Zone create favourable conditions for the establishment of an EU-China LCTIDZ. This is mainly reflected in the following:

- With Zhongshan S&T Park acting as the hub of hi-tech development, the establishment of an 'energy saving' technology base in the Development Zone will help to facilitate its future low carbon development.
- Actual applications of the low carbon concept can be demonstrated in the Park through planning and infrastructure construction, e.g. low carbon workplace, production and lifestyle.
- The technology development direction, the need for industrial upgrading and the general environment in the Dachang District will promote the formation of an effective low carbon industrial chain.
- An innovation incubator and future attraction of highly-skilled professionals will help to create an important technology R&D and testing base in the Park.
- By realising all the above, the Park can become the platform for international exchange of information on low carbon development (increasing the international standing of Nanjing Yangtze River Development Zone at the same time) as well as the 'provider' of high-tech low carbon technology services to companies in the surrounding areas.

The development and innovation of energy and emissions reduction technologies, and the development of a LCE (through collaborations between the government and the business community and the development of a low energy intensive, low pollution and low emissions industrial model) can be incorporated into the second and third phases of Zhongshan S&T Park. By combining 'Low Carbon Zone Planning', 'Low Carbon Industries Development Roadmap' and 'The Strategies for Low Carbon Technology Introduction and the Creation of Low-Carbon Investment Environment and Platform', low carbon development can realistically become an important strategy for the future growth of this region.

Chapter 8 EU-China Low Carbon Technology and Investment Cooperation – Policy Framework and Recommendations

8.1 EU-China Low Carbon Economy Cooperation – Policy Framework and Cooperation

As the impact of climate change on the ecological environment and economic development becomes more visible and serious, there is an inclination in Europe and China to see the climate change strategy as part of the strategy for economic growth or revival and sustainable development.

The concept of low carbon economy (LCE) was first introduced by the UK in 2003, and has since been accepted – together with the concept of low carbon society – by many EU Member States as future development strategy. Faced with the challenges of climate change and economic crisis, European governments see the need for early actions to keep the EU at the forefront of a global transition to a LCE. For example, the UK is not only the first country in the world to introduce a climate change legislation (Climate Change Act 2008), but also the first to introduce a detailed low carbon transition strategy in July 2009 – Low Carbon Transition Plan. The Plan covers major industries and sectors such as power, industrial, transport and buildings, and is accompanied by more detailed sector-specific plans such as the Renewable Energy Strategy (RES), Low Carbon Industrial Strategy and Low Carbon Transport Innovation Strategy.

The UK is not the only country in Europe to have adopted low carbon transition measures. As an advanced industrialised country, Germany currently has the world's most advanced technologies for energy and environmental protection. It has also introduced, via legislation and strong enforcement measures, clear targets and implementation timelines for its climate change and energy saving policies. Among its climate change and LCE related measures are: introduction of eco-tax, the uptake of modern energy management systems by businesses, development and diffusion of low carbon technology such as 'co-generation' and low carbon power generation technologies, promotion of renewable energy through feed-in-tariffs, and the construction of energy saving buildings. Germany has also actively engaged in international cooperation, especially with developing countries, on climate change.

For China, the need for the development of a 'green' economy is also deemed essential as an opportunity to address not only climate change but also its future sustainable development. During the recent State Council meeting and the 10th Standing Committee meeting of the 11th National People's Congress (NPC), the Chinese leadership showed strong commitment to develop a 'green' and low carbon economy and to make the latter central to China's future economic transformation. To achieve this aim science and technology plays a particularly prominent role. In the recently published NPC's Standing Committee's resolution on climate change, the development and deployment of energy saving and efficiency, clean coal, renewable energy, nuclear energy and other related low carbon technologies are highlighted as important development strategies.[1]

[1] http://www.ccchina.gov.cn/cn/NewsInfo.asp?NewsId=18996

A LCE development strategy and framework has also been adopted. It calls for the development of a ‘green’ economy, implementation of LCE policy, more ‘green’ investments, and the promotion of ‘green’ consumption and ‘green’ growth. It also emphasises the opportunities presented by LCE including the development of low carbon energy, industries, buildings and transport. It also calls for the development of clean energy vehicles and rail transportation and a highly efficient, low energy intensive and low emissions economic model.

Low carbon development is highly relevant to the future development of China, the EU and the world. The question now is not if or when LCE development is needed. It is a question of how fast and at what scale it should be developed. At the heart of LCE are low carbon technology development, deployment and diffusion. Countries that take actions quickly will have the ‘first mover advantage’. Consequently, EU-China low carbon technology and investment cooperation will help to guide and drive the development of LCE in both regions.

The findings from the feasibility study show that EU-China low carbon technology and investment cooperation ought to focus on the following:

- **The integration of circular economy and LCE with the former being gradually upgraded to the latter** including integrated solutions for water shortage, pollution and CO2 emissions.
- **Low carbon energy**: including the development and utilisation of renewable energy, recycling of discharges from thermal power generation and large-scale re-use of CO2.
- **Energy transmission**: including the development and deployment of smart grids.
- **Low carbon industries**: non-conflicting energy saving, pollution control and CO2 emissions reduction measures in heavy industries including steel, cement and chemical, and the establishment of low carbon production chains.
- **Low carbon agriculture and industrialisation of the agricultural sector**: including reducing the impact of climate change on agricultural production, and the application of low carbon concept and technology during the industrialisation of the agricultural sector.

8.2 EU-China Low Carbon Technology and Investment Demonstration Zones – Policy Recommendations

To facilitate a strategic and effective EU-China cooperation on LCE, the feasibility study makes the following recommendations:

- Development of ‘low carbon coal power’ and ‘low carbon agriculture’ in Pingliang City, Gansu Province.
- Development of ‘low carbon chemical’, ‘low carbon steel’ and ‘low carbon technology R&D and services’ in Nanjing Yangtze River Development Zone in Jiangsu Province.

Cooperation in these two different but representative regions will provide desirable demonstration effects for global climate change mitigation, EU-China low carbon investment and technology cooperation and China’s regional development. This is illustrated below.

Firstly, climate change is a global issue and as a result, participation from all countries and widespread deployment of low carbon technology are needed in order to achieve effective CO2 emissions reductions and sustainable development. Hence, a strengthening of international information exchanges and cooperation on the development of low carbon technology, such as CO2 capture, conversion and utilisation technology, are vital. EU-China LCTIDZs will provide practical operational experiences on how international cooperation in the climate change regime can be realised. They can also provide a new model of cooperation that will help to build trust among international communities.

Secondly, European businesses, especially large enterprises, have accumulated more than 30 years of experience in investment and technology introduction and 'localisation' in China. In recent years, European businesses have also become important market players in climate change related industries such as energy, buildings and chemicals. Equipped with both the understanding of advanced low carbon technology development in Europe and the knowledge of the Chinese market, these businesses can become the 'bridge' for EU-China low carbon technology cooperation. Many European SMEs that focus on low carbon technology would also find investment opportunities in China attractive. It will help to accelerate commercialisation of new technologies, reduce production and R&D costs, and allow large-scale demonstration of new technologies.

However, European businesses of all sizes face difficulties in exporting technology to China and commercialising it at a large scale there due to the immaturity of its low carbon technology market and its less than satisfactory policy and market environment. With strong support from both the EU and China, Pingliang City and Nanjing Yangtze River Development Zone demonstration zones can provide the platforms for a new model of low carbon technology introduction and cooperation.

To facilitate technology introduction and deployment, the demonstration zones can act as the place to test out new modes and mechanisms of EU-China low carbon technology cooperation. These include:

- Low carbon technology information and experience exchanges and policy dialogue
- Low carbon technology transfer, diffusion and co-development platform
- Low carbon technology R&D and diffusion fund

Thirdly, EU-China low carbon technology and investment cooperation will help to accelerate China's regional LCE development and structural readjustment. For example, the development of Pingliang City is currently dominated by large SOEs such as the Huaneng Group (power sector), Conch Cement (buildings) and Sinopec (chemical) where international technology cooperation is almost non-existent. On the other hand, Pingliang City is ready for a low carbon 'leapfrog', and strong support from the EU and China and through international cooperation (e.g. technology cooperation between the EU and Huaneng) will help to facilitate this.

Similarly in Nanjing Yangtze River Development Zone, through the use of more advanced technology and management practices, big European businesses (such as Yangzi-BASF) have already contributed significantly to local development. However, the process of and the needs for a low carbon transition in Nanjing will be different from those in Pingliang City. Here the emphasis is on moving from a 'resource and capital intensive' investment to a 'technology and services intensive' investment, and on providing a platform for SMEs to develop and internationalise low carbon technologies.

From the discussions above, it is clear that the outlook is good for future EU-China cooperation in the two demonstration zones in low carbon technology transfer, deployment and co-development. Specific examples include:

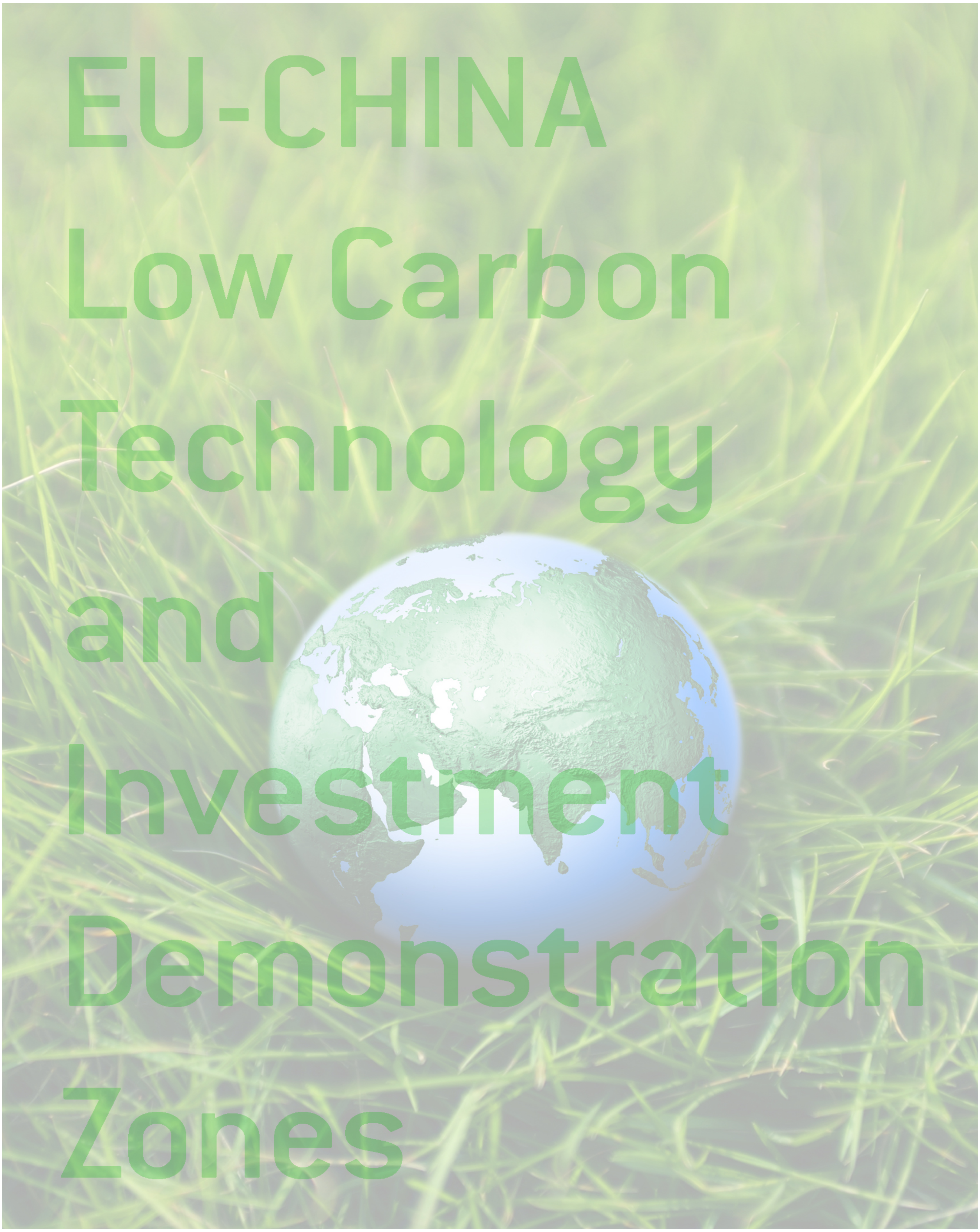
For power, buildings, chemical and steel sectors:

- Control of pollution caused by coal-burning especially the emission of CO_2
- CO_2 emissions reduction, capture, conversion and large-scale utilisation
- High efficiency generators
- Low CO_2 emission steel-making technology
- Use of ultra-low temperature waste heat and pressure
- Energy system optimisation and management

For biogas use and environmental protection:

- High efficiency biogas engineering and equipment
- Large biogas power generation and comprehensive use projects
- Air purification and noise pollution reduction
- Bio-fuel equipment development and upgrading

EU-China LCTIDZs provide an innovative platform for EU-China cooperation on LCE. Cooperation in these zones will promote technology upgrade and development of new technologies in both China and the EU. This will in turn help to achieve their short and long term CO_2 emissions reduction targets. It will also allow the EU and China to work with the business community to build a new IPR protection regime that will be conducive to rapid and large-scale diffusion of low carbon technology. This will bring real economic benefits for both parties and create a strategic and effective EU-China cooperation on climate change.



EU-CHINA Low Carbon Technology and Investment Demonstration Zones