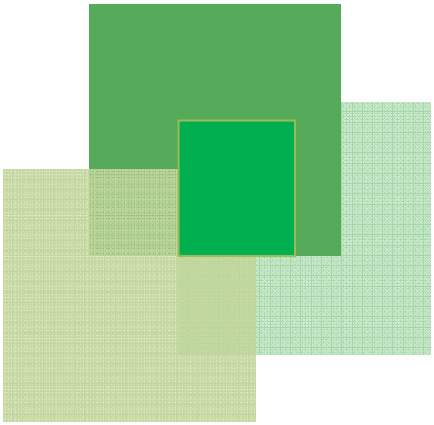

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Geneva

Skills for green jobs in China

Unedited background country study

China Academy of Labour and Social Security
Ministry of Human Resources and Social Security, China

ILO Skills and
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2010

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Foreword

The world finds itself in a slow recovery after the deepest recession since the Great Depression. The world is also coping with a host of environmental problems and the urgent need to reduce carbon emissions. A greener future also promises an enormous potential in a much needed employment growth. However, without suitable skills, this potential cannot be realized. Today, skills gaps are already recognized as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, green building and retrofitting, environmental services, and green manufacturing. Training response measures are successful where they are coherent across policy domains, systemic and systematic, and targeted at disadvantaged groups. These training measures can only be effective if based on timely identification of skills needs. Effectiveness of training measures is decisive not only for the economic recovery but also for a longer-term sustainability agenda.

This report was produced in the framework of the project, 'Skills for green jobs'. The project was implemented in cooperation between the International Labour Organization (ILO) and the European Centre for the Development of Vocational Training (Cedefop). The project identifies skills needed for greener economies with respect to structural shifts, and new, emerging and changing occupational profiles. The 'Skills for green jobs' study is embedded in the Green Jobs Initiative, a joint initiative of the United Nations Environment Programme (UNEP), the ILO, the International Employers Organization (IOE) and the International Trade Union Confederation (ITUC), to assess, analyze and promote the creation of decent jobs as a consequence of the needed environmental policies. The global study was jointly funded by the Skills and Employability Department of the ILO and the Green Jobs Initiative.

The following countries have been included in the study: the ILO covered Australia, Bangladesh, Brazil, China, Costa Rica, Egypt, India, Indonesia, the Republic of Korea, Mali, the Philippines, South Africa, Thailand, Uganda and the United States. In addition, Cedefop covered six European Union (EU) member States: Denmark, Estonia, France, Germany, Spain and the United Kingdom. The ILO global synthesis report,[1] which analyzes the situation in all 21 countries involved in the study, and the European synthesis report,[2] which covers the six EU countries, as well as all individual country reports, are available at: http://www.ilo.org/skills/what/projects/lang--en/WCMS_115959/index.htm (the ILO website) and http://www.cedefop.europa.eu (Cedefop website; look under *Skills Needs* theme). The unedited background country studies have been published in the electronic form in order to make them available quickly. The summaries are published as part of the synthesis reports.

The global project in the ILO was coordinated by the Skills and Employability Department and, in particular, benefited from comments and technical guidance by the team under the leadership of Olga Strietska-Ilina, Christine Hofmann, Mercedes Duran and Shinyoung Jeon. The ILO coordinating team would like to express great thanks to the China Academy of Labour and Social Security of the Ministry of Human Resources and Social Security for their background country research which contributed to the global study. Special thanks also go to the ILO regional and country field offices for the project support and the ILO colleagues who assisted research at national level.

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[1] Strietska-Ilina, O.; Hofmann, C.; Duran Haro, M.; Jeon, S. (forthcoming 2010). *Skills for green jobs: A global view. Synthesis report based on 21 countries* (Geneva, ILO Skills and Employability Department).

[2] Cedefop. (forthcoming 2010). *Skills for green jobs: European synthesis report* (Luxembourg, Publications Office of the European Union).

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China Academy of Labour and Social Security
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Abstract

China has committed to a low-carbon development pattern which has many challenges ahead, and the skills strategy arising from the transition to a low carbon economy is necessary, but inadequate skill response is a problem here. The skills needs in China's industries, which are rapidly changing due to new green jobs or existing jobs turning green, have been growing. China's skill response should be swift and effective, with coordination between various government departments, which should play a more active role by anticipating the changing green skills needs by surveys of employers and employees. And China's tripartite mechanism among government, employers and employees in skill formation and delivery is necessary.

Executive summary

Introduction

China's shift towards a low carbon economy and the growing importance of sustainable development will bring about an urgent need for new skills and the creation of green jobs. China's priorities for attacking climate change involve the need to analyze industry to identify greening opportunities and invest in new green technology while ensuring that the green jobs generated are decent.

Key challenges

China will face a number of employment and skills related challenges in preparing for the shift towards a greener economy. Greening of the economy requires workers in many occupations to have new green skills, and the skills development strategies and training programmes need to be adjusted to meet this new demand. Vocational training, recognized nationally and developed by industry, plays a critical role in provision of green skills, as vocational training programmes are responsible for providing training for 80 per cent of occupations. Whilst there are a growing number of tertiary qualifications in the field of sustainability, university qualifications will only form part of the solution to addressing China's environmental challenges. As the majority of work to green enterprise and industry is expected to be carried out by non-University educated workers, vocational training will be critical in skilling a labour force geared towards green jobs, including training to meet immediate business needs, as well as providing pathways to higher level qualifications.

With green occupations a new concept in China, only very few professional qualification standards have been adopted for green occupations. In order to anticipate the future green skills demands in the labour market more extensive research and data collection need to be conducted and existing skills anticipation mechanisms need to be strengthened

Managing the skills impacts of the green transition

- **Green restructuring and needs for reskilling**

The impacts of greening on the labour force vary greatly and are felt the most among energy-intensive industry. Unemployment is increasing in the coal and cement industries as plants, previously responsible for employing thousands of workers, are downsizing. In some sectors, such as forestry, wind power, solar power and recycling, green restructuring is expected to have a positive effect on employment. Workers in downsizing sectors need to be provided with new skills to help them find re-employment.

- **Greening existing jobs and skills sets**

Greening existing jobs is necessary to lessen the environmental impact of energy-intensive industry. Building and construction, transport and agriculture are among high-impact industries that account for around 70-80 per cent of overall resource use and emissions. The building sector in China is an industry which is expected to grow by 7 per cent annually. Energy-efficient measures in the construction industry lead to direct, indirect, and induced jobs. Scope for greening also extends to the automotive industry, where growth can be directed towards making more efficient models using cleaner engine technologies; and the recycling industry, where greening opportunities exist in the management of e-waste, of which 70 per cent of the global total is estimated to be borne by China. Greening of these industries will impact the skills sets

required in different occupations throughout the sector. Many good company level initiatives to set up training programmes exist, but green skills training has not yet been included in the regular training curricula.

- **New green occupations**

Investment to tackle the effects of climate change is seeing new job opportunities emerge in sectors related to clean technology; renewable energy, such as solar and wind power; recycling; urban and rural renovation and nature conservation. The 2007 China Solar PV Report projects that employment in China's PV industry could reach 100,000 by 2020 and as many as 5 million by 2050. Employment in the wind power industry was around 120,000 in 2008 and is also expected to grow significantly. New job opportunities in some sectors are contrasted by bottlenecks caused by a shortage of green skills. China will need a thoughtful green strategy to better match the supply and demand for green jobs and address the skills gap.

Conclusion and recommendations

With a significant share of China's economic stimulus package directed at low-carbon investment, the indirect impact on the green economy is expected to be great. A green economy requires green jobs but there are skills gaps and shortages in each sector of the economy. Recommendations for addressing the challenges associated with China's greening economy are to:

- Set up tripartite dialogue and between government, employers and employees to discuss the transformation of the education and training sector, emphasizing shared responsibility amongst stakeholders for investment in education.
- Ensure that the changes to the education system are driven and lead by the State. National qualification standards for all green collar occupations are needed and existing levels of government investment in vocational education and training needs to be increased.
- Facilitated through consultation with industry, employers and trade unions, develop a green curriculum that meets the needs of industry. Teachers and trainers should mostly be industry experts as well as academics. Flexible learning delivery methods will make green training more accessible to workers and encourage participation across the sub sections of the community.
- Build business awareness of specific measures they can take to reduce the environmental impact of their activities and their compliance with relevant state and national legislation. As sustainability remains a relatively low priority for businesses that are not large emitters, the government will need to encourage investment in green skills training.
- Raise the profile of the employment opportunities in green and sustainability sectors through communication of accurate career advice, training and the creation of employment pathways.
- Conduct further research on professional qualification standards for green jobs and skills.

Abbreviations and acronyms

BYD	Bi Ya Di Auto Corporation
CALSS	China Academy of Labour and Social Security
CDM	Clean Development Mechanism
CNG	Compressed Natural Gas
ESLs	energy-saving lamps
GEF	Global Environmental Facility
GHG	Greenhouse gas
GTZ	German Technical Cooperation Unit / Deutsche Gesellschaft für Technische Zusammenarbeit
GW	Gigawatt
ICT	Information and communication technologies
ILO	International Labour Organization
IOE	International Employers Organization
ITUC	International Trade Union Confederation
LCCI	Low Carbon City Initiative
LPG	Liquefied Petroleum Gas
MEP	Ministry of Environmental Protection
MOE	Ministry of Education
MOHRSS	Ministry of Labour and Social Security
MOST	Ministry of Science and Technology
MW	Megawatt
NDRC	National Development and Reform Commission
NGOs	Non-governmental organizations
NQL	National Qualification Level
R&D	Research and Development
RE&EE	Renewable energy and energy-efficient
SCS	South China Sea
SOEs	State-owned Enterprises
STEs	Secondary Technical Schools
SWS	Skilled Workers Schools
SVSs	Secondary Vocational Schools
TCs	Technical Colleges
TVET	Technical and Vocational Education and Training
UNEP	United Nations Environment Programme

VET	Vocational education and training
VTE	Vocational and technical
WB	World Bank
WWF	World Wildlife Fund

1. Introduction

In the past thirty years, China has experienced unprecedented economic growth and development. Recently, however, growing threats from climate change are challenging China to take urgent action. The growing importance of sustainable development and the shift to a low-carbon economy will require new skills and qualifications, offering great potential for the creation of green jobs. The objective of this report is to identify the strategic skills development responses in light of environmental degradation, climate change and the global call for greening economies. It will outline the major challenges and priorities for climate change adaptation and subsequent greening policies and strategies. Specifically, the report will address the skills implications and responses of greening existing industries, as well as the potential for job creation in new industries.

It is urgent for China to create more green jobs. China faces challenges which require urgent action to sustain growth and guard against the risks of catastrophic climate change. Currently, China is the world's second biggest emitter of greenhouse gases, with the United States in first place. China's greenhouse gases, mostly produced by burning fossil fuels, make up 17.9 per cent of the global total. And according to the International Energy Agency, China's emissions will exceed those of the United States by 2010. Moreover, China's carbon emissions per capita are also approaching the global average, and look set to exceed it before 2010.

Climate change may indeed have a serious impact on China's environment and economy. The warming winters and China's increasingly severe natural disasters could only be the start of negative impacts of global warming. The effects of shrinking glaciers and rising snowlines could also have a disastrous effect on China's northwest, which relies on snowmelts for agriculture and stock-raising. We do need to take climate change seriously and reduce our emissions.

China has signed up to the Kyoto Protocol on a principle of "common but differentiated responsibilities", and also signed the Copenhagen climate accord on 9 March 2010. But the target of maintaining atmospheric concentrations of carbon dioxide at around 0.055 per cent is clearly at odds with China's current phase of rapid industrialization. It would severely restrict the country's legitimate future development if there are no appropriate green job strategies. China's current process of industrial growth and urbanization will continue until at least 2030, and it will be impossible to prevent an increase in greenhouse-gas emissions between now and 2050. If China was now to begin the transition to a low-carbon economy, the cost of cutting emissions would be far greater than previously imagined. For example, making buildings more energy-efficient would require an additional 15 per cent of investment, while funding for renewable energies would need to increase by at least 30 per cent. Where would this money come from? In the short term, the costs of technology for carbon capture and storage are also too high, and the process is energy-intensive, making it of dubious value as a method to reduce emissions.

China established in 2007 a National Leading Group to Address Climate Change, headed by Premier Wen Jiabao. It has set the aims of cutting the energy consumption per unit of gross domestic product by 40 to 45 per cent from 2005-2020.

China's strategy for green economy starts with the wise use of energy as China has a target of being able to generate energy from coal with "near-zero" greenhouse gas emissions, within the next decade. There are several hundred years of coal resources, which will continue to be used for energy security reasons. China's research on storing carbon dioxide underground, monitoring and verifying it – with a target for a pilot scheme of injecting 100,000 tons of CO2 – will provide confidence that it is technically feasible. But, in China, energy diversification is happening. For

instance, China has 11 nuclear reactors in operation, and a further 22 are under construction. Nuclear power only contributes 2 per cent of current power generation, but this is projected to rise to as much as 16 per cent by 2030. Gas is one affordable energy source with less environmental impact than coal. But it is becoming harder to recover, since China is going to have to look further in more remote locations, in deeper reservoirs, in more complex geological structures, to recover oil and gas.

According to the United Nations Environment Programme (UNEP et al. 2008), "green jobs" are: work in agricultural, manufacturing, research and development (R&D),administrative, and service activities that contribute substantially to preserving or restoring environmental quality … this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution.

The China Academy of Labour and Social Security, a division of the Ministry of Human Resources and Social Security, was commissioned by the International Labour Organization (ILO) to coordinate and prepare the China contribution of the 'Skills for Green Jobs' global report. This report is part of a wider 'Green Jobs Initiative' jointly sponsored project by ILO, the United Nations Environment Programme (UNEP), the International Employers Organization (IOE) and the International Trade Union Confederation (ITUC). The Green Jobs Initiative is intended to support efforts by governments, employers and trade unions to promote environmentally sustainable jobs and developments in a climate challenged world.

The major objective of the Skills for Green Jobs research project is to identify the major challenges and priorities for skills development related to climate change and the strategic development responses currently in place, as well as those being contemplated. Specifically, these challenges and priorities relate to:

- Arrangement of laid-off employees due to closure of polluting enterprises;
- Supporting the emergence of new, green jobs; and
- The 'greening' of established jobs.

The paper is structured as follows. Section 2 provides an economic and policy context for the current debate on climate change, and the skills strategy arising from the transition to a low carbon economy. Section 3 identifies the skills needs in China's industries, which are rapidly changing due to new green jobs or existing jobs turning green. Section 4 recaps the key conclusions, and Section 5 provides a set of policy and research recommendations to move forward with. The research method we used are the combination of qualitative and quantitative approaches, and we firstly did literature review, and then acquired information through visits to various enterprises, government departments and academic institutions

In China, there have been many new green initiatives adopted, however, they are all still in their initial phase. Therefore, there are many limitations on the research concerning training mechanisms and standards. China has not yet had the right strategic skills development responses of the country in the light of environmental degradation, climate change and the global call for greening economies. However, it is necessary to have the right skills for the green economies.

2. Policy context

2.1 Key challenges and priorities for the green economy

There are a number of major environmental issues driving China's green policy response. Currently, China is the world's second biggest emitter of greenhouse gases, with the United States in first place. China's greenhouse gases, mostly produced by burning fossil fuels, make up 17.9 per cent of the global total. And according to the International Energy Agency (IEA), China's emissions will exceed those of the United States by 2010. Moreover, China's carbon emissions per capita are also approaching the global average, and look set to exceed it before 2010.

There are many challenges for mitigating and adapting to climate change in a number of China's key industries. China's steel production has surged to account for 38 per cent of global output in 2007, but despite improvements the country's mills are still lagging behind those of Japan, South Korea, and Western Europe in terms of energy efficiency, carbon emission reductions, and waste avoidance. China is also the leading producer of cement with over 1 billion tons, almost half of the total global production. Comprised of mainly small and medium-sized production facilities, on average China's cement facilities generate more CO2 emissions per ton than those in Japan, Australia, New Zealand, and the European Union. This critically relates to climate change as cement is responsible for 5 per cent of greenhouse gases emitted worldwide (UNEP et al., 2008).

China's main priorities should be to analyze current industries for greening opportunities, as well as invest in new green technologies. There are many employment green job opportunities in existing occupations. Non-wood pulp and paper production is a shrinking proportion of paper production yet remains a major source of income and employment in China. However, upgrading non-wood pulp and paper mills could be a major source of green employment, with the potential to maintain employment for as many as 1 million people and income levels for 8 million farmers. Furthermore, there are a number of employment opportunities in new industries, like energy supply alternatives. More than 600,000 people are employed in the solar thermal sector - by far most of them in China (UNEP et al., 2008). Additionally, renewable technologies are an important opportunity for continued economic and technological development.

Climate change may indeed have a serious impact on China's environment and economy. The warming winters and China's increasingly severe natural disasters could only be the start of global warming's negative impacts. The effects of shrinking glaciers and rising snowlines could also have a disastrous effect on the country's northwest, which relies on snowmelts for agriculture. It is important to take climate change seriously and actively work to reduce China's emissions.

Furthermore, China's other priority is that green jobs need to be decent work, i.e. good jobs which offer adequate wages, safe working conditions, job security, reasonable career prospects, and worker rights. China, which has the largest amount of waste, has a mix of formal and informal collectors. About 1.3 million people are employed in the formal waste collection system and an additional 2.5 million informal workers or scrap collectors. But beyond waste and scrap collection activities, China has a far larger number of people involved in all aspects of recycling, reuse, and remanufacturing—as many as 10 million according to one estimate. A recent report by Recycling Magazine stated that 90 per cent of these workers are in very small workshops. Some of the poorest people are employed to sort and recycle the plastic scrap. Furthermore, more often than not, it is not 'responsible recycling' that is being done: it is reprocessing with mostly rudimentary methods, in which there are few environmental standards (Recycling Magazine, 2009).

People’s livelihoods and sense of dignity are bound up tightly with their jobs. A job that is exploitative, harmful, fails to pay a living wage, and thus condemns workers to a life of poverty can hardly be hailed as green. There are today millions of jobs in sectors that are nominally in support of environmental goals—such as the electronics recycling industry in China—but whose day-to-day reality is characterized by extremely poor practices, exposing workers to hazardous substances or denying them the freedom of association.

2.2 The response strategy

2.2.1 General environmental strategy

China signed the UN Framework Convention on Climate Change in 1992 and a signatory of the Kyoto Protocol on a principle of “common but differentiated responsibilities” and is eligible for CDM participation in competition with other developing countries. China’s pursuit of sustainable development has in many respects been consistent with climate protection and has taken an active role in international and domestic activities regarding global climate change. The Chinese State Council announced that China is going to reduce the intensity of carbon dioxide emissions per unit of GDP in 2020 by 40 to 45 per cent compared with the level of 2005. This is a "voluntary action" taken by the Chinese government "based on our own national conditions" and "is a major contribution to the global effort in tackling climate change." (Xinhua News Agency, 2009). There are over 300 pieces of environmental legislation affecting Chinese business and utility costs are rapidly rising.

China’s Clean Development Mechanism (CDM) Fund will provide technical assistance to central ministries and local government, and will increase public awareness of climate change. It will help develop policy through research and dialogue with government agencies, and also invest in some clean coal projects. Furthermore, China established in 2007 a National Leading Group to Address Climate Change, headed by Premier Wen Jiabao. It has set the aims of cutting the energy consumption per unit of gross domestic product by 20 per cent from 2005-2010; to increase the use of renewable energy to 10 per cent of total energy consumption by 2010, and increasing forest cover to 20 per cent by then.

Sustainable development is a national strategy in China, and under this umbrella strategy, many policies, plans and measures on energy efficiency, renewable energy, reforestation, etc. generate climate benefits. During the past two decades or so, China has promulgated dozens of laws and regulations that promote sustainable development, with positive impacts on climate change, including laws on environmental protection, energy conservation, development of new and renewable energy, reforestation, soil and water conservation, and the like. From 1998 through 2008, a total of 980 billion Yuan, accounting for 1.29 per cent of GDP, was invested in improvement of the environment and preservation of ecosystems. Efforts are now under way to prepare regulations or detailed policies to implement the China Energy Conservation Law. Forest cover has increased from 13 per cent in 1988 to 19.7 per cent today, which contributes to carbon sequestration.

The Chinese government, in accordance with national sustainable development strategy and the national conditions, has enacted and promulgated a series of climate change-related policies and legislative measures, the most important of which is energy-saving emission reduction policies, which are the priority areas to reduce greenhouse gas emissions and promote low carbon development of internal consistency. China’s energy efficiency has been increasing. From 1990 to 2005, China's energy consumption of unit GDP energy consumption reduced by 46.6 per cent, reduce carbon dioxide emissions equivalent to 1.8 billion tons. The current target is to be able to generate energy from coal with “near-zero” greenhouse gas emissions, within the next decade. There are several hundred years of coal resources, which will continue to be used for energy security reasons. However, measures have been taken for energy diversification. The Chinese government attaches great importance to climate change and is creating a series of policies and

measures to address the issue. One of the government's initiatives to reduce the country's contribution to climate change was to establish a national target to decrease energy intensity by 20 per cent by 2010. In a move to help China achieve this target, and to facilitate national and international low carbon development, World Wildlife Fund (WWF) - with the support of local and global partners - will implement a Low Carbon City Initiative (LCCI) in China in the next five years.

For instance, China has 11 nuclear reactors in operation, and a further 22 are under construction. Nuclear power only contributes 2 per cent of current power generation, but this is projected to rise to as much as 16 per cent by 2030. Gas is another affordable energy source with less environmental impact than coal. However, it is becoming a scarcer resource, requiring China to look further in more remote locations, in deeper reservoirs, in more complex geological structures, to recover oil and gas. China has also been exploring the clean and renewable energy. China's renewable energy accounts for 7 per cent of primary energy, and China is actively developing wind, solar, nuclear, hydroelectric energy, through optimizing the energy structure.

In the Eleventh Five-Year Plan from 2006 to 2010, China has explicitly put forward the quantification of energy-saving emission reduction targets, which will push forward the development of the green jobs and skills, and be beneficial to sustainable development strategies. In 2006, the Chinese government adopted the "National Climate Change Program", "long-term renewable energy development plan" and "Eleventh Five-Year Renewable Energy Development Planning", promulgated the "Energy Conservation Law", "Renewable Energy Law", "Cleaner Production Promotion Law" and other related legislation. In August 2008, China adopted the "Circular Economy Promotion Law", in order to reduce emissions and the construction of energy-saving environment-friendly society system has laid a foundation, Jiangsu, Beijing, Liaoning, Zhejiang, Guangdong and other provinces and municipalities have already developed a circle of the region's economic development the overall planning, Shanghai, Baoding, Jilin and other cities to carry out a pilot low-carbon city, will further the development of energy-saving and low-carbon emission reduction into the local level.

Box 1: Low-carbon city example

China is in the process of rapid urbanization. The number of cities in China has increased from 193 in 1978 to 661 in 2007, among which 54 are so-called mega-cities and 84 are large cities, compared to, respectively, 13 and 27 in 1978. By the end of 2006, the urbanization rate in China was about 43.6 per cent of the population. This rate is rapidly increasing, with 75 per cent of the population estimated to live in cities by 2050.

Energy consumption in heavy industries - such as iron and steel, chemicals and energy - accounts for 70 per cent of the total in the industrial sector, and is still growing at a fast pace. Industries themselves represent 70 per cent of China's total energy consumption. Heavy industry provides the goods and products which are increasingly consumed in cities.

The energy consumption increase in China's cities does not only result from rapid industrialization, but also from the buildings and transportation sectors. There are 17 billion m2 of buildings in China's urban areas, with 1 billion m2 added each year. China's vehicle population is also growing quickly, having surpassed 150 million by June 2007. In addition, urban energy consumption per capita is estimated to be three times higher than that of rural areas. The annual migration of approximately 10 million people from rural areas to urban centers projects a scenario of continued and rapid increase in urban energy consumption.

Vehicle emissions remain the biggest source of air pollution in cities. The pollution is the result of factors such as inappropriate urban planning, insufficient public transportation investment, growing vehicle numbers and low gas emission control standards.

Therefore, many Chinese cities have the challenges such as heavy polluting energy consumption, low energy efficiency and growing CO2 emission. In order to deal with these challenges, many Chinese cities have set clear vision on urban functions in light with the city's capacity for environmental sustainability. The

areas for a low-carbon city also include the use of energy-saving technologies, spread of environment-friendly life styles, efforts to combat pollution, etc.

A low-carbon city has the following objective, strategy and outcomes:

Objective

Contribute to the national target of a 20 per cent reduction in energy density by attempting to decouple economic development and CO2 emissions.

Strategy

Promote climate friendly solutions for key sectors in target cities to showcase and promote the positive effects of using clean and sustainable technology.

Outcomes

1. A portfolio of best practice models for the implementation of low carbon projects so as to promote and facilitate the practice of similar techniques and technology throughout China.

2. A large network of partners, funding and expertise.

3. Improvement of energy efficiency on both supply and demand sides.

4. High efficiency infrastructure on housing and transporting.

5. Enhancement of the monitoring and enforcement capability at city level.

6. 10 per cent Reduction of Major Environmental Pollutants.

7. Forest Covering Rate Increasing from 18.2 per cent to 20 per cent.

In order to achieve these targets, the city governments will promote best practice on regulation and policy, low emission technology cooperation and diffusion, low emission business expansion, and capacity building and awareness raising in the public. Besides, integrated public transport systems, green building technology and clean production technology are among options to promote low-carbon cities. They also use fiscal stimulation to local governments in the development of clean energy programs. Up to now, many Chinese cities such as Beijing, Shanghai, Baoding, Zhuhai, Shenzhen, Hangzhou, Guiyang, Jilin, Nanchang, Guangyuan, Ganzhou and Wuxi have started a pilot low-carbon development road. With the goal of setting up low-carbon cities and through establishment and implementation of policies promoting low-carbon economy, governments are guiding enterprises to develop green industries, improve resource and energy efficiency to achieve win-win situation of environmental protection and economic growth, while reducing resource consumption and pollutant emissions. For example，Shanghai has focused on Energy efficiency of large commercial buildings. The municipal government has done energy consumption survey, established databases, and set up models for renovation and management in office buildings and hotels; The government of Shanghai also disseminates new technologies for design, renovation and construction of eco-buildings. The city of Baoding has mapped out the low-carbon development plan. As the growth rate of industrial increase value and finance revenue in Baoding climbed to first place in Hebei province, the growth rate of low-carbon industry amounted to 40 per cent of the total. In 2008, Baoding's China Power Valley construction project sold 500 MW of solar products and 5089 MW of wind power products, the equivalent of 10.64 million tons of carbon dioxide emissions. Baoding has the network on sustainable energy info exchange and tech cooperation, and encourages the investment and export of sustainable energy product. Besides, Baoding government intends to include the concept of low-carbon into the city planning and industrial park construction. Therefore, Baoding has become a solar energy demonstration city in China, and has established an industrial park of wind and solar technology. Baoding released in December 2008 low-carbon urban construction paper, hoping to develop the urban industrial economy dominated by low-carbon model for the public to the concept of low-carbon living and behavioural characteristics.

2.2.2 Green response to the current economic crisis

As a result of the economic crisis of 2008-09 there have been sharp reductions in industrial production. For the past year, the Chinese economy has suffered through a serious economic slowdown caused by the collapse of the stock and housing market bubbles, the destabilizing effects of the housing implosion on financial markets, and the sharp drop in export volume. The stimulus package, while its main purpose is GDP growth, included investment in measures towards a green economy. In November 2008, China disclosed a 4-trillion-yuan (US$585 billion) package that designates at least 350 billion Yuan (US$51 billion) for biological conservation and environmental protection. Moreover, China's Ministry of Environmental Protection (MEP) has announced that the stimulus will not be spent in the energy and resource-intensive industries or high-pollution industries and will benefit the renewable energy and pollution-control industries. The announced 4,000 billion Yuan economic stimulus package in China is gaining benefits. According to HSBC's Climate Change Center, 34 per cent of the package is "green" investment. This Chinese Green stimulus plan was joined earlier this year by similar government initiatives elsewhere in Asia. Some have interpreted this as evidence that the United Nations 'Green New Deal' is gaining momentum.

As part of the stimulus package, the government made a promise to address measures towards a green economy. During the Chinese recovery process, the government has focused on the following areas: energy efficiency; expanding mass transit and freight rail; constructing smart electrical grid transmission systems; wind power; solar power; and biofuels. Most of the government spending will be in the form of public infrastructure investments, public building retrofits, public transportation, and building smart grid systems, because the money to support these activities can be delivered relatively quickly by the government, and through the central government to local governments. Investments in renewable energy and energy efficiency are also central to this proposal, and would be funded through a combination of public funds, tax credits, and loan guarantees to spur private-sector investment.

This 4,000 billion Yuan fiscal expansion, if responsibly deployed, would frontload spending to launch a green energy economic development programme based on all of the renewable energy and energy efficiency proposals. This initial boost in direct government spending would be financed as part of the low-carbon transition, which calls for a balanced mix of private and public funding, the latter financed with revenue from a carbon cap-and-trade programme.

Investments in these green economy areas will produce employment opportunities across a broad range of familiar occupations—roofers, welders, electricians, truck drivers, accountants, and research scientists. It will also strengthen career ladders by providing pathways for workers to move up from lower-paying to higher-paying green jobs that can be created on a geographically equitable basis throughout all regions of the country. If this green economic recovery programme was fully implemented in 2009, it would reduce the number of unemployed people.

All regions of China can gain significantly from this green economic recovery program. Of course, due to climate and geography, not all areas of the country are equally capable of capturing the benefits of specific technologies—for example, solar or wind power. They are all, however, equally capable of making investments to dramatically improve energy efficiency through retrofitting buildings, expanding public transportation systems, and increasing the efficiency and stability of the electric grid. Similarly, all areas of the country have significant renewable energy resources or the ability to participate in the work of producing the goods and services that will be demanded by a transition to clean energy.

2.3 The skills development strategy in response to greening

2.3.1 Existing skills strategy

Vocational education and training (VET) in China is provided at three levels: junior secondary, senior secondary and tertiary. Most of the skilled workers needed by the green jobs are provided by vocational education and training system.

About half of all secondary school students attend vocational and technical (VTE) schools, making this a highly important part of China's educational system. These schools were aimed at equipping about half of all secondary school graduates with practical job skills, and the remaining half, who attend general secondary schools, for general employment and for further education. In addition to enrollments in full-time courses of two, three and four years' duration, the VTE secondary schools have substantial enrollment in short courses for in service training and for specialist pre-employment training.

VET in China is provided by both the Ministry of Education (MOE), in charge of Secondary Technical Schools and Vocational Schools (STSs and SVSs) and Technical Colleges (TCs) that provide mainly pre-service training, and the Ministry of Human Resources and Social Security (MOHRSS), which oversees Skilled Workers Schools (SWS), providing training at secondary level. The STSs are largely engineering trade schools responsible to the relevant technical bureaus. The SVSs are for the most part managed and financed by local education bureaus. SVS graduates find their own employment in the emerging labour market. Finally, SWSs are managed by local labor bureaus, technical bureaus and enterprises. The labor market is not fully developed as that of the developed countries, and although the central assignment of graduates from STSs and SWSs to jobs in SOEs is being abolished, students who are sponsored by SOEs and local governments are committed to employment under terms of agreements that are often between the school and the enterprise or local government. It is reported, however, that most graduates have to find employment by themselves now. There are also high proportions of fee-paying students in STSs and SVSs who are not committed to any employer.

Vocational training will play a critical role in supporting China’s successful transition to a carbon-neutral economy. Vocational training covers 80 per cent of occupations in China and provides nationally recognized training developed by industry, for industry. Vocational training is competency based, delivered and audited against national standards and recognized in all areas.

Whilst there are a growing number of tertiary qualifications in the field of sustainability, it must be acknowledged that university qualifications will form only part of the solution to addressing China’s environmental challenges. The majority of changes to daily operational practice will be enacted by people who are not university educated climate change professionals. As a result, providers of vocational and tertiary training in sustainability need to demonstrate a strong connection between sustainability training and workplace implementation and provide opportunities for students to apply these skills in practice.

Emerging training in sustainability will need to include both full qualifications and targeted skill sets to meet immediate business needs, as well as providing pathways into full and higher level qualifications.

Sustainability skills need to be included in vocational qualifications at a range of levels, including for Chinese vocation appraisal, stand-alone courses undertaken prior to employment or as part of ongoing professional development.

In China, the national training packages provide an ideal framework to integrate sustainability skills and knowledge into a practical vocational framework. As with other broad ranging skills such as occupational health and safety and employability skills, sustainability skills

specific to sectors and occupations have the capacity to form an important component of all skills, or units of competency, within national Training Package qualifications. However, there are no green jobs skills standards in China since green occupation is a very new concept. China Enterprises Federation supports the Chinese Industry's position on a new model for Training Packages that recommends the inclusion of environmental considerations into every unit of competency.

Within industries, there is a shift towards internationally competitive, high-quality and technologically advanced products, reflecting increased exposure to international markets. A significant factor in the increased competitiveness of the economy has been the sharp rise in foreign direct investment inflows, principally to the manufacturing and real estate sectors. Gross foreign direct investment inflows grew fast and now account for almost half of all such flows to developing countries. In China, many low-carbon industries or enterprises are booming. For example, China rapidly has moved along the path of renewable energy development. About 16 per cent of China's electricity came from renewable sources in 2006, led by the world's largest number of hydroelectric generators. Total installations of hydropower reached 145,000 MW in 2007. China has set a target of 190,000 MW for 2010. Technology development and increased amounts of investment in renewable energy technologies and installations has increased markedly throughout the 2000s in China, and investment in renewable energy is now part of China's economic stimulus strategy. Researchers from Harvard University and Tsinghua University have found that China could meet all of their electricity demands from wind power through 2030. With the booming of these low-carbon enterprises, the need for skills of green occupations is huge, and some enterprises, such as BYD (Bi Ya Di Auto Corporation), have their training programmes targeting green jobs. However, technical schools, vocational schools and colleges and universities do not have specific courses for green jobs skill training. Although government has noticed the need for green jobs skills, there are no national initiatives for training curricula for green occupations.

2.3.2 Need for green skills strategy

Sustainability will become central to China development strategy. It is essential to integrate sustainability into all aspects of development – into the products businesses make, into the operations and processes of enterprises, and into accounting practices, China will increasingly demand green skills and knowledge.

In preparing for a greener economy today and in the future, China faces three major skills challenges. The lack of skilled professionals and the absence of any benchmark to define what a sustainability specialist is constitute a significant risk to business uptake. There are no Chinese standards to indicate what skill sets are required to be qualified to provide advice or implement sustainability business strategies.

The first challenge is to green existing jobs. A greener, more sustainable economy does not mean that we just train up some new workers in green skills and they clean up after the rest of us. Greening existing jobs is crucial to meet current demand for retrofitting and the re-tooling of industry so vital to ensure our existing industries continue to grow. It is particularly important in sectors with a high environmental impact – including building and construction, energy, transport and agriculture. Activities in these high-impact areas account for around 70-80 per cent of overall resource use and emissions. As these industries respond to the demands of a greener economy and policy environment, jobs will require new skills. Workers in these industries need training and upgrade-skill so that they can adapt to new technology and new ways of working. And it has already been said that we need to up-skill existing workers so that we can respond to the present and ever-growing demand for retrofitting.

The second is to train new workers in the appropriate skills, so we can meet the demand for employees with the right skills in renewable industries and new green technology as they

develop. Demand for energy efficient alternatives is already outstripping the number of workers who can do this kind of work. A good example is the government subsidy to encourage the conversion of cars from petrol to LPG（Liquefied Petroleum Gas). People who were keen to take up this opportunity found themselves waiting in a long line, because there simply weren't enough mechanics with the skills to do this work. There is a similar story on the take-up of solar energy. And, as we have noted, we don't have nearly enough skilled workers in the range of occupations needed to retrofit buildings.[3]

Our third skills challenge will be in anticipating the future demands for green skills in emerging industries. China's current approaches to green skills are grossly inadequate. No-one collects systematic data on the skills and knowledge base of the workforce necessary to sustain the shift to a low carbon economy. Yet a good understanding of green skill requirements in a range of industries is a precondition to taking action. China also needs much better data on consumer demand for green products and services, so we can anticipate future demand and ensure we train an adequate number of workers in green skills. Unlike nations like Germany or the UK, China does not have a green skills jobs target. China should rectify this to drive ambition, investment, planning and skills demand.

According to the state sustainability strategy[4], China has selected six areas for future green investment in accordance with the strategy and market needs. It is expected that those sectors and jobs will increase to change the China labour market structure in the near future, although the skills for these occupations will change with the development of the sectors.

Table 1. Employment effect analysis of low-carbon development (Unit: 10,000 people)

Sector	Sub-sector		Direct employment	Indirect and induced employment
			2005～2020	2009～2020
Forestry	Forestry plantation and replantation		760	1,108.8
	Management on sustainable forest		16.69 ~ 20.86	5.4 ~ 6.75
	Forest tourism		315.4	361.6
Electricity	Thermoelectricity		-23.0	78.25
	Wind power		50.08 ~ 73.45	142.51 ~ 206.62
	Solar power		18.64	62.35
Infrastructure	Steel Industry		-24.86 (2005 ~ 2011)	--
Total			1,112.95 ~ 1,140.49	1,758.91 ~ 1,824.37
Green investment (2008-2010)		56.7	151.7	151.7
		92.0	141.9	141.9
		2.63	6.36	6.36
Total			151.3	300.0

Source: ILO (2009).

[3] Survey by the research group of CALSS, 2009.

[4] Report on China Sustainability Strategy, Chinese Academy of Sciences, 2005.

Table 2 outlines these areas as well as a number of green employment opportunities. Many of these jobs are already Chinese worker's occupations; therefore they only require a "green" upgrading of training and skills.

Table 2. Six areas for green investment and green jobs

Green Investments and Jobs	
Strategies for green economic investment	**Representative jobs**
Building Retrofitting	Electricians, Heating/Air Conditioning Installers, Carpenters, Construction Equipment Operators, Roofers, Insulation Workers, Carpenter Helpers, Industrial Truck Drivers, Construction Managers, Building Inspectors
Mass Transit/Freight Rail	Civil Engineers, Rail Track Layers, Electricians, Welders, Metal Fabricators, Engine Assemblers, Bus Drivers, Dispatchers, Locomotive Engineers, Railroad Conductors
Smart Grid	Computer Software Engineers, Electrical Engineers, Electrical Equipment Assemblers, Electrical Equipment Technicians, Machinists, Team Assemblers, Construction Laborers, Operating Engineers, Electrical Power Line Installers and Repairers
Wind Power	Environmental Engineers, Iron and Steel Workers, Millwrights, Sheet Metal Workers, Machinists, Electrical Equipment Assemblers, Construction Equipment Operators, Industrial Truck Drivers, Industrial Production Managers, First-Line Production Supervisors
Solar Power	Electrical Engineers, Electricians, Industrial Machinery Mechanics, Welders, Metal Fabricators, Electrical Equipment Assemblers, Construction Equipment Operators, Installation Helpers, Laborers, Construction Managers
Advanced iofuels	Chemical Engineers, Chemists, Chemical Equipment Operators, Chemical Technicians, Mixing and Blending Machine Operators, Agricultural Workers, Industrial Truck Drivers, Farm Product Purchasers, Agricultural and Forestry Supervisors, Agricultural Inspectors

3. Anticipation and provision of skills

3.1 Green structural change and (re)training needs

3.1.1 Green restructuring and its impact on the labour market

Green restructuring has its huge impacts on the labour market. In some sectors, the employment implication is rather positive. These sectors are forestry, wind power, solar power and recycling industries, etc.

Forestry has made great positive contribution for mitigating global climate change. In order to mitigate and adapt to global climate change, forestry mainly adopts three channels, including carbon sinks, carbon reserve and carbon substitution, and series of action. According to the research, we can see that a series of actives of forestry dealing with climate change, such as afforestation, forest management and development of forest tourism, can create a large number of green jobs. It has an important strategic significance for the response to global climate change and to ease the employment problem in the context of financial crisis.

In fact, implementation of conversion cropland to forest, in addition to afforestation, has also created many new jobs, such as pre-survey before implementation of the project, engineering planning and design, training of engineering implementation, engineering assessments and monitoring, etc. If we consider a variety of indirect employment effects of afforestation activities, such as forest management and protection, forest tourism, forestry and other sideline, the impact of conversion cropland to forests on employment should be fairly positive. In addition, the fields for afforestation are mainly barren hills and wasteland in China, even conversed lands were mostly lower in terms of farming output. After 2006, in order to protect food production, conversion cropland to forest areas have significantly reduced, turning to consolidate the preliminary results of conversion cropland to forest by forest management and protection. In the project implementation process, the central and local governments and the forestry-related functional departments have attached great importance to development of alternative industries and labour force training, and the surplus labour force in most regions after conversion cropland to forests has generally been a good transfer or resettlement, therefore, negative impact on employment of afforestation projects is not significant as a whole.

The research results show that, from 2005 to 2008 and from 2009 to 2020, the total number of short-term standard direct employment (based on 300 days of work per person per year) created by afforestation are approximately 5.77 and 1.83 million respectively; the number of new forest resources management jobs are 11.16 and 9.7 million respectively; the number of direct employment created by forest tourism industry are 357.08 and 1,751.46 million respectively (Table 3).

Table 3. Employment creation of the forestry industry in China

Index		Direct employment effects (10,000 people)		Indirect employment effects (10,000 people)	
	Year	2005-2008	2009-2020	2005-2008	2009-2020
Forestry	Afforestation and reforestation	577	183	841.6	266.9
	Sustainable forest management	8.93 ~ 11.16	7.76 ~ 9.70	2.89 ~ 3.61	2.51 ~ 3.14
	Forest tourism	46.6	268.8	53.3	308.3

Source: ILO (2009).

The new energy industries are booming in China thanks to the government support and business innovation. Both wind power and solar power industries in China have very huge potentials for employment creation. (See Tables 4 and 5).

Table 4. Employment creation of the wind power industry

Year	Installed capacity of wind power (10,000 KW)	Job opportunities (1,000 persons)
2005	126.3	1.9 ~ 2.5
2006	259.9	3.9 ~ 5.2
2007	590.3	8.9 ~ 11.8
2008	1,215.3	18.2 ~ 24.3
2009	2,115.3[5]	31.7 ~ 42.3
2010	2,500[6]	37.5 ~ 50.0
2011~2020	12,000[7]	111.6 ~ 148.8[8]

Source: ILO (2009).

Table 5. Indirectly created and induced jobs of solar power generation industry (unit: 1,000 persons)

Sector	Year	Indirect employment	Induced employment	Total
Solar PV Industry	2005	11.1	29.4	40.5
	2006	32.9	89.1	122.0
	2007	74.0	203.3	277.3

Source: ILO (2009).

There are significant employment impacts of green jobs in many of China's declining industries. For example, on a country basis, China has the largest number of cement plants and workers. In 2000, there were between 8,000 and 9,300 cement production plants of various sizes in China. Chinese cement plants remain very labour intensive. Based on the above, the number of job lost aroused by closed small Chinese coal-fired power plants is shown as figure in table 6:

[5] Estimation based on data from Jan. to June 2009.

[6] It is the high target data published by Wind Power Report 2008.

[7] It is the high target data published by Wind Power Report 2008.

[8] It is achieved based on the assumption that the total employment per 10,000 KW will decrease 38 per cent.

Table 6. Employees reduced aroused by closed small Chinese coal-fired power plants (2003~2020)

Year	Closed capacity of small coal-fired power plants (MW)*	Affected employees (1,000 persons)
2003	1,800	11.16
2004	1,840	11.41
2005	240	1.49
2006	3,140	19.47
2007	14,380	89.16
2008	16,690	103.48
2009	1,300	80.60
2010	1,000	62.00
2011	8,000	49.60
2012-2020	28,800	178.56
Total	97,890	606.93

Source: ILO (2009). *MW = megawatts

Consequently, during 2005 to 2020, the number of employees reduced is expected to be about 584,400. If more plants with large capacity (such as 125 MW or 200 MW) are closed in the future, the total number of employees reduced will increase.

A report conducted by Battelle and commissioned by the World Business Council for Sustainable Development states that in some instances, they require 10 times the amount of workers in developed countries (UNEP et al., 2008). In order to have a cleaner environment, China has developing the desulfurization industry, and the overall employment created by Desulfurization industry from 2005 to 2020 would be 1,080.5 thousand persons. (ILO, 2009[9])

As a result of the green economy movement, many measures taken in the cement industry, including the relocation of polluting enterprises, will improve the urban environment. For example, Miyun County in Beijing was to speed up the ecological quality, and shut down polluting enterprises to improve the urban environment. The county takes the closure, removal, replacement and other measures to gradually make the county cleaner, and achieve marked results after continuing efforts such as the closure and relocation of the polluting enterprises. The closure of Sangyong Cement Plant, the largest source of pollution in Miyun is a step forward for green development.

The coal industry has also experienced employment impacts of green jobs. China - the world's largest coal producer - cut some 870,000 jobs in the second half of the 1990s. The growth of production has slowed in recent years, from 15 per cent to 8 per cent. Employment in China's quarrying and mining sectors has fallen steadily as well, with a total loss in jobs of 31 per cent between 1997 and 2002. But China continues to add huge capacities in coal-fired power plants - 209,000 MW in 2006 and 2007 alone. Modern plants employ very few workers: one in southern China near the Vietnamese border needs just 270 workers for a 1,200 MW facility, compared with older plants that employ up to 1,000 people in a 50 or 100 MW facility (UNEP et al., 2008). As China moves toward a green economy, industries like coal, a major source of greenhouse gases, will become obsolete. As these industries employ millions of workers, vocational training and skill upgrading of these workers will be required.

[9] China Energy Industry Analysis Report, Pan Jiahua, ILO, 2009.

3.1.2 Identification of training needs

The development of new techniques and green industries has high demands for technical staffs, but as a developing country, China has many less-educated and low-skilled labour forces. It is a disadvantage for China's labour transformation and would reduce the employment opportunities for many low-tech labourers. Many of China's declining industries, in response to the measures towards green economy, will have skills implications. In the cement industry, the Chinese government has released new energy standards aimed at a 15 per cent reduction in energy use by 2010. This shift toward energy-efficient plants, both newly constructed and retrofitted, is likely to produce some construction jobs in the short term, but will require fewer workers in the long run. Jobs remaining in this more efficient industry will require higher levels of skills and enhanced training programs for workers, and could be considered a light shade of green, but this industry is not expected to be a major source of new green employment (UNEP et al., 2008).

If many of these declining, dirty industries become obsolete as a result of the movement towards a green economy, millions of unemployed workers will require new green skills. Additionally, China has reported shortages of skilled workers. To remedy such shortages requires not only adaptations in training new workers, but also retraining efforts for those workers who transition from older, polluting industries to new ones (UNEP et al., 2008).

Right skills for green jobs are the prerequisite to make the transition to a greener economy happen. Today, skills gaps are already recognized as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, renovation of buildings, construction, environmental services, manufacturing (MOHRSS, 2009). The adoption and dissemination of clean technologies requires skills in technology application, adaptation and maintenance. Skills are also crucial for economies and businesses, workers and entrepreneurs, to rapidly adapt to changes as a consequence of environmental policies or climate change.

3.1.3 Skills responses

Skills response should be taken by all the stakeholders of governments at all levels, businesses, trade unions, individuals, and NGOs (non-governmental organizations). It is businesses' responsibility to work with the Government and other agencies to have appropriate skill responses in order to minimize the ecological footprint of their activities and comply with relevant state and national legislation. Currently sustainability is a relatively low priority for businesses that are not large emitters.

As a result, business commitment to changing practices to reduce the impact on the environment needs to be developed through education to achieve incremental change in business operations. Over time, businesses will be better placed to respond to supply chain requirements from the larger organizations with which they interact. Exclusive reliance on legislation as the skills response may achieve base level compliance, however this strategy is unlikely to support the innovative business responses required in the longer term. Green jobs skills response is an ongoing process that cannot be achieved overnight. It requires greater internal support and motivation by a business than could be achieved successfully through legislation. If publicly funded training for existing staff is not available, it will be incumbent on government to provide strong incentives and case studies to support employers to achieve this attitudinal and behavioural change.

To cope with changes in the economy's skill requirements, the educational system was transformed in several ways. To prepare workers for new occupations, schools added courses in practical subjects to the traditional academic curriculum. While there is a role for classroom modes of delivery, these are less likely to appeal to employers due to the loss of productive staff

time on the job. Consequently flexible learning delivery models, including online, workbook or CD-ROM based resources, will play a critical role in supporting greater business uptake.

3.1.4 Case studies

Case study 1: Forrester

In the structural adjustment, some occupations are booming. In the past 20-odd years, four million hectares of trees have been planted annually on average with the continuously increasing investment from the central government. Meanwhile, the country also encourages citizens at the right age to take part in tree planting. By the end of 2007, 10.98 billion person-time in total had joined voluntarily and planted 51.54 billion trees all over China. In recent years, through the measures like collective forest property reform, farmers' enthusiasm for tree planting and forest protection has been aroused. At present, China has 54 million hectares of man-made forest, its stock volume reaching 1.505 billion m3, with the country's forest coverage increased from 12 % in the early 1980s to 18.21 % now. In 2006, total area of green belt and park in urban area in China reached 1.32 million hectares with 35.1% green coverage. It is estimated that from 1980 to 2005, a total accumulated net sequestration of 3.06 billion tCO2 was achieved by afforestation, and 1.62 billion tCO2 by forest management respectively, and 430 million tCO2 from deforestation were avoided. All this has further enhanced the capability of forest as the sinks of greenhouse gas. For example, the forester occupation is rather promising for greening the economy. A Forester is a person who inspects the forest, cares the forest to prevent fire and protect the forest resources. There are three levels in this forester occupation: primary (National Qualification Level or NQL 5), middle (NQL 4), advanced (NQL 3). A forester should have the abilities of field care, understanding the information from outside, communications, judgement, expression and ideation, and should be healthy. The state has set up the occupational standards:

a. Minimum educational level:

Junior middle school

b. Training requirement:

The purpose and syllabus could be determined by the relevant full-time vocational schools. However, the minimum training requirements for reaching each level are as the following:

- Primary: 120 hours of standard training;
- Middle:100 hours of standard training;
- Advanced: 80 hours of standard training;

c. Trainers

The requirements for trainers are as follows:

The trainers teaching the trainees for primary level should have the minimum requirement of advanced level of NQL; The trainers teaching the trainees for middle level and advanced level should have the minimum requirement of technician level of NQL; The trainers teaching the trainees for technician and advanced technician level should have the minimum requirement of advanced technician level of NQL.

Up to date, many areas have training programs for foresters, and many foresters were lumberjacks before. With China's efforts for forestation, more and more foresters are needed. It is estimated that there will be 2.5 million foresters in 2010. The training is mainly provided by vocational schools or technical schools, and sometimes supported by the local forestry bureaus of the local governments.

Case study 2: Energy industry in China

China is optimizing the energy consumption structure through vigorously developing renewable energy, boosting nuclear power plant construction and speeding up the development and utilization of coal-bed methane. The target by 2010 is to raise the proportion of renewable energy (including large-scale hydropower) in the primary energy consumption up to 10 per cent, and the extraction of coal-bed mine methane up to 10 billion m^3. Through building up its independent innovation capacity, and promoting international cooperation and technology transfer, China will work hard to achieve big breakthroughs in R&D (Research & Development) on energy development, energy conservation and clean energy technology, to quicken the commercialization of advanced technologies; to enhance the technological capacity of agriculture, water conservancy and forestry sectors to adapt to climate change; and to provide strong scientific and technological support for efforts to address climate change by 2010. In order to have high efficiency in energy consumption, China is accelerating the pace of phasing out of backward production capacity. In 2007, the government announced a timetable for different areas to phase out of their backward production facilities in 13 industries during the latest Five-year Plan period. In 2006, China saw the shutdown of 14.38 GW (gigawatts) installed capacity of small thermal power generation units, and the elimination of 46.59 million tons of iron-smelting obsolete capacity, 37.47 million tons of steelmaking capacity and 52 million tons of cement production capacity. More than 2,000 heavily polluting papermaking plants, chemical plants, and printing and dyeing mills were ordered to close down, as were 11,200 small coal mines. In addition, China is limiting the excessively rapid expansion of high energy intensive and emission intensive industries. Relevant policies have been promulgated to control new projects. Standards of market entry for high energy intensive industries have been promulgated. By raising the entry standard of energy-saving and environment protection and by adjusting tax rebates for exports and customs duties, the government is working to restrain the export of high energy-intensive, pollution-intensive and resource-intensive products. The expansion of high energy intensive industries is being slowed. More high-efficiency, energy-conservation equipments are used in the power-generation and coal-producing sectors, and the government has quickened its pace to phase out small thermal power stations and coal mines. In 2007, the coal consumption of power generation with capacity 6MW or above dropped from 448 gce/kWh in 1980 to 370 gce/kWh. Energy and electricity consumption per unit production of raw coal in 2007 dropped by 5.9 per cent and 5.1 per cent, respectively, as compared with the previous year. The Renewable Energy Law was enacted in 2005 to give the obligation for grid companies to purchase all the electricity generated from renewable energies; renewable electricity has a privilege to be fed into the grid with a favourable price; and the incremental feed-in tariff of renewable electricity to the grid is shared by all the society. A dedicated fund was established for developing renewable energy to support the evaluation and investigation of renewable energy resources, related technological research and development, construction of pilot and demonstration projects, and the development and utilization of renewable energy in the countryside. By the end of 2007, the total installed capacity of hydropower in China was 145 GW, and the corresponding annual power generation was 482.9 TWh, ranking first in the world in both installed capacity and power generation. An average of 26 GW of installed capacity was added in 2006 and 2007, with an average increase of 12 per cent each year. The scale of wind power increased several-fold. Currently, with installed capacity of more than 6 GW, China ranks fifth in the world. In 2006 and 2007, some 3.05 GW was added, an average annual increase of 148 per cent. Heat collecting area of existing solar water heaters has reached 110 million m^2, keeping China the world leader in this field for many years. The installed capacity of biomass power generation is 3 GW, and the annual production capacity of ethanol fuel is more than 1.2 million tons. The installed capacity of nuclear power is 9.06 GW, an increase of 30.5 per cent over 2006. The share of coal in the primary energy consumption dropped from 72.2 per cent in 1980 to 69.4 per cent in 2007. The share of hydropower, wind power and nuclear power combined was raised from 4 per cent to 7.2 per cent in the same period. The total utilization of renewable energy equals to approximately 220 million tce (including large hydropower). According to the Mid- and Long-term Plan for the Development of Renewable Energy and Mid- and Long-term Plan for the Development of Nuclear Power, China will continue to promote the comprehensive hydropower cascading development of river basin. It will quicken the pace of constructing large hydropower stations on the precondition of environmental protection and

proper migrant's relocation. Medium and small scale hydropower stations will also be developed where local conditions permit. China is determined to accelerate the development of wind power, to achieve industrialization by scaling up exploitation. It will raise its capacity for R&D and manufacturing wind-power equipment and make every effort to construct several wind-power farms at scale of GW and wind-power bases at scale of 10 GW. China will vigorously promote biomass energy development and utilization by attaching significant importance to bio-energy based power generation, biogas, biomass briquette and biofuel. China will actively develop solar power and solar heating while strengthening the research, development and utilization of new energy and alternative energy. It will make better use of coal-bed methane and coal-mine methane, and develop small scale distributed power fueled by coal-bed methane. China enthusiastically develops nuclear power. It is working hard to reform the nuclear power system and spur mechanism innovation in an attempt to establish a market-oriented nuclear power development mechanism. It will strengthen its capacity for R&D and manufacturing nuclear power equipment, and raise its ability to absorb imported technology and make innovations on this basis. It will strengthen the related technical services system for nuclear power operation, as well as the training of professionals. It will implement preferential policies on taxation and investment that will promote the development of nuclear power, improve nuclear power safety system and quicken the enactment of laws and regulations in this field. Finally, China will push forward clean coal utilization and develop efficient and clean power generating technology, such as large-scale combined cycle units and poly-generation, and promote R&D on the technology for carbon capture and storage.

The energy sectors in China have lots of training activities, and some sectors have national standards of the occupation, such as workers in solar energy and small wind power. The main problem is that some most advanced technologies are too expensive for a developing country like China, therefore, some training contents could not be fully used in reality. According to the statistics, generally speaking there are following training contents:

- **Energy planning:** Socio-economic analysis, surveying methodology, resource assessment, renewable technology characteristics, data collection and analysis**,**
- **Project design and management:** Detailed knowledge of renewable technology characteristics, needs assessments, budgeting, scheduling, economic and financial analysis, finance, human resource management, computer tools for project management**,**
- **System design :**Performance estimation methods, component characteristics, operating efficiencies, resource availability, potential problem areas, failure modes and risks,
- **Specification and purchasing of components:** Fitting specifications to needs and environmental constraints, purchasing methodology, tender preparation and evaluation, critical and non-critical specifications, warranty needs, information needs, standards and certifications**,**
- **Installation services:** Guidelines for installation of the target technology, Critical points for proper installation. Alternate methods for unusual circumstances**,**
- **Maintenance services:** Troubleshooting and maintenance procedures, use of test equipment, identification of incorrect operation, user interaction**,**
- **Business skills for renewable energy implementation:** Market assessment, product pricing, after sales support, record keeping and analysis, marketing of the product or service, obtaining and efficiently using finance, forecasting of cash flows, development of service businesses**, and**
- **Finance of renewable energy systems:** Sources of finance, incentives and special conditions for renewable energy, CDM and its effect, accessing grant funds, preparing financial applications. The training courses are targeting all customers, from officials, engineers to workers, and the providers of the training courses are the relevant government ministries, bureaus, and the industry associations, and some courses are provided by universities, colleges and technical schools.

3.2 New and changing skills needs

3.2.1 New green collar occupations

The employment impact of green jobs is also significant in new industries. The following table outlines the global employment in the renewable sector.

Table 7. Estimated employment in the renewable sector, selected countries and world, 2006

Renewable energy source	World*	Selected countries	
Wind	300,000	Germany	82,100
		United States	36,800
		Spain	35,000
		China	22,200
		Denmark	21,000
		India	10,000
Solar PV	170,000**	**China**	55,000
		Germany	35,000
		Spain	26,449
		United States	15,700
Solar thermal	624,000-plus	**China**	600,000
		Germany	13,300
		Spain	9,142
		United States	1,900
Biomass	1,174,000	Brazil	500,000
		United States	312,200
		China	266,000
		Germany	95,400
		Spain	10,349
Hydropower	39,000-plus	Europe	20,000
		United States	19,000
Geothermal	25,000	United States	21,000
		Germany	4,200
Renewables, combined	2,332,000-plus		

*Countries for which information is available.
**Under the assumption that Japan's PV industry employs roughly as many people as Germany's PV industry

Source: UNEP et al. (2008).

It is interesting to note that China employs over 50 per cent of the estimated employment in the renewables sector. In particular, more than 600,000 people are employed in the solar thermal sector - by far most of them in China.

Table 8. Employment in China's renewable sector, 2007

	Wind power	Solar PV	Solar thermal	Biomass	Total
Generation	6,000	2,000		1,000	9,000
Manufacturing	15,000	38,000	400,000	15,000	468,000
Service	1,200	15,000	200,000	250,000	466,200
Total	22,200	55,000	600,000	266,000	943,200
Output Value*	25	50	40	10	125

*Output value expressed in billion Yuan (1 billion Yuan = $135 million).

In China, more than 15 major solar cell manufacturers were thought to employ over 20,000 people in 2006, though comparison with data in Table 3 suggests this figure to be on the low side (and installation and maintenance add more jobs). Production and employment look set to continue their steep rise. The China Solar PV Report from 2007 projects that employment in China's PV industry could reach 100,000 by 2020 and perhaps as many as 5 million by 2050 (UNEP et al., 2008).

Another increasingly important green industry is wind power. China's wind power developed so fast in the past 20 years. In 2006 alone, the growth rate was 104.55 per cent, reaching a total installed capacity of 2,589,400 kw. During the period from 1997 to 2006 installed capacity of wind power experienced an increase of nearly 17 times. China's wind power in 2006 reached the volume of 2.7 billion kwh, increasing 67.4 per cent compared with the previous year. In 2008, the total installed capacity reached 12,210,000 kw, five times of that in 2006. The total employment in China's wind power industry is about 120,000 in 2008. Green collar occupations in industries like the renewables sector and clean energy have enormous potential for high job creation.

3.2.2 Greening existing occupations

Additionally, there are a number of existing occupations that can be upgraded for the purposes of promoting a greener economy. For example, in the auto industry, China accounts for a large chunk of the world's vehicle production and employment with 1.6 million employees. To create large numbers of greener jobs in the auto industry, a concerted international fuel-efficiency strategy is needed—with mandatory targets, accelerated technology diffusion mechanisms so that the most efficient and cleanest engine designs are introduced in timely fashion, incentives for consumers to purchase the most efficient models, and large-scale investment to generate additional breakthroughs in cleaner engine technologies and fuels (UNEP et al., 2008).

Another opportunity to green an existing industry is in construction, by introducing retro-fitting and energy efficiency measures. More than 50 per cent of all new building construction is now taking place in Asia, mainly in China. In the next two decades, 300 million Chinese are projected to move into urban centers, and China alone will add 2 billion square meters (21.5 billion square feet) of new construction each year, doubling its building stock by 2020. The building sector in China is expected to grow by 7 per cent annually. Energy-efficient measures in the construction industry leads to direct, indirect, and induced jobs (UNEP et al., 2008). The wastewater treatment industry is also becoming greener due to technological advancement. For example, the Daqing Oilfield Co., Ltd did not have high efficient and effective wastewater treatment methods, but in recent years, it adhered to the enterprise tenet of "devoting energy to create harmony". It comprehensively implemented the strategy of establishing a green and

ecological oilfield and actively propelled clean production. With regard to problems of oily wastewater treatment, it explored and applied new technique of biochemical treatment and established Changyuan Biochemical Treatment Station of Oily Wastewater. This station was established in August 2006, and put into operation on 16 Nov. 2007, with total investment of RMB 0.171 billion Yuan, occupation area of 3.71 square meters and daily wastewater treatment capacity of 30,000 cubic meters.

This station adopted treatment process which placed biochemical treatment first and physic-chemical treatment second, and increased the biodegradability of wastewater through air flotation, anaerobic hydrolysis tank and contact oxidation tank. Under the action of biological fertilizer, the oil, long chain polymer, etc. contained in the wastewater were degraded after chain scission and the wastewater achieved to national standards after treatment. The whole production system adopted PLC remote automatic control, and realized computer automatic management. Therefore, the Changyuan Station of Biochemical Treatment of Oily Wastewater was a station with high degree of automation and high treatment capacity in China. The establishment and operation of Changyuan station has resolved problems of biochemical treatment of wastewater containing oil and polymer in cold areas with high latitude. Through the comprehensive regulation of its regional wastewater, the station has realized the goal of reducing chemical oxygen demand greatly, and played an obvious role in emission reduction. It has made an important step in protecting the water environment of Songhua River, establishing charming Daqing and creating "Green and Ecological" Oilfield, and played an important role in creating a harmonious enterprise. Within one year after putting into operation, the station has treated 7.52 million cubic meters of wastewater containing oil in total. In 2007 and 2008, it was honored as a "green and environmental protection station" by the mother Group Company.

Non-wood pulp and paper production remains a major source of income and employment in many areas. The shift away from non-wood pulp and paper manufacturing will result in the loss of income for farmers as well as actual job losses. Estimates for the number of jobs lost in China are as high as 1 million. If these non-wood pulp and paper mills were upgraded and made more efficient, they would be a major source of green employment. A 2006 study by the International Finance Corporation, funded by the Finnish Ministry of Trade, and Industry, analyzed the potential for a more sustainable non-wood pulp and paper industry in China. The study concluded that by modernizing pulping and chemical recovery processes, China could significantly reduce pollution, energy consumption, and water consumption, while maintaining employment for 8 million people in the industry (UNEP et al., 2008).

Finally, many opportunities exist to create greener occupations in the recycling industry. In recent years, China has become a major destination of global e-waste. The State Environmental Protection Administration – China's top environmental authority – estimates that 70 per cent of e-waste generated worldwide has been sent to China. Of the over 5,000 metal recycling enterprises in China, only 1-2 per cent are large or middle sized firms. In Guiyu, there are more than 300 e-waste dismantling firms and more than 3,000 family recycling workshops dispersed across its 21 villages. Nearly 60,000 workers dismantle over 1.5 million tonnes of e-waste annually. The e-waste industry has become Guiyu's economic pillar, generating almost 1.2 billion RMB (approx. US$152 million) in 2006 alone, accounting for over 90 per cent of the local fiscal income.

The whole industry is cramped by small companies or family workshops, which seldom have any measures to protect the labourers or the environment (Recycling Magazine, 2009). Greening in this industry would not only involve upgrading technology and skills, but also contribute to better decent work opportunities for the workers.

3.2.3 Identification of skill needs

It is a nationwide movement to refresh the traditional trades with training in 21st century knowledge and skills, which also means green job skills in large part. As a result of investments to mitigate and tackle the effects of climate, new job opportunities will emerge in sectors related to environmental services, clean technologies, renewable energies, recycling, urban and rural renovation or nature conservation. The green-collar movement in China advances new, more environmental technologies by training the work force that can manufacture, install and maintain them. It seeks energy security and climate change prevention through an emphasis on non-fossil fuels and energy efficiency. The government has realized the importance of technical skills for economic development and industrial structure adjustment. In 1998, the Chinese government drafted the Mid and Long-term National Plan for Vocational Skills Development, which has the mechanism for matching the demands and supply of skills in accordance with the state economic development strategies. The technical schools and vocational schools will adjust the majors with the market needs, and the majors related with low-carbon economy are increasing since the government has decided to develop the low-carbon sectors. The central and local governments, especially the educational departments and human resources departments, have also guided the development of these schools, and the majors with the promising sectors, such as solar energy and electricity car, are promoted.

New technologies create new training demands. One example is that information and communication technologies (ICT) has changed skill demands in many ways, and many green occupations also need ICT. The use of ICT is very often associated with cognitive and analytical tasks. Since demand for problem-solving and communication skills has risen, the high-skilled workforces are needed in many areas. A narrow application of the green-collar concept focuses on jobs in new energy technologies. In West China, many installers of geothermal heating systems and workers provide energy for homes and businesses across China. So it is necessary to training the installer with green technologies. However, much of the skills demands are identified by the enterprises.

Retrofitting Chinese cities, for example, requires workers with construction skills who also have up-to-date training on energy-efficient construction, and the new energy economy will create some brand new industries and many brand new jobs. But even more of it will involve transforming the industries and jobs we already have. The government realized that it is a must to have energy-efficient houses, so the Ministry of Housing and Urban-rural Development identified the priority of retrofitting as a way to combat climate change.

For these skills demands, the Chinese government used some surveys to identify, and sometimes the research organs affiliated to the government will apply quantitative projections of employment based on econometric model, and thus to have some results on future skill needs. Besides, the public employment service could also identify the skill needs in labour market. China has its country-wide public employment service system, which could help match the supply and demand in the labour market by providing services to both employers and job-seekers. Nowadays, the public employment service in China provides job seekers with job guidance and placement service, and can assist the workers in meeting skills and training needs. The public employment service also provides training and retraining to the job seekers. Therefore, it could play a very important role in detecting and address the skill shifts and demands.

3.2.4 Skills responses

The Ministry of Human Resources and Social Security (MOHRSS) and the Ministry of Education have begun to respond to the growing need for VET to accommodate green skills and knowledge. Coherent accompanying skills development measures in making by the MOHRSS include:

1. Construction of basic training system for skills of green jobs:
   - Developing green jobs by all means;
   - Establishing standards for skills of green jobs and qualification for workers;
   - Training for trainers on green job skills.
2. Entrepreneurship training on skills for green jobs:
   - In business start-up training, skills for green jobs will be included;
   - Encouraging people with entrepreneurial spirit to set up green enterprises and development of skills for green jobs;
   - In the database of entrepreneurship training lists, add green enterprises skills category.
3. Improvement of infrastructure for training for skills of green jobs:
   - Establish courses and training projects on skills for green jobs;
   - Textbooks and related guidance books and materials on training for green jobs;
   - Publicity and research on skills for green jobs.
4. Support systems by the government:
   - Subsidies for the workers who participated in the training for skills of green jobs;
   - Micro credits and taxation breaks for those who take part in green entrepreneurship training.

There are no specific, industry-based competency standards for sustainability and guideline competency standards that can be taken up in any industry sector. However, some industries have begun to think about competency standards. Green occupations exist in a range of industries, including in construction and manufacturing. A number of provinces have provided funding to industry associations to develop green plumbing initiatives, which assist plumbers to become trained and accredited in household water and energy efficiency. There is also great demand for ‘eco-smart’ electricians.

In the e-waste recycling industry, there have been attempts to undergo various measures to make greener designs. The government, which is short of both resources and expertise, has been struggling to do the work. Seven central government departments and administrations jointly issued the Management Regulation on Pollution Control of Electronic Information Products, which took effect on 1 March 2007 which will gradually phase out the use of several hazardous materials in electronic products to control pollution from the source, forcing domestic manufacturers to use ‘greener’ designs (Recycling Magazine, 2009). These greener designs will consequently require skills upgrading for the workers

3.2.5 Case studies on new green collar occupations

Case study 3: Small Wind Power Worker

China's MOHRSS has established the occupational standard for Small Wind Power Worker.

In China, the Small Wind Power Worker is the person who does installation, adjustment, operation management and maintenance of the small wind power of less than 10 KW per turbine. This occupation has 5 levels: primary (National Qualification Level or NQL 5), Middle (NQL 4), Advanced (NQL 3), Technician (NQL 2), Advanced Technician (NQL 1). A small wind power worker should have the abilities of observation, understanding, judgement, expression and ideation, and could have the capabilities of computation and map reading, and has agile fingers and arms and good coordination. The state has the following requirements for a Small Wind Power Worker, which was developed in 2007 after intensive consultation with the Ministry of Agriculture:

a. Minimum educational level

Junior middle school

b. Training requirement

The purpose and syllabus could be determined by the relevant full-time vocational schools. However, the minimum training requirements for reaching each level are as the following:

Primary: 220 hours of standard training;

Middle: 180 hours of standard training;

Advanced: 140 hours of standard training;

Technician: 100 hours of standard training;

Advanced Technician: 80 hours of standard training.

The basic technical skills taught in the above-mentioned vocational levels of training include:

1. Basic knowledge on wind power generation. E.g. the knowledge about wind power utilization, the components of the small wind power generation system and its application, and the basic manufacturing methods of the small wind power generation system;

2. Knowledge on reading and drawing graphics. E.g. basic knowledge on reading and drawing graphics, basic knowledge on floor plan, basic knowledge on electric wiring diagram and basic knowledge on equipment assembly graphics;

3. Basic knowledge on theories. E.g. basic knowledge on electric applications, basic knowledge on mechanical transmission, and knowledge on common legal units of measurement and their conversion;

4. Safety knowledge, including common knowledge on fire, electricity, work safety and first aids;

5. Relevant laws and regulations.

Besides, the trainees will receive training on work ethics.

c. Trainers

The requirements for trainers are as follows:

The trainers teaching the trainees for primary level should have the minimum requirement of advanced level of NQL; The trainers teaching the trainees for middle level and advanced level should have the minimum requirement of technician level of NQL; The trainers teaching the trainees for technician and advanced technician level should have the minimum requirement of advanced technician level of NQL.

The number of small wind power workers is, according to estimation, 120,000 at the end of 2008. The government has programs to train the workers for this occupation is 5,000 in 2008, but the trainees will increase dramatically with the government support for clean energy development. However, this is a new occupation, and the government has just set up a standard. Therefore, the number of workers who

passed the examination and got the certificates is only 200. According to the experts, the technical workers with certificates will increase significantly as the country has committed to clean energy development strategy. The providers of such training are mainly the vocational and technical schools and colleges, and the government would like to support such training courses. Some universities, such as Tsinghua, also have majors on electricity, and wind power is also their specialty.

Case study 4: Solarteur

China's MOHRSS has established the occupational standard for solarteur in 2003.

Solarteur is the occupation which install, construct, adjust, maintenance and management of solar and PV equipment.

In China, the solarteur occupation has 5 levels: primary (NQL 5), Middle (NQL 4), Advanced (NQL 3), Technician (NQL 2), Advanced Technician (NQL 1).

A solarteur should have the abilities of observation, understanding, judgement, expression and ideation, and could have the capabilities of computation and map reading, and has agile fingers and arms and good coordination. The state has the following requirements for a solarteur:

a. Minimum educational level

Junior middle school

b. Training requirement

The purpose and syllabus could be determined by the relevant full-time vocational schools. However, the minimum training requirements for reaching each level are as the following:

Primary: 240 hours of standard training;

Middle:200 hours of standard training;

Advanced: 160 hours of standard training;

Technician: 120 hours of standard training;

Advanced Technician: 100 hours of standard training.

The basic technical skills taught in all the above-mentioned five levels training period include:

1. Basic knowledge on solar energy utilization. E.g. basic knowledge about solar radiation, the components, types and operational principles of solar water heater and solar cooker, the basic knowledge about solar radiation, the components, types and operational principles of solar house and greenhouse, and the basic knowledge about solar radiation, the components, types and operational principles of solar photovoltaic system;

2. Knowledge on reading and drawing graphics. E.g. basic knowledge on reading and drawing graphics, basic knowledge on principle sketch of the system, Schematic Piping Diagram and building structure, basic knowledge on floor plan, basic knowledge on electric wiring diagram and basic knowledge on equipment assembly graphics;

3. Basic knowledge on theories. E.g. basic knowledge on engineering heat transfer, basic knowledge on electric application, and basic knowledge on mechanical transmission;

4. Knowledge on materials. E.g. nature of the commonly used materials, metal materials, nonmetallic materials, and anti-corrosion and insulation materials;

5. Safety knowledge, including common knowledge on fire, electricity, work safety and first aids;

6. Relevant laws and regulations.

Besides, the trainees will receive training on work ethics.

c. Trainers

The requirements for trainers are as follows:

The trainers teaching the trainees for primary level should have the minimum requirement of advanced level of NQL; The trainers teaching the trainees for middle level and advanced level should have the minimum requirement of technician level of NQL; The trainers teaching the trainees for technician and advanced technician level should have the minimum requirement of advanced technician level of NQL.

According to estimation, the number of solarteur is 2,000,000 at the end of 2008. The government has programs to train the workers for this occupation is 12,000 in 2008, but the trainees will increase dramatically with the government support for clean energy development. However, this is a new occupation, and the government has just set up a standard. Therefore, the number of workers who passed the examination and got the certificates is only 2,000 in 2008 since this is a new qualification. The providers of such training are mainly the vocational and technical schools and colleges, and the government would like to support such training courses.

Case study 5: The recycling occupations

Recycling is booming in China. It is hard to have an accurate statistics of number of the employed in this sector. However, there are 160,000 garbage collectors in Beijing who make a living from the detritus of urban life - plastic sheeting, office printouts, bottles, radiators and scraps of cardboard. Recycling has become a global industry and China is the largest importer of the world's waste materials. Great efforts in developing the recycling industry can effectively relieve China's problem of resource shortage. China is a country in which the per capita resources are comparatively short of.

Great efforts to develop the recycling industry can increase employment posts. As a whole, the recycling industry is a labour-intensive industry; so, great efforts to develop the recycling industry can both effectively make use of China's comparative advantages and increase employment posts so as to relieve the pressures on employment. The investigation shows that with every import of 10,000 tons of waste material, there will be an increment of 1000 employment[10].

For the moment, there have existed nearly 10 million dismantling enterprises in the Changjiang River Delta and the Pearl River Delta, thus shaping up the industrial chain of "imports of waste and used products. Exports of new products regenerated -- imports of waste and used products" and processing areas, which have not only promoted the rapid development of the local economies but also have created the employment of tens of millions people. In addition, the network of reclaiming waste and used materials, which spreads all over the middle and large cities in China, has become an important channel to solve the employment issues for migrant workers from the countryside. The training of these garbage collectors are mainly carried out by the garbage companies, which have some initiative standards for rubbish classification, generally recyclables and unrecyclables, and some companies have further training of identification of useful materials. The training term is about one week, but there are standard courses.

Relevant laws and regulations as well as policies are distempered. In order to make the best use of recycled resources, some developed countries in the west have put forth laws and regulations as well as policies to encourage the development of the recycle economy successively, which have greatly driven the development of the recycling industry. But in China, laws and regulations as well as policies that promote the development of the recycling industry are insufficient, thus making people and enterprises doubtful about the development of the industry and less confident so as to dare not invest too many funds to enlarge the operational scale and improve the technological level.

The resource recycle technologies lag comparatively far behind. Due to insufficient emphasis and

[10] Survey by the research team of the CALSS, 2009.

comparatively less investment, China's R&D capabilities in resource recycle are rather weak, which leads to the behind-lagging techniques in processing waste and used materials and the comparatively low level of technologies and equipment. Thus, there exists a rather huge gap between the reality and the requirements on the integrated utilization of resources and environmental protection. Especially, the reclaiming and utilization technologies in such waste and used materials like storage batteries, dry batteries, computers, TV sets, and refrigerators still lag behind comparatively, which has led to a failure to make effective use of a great deal of electronic "garbage". In recent years, it is still difficult to spread and apply some of the applicable advanced technologies due to the lack of funds although the state has reinforced the research and development of relevant technologies and has made some achievements.

Table 9. Recycling employment

Stages	Formal employment	Informal employment	Total employment
Collection		440,000	440,000
Disassembly	400	125,000	125,400
Material recovery	15,000	125,000	140,000
Final disposal	600		600

Source: Survey by the MOHRSS (2009).

Employment in reuse stage, China has 2,000 reuse market, employing 5 million people, including 1 million laid-offs, and 98 per cent of them are in informal employment, 1 per cent of over 5000 metal recycling enterprises are large and middle sized firms.

Although there is no national standard for the occupation in recycling, the government has the expectation to establish certain norms. The existing training programme is targeting for both the public and some garbage collectors. The contents of the training are garbage classification----generally just for the recyclables and unrecyclables. The main problem is that the training just covers part of the garbage collectors and the training courses are not in full details.

The providers of such training activities are mainly the local governments, and sometimes the local communities would like to provide these training too.

3.2.6 Case studies on greening existing occupations

Case study 6: Jobs in wastewater treatment

The existing occupations could be made greener by technological improvement. The wastewater treatment is one example.

By the end of 2008, of the 661 cities in the country, there were 383 cities which established 892 wastewater treatment plants, wastewater treatment rate increased from 34 per cent in 2000 to 62 per cent, and formed wastewater treatment technology route and management mechanism adjusting to the situation of the country. Of which, wastewater treatment rate in 135 cities got to or was close to 70 per cent, treatment scale per plant was to 1 million cubic meters per day. Because of the increasing attention of governments at all levels on the environmental protection, China wastewater treatment industry is growing rapidly, total volume of wastewater treatment increases year by year, town wastewater treatment rate increases continuously, but at present, China wastewater treatment industry is still in the primary development stage. On the one hand, capacity of China wastewater treatment can't catch up with the rapid expansion of the water using scale, and construction of the matching equipments such as pipe network, sludge treatment, etc. lags behind seriously. On the other hand, there is an obvious gap between China wastewater treatment rate and the one in developed countries,

and the load rate of treatment facilities is low.

So, China should perfect the policies and regulations of wastewater treatment, establish supervision system, create rational wastewater treatment charge system, support the development of domestic environmental protection industry, and promote industrialization and marketization of wastewater treatment industry. Wastewater treatment industry is a sunrise industry, and the development prospect is very broad. China will invest 300 billion Yuan to promote urban wastewater treatment and utilization during the "11th Five Years Plan Period", and China wastewater treatment industry will have a rapid development period since then.

Urban sewage is a leading contributor to water pollution in China, but the country runs starkly short of treatment facilities. Treatment of sewage is essential to ensure that the effluent in the receiving water is ultimately discharged or is not significantly polluted. However, the degree of treatment required will vary according to the type of receiving water. A lower level of treatment may be acceptable for discharges to coastal waters where there is rapid dilution and dispersion. Sewage treatment involves:

1. The removal of solids by physical screening or sedimentation;

2. The removal of soluble and fine suspended organic pollutants by a biological oxidation process.

To achieve the ambitious target of raising the sewage treatment rate to over 60 per cent in all urban areas by 2010, China will need to embark on an all-out construction effort. Some 10,000 new treatment plants will be needed just to achieve a treatment rate of 50 per cent at the current rate of discharge. Sewage treatment produces sludge as by-products and these have to be treated and disposed of separately in an economical and environmentally acceptable way. Every day, an estimated 3.7 billion tons of sewage is discharged in China. With a current treatment rate of just 45.6 per cent, more than half of that sewage runs freely into rivers or lakes, seriously degrading water systems and harming biodiversity. China has only one treatment facility for every 1.5 million urban and suburban dwellers, compared to one for every 10,000 people in the United States.

For better treatment purpose, China used some new technologies and equipment. The main equipment for sewage treatment: Flocculation reactor, reactor flotation, activated carbon adsorption column, ozone generator and the flow monitoring device, the return sludge pump, Roots Blower, pipeline booster pump submersible sewage pump, self-priming pump.

Besides, some new ways are also used, such as the advanced molecule treatment.

Case study 7: Biogas jobs in rural areas

For recycling economy, China has been making efforts to create more green jobs. For example, the biogas industry is developing well. From the government side, a complete and efficient network has been formed: Under Department of Science, Education and Rural Environment, Ministry of Agriculture, Division of Renewable Energy has been established; There are 34 administrative departments and technical extension institutes at provincial level; about 200,000 people work for China's rural energy industry; 46,000 people for management and dissemination; 36,000 for enterprises and industrial services; 170,000 rural technicians. The rapid development has attracted hundreds of companies to develop biogas products and equipments and some of them have won national biddings. There are nearly 22 million households with digesters and how to provide good service has become a big problem. Some service associations and energy companies have emerged and the formation of service system is no longer dominated by government but participated by NGOs and industrial bodies.

According to the national plan, by the end of 2010, there will be 40 million households using biogas digesters and the annual biogas output shall reach 15.5 billion m^3. Among the 146 million households that are suitable for biogas development, the dissemination rate shall reach 30 per cent and in 2020, the rate shall be 70 per cent. According to the national, by the end of 2010, 4,000 large biogas plants shall be built on husbandry farms and the total number of large biogas plants shall be 4700, accounting for 52 per cent of the total number of large scale husbandry farms. The potential pollutants shall be

utilized as precious resources.

Firstly, the employment admittance requires the technician to get a national-acknowledged certificate to guide or build digester. But the total number of certified technicians cannot meet the huge demand for building new digesters, leading to poor-quality digesters with a short life.

Secondly, the significance and contributions of rural biogas technology have not been fully recognized. Biogas projects have effectively increased farmers' income and improved their living standards and treated industrial and agricultural wastes, but most social, environmental benefits and contributions to community development and to global climatic changes alleviations are external. It cannot benefit farmers in terms of cash income. Thirdly, the majority of poor farmers and small farms cannot afford building a digester because of financial shortage.

Rural biogas has developed steadily. By the end of 2007, there are 26.5 million households built biogas digesters, producing 10.2 billion m^3 biogas every year. Farmers' increased income and reduced expenditure reached 13 billion Yuan and 90 million farmers have been directly benefited. There are 18,000 small biogas plants with total volume 700,000m^3 and 8576 large biogas plants built on husbandry farms. Central government has invested in Eco-campus building in Hebei, Fujian, Shanxi, Hubei, Guangxi, Hainan, Chongqing, Sichuan, Yunnan and Shaanxi provinces. The total investment was 800 million RMB Yuan in 2007 and 800 million in 2008. In China, the occupation of methane using workers has 500,000 people, and the annual training number is 1.35 million.

Investment in biogas development has increased dramatically. During the Ninth Five-Year plan period, Chinese government has invested 6 billion Yuan for biogas development. Since 2003, the annual investment has been over 1 billion Yuan and in 2006 over 2 billion and 2.5 billion in 2007. The financial support has accelerated biogas development. Besides, the private sector has been attracted by the rapid development and the private investment has increased. External funds from World Bank and CDM projects have also become a major source.

Rural energy and ecology development cooperation project has got a US$33.119 million loan from Asian Development Bank and Global Environmental Facility (GEF) grant US$6.361 million, and 16,005 household biogas digesters have been built, accounting for 82 per cent of the planned number; GEF Project of Livestock waste management in East Asia has aimed to reduce and prevent the pollution of the international waters, namely South China Sea (SCS) from rapidly increasing livestock production. A World Bank loan project of New Countryside and Eco-household Programme shall be finalized this year with WB loan of US$120 million. This programme has very positive impact on the development of skills in the biogas industry since the training of staff members as well as workers.

Case study 8: Car manufacturing – Occupations to become greener

Some occupations are becoming greener. For example, the car manufacturers are producing more environment friendly vehicles. The National Commission of Reform and Development has publicized supporting policies for new energy vehicles and launched a pilot programme in 13 cities that will subsidize the use of new energy cars in the public transport system. China's endeavour toward the mass use of electric vehicles is getting momentum, although there are still many barriers that may hinder the development of electric cars in China.

Additionally, China is to set standards and rules that are closely related to the manufacturing and use of electric vehicles. China is set to become the world's largest producer of environment-friendly cars within 10 years, largely due to the central government's backing and the domestic car makers' ambitions to push electric vehicles. The country is set to dominate the battery-powered car segment as the government has aggressively pushed for technology development, which in turn will breed more early adopters. China's environmental watchdog has adopted an auto emission standard equivalent to Euro III nationwide in 2008. The State Council issued a plan in March 2007 aimed at turning China into a global leader in new energy cars, including electric ones, by 2011 with an annual production capacity of

500,000 units.

A number of Chinese carmakers have scheduled to introduce electric vehicle models in recent years. Prominent among them are market leader BYD's E6 with a price tag of 250,000 Yuan. Chery's S18 is also likely to debut with a tag of 70,000 Yuan. The skills for these car-related jobs are in strong demand, since many workers have to shift or upgrade their skills as issues like battery technology and support infrastructure still need to be strengthened before electric vehicles take off. Besides, China's Ministry of Environmental Protection (MEP) is setting up National Emission Standard IV and V on new cars and petrol and diesels fuels. China introduced Standards I, II and III respectively in 2000, 2005, and 2007. Beijing became the first Chinese city to enforce Standard IV on newly bought and produced cars on March 1, 2008. Other cities, including Shanghai and Guangzhou, are also moving to lower car exhaust emissions in attempts to address growing pollution concerns. The rule is more likely to affect older vehicles because stringent emission standards are already applied to new cars.

China's intention, in addition to creating a world-leading industry that will produce jobs and exports, is to reduce urban pollution and decrease its dependence on oil. Replacing a gasoline-powered car with a similar-size electric car in China would reduce greenhouse emissions by only 19 per cent. Beyond manufacturing, subsidies of up to $8,800 are being offered to taxi fleets and local government agencies in 13 Chinese cities for each hybrid or all-electric vehicle they purchase. The state electricity grid has been ordered to set up electric car charging stations in Beijing, Shanghai and Tianjin.

Using electricity as a transportation energy source means that emissions per kilometer travelled are related only to the emissions produced at electricity generating power plants. Electric vehicles tend to have lower overall primary energy requirements per kilometer than gasoline cars of the same size, depending on primary energy sources (WRI, 2005). In China's eleventh five-year plan, electric vehicles are one of the research areas pinpointed for development. Universities, research institutes, and car manufactures are encouraged to carry out pilot projects and in-depth researches. This research includes not only opportunities for four-wheeled EVs, but also electric powered bicycles.

China has also introduced alternative fuels which can replace petroleum-based fossil-fuels as the feedstock used for on-road transportation and reduce net carbon dioxide emissions. Three alternative fuels are:

1. Compressed Natural Gas (CNG)

2. Ethanol

3. Bio-diesel

Compressed Natural Gas (CNG)

CNG as a transportation fuel is appealing because it is a more efficient fuel than gasoline, is less carbon intensive, and burns much cleaner. Estimates of the performance of CNG vehicles are a 25 per cent reduction in carbon dioxide, 90-97 per cent reduction in carbon monoxide, and 35-60 per cent reduction in nitrogen dioxide as compared to a gasoline equivalent (WRI, 2005). In China, CNG is currently used to power about 110,000 public vehicles, mainly buses and taxis, in about 11 major cities (WRI, 2005).

Ethanol

In China, ethanol production from corn is approximately 2 million tons per year with production supported by a subsidy of about 2,000 RMB/ton (Zhu, 2006). This is the only alternative fuel to be supported currently by Chinese fiscal policies. This subsidy is aimed at helping reduce dependence on foreign oil; however, ethanol production is currently displacing crop land and effects on food security are constraining further expansion.

Bio-Diesel

Bio-diesel is a generic name given to any diesel fuel created from high lipid-content biomass and designed to function in existing diesel engines. Bio-diesel is different from ethanol in that it can be produced not only from virgin crop feedstock, but also from waste oil and grease. Bio-diesel is estimated to reduce greenhouse gas emissions by as much as 90 per cent as compared to regular

diesel (GTZ, 2006). Depending on quality, bio-diesel can be blended with regular diesel in amounts ranging up to 20 per cent without requiring engine modifications.

Currently, China's bio-diesel production is quite small. By the end of 2007, though, it is estimated that there are 42 plants in China producing about 200,000 tons/year of bio-diesel, mostly from waste oil. This production is still well below the potential for waste oil recovery which is estimated in China to be approximately 2 million tons of bio-diesel per year from a total annual waste oil feedstock of 3 million tons. This market would be expanded greatly if government support for diesel vehicles were implemented.

China wants to raise its annual production capacity to 500,000 hybrid or all-electric cars and buses by the end of 2011. Premier Wen Jiabao highlighted the importance of electric cars three years ago.

With the greening of car manufacturers, training is booming. For example, the BYD has 5,000 auto engineers and 30,000 employees in China. It has its own technical schools in each of its locations and also established training cooperation with local vocational schools and universities. Every year, about 1/3 of its employees receives training for new technologies, plus entry training for new employees since most of them have to change their skills. The BYD has its pre-employment training for the new employees. The duration is one month, and the contents of the pre-employment training are the regulations of the company, basic knowledge about work safety, car and electricity car and mechanical principle. After admitted to the company, the new workers will work a certain period of time, and then be trained for 3-6 months. For the workers transferred to electricity car section, they should have about 3 months of retraining in order to suit for the new jobs. The vocational schools in BYD will provide most of the training courses, but sometimes, the BYD will send their key employees and engineers to relevant universities for further training or study, and such a training or study could be rather flexible in accordance with the actual requirements of their future jobs.

Case study 9: Energy-saving lamps and building retrofitting

Another example is the building retrofitting. For environment purposes, the National Development and Reform Commission of China (NDRC) and the United Nations Development Programme (UNDP) signed a joint agreement on a project to promote the use of energy-saving lamps (ESLs) in China. The four-year "Green Lights Project" will get US$14 million from the Global Environment Facility (GEF) to phase out high-energy consuming incandescent lamps and promote ESLs in China. China is expected to save 160 billion to 216 billion kwh of electricity in 10 years after the project is completed by 2012, and that will reduce carbon dioxide emissions by 175 million to 237 million tonnes, according to the NDRC.

Voices for using more ESLs have become louder around China in recent years, and some cities have announced their plans to phase out incandescent lamps. Last year, China promoted the use of 62 million ESLs, and the goal for this year is 120 million. China's production of incandescent lamps fell 23 per cent to 3.4 billion in 2008 from a year ago, while the output of energy-saving fluorescent lamps rose by 14 per cent to 4.8 billion in the same period. Therefore, the energy saving lamp industry becoming greener and this existing occupation is green too. For training purpose, the way is almost the same as those for ordinary lamp making.

The third example is the retrofitting of the buildings. In many big cities, the governments provide funds for renovation of the building so as to make them more energy efficient. The workers who do these jobs are the same as before, but have the green effects.

Case study 10: Agricultural Technical Instructor

The agriculture is becoming greener, and the occupation of Agricultural Technical Instructors is an existing one, but they are using greener technologies in many areas of work. Biological pesticides are agricultural biological preparations which accords with China's current policy. Biological pesticides are derived from the nature with good compatibility with environments. In China, biological pesticides are expected to replace some chemical pesticides, and the market share of biological pesticides is likely to increase significantly. In 2008, the total production of pesticide is 298,200 tons in China. The pesticide varieties with more than 10,000 tons demand amount all over China will include dichlorvos, acetochlor, copper sulfate, glyphosate, trichlorfon, disosultap etc, 5,000 to 10,000 tons varieties include phoxim, carbendazim, monosultap, butachlor, atrazine, omethoate, triophanate-methyl, chlorpyrifos, 4-D butyl ester, dimethoate, acephate etc. In addition, the provinces with more than 20,000 tons of pesticide demand amount are Heilongjiang and Hunan, and the following provinces are ranging from 10,000 tons and 20,000 tons, like Guangdong, Yunnan, Shandong, Henan, Anhui, Hubei, Hebei, Jiangsu, Liaoning, Guangxi, Fujian, Jiangxi, and Zhejiang. These pesticides have serious effects on environment, and the government has decided to reduce the usage of environment-destructive pesticides.

Guided by a series of policies concerning construction new rural areas, the bio pesticide industry in China will have good opportunity in the following years. Seen from the policy environment, the documents, like Central Government's proposals on making the 12th Five-year Plan, National Guideline on Medium and Long-Term Programme for Science and Technology, CPC Central Committee and State Council on further construction of a new socialist countryside etc, all show that bio pesticide industry has become a booming sector for greening jobs. The adjustment policies of national pesticide industry structure will have crucial influence on the future trend of job market, so the bio pesticide companies complying with national industry policies and adjusting the product structure in time will gain more profit in the future industry integration. In addition, China has not only enlarged the independent research and development on bio pesticide, but also improved industry concentration through industry integration and controlled sales channel pesticide companies. By the end of 2008, there are about 300,000 workers in the occupation as Agricultural Technical Instructors. Every year there are 75,000 trainees as potential agricultural technical instructors who receive training on new agriculture technologies, including bio pesticide use and other environment-friendly methods. However, the qualified technicians for agriculture are still inadequate, there are only 31,500 qualified Agricultural Technical Instructors. But the instructors will increase significantly with the government and business support, and the training institutions will have more training programmes on that subject.

4. Conclusions

4.1 Main 'greening' shifts in economies and labour markets

China is planning a vast increase in its use of wind and solar power over the next decade and believes it can match Europe by 2020, producing a fifth of its energy needs from renewable sources. China would easily surpass current 2020 targets for the use of wind and solar power and was now contemplating targets that were more than three times higher. The goal for wind energy is 100 GW by 2020. Similarly, by 2020 the total installed capacity for solar power will be at least three times that of the original target of 3GW. China generates only 120 MW of its electricity from solar power, so the goal represents a 75-fold expansion in just over a decade. Some experts have cast doubt on whether Britain will be able to reach 20 per cent. On another front, China has the ambitious plan of installing 100 million energy-efficient lamps this year alone. Beijing seeks to achieve these goals by directing a significant share of China's 40,000 billion Yuan economic stimulus package to low-carbon investment. Of that total, more than $30 billion will be spent directly on environmental projects and the reduction of greenhouse gas emissions. But the indirect green share in the stimulus, in the form of investment in carbon-efficient transport and electricity transmission systems, would be far larger. HSBC Global Research estimated the total green share could be over a third of the total package. China also believes that its economic recovery programme will lead to more efficient use of resources and an increased demand for renewable energy. Due to the impact of global financial crisis, people are all talking about green and sustainable development. Enterprises and government at all levels are showing more enthusiasm for the development of clean energy such as solar power generation, and the Chinese government is now considering rolling out more stimulus policies for the development of solar power. The government would also plough money into the expansion of solar heating systems. China is already a world leader, with 130 million square metres of solar heating arrays already installed, and is planning to invest more. China is playing a constructive and a positive role in negotiations aimed at agreeing a deal in Copenhagen. The government realized that China would have to pursue "a sustainable development path", and China is open to the idea of limits on the carbon intensity of its economy (the emissions per unit of output). In addition, China has taken note of some expert suggestions on carbon intensity with a view to have some quantified targets in this regard. China's stimulus package was already showing signs of re-energizing the Chinese economy. The economy grew by 6.1 per cent and 7.9 per cent in the first and second quarter of this year. It is predicted that China would meet its target of 8 per cent growth this year and structural readjustment is under way for a greener economy since China has promised to reduce its unit GDP energy consumption by 40-45 per cent by 2020. With these economic changes, the jobs in green sectors will grow, while the opportunities in the polluting economy are diminishing, and higher skills are needed for the green jobs. As a whole, the employment effects of the greening shift are positive, although some sectors, such as traditionally polluting industries, will lose jobs significantly.

4.2 Skills implications and development

4.2.1 Anticipation and identification of skill needs

Green jobs will require new skills among workers. In particular, China will be required to focus on training workers in environmental management and protection skills and in eco-friendly technologies, including training which supports renewable energy sectors, energy efficiency and recycling. The good approaches to access green skills needs are the following three: First, surveys of employees and employers on green skills; Second, quantitative projections of

employment based on appropriate econometric models; Third, foresight qualitative analysis of green skills.

Sustainable development and green jobs are also cross-cutting themes, so the skill needs are multiple. It is necessary to improve workers' knowledge and skills base in order to achieve a major shift in resource efficiency and the delivery of new products and services with lower environmental impacts.

The focus is now on sustainable economic development to enable people to satisfy their basic needs, and enjoy a better quality of life, without compromising that of future generations. Strategic programmes of environmental investment, protection and innovation are being developed to ensure continued economic growth. To enable this to succeed the behaviour of people and businesses will need to change. As a result the environment is now firmly on the business agenda, which will impact on the workforce skills needed as new processes are developed to deal with:

- renewable energy;
- carbon emission reduction/working towards a low carbon economy;
- intelligent energy;
- increasing energy efficiency;
- waste minimization and recycling;
- energy-saving construction;
- green production;
- development of green and sustainable communities;
- nuclear decommissioning/new nuclear power;
- timber and forestry/rebuilding;
- biodiversity; and
- environmental protection and enhancement (e.g. reclamation of derelict and underused land).

Other areas of employment development are:

- Green and sustainable procurement (from office supplies to building products). There will be increased opportunities for procurement professionals within the development of green supply chains;
- the development of R&D and technology commercialization; and
- the development of green businesses especially the environmental technologies sector.

There are strategic skills gaps and shortages in each sector of the economy. These are more acute in some than in others. There is also a need to deliver generic skills for green jobs in all sectors, at all levels, including in management and leadership, in order to bring about the culture change required to manage the transition to a resource efficient economy successfully. Sector-specific and cross-sector efforts for green jobs are needed.

The blue-collar jobs that have long supported a strong Chinese middle class -- jobs for electricians, plumbers and transportation and manufacturing workers of all kinds -- are getting a green update. It's a nationwide movement to refresh the traditional trades with training in 21st century knowledge and skills. The green-collar movement advances new, more environmental technologies by training the work force that can manufacture, install and maintain them. It seeks

energy security and climate change prevention through an emphasis on non-fossil fuels and energy efficiency.

But more than any of that, it promotes jobs. Green-collar advocates point out that these jobs are inherently local: Upgrades to a building's energy efficiency, for example, cannot be installed overseas. And what is especially hopeful about the movement is that it insists at its foundation on family-sustaining wages and upward mobility.

4.2.2 Response policies and programmes

First, China should have right energy policy.

In the next quarter-century, about $3.7 trillion will be needed for China's investment in energy supply infrastructure. The shape of this investment will help determine the energy use patterns and CO2 emissions for a generation. In the power sector China's reliance on coal is well known, as is the rate of expansion. Estimates suggest that 1,260 GW of new power stations will be built by 2030, 70 per cent of which will be coal-fired. In the first instance, policy should focus directly on decarbonization rather than on emissions, and on causes instead of consequences.

Second, China should upgrade workers' skills. Worldwide, a broad range of new and different skills at the vocational, technical and managerial levels are needed to reduce greenhouse gas emissions and facilitate the transition to low-carbon economies. Renewable energy and energy-efficient (RE&EE) technologies, as well as policies and institutions advocating a shift from carbon-intensive to low-carbon activities are increasing the demand for new and different skills for green jobs. At the same time, the skills used in so-called "brown" jobs will be in decline. Generally speaking, "green" skills and competencies are still largely missing in universities and TVET (Technical and Vocational Education and Training) institutions, and in the business and public sectors.

Improved knowledge of the employment and skills impact of climate change is needed so that governments and the social partners can agree on the joint solutions to face the challenges of climate change at the national, industry and company levels.

Third, China should have new technologies. Various studies have estimated the potential net employment effect of green gas mitigation policies, and most of these studies demonstrate that the overall impact is positive for employment creation. However, as in the case of technology and trade, if the potential is to be realized, economies require new, diversified, and greater skills. These include high-level skills for research and development in new technologies, technical skills related to the installation, operation, and maintenance of energy-efficient buildings, and the core skills required to support the implementation of reforms and changes.

The building sector in China is in the midst of a massive boom. China's existing building codes, if effectively enforced, would deliver significant energy efficiency gains. China could work to mainstream and massively expand the use of existing close-to-zero-energy housing technology, and cooperate to develop better and cheaper technologies in this sector. The growth in fuel use for transport in China is accelerating and in the medium term will outstrip emissions growth from all other sources. Increased demand coupled with declining domestic resources adds to the climate incentive for reduced oil use. With 80 per cent of Chinese vehicles manufactured by joint venture companies, many with EU partners, there are opportunities for collaboration on joint roll-out of higher emissions standards across a huge combined market. Similarly, the search for low-carbon and sustainable liquid transport fuels presents opportunities for joint development and deployment – for example, around new-generation biofuels.

In China, the Government adopted the 2003-2010 National Rural Biogas Construction Plan, providing new employment opportunities for many unemployed farmers in rural areas. In order

to meet the shortage of technical capacity for the operation and maintenance of digesters in Shanxi Province, 40 training courses were held and by 2005 over 4,000 people had been awarded the National Biogas Professional Technician Certificate. Further research continues, not only on skills and markets for biofuels, but also on their long-term environmental costs and benefits.

The above examples emphasize that appropriate skills development can offer proactive support for the creation of new jobs through mitigation and adaptation measures, thereby fostering sustainable development. However, there will also be a growing need to help re-train the workers who are affected and build the capacities of the most vulnerable workers in China so that they can respond more effectively to the local consequences of climatic changes.

4.2.3 Effective delivery mechanisms

Effective delivery mechanisms should be created by the synergy of various stakeholders. Supportive policies can at the same time promote green development. Promoting the development of green jobs skills is about strengthening the institutions and governance systems which nurture enterprises – strong and efficient markets need strong and effective institutions. It is also about ensuring that human, financial and natural resources are combined equitably and efficiently in order to achieve green technology innovation and enhanced efficiency. This calls for new forms of cooperation between government, business, labour and society at large to ensure that the quality of present and future life and employment is maximized whilst safeguarding the sustainability.

In order to develop skills for green jobs, there should be coordinated efforts made by government departments, trade unions and employers' organizations to integrate skills development issues and strategies into the design of policies on trade, technology and the environment. Coordination with the ministries and agencies responsible for policy design and implementation in these areas is therefore required if national education and skills development systems are to be able to:

1. equip workers, employers and young women and men with the skills required by emerging green industries and jobs;

2. build national capabilities to manage the transition between declining and growing sectors and occupations.

Without such measures, the result will be skill gaps, high individual and social adjustment costs, and missed opportunities to boost productivity, accelerate employment growth and expand development.

An effective delivery mechanism also needs the active participation of NGOs, which are becoming more and more important in China's civil society development.

Besides, a delivery system should have the following features for effective purpose:

- **Cost-effectiveness**—A more cost-effective approach would reduce emissions at lower cost.
- **Equity**—Agreement is more likely to be reached, and to be implemented, if it is perceived by all parties to be sufficiently equitable—or, at the least, not demonstrably unfair.
- **Dynamic flexibility**—Commitments that can be scaled up or down, or otherwise modified, will allow easier reassessment and revision in light of new scientific and economic information.
- **Complementarity**—In the event of multiple regimes or approaches, complementarity of designs would facilitate linkages among them.

- **Environmental effectiveness**—In addition to stringency, important factors that help determine environmental effectiveness include: controlling leakage, or the movement of emissions-generating activities with weaker or no controls; stimulating long-term technological change; and ensuring adequate enforcement.

5. Recommendations

China needs to close the skills gaps for green jobs in all sectors. In construction areas, China should provide sufficient skills to apply new standards towards low-carbon buildings. Emphasis on high end of skills would be misplaced –In fact, education and training should be equal to all workers, no matter high or low skilled. All skills are necessary, and entrepreneurial skills are as important as technical know-how, and training should reach rural areas and the urban poor. To tackle the gaps between green jobs demands, China needs to strengthen basic education, vocational training, the job market, and lifelong learning. The incentives for skills providers and employers are necessary for the smooth running of the training programmes, which emphasize the skills development and industrial, investment, trade, technology and environmental policies.

5.1 Policy recommendations

In order to have better responses to climate change and green jobs, china should adopt the following measures for the education and training system:

1. Social dialogue and tripartite structure on training are needed for China

Skills for green jobs could be developed more efficiently through the cooperation of governments, employers and employees. A major feature of education and training reform should be sharing responsibilities for investing in education and training and, in particular, lifelong learning, through various forms of partnerships between the State, the social partners, individuals and other stakeholders. In particular, strong co-ordination or collective action amongst employers shall lead to the building of both knowledge as well as trust over time. Strong employers' associations and industry-level bargaining can reduce poaching of skills and help diffusion of best practice to cope with skill requirements for green jobs. Trade unions in China should be more independent and represent the interests of the workers, and put pressure on employers to invest more in training.

There is an urgent need to involve the social partners more closely in discussions on training policy and skills development at the national and provincial levels, if the desired reforms and increased investment are to a green economy. Also, training and skills upgrading and change should become an important part of collective bargaining at the enterprise level for shaping the skill structure for green purposes. The most successful training systems in the world are underpinned by a strong social dialogue process, such as German training system. China should learn from Germany for quick response to green jobs skills. Responsibility should be shared between the government (primary responsibility), enterprises, the social partners, and the individuals. There is a great need for increased private sector investment and new, innovative methods of financing training for green occupations.

2. The state should have more active role in vocational training issues

China's market mechanism is not well developed due to it short history of market economy. The alternative solution to market failure problems is for the state to play a role in the development of training for skills of green collars. It is justified to ensure individuals have equal access to this important determinant of future success, to increase the societal stock of skills in order to foster low-carbon economic growth. The Chinese government has to play an active role.

As an authorized testing of vocational skills and a pass in the job market, the occupational qualification certificates have been widely recognized among employers and employees. Further steps will be taken to coordinate the work of occupational qualification certification and the labor preparatory training system. National qualification standards for all green collar occupations should be fully established. It is necessary for the establishment of the occupational labour market and the smooth flow of skilled workers of green jobs.

There is a critical need for significantly increasing existing levels of investment in vocational education and training in China for all people (including women and groups with special needs, such as people with disabilities). Education and training investments should be closely linked to China's low-carbon economic and employment growth strategies.

The state has to assume primary responsibility for basic education and to promote equal opportunities in training by developing special targeted training programmes for women, young people, older workers, people with disabilities, and otherwise contributing to overcoming discrimination. The private sector needs to take over a greater share of the burden of financing the workplace and lifelong learning needs of their staff. New incentives to stimulate increased private sector involvement in training need to be developed.

5.2 Recommendations for education and training

For education and training, the link between education and the economy is a must, and training should match the needs of the labour market.

The major forces driving changes in green jobs, such as efficient ways of work, energy-saving measures and rapid advances in technology for green purposes have several important implications for skill demand and human resources development and training. Firstly, the use of new technologies, new manufacturing processes and new modes of work for green economy have led to skills intensification of the national economy and an increase in the demand for skills. In particular, there is a huge shortage of skilled labour at management and technician level, which is felt most acutely by those operating in international markets. But the education and training system, which is still geared mostly to the traditional industries, is struggling to keep up. This constantly changing situation means a continued skills gap.

Teachers should have relevant knowledge of green job trades and most of them should come from industry sectors rather than being academics. Industry and employers, and unions should be consulted on the curriculum of green collar occupations to be taught since currently the effective and regular consultation mechanism has been fully established, although sometimes the government will seek opinions from the workers and the employers.

The training system will need to become much more flexible in the courses offered and how these are delivered. There will need to be much stronger linkages with enterprises to ensure that workers develop both the theoretical knowledge and workplace-based skills. All in all, the Chinese training system should have a more rapid response to green job skills.

China faces significant challenges in responding to emerging skill needs resulting from climate change and sustainability challenges, particularly as we approach the introduction of the Low Carbon Development Scheme. The need for specialist training in green jobs skills is required as a first priority in the areas mentioned before. However, China needs to have a more broad view and areas for green jobs and training. The key sectors of Manufacturing, Mining and Energy, Utilities, Construction, Agriculture and Transport should all be included.

The issues for both large and small business include:

- Building business awareness of organization-specific measures required to reduce the environmental impact of the business.
- Appropriate public funding mechanisms to develop and broaden the existing suite of national training packages should include green jobs skills.
- Creating training that is responsive to current and emerging business needs. Limited access to climate change resources – professionals, learning materials and infrastructure –may create barriers to accessing structured sustainability training.
- Creating appropriate auditing standards for sustainability professionals as well as currently qualified individuals in areas of energy, water and power.

It is important to raise the profile of the employment opportunities in green and sustainability sectors through communication of accurate career advice, training and employment pathways in the following:

- Define vocational skills and knowledge needed to address climate change according to qualifications, skill sets and units of competency found within national Training Packages.
- Support business uptake of training in sustainability skills through strong marketing of economic and business benefits, innovative case studies and good practice solutions to sustainability challenges.
- Support participation and upgrade of green jobs skills by business and existing employees by prioritizing flexible learning delivery modes.
- Prioritize integration of climate change content into vocational training delivery in key targeted sectors as soon as practicable.
- Address the shortage of qualified educational professionals with climate change industry experience by permitting MOHRSS to map training delivered by a qualified industry expert against national competencies and provide funded skills recognition services.
- Leverage existing career advice programmes to support uptake of careers in sustainability by new entrants and people already in the workforce.

5.3 Recommendations for further research and data collection

The green industries could significantly improve China’s energy security and economic sustainability**.** It is said that China's carbon emissions will start to fall by 2050, but China still needs to expand its economy to pull people out of poverty, it was is too soon to discuss emissions caps.

It is suggested that the further research should focus on the national qualification standards for green jobs and skills. For this reason, data on relevant green jobs, such as number of employees, skill levels and future needs, should be further collected.

References

Baumert K.A. 2002. *Building on the Kyoto Protocol: Options for protecting the climate* (Washington, DC. World Resources Institute), 1J256.

Berrah, N.; Feng, F., Priddle, R.; Leiping, W. 2007. *Sustainable energy in China: The closing window of opportunity* (Washington, DC, World Bank).

Birner, S.; Martinot, E. 2005. *Promoting energy-efficient products: GEF experience and lessons for market transformation in developing countries*.

Blackman, A.; Wu Xun. 1998. *Foreign direct investment in China's power sector: Trends, benefits and barriers. A report by Resources for the Future* (Washington DC).

China Academy of Labour and Social Security (CALSS). 2009. *Survey on Green Jobs and Skills Need. August 2009.*

China Daily. 2007. *Climate change taking toll on glaciers*, 17 July.

Fan Gang; Cao Jing; Yang Hongwei LI Lailai SU Ming. 2008. *Toward a low carbon economy: China and the world*, 14-15 Dec. 2008 (Beijing).

GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit / German Technical Cooperation Unit). 2006. *Environment Report 2006*.

Hoehne N.; Galleguillos C.; Blok K.; et al. 2003. *Evolution of commitments under the UNFCCC: Involving newly-industrialized economies and developing countries*, Berlin, Research Report 20141255 UBA-FB 000412 on behalf of the German Federal Environmental Agency, Feb.

International Climate Change Taskforce. 2005. *Meeting the climate challenge* (The Institute for Public Policy Research, Center for American Progress, and the Australia Institute).

International Energy Agency (IEA). 2006. *CO2 emissions from fossil fuel combustion* (2006 Edition).

International Energy Agency (IEA); Intergovernmental Panel on Climate Change (IPCC). 2000. *Special report on emissions scenarios (SRES)* (Cambridge University Press, Cambridge, UK). Paris

International Labour Organization (ILO). 2009. *Low carbon development and employment in China*.

International Panel on Climate Change (IPCC). 2007. *Climate change 2007: Mitigation of climate change* (Cambridge University Press, Cambridge, UK).

Jiang K.; Xiulian, H. 2006. "Energy demand and emission in 2030 in China: Scenarios and policy options, in *Environmental Economics and Policy Studies*, Vol. 7, No. 3, pp. 232-50.

Jiang K.; Xiulian, H.; Qiang, L. 2005. *Clean coal technology: A critical choice for China*, - Appendix 4 of *Modelling development and emission scenario analysis in China* (Energy Research Institute, China). Available at: www.e2models.com/CD/china.htm.

Jiang, K. 2007. “Energy technology research in China”, in L. Jakobson (ed.): *Innovation with Chinese characteristics: High-tech research in China* (Basingstoke, Palgrave Macmillan).

Jiang, K.; Hu, X.; Matsuoka, Y.; Morita, T. 1998. *Energy technology changes and CO2 emission scenarios in China* (Environment Economics and Policy Studies).

Jiang, Y. et al. 2007. *China building energy efficiency annual report* (Tsinghua University).

Lei, P.; Pamlin, D.; Sehgal, R.; Galli, A.; Kitzes, J.; Wackernagel, M. 2007. *The import of CO2 emissions from China and India. Sweden’s contribution to reduction of CO2 emissions – A global dimension* (WWF, Global Footprint Network).

Li, Z. 2006. *Rapid growth of China’s cities challenges urban planners,* m*igrant families*, World Watch Institute, 27 June. Available at: http://www.worldwatch.org/node/4148

Liu, Z. 2005. Deputy Minister of Chinese Ministry of Construction: *Energy conservation, land saving and ecological design, sustainable development of residential buildings Summit Forum.*

Ministry of Human Resources and Social Security (MOHRSS). 2009. *Survey on Green Employment and Skills.*

Ministry of Science and Technology (MOST). 2006. *First national climate change assessment* (Chinese Meteorological Administration and Chinese Academy of Sciences).

National Bureau of Statistics. *China Statistical Yearbook*. (China Statistics Press) various years.

National Development and Reform Commission (NDRC) 2007a. *11th Five-Year Plan on energy development*.

—. 2007b. *China’s national climate change programme.*

Nordhaus, W. 2007. “Critical assumptions in the Stern Review on climate change” in *Science*, Vol. 317, pp. 201-2.

Olmstead, S.M.; Stavins, R.N. 2007. “A meaningful second commitment period for the Kyoto Protocol”, in *The Economists' Voice*, Vol. 4: Issue 3, Article 1. Available at: http://www.bepress.com/ev/vol4/iss3/art1.

Pan, J. 2003. *Commitment to human development goals with low emissions: An alternative to emissions caps for post-Kyoto from a developing country perspective*. Milan, Side Event Full Paper.

Pan, J.; Guiyang, Z.; Ying. C. 2005. “The mode of the leaders of 20 countries conference on climate change and the participation of developing countries” in *World Economics and Politics*.

People’s Daily. 2004. *China outlines ten programs for energy efficiency* (People’s Daily Online) *Energy Bulletin*, 9 Dec. Available at: http://www.energybulletin.net/node/3566

Pershing, J.; Baumert, K. 2004. *Climate data: Insights and observations* (Arlington, Pew Centre on Global Climate Change).

Recycling Magazine. Volume 2, 2009. China Environment Sciences Publishing House (Beijing).

Stern, N. 2006. *The economics of climate change. Stern review on the economics of climate change* (London).

United Nations Environment Programme (UNEP); International Labour Organization (ILO); International Organisation of Employers (IOE); International Trade Union Confederation (ITUC). 2008. *Green jobs: Towards decent work in a sustainable, low-carbon world.* Available at: http://www.unep.org.

Wang T.; Watson, J. 2007a. *Who owns China's carbon emissions?* Sussex Energy Group and Tyndall Centre for Climate Change Research, Briefing Paper No. 23.

—. 2007b. *Energy and climate scenarios for China: Some considerations*. Briefing paper for Tyndall Centre Workshop on Future Pathways for China's Emissions, held at Guohong Mansion, Beijing, 12 Sep. 2007.

Wang, X. 2007. *China cement industry research report,* http://www.conch.cn//news_file/200791712507349.pdf.

World Bank (WB); MOST China; The Deutsche Gesellschaft für Technische Zusammenarbeit / German Technical Cooperation Unit (GTZ); Federal Ministry of Economic Cooperation and Development; Swiss State Secretariat for Economic Affairs. 2004. *Clean development mechanism in China: Taking a proactive and sustainable approach*.

World Resources Institute (WRI). Washington, DC 20002, USA. 2005. *Annual Report 2005*.

Xinhua News Agency. 2009. 26 Nov. *Reduction of Per Unit GDP CO2 Emission by 40% to 45% to 2020*.

Zhu. 2006. China Chemistry Industry newspaper, 22 Nov 2006, Chemistry Industry Publishing House, Beijing, China.

Zhuang, G. 2007. *Low carbon economy: No alternatives left for China* (Chinese Academy of Social Sciences).

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