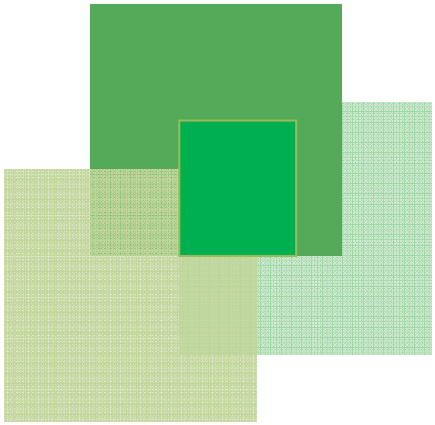

International Labour Office
Geneva

KRIVET 한국직업능력개발원

Skills for green jobs in the Republic of Korea

Background country study

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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.

[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).

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 Korea Research Institute for Vocational Education and Training (KRIVET) for the financial support to the study and to the authors of the report, Soo Young Lee, Mi Sug Jin, and Chang Yong Song of KRIVET, 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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Director
ILO Skills and Employability Department

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President
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Abstract

Since Korea's Green Growth National Vision announcement in August 2008, Korea is attracting global attention to its comprehensive nation-wide policy measures and implementation efforts. This report particularly presents the changes in the labour market due to greening initiatives and skills development strategies for emerging green jobs.

The objectives of this report are:

1) To explain major policy measures including general environmental strategy towards a green growth, green response to the current economic crisis, and skills development strategy in response to greening in Korea;

2) To discuss the green structural change and its impact on the labour market, and to outline the plans that Korea has put in place for skills response;

3) To present case studies that show actual examples of skills response to green economy in various sectors; and

4) To discuss the general issues, challenges and limitations of the current approach and suggest policy recommendations.

This report was prepared in consultation with several researchers in government-funded research institutes and universities, agencies involved in the formulation and implementation of Korea's green growth strategy, and representatives of civil society and the private sector in Korea. The authors reviewed a wide range of documents including numerous government issued reports and documents, legislations and laws, academic papers, and news paper articles on green growth. In addition, the authors conducted several expert panel discussions on issues discussed in this report.

To carry out case studies, the authors interviewed more than 50 people from ten different agencies or organizations in green sectors; some were students of a training programme and others include instructors, directors of HR departments, current employees, and representatives of the organizations. Those conversations with people who were actual beneficiaries of the green policy measures and those who were implementing the policy at the ground level served as invaluable resources for this report.

The views and opinions expressed in this report are the sole responsibility of the authors and do not necessarily reflect those of the institutions and individuals cited in this document.

Executive summary

At a national address on the 60th anniversary of the Republic of Korea on 15 August 2008, President Lee Myung-bak proclaimed a "low-carbon, green growth" strategy as a new vision to guide the nation's development. Since then, Korea has been undertaking major restructuring processes across different ministries and central government offices to implement this vision in policies and practices.

Key challenges and priorities for a green economy

Korea has experienced an unprecedented level of economic growth and is now the world's 15th largest economy (World Bank, 2010). Korea's CO_2 emissions are on an upward trend, although the increasing rate has lessened since the 1997 financial crisis when Korea's economy underwent a major restructuring process. However, among OECD countries, Korea ranked 6th in terms of CO_2 emission volume (International Energy Agency, 2009) and also ranked high in terms of the rate of annual increase of CO_2 emissions at 2.4 ppm/year (1997-2006) relative to the global average of 1.9 ppm/year.

Korea's high CO_2 emissions are due to the economic and social structure of the country, which is very dependent on high energy consuming sectors such as manufacturing and transport. Korea is the 10th largest energy consumer in the world, with 97 per cent of its energy consumption drawn from imported energy sources. This shows a relatively high energy consumption rate with low energy efficiency (KIET, 2008). In 2006, industries consumed 56 per cent of the total final energy. Transportation has shown the highest annual growth rate of final energy consumption, but due to the increase of oil prices since early 2000, this growth rate has been slowing down (ibid).

While international environmental regulations on greenhouse gases (GHGs) have been intensified since the 1997 Kyoto Protocol, Korea's efforts to reduce CO_2 emissions have been poor. Europe's Climate Action Network (CAN) ranked Korea as 48th among 56 countries in addressing global climate change in 2007 (Europe's Climate Action Network, http://www.climnet.org/). The Low Carbonization Index (2005) also indicates that Korea needs to take action urgently in order to reduce its CO_2 emission in response to global climate change.

General environmental strategy

Korea has established a legal and regulatory framework, and various policy measures in response to continuing and growing international pressure for the reduction of GHGs. The National Climate Change Adaptation Master Plan (Ministry of Environment, 2008a) outlines short-term (2009-2012) and long-term (2013-2030) visions towards low-carbon green growth including climate change monitoring and prediction, and impact and vulnerability evaluation and adaptation programmes.

In 2009, the government announced Korea's 2020 mid-term GHG mitigation target and has begun to take national consensus-building processes through expert consultations, public surveys, and public hearings with various stakeholders. Three mitigation scenarios for 2020 are proposed which reduce emissions by 21, 27, and 30 per cent respectively from the Business As Usual (BAU) reference case.

In terms of energy policy, the 1st National Energy Basic Plan - 2008~2030, sets targets for increasing the percentage of electricity generated by nuclear power plants to 40 per cent by 2030, from 24 per cent in 2008 (Inter-ministerial Committee, 2008). In addition, the government expects the percentage of electricity generated by renewable energy such as wind power, solar energy, bio energy to increase from 2.49 per cent in 2008 to 11 per cent in 2030 (Inter-ministerial Committee, 2008). The current Feed-In Tariff (TIF) will change to the Renewable Portfolio Standard (RPS) system from 2012. The RPS is a regulation that requires electricity supply companies to produce a specified fraction of their electricity from renewable energy sources, such as wind, solar, biomass, and geothermal. RPS is a stronger policy measure to increase renewable energy generation by the suppliers than TIF.

Through energy related policy measures including the Energy Management by Objectives System, Expanding Cleaning Energy Sources, and the National Smart Grid Roadmap implementation, the government expects to reduce GHGs by a cumulative total of 932.9 million tons by 2020. Moreover, these energy policy measures are expected to create 149,889 new jobs in the energy related fields by 2020 (Presidential Committee on Green Growth, 2009c).

Green response to the current economic crisis

The Presidential Committee on Green Growth was launched in 2009 and has been coordinating greening policies and strategies across different ministries and government offices including the 1st National Energy Basic Plan 2008~2030 (August 2008); the Low Carbon Green Growth Strategies (2008); the Climate Change Response Plan (Sep. 2008); the Green Technology R&D Plan (2009); and the New Growth Engine Industries Development Vision and Strategies (2009).

In July 2009, a Five-Year Green Growth Plan (5YGGP) was announced, articulating a medium-term action plan for implementing the green growth strategy. The 5YGGP intends to turn strategy into concrete and operational policy initiatives towards achieving 'green growth' over the period from 2009 to 2013 (UNEP, 2009). The total funding is USD83.6 billion, representing 2 per cent of GDP. Furthermore, the Basic Law for Green Growth is currently under review by Congress.

The vision of Korea Green Growth is to become the 7th green nation by 2010 and the 5th by 2050 on the green competitiveness index which is composed of the low carbonization index and the green industrialization index.[3] To meet the vision, the proposed strategies for implementation include policy measures for climate change mitigation and adaptation, securing energy independence, growing the new green technology industry, and improving green transport and quality of life.

[3]Green Competitiveness Index was developed by Samsung Economy Research Institute (SERI, 2008).

The Green New Deal Project is an initiative that aims to combine the green growth initiative with the strategy to deal with unemployment resulting from the recent financial crisis. The three core fields are: 1) improving green SOC [4] (establishing a green transportation network, green national information infrastructure, and revitalizing the 'Four Rivers'); 2) low carbon/high efficiency industrial technology; and 3) initiatives supporting eco-friendly lifestyles.

The skills development strategy in response to greening

In Korea, initiatives promoting a green economy are very much government driven. This has the advantage of creating centrally coordinated efforts and efficient implementation over a short period of time. The government also invests large amounts in educating university students, including graduate school students, as they have been identified as a primary target group for skills development and education policy under green growth initiatives. Vocational and Educational Training (VET) has not traditionally focused on green jobs—in fact, only 10 per cent of the unemployed VET recipients (approximately 12,000) were trained in green industries.

The development of green technologies is expected to create 481,000 jobs by 2012 and 1.18 million jobs by 2020 (UNEP, 2009). By 2012, research and development investments in climate change mitigation will have more than doubled from the current 2008 level of KRW 700 billion. KRW 5 trillion is being invested over the next five years for Korea to become a global leader in green technology.

Skills in transition to a greener economy

Green structural change and retraining needs

Currently a comprehensive system to identify green skills needs in Korea does not exist yet. To date the main vehicle for identifying emerging skill needs is through the various Sector Councils Human Resource Development (SCHRD) bodies. Starting with three SCHRDs in 2003, a total number of SCHRDs has grown to 23 including newly-established green SCHRDs, e.g., renewable energy and green finance SCHRDs. Both green SCHRDs will begin to administer skills surveys to their member enterprises to assess skills changes, skill needs and resource gaps in the respective industries. The results will be available in late 2010.

Restructuring of higher education is occurring to meet the needs of greening occupations, particularly for middle level technicians. The Korea Polytechnic College conducted educational needs assessments and restructured its curricula to cater for and respond to skills needs of recent green growth initiatives.

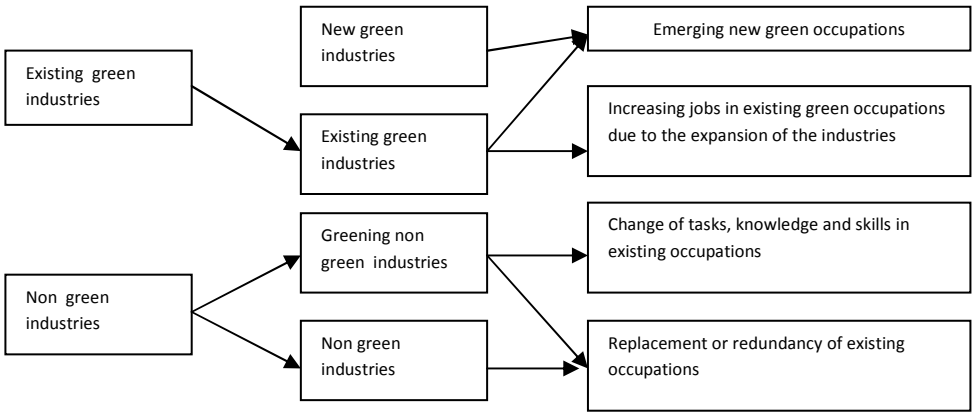
Green restructuring and its impact on the labour market

In the next five years, the growth rate of green jobs (6.0 per cent) is expected to be much higher than the average growth rate of the total jobs (1.3 per cent) in Korea (Presidential Committee on Green Growth, 2009b).

[4]Social Overhead Capitals (SOC) are capitals spent on social infrastructures such as roads, rails, transportation, schools, libraries, public parks, etc.

The Korean Presidential Committee on Green Growth anticipates labour market shifts due to the restructuring of industries in response to green growth, as summarized in the following diagram:

Figure 1: Labour market shifts due to restructuring of industries in response to green growth



Source: Presidential Committee on Green Growth (2009b).

Skills response

Vocational Educational and Training (VET) centres and institutions still provide traditional training courses and few VET centres are currently retraining workers affected by green growth. Although many programmes include 'green' in their course titles, their content does not always consider green skills. While diverse policy measures and strategies have been issued at the national level, it will take a long time to implement the policy at local training centres and institutions level.

In 2009, the Ministry of Labour initiated a new programme called the Vocational Education and Training Reform Centre, which provides vocational education and training based on skills identified by the SCHRDs. For example, with support from this programme, the automobile SCHRD is providing skills training in the development of eco-friendly automobiles.

Several government support strategies are proposed aimed at enhancing skills and competencies of green workers in sectors that are becoming greener. The government will support training costs and income subsidies for businesses that provide their workers with training opportunities which prepare them for green skill demands.

Changing and emerging occupations and related skill needs

New and emerging occupations

The Korean Employment Information Service (KEIS) published a list of 55 "new generation" occupations. Those identified as relevant to Future Growth Engine Project fall under three categories: the green technology industry (for example, solar photovoltaic and wind power developers, GHG auditors, LED

(Light-Emitting Diode) engineers, fuel cell developers for green transport); the advanced convergence industry (for example, nano-based technology researcher/developer; robot researcher/developer; user interface researcher); and the high value service industry (for example, bioinformatics specialist; food developer). The green technology industry category is most relevant to green growth. Other new occupations expected to emerge due to greening of the economy include hydrogen cell researchers, geothermal system engineers and carbon brokers.

Green technologies are believed to create more sustainable employment opportunities for technical and professional workers. The development of green technologies is expected to create 481,000 jobs by 2012 and 1.18 million jobs by 2020.

Greening existing occupations

Transportation and construction are the two main sectors that require significant greening because these two sectors will be most affected by new energy and environmental regulations and policy measures. For example, in the construction industry, architects will require more knowledge in eco-friendly design and construction, heating engineers will require training in efficient energy saving and heating system design, and accountants will require a better understanding of the costs and benefits of environmental facilities, equipments, and processes.

While green jobs in manufacturing and services will increase by 4.5 and 12.1 per cent respectively, green jobs in agriculture, fishing and mining industries will decrease by 3.4 per cent (Presidential Committee on Green Growth, 2009b). The decrease in jobs in these sectors will be due to the overall decrease in low skilled jobs. Therefore, education and training strategies for agriculture, fishing and mining should particularly address upgrading skill levels of current employees in these sectors. Farmers also need retraining in coping with the impacts of climate change on crops as well as catering for consumers' increasing demands for sustainable and organic products.

Skills response

The VET Reform Centre (VETRC) was launched in response to the need for new green skills. The New and Renewable Energy SCHRD and the Green Finance SCHRD have collaborated with the VETRC. The NRE SCHRD will provide currently employed workers with a vocational training programme for new and renewable energy related skills. The programme consists of short-term training courses (1-2 days) covering solar energy design, solar energy and earth heat pump implementation as well as renewable energy CDM (Clean Development Mechanism). The Green Finance SCHRD provides advice in green finance investment as well as green industry trends, risk analysis, green financing and socially responsible investment.

With support from the Ministry of Environment, several education programmes for environmental specialists were launched. There are two examples of education programmes for college graduates with degrees in environmental studies. The "waste-to-energy facility design and operation education programme" is for unemployed college graduates to enhance their employability equipping with new knowledge and skills. The "GHG management specialist education

programme" is a government-funded education programme to develop specialists in GHG management and consulting.

The skill needs for new and emerging green occupations has not yet been quantified. Based on the Ministry of Labour's recent report "Strategies to expand green jobs", it is expected that the next rounds of VET skill needs surveys will have new classifications, including emerging green industries.

Anticipation and monitoring of skills needs

The Ministry of Labour and Ministry of Education, Science & Technology both report on work force demand and supply forecasting at a national level every two years. This national work force forecasting focuses on the projected number of jobs in a field, but provides limited information about the types of skills and knowledge required. The Korean Research Institute for Vocational Education and Training (KRIVET) has launched a project that will design and conduct a new national survey specifically focused on skills needs. The results of this national survey will be available by the end of 2010. KRIVET's national skills needs survey will complement the SCHRDs' skills needs surveys.

Since the national VET needs surveys are based on the broad classification of industry sectors, they give a broad overview of skills needs across all industries, but do not reflect the recent changes in green skills, green jobs and green industries in a specific way. The SCHRDs are planning to identify and monitor the skills changes and TVET needs in selected industries.

Case studies

Case studies for Korea have been provided in the agricultural, energy, automotive and technology sectors.

Case Study 1: Heuksalim Social Enterprise (SE) expanded opportunities for farmers - Agricultural social enterprises and organic farming

Heuksalim is a non-profit organization established in the 1990s running an exemplary social enterprise closely linked to organic farming. Heuksalim promotes organic farming through research and development, production of organic fertilisers, usage of eco-friendly pesticides, consultations for organic farming, and education and training programmes on organic farming. In addition it certifies organic products through laboratory analyses and field monitoring processes. With government funding, Heuksalim recently launched a social enterprise which employs 60 people in the regions of Goisan, Cheongju, and Cheongwon. The employees carry out work in the following four areas: (1) developing organic farming skills and eco-friendly native crops and producing organic seedlings that can be grown in urban farms; (2) networking with local schools to supply organic food for school lunches; (3) organizing farmers' markets where local farmers can sell their products directly to consumers and provide short training sessions to those interested in starting their own small farms; (4) expanding the organic lunch catering business to more organizations.

Heuksalim SE demonstrates that social enterprises can create jobs and additional income for farmers as well as provide educational opportunities to develop skills and knowledge. Employees will be able to build competencies through educational initiatives including on-the-job training on advanced farming

and auxiliary high-value business such as sorting, packaging, and direct distributing.

As Heuksalim has developed through practical experience, its education programmes are reported to be more practical and applicable than those provided by government or universities.

Case Study 2: Forest tending projects: Green New Deal Projects

The Korea Forest Service announced that 66,487 new jobs will be created in 2009 in the areas of cultivating forest resources, maintenance of green space and forest services, expansion of forest biomass collection, national disaster prevention and research & development. The Forest Tending programme was launched in 2005 and is continuously increasing its budget and participants. Since the Green Growth announcement, the budget for the 2009 Forest Tending programme has doubled. The programme creates jobs for low-income and unemployed youth. All the participants are required to attend an introductory education and training course, which covers theories and practices about the objectives of forest tending, forest tending techniques, machinery operation techniques and safety management. The courses take place over a two-week period and the course fees are subsidized by the government.

Case Study 3: Jobs in environmental industries

Korea's environmental industry is lagging compared to other industries such as IT and automobile manufacture. Furthermore, most Korean businesses in the environmental industry are small, with low levels of expertise. Nevertheless, the environmental sector on a national level has grown rapidly and was expected to reach more than 31 trillion KWN by 2010 as projected in 2004 (KIET, 2004). Since 1995, the environmental sector has increased by 11.3 per cent annually and in 2005 contributed to 2.95 per cent of the GDP. There are 25,018 businesses in this industry with a total of approximately 184,333 employees. However, while the developed countries are entering the third generation of environmental technology such as environment restoration technology, Korea is still in the stage of the first generation (post-processing) and the second generation (pollution prevention) (Hwang et al., 2007).

To develop the skilled workforce in environmental studies, the government has launched specialized graduate schools in the area of climate change. Each school received 150 million KWN per year for ten consecutive years for programmes focusing on national GHG emission statistics, GHG mitigation strategies, climate industry management strategies, climate change impact evaluation and response measures, the carbon market and international agreements. Currently the supply of graduate level students in environmental studies exceeds future demands. Therefore, for students who studied conventional environmental studies, these specialized graduate schools aim to provide new opportunities to expand their knowledge and skills to new areas such as GHG management, carbon trading, and environmental consulting.

Case Study 4: Education and Training Centre for Energy Technology, Seoul National University of Technology[5]

The Education and Training Centre for Energy Technology at Seoul National University of Technology (SNUT) is a government-funded national centre that was established to develop higher level researchers and engineers through graduate school programmes. It also aims to provide education and vocational training for employees in the energy field, including support for on-the-job training. The Centre at SNUT emphasizes the importance of vocational training for current employees in addition to initial education. From 2007 to 2009, 9,390 people received education and training through this Education Centre Programme with a budget spent of 6,500 million KWN (Education and Training Centre for Energy Technology at SNUT, 2009).

Many new public and private education centres and institutions have emerged since the government's green growth initiative. However, without a systemic human resources supply and demand analysis, and both short-term and long-term prospects, the expansion of educational centres may present problems by causing unemployment in the future.

Case Study 5: Sustainable Building Technology Education Programme at Korea Institute of Construction Technology Education

This is a government-funded education programme run through the Ministry of Land, Transport and Maritime Affairs to foster expertise and sustainable development in eco-friendly construction. Trainees of this programme include university students, graduates who have majored in construction or architecture, and current workers in the field. The full-time intensive curriculum takes four weeks and covers eco-friendly architecture design principles and theories, sustainable building design, sustainable building systems and sustainable construction technology and resource management.

The students enrolled in this programme because they believe the demand for eco-friendly sustainable buildings is increasing. Participating students claim they benefitted from the practical knowledge and skills of the programme, which they could not have learned in school. Thus, the students felt that the intensive programme was more responsive to the rapid changes of new technologies and skills. There were three sessions offered in 2009 whereby 50 students participated in each session.

The emphasis on the demand for new technologies is a strong aspect of this programme; however, the students found that subsequent employment opportunities were not well supported. The labour market for students specialized in the green building industry must change to create opportunities for these skilled workers.

Case Study 6: LED Lighting Technology Education Centre (LTEC)

The government has implemented various policy measures to expand the LED market throughout various industries including: LED lighting replacement projects in public buildings, international conference halls, subway stations; LED lighting appliances in newly developed cities; and LED in green houses. For example, as a

[5]http://www.etec.or.kr

part of the Green New Deal Project, a project for LED lighting replacement in public facilities is expected to create 10,030 jobs. To implement these projects, expertise is needed including LED element researchers, LED lighting system specialists and LED heat reduction engineers. The Ministry of Knowledge Economy expected that 13,000 LED specialists will be needed by 2015. The LTEC[6]was established to educate and develop lighting technology expertise in the field as part of the education centre programmes by the Ministry of Knowledge Economy.

LTEC offers various types of long-term and short-term programmes and field practicum to meet particular needs of participants. The LTEC conducted education needs assessments and satisfaction surveys of participating industries to determine the experiences, challenges and needs of the LED industry. A higher demand for lighting design and LED application areas is expected, which require interdisciplinary knowledge and skills.

Case Study 7: Hyundai Hybrid automobile training programmes for maintenance technicians

In 2009, Hyundai introduced its first hybrid automobile to the Korean market. These vehicles are now on the road and there is a need for educating and training maintenance technicians in service centres nationwide. General education about this new hybrid product is offered across Hyundai including all employees in sales and marketing departments as well as maintenance technicians. At the level of maintenance technicians, the transition to new automobiles using hybrid or fuel cells will not necessitate replacement of the existing workers as the fundamental technology remains the same. However, updating and upgrading skills of current employees is crucial. Moreover, as the technology advances, the most important competencies for maintenance technicians will not be the ability to repair faults but to diagnose problems and identify the right module to replace. Hyundai utilizes diverse delivery methods for employee training for technicians and sales persons on maintenance and product education, and the company emphasizes the importance of on-the-job training.

Hyundai partners with 12 colleges and universities and ensures new skills needs are reflected in their curricula. In exchange teachers and professors from these partner institutions teach current employees about new technologies and skills.

In 2009, there were 2,327 maintenance service centres and 24,682 technicians participating in the Hyundai education programme (from an unpublished report, Hyundai Education Centre).

Conclusion

It is predicted that the number of green jobs will increase more rapidly than non-green jobs in Korea (Presidential Committee on Green Growth, 2009b). Some industries such as the automobile industry have attempted to assess the skills needs in line with a greening economy. However, in Korea, there has not been a comprehensive system to specifically identify green skills needs.

[6]http://www.ltec.or.kr

Since Korea has achieved rapid economic growth over the past four decades, mostly in manufacturing and heavy chemical industry, the amount of Korea's CO_2 emissions have increased sharply. Korea did not take environmental problems into consideration while embracing rapid economic development as seriously as it should have and thus until recently has not aggressively reacted to the international efforts for more environmentally sustainable growth. However, in 2008, the Korean government adopted an ambitious national plan for green growth which targets harmonious economic growth with environmental sustainability. The Five-Year National Green Growth Plan and the Presidential Committee on Green Growth are the representative efforts of Korea's recent political shift to green growth.

The Korean government recently announced 12 policy plans in areas that aim to create a virtuous circle of green growth and green job creation (Presidential Committee on Green Growth, 2009b). These include policies focusing on developing infrastructure for green job creation, expanding vocational education and training for green jobs, and development of core green talents.

Over a very short period, Korea has restructured a large number of policies and strategies across different ministries to align with centrally focused green growth initiatives. However, although many new policies and strategies have been created, many of them are still too vague to be put into practice yet. At the time this report was being prepared, 16 months had passed since the President first announced green growth initiatives. There have been numerous seminars, conferences, workshops, public hearings, and publications on the topic of green growth. Yet, evidence of green jobs and green skills development in Korea remains anecdotal.

Nonetheless, we have begun to witness signs of a paradigm shift to green growth and sustainability across our society. Diverse delivery mechanisms are being utilized for green skills development, ranging from short-term training courses and seminars to formal education systems such as specialized graduate school programmes, to e-learning or on-the-job training.

Recommendations

Korea's current green growth initiative needs to integrate top-down environmental policies with the experience and know-how from the bottom-up practice of industries, NGOs and civil organizations linked to the environmental movement.

Restructuring and enhancing the national information infrastructure related to green jobs and green skills is required for identifying how many, what type and the demand for 'green jobs' as well as building consensus on the definition of a 'green job'. It is difficult to provide an accurate prediction about the future of green jobs; however, by mapping green skills and green jobs the VET programmes can be developed to better support green growth policies as well as to improve the quality of green job workers.

For effective skills development, qualified teachers and appropriate curricula are essential for success. Since a great portion of green technologies are new and interdisciplinary, it is difficult to find experts and it will take some time to prepare new VET teachers for the field. Along with retraining programmes for VET teachers, the government should implement financial and legislative policy measures to attract qualified practitioners in the field of green technology and the green industry, and utilize those competent practitioners as qualified VET teachers and trainers. The government needs to create a cross-sectoral system to support the

linkage and partnership between different educational institutions and training facilities. In addition, the partnership between education and industry at various levels needs strengthening.

Green career development in Korea is currently split into highly skilled engineers and researchers and low skilled construction or manufacturing workers. Education and training policy measures and strategies need to be inclusive to ensure skills advancement and career development of all workers from low-skilled to high-skilled positions, yet also differentiated to cater for different needs. For example, 97.6 per cent of the total green jobs created through the Green New Deal (i.e. 934,000 jobs) are mostly manual workers for temporary jobs on civil engineering and green construction public works. For long-term sustainability Korea needs to continue efforts to transform short-term employment of manual workers into more sustainable green jobs with high level skills.

Abbreviations and acronyms

5YGGP	Five-Year Green Growth Plan
BAU	Business As Usual
BT	Bio Technology
CAN	Climate Action Network
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CEOs	Corporate Executive Officers
CFD	Computational Fluid Dynamics
CO_2	Carbon dioxide
COP	Conference of Parties
DME	Dimethyl ether
ECPI	Energy and Climate Policy Institute for Just Transition
ED	Education
ESCO	Energy Service Company
ESG	Environmental, social, governance
EU	European Union
FGD	Flue Gas Desulfurization
GDP	Gross Domestic Product
GF	Green finance
GHG	Greenhouse gas
GIS	Global Information System
GPS	Global Positioning System
HCI	Human Computer Interaction
HEV	Hybrid Electric Vehicle
HFCs	Hydrofluorocarbons
HR	Human resources
HRD	Human Resource Development
IPTV	Internet Protocol Television
ISCED	International Standard Classification of Education
IT	Information Technology
ITA	Individual Training Account
Kbiz	Korea Federation of Small and Medium Businesses
KCCI	Korea Chamber of Commerce and Industry
KCTU	Korean Confederation of Trade Unions
KEEC	Korea Environmental Education Center
KEIS	Korea Employment Information Service
KFEM	Korea Federation for Environment Movement
KIET	Korea Institute for Industrial Economics and Trade

KLR	Korea Labour Research
KRIVET	Korea Research Institute for Vocational Education and Training
KWN	Korea Won
JI	Joint Implementation
LED	Light-Emitting Diode
LOHAS	Lifestyles of Health and Sustainability
LTEC	Lighting Technology Education Centre
MTOE	Million Tons of Oil Equivalent
NGO	Non-governmental organization
NRE SHRD	New Renewable Energy SCHRD
NT	Nano Technology
OECD	Organisation for Economic Co-operation and Development
OES	Occupational Employment Statistics
OJT	On-the-job training
PFCs	Perfluorocarbons
R&D	Research & Development
RFID	Radio Frequency Identification
RPS	Renewable Portfolio Standard
SCHRD	Sector Councils Human Resource Development
SD	sustainable development
SE	Social enterprises
SF_6	Sulfur Hexafluoride
SNUT	Seoul National University of Technology
SoC	System on Chip
SOC	Social Overhead Capitals
SMEs	Small and Medium Enterprises
SPV	Solar Photovoltaic
SW	Software
TIF	Feed-In Tariff
TOE	Tons of Oil Equivalent
TVET	Technical and Vocational Education and Training
U-City	Ubiquitous City
UI	User Interface
UNEP	United Nations Environment Programme
VET	Vocational Education and Training
VETRC	Vocational Education and Training Reform Center
VOD	Video on Demand

1. Introduction

At a national address for the 60th anniversary of the Republic of Korea on 15 Aug. 2008, President Lee Myung-bak proclaimed a "low-carbon, green growth" strategy as a new vision to guide the nation's development. Since then, Korea has been undertaking major restructuring processes across different ministries and regional offices as well central government offices to implement the vision through policies and practices. Such government-wide efforts are synthesized and articulated in a "Five-Year Green Growth Plan," which was announced on 6 July 2009. With total funding of USD83.6 billion, representing 2 per cent of the Gross Domestic Product (GDP), this five-year plan intends to turn strategy into concrete and operational policy initiatives towards achieving 'green growth' over the period of 2009 to 2013 (UNEP, 2009).

"Green growth" addresses the transition towards a low-carbon economy as a response to global climate change. This concept promises a paradigm shift from "quantitative growth" to "qualitative growth." Meanwhile, the recent global economic crisis has spurred response packages in many countries. Korea also launched the Green New Deal in January 2009 to revitalize the economy and create over 960,000 new jobs.

These green growth initiatives and stimulus packages inevitably lead to restructuring of the economy and industries, which in turn bring about changes in employment and jobs. Green jobs have been identified and emerged across different sectors. Green jobs require adequate skills and call for education and training strategies to reduce skill gaps that may exist under the transition to a sustainable green economy.

However, these changes in industries, employments and occupations have only recently been recognized and close investigations into these changes are now underway. All of the necessary data for an in-depth study are not yet available. The current national statistics on employment and jobs do not reflect all greening changes. Despite the limitation of available data, this is a critical time to understand emerging green jobs to better prepare for the coming green growth economy. An understanding of the job characteristics, competency requirements, and education and training is needed along with further insight into the supply and demand prospects of those jobs for both the short-term and mid-term.

To better understand skills demands for green jobs and efficient skills response strategies, we conducted a national case study by analyzing existing quantitative data along with qualitative data from interviews. Although this study is still limited in terms of its scope and coverage of the topic, we hope this study can provide a starting point to initiate meaningful dialogue among stakeholders in the country including the government, employers and unions.

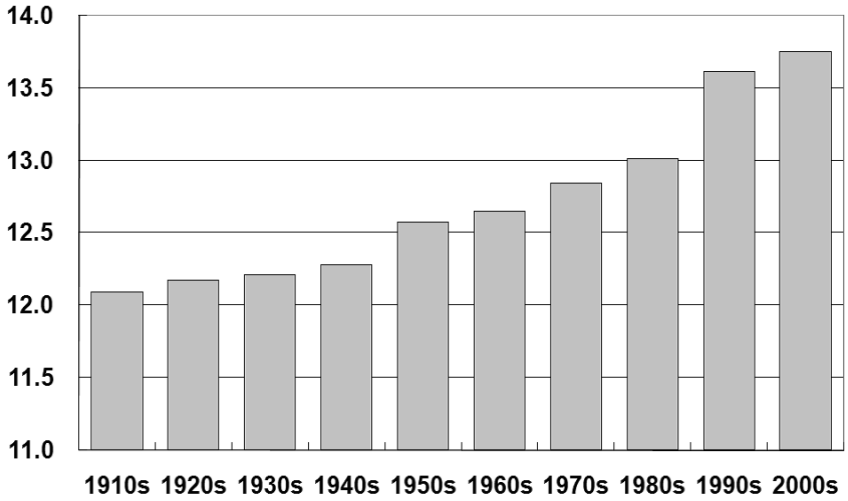
2. Policy context

2.1 Key challenges and priorities for the green economy

Climate change and CO_2 emissions

During the past 100 years from 1912 to 2008, the mean temperature of Korea has increased approximately 1.5°C as shown in the Figure below, which is much higher than the global mean temperature increase of 0.74±0.03°C (1906-2005). This increase is attributed to both global warming and the urbanization effect in Korea.

Figure 2. Changes in decadal mean temperature in Korea, 1912-2008



Source: National Institute of Meteorological Research (2004).

Korea's CO_2 concentration increase rate is 2.4ppm/year (1997-2006), which is also higher than the global average of 1.9ppm/year. Among OECD (Organisation for Economic Co-operation and Development) countries, Korea ranked 6th in terms of CO_2 emission volume and furthermore ranked at the top in terms of annual increase rate of CO_2 emissions (International Energy Agency, 2009).

Table 1. CO_2 emissions of Korea and major OECD countries, 2005

	Korea	World ranking	OECD country
Emission volume	590M m/t	6th	1st USA (7.07B m/t), 2nd Japan (1.36B m/t)
Increase rate(1990~2004)	90.1%	1st	2nd Turkey (72.6%), 3rd Spain (49.0%)
Per capita emission	12.28m/t/ person	14th	1st Luxemburg (28.02 m/t/person)
Increase rate(1990~2004)	69.5%	1st	2nd Turkey (36.2%), 3rd Spain (35.6%)

Source: Korea Prime Minister's Office (2007).

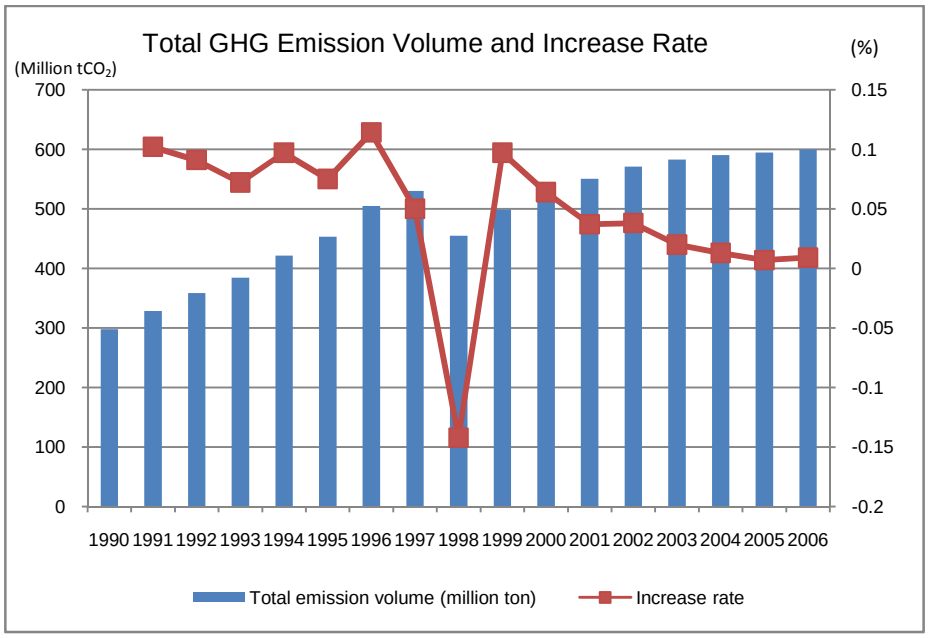
Table 2. GHG emission indicators, 2005

	1990	1995	2000	2005	2006	1990-2006 Increase rate (%)
Total GHG volume (A) (million tCO_2eq)	298.1	453.2	531.0	594.4	599.5	4.5
Population (B) (1,000)	42.9	45.1	47.0	48.1	48.3	0.7
GDPW 100 billion (C) (constant price in 2000)	320,696	467,099	578,665	723,127	760,251	5.5
GHG emission per capita (A/B) (tCO_2eq/person)	6.95	10.05	11.30	12.35	12.41	3.7
GHG/GDP (A/C) (tCO2eq/GDP M Won)	0.93	0.97	0.92	0.82	0.79	-1.0

Source: Ministry of Knowledge Economy (2009).

Korea's CO_2 emissions are on an upward trend, although the increasing rate has lessened since the 1997 Financial Crisis when Korea's economy underwent a major restructuring process.

Figure 3. Annual total GHG emission volume and increase rate, 1990-2006

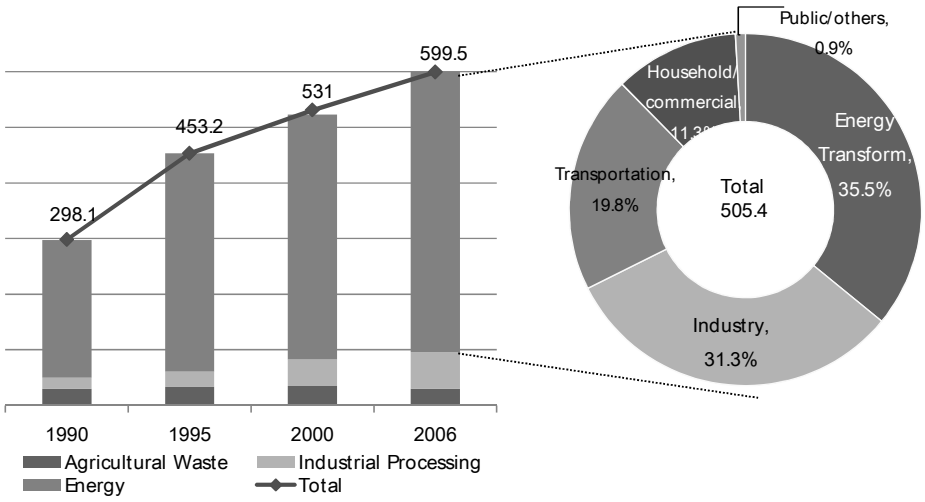


Source: Ministry of Knowledge Economy (2009).

Korea's high CO_2 emission is due to the economic and social structure of the country which is highly dependent on high energy consumption. In addition, the percentage of Korea's fossil fuel-based energy among all energy sources is about 80 per cent, which is higher than other developed countries such as Japan (73 per cent), United States (64 per cent), and France (53 per cent). Over 84.3 per cent of

the total CO_2 emissions derive from energy consumption, and industries are responsible for 31.3 per cent of CO_2 emissions from energy consumption.

Figure 4. CO_2 emissions by sector, 2005



Source: Presidential Committee on Green Growth (2009a).

Korea's industry structure is concentrated with a high percentage the manufacturing sector (i.e. manufacturing vs. service share is 28.4: 56.3 in 2005). This has led to a high energy-dependency and in turn resulting in a higher CO_2 emission rate compared to other developed countries.

While international environmental regulations on greenhouse gases have been intensified since the 1997 Kyoto Protocol, Korea's effort to reduce CO_2 emissions has been poor. Europe's Climate Action Network (CAN) ranked Korea as 48th among 56 countries in addressing global climate change in 2007 (http://www.climnet.org/). The Low Carbonization Index (2005) also shows that Korea needs to urgently take action in order to reduce its CO_2 emission in response to global climate change.

Table 3. Low Carbonization Index, 2005

	Japan	Germany	United Kingdom	USA	Korea	China	OECD
Renewable energy production (kWh)	233.0	428.5	150.2	996.8	4.2 **(15th)**	23.8	232.2
CO_2 (m/t/real GDP USD1,000)	0.24	0.41	0.33	0.53	0.70 **(12th)**	2.68	0.47

Source: SERI(Oct. 2008).

Note: **( )** is Korea's world ranking.

Energy consumption

Korea has experienced an unprecedented level of economic growth. Driven by the chemical industry and the heavy industry in the 1960 to 1970s and by the Information Technology (IT) industry in the 1990s, Korea is now the world's 15th largest economy (World Bank, 2010). Many of Korea's manufacturing sectors including shipbuilding, steel, automotive, semiconductors and mobile handsets have become global front runners. However, Korea's traditional industries such as steel, petrochemical, and cement are energy dependent industries. Korea is the 10th largest energy consumer in the world, with 97 per cent of its energy consumption drawn from imported energy sources. This shows a relatively high energy consumption rate with low energy efficiency (KIET, 2008).

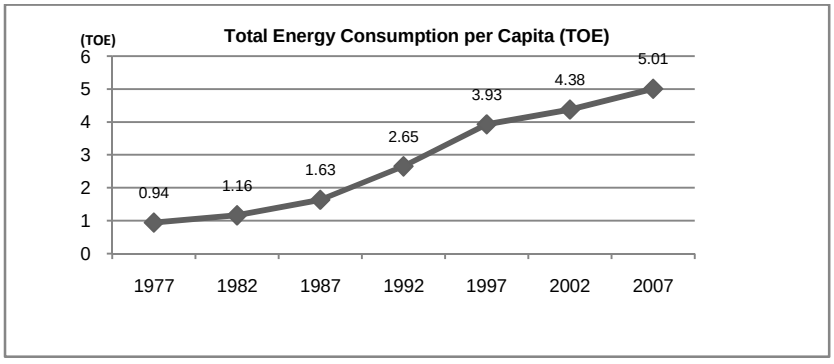
From 1981 through to 2006, Korea's total energy consumption increased 6.7 per cent annually. In addition, energy consumption per capita increased 5.8 per cent annually over the same period. Korea's total energy consumption between 1998 and 2006 shows a relatively low growth rate compared to previous periods, which is primarily due to Korea's 1997 Financial Crisis.

Table 4. Major energy indicators, 1981~2006

						Annual growth rate			
	1981	1990	1997	1998	2006	81~90	90~97	98~06	Average (81~06)
GDPW (100 billion; constant price in 2000)	147.5	320.7	523.0	487.2	760.3	9.0	7.2	5.7	6.8
Population (in millions)	38.7	42.9	46.0	46.3	48.3	1.1	1.0	0.5	0.9
Total energy consumption (MTOE)	45.7	93.2	180.6	165.9	233.4	8.2	9.9	4.4	6.7
Energy consumption per capita (TOE/person)	1.18	2.17	3.93	3.58	4.83	7.0	8.8	3.8	5.8
Energy intensity (TOE/GDP Million Won)	0.310	0.291	0.345	0.341	0.307	-0.7	2.5	-1.3	-0.04
Energy intensity (TOE/GDP 1,000 US)	0.350	0.329	0.390	0.347	-0.7	-0.7	2.5	-1.3	-0.04

Source: Ministry of Knowledge Economy; Korea Energy Economics Institute (2008, p. 25).

Figure 5. Trend of total energy consumption



Source: Ministry of Knowledge Economy; Korea Energy Economics Institute (2008).

The 1997 Financial Crisis instigated significant changes in the energy consumption structure at the time with a move towards economic development of greater energy efficiency. Among Korea's sectors, industries consumed 56 per cent of the total final energy in 2006. Transportation has shown the highest annual growth rate of final energy consumption, but due to the increase of oil prices since early 2000, this growth rate has been slowing down (KIET, 2008).

Table 5. Final energy consumption by sector, 1990-2006

Unit: TOE, per cent

	1990	1997	1998	2006		Annual growth rate			
				Volume	%	81~90	90~97	98~06	Average (81~06)
Industry	36,150	77,908	76,039	97,235	56.0	8.4	11.6	3.1	7.1
Transport	14,173	30,738	26,184	36,527	21.0	16.0	11.7	4.2	9.6
Household Commercial	21,971	33,071	27,418	35,986	20.7	3.7	6.0	3.5	3.3
Public etc.	2,812	2,715	2,487	3,836	2.2	4.5	-0.5	5.6	2.9
Total	75,107	144,432	132,128	173,584	100.0	7.6	9.8	3.5	6.2

Source: Ministry of Knowledge Economy; Korea Energy Economics Institute (2008, p. 26).

If Korea's energy-dependent industry structure continues at the current level, energy demands will continue to increase in millions from 236.5 TOE in 2007 to 299.3 TOE in 2012, and to 544.0 TOE in 2030 (Ministry of Knowledge Economy, 2009). Unless the country begins to implement major transformative changes in its economic structure as well as aggressive measures to improve energy efficiency and reduce GHG emission, than Korea will lose its momentum for further growth.

2.2 The response strategy

2.2.1 General environmental strategy

In response to continuing and growing international pressure on the reduction of greenhouse gases, such as the Climate Change Policy post-2012, Korea has established a legal and regulatory framework, and various policy measures. Korea announced its National Climate Change Adaptation Master Plan (Ministry of Environment, 2008a) which provides national visions and objectives to respond to climate change, and action plans toward low-carbon green growth for both a short term (2009-2012) and long term (2013-2030). The scope of this plan includes climate change monitoring and prediction, and impact and vulnerability evaluation and adaptation programmes.

More recently, on 4 Aug. 2009 the Government announced Korea's 2020 midterm GHG mitigation target and has begun to take national consensus-building processes through expert consultations, public surveys, and public hearings with various stakeholders. Three mitigation scenarios for 2020 are set up to reduce 21 per cent, 27 per cent, 30 per cent respectively from Business As Usual (BAU).

Scenario 1: 21 per cent reduction from BAU (= 8 per cent increase from 2005 level)

- Can be achieved through implementation of measures with short-term cost (such as green building construction) but potential long-term benefits.
- Reflecting renewable energy and nuclear energy increase policy included in National Energy Basic Plan (Aug. 2008).

Scenario 2: 27 per cent reduction from BAU (= Return to 2005 level, i.e. 594MtCO_2e)

- Can be achieved through implementation of additional measures from scenario 1, which have a mitigation cost of less than 50,000 KRW per ton of CO_2.
- Including strategies to eliminate fluorinate gases (e.g., HFCs (Hydrofluorocarbons), PFCs (Perfluorocarbons), SF_6 (Sulfur Hexafluoride)) and increase supply of energy-efficient hybrid automobiles and bio-fuels.

Scenario 3: 30 per cent reduction from BAU (= 4 per cent reduction from 2005 level)

- Can be achieved through implementation of aggressive measures with high mitigation cost to meet the maximum mitigation level demanded by the European Union (EU).
- Require to actively implement next generation green automobiles including electricity or fuel-cell automobiles, advanced high energy efficiency products, and carbon capture and storage (CCS) technologies.

These mitigation targets seem to be ambitious considering the current upward trends of CO_2 emission in Korea and the short period of time until the year 2020 (UNEP, 2009). Before the UN Climate Change Conference in Copenhagen Conference of Parties (COP) 15/CMP (meeting of parties to Kyoto Protocol related to Clean Development Mechanism) 5 held in December 2009, the Korean government announced 30 per cent reduction from BAU (i.e. Scenario 3), which is the most reduction plan among the three scenarios. Nevertheless, these targets represent the vision and will of the President and the government which have appeared in prior policy plans sending concrete signals to employers that they need to take the necessary measures to meet these targets in practice.

The government is in the process of developing a Carbon Visibility Index to make carbon related information more visible to employers and the general public. A Carbon Labelling System that indicates CO_2 emission throughout the entire production, consumption, and waste processes will be expanded to include most products and services. Residential and commercial buildings will be equipped with a carbon gauge that shows carbon emission levels in real-time. More systematic statistical data on GHG continues to be collected, and employers' reporting system on GHG emission will be reinforced to prepare for carbon emission trading system.

In major sectors, specific GHG reduction targets have been established. To design and construct energy efficient buildings, utilities and appliances, reinforced regulations and standards will be implemented and new design and engineering technologies need to be developed. To reduce GHG in transportation, the current public transportation transit system will undergo improvement, promoting bike-friendly roads and services. In addition, green automobiles will be encouraged through a low carbon automobile purchase incentives plan and related Research & Development (R&D) support plans.

Table 6. Major indicators of GHG reduction target level based on Scenario 3

Sector	Target level				
	2009	2010	2011	2012	2013
Construction: Reinforced insulation standard for building windows (per cent)	0	--	20	--	40
Transportation: Per cent of public transportation share in metropolitan areas (per cent)	50	51	53	55	56
Transportation: Accumulated number of green automobiles (1,000)	30	50	80	130	
Energy: Percentage of usable waste to energy	3.1	3.5	14.1.	21.2	33

Source: Presidential Committee on Green Growth (2009a)

In addition, various CO_2 reduction strategies are proposed across a wide range of sectors and stakeholders. At the individual level, a change of life style (e.g., recycling and food waste reduction) that is more environmentally conscious is promoted. At the industry level, Carbon Capture & Storage (CCS) has been addressed as an effective measure to reduce GHG emissions. Forest tending projects are expected to increase forest capacity to capture and store carbon from 1,452 million CO_2 ton in 2009 to 1,613 million CO_2 ton in 2013. The wood pallet will be able to replace fossil-based energy source for heating in rural areas.

Table 7. Major indicators of CCS measures

	Target Level				
	2009	2010	2011	2012	2013
Discharge reduction rate compared to expected food waste (2 per cent increase/year)	-	5	10	15	20
Forest carbon storage (million CO_2)	1,452	1,494	1,535	1,575	1,613
Wood pallet production (10,000 ton)	3	11	20	28	40
Development of forest resources in foreign countries (1,000ha)	200	220	245	270	296
Development of marine forest (ha)	100	900	2,500	3,000	3,000

Source : Presidential Committee on Green Growth (2009a).

Energy related policy measures are another major government strategy in response to climate change. The Energy Management System sets a certain target of energy consumption or efficiency and manages an implementation plan and management system to meet the target. By 2012, workplaces of which energy consumption is more than 20,000 TOE per year (about 54 per cent of the total workplace in Korea) will require the establishment of an energy target, and systematically monitoring and evaluating the process to meet the target. Workplaces will face penalties if the established target is not met, also monetary incentives and technical supports will be rewarded to workplaces showing efficient and effective EMS implementation.

In order to reduce GHG, alternative clean energy source developments are strongly encouraged. Nuclear energy is one example of clean energy that emits almost zero CO_2. Recently, Korea has been awarded a contract worth an estimated

USD40 billion to build four nuclear power plants in the United Arab Emirates. This indicates that Korea's nuclear energy R&D level is globally competitive.

The 1st National Energy Basic Plan set a national plan to expand the percentage of nuclear power plants up to 40 per cent by 2030, from 24 per cent in 2008(Inter-ministerial Committee, 2008). In addition, the government expects the percentage of new renewable energy will increase from 2.49 per cent in 2008 to 11 per cent in 2030. To this end, Feed-In Tariff (TIF) will change to Renewable Portfolio Standard (RPS) system by 2012. TIF or renewable energy payment is a policy mechanism designed to encourage the adoption of renewable energy sources by supporting price differences between the cost of renewable energy generation and traditional energy generation. On the other hand, RPS is a regulation that requires electricity supply companies to produce a specified fraction of their electricity from renewable energy sources, such as wind, solar, biomass, and geothermal. RPS is a stronger policy measure to increase renewable energy generation by the suppliers than TIF.

At the same time, policy measures that encourage higher demand for renewable energy are proposed and being implemented. 100,000 Solar Photovoltaic (SPV) homes and 1 million Green homes supply programme are examples that will demand more renewable energy (Korea Energy Management Corporation, 2008; 2009).

When a residential home installs a SPV system, the government provides support and this amount is based on an annual subsidy cap. This subsidy programme started from 2004 and a total of 24,000 homes received a subsidy through this programme by 2008(Korea Energy Management Corporation, 2009). The original goal was to cover 100,000 homes by 2012, but this programme has merged with the green home programme since 2009, which targets to equip 1 million homes with a renewable energy system by 2020.

The subsidy provided to residential home owners covers a portion of the installation cost for a renewable energy system. For example the subsidy covers up to 60 per cent of the equipment cost for the SPV and wind energy systems and 50 per cent of the equipment cost for the solar heat, geothermal, and bio pallet systems. When the annual subsidy cap is reached, the programme can be terminated early.

Table 8. Government support for green buildings

Category		Size of support	Support rate	Others
Solar Photovoltaic (SPV)	Fixed	Less than 3kW /a building	Within the maximum of 60 per cent	Based on grid-connect type
	Pursuit			
	BIPV			
Solar heat	Flat	Less than 8~30 ㎡/ a building	Within the maximum of 50 per cent	Excluding night electricity equipment
	Single vacuum tube			
	Double vacuum tube			
Bio	Wood pallets boiler	Less than 58.1kW/ a building (less than 50,000 ㎉/h)	Within the maximum of 50 per cent	-
Small wind	Small wind power	Less than 3kW/ a building	Within the maximum of 60 per cent	Based on grid-connect type
Geothermal	Vertical closed	Less than 17.5kW/a building (less than 5RT/ a building)	Within the maximum of 50 per cent	Excluding night electricity equipment

Source: Korea Energy Management Corporation (2009); New & Renewable Energy Center (2009).

The obligation of renewable energy use in public buildings and renewable energy building certification programme for non-public buildings are additional strategies to increase demand for further renewable energy generation. To reduce energy consumption, increasing energy efficiency is another challenge. A smart grid delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency. Based on Korea's advanced IT level, the National Smart Grid Roadmap was established in 2009 and is being implemented. By implementing the above energy related policy measures, the government expects to reduce a total of 932.9 million tons of GHG by 2020. Moreover, these energy policy measures are expected to create 149,889 new jobs in the following energy related field by 2020(Presidential Committee on Green Growth,2009c).

Table 9. GHG (CO_2) reduction effects

Unit: million ton

		2012		2015		2020	
			Accumulated		Accumulated		Accumulated
Energy management by objectives system		9.7	23.0	13.5	59.4	37.7	190.9
Clean energy	Nuclear	21.3	29.4	51.8	156.3	99.0	545.8
	New renewable	6.4	12.5	13.2	45.5	29.0	157.5
Smart grid		1.4	1.4	3.3	9.4	7.2	38.7
Total		38.8	66.3	81.8	270.6	172.9	932.9

Source: Presidential Committee on Green Growth (2009c).

Moreover, these energy policy measures are expected to create 149,889 new jobs in the following energy related field.

Table 10. Job creation effects in energy fields

		2012	2015	2020
Energy management by objectives system		991	1,271	2,538
Clean energy	Nuclear	13,109	24,177	50,061
	New renewable	16,584	31,592	66,689
Smart grid		4,445	19,265	30,601
Total		35,129	76,305	149,889

Source: Presidential Committee on Green Growth (2009c).

2.2.2 Green response to the current economic crisis

Since the time of President Lee's national address on the importance of green growth on 15 Aug. 2008, many new greening policies and strategies have been developed and implemented. The *Presidential Committee on Green Growth* was launched in February 2009 and has been coordinating greening policies and strategies across different ministries and government offices, which has followed a series of new national policy plans and strategies including the 1st National Energy Basic Plan 2008~2030 (Aug. 2008); Low Carbon Green Growth Strategies (Sep. 2008); Climate Change Response Plan (Sep. 2008); Green Technology R&D Plan (Jan. 2009); and the New Growth Engine Industries Development Vision and Strategies (Jan. 2009). On 6 July 2009, a Five-Year Green Growth Plan (5YGGP) was announced articulating a medium-term action plan for implementing the green growth strategy. Furthermore, the *Basic Law for Green Growth* is currently under review by Congress.

Five-Year Green Growth Basic Plan (5YGGP)

The 5YGGP ('09~'13) established mid-term (five years) action plans based on in-depth reviews of priority of green growth national strategy investment areas and importance and relevance of green growth programmes and projects. 5YGGP

specifies annual investment and support amounts, responsible government ministries and departments, and expected outcomes as well as description of each programme and project. The vision of Korea Green Growth is achieving 7th strong green nation by 2010 and 5th by 2050on the green competitiveness index which is composed of the low carbonization index and the green industrialization index.[7] To meet the vision, three strategies and ten policy directions are set forth as below.

Figure 6. Vision and strategies of Korea Green Growth

Vision : Achieving world 7th strong Green Nation by 2010, and world 5th by 2050

Three strategies and 10 policy directions	
Strategies	**Policy directions**
I. Measures for climate change and securing energy independence	1. Reduce carbon emissions 2. Decrease energy dependence on oil and enhance energy self-sufficiency 3. Support adaptation to climate change impacts
II. Creation of new growth engines	4. Develop green technologies as future growth engines 5. Greening of industry 6. Develop cutting-edge industries 7. Set up policy infrastructure for green growth
III. Improving quality of life and strengthening the status of the country	8. Green city and green transport 9. Green revolution in lifestyle 10. Enhance national status as a global leader in green growth

Source: Presidential Commission on Green Growth(2009a).

To meet the objectives of the national green growth set in 5YGGP, the government will employ five policy measures:

1) large scale government investment to establish basic infrastructures,
2) enhance strong regulations,
3) incentives or penalty,
4) include hidden costs in economy, environment and social policy (such as environmental tax), and
5) moral persuasion. The amount of investment for 10 policy directions is shown in Table 11.

[7]Green Competitiveness Index was developed by Samsung Economy Research Institute (SERI, 2008).

Table 11. Investments plan for green growth in Korea, 2009–13 (in USD billion)

Category of action plan and policy direction	Amount of investments			
	Total	2009	2010-11	2012-13
	83.6	13.6	37.6	32.4
[1] Measures for climate change and securing energy independence	44.3	6.7	22.7	14.9
1. Reduce carbon emissions	4.4	0.8	1.7	1.9
2. Decrease energy dependence on oil and enhance energy self-sufficiency	11.6	2.2	4.4	5.1
3. Support adaptation to climate change impacts	28.3	3.7	16.7	7.9
[2] Creation of new growth engines	22.3	3.7	8.3	10.2
4. Develop green technologies as future growth engine	8.8	1.6	3.3	3.9
5. Greening of industry	3.6	0.6	1.4	1.6
6. Develop cutting-edge industries	8.5	1.2	3.0	4.2
7. Set up policy infrastructure for green growth	1.4	0.2	0.5	0.6
[3] Improving quality of life and strengthening the status of the country	21.7	4.0	8.2	9.5
8. Green city and green transport	19.7	3.7	7.4	8.6
9. Green revolution in lifestyle	1.5	0.3	0.6	0.6
10. Enhance national status as a global leader in green growth	0.5	0.1	0.2	0.2

Note: Currency rate (= Korean Won / U.S. Dollar) = 1284.7 (30 June 2009)

Source: UNEP (2009).

Green New Deal Project

The government announced the Green New Deal Project (Jan. 2009) that links green growth initiatives and urgent job creation needs due to global economic crisis.

Figure 7. Overlap between Green New Deal and Korean New Deal and Future Growth

Source : Inter-ministerial committee (2009).

The Green New Deal Project includes programmes that promote a transition to green economy and have the potential to create further growth and jobs.

Many of the Green New Deal programmes can be found in the 5YGGP that were discussed in the earlier section, since the 5YGGP is a more comprehensive green growth initiative established after the Green New Deal. Nevertheless, the Green New Deal specifically addresses the importance of government programmes that would results in more job creations. Figure 7 illustrates the overlap between the Green New Deal with the previous Korean New Deal and Future Growth Engine project (which will be discussed in the next section).

The Green New Deal Project is composed of nine essential programmes in three core fields. The three core fields are green SOC,[8] low carbon/high efficiency industrial technology, and eco-friendly/green life. There are an additional 27 linked projects.

Table 12. Green New Deal Project

Core fields	Essential programmes
Green SOC	Revitalizing the "Four Rivers"
	Establishing a Green Transportation Network
	Green National Information Infrastructure
Low carbon/High efficiency industrial technology	Alternative Water Resources
	Green Cars and Clean Energy
	Expansion of Resource Recycling
Eco-friendly/Green life	Forest Biomass
	Green Home and Green Building
	Formation of Green Living Spaces

Source : Inter-ministerial Committee (2009).

Table 13. Financial spending and expected green jobs creation scale by Green New Deal Project

Project		Financial spending (100 million KWN)			Jobs (person)		
		Already reflected in budget (2009)	Additional spending (2010-12)	Total	Already reflected in plan (2009)	Additional job creation (2010-12)	Total
Total		**43,626**	**456,866**	**500,492**	**93,360**	**863,060**	**956,420**
Essential projects (9)	Revitalizing the "Four Rivers"	4,881	139,895	144,776	7,000	192,960	199,960
	Establishing a Green Transportation Network	18,349	78,187	96,536	25,042	113,025	138,067
	Green National Information Infrastructure	250	3,467	3,717	816	2,304	3,120
	Alternative Water Resources (mid-size dams)	1,845	7,577	9,422	3,063	13,069	16,132
	Green Cars and Clean Energy	3,209	17,318	20,527	1,643	12,705	14,348
	Expansion of Resource Recycling	506	8,794	9,300	2,377	13,819	16,196
	Forest Biomass	3,131	21,043	24,174	22,498	148,204	170,702

[8]Social Overhead Capitals (SOC) are capitals spent on social infrastructures such as roads, rails, transportation, schools, libraries, public parks, etc.

Project		Financial spending (100 million KWN)			Jobs (person)		
		Already reflected in budget (2009)	Additional spending (2010-12)	Total	Already reflected in plan (2009)	Additional job creation (2010-12)	Total
Total		**43,626**	**456,866**	**500,492**	**93,360**	**863,060**	**956,420**
	Green Home and Green Building	-	80,500	80,500	-	133,630	133,630
	Eco river establishment	52	4,786	4,838	393	10,396	10,789
	Disaster Hazard Area Maintenance Project	5,137	19,901	25,038	8,529	33,038	41,567
	Clean Korea action plan	437	1,666	2,103	3,236	11,310	14,546
	Greening waterfront regions	331	7,669	8,000	827	19,073	19,900
	Transit Facilities establishment	1,782	3,396	5,178	2,959	5,639	8,598
	Bus Rapid Transit system	200	1,544	1,744	253	1,955	2,208
	National Bike Trails Network	-	4,980	4,980	-	8,268	8,268
	Bike Express Road (pilot programme)	-	3,000	3,000	-	4,980	4,980
	Integrated Building Energy Management system	-	340	340	-	760	760
Linked projects (27)	Promoting electronic documents usage	-	800	800	-	8,430	8,430
	Computerization of road-based underground facilities	400	2,199	2,599	-	7,767	7,767
	Expansion of International Water Industry	199	1,790	1,989	171	1,281	1,452
	Seawater Desalination Technology development	246	878	1,124	1,700	5,700	7,400
	Reuse of wastewater	403	3,364	3,767	431	5,570	6,001
	Proprietary Technology of Green Car	414	1,522	1,936	42	154	196
	Bio Ethanol Automobile Diffusion	-	30	30	-	60	60
	Bio Ethanol (E5) Diffusion(pilot)	-	272	272	-	575	575
	Biomass conversion into energy	362	10,858	11,220	2,853	21,519	24,372

Project		Financial spending (100 million KWN)			Jobs (person)		
		Already reflected in budget (2009)	Additional spending (2010-12)	Total	Already reflected in plan (2009)	Additional job creation (2010-12)	Total
Total		**43,626**	**456,866**	**500,492**	**93,360**	**863,060**	**956,420**
	Biomass production base building	546	2,262	2,808	582	4,3432	4,924
	Closed landfill redevelopment	-	5,300	5,300	-	9,230	9,230
	Disaster prevention, damaged forest restoration	786	6,541	7,327	8,430	44,218	52,648
	Forest biomass utilization	65	816	881	420	2,710	3,130
	Farming and fishing village Theme park development	95	755	850	95	755	850
	LED lighting replacement in public facilities project	-	13,356	13,356	-	10,030	10,030
	Building Green IT technology test beds	-	100	100	-	10,000	10,000
	Development of Green home doctors	-	160	160	-	1,332	1,332
	Greening the roof and the surface of buildings	-	1,130	1,130	-	2,800	2,800
	Building Eco-road	-	310	310	-	920	920
	Converting small idle facilities into cultural spaces	-	360	360		532	532

Source : Inter-ministerial Committee (2009).

A majority of the financial spending is concentrated on the civil engineering and green construction public works and 97.6 per cent of the total green jobs or the 934,000 jobs created through the Green New Deal are mostly manual workers for temporary employment. Therefore, Korea requires continuous efforts in order to transform short term employment of manual workers into more sustainable green jobs.

Green technologies as future growth engines

Green technologies are believed to create more sustainable employment opportunities for technical and professional workers. The development of green technologies is expected to create 481,000 jobs by 2012 and 1.18 million jobs by 2020 (UNEP, 2009). Green technologies refer to a wide range of technologies aimed at reducing energy use and minimizing contaminants which are essential for sustainable growth. By 2012, Korea's R&D investments in climate change mitigation will have more than doubled from the current level of KRW 700 billion

in 2008. This will take place by investing about KRW 5 trillion over the next 5 years for Korea to become a global leader in green technology. Green technologies through convergence among IT (Information Technology), BT (BioTechnology) and NT (NanoTechnology) will be fostered and exported. Korea's core technologies have been selected based on the rule of "choice and focus" to secure technologies best suited for its circumstances. These green IT and IT converged technologies will create an additional 48,000 jobs.

The government's strong interests and attention to green technologies reflects the country's belief that it is crucial to have advanced and original R&D capacity in order to be globally competitive in the green global economy. The people who develop and implement green technologies are an essential component in the advanced and original R&D capacity. The government puts a large amount of investments in the education of university students including graduate school students, and they have been a primary target group of skills development or education policy under green growth initiatives.

Table 14. List of 27 core technologies in Korea green growth national plan

Sector	27 Core technologies	
Climate change	1. Monitoring and modeling for climate change	(4)
	2. Climate change assessment and adaptation	(4)
Energy source technology	3. Silicon-based solar cells	(1)
	4. Non-silicon based solar cells	(4)
	5. Bio-energy	(4)
	6. Light water reactor	(1)
	7. Next-generation fast reactor	(3)
	8. Nuclear fusion energy	(3)
	9. Hydrogen Energy R&D	(3)
	10. High-efficiency fuel cell	(3)
Efficiency improvement technologies	11. Plant-growth-promoting technology	(3)
	12. Integrated Gasification Combined Cycle	(3)
	13. Green car	(2)
	14. Intelligent Infrastructure for transportation and logistics	(4)
	15. Green city and Urban Renaissance	(3)
	16. Green building	(3)
	17. Green process technology	(2)
	18. High-efficiency light-emitting diodes/Green IT	(1)
	19. IT-combined Electric machines	(3)
	20. Secondary batteries	(2)
End-of-pipe technology	21. CO_2 capture, storage and processing	(3)
	22. Non-CO_2 processing	(2)
	23. Assessment of water quality and management	(2)
	24. Alternative water resources	(2)
	25. Waste recycling	(2)
	26. R&D in Monitoring and processing for hazardous substances	(3)

Sector	27 Core technologies	
R&D in Virtual Reality	27. Virtual reality	(2)

(1) Technologies for short-term intensive investment;
(2) Technologies for mid-term intensive investment;
(3) Technologies for long-term intensive investment; and
(4) Technologies for long-term gradual investment.

Source : UNEP (2009).

2.3 The skills development strategy in response to greening

2.3.1 Green jobs skills development

Vocational education and training (VET)

In the past, VET was not focused on green jobs in Korea. A total of the 11,991 unemployed received VET in the New Growth Engine Industries area in 2008, representing only 8 per cent (or 149,000) of the total unemployed who received VET in 2008. Furthermore, there were only 1,509 VET recipients in green industries and concentrated in specific sectors such as renewable energy and greening industry and space.

Table 15. VET for the unemployed in New Growth Engine Industries, 2008

(unit: person, per cent)

	Total	Green industries	Advanced convergence industries	High value-added service industries
Total	**11,991**	**1,509**	**1,627**	**8,855**
Polytechnics VET for the unemployed (23,000)	590 (2.6)	180 (0.8)	295 (1.3)	115 (0.5)
Prioritized Occupation VET for the unemployed (18,000)	1,166 (6.4)	539 (3.0)	520 (2.8)	107 (0.6)
VET for the new and between jobs unemployed (108,000)	10,235 (9.5)	790 (0.7)	812 (0.8)	8,633 (8.0)

Source : Presidential Committee on Green Growth (2009b).

Currently, 796 university courses are identified to be either directly or indirectly related to green jobs, which annually produce 78,000 graduates; however, this is a rough estimation. A more in depth examination into the curricula in universities is needed in order to gain a better understanding of the skills and competencies of graduates, and to determine to what extent their skills and competencies are related to the green economy. It is estimated that there are 88,000 researchers in green technology fields in 5,890 institutions (69 public research institutes, 512 large companies, and 5,309 Small and Medium Enterprises (SMEs)). Approximately 39.1 per cent of the green researchers hold a doctoral degree and

35.9 per cent hold a graduate degree. The government announced that the education programmes for green researchers (see Table 16) will contribute to 112,786 new green researchers by 2013. In particular, 41,000 (36.4 per cent) researchers will be in environment conservation and resource recycling and 28,165 (25.0 per cent) researchers will be in the renewable energy field.

Table 16. Prospects of green researchers by various fields, 2009-13

	2009	2010	2011	2012	2013	Total
Total	**29,391**	**19,919**	**16,890**	**25,059**	**21,527**	**112,786**
Renewable energy	6,971	5,129	4,517	6,091	5,457	28,165
High efficient energy	2,696	2,167	2,025	2,533	2,356	11,778
Greening industry and space	5,812	4,256	3,811	5,312	4,707	23,897
Environment conservation and resource recycling	11,380	7,021	5,653	9,295	7,660	41,009
Pollution-free economic activities	2,532	1,347	884	1,828	1,347	7,937

Source : Presidential Committee on Green Growth (2009b).

The National Qualification Testing Division in the Human Resources Development (HRD) Services of Korea is conducting research to restructure the National Qualification System to be more responsive to the current greening economy. New qualifications will be created and existing qualifications will be revised with regards to its scope and coverage to adapt to the necessary changes to the green economy.

Table 17. Number of current national qualifications related to green economy, 2008

Area	Number of qualification subjects	Representative qualification	Number of people obtained qualifications (2008)
Energy	2 fields, 6 subjects	Energy management engineer · industrial engineer, Nuclear power generation engineer · professional engineer, etc	469
Energy efficiency, Greening industry space	6 fields 92 subjects	Gas engineer · professional engineer · master craftsman, Railroad car industrial engineer · engineer · professional engineer, etc	62,073
Environment conservation and resource recycling	2 fields 20 subjects	Environment craftsman, Soil environment professional engineer, Natural environment management professional engineer, Waste disposal professional engineer, etc	4,609

Source : Presidential Committee on Green Growth (2009b).

2.3.2 Trade unions and civil society organizations' response

Historically, the environmental movement and labour movement in Korea have shared the common interest in democracy and protecting capitalism. The Korean Confederation of Trade Unions (KCTU) shows concerns for the government's green initiatives (Kim et al., 2009). KCTU is concerned that CO_2 mitigation measures will cause a reorganization of the current structure of Korean industries and in turn, this will lead to a reduction of jobs in current sectors and create new jobs in new sectors. However, there is no clear and reliable data to forecast these changes. Without concrete forecasting data, it is very difficult for workers and trade unions to react and prepare for the change. The government announced Korea's CO_2 mitigation target by 2020, but did not propose specific targets by industry. Therefore, it is still difficult to estimate the actual impact on job changes in each industry. KCTU clustered the main industries into three groups based on the number of employees and the amount of CO_2 emission. The group including ground transportation, steels, chemicals, cements, and petroleum process is identified as the most vulnerable to job changes because the number of employees is high and their CO_2 emission is also high so these industries will be impacted significantly by the government's CO_2 mitigation measures. According to KCTU's survey on its members' perspectives on the political measures on climate change, 85.3 per cent of the respondents agreed that the climate changes would impact the current job status due to a change in the industrial structure.

Nonetheless, KCTU is not able to provide any specific strategies or measures to respond to the potential changes yet. It seems that trade unions including KCTU are just beginning to conduct research on the impact of green growth initiatives on union members' job security and changes and develop strategies to prepare and react to the government measures. However, trade unions' involvement and interests in skills development and training of union members are not visible at this point. The main focus of trade unions in Korea has been the promotion of union members' rights and job security. Compared to many European countries, the unions' involvement in TVET (Technical and Vocational Education and Training) of its members is very limited in Korea. Most of education and training programmes provided by the unions are limited to ones related to union members' rights and the legal matters between employers and union members. Therefore, it is not possible to find trade unions' strategies or perspectives on skills development for greener economy. This implies that the government more actively seeks employees' needs and voices in skills development and should have a system to reflect employees' demands.

Long before the recent government green initiatives, NGOs in environmental protection were established and have done their activities for environment protection in Korea. The Korea Federation for Environment Movement (KFEM), the oldest and the largest NGO for environment movement, was launched in 1984.[9] Now, the individual members of KFEM consist of more than 70 thousand members. During the last three decades, KFEM has engaged in diverse activities to protect the environment such as monitoring air pollution and water contamination, preservation of ecology of wetlands, energy saving movement, etc. In 2002, the Korea Environmental Education Center (KEEC), affiliated with KFEM, was established. KEEC has set up their objective as "Environmental Education for All", while most of education has focused on the youth. Environmental education in

[9]In the beginning, the name of the organization was Korean Research Institute of Environmental Problems.

KEEC was aimed to mainly foster green competence among the youth, including environmental awareness, positive attitude towards the environment, relative knowledge and skills, etc. In addition, KEEC has provided citizens with instructors and teacher training related to environmental protection such as eco-guide training class, environmental instructor training class, eco-experience, etc. Three education centers under KEEC have launched since 2004. In one of the education centers, Nami Eco-school has tried to provide integrative education including environmental education, Lifestyles of Health and Sustainability (LOHAS), and green art, etc. In another education center, Dobong Eco-class supported jointly by KEEC and Dobong regional district office, has provided short-term mid-term environment education and eco-experience education to citizens in the district.

In addition to NGOs directly related to the environment movement, many civil organizations including consumer organization, teachers' association, and life cooperatives lead campaigns to save energy and educate citizens about the climate changes. In addition, more practical movements such as "bike commute," "public transportation commute," "use reusable shopping baskets (eco-bags)" are being implemented through partnerships between local organizations and local governments. However, civil society organizations or NGOs need to develop more content knowledge and expertise on climate change and green growth issues to lead and educate citizens more systematically beyond a simple campaign level and should be able to play a more active role of monitoring of the government policies.

In Korea, the green economy initiatives are mainly government-driven measures. This has an advantage of centrally coordinated efforts and efficient implementation over a short period of time. On the other hand, this government-led approach must include a means to incorporate diverse social dialogue. As discussed before, NGOs have diverse experiences in environmental issues and environmental education, and the current green economy policies could draw practical implication from the NGOs' experiences. However, there is a lack of communication among green initiatives led by the government and those by NGOs despite the fact that the policies and activities of both sides must be interrelated and somewhat overlapped. The government must make an effort to cooperate with NGOs and utilize the expertise and experience of NGOs, and NGOs must try to participate actively in recent green initiatives.

It takes time for employees and ordinary citizens to understand the importance of climate change, political measures to these changes, and potential impacts on their lives including job changes. The government should ensure that there are places where employees and citizens can develop a better understanding of the green economy and prepare themselves.

2.3.3 Response to green economy by small and medium enterprises

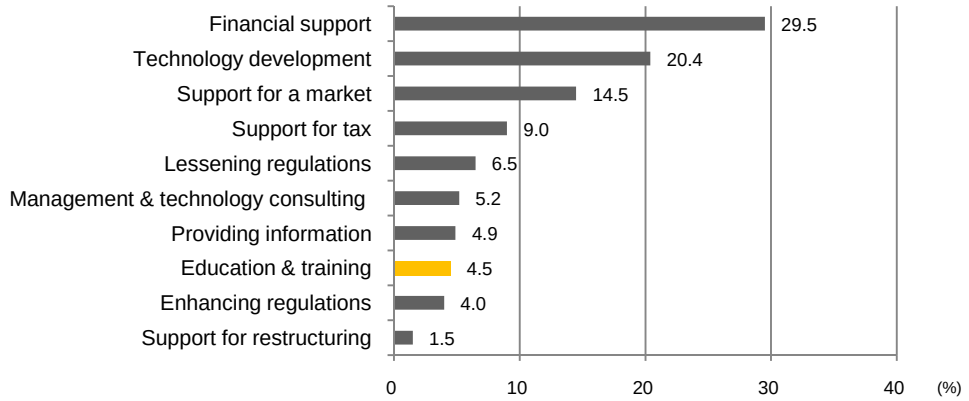
The Korea Chamber of Commerce and Industry (KCCI) is Korea's largest private economic organization representing 120,000 members in 71 regional chambers. KCCI communicates with the Ministry of Environment through Enterprise Environment Policy Council and provides climate change related education with its members. In particular, at the Enterprise Environment Policy Council conferences in 2009, the Ministry and representatives of industries discussed how the government's GHG mitigation target can be actualized at the workplace level and to what extent businesses and enterprises can do to meet this target. In addition, the importance of partnership between the government and the industries to respond to the climate change was emphasized at the Council. KCCI conducted a survey with 508 members regarding the recent government climate

change policy measures. The industries and sectors preferred voluntary participation in and implementation of mitigation measures and strategies rather than the government directed measures. Of the respondents, 65.6 per cent preferred the lowest GHG mitigation target (i.e. 21 per cent reduction from BAU) (Cho and Han, 2009). Because Korean industrial structures are heavy on manufacturing and high CO_2 emission sectors including steels, chemicals, cements, the industries seemed to judge that it would be difficult to dramatically reduce the current CO_2 emission within a short period of time.

The Korea Federation of Small and Medium Businesses (Kbiz) conducted another survey with 2,000 small and medium sized businesses regarding green growth initiatives (Kbiz, 2009). In general, one third of the respondents indicated that the current government's green growth policy is not directly useful for SMEs. Out of 2,000 responding businesses, only 10.3 per cent is either already working or planning to work in green economy areas. In particular, SMEs in advanced level of technology sectors are tend to work more in green economy sectors. One of the main reasons why SMEs are not advancing to green economy sectors was due to a lack of original technology in the green sectors. In Korea, green industries are considered advanced technology sectors and SMEs seemed to think a new advancement to green sectors require the development of advanced technology so that only large enterprises not SMEs have enough financial and technological capacity to do so.

The Korea Institute for Industrial Economics and Trade (KIET) surveyed 300 SMEs in green sectors including manufacturing, services, and construction (KIET, 2009). Of the respondents, 74.6 per cent rated their own green products very highly due to a high level of their technology and skills. On the other hand, marketing was the biggest obstacles they encountered to compete in the market. Only a few respondents indicated a lack of talent as a barrier. In general, more than 40 per cent of the respondents forecasted that green industries will be the main industries that will lead the economy. The SMEs in green sectors showed that financial support is most needed from the government (29.5 per cent). However, their demand for education and training support was relatively low (4.5 per cent).

Figure 8. Most needed areas of support from the government



Source : KEIT (2009).

Many SMEs did not have enough information about both international and national environmental regulations and were not able to develop response strategies to the government's climate change measures (Small and Medium Businesses Administration, 2009). The government needs to provide support strategies specifically for SMEs to be better prepared.

3. Anticipation and provision of skills

3.1 Green structural changes and (re)training needs

In this chapter, we will describe (re)training needs which derive from: (a) Major employment shifts within and across sectors and economic activities due to climate change and demands for greening economy; and (b) Skills, trade and occupations that become obsolete as a result of green structural changes.

3.1.1 Green restructuring and its impact on the labour market

In the next five years, the growth rate of green jobs (6.0 per cent) is expected to be much higher than the average growth rate of the total jobs (1.3 per cent) in Korea (Presidential Committee on Green Growth, 2009b). In particular, new jobs will be created by renewable energy and environmental improvement programmes. In 2006, a total number of employees in environmental industries are 390,406, of which 178,174 employees (45.6 per cent) are directly related to environment fields. By 2012, about 8,000 social jobs in environment fields will be created (Kim, 2009), and 35,000 jobs will be created in the field of wind and solar energy. While the employment induction coefficient per billion KWN of the environment industry is 10.3 and 18.8 in wind energy, the employment induction coefficient for solar energy (102.0) and social jobs (119.0) is much higher than other fields.

Solar energy has the potential to create a larger number of new jobs than conventional industries, offering a solution to the problem of "jobless growth." By 2012, 100,000 new jobs in renewable energy, with another 100,000 in energy efficiency and 17,000 in waste-to-resources sectors will be created. The renewable industry alone is expected to generate 950,000 new jobs by 2030. By 2012, Korea will seek to foster 400 green social corporations and generate new employment opportunities in fields encompassing green and renewable energy sectors, recycling industry, catering services based on green agricultural produce and local ecological environment.

The Ministry of Labour analyzed the current National Standard of Industry and National Standard of Occupation to identify green industries and green occupations. From a total of 169 industries (3digits), 47 industries and 53 occupations out of 139 total occupations (4 digits) are identified as being related to the green economy. In addition, if those industries indirectly related to sectors are included, than 73 industries and 114 occupations could fall into the green category.

From the above rough categorization, it is estimated that there are 320,000 green jobs and 1,070,000 green-related jobs in 2007.

Table 18. Green jobs and green-related jobs by sector, 2007

(unit: person, per cent)

	Agriculture, fishing, mining	Manufacturing	Services	Total
Total jobs (OES'07)*	1,913,515	4,144,775	17,691,353	23,749,643
Green jobs	10,578	114,157	161,647	286,382
per cent	0.55	2.75	1.09	1.21
Green-related jobs	23,948	519,338	523,074	1,066,360
per cent	1.25	12.53	2.96	4.49

* OES : Occupational Employment Statistics
Source: Inter-ministerial Committee. Unpublished report.

The following table shows the number of green jobs and green-related jobs by skill level, i.e. acquired education level. If we look at the green jobs, over 70 per cent of the people have an advanced level of skills. On the other hand, among green-related jobs, there are 42 per cent with a middle level range of skills which is similar to the 40.4 per cent of those with an advanced level of skills. This difference should be considered when looking at their skills gaps and training needs for green jobs versus green-related jobs respectively.

Table 19. Green jobs and green-related jobs by educational level, 2007

(unit: person, per cent)

	Basic	Middle	Advanced	Total
Green jobs	45,882	35,569	204,931	286,382
per cent	16.0	12.4	71.6	100.0
Green-related jobs	187,069	448,300	430,991	1,066,360
per cent	17.5	42.0	40.4	100.0

Basic level : ISCED 3A, High school graduates, craftsmen
Middle level : ISCED 5B, 2 or 3 year college graduates, technicians, industrial engineers
Advanced level : ISCED 5A, 4 year university graduates, managers, researchers, engineers, professional engineers
ISCED : International Standard Classification of Education
Source: Inter-ministerial Committee. Unpublished report.

Table 20. Green jobs and green-related jobs by industry and educational level, 2007

		Level of skills			
	Industry	**Basic**	**Middle**	**Advanced**	**Total**
Green jobs	Agriculture, fishing, mining	8,187	1,270	1,122	10,578
	Manufacturing	17,587	16,628	79,943	114,157
	Services	20,109	17,671	123,867	161,647
	Total	45,882	35,369	204,931	286,382
Green-related jobs	Agriculture, fishing, mining	14,169	4,165	5,613	23,948
	Manufacturing	72,969	291,331	155,038	519,338
	Services	99,931	152,804	270,339	523,074
	Total	187,069	448,300	430,991	1,066,360

Basic level : ISCED 3A, High school graduates, craftsmen
Middle level : ISCED 5B, 2 or 3 year college graduates, technicians, industrial engineers
Advanced level : ISCED 5A, 4 year university graduates, managers, researchers, engineers, professional engineers
ISCED : International Standard Classification of Education
Source: Inter-ministerial Committee. Unpublished report.

Green jobs demand and supply prospects

Green job prospects by 2013 are proposed based on the categorization of the green industry and green occupations. Since this forecasting method uses 2 digit industry classification and 3 digit occupation classification, this is a rough estimation. Nevertheless, the following prospects provide a broad view of the increasing demand for green and green-related jobs in the near future. The forecasting equation uses:

1) the actual economic growth rate and number of employees for 2008,
2) the expected economic growth rate of -1.7 per cent and decrease of employees by 100,000 for 2009, and
3) the estimated economic growth rate of 4.0 per cent for 2010-2013.

Between 2009 and 2013, a number of green jobs will continually increase by 9.0 per cent (annual average increase rate, approximately 34,000 jobs) and in 2013 an estimated total of 480,000 green jobs. On the other hand, green-related jobs will increase by 5.0 per cent, with an estimated total of 1,420,000 green-related jobs in 2013. While green jobs in manufacturing and services will increase by 4.5 per cent and 12.1 per cent respectively, green jobs in agriculture, fishing and mining industries will decrease by 3.4 per cent.

Table 21. Green jobs prospects by industry

(unit: person, per cent)

						2009-2013		
		2007	2008	2009	2013	Increase/ decrease	Annual average increase/ decrease	Annual average increase rate
Green jobs	Agriculture ,fishing, mining	10,578	12,690	9,865	10,415	-2,275	-455	-3.4
	Manufacturing	114,157	117,293	121,150	145,835	28,542	5,708	4.5
	Services	169,756	183,965	206,961	325,840	141,875	28,375	12.1
	Total	294,492	313,948	337,976	482,091	168,142	33,628	9.0
Green-related Jobs	Agriculture, fishing, mining	23,948	26,434	24,580	26,216	-217	-43	-0.1
	Manufacturing	519,338	537,774	536,781	606,737	68,963	13,793	2.5
	Services	523,074	551,248	576,236	790,778	239,530	47,906	7.5
	Total	**1,066,360**	**1,115,456**	**1,137,597**	**1,423,732**	**308,276**	**61,655**	**5.0**

Source : Inter-ministerial Committee. Unpublished report.

In terms of skill level, green jobs that require middle skill level will increase at the highest rate at 11.0 per cent, whereas green jobs that require a basic level will increase by only 6.1 per cent. On the contrary, green-related jobs with middle skill levels will increase at the lowest rate at 3.4 per cent, and green-related jobs with advanced skill levels will increase at the highest rate at 6.5 per cent.

Table 22. Green jobs prospects by skill level

(unit: person, per cent)

						2009-2013		
		2007	2008	2009	2013	Increase/ decrease	Annual average increase/ decrease	Annual average increase rate
Green jobs	Basic	53,992	56,265	57,570	75,662	19,398	3,880	6.1
	Middle	35,569	38,037	43,242	64,037	26,000	5,200	11.0
	Advanced	204,931	219,647	237,163	342,392	122,745	24,549	9.3
	Total	294,492	313,948	337,976	482,091	168,142	33,628	9.0
Green-related Jobs	Basic	187,069	194,131	199,597	251,205	57,074	11,415	5.3
	Middle	448,300	466,451	468,779	550,063	83,612	16,722	3.4
	Advanced	430,991	454,874	469,221	622,464	167,590	33,518	6.5
	Total	1,066,360	1,115,456	1,137,597	1,423,732	308,276	61,655	5.0

Source : Inter-ministerial Committee. Unpublished report.

Further breakdown of prospects by industry and skill level reveals that the decrease of green jobs in agriculture, fishing and mining is mainly due to a decrease of jobs with basic skills. Therefore, education and training strategies for agriculture, fishing and mining should particularly address upgrading skill levels of current employees in these sectors.

Table 23. Green jobs prospects by industry and skill level

(unit: person, per cent)

						2009-13		
		2007	2008	2009	2013	Increase/ decrease	Annual average increase/ decrease	Annual average increase rate
Green jobs	Agriculture, fishing, mining	10,578	12,690	9,865	10,415	-2,275	-455	-3.4
	Basic	8,187	10,325	7,257	7,564	-2,761	-552	-5.1
	Middle	1,270	1,227	1,470	1,658	431	86	6.4
	Advanced	1,122	1,138	1,137	1,193	55	11	0.9
	Manufacturing	114,157	117,293	121,150	145,835	28,542	5,708	4.5
	Basic	17,587	16,672	18,288	22,781	6,109	1,222	6.5
	Middle	16,628	16,720	17,258	19,645	2,926	585	3.3

						2009-13		
		2007	2008	2009	2013	Increase/ decrease	Annual average increase/ decrease	Annual average increase rate
	Advanced	79,943	83,901	85,604	103,409	19,508	3,902	4.3
	Services	169,756	183,965	206,961	325,840	141,875	28,375	12.1
	Basic	28,218	29,267	32,024	45,317	16,050	3,210	9.1
	Middle	17,671	20,090	24,515	42,733	22,644	4,529	16.3
	Advanced	123,867	134,608	150,421	237,790	103,182	20,636	12.1
	Total	**294,492**	**313,948**	**337,976**	**482,091**	**168,142**	**33,628**	**9.0**
Green-related Jobs	Agriculture, Fishing, Mining	23,948	26,434	24,580	26,216	-217	-43	-0.1
	Basic	14,169	16,586	13,592	14,509	-2,077	-415	-2.3
	Middle	4,165	4,056	4,613	5,017	960	192	4.4
	Advanced	5,613	5,791	6,375	6,691	899	180	3.0
	Manufacturing	519,338	537,774	536,781	606,737	68,963	13,793	2.5
	Basic	72,969	73,926	75,105	83,526	9,600	1,920	2.5
	Middle	291,331	303,623	298,418	335,633	32,010	6,402	2.0
	Advanced	155,038	160,225	163,258	187,578	27,353	5,471	3.2
	Services	523,074	551,248	576,236	790,778	239,530	47,906	7.5
	Basic	99,931	103,619	110,900	153,170	49,551	9,910	8.1
	Middle	152,804	158,772	165,748	209,413	50,641	10,128	5.7
	Advanced	270,339	288,857	299,588	428,195	139,338	27,868	8.2
	Total	**1,066,360**	**1,115,456**	**1,137,597**	**1,423,732**	**308,276**	**61,655**	**5.0**

Source : Inter-ministerial Committee. Unpublished report.

3.1.2 Identification of (re)training needs

In Korea, there has not been a comprehensive system to identify skills change and training needs for all industrial fields. Instead, the manpower demand and supply forecasting at the national level has been conducted every two years through the support of the Ministry of Labour and Ministry of Education. This national manpower forecasting provides quantitative information at the 2-digit of occupation or industry classification level. The forecast can provide information on a projected number of new employees that will be needed in a certain industrial field based on the current number of employees in the field, general and specific changes in the field, and the number of recent and future graduates in the areas of study relevant to the field. However, this national manpower forecasting focuses on the projected number of jobs in a field and provides limited information about the project level and/or type of skills and knowledge. To this end, the Korea Research Institute for Vocational Education and Training (KRIVET) has launched a project

which will design and conduct a new national skills survey. The results of this national survey will be available by the end of 2010.

At the regional level, there has been a "Vocational Education and Training Needs Survey" since 2005. This survey consists of three parts:

1) Workplace manpower census and VET needs survey,

2) The unemployed VET needs survey, and

3) VET institutions' VET programme survey.

With the funding from the Ministry of Labour, public research institutions such as KRIVET or Korea Labour Research (KLR) conduct the surveys in the five regional labour markets and produce aggregated data at the national level. Last year, the "Workplace manpower census and VET needs survey" sampled nationally representative 7,000 workplaces and asked them about the type of VET provided (e.g., on-site training, e-learning, financial support for further education, training abroad), the number of participants in each VET type, the level of participating employees (e.g., R&D professionals, technicians, manual workers, etc.) in each VET type, changes in the number of employees for the past two years, and recruitment plan including recruit method, field, number, and experience level of prospected employees. "The unemployed VET needs survey" was conducted on approximately 7,000 unemployed participants who visited the five regional Employment Support Centers or Job Centers. Survey questions included previous employment experience and status, type of jobs that they were looking for, VET experiences (area, type, duration, provider, and helpfulness), future VET needs (area, type, and duration). "VET institutions' VET programme survey" was conducted with the all 633 VET institutions for the unemployed that were funded by the Vocational Competence Training Fund, a part of the Employment Insurance Fund (Ministry of Labour). This survey asked type, content field/area, duration, cost, number of participants, number of graduates, number of people who earned qualification after the programme, number of people who are employed after the programme of each VET programmes that a VET institution provided. In addition, the VET institutions were asked to list VET programmes that they would like to offer in following year using the Vocational Competence Training Fund by the Ministry of Labour. They had to provide specific information for those future programmes including type, content area, duration, cost per person, and number of trainees.

Through the above sets of surveys, the Ministry of Labour is able to monitor general VET status and the needs from both employers and the unemployed. The survey results can guide the Ministry to make an educated decision on how to more efficiently allocate the Vocational Competence Training Fund across different VET programmes. Nevertheless, the VET needs surveys are based on the broad classification of VET as shown in Table 24. Thus, the surveys can only provide limited information regarding specific skills. Until last year, the VET classification did not reflect recent changes in green skills, green jobs and green industries. Based on the recent report to the President by the Ministry of Labour regarding "strategies to expand green jobs," we expect that the next round of VET needs surveys will have new classifications including emerging green industries.

As in Table 24, classification is not specific enough to identify skills needs in green jobs and green industries. In order to conduct a common survey with the same sets of questions for all industries, the survey items tend to be general. Also

detailed classifications can be a burden for respondents to answer. Thus, for the convenience from the perspective of survey administration and analysis and to get a higher response rate, the current level of classification is understandable. However, to provide more helpful information to policy makers, VET providers, employers and the unemployed, more detailed and specified classification of skills areas should be surveyed.

Table 24. Classification of VET (Ministry of Labour)

Agriculture, fishery, mining	**Textile**	**Chemical, ceramic**	**Metals**
Agriculture Forestry Fishery Food, drink processing Mining Others	Fabric processing Clothing Sewing Shoemaking Design Textile machinery Others	Chemical manufacturing Ceramics Chemical machinery Hazardous materials and gas Others	Metal processing Others
Machinery, equipment	**Construction**	**Electricity**	**Electronics**
Machine manufacturing and assembly Design and drawing Equipment and maintenance Operation Welding, sheet metals Others	Civil engineering Construction Land development Others	Machinery, equipment, control Assembly, manufacturing Power production Electric work Others	Equipment, facilities, control Processing, assembly, repair Others
Information, communication	**Transportation**	**Industry application**	**Craft**
Communication equipment operation Repair system Programming Database Information, communication application Others	Automobiles Shipbuilding Aviation Others	Printing, publishing Design Optics	Jewelry, metal craft Furniture, wood craft, ceramic craft Embroidery Seal Others
Services	**Office management**	**Finance, insurance**	**Environment**
Food services Tourism and accommodations Others	Financial management Human Resources Production Management Sales Trading Office clerks Safety management Others	Finance Stock, insurance Others	Environment management Others
		Medical	**VET by Trainees' level**
		Medical treatment Medical assistant Others	Executive level Manager level Staff level

Source : Ra et al. (2006).

At the national or regional level, it may not be possible to have a comprehensive survey that asks specific VET needs for all industries. Sector Councils seem to be more appropriate for industry specific needs survey and monitoring. Sector Councils Human Resource Development (SCHRD) was established to identify and monitor the skills change and TVET needs in selected industries. In 2003, with financial support from Ministry of Education & HRD and Ministry of Industry & Resources, three SCHRDs started to work: machinery SCHRD, electronics SCHRD, and e-Biz SCHRD. In 2005, seven more SCHRDs were organized: steels/heavy metals SCHRD, shipbuilding SCHRD, automobile SCHRD, textile SCHRD, petrochemical SCHRD, semi-conductor SCHRD, and display SCHRD. In 2009, new SCHRDs were established in industries including green finance, new renewable energy, global healthcare, ubiquitous sensors, which reflect the current national policy priority for the green economy.

Most SHRDs have been run by the business association of each industry. SCHRDs are expected to analyze the current situation of HR supply and demand and to figure out skills needs for each industry. By analyzing the information collected through SCHRD, SCHRD industries can develop VET programmes that are in need by the industry and strengthen the linkage between education and industry. For example, in 2008, the SCHRD of automobiles administered the training needs survey and conducted a job analysis related to the frontline workers of intelligent eco-friendly automobile production. However, the survey did not asked about skills needs or skills change directly but asked workers shortage or surplus at 2 or 3 digit occupation codes. From this kind of survey, it is not easy to directly utilize the results for VET programme development. Green job related SCHRDs are planning for the skills needs survey and VET needs survey. However, it is too early to find results for those surveys. Nonetheless, it is promising that those green sector SCHRDs will be able to provide more detailed information on skills and training needs in emerging green industries. In addition, the older SCHRDs in traditional sectors such as shipbuilding and heavy metals also should pay more attention to the skills change due to the green economy and environmental challenges. The traditional SCHRDs should play a more active role in identifying skills changes and helping their employees to prepare for these changes.

Since there has not been a strong culture of the partnership between industries for VET and due to a short history of business associations, most Sector Councils have a long way to go to provide the comprehensive and concrete information on skills needs and man power demand and supply system. Furthermore, they have a challenge to develop effective VET programmes based on the information they collect.

3.1.3 Skills response

VET centers and institutions still provide traditional training courses. It is challenging to locate VET centers to retrain those workers affected by the green growth industry. There are many programmes named green in its course title, but the contents do not necessarily reflect green skills. While the diverse policy measures and strategies have been issued at the national level, it will take a long time to implement the policy at the local training centers and institutions.

In 2009, Ministry of Labour has initiated a new programme called Vocational Education and Training Reform Center (VETRC). The new programme is trying to provide the VET for identified skills by SCHRD. With support from the VETRC programme, Automobile SCHRD started to develop and provide the skills training

in response to green automobiles and eco-friendly automobiles. In partnership with two extinguished engineering colleges in Korea, Automobile SCHRD created a plan to develop the future generation automobile technicians training programmes, certification of skills of future generation automobile skills. However, the output or outcome of these new programmes is too early to be discussed.

3.1.4 Case studies

Agriculture, fishing, forestry: Redefining and expanding the traditional boundary of the industry and retraining needs

Climate change and global warming have impacted agricultural practices in Korea. For example, the best regions for apple orchards have moved north; the quality of the best selling apples (e.g., Fuji apples) has been degrading due to the increasing temperature; and the cultivation boundary for barley has been shifting farther to the north over the past 40 years. Such changes force farmers to change their main crops in order to adapt to the climate change. The change from the temperate climate to a warm and subtropical climate affect the crops in the region as the crops become more susceptible to disease from blight or harmful insects and to the damages from floods and storms, each degrading the quality of traditionally grown crops.

The fishing industry faces similar challenges. The cold water species such as the codfish and the Alaska Pollack are replaced by the warm water species such as squids and mackerels. Because those warm water species are less expensive in the market than the cold species, the income of the fisheries decreases. In addition, reports have revealed increasing damages by overgrown ocean microorganisms and parasites, and the destruction of sea weeds and algae due to sea desertification. In an attempt to adapt to the changing environment, the ocean ecosystem is changing, which in turn causes changes in the fishing industry.

This change to a warmer climate zone produces opportunities to create and implement innovative changes. Due to a change in the climate zone, double cropping may be possible. High value subtropical crops can bring greater income to the farmers. Also, farmers can increase savings by reducing the heating cost with a green house during the colder seasons. New high value fish or shellfish farming can be an additional income source for the fishing industry. Nevertheless, adaptation efforts to change require appropriate skills and knowledge to best respond to such new changes.

In addition to the climate change, the population of stocks in the agriculture and fishing industry has been decreasing, which is a significant obstacle to overcome when aiming to revive the agriculture and fishing industries.

Due to the increasing aging population of farming households and the accelerated migration trends from rural to urban areas, the number of farming households is continually decreasing. In particular, the number of full-time farmers is decreasing at an increasing rate. Female farmers outnumber male farmers; the number of male farmers is decreasing at a greater rate than that of female farmers.

Table 25. Number of farm households and farmers, 2006-08

(unit: 1,000 households, 1,000 people, per cent)

	2006	2007	2008	Change from the previous year	
				Increase/decrease	Change rate
Number of farm households	1,245	1,231	1,212	-19	-1.5
Full-time famers	785 (63.0)	755 (61.4)	707 (58.3)	-48	-6.4
Part-time farmers	460 (37.0)	476 (38.6)	505 (41.7)	29	6.2
Number of farmers	3,304	3,274	3,187	-87	-2.7
Male	1,607 (48.6)	1,590 (48.6)	1,542 (48.4)	-48	-3.0
Female	1,697 (51.4)	1,684 (51.4)	1,644 (51.6)	-40	-2.4

Source : Rural Development Administration (2008).

The population structure poses a further problem. In 2008, the number of farm households with their manager's age over 70 reached 370,000. This number reflects a 7.1 per cent increase from the year 2007. On the other hand, the number of farm households whereby the manager's age was less than 40 dropped to 24,000, a decrease of 20.1 per cent from the previous year. In addition, the change of life style of consumers presents another challenge to the agricultural industry. With people's increasing interest in Lifestyle of Health and Sustainability (LOHAS), consumers' demands for better-quality, foods for the improvement of consumers' well-being have expanded at a fast rate. A growing number of consumers prefer eco-friendly organic crops and foods, and expect certain information be accessible by the public in particular that relating to the cultivation, manufacturing and distributing processes as well as the safety and environmental sustainability of the products.

Table 26. Number of farm households by age of the farm manager

(unit: 1,000 people, per cent)

		Total	Less than 40	40~49	50~59	60~69	Over 70	Over 65
2007		1,231 (100.0)	30 (2.5)	156 (12.6)	291 (23.7)	408 (33.2)	345 (28.0)	572 (46.5)
2008		1,212 (100.0)	24 (2.0)	138 (11.4)	283 (23.3)	397 (32.8)	370 (30.5)	583 (48.1)
Change from the previous year	**Increase/ decrease**	-19	-6	-17	-8	-12	25	11
	Change rate	-1.5	-20.1	-11.2	-2.9	-2.8	7.1	1.9

Source : Rural Development Administration (2008).

Farmers need to be prepared to respond to climate change and consumers' demands. For example, agricultural practices are becoming more systematic

incorporating advanced information and engineering technologies. The Global Positioning System (GPS) and the Global Information System (GIS) have been introduced to manage precise farming such as locating harmful insects, estimating crop yields, and managing appropriate water supplies. Plant factories are now being built to provide the most appropriate artificial growing environment and automate the whole production process using LED, an environment control system, as well as a robot controlled system. Such changes require new skills and knowledge on engineering and technologies which traditional farmers are not equipped with. In turn, this raises the possibility that well educated people in farming areas who previously migrated to cities for better jobs, may stay in the farming areas applying their knowledge to newly advanced agricultural practices. This implies that curricula for agricultural high schools and colleges should reflect this demand for advanced technology uses in agriculture.

Organic farming receives greater attention as an alternative farming method to conventional farming. Organic farming leads to the creation of new jobs such as those involving organic farming consultation, organic product certification, environment impact evaluation, and laboratory analyses of soil, water, atmosphere and alternative products for fertilizers and pesticides.

The agricultural industry is now expanding to include broader work profiles. The creation of new jobs in rural areas is evident through social enterprise programmes in agricultural areas. This can create jobs for part-time farmers and families of farmers providing an additional income source while at the same time providing public and social services to the rural regions. There was a total number of 251 social enterprises (SE) certified by the Ministry of Labour (July, 2009). Of these, 44 SEs are making and selling lunch boxes and side dishes using organic products and four SEs are working to promote organic farming. Other SEs in the agricultural regions are involved in the development of land and reservoirs for eco-tourism, fostering organic farming and restoration of native crops, school lunch catering projects using organic products, install and operating facilities that produce energy from livestock excretions, etc.

[Case 1] Heuksalim: Expanded opportunities for farmers - Agricultural social enterprises and organic farming

Heuksalim[10], a non-profit organization, is running an exemplary social enterprise that is closely linked to organic farming. Since its establishment in the early 1990s, Heuksalim, which means *revive the earth or soil*, promotes organic farming through research and development, production of organic fertilizers, usage of eco-friendly pesticide organisms, consultations for organic farming, and education and training programmes on organic farming. In addition, Heuksalim certifies organic products through laboratory analyses and field monitoring processes. More recently, Heuksalim has launched a social enterprise and obtained financial support from the government. Heuksalim's social enterprise employed 60 people in three regions: Goisan, Cheongju, and Cheongwon. The employees work in four areas:

(a) Some works for the organic farm that Hueksalim's SE runs. Low income farmers are working in this farm to learn about organic farming skills and eco-friendly native crops, and produce organic products and organic seedlings that can be grown in urban farms;

[10]http://www.heuk.or.kr/

(b) Heuksalim's SE also networks with local schools to supply organic products and foods for school lunch, which can be a very steady business for a long run. In addition, Heuksalim's SE also involves sorting and packaging organic products, which can add more value to raw products;

(c) Heuksalim's SE organizes farmers' market where local farmers can directly sell their products to final consumers without additional distribution processes. Farmers' markets open in different locations including even large companies, governments, or other organizations. At the farmers' market, they provide a short education and training session for non farmers who would like to have a small organic field or garden next to their house in urban areas;

(d) To expand their organic lunch catering business to more organizations such as Day-care centres, kindergarten, universities, Heuksalim's SE partners with related institutes and organizations.

The case of Heuksalim's SE shows that SEs can not only create jobs for low income farmers to have additional income but also provides educational opportunities whereby employees can develop new skills and knowledge. Employees will be able to build competencies through educational initiatives including on-the-job training on advanced farming and auxiliary high-value business such as sorting, packaging, and direct distributing. Heuksalim also runs various education programmes on organic farming from basic introductory level to advanced seminars. There are many other education programmes provided by governments or universities, but those programmes often do not recognize discrepancies between theories and practices. On the contrary, because Heuksalim originates from practice, its education programmes are reported to be more practical and applicable.

[Case 2] Forest tending projects: Green New Deal Projects

The Korea Forest Service announced that 66,487 new jobs in the five areas will be created in 2009. The forest tending programme was launched in 2005 and is continuously increasing its budget and jobs. Since the Green Growth announcement, the budget for the 2009 Forest Tending Programme has doubled from the previous year. The Forest Tending Programme creates jobs for low-income and unemployed youth. If there are many applicants for those jobs, priority will go to people with relevant qualifications or work experience. Otherwise, prior credentials are not required for those jobs created by the public forest tending programmes. All of the workers in this programme are required to attend an introductory education and training course before participating in the programme and additional training sessions throughout their participation. Introductory education and training courses cover theories and practices about the purpose and objectives of forest tending, forest tending techniques, machinery operation techniques, safety management, etc. The courses take place over a two-week period and the course fees are subsidized by the government. Table 27 illustrates emerging green jobs programmes related to forestry and the major outcomes of each programme.

Table 27. 2009 Green jobs related to forestry

Area	Sub programmes	Major outcomes	Created jobs (person)
Cultivating Forest Resources	Forest tending	136,000 ha	31,825
	Afforestation, cultivating the seedlings	19,000 ha Afforestation Produce 36 million seedlings	1,030
	Forest restoration	Beakdoo mountain range 11ha restoration	95
Maintenance of green space and forest services	Maintenance of hiking paths	Maintained 350km hiking paths	319
	Mountain eco-village construction	99 Villages under construction	402
	Arboretum, museum development	23 Arboretums and 7 museums are either open or under construction	130
	Urban forest, eco-forest development	270 Urban forest (26km)	730
	Forest service helper	Provided green services	8,502
Expansion of Forest Biomass collection	Biomass collectors	Collected 300,000 ton	4,246
	Biomass utilization	Produced wood pallets 1,869 ton	300
National Disaster Prevention	Fire prevention and control	Spatial distance(234 locations) construction	46
	Forest disease and insect extermination	60,000ha Implementation	12,290
	Debris barrier foundation construction	473 debris barrier Forest road 123km	6,064
R&D support	Foreign resource development and internship	Foreign afforestation 6,400km	130
	R&D	Advanced human resources development	378

Source: Korea Forest Service (2009).

Table 28. Budgets and number of social jobs in forestry

(unit: million KWN, person)

	2005		2006		2007		2008		2009	
	Budget	Jobs	Budget	Jobs	Budget	Jobs	Budget	Jobs	Budget	Jobs
Total	**22,412**	**2,096**	**37,152**	**3,595**	**198,472**	**14,759**	**279,253**	**20,923**	**506,791**	**38,266**
Forest tending	**22,412**	**2,096**	**33,454**	**3,028**	**155,000**	**10,069**	**221,095**	**14,608**	**421,237**	**30,224**
- Expert forest tending programme	-	-	-	-	114,799	6,588	167,051	8,958	226,751	12,545
- Public forest tending programme (social jobs)	22,412	2,096	33,454	3,028	40,201	3,481	54,044	5,650	194,486	17,679
Promoting forest services	**-**	**-**	**3,698**	**567**	**43,472**	**4,690**	**58,158**	**6,315**	**85,554**	**8,042**
Forest service helpers	**-**	**-**	**2,358**	**437**	**11,028**	**895**	**14,977**	**1,597**	**19,198**	**1,556**
- Mountainous district specialized monitoring	-	-	-	-	-	-	1,284	107	1,241	113
- Mountain eco-village operation managers	-	-	-	-	-	-	531	58	905	90
- Forest commentators	-	-	327	113	2,294	167	4,195	319	4,888	341
- Forest ecosystem managers	-	-	507	156	2,110	153	2,684	557	3,154	240
- Forest path examine managers	-	-	644	41	4,837	399	4.065	357	4,615	377
- Mountain climbing guide	-	-	-	-	269	18	-	-	1,125	88
- Arboretum coordinator	-	-	392	32	508	47	631	60	797	72
- Urban green zone managers	-	-	488	95	1,010	111	1,587	139	2,473	235
Forest protection and reinforcement	**-**	**-**	**1,340**	**130**	**32,444**	**3,795**	**43,181**	**4,718**	**66,356**	**6,486**
- Forest protection watchman	-	-	1,340	130	32,444	3,795	43,181	4,718	66,356	6,486

Source: Korea Forest Service (2009).

Compared to the forest tending programme, a majority of the education and training programmes for forest services are short and targeted for people with related experiences or prior knowledge in the field.

Table 29. Education and training for forest services

Programmes	Level	Institution	Education periods	Subjects	Number of participants
Forest commentators	Intro	Institute for Forest Human Resources Development	3 days	- Forest ecosystem commentary, forest and human - Emergency treatment, customer service - Climate change and its impact on forest - Forest commentating techniques, tree identification and classification	372 in 2008; 183 in 2009
	Advance		3 days	- Understanding and commentary of forest ecosystem - Commentary and interpretation of a topic programme - Climate change and its impact on forest - Forest commentating techniques	
Forest path examine managers	Intro	Institute for Forest Human Resources Development	3 days	- Mountain climb introduction, accident prevention - Policy related to mountain climb - GPS utilizing techniques and forest path examination methods	328 in 2008 (216 intro; 112 advanced)
	Advance		3 days	- Mountain climb introduction, accident prevention - Policy related to mountain climb - Monitoring methods	
Mountain climbing guide	Intro	Institute for Forest Human Resources Development	3 days	- Mountain climb theories and practices, accident prevention - Policy related to mountain climb - GPS utilizing techniques and map reading techniques	78 in 2009
Arboretum coordinator	Intro	Institute for Forest Human Resources Development	3 days	- Design and construction of arboretum - Plant management techniques, plant identification and classification - Plant collecting theory and practice - Greenhouse plating management - Botanical specimen making - Understanding trees in warm temperate climate zones	57 in 2008, 64 in 2009
Urban green zone managers	Intro	Institute for Forest Human Resources Development	3 days	- Policy on urban forest and foreign cases - Related laws and green zone management planning - Understanding and identification of trees and plants - Urban forest management	130 in 2008, 36 in 2009
Mountain eco-village operation managers	Intro	Institute for Forest Human Resources Development	3 days	- Understanding of mountain eco-village construction programme - Mountain eco-village operation and management - Role of managers, communication - Public relations activities, marketing strategies	57 in 2008, 75 in 2009
Mountainous district specialized monitoring	-	Practicum	-	- Field practicum for programme managers - Safety and customer relations	

Programmes	Level	Institution	Education periods	Subjects	Number of participants
Forest ecosystem managers	-	Practicum	-	- Field practicum for programme managers - Safety and customer relations	
Forest protection watchman	Intro	Forestry association main office education departments	1 week	- General forest protection issues - Forest machinery, accident prevention	1,910 in 2008, 1,579 in 2009

Source: Korea Forest Service (2009).

[Case 3] Jobs in environmental industries

Compared to other industries such as IT or automobiles, Korea's environmental industry is lagging behind compared to other developed countries. Additionally, a majority of Korean businesses in the environmental industry are small in size with low levels of expertise. Nevertheless, the environmental industry market on a national level has grown rapidly and was expected to reach more than 31 trillion KWN by 2010 as projected in 2004(KIET, 2004). Since 1995, the environmental industry has increased by 11.3 per cent annually. In 2005, the environmental industry contributed to 2.95 per cent of the GDP. There are 25,018 businesses in this industry with a total of approximately 184,333 employees.

While the developed countries are entering the third generation of environmental technology such as environment restoration technology, Korea is still in the stage of the first generation (post-processing) and the second generation (pollution prevention) of environmental technology. Korea's level of related skills is relatively low standing at 40-70 per cent of the developed countries' skill level (Hwang et al., 2007).

Table 30. Category of jobs in environmental industries

Job category	Job profile
R&D researchers	Research and develop technologies at universities or research institutes
Environment managers	Qualified engineers and technicians in environment fields
Environment business managers	Consulting, environment auditing, environment certifying, and LCA analysis
Other graduates from environment related majors	People who took environment related course at 2 year college or universities

Source: Hwang et al. (2007)

Until recently, the overall supply of manpower in the environmental industry had exceeded the demands. In particular, the oversupply of people with advanced degrees was serious problem, because many of the environment-related jobs were low-skilled jobs with poor working environments. Since the total market size of the environmental industry was small and environmental consciousness of employers had been low, employment opportunities for graduates was limited.

Table 31 shows supply and demand prospects of employees in environment industry by educational level. This was forecasted in 2007 before the Green growth plan was announced. Thus, we can expect some changes in this prospect.

Table 31. Supply and demand prospects of employees in environment industry by educational level

(unit: person)

		2008	2009	2010	2011	2012
Total	Supply(A)	4,919	4,926	4,907	4,890	4,872
	Demand (B)	3,278	3,406	3,481	3,375	3,589
	A-B	1,641	1,520	1,426	1,515	1,283
2-year college	Supply	856	811	766	721	676
	Demand	569	565	548	490	507
Undergraduate level (4-year university)	Supply	2,593	2,628	2,639	2,650	2,660
	Demand	2,143	2,241	2,308	2,262	2,413
Graduate schools	Supply	1,470	1,487	1,503	1,519	1,536
	Demand	566	599	625	623	669

Note: environment, biology and resources related majors were included

Source: Ministry of Environment (2008b).

The number of graduates from environment-related departments was expected to decrease continually (a decrease of approximately 1,000 graduates annually). This seemed to be due to a low-income and hard working condition as well as low level of the market demands. Approximately 54 per cent of environment specialists worked in small and medium size companies (10-49 total employees). There was a lack of participation and interest in the environment from the large companies.

The green growth initiatives called for close attention to environmental industries. Demands for new jobs and occupations increased and new training and retraining programmes were initiated. With the support from the Ministry of Environment, several education programmes for environmental specialists were launched. There are two examples of education programmes for the employed college graduates of environmental studies. We interviewed students who participated in the programme and a teacher who organized the programme. First, the "waste-to-energy facility design and operation education programme" for unemployed college graduates, is a special programme that launched to provide opportunities for the unemployed college graduates to further their education in a specific area and improve their chances to find a job. The programme is organized by a six-week classroom study followed by a one week practicum with related companies. For this session of the programme, there were 25 students enrolled. Fifteen students were environmental majors and the other students majored in chemical engineering, civil engineering, etc. Out of 25 students, nine students had previous working experience and enrolled this programme to find a better job. Others had no working experience. Students perceived that the curriculum this programme offered was able to provide competitive knowledge and experience. Moreover the current global and national interest in environment was one of the main reasons why the students chose this programme. The students expected the environmental field would have a promising future. They were interested in this new field of study, which they were not exposed in school. However, the students all agreed that a six-week curriculum was too short to cover the whole area. They felt they only scratched the surface of the area and need further training in the field. Because this was the first cycle of the programme, the curriculum and a linkage to

a concrete job opportunity was not clear to the students. The programme has room for further improvement including support for students to find a job in related fields.

Another example is the "GHG management specialist education programme." This is a government funded education programme to develop specialists in GHG management and consulting. The programme consists of 180 hours (6 hours/day for 6 weeks) and 30 to 35 students per session (with a total of six sessions offered in 2009). Tuition is free of charge to students. The curriculum covers an overview of climate change, global trends, emission trading, Clean Development Mechanism (CDM), CO_2 emission analysis, and so on. Classroom lectures and practicum are combined. The instructors for this programme include professors, researchers and practitioners in the field. Students were particularly satisfied with the fact that the curriculum includes not only basic theories but also opportunities for hands-on exercises where students are able to work with a real dataset. Students also work as a team to solve authentic problems in the classroom. Students were from various academic backgrounds and had a chance to learn from each other, because the topic and contents of the programme were interdisciplinary. Since environmental study is a very broad area, the graduates of the environmental study told us they covered so many topics in a narrow depth. Thus, they felt this GHG management specialists education programme offered an opportunity for them to focus on one area of the environmental studies. The students interviewed indicated that the recent green growth initiatives increased their awareness about this topic and they felt there would be more jobs created in this area.

This programme was intended for unemployed college graduates to be better prepared for prospective jobs. However, current employed workers were also able to enroll in the programme. Most of them were in charge of GHG management or CDM-related tasks in their workplace and needed to have more knowledge and understanding of the field. Those currently employed told us that what they had learned in school was not specific enough for them to apply it in practice. Thus, they felt they need for further training or retraining in this emerging area, but the opportunities for further study is limited. Thus, they were satisfied with this programme. These two specialist education programmes for specific areas are examples that identify areas where people can be retrained or further trained in addition to their conventional study in schools, with which the students' job competitiveness may be limited.

Along with the GHG management specialist education programme, the Centre for Employment Consultation is established to provide customized employment advice for students who participated in this education programme. Although job openings for graduates of the GHG programme are limited, the students remain optimistic about the prospects in obtaining GHG management specialist occupations. A stronger linkage between the education programmes and job opportunity should be enhanced and partnership with related businesses with TVET programmes needs to be expanded.

For the development of the advanced level workforce in environmental studies, the government launched five specialized graduate schools in the area of climate change. Each specialized graduate school received 150 million KWN per year for ten consecutive years in the following five areas.

Table 32. Education and research contents of specialized graduate schools for climate change

Specialized areas	Education and research contents
National GHG emission statistics	National GHG emission index development National GHG inventory development GHG statistics and database development by industries
GHG mitigation strategies	Kyoto mechanism research GHG emission reduction strategy development Reduction strategy cost/benefit analysis
Climate industry management strategies	Development and evaluation of Enterprise's competitive climate adaptation strategies
Climate change impact evaluation and response measures	Climate change monitoring and weakness evaluation Research on characteristics of future climate threats Climate change response strategy development
Carbon market and global agreement	Emission trading, CDM, JI CO2 funds, Climate finance Global agreements and responses

Source: Environmental Management Corporation (2009), http://www.emc.or.kr/

The objectives of these specialized graduate schools are to educate students in advanced levels who are equipped with knowledge and skills that are required to better respond to the recent climate change. As we discussed earlier, the supply of graduate level students in environmental studies exceeds the current and future demands. Thus, these specialized graduate schools can provide a new opportunity for students who studied conventional environmental studies to expand their knowledge and skills to a new area. The crucial issue to consider is, however, to what extent the job market for these graduates will expand in the near future. The recent green economy and response measures to the climate changes create more jobs in such as GHG management, carbon trading, and eco consulting areas. The specialized graduate schools and specialist education programmes will produce people with relevant knowledge and skills for the new jobs. However, it is unknown the estimated size of a prospective market for these specialists.

3.2 New and changing skills needs

3.2.1 New green collar occupations

Korea Employment Information Service (KEIS) published a list of 55 new generation occupations in Korea. These new generation occupations, which correspond to the Future Growth Engine projects, are organized by the following three areas: green technology industry, advanced convergence industry, and high value service industry. The green technology industry category is most relevant to green growth. These new occupations are expected to gain in popularity in the future. This list of new occupations is not included in the current National Standards of Occupations as the statistical data on these new occupations and related jobs are not yet available.

Table 33. Green technology industry

Category	Prospective occupations	Main job description
New and renewable energy	Solar photovoltaic researcher & developer	Thin film solar cell material design and development; Solar cell module research; Solar cell related production equipment and facility research and development
	Marine bio-energy researcher	Improvement of ocean species(such as seaweeds) for mass production; Enzyme technology appropriate for seaweeds and refining seaweeds to energy technology research
	Geothermal system development Engineer	Design and development of geothermal core technology such as heat exchanger & heat pump
	Wind Power researcher and developer	Research and development of machinery, electricity and control device for wind power
Low-carbon energies	Carbon Capture and Storage researcher	In order to mitigate environmental impact, capture and store CO_2 gases which are released from fossil fuel combustion using wet Flue Gas Desulfurization (FGD) process, flue gas plasma discharge technology, CO_2 separation technology and developing related products
	Greenhouse Gas Auditor	Register and manage CDM (Clean Development Mechanism) programmes in workplaces; conduct inspection and audit process to prepare the Kyoto Protocol
Water management	Seawater Desalination researcher	Design and building plants that desalinize seawater
	Advanced water treatment researcher	Treat and clean water with small energy; sustainable water supply despite climate change
LED applications	LED device engineer	Research and develop LED elements that emit new wave length lights by using the characteristic of LED which emits different wave length lights based on the type and composition of materials(semi conductor)
	LED lighting system engineer	When replace existing lights with LED lights, evaluate light characteristics, replacement appropriateness, effectiveness, usefulness
	LED Thermal Protection system engineer	Research and develop system that protects the damage of heat sensitive semiconductor by eliminate heat from the LED's electricity to light process
Green transportation system	Hybrid Fuel Cell researcher and developer	Develop Fuel Cell for hybrid automobiles; research and develop batteries that store electric energy from Fuel cell.
	Hybrid Power System developer	Develop the power system for hybrid automobiles when operating by electricity
	Maritime environmental regulation specialist	Monitoring international maritime environmental regulation standards; consult ship design and ship building engineers about international maritime environmental regulations
	Developer of Alternative fuels for ships	Develop alternative fuel (such as alcohol, Dimethyl ether (DME) that can be used for ships without air pollution
	Eco-friendly Ship designer	Design eco-friendly ships by analyzing international maritime environmental regulation and potential air pollution generated by ships

Category	Prospective occupations	Main job description
State-of-the-art green city	U-city (Ubiquitous City) planner	Planning convergence between IT techniques and city functionality of U-City
	U-city Infrastructure Operator	Manage U-city infrastructure for stable and continuous U-city functionality with proper IT infrastructure (communication network, IT equipment and facilities) operation
	Building energy consultant	Consult construction techniques, building materials, equipment that enhance energy efficiency

Source : Korean Network for Occupations and Workers (2009), KEIS. http://know.work.go.kr

Table 34. Advanced convergence industry

Category	Prospective occupation	Main job description
Broadcasting and telecommunication converging technology industry	Telecommunications Engineer	Wired and wireless communication network design, construct, and manage; Research and operate voice, data and broadcasting related communication techniques, protocol and equipment
	UI (User Interface) researcher	Develop UI (User Interface) that uses can easily interact with computer and other devices
	HCI (Human Computer Interaction) consultant	Research and develop technologies that create human-centered environment by designing computers, mobile phones, and digital TVs
	Internet Protocol Television (IPTV) image processing specialist	Converting the existing contents of TV and VOD to fit to the IPTV terminals
IT converging technology system	System Semiconductor researcher and developer	In order to produce system semiconductor (System on Chip, SoC), construct semiconductor production facilities, analyze defect cause and treatment, and testing pilot products by applying knowledge of electron theory and principles of equipment operation
	RFID systems engineer	Design and develop a series of the system including tag, reader, middleware that consist of RFID
	RFID Equipment Technician	Design and develop equipment including tag, reader, middleware that consist of RFID
	Embedded technology engineer	Design and develop hardware and embedded systems for home appliances, automobiles, mobile phones, and wireless network; programming operating system and command system
Robot applications	Intelligent Robot researcher and developer	Research and develop intelligent robots which recognize external environment by itself and operate autonomously by judging the situation
	Emotional robot specialist	Develop robots that operate most effectively and efficiently according to human intention by researching Human-Robot Interfacing
	Robot perception technology researcher	Enabling robots to recognize objects or locations that the robots need to respond to by providing the robots with information on external environment
New materials & Nano fusion	Nano project planner	Analyze patent trends related to nano technologies, analyze nano technology market and information, related project planning and management, develop strategies for business and research direction

Category	Prospective occupation	Main job description
	Nanomaterials researcher and developer	Research and develop nanomaterials such as nano film, nano ink, nano technology applied fabric, and display core materials
	Nanodevices researcher and developer	Research and develop nanodevices such as nano chips, D RAM, land flash, etc.
	Nano based technology researcher and developer	Research and develop devices and production equipment of nano measurement such as nano disease technology, industrial ink-jet printing technology, nano related manufacturing technology
	Nano Products researcher and developer	Develop nano technology applied products in bioengineering, environment, energy fields such as bio diagnostic test, cosmetics, nano–spray, nano-filter, antimicrobial agent, etc.
Biomedicines/Bio-resources and medical devices	Specialist in bioinformatics	Research and develop the systematic collection, management and processing bio-related data and information based on the purpose
	Biometric measuring device developer	Develop devices that keep monitoring and diagnosing biological data such as breathing, blood sugar, heart beats of the old and feeble people who are vulnerable to disease and send the analyzed data to doctors or health service personnel.
High value-added food industry	Fusion Food developer	Research and develop recipes of the world and develop new menu which can attract foreigners' taste
	Functional Foods researcher	Design foods which can control biological rhythm and bio defense system, disease prevention and recovery

Source: Korean Network for Occupations and Workers (2009), KEIS. http://know.work.go.kr

As listed above, many of the new occupations require a high level of education and skills. Therefore, the role of universities (in particular for graduate programmes) and research institutions as educational organizations is critical to develop human resources for these new occupations. Colleges and universities must restructure the curricula and department system in order to adapt to these changes. Some may choose to revise the current curricula by incorporating green technologies into existing programmes, and others may create new departments or programmes to specifically target the emerging demands.

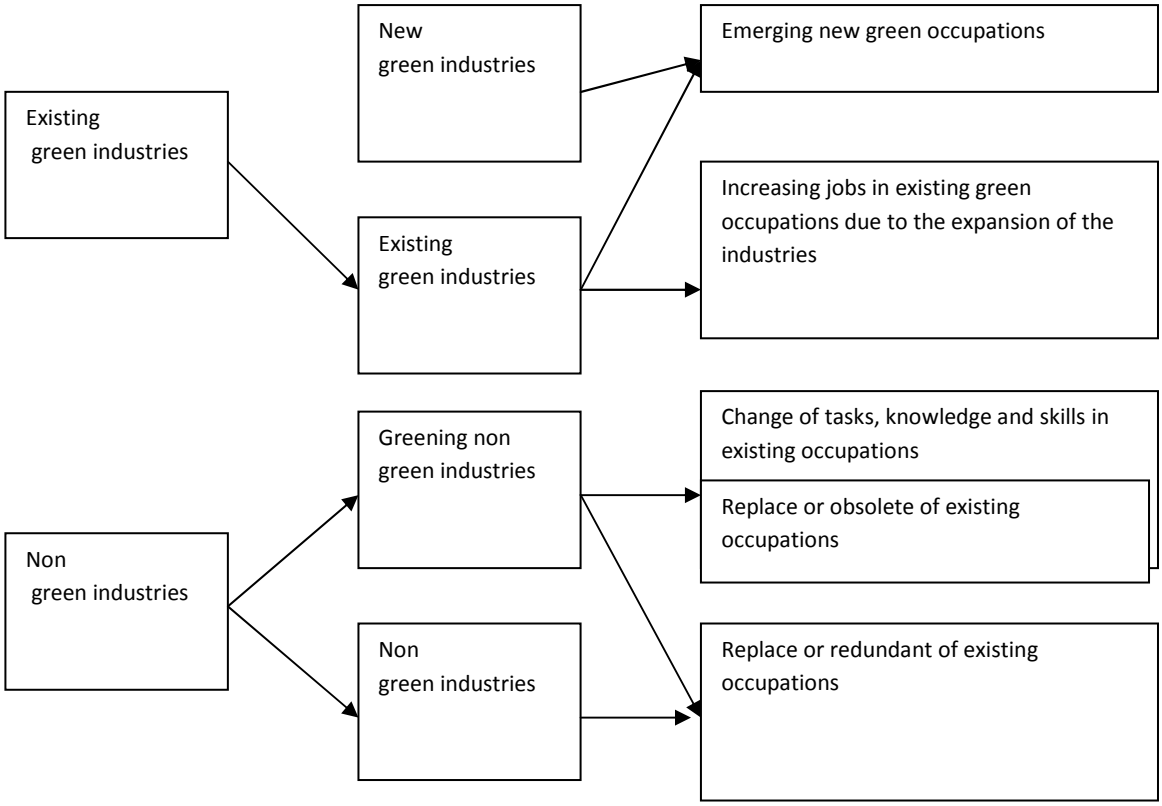
Additionally, continuing education and training for current employees are becoming crucial. New or restructured industries create new jobs requiring different skills and knowledge. However, employers cannot replace all existing employees because of their change of focus in business. In general, to educate and train current employees to adapt to changes is often a less expensive and more efficient method in comparison to recruiting, training, and hiring new employees with targeted skills and knowledge on green technologies.

3.2.2 Greening existing occupations

The Green Growth Committee summarizes the four types of labour market changes due to the green growth as follow. First, in some occupations in existing green industries, the required tasks for the occupations would change but the number of jobs will increase due to an expansion of the related industries; such as nano materials researchers, agricultural environment consultants, environmental engineers, marine biologists, etc. Second, in some occupations, required tasks, knowledge and skills will change. The examples of greening occupations include architects who require more knowledge and skills in eco friendly design and construction, heating engineers who require skills for more efficient energy saving

and heating system, and accountants who require better understanding the costs and benefits of environmental facilities, equipments, and processes. Third, new occupations will emerge due to the green economy. Examples include hydrogen cell researchers, solar photovoltaic system developers, geothermal system engineers, carbon brokers, etc. Forth, there will be occupations that will be replaced or obsolete such as fossil fuel mine workers.

Figure 9. Change of occupations in labour market due to the restructuring of industries



Source : Presidential Committee on Green Growth (2009b).

Transportation and construction seemed to be the two main sectors that require most greening the existing occupations and tasks, because these two sectors will be affected the most by the new energy and environmental regulations and policy measures. Transportation is the sector that produces the most amounts of CO_2 emissions. There are many measures to reduce CO_2 emissions from transportation, such as promoting public transportations, bike commutes, modal shift, and green logistics. In particular, research and development eco friendly automobiles are being accelerated. It is estimated that prospective demands for workers in hybrid automobiles maintenance, charging stations, mitigating automobile pollution specialists will gradually increase. Construction is another sector that requires extensive retraining for their workers since many energy efficient systems will be required and new energy regulations will be enacted.

There are several government support strategies proposed to enhance skills and competencies of green workers in industries that become greener. The government will support training costs and income subsidies for businesses which provide their workers with training opportunities to prepare for job changes. The

retraining programmes for the middle level technicians and engineers who are currently working in automobiles, ship building, petroleum chemicals, and textiles will be particularly enhanced. For example, by 2012, there is a plan to provide specialist training programmes for 500 workers in small and medium automobile parts manufacturing businesses.

Green skills alliances between large enterprise, universities, and small and medium businesses are encouraged. If the green skills alliances provide green technology specialized training, financial support for facilities and equipment for the training (maximum 1,500 million KWN for three years) and training specialists' income will be subsidized (maximum 120 million KWN for six years). In addition, Green Factory Innovation programmes will be expanded to promote CEOs and HRD specialists' perceptions on the importance of green workplace innovations.

3.2.3 Identification of skill needs

As described 3.1.2, there is no comprehensive system to figure out skills changes and skills need in Korea. In particular, there exists few means to find out skills need for new occupations such as green occupations. So far now, SCHRD is the only official way to determine emerging skills needs. Since 2009, two more SCHRD related to green industry were established; New Renewable Energy SCHRD (NRE SHRD) and Green Finance SCHRD (GF SCHRD). As the one of main missions of SCHRDs is to determine skills change and manpower mismatch, both two SCHRDs will begin to administer skills surveys to their member enterprises to determine skills changes, skills needs and man power mismatch in the industry. The results will be available in late 2010.

3.2.4 Skills response

As described in 3.1.2, the VET Reform Center (VETRC) was launched directly to respond to the new skills needs. NRE SCHRD and GF SCHRD also joined VETRC programmes and thus they will soon provide the skills training programmes in NRE and GF. NRE SCHRD will provide the currently employed workers the vocational training programme for new and renewable energy related skills. It announced the programme and started to advertise it. The programme is composed of short-term training courses (1-2 days) such as solar energy design courses, solar energy implementation courses, earth heat pump implementation courses, new and renewable energy CDM courses, etc. GF SHRD provided green finance investment advising which teach knowledge about green industry trend, risk analysis, comparison of green finance items and social accountable investment etc. In addition, the social accountable investment courses are provided. The courses are composed of introduction of ESG (environmental, social, governance), evaluation of sustainability, SRI finance, etc

Restructuring curricula of Korea Polytechnic Colleges to meet the needs of middle level technicians is another example of skills response of greening occupations. Since 2008, Korea polytechnic college went through major curricula restructuring to respond to the recent green growth initiatives and new growth engine industries.

We conducted an interview with professors who are in charge of this curricula restructuring project at the central level to examine the overall changes and anticipated outcomes. In addition, we visited one of the polytechnical colleges which made a recent curricula change in the energy field. The change was implemented since early 2009. Thus, it was too early to evaluate the impact of

these changes, but at the moment we were able to discuss the rationales for these changes. Korea identifies that the demands for technicians and technologists along with scientists and engineers will gradually increase as the national economy moves towards green growth. In order to develop technicians and technologists who can meet the needs of green economy, restructuring of the polytechnical colleges seem to be critical. To this end, over the next five years (2009-2013), 20 per cent of the existing courses and curricular will be under restructuring process and produce approximately 10,000 technicians and technologists in green industries.

Table 35. Polytechnical college curricular restructuring plans (2009-13)

(unit: numbers, 1,000,000 KWN)

		Total	2009	2010	2011	2012	2012	2013
Number of courses/ department under restructuring	Total	65	13	13	13	13	13	13
	Technicians	50	10	10	10	10	10	10
	Craftsman	15	3	3	3	3	3	3
Expected costs	Total	65,500	13,100	13,100	13,100	13,100	13,100	13,100
	Equipment	59,800	11,960	11,960	11,960	11,960	11,960	11,960
	Facilities	5,700	5,700	5,700	5,700	5,700	5,700	5,700

Source: Korea Polytechnics (2009).

Table 36. Partial list of restructuring curricular of Polytechnical colleges (2009-10)

	Campus	Applied course/department	Related new growth engine area	Level
1	Asan	Information, communication system	New IT	Technician
2	Yeoja	Digital design (semi conductors)	New IT	Technician
3	Mokpo	Shipping, marine system	Transportation	Technician
4	Incheon	Solar cells, fuel cells	Energy, environment	Technician
5	Changwon	CO_2 capture	Energy, environment	Technician
6	Choongju	Solar cells, fuel cells	Energy, environment	Craftsman
7	Daegu	IT convergence system	Convergence new industry	Technician
8	Jungsoo	Electronics	Convergence new industry	Technician
9	Kwangju	Multimedia	Knowledge services	Technician
10	Kangseo	Media contents	Knowledge services	Craftsman
11	Jeju	Electrical control	New renewable energy	Craftsman
12	Hongsung	Electrical measurement and control	New renewable energy	Technician
13	Pusan	Automobiles	Green transportation	Technician
14	Kwangju	New materials application	New materials, nano convergence	Technician
15	Bio	Bio culture process	Bio pharmaceutical, medical devices	Technician

Source : Korea Polytechnics (2009).

In order to apply for the restructuring curricula funds, polytechnical college campuses across the country proposed new courses and curricula based on their

extensive needs assessment of respective industry and local labour market where the applicant campus is located in. In particular, since one of the main objectives of the polytechnical colleges is to provide ready-to-work technicians and technologists upon the demands of local labour markets, the needs assessment of the local labour market must be critical. The prospective businesses where the graduates of the polytechnical colleges would work after graduating the programme are identified in the proposal. In addition, tasks and job analysis of prospective workplaces was conducted where graduates of the programme can be hired. After revising the curricula, the overall application rate for the polytechnical colleges increased by 30 per cent.

For example, the Polytechnical II College Incheon campus changed the electrical measurement and control programme to the electrical energy system programme to meet the recent increasing demands for energy equipments and facilities control technicians. The school revised the main curriculum to cover new renewable energy systems such as solar photovoltaic (SPV), wind power, fuel cells, etc. Also the curriculum enhanced hands-on practice programmes by providing new equipments and facilities of new renewable energy systems. Along with the newly revised initial education for the future technicians, the department also provides training programmes for the current employed in the field using the same equipments and facilities. By revising the curriculum to meet the current needs of the labour market, the department expects to recruit more students and raise the employment rate of the graduates.

3.2.5 Case studies on new green collar occupations

New renewable energy

In the next section, we will explore the renewable energy field to identify opportunities for new green jobs. In new renewable energy, we conducted interviews with managers from major solar photovoltaic companies regarding employers' perspectives and a director of VET programmes for current employees in energy fields about VET for the current employees.

Although Korea is not a frontier in the area of new renewable energy, Korea's global competitiveness of semiconductors and heavy industry is very high and these existing technologies can contribute to the advancement of new renewable energy technologies such as solar photovoltaic (SPV) and wind.

In particular, Korea's technology level for SPV is estimated approximately 90 per cent of the level of technology of the more developed countries. The capacity of SPV power generation facilities in Korea takes about 5.0 per cent of the global market share in 2008.

Table 37. Global SPV power generation facility capacity in 2008

Rank	Country	Capacity (MW)	Global market share (per cent)	USD million (per module)
1	Spain	2,281	41.3	8,782
2	Germany	1,532	27.8	5,822
3	United States	332	6.0	1,262
4	Korea	274	5.0	986
5	Japan	226	4.1	835
6	Italy	162	2.9	583
7	France	95	1.7	352
8	Greece	66	1.2	244
9	China	69	1.3	235
10	Portugal	42	0.8	155
11	India	32	0.6	118
	Others	409	7.4	1,534
	Total	**5,520**	**100.0**	**20,908**

Source: Display Bank (2008).

Because there is little geographical restriction for solar photovoltaic power generation, SPV is considered to be a very promising energy source. However, the production unit price of SPV is still too high to be commonly used. Due to Korea's technological advancement in semiconductors and displays, which share similar base technologies with SPV, Korea's global competitiveness of SPV is quite high at approximately 80-90 per cent despite its relatively short history.

The government financial support for SPV R&D has increased by 35 per cent from the previous year although the government support for expanding national markets for SPV appears to have been reduced. This is partly due to the fact that the policy on exporting SPV R&D technologies to other countries is a priority. The government support for the national market is expected to increase after the level of R&D has climbed up to a certain level.

The Electricity Generation Difference Compensation is a government subsidy to compensate the difference between the price of general electricity and that of electricity produced by renewable energy source which is often more costly to generate. Without this compensation programme, there is little reason or incentive for building SPV generations and installing SPV systems because their installation and management cost is still too high. In addition, since 2004, the government has been subsidizing approximately 60-70 per cent of the installation cost for SPV systems for household use.

Since 2006, the SPV market in Korea has expanded. This indicates that the government’s financial burden has expanded as well. The government expected that the total SPV capacity would reach 100MW by 2011, but the capacity has already reached an approximate 280 MW in 2008. Thus, the number of SPV businesses has decreased slightly in 2009. Nevertheless, the SPV market is still expanding in Korea. To reduce the government’s financial burden for subsidies and other support, Renewable Portfolio Standards (RPS) will be introduced after 2012

rather than Electricity Generation Difference Compensation, RPS mandates that a certain percentage of total electricity production should consist of renewable energy.

Table 38. The number of companies in SPV business

	2005	2006	2007	2008	2009	Total
Number of business registration in SPV specialized area	47	566	914	1,036	969	3,532

Source: New & Renewable Energy Center (2009).

Table 39. Electricity generation difference compensation unit price (2010)

Category	Capacity	Unit price (proposed price)	Decrease rate (%)	Unit price in 2009
Buildings and establishments	Less than 30kW	557.19	5.50	(589.64)
	30kW to 200kW	531.87		(562.84)
	200kW to 1000kW	506.54		(536.04)
Field area	Less than 30kW	506.64	14.09	589.64
	30kW to 200kW	483.51		562.84
	200kW to 1000kW	460.49		536.04
	1MW to 3MW	437.47		509.24
	More than 3MW	368.39		428.83

Source : New & Renewable Energy Center (2009).

Table 40. SPV market growth prospected by SPV industries

	2007	2008	2009(E)	2010(E)	2011(E)
Public mandatory programme	0.8	1.7	2.3	3.3	4.6
Supply support programme	4	1.8	2	2.4	3.1
Regional area supply support programme	4.7	6.5	9.1	12.8	17
1 million Green Home construction programme	9.2	10.5	14.4	18	22
Electricity generational difference compensation programme	29	257	50	70	80
Annual install capacity	47	277	78	106	126
Cumulated total capacity	82	360	437	543	670

Source: Display Bank (2008).

There is a total capacity ceiling that can be supported by the government. Therefore, this support ceiling interferes with further building and installing SPV systems.

Table 41. Capacity ceiling of electricity generation difference compensation

	2009	2010	2011
Capacity ceiling	50 MW	70 MW	80 MW

Source: New & Renewable Energy Center (2009).

Many major companies are still under consideration of investing in the SPV business. SPV technology in other countries is still more advanced than that of Korea. Thus, if major companies want to launch the business of SPV, they first need to invest in R&D to close the technology gap before further investing in the market. In turn, it will take some years before major companies participate in the SPV business market. Until then, most SPV companies remain as small- and medium-size companies.

S-Energy is one of the leading SPV companies in Korea. Its main business includes SPV module manufacturing and system installation with approximately 290 employees. In general, there are four areas of SPV related work: R&D, manufacturing, installation, and marketing. The necessary skills and expertise for each area varies. Under R&D, more advanced levels of educational qualification, often higher than a graduate school level is needed. On the other hand, employees in manufacturing require less advanced level of skills and knowledge. In the area of installation, workers with expertise in civil engineering, mechanical engineering, and electricity engineering are needed. In the area of marketing, people with expertise and knowledge in business or foreign trade are expected. Among the above four areas the demands for system installation workers have shown the fastest increase. Workers for system building and installing will be in greatest demand in the beginning of the early implementation phase; however, later in the process, marketing expertise will be in greater demand. There is no systematic means to identify skills gaps. The company utilizes diverse education and training opportunities such as conferences or invited experts' seminars for their employees to upgrade their skills and knowledge. It is expected that the market will further expand and the demands for manpower will increase well. Thus, the field demands people with necessary skills and knowledge through initial education and training as well as retraining programmes for current employees to learn the new skills.

3.2.6 Case studies on greening existing occupations

[Case 4] The Education and Training Center for Energy Technology, Seoul National University of Technology (SNUT)

The Education and Training Center for Energy Technology at SNUT[11]is a national center that was established through government support to develop higher level researchers and engineers through graduate school programmes, additionally to provide education and vocational training for employees in the energy field including support for on-the-job training. Table 42 shows the budget and the number of people who received education and training through this Education Center programme.

[11] http://www.etec.or.kr

Table 42. Education Centers for Energy Technology Programme

2007		2008		2009	
Budget (million KWN)	No. of participants	Budget (million KWN)	No. of participants	Budget (million KWN)	No. of participants
2,400	3,387	2,050	2,603	2,050	3,400

Source: SNUT (2009).

Table 43. Education Centers for Energy Technology Programme outcomes

	Number of education and training programmes for current employees in the field		Level of satisfaction for the education programme	
	Planned	Accomplished	Planned (%)	Accomplished (%)
2007	3,558	3,852	75	81
2008	2,831	2,727	75	79

Source: SNUT (2009).

The Center at SNUT focuses on energy efficient technology and renewable energy, which include the development and management of new systems, appliances and devices. Major topics at the Center include renewable energy engineering, energy environment engineering (response to climate change), energy system engineering (intelligence building facility system), energy safety (gas explosion prevention and management), and energy policy (global trading and technology agreements).

Many new public and private education centers and institutions have emerged since the government's strong initiative of green growth economy. However, without a systemic human resources supply and demand analysis, and both short-term and long-term prospects, the expansion of educational centers may have pitfalls by causing unemployment in the future. We have already seen the difficulty of the trained people to find jobs in many government-driven training programmes in Korea. Therefore, the overall education system should be adaptable based on the development of the market as well as human resources in the field. To this end, the Center at SNUT is emphasizing the importance of vocational training for current employees in addition to initial education. Since the energy field is very broad and utilizing a converging technology, it may be necessary to study more broadly at the undergraduate level and to specialize one area at a graduate level. Table 44 shows a representative list of education programmes that offered by the Center at SNUT.

Table 44. List of education programmes of the SNUT

Topic	Number of participants
ESCO Manager education	57
UK's strategies and research trends on Energy efficiency and introduction of renewable energy	23
Energy utilization and freezing techniques of ancestors	29
Design factors for eco-friendly buildings and renewable energy introduction strategies	22
Utilizing solar energy techniques in buildings	33
Everyday waste automatic collection and recycling and energy conservation	22
Local heating energy heat pipe networks design and system	26
Hydrogen economy prospects and policy directions	25
Bio engineering to solve energy environmental problems	25
Safety management of City gas facilities	37
Reduction techniques of environmental impacts of buildings	19
High productive LED and lighting techniques for solid lighting sources	21
Future technology of energy and environment	102
Semi annual cooperative conference of Energy and Gas	152
Energy boiler and hear exchanger efficiency	30
Transforming organic resources to energy	64
ESCO education for practitioners	24
Practicum of Fire simulation 1, 2	121
Indoor environment control via ventilation and improving energy efficiency	39
CFD techniques for energy equipments	35
Fuel cell system and energy equipments operation system	34
Machinery equipment in construction development direction	34
Energy circulation equipment and system for multi residential housings	33
Problems and solutions of noise from energy equipments	34
Seminar for developing AMP curriculum and materials	20
Environmental pollutant stabilizing Processing techniques	20
Special lectures for CEOs	13
Korea Associations for Energy Engineering	150
LED lighting practicum	20
Lighting simulation practicum	14
Building energy analysis strategies and simulation for architects and designers	23

Source : SNUT(2009).

[Case 5] Sustainable Building Technology Education Programme at Korea Institute of Construction Technology Education[12]

This is a government-funded education programme by the Ministry of Land, Transport, and Maritime Affairs to foster expertise and sustainable development in eco-friendly construction. Trainees of this programme include university students, graduates who have majored in construction or architecture, and current workers in the field. The full-time intensive curriculum spans over four weeks and covers eco-friendly architecture design principles and theories, sustainable building design, sustainable environment technology and building equipment, sustainable construction technology and resources, and so on. There were three sessions offered in 2009 whereby 50 students participated in each session.

The students applied to this programme because they believe the demands for eco-friendly sustainable building are increasing. In the interview, the participating students addressed how they were able to learn practical knowledge and skills from the programme, which they could not have learned from school. Demands for sustainable building technologies are increasing, but the current university curriculum does not cover these new developments yet. Thus, the students felt that the intensive programme was more responsive to the rapid changes of new technologies and skills.

Nevertheless, the students thought that the employment opportunities could be better supported. Upon completion the programme, students receive a certificate of the programme, but the certificate is not an official qualification that can be valued in the field. The emphasis on the demand for new technologies is a strong aspect of this programme, but the labour market for the students specialized in the Green Building Certification system must change so that these workers can be formally recognized for their skills.

[Case 6] Jobs in LED industry and LED Lighting Technology Education Centre

The LED industry is considered to be a promising industry that can be applied to various other industries to promote energy efficiency.

[12]http://www.kicte.or.kr/

Table 45. LED market size, 2008

Category		Global market (USD100 million)	Share (%)	National market (KWN100 million)	Share (%)
LED optical element		51.9	23.9	6,127	25.1
LED Applied devices	Mobile phone module	67.2	59.7	14,000	67.0
	LED BLU module	3.7		1,000	
	Automobile module	30.4		160	
	LED Display	26.7		1,115	
	others	2		60	
LED lighting appliances		35.6	16.4	1,923	
Total		**217.5**	**100**	**24,385**	**100**

Source: Korea Development Bank Research Institute (2009).

The government implemented various policy measures to expand the LED market throughout various industries including: LED lighting replacement projects in public buildings, international conference halls, subway stations; LED lighting appliances in newly developed cities; LED in green houses; and LED for fishery. For example, as a part of Green New Deal Project, *LED lighting replacement in public facilities project* is expected to create 10,030 jobs (see Table 46). To implement these projects expertise in LED element researchers, LED lighting system specialists, LED heat reduction engineers are in demand. The Ministry of Knowledge Economy expected that 13,000 LED specialists will be needed by 2015.

Table 46. Prospects of LED specialists

	2003	2005	2006	2008	2011	2015
Demand	1,500	3,000	4,500	5,000	7,000	13,000
Supply	800	1,500	2,000	2,700	-	-

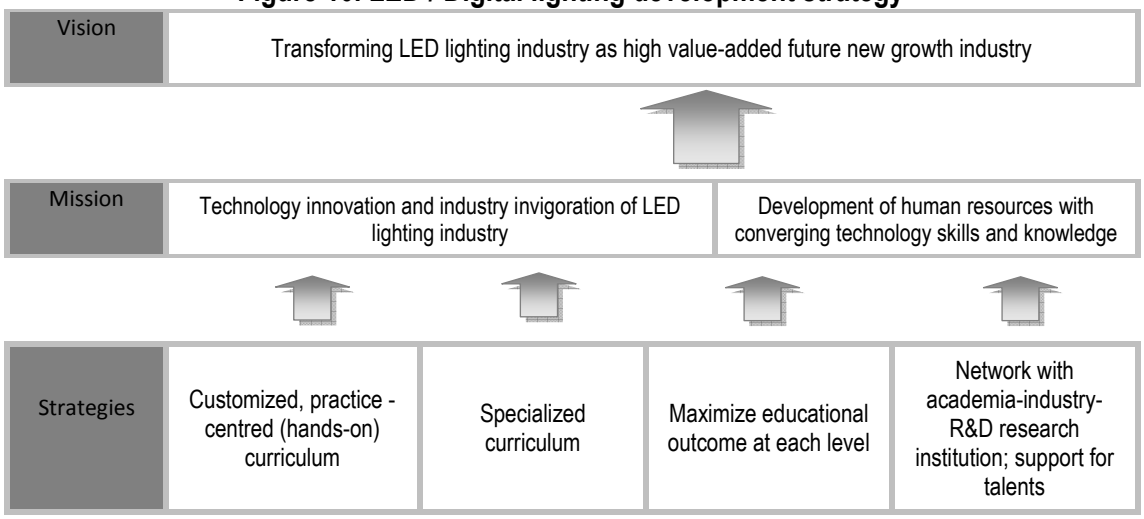
Source: Ministry of Knowledge Economy (2007).

Systematic education for LED specialists is needed but this is challenging to develop and implement in higher education since the nature of the field is interdisciplinary. Such a promising education programme is offered by the Lighting Technology Education Centre (LTEC).

LTEC[13]was established to educate and develop lighting technology expertise in the field as part of the education centre programmes for current employees by the Ministry of Knowledge Economy. The Korea Institute for Lighting Technology and other research institutions collaborated with other institutes to develop this LED Lighting Technology Education Centre which focuses on three areas: Epi chip, Package/Module, and Lighting application.

[13] http://www.ltec.or.kr

Figure 10. LED / Digital lighting development strategy



Source: Ministry of Knowledge Economy (2007).

Table 47. Main projects of LTEC

Specialized education programme	Facilities and equipments	Resources	Specialized Human Resources Database
- Specialized programme to meet industrial needs - Field practice centred customized programme - Technology advice and solutions for bottleneck issues in the industry	- Facilities and equipments that are not readily available in companies - Lighting software	- References on LED lighting application and other lighting sources - Resources on testing and evaluation devices - Reliability analysis data - Resources on test methods and standardization	- Human Resources Database for vocational education for current employees - Human Resources Database for science researchers and engineers - Support for LED lighting expertise

Source : LED Lighting Technology Education Center Homepage (http://www.ltec.or.kr).

LTEC offers various types of programmes such as long-term intensive programmes, short-term seminars, and field practicum to meet particular needs of participants. LTEC conducted education needs assessments and satisfaction surveys of participating industries to determine LED education experiences, challenges and needs. Higher demands are expected for lighting design and LED application areas, which require interdisciplinary knowledge and skills.

[Case 7] Hyundai Hybrid automobile training programmes for maintenance technicians

Hybrid automobile industry of Korea is expected to continuously expand its national market size and the number of employees in the field. By 2015, the employment level will reach 32,923 from 2,012 in 2010.

Table 48. National market prospects of hybrid automobiles industry

	2005	2010	2015	2020	Annual increase rate	
					2005-2010	2010-2020
National market size	8	422	5,174	10,705	123.0	38.2
Production	8	402	9,407	32,114	120.9	55.0
Value added	2	103	2,408	8,221	120.9	55.0
Employment	56	2,012	32,923	80,285	104.8	44.6
Export	0	0	4,703	22,480	-	-
Import	0	20	470	1,070	-	48.8

Source: Hwang et al. (2009).

We interviewed the people responsible for organizing and implementing the company-wide education and training programmes for automobile maintenance technicians in Hyundai. In 2009, Hyundai introduced its first hybrid automobile to the Korean market. As the hybrid automobiles are running in the road, there needs an education and training for maintenance technicians in service centers across the nation. General education about new products, such as the hybrid automobile, is offered across the company including all employees in sales and marketing departments as well as maintenance technicians. In addition, more in-depth education and training about hybrid automobile technologies for the maintenance technicians is offered. At the level of maintenance technicians, the transition to new automobiles like hybrid or fuel cells will not replace the existing workers as the fundamental technology remains the same. Moreover, as the technology advances, the most important competencies for maintenance technicians involve 'diagnosing' the problem and 'identifying' the right module to be replaced rather than 'repairing' the problems or faults. Therefore, updating and upgrading skills of current employees are crucial.

Hyundai works 12 partnership schools including 2-year colleges and 4-year universities. Hyundai communicates with these schools about new skills needs and the schools incorporate these needs into their curriculum. Teachers and professors in these partnership schools also teach the new technologies and skills for current employees.

Table 49. Number of participants of education programme, 2009

	Number of Maintenance Service Centres				Number of technicians			
	Directly managed centres	Designated plants	Related centres	Total	Directly managed centres	Designated plants	Related centres	Total
Hyundai	25	391	1,077	1,493	2,816	7,351	4,523	14,690
Kia	20	252	562	834	1,870	5,368	2,754	9,991
Total	45	643	1,639	2,327	4,686	12,718	7,277	24,682

Source : Unpublished report. Hyundai Education Center.

Hyundai utilizes diverse delivery methods for employee training as shown below. In particular, the company emphasizes the importance of on-the-job training (OJT) and hands-on practice to meet customized needs.

Table 50. Education programme contents and delivery methods

	Recipients of ED programmes	Contents	Delivery methods
Maintenance Education	Technicians (direct management and cooperation centres)	HEV(Hybrid Electricity Vehicle) system principle and maintenance guide emphasizing problem diagnosis technique training	• For all technicians, face-to-face training Online self study materials •E-Learning education (since 2008, 3,450 participated)
Product Education	Sales persons (direct management and agencies)	HEV products and operation education emphasizing customer relations and product sales education	• HEV principles and how to operate HEV • Online self study materials (e-salesacademy.com)

Source : Unpublished report. Hyundai Education Center.

4. Conclusions

4.1 Main 'greening' shifts in economies and labour markets

As Korea has achieved a rapid economic growth over past four decades mostly based on manufacturing and heavy chemical industry, amount of Korea's CO_2 emission increased sharply. Korea did not take environmental problems seriously into consideration while taking a wide stride to the rapid economic development and thus until recently had not been well responded to the international effort for eco-friendly growth. However, in 2008, the Korean government adopted the ambitious national plan for green growth that will achieve harmonious economic growth and environmental sustainability. The Five-Year National Green Growth Plan and Presidential Committee on Green Growth are the representative efforts of Korea's recent political shift to green growth.

It is too early to evaluate substantial impacts of green growth initiatives on the national economy or labour market. However, as one of main objectives of green growth plan is to put green technology development as the new engine for economic growth at national government level, considerable amount of money goes to the R&D area in green technology development. Most green jobs will be created in higher level skilled R&D field. Higher educational institutions began to meet the need for highly skilled human resources in green technology by curriculum reform. From the prospect of green jobs, green-related jobs which include the medium level of the skills will be increased in the near future. Thus, the needs for training and retraining for workers related to green jobs will increase as well. So far, the green growth initiative has been strongly driven by national government level. However, the participation of industry and employees is imperative to continue the green growth initiative.

For the impact of greening on the labour market, it is important to look at Green New Deal, one of the main projects to provide the unemployed with jobs related to greening initiatives. This project is to create almost 1 million green-related jobs by 2012. However, so far, the jobs created by Green New Deal were mostly temporary manual workers such as cleaning or construction and could not be sustainable without public funding. While Green New Deal is a smart initiative to combine the green growth initiative with the strategy to deal with the unemployment resulting from the recent financial crisis, training and employment programmes which can have longer effect on workers' careers should be considered.

4.2 Skills implications and development

4.2.1 Anticipation and identification of skill needs

While it is a rough estimate using 2-digit industry and 3-digit occupation classification, there have been some forecasts of manpower demand and supply in green jobs. It is predicted that green jobs will increase more rapidly than none green jobs. Some industries such as the automobile industry tried to figure out the skills need along with greening economy. However, in Korea, there is no comprehensive information system to identify skills needs in general, in particular green skills needs. Most efforts related to skills needs were limited as they covered only a selected number of industries or used skills classifications that were too broad. In addition, some surveys on skills needs for vocational training programmes were conducted to either trainees or programme providers. Therefore,

it was difficult to collect information from industries. Faced with the problems of identifying skills needs, the Korean government started to build infrastructure for skills needs information.

It is worthwhile to point out the recent effect by SCHRD based government supports for identifying skills needs related green jobs. For green skills development, some sector councils started to determine the skills needs. While sector councils are not well prepared and experienced in skills surveys, SCHRDs will play a major role for identifying skills needs present and the future if some expert research institutions can cooperate with them.

4.2.2 Response policies and programmes

Virtuous circle of green growth and green jobs

The Korean government recently announced 12 policy plans in three areas that will create a virtuous circle of green growth and green jobs creation (Presidential Committee on Green Growth, 2009b).

Area 1. Prepare infrastructure for green job creation

In order to regularly monitor the demand and supply for human resources, the government will produce *Prospect of green human resources demand and supply*, which focuses on skills demand and shortage in green industries. In addition, the government will introduce the *Employment impact evaluation system* to analyze and evaluate the impact of various green industry and economic policies on green jobs.

The government will also support the employee-employer partnership councils at individual workplace level. The councils will collaborate to create green work processes, to improve energy efficiency, and discuss human resources management strategies including vocational education and training and the re-distribution of employees. At the national level, green job partnerships among relevant ministries will be initiated. The Sector Councils expanded to include renewable energy, LED, ubiquitous city, and next generation automobile industries. The Green labour market information system will be developed to collect and analyze information on new green jobs, trends in green job changes, green occupation, forecast the demand of green skills, and to provide this information to the public. The government will continue to monitor new green job creations and assess the value of these new green jobs. Furthermore, the financial and technology support will be increased in order to improve the work environment through a conversion to a green workplace for small and middle size enterprises. The current Work-net, which is an online employment information system, will be restructured to provide employment and training information on green jobs. Additionally, offline employment support centres will provide information on green jobs.

Area 2. Expand vocational education and training for green jobs

Specialized vocational education and training (VET) centres and programmes will be enhanced to include renewable energy, energy efficient, and eco-friendly construction areas.

Also, eco-friendly VET for the unemployed will support a rapid transition to green jobs. The current VET centres for the unemployed are primarily in traditional manufacturing areas, and the number of trainees in green areas is very limited. The

VET programmes for the unemployed will expand to green sectors such as renewable energies, LED, and electricity IT and software. Moreover, the number of green VET programmes and trainers will be increased to prepare for the increasing demands in green skills development.

The government will also provide special financial support for employers who provide VET for their employees to make a better transition from traditional backbone industries (e.g., machinery, textile, ship building, steels, etc.) to green industries. When enterprises, employer associations, and universities form a Green Skills Alliance, specialized training for green technologies, and financial support for facilities, equipments, and personnel expenses will be supported. Green factory innovation will be promoted to utilize in-house green experts as trainers for its employees. Green human resources supply that meets regional local needs will be fostered such as eco-friendly agricultural worker training and development of technicians by local poly techniques. The Korea National Qualification system will also reflect green technologies and greens skills; some qualifications will be revised to include green technologies and other new qualifications such as solar energy engineers will be created.

Area 3. Development of core green talents

The government will invest 1.1 trillion KWN to support the development of core green talents through green technology R&D programmes in converging technology areas such as NT, IT, and BT. Through this investment, 100,000 individuals at the advanced graduate and doctoral level in green technologies will be trained. Various national programmes including the World Class University programme, World Class Institute programme, specialized graduate school programmes, and regional specialized research centre programmes will emphasize areas such as global climate changes, green energy system, hybrid energy harvesting, etc. In addition, green service areas such as green consulting, green finance, green management, CDM, and Carbon emission trading experts are receiving more attention. Furthermore, green career guidance and career education for K-12 students will be enhanced and new curricula for green growth education is in the process of development.

4.2.3 Effective delivery mechanisms

Diverse delivery mechanisms can be utilized for green skills developments including short-term training courses and seminars, and formal education system such as specialized graduate school programmes. Short-term (e.g., less than a month) TVET courses have flourished in response to the government's initiatives towards green economy. For some areas, these short term course are enough to learn new skills or upgrade existing skills for greening occupations. On the other hand, more systematic long term education and training are needed in other areas. E-learning is an effective delivery mechanism as it can be simultaneously offered to a large number of trainees. It can be a good introductory course for a new topic. Nonetheless, e-learning would not be suitable to train skills that require hands-on practice and exercises. Effective delivery mechanism for green TVET should be identified based on the learning objectives and characteristics of learners and the contents of learning.

5. Recommendations

5.1 Policy recommendations

As described so far, recently the Korean Government has started to develop and implement concrete policies and strategies for green growth and the green industry and market, but these are not yet fully operational in the field and it is still too early to discuss any outputs and outcomes. Thus, the number of green jobs and green-related jobs is marginal. Furthermore, the Korean Government has begun to paying greater attention to skills development; however, there are too few concrete policies which specifically target to support skill development in green jobs. Based on our review of green job policies and the current skills development programmes, we recommend the following issues to be addressed.

5.1.1 Integrating approach for greening economy and the importance of educating green competencies for all

In Korea, the recent green growth initiative was strongly driven by national economic growth motive and by the government. The main focus is on economic growth by advancing green technology such as technology for renewable energy, technology for hybrid automobiles, etc. However, the ultimate goal of the greening economy is to achieve sustainable development (SD). SD is the development to increase the social inclusiveness as well as economic growth without destroying the environment. Green growth initiative focused only on green technology must be very limited considering the comprehensiveness and balance of sustainable development and in some cases, it may have conflict with environmental policies. In this sense, the current green growth initiative of Korea should try to integrate the experience and knowledge of environmental policies and the practice of NGOs' or civil organization related to environment movement. As can be seen in the members of the Presidential Committee on Green Growth which includes few environmental NGOs activists, there is a lack of integration of green growth initiatives and environment protection as well as a lack of effort to integrate a top-down approach and bottom-up approach.

In terms of green jobs creation, coordinating a top-down and bottom-up approach becomes more important. As in the example of organic farming social enterprises, Heuksalim shows that the bottom-up approach can create green jobs in effective and feasible ways by being able to figure out the demand in a real context.

To pursue sustainable development, it is imperative to educate green competencies for all members of society. Green competencies include basic knowledge and skills about environment protection, environmental awareness and respect for environment. Most education and training by environment organization has focused on the green competencies. Thus, coordinating with the effort of environmental movement may provide a ground for skills response for the greening economy.

5.1.2 Strengthening information infrastructure related to green jobs and green skills

Green jobs and green skills are emerging concepts. Stakeholders including policy makers agree on the importance of green initiatives as a response to the global climate change and recent economic crisis, and they understand the need for creating more green jobs. Nevertheless, relevant information and data are very

limited at this point. The current information and data system does not reflect "green" aspects. In order to develop and implement effective policies, we need strong supportive evidence. We need to restructure and enhance the national information infrastructure related to green jobs and green skills. How many green jobs will be created? Which industries and sectors will be in need of green jobs? What is the current state of the skills shortage and demand for green jobs? What kind of skills will be in demand for green jobs? Is there a need for a systematic training course for green skills? Would OJT or other methods of training be more efficient and effective? Will these green jobs be competitive with other types of jobs? These are only a few of the questions in need of answers before the implementation of strategies. Otherwise, VET in green jobs may simply provide new training programmes for a few jobs with little improvement from the existing VET programmes.

In particular, the term "green jobs" is a relatively new concept without a clear, unified definition nor is there specific information on the characteristics of green skills, and so it is urgent to build a consensus in identifying green jobs and green skills among various stakeholders. The scope, boundary, types and characteristics of green jobs and green skills need to be further explored, discussed, and shared. To do so, we need to conduct quantitative, systematic skills surveys in green jobs along with qualitative job analyses at the national, regional and sector level. In Korea, while the Ministry of Labour is in charge of the national HR demand and supply surveys, other relevant Ministries are conducting the national HR demand and supply surveys for their own specific field, such as science and technology, environment, or public health. Each Ministry focuses on their target population. Since green jobs and green skills are new and interdisciplinary (or inter-ministerial), it is unclear at this point which Ministry is responsible for the skills demand and supply survey for this field. A national information infrastructure for green jobs and green skills is a necessity, which can be either a new system or a revision of the existing system to collect, analyze and provide meaningful data and information regarding green jobs and green skills. Based on the concrete data, we can develop more feasible policies and more efficiently and effectively implement and evaluate the policies.

It is crucial to determine specific skills needed for green jobs both for the short and long-term, and to determine plausible career paths in green jobs. For example, the Green Jobs Act in the United States emphasizes the study of green skills and green jobs. It is difficult to provide an accurate prediction about the future of green jobs; however, by mapping green skills and green jobs we can restructure VET programmes to better support green growth policies as well as to improve the quality of green job workers.

5.1.3 Integrative utilization of VET system

In Korea, there are diverse education and training institutions and facilities that provide VET such as vocational high schools, polytechnics, higher education institutions, public training centres, and private training academies. As described before, there are different types of skills for green jobs in terms of skill level, industrial field, and delivery modes. In order to provide green skilled workers with the most appropriate VET, it is important to utilize diverse VET systems. The Korean government should create a meta-ministerial system to support the linkage and partnership between different educational institutions and training facilities. Since some VET systems fall under the jurisdiction of the Ministry of Education, Science and Technology (e.g., high schools and universities) while others fall under the Ministry of Labour (e.g., Polytechnics and public training centres), it is

difficult for different VET institutions and facilities to collaborate. As the current knowledge-based society has been demanding lifelong learning for all members and the emerging green paradigm adds a further need for continuous skills development, flexible school-to-work and work-to-school transitions are in greater need now. People should be able to choose their own educational opportunities which are most relevant and appropriate to their needs. However, the current VET systems in Korea are limited and compartmentalized according to its target students as well as the levels and content of the VET programmes. At the national level, the VET systems across different institutions and facilities need better coordination and management. Students and trainees should be able to identify their needs and select the most appropriate VET programme to suit their needs. The recently implemented Individual Training Account (ITA or VET Account) system in Korea is an example of how the government is supporting flexible and active VET participations of individual workers. However, the current ITA system is sponsored and managed by the Ministry of Labour and eligible VET programmes are offered by only those institutions and facilities under the Ministry of Labour. On the other hand, the Ministry of Education, Science and Technology launched the Lifelong Learning Account system. The scope and boundary of ITA and Lifelong Learning Account are under debate. This provides another reason to support the need for a meta-ministerial system in order to support and coordinate the linkages and partnerships among various VET systems.

Also, the quality of various VET programmes needs to be developed, and monitored and evaluated by the government, workers (i.e. students and trainees), and employers. In Korea separate ministries evaluate different VET programmes and institutions according to different standards. The quality control of VET programmes and institutions are important to ensure high-quality learning opportunities for participants. However, the programme and institution should better incorporate participants' needs. To what extent the educational needs of students and trainees are met through the VET programmes should be assessed. In addition, the demands by employers for skills development should be accounted for. Employers' evaluation on the VET programmes and institutions should be taken more seriously. There are skills demand and supply surveys and employer surveys in specific sectors. However, the information and data collected are not being applied effectively to contribute to the development of VET programmes. The information infrastructure system for green jobs and green skills, as previously recommended, will be able to support integrative utilization of VET systems.

In addition, the partnership between education and industry at various levels should be strengthened. As green skills and green jobs are developing at a faster speed, the linkage between skill suppliers and skill demanders becomes more critical. For highly skilled workers in green technology industries, graduate schools and universities should closely work with industries, while the public and private training centres must immediately respond to the emerging needs of the industry by providing short-term training opportunities.

Since 1996, the employment insurance system has been introduced in Korea and it has provided the broad and diverse vocational training opportunities to both the employed and unemployed. The employment insurance system can specifically address the importance of green jobs and green skills. The government can utilize employment insurance funds to support VET programmes for green jobs and green skills and support related research including needs surveys and skills surveys in the field of green jobs.

5.1.4 Diverse and flexible curriculum development and retraining teachers

The Ministry of Labour reviewed current VET strategies and policies and proposed new VET strategies and programmes to support green growth. The new strategies include changing the traditional training centres to provide middle level technicians in non-green manufacturing industries with new programmes related to green growth. While it is theoretically possible to expand the training opportunities for green skills workers through this strategy, it is not feasible due to the weak capacity of private training centres. Thus, a step-by-step gradual approach should be considered. To provide skills development for green skilled workers it is important to have the appropriate curricula and qualified teachers; however, not all training centres are prepared. At the beginning stage, the Polytechnic is an optimal place to develop new curricula. The Korea Polytechnic, which is under Ministry of Labour, is a two-year vocational education college and offers short and mid-term vocational training for the employed and unemployed. Korea Polytechnic conducted educational needs assessments and restructured curricula to reflect the current changes to green jobs. For example, the department of electricity and energy has changed its name to the department of renewable energy and has developed new courses that cover various renewable energy sources and applications. Currently, it is a transitional phase involving the merging of the old and new curricula, thus it is too early to evaluate the outcome of the new programmes. Nevertheless, according to positive anecdotal examples, we were able to see the potential of these new programmes. Korea Polytechnic illustrates a rapid response to policy change, which in part is due to the close linkage between the management and operation of the Korea Polytechnic and the Ministry of Labour. Policy changes in the central government were effective immediately at the Korea Polytechnic. Curricula changes in other public and private training centres, however, will take more time. To facilitate the necessary changes, financial support from the government at the national and regional level is needed. In addition, associations of employers and employees should strongly demand changes in VET curricula since they are main consumers of those VET programmes.

For effective skills development, qualified teachers along with substantive curricula are the keys to success. Since a great portion of green technologies is new and interdisciplinary, it is difficult to find experts in green technologies and it will take some time to prepare new VET teachers for the field. Thus, the new green VET programmes are experiencing difficulty in finding qualified teachers. Without qualified trainers and teachers for the green VET programmes, VET will not be successful. It is critical for the current trainers and teachers in the existing VET programmes to be retrained in order to equip them with the skills and knowledge of green technologies. Along with retraining programmes for VET teachers, the government should employ financial and legislative policy measures to attract qualified practitioners in the field of green technology and the green industry and utilize those competent practitioners as qualified VET teachers and trainers.

5.1.5 Green skills development in the context of community development plan

Most green growth strategies are closely related to community development. Green technology needed for the green skill industry such as construction of energy saving housing, green transportation, and production of alternative energy may improve the quality of life in the local area by creating local jobs. Thus, the central government should cooperate with the local government for the green growth plan

and job creation. Regional governments should devise the development plan connected to green growth policy. In particular, they need to create relevant green jobs in their regions in terms of their natural environment, population, and industry. Based on systematic planning, the local government must organize local VET facilities in their areas to provide training for green skills.

In addition to skills training for the workers in the local areas, lifelong education should be provided for adults in the region since public awareness of green growth and sustainable development are the basic sources to create green jobs. As there are many public adult learning centres in local areas, the local government should introduce the education programme to increase awareness towards green development by local citizens.

5.1.6 Strategies for career development for green collar workers

While there is a wide range of workers in green jobs or green-related jobs in terms of their required skill levels, skill acquisition, and development needs, green jobs supported by the recent green initiatives in Korea are split into two groups: first, a large amount of funds support high-skilled researchers and engineers in the field of advanced and emergent green technology; second, green jobs which were created by Green New Deals are for relatively low-skilled workers such as road construction manual workers or LED light bulb assemblers. These low skilled workers are often employed temporarily and tend to do the manual work through which they have little opportunity to improve their existing skills.

It should be recognized how the Korean Government immediately responded to the recent financial turmoil under the large umbrella of the green growth initiative, the Green New Deal. However, it is debatable as to whether the temporary manual construction workers are considered to be qualified green collar workers. Their work will result in creating a green environment. Nonetheless, their day-to-day tasks and skills are not drastically different from those of any other construction jobs. Therefore, if we would like to create truly green jobs that are more sustainable than the traditional blue collar jobs, it is important to develop a career path to help green collar workers through the provision of appropriate training and a qualification system.

Most of the education and training supports are currently geared towards high-skilled workers through the increase of research and development funds, financial support for graduate students, and the creation of new research and education programmes at the master's and doctoral degree levels. Education and training supports for the workers with less advanced qualification are rare to find. Green technology will lead the nation into an improved economy; however, without strong middle skill level technicians and sustainable green collar workers, which are composed of larger portions of the population, the success of the nation will be in jeopardy. Education and training policy measures and strategies need to be inclusive to ensure skills advancement and career development of all workers from low-skilled to high-skilled positions, yet differentiated policy measures and strategies should be developed and implemented to meet different needs. The government should pay more special attention to the education and training for middle-level technicians and green collar workers as they are often neglected under the current policy.

5.1.7 Enhanced partnership among tripartite

Compared to Europe, the respective role and relationship among tripartites of the Korean labour market is culturally and historically different. In Korea, the involvement of employee unions in their members' education and training has been limited to the education of labour relationships with employers' and workers' rights. Education for skills development of their members in the relevant field is seldom provided. Therefore, we cannot find any information regarding how labour unions are responding to the need of skills development under green initiatives.

The most recent report from the Green Growth Committee on green jobs creation and human resources development presents optimism. The government addresses the importance of building an employee-employer partnership to support greening the individual workplace initiatives. Nonetheless, it is unclear at the operational level as to how these partnerships will be formed, managed, and sustained. Respective roles and responsibilities of each party need to be specified and examples of concrete tasks should be presented for the collaboration among each. In addition, a greater number of various stakeholders should all take more active initiatives in this endeavour including the central government and local government, small, medium, and large companies, and individual employees.

5.2 Recommendations for further research and data collection

As we described in this report, the responses of skills development policies and programmes to both national and global green growth initiatives are mostly government initiated and directed in Korea. This approach has an advantage to yield a fast nation-wide response on the issue. Over a very short period, we were able to restructure a large number of policies and strategies across different ministries to align with centrally focused green growth initiatives. This is an effective way to start a new initiative. However, this approach has pitfalls too. Many new policies and strategies have been created; however, many of them are too vague to be enacted in practice. In other words, they often remain as rhetoric phrases. It takes additional effort and time to operationalize the policy measures and strategies. It has been 16 months since the President first announced green growth initiatives. There have been numerous seminars, conferences, workshops, public hearings, and publications on the topic of green growth. As we were writing this report, we were able to get a glimpse of green jobs and green skills development in Korea. Unfortunately, because many of them are still in its early stage, we could only provide ideas, concepts, and plans, and illustrate anecdotal examples. Many practitioners in the field were either reluctant or refused to discuss with us regarding their green jobs and green skills development and implementation, because they felt there was not enough evidence to show their success to the public.

Many people have heard optimistic and ambitious stories about green growth, the green dreams have not yet been actualized in practice. Green jobs and green skills development are not entirely new or different from previous practices. While looking for significant signs of change, we may have missed the smaller but more important signs. A great portion of the sustainable change towards green jobs and green skills development will occur gradually over time. Also, policies should be able to support these gradual changes.

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Appendix: List of key resource persons

(interviewees, participants in the focus groups, expert panels etc.)

Heuksalim

Si-young Choi, Director of Heuksalim

Students of Agriculture Meister College

S-energy

Hyukbong Chang, Manager of Planning team

Education and Training Center for Energy Technology, Seoul National University of Technology

RaeHyun Kim, Director of Energy Technology Education Center

Korea Polytechnics

Minsang Park, Planning Team

Byungchul Min, Manager of Planning Team

Sung-sik Moon, Professor in mechanical design department, Inchoen Polytechnics II

Hae-choon Lee, Professor in electric measurement and control, Inchoen Polytechnics II

Waste-to-Energy design and operation education programme for unemployed college graduates

Sunghyun Cho, Manager ofEcoholdings

Students of Waste-to-Energy design and operation education programme

GHG management specialist education programme, Environment Management Corporation

Students of GHG management specialist education programme

Jihae Yoon, Senior researcher, Ecoeye

Wontak Bae, Senior researcher, Ecoeye

Sustainable Building Technology Education Programme at Korea Institute of Construction Technology Education

Kyung Hoi Lee, Director, Center for Sustainable Building Technology Education

Si-eok Kim, Manager, Center for Sustainable Building Technology Education

Students of Sustainable Building Technology Education Programme

LED Lighting Technology Education Centre

Jae-yeop Noh, Research Fellow at Korea Institute for Lighting Technology

Hyundai Hybrid automobile training programmes for maintenance technicians

Hyuk-sung Kwon, General manger of technical training, Hyundai-Kia automobiles

Jungwon Park, Manger of technical training, Hyundai-Kia automobiles

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Expert panels

Chanhyuk Park, Senior Researcher, Green Industry Promotion Office, Korea Environment Industry and Technology Institute

Jinyoung Chung, Senior Researcher, Environment Technology Research Division, Korea Institute of Science and Technology

Joongjin Kim, Senior Researcher, Korea Employment Information Service

Hyung-dong Kang, Vice chair, Joosung Engineering

Jung-in Kim, Professor, Department of Industry Economics, Chung Ang University

Gayoung Yoo, Professor, Department of Environment Engineering, Kyunghee University