Chapter 1
Overview

Abstract The green economy is a new economic paradigm which seeks to achieve economic development, while at the same time protecting the environment and achieving sustainable economic and social development. This requires transitioning to green jobs and green skills, and to creating new jobs in relation to the greening of workforces. Green jobs are relevant across all key sectors: agriculture, manufacturing, building, transport, tourism, and renewable energy. Skills acquisition and enhancement have great positive implications for all aspects of education and training, and for businesses.

Keywords Green jobs · Green skills · Green economy · Green growth · Sustainability · Skills development priorities · Waste management and recycling · Renewable energy · Skills acquisition and enhancement · Skills toward sustainability · Energy transition · Smart cities · Environmental goods and services · Education and training

Green Economy and Green Growth

The green economy is a new economic paradigm that aims to achieve development while protecting the environment. It is considered as a way forward, purporting that there should be no conflict between economic progress and environmental protection. Greening the economy does not impede wealth creation, nor employment opportunities. Instead, relevant sectors can present opportunities for investment, growth, and jobs given the necessary conditions during transition. Transitioning to a green economy can help mitigate the adverse impact of rapid population growth in the depletion of natural resources (UNEP 2011). Furthermore, the latest OECD report *Investing in Climate, Investing in Growth* (2017), provides an analysis of how low-emission and climate-resilient development can be achieved without compromising economic growth, competitiveness, or well-being. The report provides a detailed discussion of just transition issues and how governments can manage such issues.

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Although there is no one-size-fits-all model for green growth, and policies and strategies depend on the prevailing economic situation and reflect local contexts and preferences of countries, all countries—developed, developing, and poor—can adopt green growth and more inclusive development. Green growth can open up opportunities for enhanced productivity through more efficient use of natural resources and energy; for optimizing their value for innovation made possible by favorable policies that enable enhancing values of assets and protecting the environment; and for new markets brought about by emerging demands for green technologies, goods, and services, thereby creating new jobs (World Bank 2012, OECD 2011).[1]

Green Jobs and Green Skills

The expected transition toward a green economy and jobs is anticipated to result in displacement of workers and job losses, while new jobs will arise in relation to the greening of workplaces. This is a challenge that depends on how wide or narrow the gap is between the skills that current workers possess and the set of skills that a green economy and green jobs require.

Across various definitions, the primary objective is more efficient use of energy and natural resources, minimal waste and pollution, and protection of the environment and ecosystems. It is also equally important to point out that green jobs have to be decent work: good jobs with sufficient wages, safe working conditions, job security, reasonable career prospects, and worker rights (UNEP 2008). Otherwise, a hazardous job with an inadequate wage goes against the poverty-reduction principle that is dovetailed to green jobs and green growth.

In "Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World," UNEP (2008) listed four expected impacts of green growth on employment[2]:

- Additional jobs will be created (as in the manufacturing of pollution-control devices added to existing production equipment).
- Some employment will be substituted (as in shifting from fossil fuels to renewables, or from truck manufacturing to rail car manufacturing, or from landfilling and waste incineration to recycling).
- Certain jobs may be eliminated without direct replacement (as when packaging materials are discouraged or banned and their production is discontinued).
- Many existing jobs (especially such as plumbers, electricians, metal workers, and construction workers) will simply be transformed and redefined as day-to-day skill sets, work methods, and profiles are greened.

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[1]For more extensive reading on the concept and origin of green growth and green economy, refer to *A Guidebook to the Green Economy* (2012) by the Division for Sustainable Development, United Nations Department of Economic and Social Affairs, https://sustainabledevelopment.un.org/content/documents/GE%20Guidebook.pdf.

[2]UNEP (2008). Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World, UNEP/ILO/IOE/ITUC, September 2008. Nairobi, Kenya. P3.

Filling positions in skilled green professions and trades will require development and provision of sufficient training programs in polytechnics and universities, among others. Workers will need support to adapt or transition in terms of skills; and management will need reorientation in terms of new perspectives, as well as new skills in order to optimize the new skills of their workers. Training and retraining programs should be based on a concrete framework and plan, which, in turn, should be based on sound studies and assessment within each economy, taking into consideration the level of economic development and state of transition into a green economy.

The development of modules and curricula should be a dynamic process informed by experiences and lessons learned from other countries. Each country should be able to establish a definition of green skills that can be operational in its context. For example, Australia defines green skills as skills for sustainability—i.e., "technical skills, knowledge, values and attitudes needed in the workforce to develop and support sustainable social, economic and environmental outcomes in business, industry and the community."[3] The Organisation for Economic Co-operation and Development (OECD) classifies green skills together with entrepreneurial skills under a third group of skills called converging skills (the first two skills groups being basic skills and advanced/knowledge-intensive skills); green skills are "specific skills required to adapt products, services or operations to meet adjustments, requirements or regulations designed to stem further climate change or adapt to the impact it is already having." (ILO 2011a) A broad range of knowledge and technical, managerial, and conceptual skills is indispensable during transition into a green economy. The United Kingdom has developed a green skills checklist, which is composed of ten broad groups of skills (tier 1) applicable across sectors. These are broken down into groups of general skills (tier 2) and more specific skills (tier 3) (ILO 2011a).[4]

1 Green Jobs Across Key Sectors

While pursuing green growth may cause job losses, new jobs will be created, especially skilled jobs in emerging innovations for green activities. In this case, facilitating the transition of workers to new, expanding sectors where enterprises use cleaner alternatives and provide environmental services should form an important part of plans and strategies toward a green economy.

Investing in green activities has huge job creation potential. The skills development response could be a two-pronged approach: (i) reorienting and/or retraining/

[3]Green Skills Agreement: An Agreement between the Australian Government and the State and Territory Governments http://www.ivet.com.au/cgi-bin/user.pl?download_file=1&file=17.

[4]ILO (2011a). Table 5.4: Green skills checklist (United Kingdom), pp. 104–105. http://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_159585.pdf.

upskilling existing workers to equip them with green skills applicable in enterprises across key economic sectors, such as infrastructure, agriculture, and manufacturing; and (ii) training and educating incoming workers to produce a fresh supply of skilled workers and professionals, especially for sectors directly involved in green activities like renewable energy.

Agriculture. The main green growth objective in agriculture is to boost productivity through resource-efficient technologies, agricultural inputs, and farming practices. The main challenge is reconciling traditional practices with green agricultural technologies, practices, and products. Partnerships with relevant non-government organizations, education institutions, demonstration farms, and small and medium-sized enterprises (SMEs) that provide green agricultural products are crucial.

Skills development priority: Ensuring a sufficient pool of professionals and specialists in the fields of agricultural engineering, research and development (R&D) (especially in irrigation, pest management, and soil fertility), and agro-ecology.

Manufacturing. The key areas in improving resource efficiency in manufacturing in a green economy are green innovations in designing and developing products, material and energy substitution, and modification and control of processes using new, cleaner technologies.

Skills development priorities

- training related to changes in production in heavy manufacturing industries, as well as in SMEs in the areas of production processes and management (leaning toward energy and resource efficiency, recycling, and waste management);
- upgrading of skills for technicians and workers to align with technological changes; and
- production of professionals and specialists in R&D and in revision of education curricula and training programs, eco-design, products and services, and assessment of environmental impact to promote cleaner processes and systems.

Building. Greening the building sector opens up opportunities for job creation and job transformation in the areas of new construction and retrofitting, as well as opportunities for increased production of green construction materials and products like appliances and equipment; expansion of renewable energy sources and generation; energy-efficient operation and maintenance (O&M); and other related activities such as recycling, waste management, and water and sanitation.

Skills development priorities

- training of workers and certified professionals in retrofitting buildings into green buildings and in landscaping, among others; and
- orientation of architecture and building engineering toward green designs and use of resource-efficient materials.

Transport. Shifting to more environment-friendly means of transport and improving vehicle and fuel technology to reduce negative effects, such as depletion of resources and pollution, are the priorities in greening the transport sector. Job opportunities will be in green transport infrastructure, green vehicles and their operations, and alternative fuels and other related technologies. For example, hybrid vehicles (plug-in electric and hydrogen/fuel cell-powered vehicles) that aim to reduce gasoline consumption, and efficient public or mass transport systems such as rail transit and energy-efficient bus systems are important in greening the transport sector, and they have great potential for green job generation (UNEP 2008).

Skills development priorities

- training in green transport infrastructure labor and O&M;
- production of more resource-efficient vehicles and their maintenance;
- R&D in alternative fuel technology;
- transport infrastructure design and engineering; and
- public transport network construction, O&M, and management.

Tourism. In a green economy, tourism is "sustainable tourism" that is maintained within the context of the local social, economic, and cultural environment. Being a human resource-intensive industry, tourism is among the world's largest job generators and often requires quick training and allows youth, women, and even migrant workers an easy entry into employment. Employment in related areas, such as energy, water, and waste services, also provides opportunities.

Skills development priorities

- training of local unskilled and semiskilled staff, and reorientation and training of cottage industries and small and medium-sized enterprises (SMEs) that provide related products and services;
- training and reorientation of managers and owners of related enterprises; and
- integration of green orientation in the curricula of tourism-related programs in technical and vocational education and training (TVET) and higher education.

Waste management and recycling. The greening of the waste management and recycling sector means a significant shift to the 3R approach (reduce, reuse, and recycle) and minimal use of waste disposal methods like incineration and landfills and waste to energy. This can be made possible by new technologies for collection, recycling waste, and producing energy from organic waste, among others.

Recycling promotes significant savings in resources. It generates employment and provides income to about 12 million people in Brazil, the People's Republic of China (PRC), and the United States (US). Developing countries have about 15 million people who depend on waste collection for their livelihood. However, waste management and recycling usually draw in workers with low educational attainment and having limited economic opportunities. And due to the often poor working conditions, most jobs in waste management and recycling cannot be called green jobs, because they hardly fall into the category of decent jobs. They often

involve child labor and run contrary to the principles of occupational health and safety and social protection, among others (UNEP 2011).

Skills development priorities

- training in facilities management, including on-site waste management and disposal,
- training in recycling and disposal of waste
- training and reorientation of managers and workers on minimal production of waste and use of environment friendly packaging
- training to local community workers to increase knowledge of sustainable waste management techniques and building greater community awareness.

2 Jobs in Renewable Energy

Demand for, and consumption of, renewable energy has grown steadily in Asia and the Pacific, as well as worldwide. This trend is expected to be sustained as countries transition to green growth. Renewable energy is becoming cheaper, producing lesser air pollution, and emerging related innovations continue to help implement renewable energy projects (ESCAP 2015). Countries are adopting national sustainable energy policies and plans and setting concrete goals. The PRC, for example, targets producing 16% of its primary energy from renewable sources by 2020. Japan aims to create 1.4 million new jobs in environment-related fields under its Green Innovation Program (OECD 2011).

In 2010, employment in renewable energy recorded 3.5 million workers, mostly in Brazil, the PRC, Germany, Japan, and the US. Employment grew particularly in Asia and North America (UNEP 2011). Renewable energy generation and distribution created 6.5 million jobs worldwide in 2013, growing to 8.1 million in 2015. This may reach 24 million jobs by 2030. Another example from Indonesia and South Africa showed that by spending $1 million in energy sectors, clean energy investments generate about 100 jobs in Indonesia and 70 jobs in South Africa. (UNIDO and GGGI 2015). For these two countries, net employment gains for clean energy investments are substantial and can be a net positive source of job creation. In 2015, the top 10 countries in job creation included four in Asia (Bangladesh, the PRC, India, Japan), and Asia's share of total employment in renewable energy was about 60%, a 9-percentage point increase from 51% in 2013 (IRENA 2016).

Jobs in renewable energy are not confined to energy production per se. The value chain covers manufacturing and distribution of renewable energy equipment, renewable energy project development, construction and installation work associated with the development of renewable energy capacity, O&M of renewable energy facilities, and a range of cross-cutting activities that contribute to more than one of the other value chain stages. The largest number of workers in renewable

Table 1 Hard-to-fill occupations in renewable energy

Wind energy	Solar energy	Hydropower	Geothermal	Bioenergy
• Project developers • Service technicians • Data analysts • Engineers: electrical, computer, mechanical, construction	• Installers and maintainers of photovoltaic and solar thermal systems • Building inspectors	• Engineers: electrical and O&M • Technicians • Tradespersons • Sustainability specialists	• Engineers: geothermal • Trainers	• Engineers: R&D and design • Service technicians • Trainers

Source IRENA 2014

energy is in manufacturing of equipment, project development, construction, and installation. Employment is relatively smaller in O&M, which can last for the 20- to 30-year lifetime of the installation.

IRENA (2014) listed several occupations in renewable energy considered as "hard to fill" (Table 1). Most of them are high-skills jobs such as engineers and technicians.

Skill shortages in green jobs are often a result of the general inability of education and training systems to respond to the demands of the growing industry. This may be exacerbated by lack of universities and research centers offering relevant programs. Other barriers include students' choices of programs versus the skills in demand, the absence of incentives for employers and/or industry to invest in developing the transferable skills of their workforces, limited access of the disadvantaged to training in terms of time and finance, and probably the stereotyping of women against certain disciplines such as engineering (World Bank 2012).

3 Skills Development for Green Jobs

Skills shortages for green jobs could thwart government efforts toward green growth and targeted environmental outcomes. As in any other skills shortage situation, addressing an existing job-skills gap during a transition to a green economy requires government to partner with industries and employers. Companies need to shift to a more holistic perspective supportive of sustainable development. Aside from investing in skills upgrading, firms should also provide their managers the necessary reorientation and training to develop awareness and capacities to sufficiently utilize the staff/workers' newly acquired skills (UNEP 2011).

Overall, skills development strategies for renewable energy can be outlined as the following broad processes:

Aligning Skills Provision Strategies for Green Jobs with National Development Policies

Public and private sector investments in skills provision for green jobs should be aligned with and supported by sustainable development and other enabling policies. Skills development outlined in green policies should be in synergy with strategies to increase labor capital, worker education, and labor productivity (World Bank 2012). Special focus and investment in science, technology, engineering, and mathematics (STEM) must be highlighted to respond to the existing and anticipated demand in the renewable energy sector for R&D and engineering occupations, among others. At the outset, a thorough review of existing skills development policies should be done with the end in view of aligning higher education and TVET with green growth policies.

Assessing Skills Requirements for Green Growth

It is equally important to accord high priority and investments in determining and forecasting evolving skills needs to inform assessment of and any adjustment in occupational skills profiles and training programs. The results of skills needs assessment should feed into labor market information systems to support strategies to match skills supply and demand in renewable energy and green jobs in other key sectors. Also to encourage increase in the supply of trainers, social dialogue, and advocacy with education and training institutions, industries, and all other stakeholders in evaluating and planning for renewable energy skills development must be conducted.[5]

Skills Acquisition and Enhancement

As mentioned earlier, in transitioning to a green economy, skills development programs have to provide for (i) retraining, upskilling, or adaptation training of existing workers for enterprises across sectors such as infrastructure, agriculture, and manufacturing; and (ii) training of new workers and producing skilled workers and professionals, especially in sectors directly related to the renewable energy sector.

A lot of skills, even knowledge of sustainable materials, carbon footprinting skills, and environmental impact assessment, may not be inherently "green." They become green largely depending on the context wherein they are used. Skills in building construction become green when they are used in the creation of energy-efficient buildings. Skills in impact assessment become green when the results help create more resource-efficient knowledge, practices, or products. This

[5]At the international level, skills gap analyses are done by institutions like the International Labour Organization, United Nations Environment Programme, and The International Renewable Energy Agency. At the national level, skills gap analyses must be spearheaded by governments and partners to support enabling policies in the field of education and training. At the national level, government can do skills gap analysis through regular employment surveys or project-based assessments, accompanied with stocktaking of entities providing related training and education such as universities and TVET institutions.

means that traditional skills will remain relevant in the context of green growth, but will need to adapt to green practices, for example, new knowledge and practices in energy efficiency, when applied in green jobs and enterprises. While skills development strategies for green jobs will vary depending on the country and specific industry, most emerging jobs in a green economy will need a combination of both traditional and green skills. In most cases, it may be more practical to retrain or enhance the skills of workers rather than to replace them with new ones. For low- to middle-skills jobs, traditional skills can be easily supplemented by green skills through on-the-job training programs. This will also largely depend on reorienting the content of the jobs and the way they are performed. For high-skills occupations, more extensive and intensive education and training programs might be required to complement traditional technical skills with a wider and specific set of new green skills (ILO 2011a; UNEP 2011).

Qualifications framework. The existence of a qualifications framework (QF) can facilitate integration of green skills in education and training programs and curricula or modules. A study in 2016 explored how green skills can be integrated in green jobs in Thailand's construction and tourism industries. The main strategy is to retrain workers with a set of well-defined green knowledge and skills developed through the promotion and implementation of green competencies. The initial step is to develop a set of green skills competencies (knowledge and skills) specific to an occupation in the tourism and construction industries. Examples of such occupations are electricians, carpenters, plumbers, and tourism operators (Esposto 2016). Since a QF essentially links qualifications with the actual skills needed in a particular workplace, green skills can be translated into specific competencies that can feed into competency-based training modules or curriculum designs, as well as into assessment and/or certification mechanisms. Integration of green skills in the QF will also allow for workers' mobility across green jobs and sectors.

In a holistic QF that reflects a school level to higher education continuum, generic or basic green skills can already be integrated in the school education values and attitude formation components that include appreciation for and protection of nature and the environment.

Quality assurance mechanism. A rigorous quality assurance (QA) mechanism for skills development covers curricula, programs and institutions, trainers and assessors, and assessment and certification. Integrating green skills standards into QA will not only instruct various education and training institutions but will also guide companies and employers. Quality education and training programs allow transferability of competencies across jobs and enterprises, and, again, mobility of workers across jobs and companies.

In both QF and QA, collaboration among key partners, i.e., government, industries, workers' representatives, and education and training institutions, is critical in identifying the skills needed for renewable energy and in making sure that there is enough provision for education and training. Another crucial partnership is between private companies and their trade associations. In many countries such as Germany and Denmark, governments are working with employers' and workers' associations to adapt or formulate new curricula for renewable energy. In Canada,

the Renewable Energy Advisory Committee on Training was created involving the industry, colleges, and the government. In countries where there are existing skills councils, there is already a good venue to start. The Republic of Korea, for instance, added a new sector skills council for renewable energy (ILO and EU 2011a, b).

Synergy across the education sector. Addressing skills gaps while transitioning to a green economy will be greatly aided by forging synergy across education subsectors. In putting emphasis on STEM disciplines, for example, quality at the school level is important. Furthermore, important core attributes such as awareness and attitude related to environmental protection are best developed during basic education.

For technicians and skilled craft workers, TVET apprenticeships with suppliers of renewable energy technologies offer training and exposure and/or emersion. For example, courses on installation and maintenance of wind farms are being offered by vocational training colleges in Spain. In collaboration with employers and unions, a 2-year course to become a geothermal technician is available in British Columbia, Canada. In Brazil, the National Biodiesel Programme provides assistance to rural technicians to help bioenergy crops growers (ILO and EU 2011a, b).

A STEM-focused tertiary education should be adequately provided with incentives (e.g., scholarships and grants, paid apprenticeships) to boost engagement in programs that produce the much-needed researchers and engineers for green jobs, particularly in renewable energy. Courses in areas such as engineering, biosciences, geosciences, agriculture, forestry, and business in universities serve as foundations programs for high-skilled level occupations in renewable energy. Many universities are shaping their programs to accommodate interests in renewable energy. The Oregon Institute of Technology in the US, for example, offers a first degree in renewable energy engineering. An increasing number of universities also offer postgraduate courses on renewable energy. These include the University of Auckland in New Zealand, which offers a postgraduate diploma in geothermal energy technology, and the Faculty of Technology at Makerere University in Uganda, which offers a master's degree program in renewable energy (ILO and EU 2011a, b). Recently, one of the Philippines' state universities launched a professional science master's in renewable energy engineering open to all licensed engineers in the country.

Inclusivity. In pursuing skills development for green jobs, strategies, plans, and programs should be inclusive to ensure equal opportunities for women, youth, and the marginalized. For example, overcoming gender barriers to train and engage women in high-level skills for occupations in renewable energy such as technical and engineering jobs can also help ease the problem of skills shortages. This can be achieved by opening up relevant education and training opportunities, ensuring the quality of programs, making them accessible, and providing guidance and incentives.[6]

[6]ILO. Skills and Employability. In Christine Evans-Klock, *Employment for Social Justice and a Fair Globalization. Overview of ILO programmes*. Skills and Employability Department, ILO. http://www.ilo.org/wcmsp5/groups/public/@ed_emp/documents/publication/wcms_140945.pdf.

Women and Renewable Energy

Currently, about 3 billion people still depend on open fires and traditional biomass such as wood and crop waste for cooking and heating. Most of these people live in Asia and Sub-Saharan Africa. Women and children perform most of the work to collect biomass fuels (UNEP 2016b). The availability of various forms of renewable energy and greater energy efficiency not only address climate change, but also create opportunities for energy access to the billions of people who are still not enjoying modern energy services.

For women, energy access improves opportunities by enabling them to engage in more productive activities:

- Access to energy makes routine household work easier and reduces the time taken, allowing women more time to engage in higher income jobs and entrepreneurial activities.
- Access to energy improves basic living conditions for women, including possible access to computers and information, leading to better standard and quality of life for their families.
- Employing women in the electricity or renewable energy sector, for example, allows them to participate directly in the value chain.

4 Way Forward

Green jobs creation is expected to further accelerate in the coming years as international and national initiatives to combat climate change and adopt a more sustainable approach to economic growth intensify. Transition to a sustainable economy has the potential to create green jobs across economic sectors as investments in new technologies, equipment, buildings, and infrastructure continue to increase and serve as key drivers for new employment and an impetus for retraining and transforming existing jobs. This is already happening in both developed and some developing countries.

Transition to green growth brings about skill shortages due to an increasing demand for green occupations. This does not happen in the energy sector alone, in particular renewable energy, but also across other sectors like agriculture, building, and transport. Failing to address skills shortages during the transition to sustainable development will almost certainly derail a country's pursuit of green growth. Therefore, reconsidering and replanning current skills development strategies are imperative to accommodate green growth policies. Initially, for skills development policies targeted at green jobs to be effective, they need to be integrated into national development plans, accompanied by purposive advocacy and adequate awareness campaigns designed to impact targeted trainees and students, as well as the industries and employers.

Orient Education and Skills toward Sustainability

It is increasingly clear that education and skills, attitudes, and behavior are crucial for sustainable and inclusive growth. The 2030 Agenda for Sustainable Development (UN 2015) requires a comprehensive response in terms of human capital development, talent solutions, and education and training. The Global Education Monitoring Report of 2016 (UNESCO 2016) reinforces the role of education in every dimension of sustainable development. Better education leads to greater prosperity, improved agriculture, better health outcomes, less violence, more gender equality, higher social capital, and an improved natural environment. Education and skills also provide the key tools—economic, social, technological, and behavioral—to take on the Sustainable Development Goals (SDGs) and to achieve them.

The manner in which the Sustainable Development Goal (SDG) for education (Goal 4) links with other SDGs is as follows:

Goal 1: Education is critical to lifting people out of poverty.

Goal 2: Education plays a key role in helping people move toward more sustainable farming methods, and in understanding nutrition.

Goal 3: Education can make a critical difference to a range of health issues, including early mortality, reproductive health, spread of disease, healthy lifestyles, and well-being.

Goal 5: Education for women and girls is particularly important to achieve basic literacy, improve participative skills and abilities, and improve life chances.

Goal 6: Education and training increase skills and the capacity to use natural resources more sustainably and can promote hygiene.

Goal 7: Educational programs, particularly nonformal and informal, can promote better energy conservation and uptake of renewable energy sources.

Goal 8: There is a direct link among such areas as economic vitality, entrepreneurship, job market skills, and levels of education.

Goal 9: Education is necessary to develop the skills required to build more resilient infrastructure and more sustainable industrialization.

Goal 10: Where equally accessible, education makes a proven difference in social and economic inequality.

Goal 11: Education can give people the skills to participate in shaping and maintaining more sustainable cities, and to achieve resilience in disaster situations.

Goal 12: Education can make a critical difference in production patterns (e.g., with regard to the circular economy[7]) and in consumer understanding of more sustainably produced goods and prevention of waste.

Goal 13: Education is key to mass understanding of the impact of climate change and to adaptation and mitigation, particularly at the local level.

[7]Circular economy aims to eradicate waste—not just from manufacturing processes, as lean management aspires to do, but systematically, throughout the life cycles and uses of products and their components (McKinsey and Company 2017).

Goal 14: Education is important in developing awareness of the marine environment and building proactive consensus regarding wise and sustainable use.

Goal 15: Education and training increase skills and capacity to underpin sustainable livelihoods and to conserve natural resources and biodiversity, particularly in threatened environments.

Goal 16: Social learning is vital to facilitate and ensure participative, inclusive, and just societies, as well as social coherence.

Goal 17: Lifelong learning builds capacity to understand and promote sustainable development policies and practices.

Source: ICSU and ISSC (2015)

Keep up with the Energy Transition: Addressing the Skills Gap

Expansion of renewable energy would appear to have reached a point of inflection in 2015. Global investment in renewable energy expanded significantly, growing by 5%. Renewable energy generation costs continue to fall, particularly in solar photovoltaics, enabling countries to step up investments in renewable energy. Developing economies jumped ahead of developed countries for the first time in 2015 in terms of total new renewable energy investment. The share of global investment accounted for by developing countries rose from 49% in 2014 to 55% in 2015, going ahead of developed economies, with the dollar commitment at $155.9 billion in 2015, compared with an investment of $130.1 billion by developed countries.

Growth in investments in renewable energy has been accompanied by growth in jobs in renewables. IRENA (2016) estimates that global renewable energy employment increased by 5% in 2015 to reach 8.1 million. For emerging economies, there are a number of co-benefits from renewable energy: first, distributed and off-grid renewables are contributing significantly to energy access of deprived households; second, there is a spread of clean energy; third, off-grid renewables are leading to a large number of jobs at all levels of the spectrum including low-skilled and rural employment as well as a spurt of enterprises for the distribution and O&M of off-grid energy systems; fourth, employment of women in renewable energy is found to be greater than in the energy sector as a whole.

As the transition to renewables keeps pace, it is expected that jobs in the sector will continue to grow. It is estimated that doubling the share of renewables in the global energy mix would result in more than 24 million jobs worldwide by 2030 (IRENA 2016). It is clear that this expanding labor requirement in the renewable energy sector will require more investments and planning for appropriate skills and training, support to entrepreneurship development and training in off-grid systems and strengthening firm-level capabilities, and promotion of education and training.

Develop Skills to Support Expansion of Smart Cities

Recent times have seen the sprouting of “smart” cities. This is happening not only in developed countries, but also in developing countries. The rise of the smart city

is seen as the direction to ensure the viable and sustainable development of urban centers, given that two-thirds of the global population are expected to inhabit cities by 2045. Smart cities are expected to use technology, but also to provide comprehensive processes and services to improve the quality of life for their citizens. In addition to digital technologies, expertise in accounting, financial management, and governance is required.

A recent report, *Smarter Cities, Simpler Cities*, published by the Association of Chartered Certified Accountants (ACCA 2016), expounds on a crucial theme: It is the people, not just the technology that makes a city "smart." The report highlights the necessity for smart principles to be embodied in the skills of key professionals, as much as in the city infrastructure itself. It is these professionals who will support innovations for bringing sustainable and efficient practices to the traditional functions of a city such as waste management, energy supply, and transport infrastructure. Therefore, planners, city administrators, and municipal workers are expected to play an ever more crucial role in using data insights and applying intelligent systems to help cities to function well and flourish, even as population numbers expand significantly. There is thus a need to invest in the development of skills in professionals to enable them to carry out the functions required to build and maintain the cities of tomorrow.

Respond to Growth in Environmental Goods and Services

There is a clear trend of fast-paced growth in the market for environmental goods and services, which was estimated at $866 billion in 2011 according to Environmental Business International (EBI 2012) and is expected to rise to $1.9 trillion by 2020. While the size of the market is more substantial in developed countries, it is the developing countries that are exhibiting faster growth rates (Table 2). While the biggest markets are concentrated in the US, western Europe, and Japan, the fastest growth rates are found in developing countries in Asia, the Middle East, and Africa, which exhibited growth rates of 9–10% during 2011.

Table 2 Market size and growth of environmental goods and services by country/region

Country/region	Market in $ billion (2011)	% Growth (2011)
United States	311.3	5
Western Europe	256.0	2
Japan	103.3	(1)
Rest of Asia	78.0	9
Latin America	28.5	5
Australia/New Zealand	13.6	2
Central and Eastern Europe	13.7	4
Middle East	17.5	9
Africa	10.3	10

( ) negative
Source EBI (2012)

Environmental services have been estimated by EBI to make up approximately 65% of the environmental industry as a whole. While many environmental services require some environmental goods in their provision, the sale of an environmental product usually involves embedded environmental services content or requires some form of associated installation, maintenance service, and monitoring. For example, in the photovoltaic industry, it is estimated that the rooftop installation cost of photovoltaic modules accounts for 60% of the total cost of purchase. Others have estimated that for every megawatt peak of photovoltaic modules installed, on average 20 manufacturing and 13 installations, maintenance job years will be created. With improved efficiency and massive expansion in production over the last 10 years, the unit cost of photovoltaic modules has been falling. This trend is likely to incentivize greater sales of photovoltaic modules, which in turn would signify a growing demand for related installation and maintenance services.

It is anticipated that the environmental services sector will become increasingly more important in the coming years. Many developing countries, because of their developmental stage, are now beginning to invest more in environmental infrastructure, with stronger regulatory frameworks. These trends are creating new and evolving markets for environmental services and call for investments in developing the skills of professionals rendering environmental services at the higher end of the spectrum but also at the bottom of pyramid markets in rural settings. Environmental services can support the needs of domestic and rural markets but can also tap into the higher order global value chain with adequate capacity and skills.

Improve quality of education and training at all levels. A quality basic education will ensure that a future workforce is equipped with basic learning tools and flexibility for skills development at TVET and higher education levels. A construction worker or electrical technician who had quality training and has enough experience in a certain sector can be easily trained to adapt to green jobs or jobs in the renewable energy sector. For high-skilled workers in green jobs where shortages are more severe, it is worth giving more attention to STEM, strategizing to encourage students to participate in STEM courses. Many institutions are emerging to provide initial or continuing education and training for green jobs. However, quality assurance mechanisms should be in place to maintain standards, including training infrastructure and facilities.

Target girls, females, and disadvantaged. Polices targeted at green jobs should be able to expand the access of women (as well as the youth and the marginalized) to quality education and training at all levels. Their participation in skills development programs relevant to renewable energy should be encouraged through targeted scholarships and apprenticeships, among others. Strengthening women's leadership and participation in sustainable energy solutions and engagement in relevant occupations, particularly in high-level jobs, is critical in the transition to sustainable growth and to end poverty.

Establish strategic partnerships. Forging effective partnerships on all fronts to strengthen education and training, STEM, and R&D in renewable energy will advance skills development goals for green growth. Such partnerships can take the form of international collaborations among institutions such as centers of

excellence, universities, and TVET institutions, as well as among government agencies, education institutions, and companies and firms, and employers. Bilateral collaborations among economies can promote skills standardization and mutual recognition. Development partners such as the International Labour Organization (ILO), Asian Development Bank (ADB), and World Bank have been supporting countries in skills development programs and projects. Prudent and efficient use of their assistance will benefit national skills development strategies.

Mobilize and prioritize resources. On top of private or individual willingness to finance training and public provision to fund national skills development agenda, there are many ways to mobilize funds for skills development. Among them is providing incentives to firms that are willing to invest in reskilling and/or upskilling their workers and managers. Another means is the establishment of a national skills fund such as that of Malaysia. And finally, there is assistance provided by development partners. However, the efficient use of resources is as important as the availability of resources. As such, it is important to identify priorities and to adhere to them.

Promote innovations and technologies. Innovations and technologies will be indispensable in pursuing sustainable development. Governments need to establish a conducive environment to encourage engagement in STEM and participation in R&D through policies and incentives channeled to universities, research institutions, technology centers and networks, and private firms, among others. Again, partnerships are critical in the efficient use of resources through sharing and collaboration. Promotion of innovations and technologies will need well-functioning institutions, sound research and education infrastructure, and links between public and private innovation actors and among enterprises committed to R&D.

Strengthen Professionals and Workers at All Levels for Sustainability

Emerging economies need to plan and invest adequately in talent development and skills training in key disciplines and areas that anticipate the needs of a future sustainable society. Table 3 captures a few of the disciplines that need strengthening through education and training.

ADB's Support for Green Growth

Asian regions registered the highest growth rates in the past decade, and if such a pattern continues, Asia's gross domestic product (GDP) is estimated to constitute more than 50% of the global GDP in 2050. Asia's urban population is also expected to almost double (1.6 billion to 3.1 billion). Cities will be the centers of higher education and hubs for innovation and technological development. Buildings and transport systems in urban areas will account for most energy consumption (ADB 2011). This will require establishing and/or partnering with existing centers of excellence dedicated to training in green skills and expanding this capacity.

ADB supports the SDGs. ADB's new upcoming long-term strategy leading to 2030 will describe how ADB aligns with the Sustainable Development Goals (SDGs) and the new global climate agreement. Sustainable development will be the unifying theme for ADB's future initiatives under various sectors. For example, in

Table 3 Professionals and capacities for sustainable economies and societies

Area	Components	Professional or technician responsible
Finance for sustainability	Reducing costs and boosting efficiency, green finance, enabling poorer people to access clean energy through innovative payment systems	Bankers, accountants, financial correspondents, mobile payment operators
Sustainable transport	Awareness of sustainable transport mechanisms, design and planning of bus rapid transport corridors and their management, more efficient engines, hybrids, fuel cells, alternative fuels	Engineers, surveyors, bus operators, manufacturers, urban planners, fare collecting system operators
Green cities development	Green buildings, green spaces, cycling corridors, recycling plants, water-harvesting structures	Green architects, planners, financiers, technicians for green buildings, recycling plants
Innovations in financing for clean energy	Pay-as-you-go utilities and energy services for off-grid customers	Finance professionals, mobile apps and technicians, off-grid energy system managers and O&M technicians
Renewable energy	Distributed and off-grid renewable energy, access to modern energy sources, biomass and biogas for cooking and motive power for agroprocessing and watermills	Solar photovoltaic engineers and technicians, O&M technicians
Energy efficiency	Energy-saving appliances, industrial processes, electrical motors, insulation	Engineers, technicians, construction workers, installation workers
Smart cities	Digitally connected cities with communication infrastructure, connected devices, automated municipal processes. parking solutions, lighting solutions, and Wi-Fi	Providers, manufacturers of sensors, development companies or software providers
Environmental services	Solid waste collection, street and drain cleaning, environmental management plan/compliance/monitoring and auditing, environmental impact assessment, resource management studies, water resource management, environmental management systems/ISO 14001, environmental risk assessment	Environment engineers and technicians, finance specialists, municipal workers, environment economists, energy-efficient systems installers

Source Compiled by authors

transport and building, in anticipation of rapid urbanization growth, utilization of energy-efficient and safe urban infrastructure and mass transit will be encouraged and supported. In agriculture, utmost consideration will be given to the protection of soil fertility and water for sustainable food production.

Asia needs to step up further in terms of technology and innovations in terms of energy efficiency, shifting more to renewable energy and providing the necessary skills needed to sustain these moves. As such, in various key sectors that ADB supports, the success of any undertaking depends largely on the quality of human resources. The fundamental strategy is quality education and training at all levels.