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GREEN INDUSTRIAL SKILLS FOR A SUSTAINABLE FUTURE

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Executive summary

By now, most countries have recognized the salience of transitioning towards more sustainable modes of production and consumption. Many have also taken concrete steps towards greening the economy and increasing environmental awareness. Such actions have been shown to have a positive effect on job creation, which is an essential co-benefit of the green transformation especially for developing countries. To enable and support this process, appropriate skills (i.e. green skills) are needed to develop and use green technologies in various sectors.

This report focuses specifically on explaining the relevance of skills to enable the green transformation in the industrial sector, understood broadly to comprise not only manufacturing but also other productive sectors (such as construction, transportation and agriculture). In particular, it examines what upcoming trends in greening the industry in developing countries imply for the necessary skills, what kind of skills and competencies are expected to play a role in greening the industry, and what interventions may be necessary to develop such skills. Lastly, drawing on experiences with such interventions in developing countries, it highlights what the pre-requisites are for implementing effective skill development programs and for scaling them up. While green employment creation programs have been discussed elsewhere, this report focuses on necessary interventions to improve existing green skills and/or to develop new skills in order to meet the demand created by greening the economy also in the context of other major transformations, such as digitalisation.

Insights provided by this report seek to guide policy interventions to meet the demand for green skills needed to effectively install, operate, and develop green technologies. Understanding the extent to which the transition to a green economy induces changes in the demand for green skills and, most importantly, which skills these might be, is crucial to inform policy interventions.

A significant challenge for all stakeholders involved in the skill development process is the lack of consensus on what type of occupations and skills should be considered green. Such limited uniformity in definitions hampers not only (much needed) data collection efforts; it also creates inertia in coordinating action for appropriate skill development programs. Therefore, understanding what green skills refer to, allows firms, training and education institutions (and other relevant stakeholders) to assess the availability of such skills and the need for further interventions in this area. Such interventions also need to be supported by a solid understanding of what the future holds in terms of greening economies in the coming decade(s). Observing how markets for green technologies are expected to evolve across sectors, and the extent of domestic value creation associated with different technologies (e.g. local manufacturing and learning), can point to gaps and opportunities for skill development programs.

The report stresses that the effectiveness of these skill development programs depends not only on the set of policies aimed at deploying green technologies and at building knowledge related to the transition to a green economy. Much more important is the process by which policies and interventions are implemented across sectors. Specifically, several guidelines emerge as important for stakeholders involved in skill development programs:

- Policy coherence between green skills development programs and other policy goals through a systematic process of stakeholder consultations;
- Close coordination of goals and interventions across sectors and stakeholders (at national but also at regional and even at global level);
- Solid empirical base on existing green jobs and green skills;
- Systematic mechanisms for green skills forecasting to anticipate future needs in terms of skills development interventions;
- Monitoring and evaluation of outcomes.

The private sector should be seen as a central player in green skills development programs. Therefore, the above pre-requisites emphasize the need for firms to be active participants not only in implementing such programs, but also in the policy-making process. Other stakeholders, such as civil society, trade unions, development agencies and international financial institutions are also important players in designing and implementing training programs, especially when it comes to green skills. The LKDF's focus on Public-Private Development Partnerships (PPDP) and its emphasis on monitoring and evaluation of skills development programs offers a solid framework for expanding green skills in developing countries. The above guidelines can contribute to enable the transition to a green economy in such a way that important co-benefits in the form of employment and appropriate skills are harnessed.

Abbreviations

BEE	Bureau of Energy Efficiency (India)
Cedefop	European Centre for the Development of Vocational Training
CSP	Concentrated solar power
EC	European Commission
EEP	Ethiopian Electrical Power
ESCO	European Skills/Competences, Qualifications and Occupations
GDP	Gross domestic product
GGS	Green General Skill
GHG	Greenhouse gases
HVAC	Heating, ventilation, and air conditioning
IT	Information technology
ICT	Information, communication and telecommunication
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
IRESEN	Research Institute for Solar Energy and Alternative Energies (Morocco)
LKDF	Learning and Knowledge Development Facility
LMIS	Labour market information systems
MSMEs	Micro, small and medium enterprises
NDCs	Nationally Determined Contributions
OECD	Organization for Economic Development and Cooperation
O*NET	Occupational Information Network (United States)
PPDP	Public private development partnership
PPP	Public private partnership
PV	Photovoltaics
QI	Quality infrastructure
R&D	Research and development
SDGs	Sustainable Development Goals
SWH	Solar water heaters
TVET	Technical and vocational education training

TEVETA	Technical Education, Vocational and Entrepreneurship Training Authority (Zambia)
UK	United Kingdom
UNIDO	United Nations Industrial Development Organization
US	United States
WEF	World Economic Forum

1. Skills for the green transformation

The need to transition towards more environmentally sustainable modes of production and consumption has become an imperative both for developed as well as for developing countries. Indeed, the last decades have been marked by fast pace of innovation in green technologies, leading to significant decline in costs and rapid deployment of most mature technologies, supported by adequate incentives. Increasing evidence for environmental degradation and health damage caused by pollution, along with decreasing costs for green technologies suggest, therefore, that such a transition is not only desirable but also economically possible. This gradual shift towards a greener growth pathways and higher rates of decarbonization, contributed to an acceleration of knowledge creation in this area, mobilizing (public and private) investments for greening the economy. These trends, in terms of technology diffusion and decoupling growth from environmental degradation, are expected to intensify in the future.

Empirical evidence increasingly showsw that the deployment of green technologies can also have a positive net effect on job creation[1] (ILO 2018a), an essential co-benefit for developing countries seeking to foster inclusive green growth[2]. In fact, as Andreoni and Chang (2016) argue drawing on the seminal work of Alice Amsden (e.g. 2012), creating productive jobs "via learning-based industrialization is the only pathway to truly inclusive and sustainable development." Advancing the green growth agenda in developing countries, while ensuring that employment opportunities are expanded, is therefore of utmost importance. By now, as WEF (2020) highlights, jobs in the green sector are still limited but growing at a much faster rate relative to other sectors. Thus, vast opportunities exist, placing increasing demands on education and training institutions.

The transition to a low-carbon, resource efficient economy involves systemic interventions to change methods of production across several sectors (ILO 2018a). In particular, changes are required in the most polluting sectors, specifically in the generation, use, and transmission of energy, in transportation and agriculture. To this end, although with varying level of ambition, nearly all countries have by now renewable energy support policies in place (REN21 2020). Moreover, several countries have also expressed their commitment to reducing emissions across key sectors through Nationally Determined Contributions (NDCs) following the signing of the Paris Agreement in 2015. On a practical level, the private sector has also increasingly played a role in effectively achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda, by developing sustainable business ecosystems and shaping policies through public-private dialogue.

In spite of these measures and existing opportunities, industry and transportation remain the fastest-growing sources of greenhouse gas (GHG) emissions (Friedlingstein et al. 2019). Industry-related GHG emissions, in particular, have continued to increase despite the declining share of manufacturing in global gross domestic product (GDP) (Fischedick et al. 2014). Yet, decoupling of industrial activities from an excessive use of natural resources and environmental degradation is key for the green transformation (UNIDO 2020). This process can be a "game-changer" for structural change (Altenburg and Rodrik 2017). The systemic changes necessary to enable such a transformation will result not only in new products and services but also in changes in production processes and business models (ibid.).

To make these outcomes possible, aside from policies and institutions, technology development and appropriate skills are necessary. Moreover, well-functioning labour markets are critical for ensuring that the outcomes are socially inclusive (i.e. that jobs are created and that those who lose their jobs can be

[1] While job creation is certainly essential for development, especially in low- and middle-income countries, employment effects should be considered in a wider framework of costs and benefits (OECD 2017). Specifically, the social benefit from avoided premature deaths from air pollution tends to substantially outweigh costs from job losses due to air pollution regulation (OECD 2016).

[2] In this paper we rely on OECD's (2011) definition of green growth: "fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which out well-being relies."

reintegrated in the economy) (OECD 2017), and that the needed job transitions and reallocations can be realized.

Greening the economy will inevitably change the skills required and the tasks involved in many of the existing occupations (Bowen et al. 2018). The development of skills, of knowledge and competences, is, therefore, a major component of the transition to a low-carbon economy. Such skills enable the adoption and use of resource-efficient, sustainable process and technologies by the private sector and individual consumers (Cedefop and OECD 2015).

The impacts on skills should also be seen in the broader context of transformations defining the 21st century, including the advent of the Fourth Industrial Revolution (or 4IR) and smart manufacturing processes (known as Industry 4.0). As such, green skills need to be aligned with competencies required by these processes (i.e., digital skills), given the inter-linkages between digitalization and green industrial development.

Three main trends are likely to influence what green skills are necessary and in which activities/sectors (Cedefop and OECD 2018: 9):

- greening requires *upgrading skills and adjusting qualification* requirements across occupations and industries;
- new economic activities related to the transition to a low-carbon economy create *new occupations and related qualifications and skills profiles*;
- structural change creates a *need to reintegrate workers in the declining sectors* into the labour market through re-training programs.

The relative impact of these trends on green skills development programs will vary widely across regions and countries, depending not only on the national economic structure, but also on labour market conditions, and decarbonisation ambitions.

This report focuses specifically on explaining the relevance of skills to enable the green transformation in the industrial sector, understood broadly to comprise not only manufacturing but also other productive sectors (such as construction, transportation and agriculture). In particular, it examines what upcoming trends in greening the industry in developing countries imply for the necessary skills, what kind of skills and competencies are expected to play a role in greening the industry, and what interventions in the areas of education, technical and vocational education training (TVET) and continuous training (or "lifelong training") may be necessary. Lastly, drawing on experiences with such interventions in developing countries, it highlights what the pre-requisites are for effective skills development programs. While green employment creation programs have been discussed elsewhere (see, for example, OECD 2017), in this report we focus on necessary interventions to improve existing green skills and/or to develop new skills in order to meet the demand created by greening the economy also in the context of other major transformations, such as digitalisation.

Insights provided by this report seek to guide policy interventions to meet the demand for green skills needed to both effectively operate and to develop green technologies. Understanding the extent to which the transition to a green economy induces changes in the demand for green skills, and most importantly which skills these might be, is crucial to inform policy action.

The report is structured as follows:

- **Chapter 2** provides a *taxonomy of green jobs* and *green skills*, reviewing different definitions of these concepts. Clarifying these concepts allows us to identify what kind of employment opportunities are likely to be created by the transition to a low-carbon economy, and what kind of skills may be in demand, as a result. Further, it allows us to shed more light on the type of policy interventions necessary to develop the required competences.

- **Chapter 3** briefly reviews *empirical evidence on employment effects of greening the economy in developed and developing countries* (i.e. how many jobs, in which sectors, what kinds of jobs).

The chapter also discusses the extent to which these new jobs require new skills development interventions.

- **Chapter 4** reflects on *expected trends in terms of the green technology diffusion in the developing and emerging economies* and discusses possible implications on green skills. In particular, it examines which green technologies are expected to diffuse rapidly in the coming decade and for which of these technologies localization of manufacturing and related services (i.e. value addition) is expected to be higher. With a focus on a few selected technologies, the chapter also reflects on the implications on needed skills along the value chain depending on the sophistication of different green technologies and the complexity of associated skills.

- **Chapter 5** delves deeper into *policy actions to build up the needed green skills at different levels*. It draws on the experience of various countries in implementing education and training programs, discussing drivers of industrial skills development and challenges in implementation. This assessment makes it possible to synthesize several pre-requisites for effective skills development programs. The pre-requisites will be discussed from two main perspectives:
  - » *policy specific*, or related to the area of (policy) intervention, i.e. environmental regulation to create a need for jobs and skills, research and innovation for more advanced skills, labour regulation, etc.;
  - » *process specific*, referring to the role and mode of engagement of various stakeholders (e.g. private sector, government, education and training actors) and the policy-making process for identifying skills and responding to existing gaps (i.e. foresight, coordination, monitoring and evaluation).

- Lastly, **chapter 6** concludes with recommendations for the main stakeholders involved in skills development programs (in particular the public and the private sector). Recommendations are also identified to further guide LKDF's upcoming partnerships and programs for green skills in developing countries.

2. Green jobs, green skills: definitions and implications for policy

While the concepts of green jobs and green skills have become widely used in policy and research circles, they remain oftentimes vague in terms of the type of employment and tasks/occupations they encompass (van der Ree 2019). Moreover, the concepts are often used interchangeably, which may create further confusion in policy implementation. Thus, a short clarification of these terms is necessary before delving deeper into policy discussions.

2.1 Green jobs

Definitions of green jobs vary across organisations, such that currently there is still limited consensus on what constitutes a green job and what not. First, one important difficulty associated with defining green jobs relate to the vast spectrum of actions associated with environmental sustainability, from, for instance, reducing pollution and resource exploitation, to preventing pollution by reducing the use of energy and materials (Vona et al. 2019). Further, as Winter and Moore (2013) argue, the definition of a green job "can be occupation-specific, industry-specific, reflect the underlying process or the output produces, or be very broad and inclusive". This variation of classifications echoes in uncoordinated data collection and statistics across countries or even within organisations at national level.

Second, it is not clear whether, the green jobs classifications and statistics refer to existing jobs in the

traditional economy but reclassified as "green" (Winter and Moore 2013) because they contribute to the process of transitioning to a low-carbon economy, or they are new jobs created in either traditional or "green" sectors.

Third, there is also limited agreement on which activities to consider "green"[3], leading not only to inconsistent statistics, but also to contradictions.[4] A fourth issue relate to accounting for jobs in the supply chain. Specifically, workers in the operation of renewable energy facilities would undoubtedly be referred to as green jobs, but workers supplying parts and components (metals, engines, cables, etc.) would not, although they are part of the supply chain for these activities (Connolly et al. 2016).

Figure 1 summarizes the most common definitions of green jobs used in policy circles. These definitions are rather broad and thus present similarities in terms of focusing on activities aimed at preserving and restoring the environment and in terms of employment created in the public and in private sector.

Figure 1: Common definitions of green jobs

ILO (2019, 2016)	Green jobs are decent jobs that contribute to preserving or restoring the environment, be they in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency. Green jobs help to improve efficiency in the use of energy and raw materials, limit GHG emissions, minimize waste and pollution, protect and restore ecosystems, and support adaptation to the effects of climate change.
UNEP, ILO, IOE, ITUC (2008)	Green jobs refer to "work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity, reduce energy, materials, and water consumption through high efficiency strategies, de-carbonize the economy, and minimize or altogether avoid generation of all forms of waste and pollution."
Eurostat (2009)	Employment in the environmental goods and services sector[5] refers to "employment in environmental enterprises but also in public administrations that are involved in the creation of environmental technologies, goods and services and the employment linked to ancillary activities in the various productive units."
European Commission (EC) (2013: 8)	Green jobs are "covering all jobs that depend on the environment or are created, substituted, or redefined (in terms of skills sets, work methods, profiles generated, etc.) in the transition process towards a greener economy."
United States' Bureau of Labour Services (BLS) (n.d.)	BLS uses an output and a process approach to define green jobs: (a) "jobs in business that produce goods or provide services that benefit the environment or conserve natural resources" and (b) "jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources."

Source: Own compilation based on the above sources.

[3] To add more complexity to this problem, differences in accounting for green jobs also arise from what sectors (technologies, or activities) are considered to be "green" (Winter and Moore 2013). In particular, there is often lack of consensus on what technologies are part of the renewable or clean energy, both being part of the "green economy". For instance, OECD and Eurostat exclude nuclear power from the definition of environmental services, but include nuclear waste management. The United States (US) Bureau of Labor Statistics, however, considers nuclear to be clean energy. Further, International Renewable Energy Agency (IRENA) and Greenpeace consider small-scale hydro to be renewable energy but large-scale hydro not.

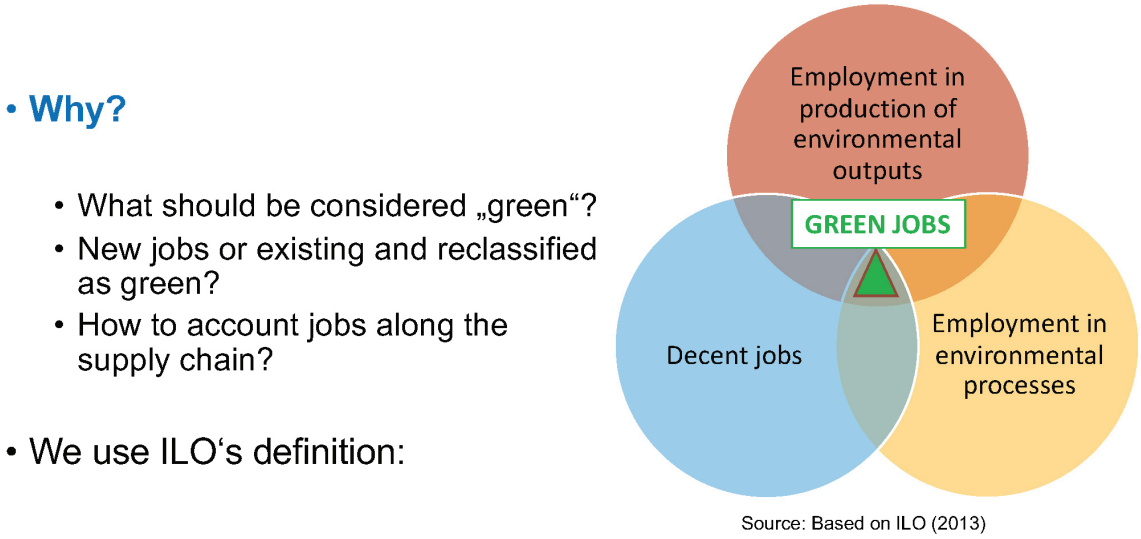
[4] For example, Connolly et al. (2016) provide the example of two farmers producing the same crop, one supplying the crop to the production of biofuels and hence classified as having a green job, while the other providing the crop to food production, thus classified as a job in the traditional sector.

[5] The environmental goods and services sector consists of "a heterogeneous set of producers of technologies, goods and services that: (1) measure, control, restore, prevent, treat, minimize, research and sensitize environmental damages to air, water and soil as well as problems related to waste, noise biodiversity and landscapes. This includes 'cleaner' technologies, goods and services that prevent or minimize pollution; (2) measure, control, restore, prevent, minimize, research and sensitize resource depletion. This results mainly in resource-efficient technologies, goods and services that minimize the use of natural resources. These technologies and products (i.e. goods and services) must satisfy the end purpose criterion, i.e. they must have an environmental protection or resource management purpose (hereafter 'environmental purpose' as their prime objective."

Yet, identifying the best definition of green jobs may not be critical for policy purposes, since "expanding the number of green jobs is not, in and of itself, a reliable indicator of progress in achieving green growth" (OECD 2012). Instead, the ultimate policy goals related to green jobs should be improved environmental outcomes and labour market opportunities. For this reason, a pragmatic approach for defining green jobs is preferred, by which key types of jobs can be identified. Such an approach should allow policy makers to recognize relevant types of employment associated with greening the industry (or the economy more broadly) so that they can guide labour market and training policy. Moreover, a pragmatic approach would also be useful to anticipating future hiring needs and job skill requirements linked to green markets development.

For consistency purposes, this report adopts ILO's definition that considers not only employment in the production of environmental outputs and in environmental processes, but also non-green jobs in non-environmental sectors created due to greening. Moreover, ILO's definition also stresses that these jobs should be "decent"[6]. This qualification is important, as green jobs are not necessarily good quality jobs. Figure 2 illustrates which types of jobs are included in ILO's classification.

Figure 2: ILO's definition of green jobs



Source: Based on ILO (2013)

2.2 Green skills

As mentioned above, a common understanding on what green jobs are allows policy makers to identify the necessary interventions (at sector or firm level) not only for stimulating employment but also for developing the required skills. ILO (2019: 19) defines skills as "the knowledge, competence and experience needed to perform a specific task or job." Defining green skills is, however, more challenging for similar reasons as those related to green jobs[7]. Cedefop (2012) defines green skills as "the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society." OECD and Cedefop (2014) take a step further and define green skills as "the skills needed by the workforce, in all sectors and at all levels, in order to help the adaptation of products, services and processes to the transformations due to climate change and to environmental requirements and regulations".

[6] ILO's decent work concept combines access to full and productive employment with rights at work, social protection and the promotion of social dialogue.

[7] Important to note is that in its publications ILO uses the concept of "skills for green jobs" instead of "green skills", referred to as "those general and technical skills applied to fulfil the requirements of productive and gainful employment in the green economy" (ILO 2011).

Thus, while green jobs and green skills are sometimes interchangeably used, differentiating between them is important, primarily because green skills offer a much more disaggregated perspective on the labour market dynamics associating with greening the economy. This then enables policy makers to identify specific training (competence building) interventions. For instance, identifying how similar the skill content of green and non-green jobs is can help determine the degree of re-training needed to enable the transition to the green economy (Bowen et al. 2018).

Cedefop (2012) (cited in OECD and Cedefop, 2014: 20) synthesizes three main ways in which the transition to a green economy affects needed skills:

- structural changes lead to increased demand for some occupations and decrease for others;
- new economic activity will create new occupations and there will be a need for new skills profiles, qualifications and training frameworks;
- many existing occupations and industries will experience greening changes to tasks within their jobs, and this will require adjustments to the current training and qualification frameworks for these occupations.

Understanding the effect of greening the economy on the necessary skills, and tailoring training programs to the skill needs of the workforce may contribute to reducing the skill gap in the labour market, and thus mitigate the potential negative employment effects of environmental regulation (Vona et al. 2015). Exploring what kind of skills are likely to be in demand is important to also grasp whether the benefits of greening are equally distributed. Becker and Shadbegian (2009), for instance, show that green technologies are skill-biased, as for a given level of output and factor usage, plants producing green products and services employ a lower share of production workers.

A key challenge, however, is identifying specific green skills within certain green jobs.[8] Vona et al. (2015, 2018) are among the few that have systematically assessed a set of skills that are used more intensively in green occupations relative to non-green ones. Using the occupation-specific information of the Occupational Information Network (O*NET) of the US Department of Labour, which provides a finer distinction between green and non-green tasks[9], Vona et al. (2015) generated a Green General Skill (GGS) index by first developing a measure of skill 'greenness' (as the ratio between the number of green specific tasks and the total number of specific tasks performed by a specific occupation). This classification illustrates that green occupations (both in the existing/enhanced and new jobs spectrum[10]) are mostly concentrated at the tails of the skills spectrum, either among high-skilled professionals (such as managers and engineers) or among low-skilled manufacturing and production occupations (such as construction workers or maintenance and repair) (see Figure 3).

[8] This is important because, for example, an electrical engineer "can plan the layout of an electric power generating plants of distribution lines and, at the same time, can design electrical components that minimize energy requirements." (Vona et al. 2015: 10).

[9] The European Skills/Competences, Qualifications and Occupations (ESCO) classification does not yet include the green economy as a separate sector and therefore distinguishes skills/competences, qualifications and occupations along the green dimension. Instead, ESCO uses the environmental dimension.

[10] The O*NET database's taxonomy of green occupations classifies them into three categories:

a. green increased demand occupations (referring to increase in employment for an existing occupation without significant change in the requirements for the occupation);
b. green enhanced skills occupations (referring to significant change to the work and worker requirements of an existing occupation); and
c. new and emerging green occupations (referring to cases where the impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements, resulting in the generation of a new occupation. (OECD 2014: 61)

Figure 3: Examples of green occupations by level of 'greenness'

	Greenness=1	Greenness btw 0.5 and 0.3	Greenness<0.3
Green Enhanced Occupations	Environmental Engineers, Environ Science Technicians, Hazardous Material Removers	Aerospace Engineers Atmospheric and Space Scientists, Automotive Speciality Technicians, Roofers	Construction Workers, Maintenance & Repair Workers, Inspectors, Marketing Managers
New and Emerging Green Occupations	Wind Energy Engineers, Fuel Cell Technicians, Recycling Coordinators	Electrical Engineering Technologists, Biochemical Engineers, Supply Chain Managers, Precision Agriculture Technicians	Traditional Engineering Occupations, Transportation Planners, Compliance Managers

Source: Vona et al. (2015: 43)

Second, to develop the GGS index, Vona et al. (2015) identify general sets of skills that potentially complement green activities. Their index identified four groups of work tasks that are especially important for green occupations:

- Engineering and technical skills: hard skills encompassing competences involved with the design, construction and assessment of technology usually mastered by engineers and technicians. This know-how prevails for eco-buildings, renewable energy design and energy-saving R&D projects.
- Science skills: competences stemming from bodies of knowledge broad in scope and essential to innovation activities, for example physics and biology. Especially in high demand in each stages of value chains and in the utility sector (Cedefop 2009). Such skills are essential for environmental scientists, materials scientists, hydrologists, for instance.
- Operation management skills: know-how related to change in organisational structure required to support green activities and an integrated view of the firm through life-cycle management, lean production and cooperation with external actors, including customers. Such skills are important, for example, for sales engineers, climate change analysts, sustainability specialists, chief sustainability officers, transportation planners.
- Monitoring skills: technical and legal aspects of business activities that are fundamentally different way from the remit of engineering or of science. They refer to skills required to assess the observance of technical criteria and legal standards. Examples are environmental compliance inspectors, nuclear monitoring technicians, emergency management directors and legal assistants.

In addition to these skills, a range of soft skills are also considered to be increasingly important, not only for green skills, but generally for the "skills of the future" including also those necessary for Industry 4.0. In particular, skills related to design thinking, creativity, adaptability, resilience, and even empathy, have been repeatedly mentioned to be critical by experts at the LKDF Forum 2020.

Even if, as mentioned above, green occupations are concentrated in both high- and low-skilled jobs, the authors note that, except for monitoring skills, green skills require substantial training and formal education. Further, given Lin's (2011) finding that new occupations exhibit higher levels of task complexity and exposure to new technology, we can assume that the skill-building needs (i.e. training and education) for new and emerging green occupations will be significantly higher.

Important to mention, however, is that whether a green job is new or existing but 'enhanced' (with some new elements) depends on the economic structure of a particular country and, especially, on how advanced the country' economy undergoing green transformation is. Cedefop (2010) also argues that the level of needed retraining may be less extensive than expected, as fundamental skills for most green jobs already exist. Instead, additional training specific for green concepts and practices, upskilling or adding to existing core skills may be necessary (Mclean et al. 2018), as well as retooling with regards to fields of study and vocational skills (OECD 2017). This is also reflected in the Figure 4 below, which allows us to transition to discussing in more detail the employment effects of greening the economy in the next chapter.

Figure 4: Current and expected effects of climate change and green economy policies on employment

Effects	Examples	Expected scale
New jobs will be created (in existing and new occupations)	Solar panel technicians, organic farmers, recycling managers, staff in eco-tourism resorts, workers in natural resource conservation and restoration, environmental advisers, workers in bicycle shops.	Modest
Certain jobs may be eliminated	Coal miners, workers in bottling industry adopting water and material-saving technology, staff of obsolete or prohibited packaging materials industry	Small
Jobs will be substituted (occupations change)	Jobs in transport systems moving to rail, electric cars and shared vehicles, waste management jobs in landfilling/dumpsite moving to incineration and recycling, jobs in quarries for construction using new building materials and re-use of left-overs and waste	Modest
Most jobs will be transformed (occupational profiles change)	Workers, operators and managers in greening sectors notably buildings, agriculture or transport: all learning to manage new technology and operating practices; workers in all sectors where energy and resource efficiency is introduced (cleaner production in manufacturing, retail services without packaging, bottle companies changing to new materials and products), staff in financial institutions adopting sustainable strategies.	Large

Source: van der Ree (2019)

3. Employment effects of greening the economy

Accurately measuring the employment effects of greening the economy remains challenging for at least two main reasons: (1) inconsistent definitions of green jobs used by statistical offices; and (2) variety of activities related the greening the economy, which result not only in a direct job creation process, but also generate employment indirectly (so called indirect and induced jobs)[11]. In addition, low data availability on employment especially by job categories in developing countries has limited the more detailed studies to the OECD countries.

ILO (2018) estimates a global net job growth by 2030 of 18 million jobs as a result of changes in energy production and use to achieve the 2°C goal (24 million of new jobs and loss of around 6 million jobs).[12] While green electricity generation (i.e. based on renewable energy sources) remains an important source of employment, almost 6 million jobs can be created by embracing the recycling, reuse, remanufacture, rental and longer durability of goods (i.e. circular economy).

Whereas the net effect on employment is hard to measure and still little solid empirical evidence exists, several studies show that overall job creation and job destruction tend to be of similar size for "well-implemented" green policies (OECD 2017: 11). These impacts will depend, however, on the ability of workers to adapt their skills and switch across sectors, reason why skills development programs are essential, especially in the short-term.

Yet, the effects of the transition to a green economy on workers will not be uniform, since jobs are heterogeneous in terms of required skills and tasks to be performed. Moreover, the scale of the effects also depends on economic structure, energy intensity of manufacturing, and labour intensity.

[11] Direct employment includes jobs created by the core activities of a project (for instance workers on a renewable energy generation plant), but excludes the intermediate inputs necessary for it such as, for example the manufacturing of renewable energy equipment. Indirect employment covers traders as well as service material providers who provide inputs to primary projects, even if they do not consider themselves to work in a green sector. Induced employment effects occur along value chains other than renewables, associated with the downstream effects of the project and indirect employment.
[12] ILO's analysis is based on a scenario for decarbonizing the energy, transport and construction sectors.
[13] See Figure 1 in Chateau et al. (2018)

Specifically, non-OECD countries have not only much lower capital to labour ratios (relative to OECD countries), but also higher emissions and energy intensity associated with their economies.[13] Therefore, the impacts on job creation and job destruction as a result of policy measures aimed at decarbonisation, are expected to also be higher for non-OECD countries. As such, the shift of workers from emissions and energy intensive sectors to cleaner sectors is likely to create a higher demand for re-skilling in non-OECD countries.

In fact, ILO's (2018: 42) estimation shows that net job creation by 2030 may be negative (i.e. net job losses) for countries in the Middle East (-0.48 %, or over 300,000 jobs) and Africa (-0.04%, or around 350,000 jobs) if the economic structure of these countries does not divert from 'the historical trend'. Overall, however, several studies converge in concluding that a green (low-carbon) economy will have a neutral or slightly positive overall impact on employment; but, the impacts will be spread unevenly across countries, regions and types of workers (OECD and Cedefop 2014, Cedefop 2012, OECD 2012, UNEP 2011). Therefore, decarbonisation efforts should be accompanied by policies to support structural economic change and social assistance.

Related to the above point, another important aspect related to employment effects linked to decarbonisation is the nature of jobs that will be affected. To capture these various effects, Chateau et al. (2018) used a general equilibrium modelling framework to account for the effects of decarbonisation policies[14] on different sectors, regions, and categories of workers. The authors find that, at the global level, *low-skilled jobs tend to account for the largest share in both job creation and job destruction, while high- and medium-skilled labour[15] accounts for most of the net job gains*.[16]

Moreover, labour reallocation is expected to be higher within the low-skilled workers especially in non-OECD countries. For instance, job reallocations for low-skilled workers amount for 81% for India, 68% for China, and 86% for Indonesia (Chateau et al. 2018: 31). This suggests that skills development programs should target those workers in particular, to ensure that the labour market is able to respond to changing conditions.

These results are, however, highly sensitive to the model assumptions. ILO's (2018) global assessment, for instance, finds that reallocation is likely to benefit sectors that employ fewer highly skilled workers, meaning that employment opportunities will favour low- and medium-skilled workers. ILO (2019) concludes that new (green) occupations tend to emerge at higher skill levels (especially challenging for developing countries facing skills deficiencies at this level), which may require re-skilling, while lower-skilled occupation may require only simple adaptations (i.e. upskilling) and more environmental awareness (see Figure 5).[17]

[14] The report focuses mainly on one policy in particular, a carbon tax of $50 t/CO2 applied in all regions of the world. The analysis also considers a policy-mix scenario, where a carbon tax is combined with efficiency measures.

[15] The report groups ILO's (2008) job classifications into three skills categories: high-skilled workers refer to 'professionals' and 'managers and officials', intermediate-skilled workers refers to 'service and sales workers' and 'clerical workers', while low-skilled workers refer to 'blue collar and farm workers'.

[16] Similar results are also obtained by Cambridge Econometrics, GHK, and Warwick Institute for Employment Research (2011).

[17] Focused on the case of the US, Bowen et al. (2018) also argue that, relative to other major transitions (due to the IT technology development and outsourcing), the green transition's impact on skill retraining is lower and most retraining can happen on the job.

Figure 5: Changes in skills as a result of the green transition, by skill level

Skill level	Nature of change	Example of occupations
Low-skilled occupations	Generic change, i.e. environmental awareness; simple adaptations to work procedures	Refuse/waste collectors, dumpers
Medium-skilled occupations	Some new green occupations	New occupations: wind-turbine operators, solar-panel installers
	Significant changes to some existing occupations in terms of technical skills and knowledge	Changing occupations: roofers; technicians in heating, ventilation and air conditioning; plumbers
High-skilled occupations	Locus of most new green occupations	New occupations: agricultural meteorologists; climate-change scientists; energy auditors and energy consultancy; carbon-trading analysts
	Significant changes to some existing occupations in terms of technical skills and knowledge	Changing occupations: building facilities managers; architects; engineers

Source: ILO (2019: 111)

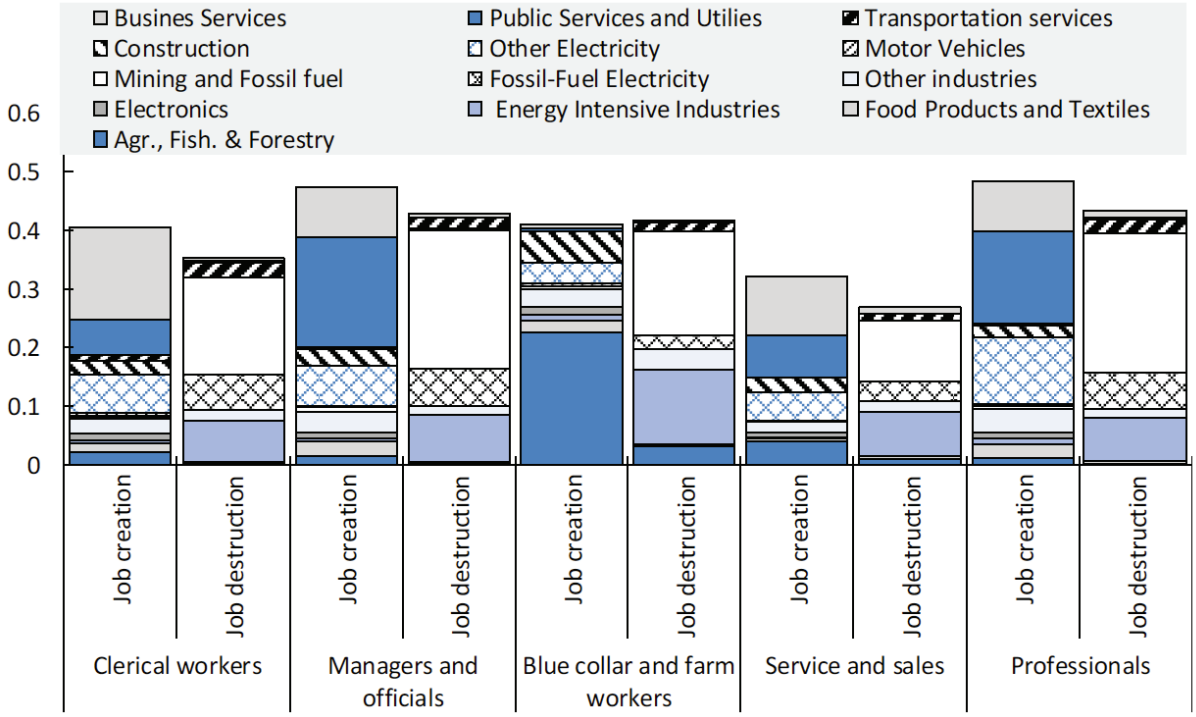
These trends should, also be seen in the context of other global technological trends, such as the digitalization and Industry 4.0, which favour job creation for medium- and highly-skilled workers. Advanced digital technologies have above-average green content, especially when it comes to robots, machine learning and CAD-CAM systems, contributing to saving water, energy, materials and minimizing waste (UNIDO 2019). Thus, job creation efforts and skills development programs should aim for complementarity with new technologies (UNCTAD 2018).[18] The net employment effects and the labour reallocation effects, also vary widely across sectors. Appendix 1 shows selected impacts of green growth policies on the economy and on employment.

More concretely, Figure 6 summarizes the job creation and destruction effects for non-OECD countries by sectors, as measured by Chateau et al. (2018). We see that across skill categories, fossil-fuel electricity and mining and fossil-fuel sectors are going to see most job destruction effects, as these are also the most energy and emissions intensive sectors. For high-skilled workers most job creation will come from business services, public services and utilities, construction and transportation, while for low-skilled workers job creation is seen in agriculture, fish and forestry sector, construction, and other electricity sectors. Renewable energy electricity generation (especially solar photovoltaics) has been a particularly important source of job creation in the green technology space (ILO 2019, IRENA 2020).[19]

[18] These two technology trends are driving what UNIDO (2019) calls Industrial Sustainable Industrial Development, by which new technologies offer not only opportunities to introduce new goods into the market but also increase production efficiency. Jobs are created in the process, as well as new dynamic competitive advantage, along with environmental sustainability. However, it is important to mention that not all digital jobs are also green jobs, as digitalisation may also contribute to increase in energy use. More research is required to examine which digital jobs are also green jobs and how to increase the greenness of digital skills.

[19] ILO (2019) provides various examples of how greening in particular sectors is likely to affect employment in various developing countries.

Figure 6: Change in sectoral composition of job creation and destruction by job category and by aggregate sectors (mixed scenario[20]) for non-OECD countries (% change in employment relative to total employment of the category in the reference equilibrium, 2011)



Note: For 'Mining and fossil fuel supply' and 'Fossil-fuel electricity' only job destructions occur, while all the job creations occur in 'Other Electricity'.

Source: Chateau et al. (2018: 33)

While empirical evidence on how many jobs the transition to a green economy is likely to generate remains thin and inconsistent, existing studies agree that regional and sector level estimates vary widely across countries, for the reasons highlighted above. Although not discussed in this report, it is important to also mention that empirical evidence also shows that jobs created in the green economy sector tend to also promote gender equality (ILO 2015; IRENA 2019).

Yet, more important than knowing concrete numbers is to understand the kind of jobs and skills that may be in demand as a result of greening the economy. OECD (2017:18) also stresses that more empirical evidence is needed on the characteristics of jobs that are being created and destroyed. While 'more jobs' is always better, it is equally important to ensure that the jobs created are 'productive' (i.e. in manufacturing, both production and services related), which is crucial for long-term development. Skills development programs in the absence of expanding and transforming the productive sectors may be self-defeating, as they may contribute to aggravating the unemployment problem (Amsden 2012). Further, in light of the variation we see in employment effects from greening, it is also important to acknowledge that country level development goals may condition the 'green agenda'. In particular, while countries with a large 'army' of unemployed may sacrifice modernization for job creation (Amsden 1997) and focus on green technologies that can also provide jobs for a high number of low-skilled workers, others would focus on deeper decarbonisation plans, prioritizing green innovation requiring (fewer) higher-skilled jobs.

[20] The mixed scenario refers to a global carbon tax of $18 t/CO2 combined with efficiency measures.

4. Future trends in green technology deployment and implications on skills

Understanding how markets for various green technologies are likely to evolve in the coming decade in developing countries, as well as the potential that these technologies have to generate local value added is critical for policy makers. In particular, such trends enable the design of skills development programs aligned with emerging demand.

In a study on the transition to a green economy by 2030, Vidican Auktor et al. (2020)[21] find significant variation in diffusion rates of various green technologies in developing and emerging economies. Specifically, *emerging economies* are likely to see moderate to rapid market growth in all green technologies (with only a few exceptions) (see Figure 7).

Figure 7: Expected trends in market development for selected green technologies in emerging economies

Source: Vidican Auktor et al. (2020)

[21] To identify trends in market development for various green technologies by 2030, the study uses the Delphi survey method combined with in-depth interviews.

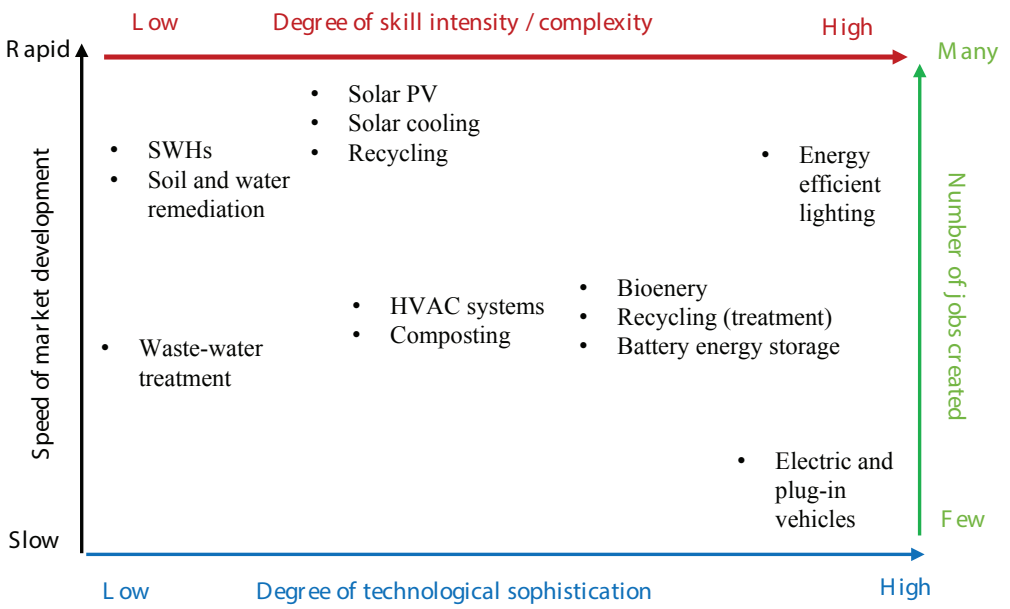
Markets for renewable energy generation technologies are expected to grow significantly in the coming decade, driven both by falling costs of generation, as well as by increasingly ambitious policy targets. Waste management, sustainable transportation, energy efficiency in buildings and in industrial processes, and sustainable agriculture related technologies are also expected to see increasing rates of deployment. As most of these sectors are also labour intensive, employment effects are also expected with greening. For instance, ILO (2019: 87) estimates a cumulative number of jobs of 4.8 million jobs in India in the renewable energy sector by 2030, 11 million in green buildings, more than 20 million in waste management, and 19 million in water management. In Egypt, solar PV energy is forecasted to create more than 20,000 new jobs and wind energy 75,000 by 2020, while 8 million new jobs may be created by 2050 in sustainable agriculture (ILO 2019: 87).

To support this process, skills development programs are necessary at different levels to accompany the effective use of these technologies for decarbonisation. Such programs are not only 'reactive', but can be important drivers of change themselves, accelerating the green transformation (ILO 2011; UNESCO-UNEVOC 2017; Pavlova 2019). Vidican Auktor et al. (2020) specifically focus on the importance of quality infrastructure (QI) related capabilities, such as developing standards, capabilities related to conformity assessment (certification, testing, and inspection), metrology, or accreditation. QI related skills are essential not only for securing access to new markets, but also for improving competitiveness, enabling innovation, ensuring environmental and consumer protection. Yet, such skills related to green technologies are often in short supply, leading not only to compromising the effectiveness of some technologies, but also to raising costs and undermining future decarbonisation plans. One such example is the case of solar PV in India, which has seen fast growth due to its innovative competitive bidding scheme resulting in large scale and cost-effective deployment (Kar et al. 2016). Yet, cost effective deployment without quality assurance resulted over time in decrease in yields. The demand for services and skills related to testing, certification and inspection has increased as a result. Developing such capabilities and competences early in the market development process can not only create jobs but can also reduce costs and sustain the greening efforts.

Even if markets for most technologies are expected to diffuse moderately to rapidly in emerging economies, variation in the degree of sophistication of related technologies (along with variation in policies) will condition the extent to which green technologies will be imported or developed/produced locally. The degree of technology sophistication may be influenced by several factors, most important being the need for research and development for the products or processes produced or utilized, but also high capital investment. Both of these factors impact the capability of running/maintaining the technology, which in turn influences the type of needed skills (i.e. higher technology sophistication would require higher/more skills).

Therefore, the speed of market development and the degree of green technology sophistication influence not only how many jobs will be created but also what kind of occupations and skills are necessary. Figure 8 provides some examples of green technologies along the spectrum of sophistication and market development for developing countries. Solar PV technologies (especially the more mature crystalline silicon technology), for instance, are expected to diffuse rapidly in developing countries and have a medium degree of technological sophistication. The number of jobs created in this sector (especially associated with decentralized solar systems) are expected to also be relatively large, with a medium-skill intensity. Given the framework conditions in emerging economies (such as existing technological capabilities and level of ambition of greening), these effects (i.e. speed of market development and jobs created) may look quite different for various technologies (electric and plug-in vehicles are, for instance, expected to diffuse rapidly in emerging economies) (Vidican Auktor et al. 2020).

Figure 8: Selected technologies based on the degree of sophistication of related technologies and expected market development, along with anticipated impacts on number of jobs and type of skills demanded in developing countries



Source: Own compilation based on Vidican Auktor et al. (2020).

These factors play a role then, on how much local value added can be created from an increase in deployment of green technologies. For instance, while markets for solar and wind energy technologies are expected to grow rapidly in emerging economies, only less than 30% of the value added for concentrated solar technologies (CSP) is expected to be provided locally, but up to 70% for more mature and cost effective technologies such as solar photovoltaics (PV) and solar water heaters (SWH) (see Figure 9).

Figure 9: Level of domestic value added and technological capabilities to be provided in emerging economies by 2030

Source: Vidican Auktor et al. (2020)

In contrast to emerging economies, *developing countries* are likely to see rapid market development only in selected green technologies. Specifically, markets for more mature (and hence less costly) technologies such as solar PV, rainwater harvesting, recycling of paper, glass and aluminium, some energy efficiency technologies, and sustainable agriculture are likely to be diffused rapidly in these countries by 2030 (see Figure 10). Yet, greening the economies of developing countries will proceed at a much slower pace (as suggested by these trends), which will of course also constrain the employment effects.

Figure 10: Expected trends in market development for selected green technologies in developing countries

Source: Vidican Auktor et al. (2020)

Aside from costs, however, diffusion also depends on supportive policies, finance, implementation and maintenance process. Yet, such capabilities are often in short supply in developing countries and even in emerging economies, as we have seen in the earlier example of India. Concerted effort is necessary to develop such competences to ensure that national targets can be achieved. Failure to do so can compromise long-term deployment even for cheap and less sophisticated technologies, as was the case of SWH in Morocco (Vidican et al. 2012). Present training initiatives in Morocco for installers of solar PV systems, system maintenance and operation, and energy efficiency auditors for the construction and industrial sectors, are aimed to reduce the skills gap early on in the market development process (Vidican Auktor et al. 2020).

These market development trends also reflect on future implications on domestic value addition and technological capabilities. Particularly, for most green technologies less than 30% domestic value added is expected in developing countries and for some more mature technologies with a medium degree of sophistication, this share may go up to 70% (for instance for wind towers, crystalline cells and modules, micro hydropower systems, or solar mini-grids) (see Figure 11).

Figure 11: Level of domestic value added and technological capabilities to be provided in developing countries by 2030

These expected trends for both developing countries and emerging economies illustrate the variety of sectors that are going to be affected by the transition to a green economy. Overall, especially in developing countries, the energy sector, agriculture, and waste management are likely to significantly benefit from greening. Although employment in the energy sector may be relatively small, greening in this sector has strong multiplier effects (ILO 2018a), such as for agro-industries and transportation. Further, agriculture and waste management have high employment shares in developing countries, reason why greening in these sectors requires active participation of workers with adequate skills. For example, ILO (2019: 100-101) lists various activities and related jobs that become important for greening the agricultural sector in Zimbabwe, such as farm power installation, maintenance and repair; design, construction, commissioning, maintenance and repair of biogas digesters; composting, vermiculture; production and sales of alternative cooking fuels and waste derived products; efficient water management; development and use of ICT technologies for early pest warning systems. Most of these activities/occupations would need additional training but can build on existing skills.

As highlighted by OECD (2017), while low-skilled workers will not face extensive employment losses, they will be exposed to a relatively large employment shift across these sectors, requiring considerably retooling regarding the field of study and vocational skills. As many of the more sophisticated technologies expected to diffuse in developing countries and (especially in) emerging economies are new to these markets, green policies are likely to also create strong opportunities for job growth for highly-skilled workers. When these trends on green technology diffusion also happen along (or are inter-related) with other major transformations such as digitalization[22], the needs for reskilling may be even higher[23].

[22] See, for example, the case of Morocco, where the Ministry of Industry is currently in the process of enabling both the greening as well as the digitalisation of economy. This offers a unique opportunity to align skill development programs such that they enable labour markets and firms to drive these economic transformations.

[23] The World Economic Forum (WEF) speaks about an unprecedented scale and speed of transformation created by the fourth industrial revolution, with extensive impacts on jobs and skills. In this context, WEF launched in June 2020 The Reskilling Revolution Platform, as a multi-stakeholder initiative to retrain and upskill the workforce.

5. Pre-requisites for effective skills development programs

Having examined which technologies are expected to play a role in greening the economies of developing countries, we reflect here on the pre-requisites for effective skills development programs and for their scale-up. We do not focus on employment creation programs (discussed elsewhere, such as OECD 2017, ILO 2011). Rather, we focus specifically on interventions to improve existing green skills and/or develop new skills. Programs to develop new green skills are particularly important for MSMEs, which often lack financial resources and capacities to provide training, especially in developing countries.

While most assessments of skills development programs stress the *policy side* of interventions (i.e. specifically policies aimed at creating both demand and supply for green skills)[24], we emphasize that for such interventions to be effective (meaning: to deliver intended outcomes, to be sustained over time and to be scaled-up), a *focus on the process* based on which such programs are developed and implemented may be even more important. We refer specifically to:

- the role and mode of engagement of various stakeholders (e.g. private sector, government, education and training organisations, trade unions, and civil society), and
- the policy making process for forecasting and identifying skills to respond to existing and future gaps (e.g. foresight, coordination, monitoring and evaluation).

These aspects are particularly important given LKDF's focus on Public Private Development Partnerships (PPDP), recognizing that to achieve development goals (including employment and poverty reduction), private sector actors, the public sector, and development agencies share a common goal; as such, the investment, risks, responsibilities and rewards have to be shared between these actors (LKDF, n.d.).[25] (Box 1 illustrates such a PPDP for green skills in South Africa.)

[24] OECD (2017) refers to, for instance, not only to demand and supply side policies, but also to regional development policies and income support.

[25] The PPDP concept builds on the well-known Public Private Partnership (PPP), based on the assumption that certain public goods can be delivered more efficiently and effectively by the private sector. By adding the development perspective, the PPDP recognizes such the PPP approach may be too narrow to address poverty development objectives.

Box 1: Skills development for a green economy in South Africa

Supported by the German Ministry of Economic Cooperation and Development in direct cooperation with South Africa's Department of Higher Education and Training, the Skills Development for a Green Economy II (SD4GE II) program has been funded for the period 2018-2022. The SD4GE II aims to create a sustainable basis of cooperation between public and private stakeholders to promote due training approaches in the area of green skills and employment. In-company mentor training is considered in this process, along with modular training programs for SMEs (in collaboration with industry associations), post graduate programs as collaboration between Technical University of Munich and University of Pretoria, train the trainer programs for TVET lecturers. Further, cooperation with industry is an integral part of SD4GE II, materializing in different forms:

- A memorandum of understanding areas of cooperation with the Southern African-German Chamber of Commerce and Industry
- Cooperation with the National Business Initiative on short courses
- Integrated development partnership with the private sector with SAR Electronic SA for the implementation of an integrated program for the transition to (high tech) employment of graduates of dual occupational programs

These programs are also aligned with skill building initiatives responding to the needs of the fourth industrial revolution.

Source: GIZ (n.d.)

Drawing on various examples of green skills development programs, we discuss below how both of these perspectives (i.e. policy and process) impact on the effectiveness of such programs.

5.1 Policy specific

It is well known by now that the transition to a green economy is strongly dependent on effective policies necessary to:

- create demand for such technologies (e.g. subsidies for deployment, environmental regulation for greening production and reducing pollution);
- develop green technologies (e.g. funding for R&D);
- enhance knowledge and needed skills (e.g. education and training programs).

Well implemented policies targeted towards achieving the goals of a green and inclusive economy are important pre-requisites for green jobs creation and effective skills development programs. If the demand for greening the industry is low, if knowledge capabilities are limited, and if capacities within education and training institutions are depleted or misguided, jobs will be scarce and skills development efforts will be ineffective.

Figure 12 provides a few examples of the most common policy interventions that contribute to creating green jobs, ranging from environmental and economic regulation, to economic and product standards policies.

Figure 12: Most common policies to create green jobs

Policy type	Objective
Subsidies	Phase out subsidies for environmentally harmful industries and shift part of those subsidies to renewable energy, energy efficiency, clean production methods, and public transit.
Carbon markets	Price carbon and address shortcomings in carbon trading and the clean development mechanism so that they can become reliable and adequate funding sources for green projects and employment.
Tax reform	Scale-up eco-taxes. Eco-taxes can be used to reduce the tax burden on workers, while discouraging polluting and carbon-intensive economic activities.
Targets and mandates	Use regulatory tools to develop greener technologies, products, and services. Examples are building codes, energy-efficiency standards (for appliances, vehicles, etc.) and targets for renewable energy.
Energy alternatives	Adopt, for instance, feed-in laws that secure access for renewable energy to the electrical grid at guaranteed prices.
Product takeback	Adopt 'extended producer responsibility' laws for all types of products.
Eco-labelling	Adopt eco-labels for all consumer products to ensure that consumers have access to information needed for responsible purchasing decisions (and thus encourage manufacturers to design and market more eco-friendly products).

Source: Own compilation based on UNEP (2008).

While each of these policies plays a role in enabling green jobs and skills[26], most activities related to greening the economy are cross-cutting and, thus, require an effective mix of policy interventions targeting several sectors at the same time. Examples are, for instance, circular economy and smart grids. Circular economy can offer vast opportunities for value creation, from waste recycling and machinery repair in agriculture to remanufacturing in the textile industry, or to resilient design in construction. The skills required also vary and many tasks involving product design, disassembly, repairs and remanufacturing are non-routine and involve a high level of knowledge[27], thus more difficult to automate and providing job opportunities across a range of skills (and sectors) (Preston et al. 2019).[28] Yet, for circular economy to be more than a fad (given its own challenges related to concept boundaries), its implementation requires a cross-sectoral approach supported not only by policies to increase resource efficiency but also targets and subsidies for clean energy, appropriate finance schemes, as well as standards and labels for product design, among others. Figure 13 provides an example of such a policy toolbox to enable the transition to circular economy in developed and emerging economies. Skills development is one element of the toolkit, which can be effective only if it is well aligned with the other carefully selected instruments.[29]

[26] In developing countries, it is well known that (at least at an early stage) environmental regulations play the strongest role for green job creation and skill development.

[27] When dealing with e-waste (often made up of complex composites) most waste-pickers lack the skills and technology to optimise recycling and repair processes, hindering not only value creation opportunities in the informal sector, but also the formal sector that depends on sourcing sufficient feedstock.

[28] A study from 2015 shows that shifting to circular economy could create up to 3 million additional jobs in Europe by 2030 (WRAP 2015).

[29] An example worth mentioning, which shows how using the right mix of policy tools can contribute to harnessing existing skills in this sector (i.e. the skills of informal workers that dominate the circular economy activities in most developing countries) can be found in Brazil. Brazil's National Solid Waste Policy adopted in 2010 stimulated local and national actors to find interventions that provide access to finance for the informal sector, adopt taxation and fiscal structures that tax resources rather than people (see Preston et al. 2019: 43-44 for more detail).

Figure 13: Selected elements of a circular economy policy toolkit for developed and emerging economies

Type	Policy	Example
Economic instruments	Landfill taxation	Landfill tax in Denmark, the Netherlands and the United Kingdom (UK)
	Carbon tax	Carbon tax in the Netherlands, Norway and Sweden
	Container deposit legislation	AB Svenska Returpak in Sweden
	Infrastructure investment	UK Recycling and Waste LP fund for smaller-scale recycling and waste infrastructure
	Differentiated VAT rate	Reduced value added tax rates in China for secondary raw materials
Information-based	Labelling	EU Ecolabel; Der Grüne Punkt in Germany
	Public education programmes	EU public information campaign on environmental damage caused by plastic waste
	Skills and training	Scotland Skills Investment Plans
Ecodesign	Extended producer responsibility	India 2016 E-Waste Management Rules; Canada-wide Action Plan for Extended Producer Responsibility
	Ecodesign requirements: durability, re-pairability, recyclability	EU's Eco-Design Directive
Other regulations	Waste prevention standard	BS 8001: 2017 – a framework standard for implementing circular economy in organisations
	Voluntary agreements	European PVC industry voluntary agreement; WRAP's Courtauld Commitment to reducing private-sector food waste
	Waste shipments: proper enforcement	UK Transfrontier Shipment of Waste Regulations
Public procurement and innovation	Green public procurement	Dutch government's Green Deal
	Targeted R&D	EU Circular Economy Finance Support Platform: EU InnovFin, backed by Horizon 2020; Innovate UK
	Pilot zones	Circular economy industrial parks in China; eco-industrial parks in Scandinavia

Source: Preston et al. (2019: 40-41)

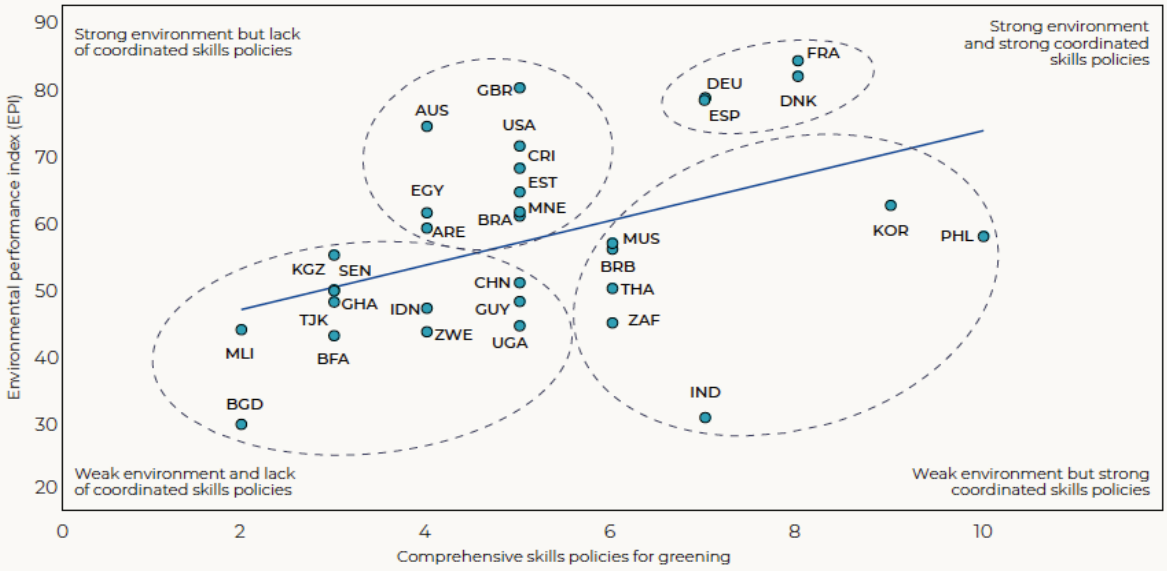
While digital accessibility and digital literacy may also be required components in national strategies to encourage innovation in the circular economy, training and other policies to develop such capabilities (i.e., green and digital skills) are even more important in other critical emerging technology sectors for developing countries, such as smart grids.[30] New jobs and skills associated with smart grid technologies are highly related to information, communication and telecommunication (ICT) and computing, as well to electricity systems skills (Cedefop and OECD 2015). As such, as seen in the case of India for example, smart grid initiatives are difficult to roll out not only for cost or financing reasons, but also because of lack of highly-skilled analysts trained in advanced computing needed to analyse the large volume of data generated by smart buildings and electricity systems, as well as workers to ensure operation and maintenance of such systems (Vidican Auktor et al. 2020).

At a more general level, China offers a good example on how a framework of policies can provide a platform on which more ambitious plans to also create green jobs and skills can be built to guide and adjust economic activities across sectors such as mining, production and circulation or consumption processes, including environmental credit systems and fiscal policies (ILO 2019: 60).

Overall, however, how policies for greening the industry are put into practice and how effectively they are linked to employment and skills-related policies vary widely across countries and even regions (ILO 2019: 61). Figure 14 illustrates well this variation when it comes to environmental policies, considered to be critical for triggering demand for skills development programs.

[30] Vidican Auktor et al. (2020) show that ICT related green technologies, such as smart grids, displayed one of the fastest rate of innovation in the last decade, which may mean that the demand for such (high) skills will also increase, not only in developed but also in developing countries, where smart grids, or e-mobility linked to renewable energy generation may require new advanced skills.

Figure 14: Countries grouped according to performance in environmental and skills policies



Notes: Y axis: the EPI uses the distance-to-target technique for indicator construction, which situates each country relative to targets for worst and best performance corresponding to scores of 0 and 100 respectively. X axis: the presence of comprehensive skills policies for greening was calculated on a 0–10 scale.

Country codes: Australia (AUS), Bangladesh (BGD), Barbados (BRB), Brazil (BRA), Burkina Faso (BFA), China (CHN), Costa Rica (CRI), Denmark (DNK), Egypt (EGY), Estonia (EST), France (FRA), Germany (DEU), Ghana (GHA), Guyana (GUY), India (IND), Indonesia (IDN), Republic of Korea (KOR), Kyrgyzstan (KGZ), Mali (MLI), Mauritius (MUS), Montenegro (MNE), the Philippines (PHL), Senegal (SEN), South Africa (ZAF), Spain (ESP), Tajikistan (TJK), Thailand (THA), Uganda (UGA), the United Arab Emirates (ARE), the United Kingdom (GBR), the United States (USA) and Zimbabwe (ZWE).

Source: Authors' calculations based on Wendling et al., 2018, qualitative analysis of country reports and an expert survey.

Source: ILO (2019: 62)

The figure shows that only a small group of European countries (Germany, Denmark, France and Spain) display both strong environmental performance and comprehensive, coordinated skills policies. A large number of developed and emerging economies have high environmental performance but moderately comprehensive (and therefore effective) green skills development programs (such as Egypt, Brazil, US, UK). Most developing countries lack on both of these dimensions. When these policies are misaligned (meaning that, for instance, green technology deployment is enabled but green skills development programs lack behind), a skill-gap may be created and large companies, able to provide training programs in-house, may capture opportunities related to greening to the detriment of MSMEs that have to rely on (often limited) publicly funded skills development programs. This suggests that ambitious targets and mandates and generous funding schemes will be effective only if paired with knowledge and skill creation policies customized to the local needs and the level of capabilities. Therefore, most hurdles lie in the process based on which such decisions are being made and implemented.

5.2 Process specific

We focus here on three main process related aspects considered to be important pre-requisites for effective green skills development programs:

- *coordination* across stakeholders to identify gaps in capabilities (skills, know-how) and to increase synergy across policy interventions;
- *monitoring of outcomes, evaluation, and adaptation* to changing market conditions;
- *forecasting* future needs for training and retraining to address the high level of uncertainty and novelty associated with the transition to a green economy.

These aspects are essential not only for policy-makers in the public sector in their effort to develop

long-term development strategies and specific policy interventions; they are equally central to the private sector in their effort to develop new dynamic competitive advantages in light of these global transformations.

While these three aspects are important for any type of skills development programs, they are particularly critical when it comes to green skills for several reasons. First, for the transition to a green economy to happen, both supply and demand creation incentives are necessary (given the public good nature of greening and the need to internalize externalities). Second, greening is associated with high level of uncertainty related to which technologies are going to play strongest role, and how fast innovation can reduce costs associated with greening; thus, concerted efforts to assess needs for green skills in the medium and long term are essential. Third, greening is a new endeavour globally and it is highly contextualized depending on domestic resources and capabilities. Therefore, few lessons can be derived from other contexts, reason why experimentation and cooperation through multi-stakeholder dialogue is key. Let us discuss these process related aspects in more detail below.

5.2.1 Coordination

For skills development programs to be effective, it is essential that skills (needs, availability, and gaps) are accurately identified, understood and mapped across sectors, regions, as well as at firm level, so that appropriate training programs can be put in place. This inevitably calls for coordination across stakeholders in the public and private sector (as well as with civil society, trade unions, and development cooperation actors) not only at policy planning stage, but also when it comes to more specific interventions related to identification of skills, training, or even community mobilisation. Such an approach is essential when it comes to, for example, greening the agriculture and forestry sector (see Box 2), water or waste management, where civil society can play a critical role in raising awareness to contribute to behavioural change.

Box 2: Greening agriculture and forestry – examples from South Africa and Morocco

Forestry-related industries are subject to rapid technological developments, continuous change, and increasingly demanding environmental sustainability standards. Adapting to these requirements can therefore be very challenging both for firms seeking to maintain their competitiveness, and for workers. Close collaboration (at national and regional level) between firms and training institutions, and with policy makers, is critical. To this end, UNIDO and Food and Agriculture Organization are currently piloting a training program in South Africa, with funding from the Government of Finland, to design and test industry-relevant training packages in partnership with forest industry. The training program aims to be replicated in Zimbabwe, Zambia and Malawi. The ultimate goal is to improve regional collaboration on forestry and wood industry education and training focused on creating green employment and sustainable forest management and utilization.

Building on the 2008's Green Morocco Plan, Morocco launched in 2020 the "Green Generation 2020-2030" strategy to modernize and green the agricultural sector. At the core of the new strategy is the realization that "the enhancement of human element" through training and mobilization of young farmers is key for increasing the competitiveness of small and medium-sized agriculture. Strengthening the skills of young farmers is viewed to be essential for enabling a new generation of more innovative agricultural organisations. To achieve these goals, a more collaborative approach is deemed necessary with agricultural rural communities, larger agricultural firms and suppliers, public sectors, education institutions, and financiers.

Source: SADC Forest (n.d.), Naji (2020).

As also argued by Cedefop and OECD (2015: 15) "weak coordination between national and/or local strategic planning and labour policies, and between different stakeholders within individual policy areas" can undermine the transition to a green economy. In the public sector of any country there are normally several ministries and specialized institutes working in skills development programs, but developing their programs mostly in silos. Moreover, the public sector works often disconnected from the private sector. In sectors driven by large companies (such as automotive or chemical industry) (well-integrated in global or regional value chains) the private sector may act as the main catalyst and driver of skills development programs often provided in-house. Yet, as MSMEs represent more than 80% of firms in developing countries, having low investment capacity and low technological capabilities, a fundamental focus on coordination (as reflected by PPDPs) is essential for achieving green and inclusive development goals. Industry associations and labour unions can play a critical role in systematically bringing the training needs of MSMEs into policy-making discussion.

Examples on how important coordination (between different initiatives and stakeholders) is for effective outcomes abound. In India, for example, coordination across ministries and other consumer and business-related institutions across sectors were key to advancing the energy efficiency agenda. The Indian Green Building Council (a private sector institution) and the Bureau of Energy Efficiency (BEE) conduct training programs for energy managers and national certification for energy auditors, green occupations that were not available prior to India's national commitment to a green economy (OECD and Cedefop 2014; Vidican Auktor et al. 2020). At the same time, BEE, in cooperation with firms and consumers/user groups, provides energy efficiency related information regarding buildings, appliances, agriculture, industries, and MSMEs, and is creating awareness among users about energy saving appliances and techniques (OECD and Cedefop 2014: 194). In collaboration with architects' professional associations, courses for green building and passive design are developed for universities. The Indian Council of Agricultural Research develops needs-based training programs in new and emerging areas, such as organic farming, while local based agricultural centres provide timely information and advice to farmers (ibid.).

The need for coordination, not only across different levels of government but also with different stakeholders (firms, education and training institutes, civil society, trade unions), is enormous. In the energy efficiency sector, for instance, (but also in other areas such as air pollution monitoring or renewable energy) large gaps have been reported between comprehensive national-level greening strategies and regional/local implementation capacities not only in India, but also in Morocco and Ethiopia (Vidican Auktor et al. 2020). Thus, lack of field managers with expertise not only in technical areas but also in policy implementation can significantly slow down the transition to a green economy. These examples, but also others in Uruguay for instance (PAGE, 2018), show how important it is to develop the human capital for greening early in the process of greening the economy, which can only be done through a cooperative approach.

In fact, while most developing countries have a national skills development strategy and action plans, few (if any) countries have in place comprehensive strategies for promoting green skills and jobs (as also discussed earlier). Zambia, however, is an example showing that as demand for these skills increases, stakeholders also feel the need for a more strategic approach to build up green skills (see Box 3).[31]

[31] Building up green skills for women is also strongly in focus in Zambia (see ILO's video material: https://www.youtube.com/watch?v=4K3AiZaiMoc).

Box 3: Collaboration towards green skills in Zambia

The Zambia Green Jobs Programme is a collaborative effort to develop green curricula in light of pressures exerted by climate change on several sectors. The programme relies on multi-stakeholder approaches to enhance skills in green buildings, clean transformation, water management, waste management, renewable energy, and land management. Aside from identifying and aligning policies to support greening, upskilling and developing of new skills is in focus. The creation of value chain linkages among sectors is among the goals of these collaborative efforts. Enterprises (and of course training agencies) are at the core of these initiatives, as they need not only workers with skills relevant for greening, but also consumers that are pro-environmental minded. Therefore, non-government organisations are also important stakeholders in this process.

Source: Mutame Siachiyako (2019).

Currently, as explained by the Director General of Zambia's Technical Education Vocational and Entrepreneurship Training Authority (TEVETA) at the LKDF Annual Forum, every curriculum revision has to now include the development of green skills. In addition, recognising the value of closely partnering with the private sector, TEVETA's engagement with LKDF's PPDP projects in various sectors allowed it to not also increase financing for its programs but also access state of the art equipment and customising its skills development programs closer to the needs of the private sector.

Another illustrative example for the importance of coordination comes from the renewable energy sector in Morocco. The limited cooperation and coordination between the public and private sector with academia and training institutions became obvious in early 2010 when large investments in renewable energy technologies were made, opening up opportunities for local value creation and green jobs. To identify existing capabilities, reduce the knowledge-gap and foster research and innovation domestically, the Research Institute for Solar Energy and Alternative Energies (IRESEN) initiated calls for collaborative research proposals (between firms and academic researchers) on specific topics linked to the national agenda for renewable energy. The results of such research projects allowed IRESEN to not only understand what is the state of knowledge but also facilitated the development of new curriculum at universities (often in collaboration with private sector, foreign agencies and development cooperation actors) to cover gaps in knowledge and develop new skills both for the private sector and for advanced research (Vidican Auktor et al. 2020). Such a collaborative approach has been further developed in the context of Living Labs at the research-oriented Mohammed VI Polytechnic University[32], where a cutting-edge applied research for different sectors with a focus also on greening and digitalization is conducted in close cooperation with firms and international research partners (Terrab n.d.). These early capacity building initiatives are also going to be beneficial for developing more advanced green skills to support the newly signed German-Moroccan partnership to develop a green hydrogen sector (Guessous 2020).

Another relevant example comes from LKDF's projects, the H2O Maghreb, between 2017-2019. Water scarcity is a major challenge not only for Morocco but also for many other developing countries. To tackle the problem of unsustainable water management practices, the H2O Maghreb project focuses on several aspects: a better understanding of current and future skills gaps and employment opportunities in this area, lack of industry professionals with skills in latest water management technologies, and lack of replication of best practices. To this end a training hub for Aquatronics was piloted in Morocco, aiming to be replicated in the Maghreb region, based on a close cooperation between policy makers, the private sector, donors, and training institutions.

The renewable energy sector is a core element of greening the economy in most developing countries. As seen in chapter 4, clean energy generation technologies are expected to diffuse rapidly in the next decade and opportunities for domestic value creation also. Yet, as most of the know-how and

[32] A major funder of this university in Morocco is the largest national company and global player in the phosphates sector, the OCP Group.

technology are imported (at least initially) and supplied by international project developers (mostly for large-scale power plants), building up a range of capabilities locally is key not only to assure quality but also to ensure that such project can be sustained in the future. To do this, aside from a long-term vision, coordination is necessary not only between public and private quality infrastructure actors (e.g. in the field of standards, certification, testing, metrology) and training agencies, but also with development cooperation agencies. A case in point is the need for capacity building on quality infrastructure and project implementation for renewable energy projects in Ethiopia (see Box 4).

Box 4: Capacity building for quality infrastructure and project management in Ethiopia

Ethiopia has set an ambitious renewable energy plan for greening its electricity generation sector. Yet, few years into the process, an urgent need for capacity building has been identified for relevant Ethiopian entities, such as the Ethiopian Electrical Power (EEP) in charge of hosting large energy projects. Specifically, there appears to be a large capacity gap on the side of EEP to assure that quality aspects are not only written down in contracts with project developers, but also followed up continuously during implementation. Even if most renewable energy equipment will be imported and selected by project developers, and if pre-expert verification of conformity are accepted as sufficient, Ethiopian staff in contracting agencies should be well trained in quality-related aspects of renewable energy technologies, including basic technical aspects, such as performance ratio, light induced degradation, and light and elevated temperature induced degradation in the case of solar, or torque in the case of wind energy technologies. Only if local staff is sufficiently trained in these and related aspects, will it be able to choose the economically most beneficial offer among project developers, negotiate the concrete terms of reference, and guarantee a decent follow-up during contract implementation. Such trainings could be organized in competence centres abroad and supported by development cooperation partners (e.g. Germany's National Metrology Institute's wind competence centre), or with the Ethiopian Conformity Assessment Enterprise that disposes of a relatively new test equipment for solar photovoltaics technology.

Source: Stamm (2019: 25)

5.2.2 Monitoring, evaluation, and adaptation

A common problem in policy-making, especially in areas that are either politicised (by donors or national actors) and/or new relative to traditional sectors, is the lack of a systematic approach in monitoring results, evaluating outcomes, and changing course to adapt to altered market conditions. Such a process requires not only time but also expertise and understanding of the 'end goal', both in short supply especially when it comes to greening the economy for which solutions and experiences are often difficult to transfer from one context to another.

Notably when it comes to the effectiveness of skills development programs, policy makers require a sound knowledge-base on the types of occupations, jobs and skill requirements, as well as effective ways to promote them. This represents, however, a major challenge as most developing countries lack functional labour market information system (LMIS) (ILO 2011) or comprehensive national classifications of occupations. Yet, these are critical for monitoring and evaluating progress and adapting strategies, also because, as mentioned earlier, green jobs and green skills are much more difficult to define and measure compared to other sectors. Moreover, a large part of the labour force is in the informal sector (and thus not visible in official statistics) (Jarvis et al. 2011), especially in some green sectors, such as waste management and agriculture, which makes monitoring and evaluation of outcomes even more challenging.

But, availability of data is just one relevant aspect for monitoring and evaluation for achieving informed policy-making (Jacob et al. 2015). In addition, processes must be defined (and perhaps institutions

created) to systematically set and assess objectives and outcomes. Monitoring and evaluating the end goal (as a measure of success) can ensure the quality of training programs.

For all these reasons, monitoring and evaluation, through policy impact assessment, for instance, is essential to ensure effectiveness of skills development programs. Flexibility to adapt existing strategies and plans to changing market conditions and understanding of the problem is also important. Yet, as Cedefop (2019: 49) found, even in the European contexts "no continuous monitoring and evaluation of policies and/or activities relevant to green skills" has been found, in spite of evidence for the importance of such processes. In countries with established systems of coordination and high level of embeddedness of training institution in the national innovation system (such as in Germany, for example) it may be sufficient to have comprehensive training programs developed and implemented in close dialogue with the private sector, trade unions and civil society. But in developing countries, where such institutions and processes are also weak, establishing early mechanisms for monitoring and evaluation are extremely important.

5.2.3 Forecasting needs

As greening the economy is a new and ongoing process (therefore defined by high levels of uncertainty), anticipation of needs when it comes to impacts on labour markets, and green skills in particular, is also an important pre-requisite for effective skills development programs. Forecasting future needs related to green jobs and occupations is essential for informed policy decisions and should form the basis for investments in new sectors/activities and related education and training.

Forecasting needs is necessary not only for new occupations. Occupations change at different rates and in different ways. In fact, changes in existing occupations far outnumber brand new occupations (ILO 2011: 91). Where LMISs exist, anticipation of needs may be easier. These processes, however, need to be facilitated by dialogue across stakeholders (at national, regional and local level)[33] also involving the civil society and trade unions. In particular, anticipation of skills requires effective interaction between industry and training institutes (OECD and Cedefop 2014: 196).

Systemic coordination mechanisms, discussed earlier, are therefore imperative. It is then not surprising that most well-established systems for early identification and forecasting of skill needs can be found in developed countries such as Australia, France, Germany, US, UK and to a certain extent South Africa[34] (van der Ree 2017). A combination of approaches is used in this process, including quantitative forecasting, qualitative needs assessments, institutional social dialogue mechanisms and regulation information flows to education and training systems (ibid).[35] UK, for instance, has established an annual Strategic Skills Audit to identify which green skills are required by those employed in strategic sectors (ibid). The findings are then fed into efforts to develop curricula and training programs cooperation with relevant stakeholders. In France, the Mobilization Plan for Green Jobs includes an observatory for emerging environmental professions that complements national-level forecasts and studies (OECD 2017).[36] The French National Observatory for Green Economy Jobs and Skills forecasts the sectoral and macroeconomic impact of the green transition, with a particular focus on jobs and skills requirements (OECD 2017: 16). To effectively do that, the observatory has established partnerships with trade unions, employer organisations, and the public employment service (ibid).

[33] Since the impact of the green transition will vary across geographical regions, local administrations can be crucial in identifying skills in the local work force in declining sectors, which may be transferable to emerging regions (OECD 2011).
[34] South Africa has made several important steps towards understanding current and future needs for green skills development. Yet, policies are programs aimed at facilitating skills development remain scatters and lack a systematic approach across stakeholders. Specifically, in the National Skills Fund 2016/17-2020/21 Strategic Plan there is no mention of green skills; instead, these issues are addressed in policy plans and documents that are green-economy specific (ILO 2018b).
[35] Given the frequent lack of industrial classification but also lack of consistent definition of green jobs and skills, quantitative forecasting has proved to be inefficient, unless combined with other more qualitative approaches across sectors.
[36] OECD (2017) and Cedefop (2019) offer more such examples from Spain and Austria.

In developing and emerging economies such initiatives are almost non-existing.[37] Yet, even more general efforts to assess future needs related to the national strategy goals are valuable. An in-depth ILO (2018c) study of jobs and skills related to the green economy in Bangladesh, for instance, points to important gaps in skills for organic agriculture and to new and emerging occupations that are expected to be created, but for which no training is yet in place (see Box 5).

Box 5: Anticipation and identification of needed green skills in Bangladesh

The involvement of farmers in using organic and bio-inputs is increasing and spans over 38 districts and around 1,063,395 farming families. This sector has very high potential for greening Bangladesh stemming from both environmental and economic considerations. Among the occupations in higher demand in organic farming are energy crop farmers, agriculture extension specialists, biologists, fishery specialists, soil conservation technicians, restoration ecologists, agricultural inspectors, farm product purchasers, food product inspectors, sustainable agriculture specialists, and precision agriculture technicians. These occupations exist in Bangladesh, but there is a clear shortage of related skills on the labour market and extensive training is needed.

When it comes to new and emerging sectors/activities, such as carbon trading, several occupations have been found to be important but lacking on the market: carbon credit traders, carbon trading analysts, energy brokers, investment underwriters, securities and commodity traders, along with staff involved in carbon capture power-plant installation, operations, engineering and management. Of these, only carbon sequestration plant installation, operations, engineering and general management staff, and carbon capture and sequestration system installation staff exist in Bangladesh, but only on a limited scale.

Source: Based on ILO (2018c: 65).

Brazil, China, Estonia and the Republic of Korea, systems for early identification of skill needs are under development; yet, the focus on green skills in particular is limited (ILO 2011: 156). In Estonia, for example, a new System of Labour Market Monitoring and Future Skills Forecasting (*Oskuste Arendamise koordinatsioonisüsteem*, OSKA) has been launched. While green skills and green jobs are not explicitly part of the OSKA system, sectoral experts and other stakeholders can make recommendations arising from the green economy (Cedefop 2019: 34).[38] In developing countries, state officials are also less inclined to forecast future skills due to large labour surpluses (see the example of Philippines in ILO 2011), ultimately transferring the burden of finding qualified workers to the private sector.

[37] See also ILO (2018)'s case studies on Bangladesh and Barbados, for example.

[38] Cedefop (2019: 34) makes an important point in that even in countries with established labour market monitoring and forecasting systems, such as Germany, "green skills are not part of regularly produced data and intelligence for skills identification and anticipation". Instead, specialized studies cover this area. This point is important to set the right expectations for developing countries seeking to improve their anticipation process.

6. Conclusions and recommendations

The process of greening the economy is likely to have important effects on labour markets everywhere. As the pace and diversity of green technology dissemination will increase in the coming decades, new markets will emerge, raising the demand for green jobs and related skills and offering opportunities for increased gender equality. Occupations related to the green economy cut across diverse sectors (from manufacturing, to agriculture, management, services, information technology (IT), and advance materials research), requiring different skills that may or may not be currently available. These ongoing changes are to be understood in the context of (and reinforced by) other major global societal and technological trends, such as increase in population, advance of digitalization and increasing automation of production processes, rapid rates of urbanization, and shift towards service- and knowledge-oriented economies. In some green technology sectors, such as e-waste management and smart grids for instance, green skills are closely inter-related with digital skills. Also, blockchain technology, for example, can contribute to increasing accountability related to greening along the supply chain. Therefore, education and training programs need to effectively take into consideration these megatrends and assess their implications for future skill needs (OECD 2017: 16).

In this context, policy-makers face unprecedented challenges to effectively address the needs in terms of skills for greening the economy. Not only is the future uncertain regarding how these global trends will evolve and reinforce each other; the transition to a green economy is itself unique given its cross-sectoral effects (thus placing higher emphasis on transversal skills), lack of precedent, and therefore shortage of best practices to draw upon. Therefore, learning, experimentation, and foresight in policy design and implementation are now even more important than in earlier development endeavours. As repeatedly emphasized in the LKDF Forum 2020, the future will be less dependent on formal education structures (i.e. college degrees); instead, 'the right skills' and continuous learning (i.e. life-long learning) will matter more to reduce the skill mismatch and to develop an agile labour force, able to adapt to changing market conditions.

This report draws on extant policy research to provide a 'high-level' analytical perspective on what we consider to be some of the most important aspects related to green skills development programs. Much more issue- and country-specific analyses can be found elsewhere (see, for instance, ILO, Cedefop, OECD). Also, while we do stress how important it is to develop sustainability related training programs at all levels (not only TVET), discussions on how to specifically implement such programs are outside the scope of this report. Further, developing and restructuring syllabi and curricula in training institutes is essential, but widely recognized and discussed elsewhere. Therefore, we acknowledge the importance of these interventions, but we focus here on other critical aspects that tend to often be discussed only in passing, primarily related to the process of policy design and implementation. Without these aspects, any training and education efforts may be misdirected.

As such, our report seeks to raise questions and stimulate debate on how different stakeholders (policy-makers, private sector, education and training institutions, trade unions and civil society, in collaboration with development cooperation actors) should think about the challenge itself (now and into the future) and the pre-conditions for systematically and effectively managing the process of green skills development.

We started by raising the very first challenge that stakeholders face when seeking to engage with this issue, i.e. **lack of consensus on what types of jobs and skills should be considered green**. Limited consensus on definitions hampers not only (much needed) data collection efforts; it also blurs boundaries, creating inertia in decisions on which stakeholders and sectors should take responsibility to design and coordinate action for skills development. In addition, we also summarize existing evidence on the effect of greening on employment and different types of skills.

A second challenge we raised is that of **understanding what the future holds in terms of greening economies**. As discussed later in the report, a key-precondition for effective green skills development

programs is the anticipation of training (and re-training) needs. However, too few studies exist on forecasting which green technologies (and thus sectors) are likely to play an important role in greening the economies of developing countries. We review existing empirical evidence and reflect on potential implications on future needs in terms of green occupations and skills.

Lastly, we **reflected on a few fundamental pre-requisites** for effective green skills development programs, related to both *relevant policies* and their alignment and to the *process of policy-making and implementation* to ensure that the envisioned outcomes are achieved. We argue that while progress has been made almost everywhere in terms of putting in place a comprehensive set of policies to enable the transition to a green economy, most difficulties lie in the implementation process related to green skills development programs. As we show, even developed countries with effective environmental policies and strong institutions still lack in terms of the effectiveness of their green skills development programs.

Based on this assessment, we highlight below:

- Key **general guidelines** for increasing the effectiveness of green skills development programs, relevant for all stakeholders involved in the design and implementation of such programs;
- **Specific considerations for LKDF**'s continuous efforts in this area.

6.1 General guidelines for effective green skills development programs

As mentioned earlier, improving the process of designing and implementing green skills development programs is essential for ensuring their effectiveness. As such, the guidelines discussed below are relevant not only for actors in the public sector developing strategies and specific policy interventions. Rather, they are equally important for the private sector playing a central role in the green skills development process, and for other stakeholders such as development cooperation actors, trade unions and civil society.

We consider these guidelines to be important also because the uncertain nature of the transition towards a green economy *require actors to learn to prepare for future changes* in market conditions. Moreover, the *transition will affect countries differently*, depending on the economic structure, development objectives, and existing technological capabilities. Thus, short-term planning and relying on best practices will be less effective. For these reasons, highlighting guidelines related to the process of designing and implementing green skills development programs is much more important.

- *Policy coherence between green skills development programs and other policy goals through a systematic process of stakeholder consultations*: Having in place a comprehensive set of policies oriented towards long-term development goals and greening the economy is essential. But even more important is to ensure policy coherence between ministries, industry associations and firms, training and education institutions, civil society and other stakeholders, to ensure that measures put in place contribute to green jobs and enhance skills in green occupations, aligned to market needs. To this end, a systematic process of stakeholder consultations is critical. Most of the time, such decisions are made in silos (either in the public or the public sector) and green skills development programs are rarely integrated into national (or sectoral) development efforts. Such processes of consultation would also ensure that the private sector receives more guidance (in the form of information, for example) and support (financial, in the form of subsidies for training and re-skilling or favourable loans for investing in employment creating sustainable businesses, and sometimes technical) to identify economical options for greening to align their actions to the national greening strategies. For employers (especially in the MSME sector), the main concern is lowering the cost of greening and facilitating access to equipment and technology and new markets. Policy coherence and cross-stakeholder consultation in the area of green skills development should ensure that these concerns are addressed.

- *Solid empirical base for green jobs and green skills:* Informed policies require a solid empirical base. Lack of clarity on definitions hinder measurement efforts. Thus, policy-makers should prioritize the establishment of comprehensive LMISs, agree of definitions, and use systematic mechanisms (based on mixed approaches, e.g. surveys, interviews, qualitative needs assessments) to identify where the green jobs are (which sectors, and what kind of occupations) and what kind of skills are existing and currently needed. Engagement with the private sector is essential for this purpose. LKDF's H2O Maghreb training project (mentioned earlier), for instance, focused on sustainable water management practices is an example on how capabilities for need assessments (for skills and jobs) should be a core element of effective green skills development programs, critical both for the private and the public sector.

- *Systematic mechanisms for green skills forecasting:* Anticipating future needs in terms of skills development interventions require strong competencies in forecasting markets for green technologies at global and national level, and reflecting on those trends in light of existing domestic capabilities. As ILO (2011: 162) argues, skill-shortages for green jobs stem from several factors, such as an underestimation of growth in certain green sectors or a general lack of scientists and engineering or of teachers and trainers in fast-growing sectors. Therefore, building capabilities and institutional capacities (i.e. dedicated cross-sectoral organisations) in foresight assessments is essential when responding to unprecedented and inter-linked global megatrends such as the green transition and digitalization. Such efforts are equally important for policy-makers and for firms. Building capabilities for needs assessments and financially supporting such programs by the public and the private sector is key. In the private sector, building such capabilities at the level of industry associations and/or trade unions (often serving as liaison between MSMEs and decision-makers) would be important.

- *Coordination of goals and interventions across sectors and stakeholders:* None of the above objectives (policy coherence, accurate measurement, identification and anticipation of green skills) would be successful without comprehensive coordination (and consultation, as mentioned above) across ministries and with private sector actors (i.e. industry associations), trade unions, workers, education and training institutions, and societal groups. As green jobs span across sectors, dialogue and coordination in this context is even more important than for skills development programs in more traditional sectors. To this end, fostering the creation of strategic leadership and management skills, more generally, may enable systematic and coordinated decision-making in governments, employers' associations, trade unions and businesses (ILO 2011: 162). More specifically, coordination across stakeholders shows that countries with well-established labour and environmental policies, effective TVET institutions, and close engagement with the private sector have adapted much quicker to the changing need for green skills (van der Ree 2019). As mentioned by TEVETA at the LKDF Annual Forum 2020, close cooperation with the private sector within the framework of PPDP projects are also important to identify opportunities for cooperation between TVET institutions and firms, which may lead to public-private financed training programs. Such partnerships for skills development do not only allow trainers and trainees to access needed equipment; they also increase ownership of all stakeholders involved and ensure that the developed skills are closely aligned to the market needs.

- *Increasing awareness on sustainability issues related to production and consumption of goods:* Such efforts are essential at all educational levels as they contribute to changing behaviour and creating demand for green technology and processes.

- *Monitoring and evaluation of:*

  - *Inputs:* Monitoring of inputs into the skills development programs is as important as monitoring of outcomes (discussed below). Specifically, we emphasize the relevance of reviewing curriculum at education and training different levels (including teacher training curriculum), to ensure that it addresses the market needs. Such platforms for monitoring inputs related to green skills and digital skills need to systematically include public and private sector actors. They should also offer the basis for national education reforms aligned with green and inclusive growth strategies.

» *Outcomes:* To ensure that policy interventions are well calibrated to deliver on the desired objectives, continuous and methodical monitoring and evaluation of progress is essential. Too often path-dependency prevails when such mechanisms are missing, leading to ineffective interventions and missed targets. Moreover, these processes also contribute to better understanding the reasons behind a potential skill gap. As the labour market is continuously changing not only with fluctuations in the economy but also with rapid changes in technology development and diffusion, continuous monitoring and calibration/adaptation of policy interventions are essential. Monitoring and evaluation do not necessarily require the creation of new agencies; instead, such mechanisms should be implemented in ongoing projects and processes.

6.2 Specific guidelines for LKDF

The LKDF, through its PPDP approach to promoting industrial skills development in developing and emerging economies, can play a critical role in catalysing the transition to a green economy. Its experience in establishing and upgrading local industrial training institutions, accumulated through a variety of partnerships across countries and sectors, has proved to be highly beneficial for effectively addressing labour markets' needs.

Given the specific challenges associated with the transition to a green economy, and the resulting demands in terms of skilling and re-reskilling, the LKDF should continue to support partnerships and implement platforms for green skills development programs, by focusing especially on the following key guidelines:

- *Promote inclusive partnerships:* LKDF's central focus is already on multi-stakeholder partnerships. Maintaining this approach, as emphasized earlier, is critical, especially for green skills, expanding opportunities for cooperation between firms, policy-makers, training academies, workers, and other stakeholders. Such partnerships should, however, ensure that stakeholders in rural areas, workers in the informal sector, women's interest organisations, and other marginalized groups critical to the success of sustainable development efforts, are included in the design and implementation of green skills development programs.

- *Assess green skills needs:* The assessment of current and future needs in terms of training and re-training associated with greening the economy has been repeatedly voiced by various stakeholders, also in the LKDF Forum. A good understanding of existing (unmet) needs and of future demands for green skills are critical for informed policy-making and for effective training (i.e. ensuring that trainees become employable).

- *Facilitate scaling-up:* Scaling-up successful training programs is an essential pre-condition for effective skills development programs. Given the emerging nature greening efforts, this is even more important for green skills programs. LKDF's continuous focus on ensuring that existing partnerships can scale-up the training programs, is essential. This could be facilitated through making sure that, for instance, local communities are including in the training programs, and that awareness and communication platforms are expanded to share lessons learned from successful training programs.

- *Support learning across borders:* In spite of the clear need to customize the transition to a green economy to each country's technological capabilities and development pathways, experts in the LKDF Forum have also stressed the importance of learning across boundaries and a certain level of (smart) standardization of training programs. Towards this goal, LKDF can play an important role by promoting collaboration across countries and regions and engaging in dialogue with relevant stakeholders to develop global standards for training and education. Such efforts could be important given shift of labour across borders and the increasing need to certify/recognize education and training across countries.

Appendix

Selected impacts of green growth policies on sectoral activity and employment

	Impacts	Examples	Plausible employment impacts
Changes in production modes	Shift away from sources of environmental damage by using more resource-efficient capital	Electric vehicles in transportation sector; Investments in buildings isolation	Changes in labour according to the degree of complementarity between capital and labour
Changes in demand patterns	Reduced demand for commodities that are sources of environmental impacts when consumed by firms or final consumers	Fossil-fuel demands	Decreased labour in sectors producing these commodities
	Reduced demand for commodities that are sources of environmental impacts during their production processes	Extraction of fossil-fuel; Ferrous metal production; Chemicals production	Decreased labour in sectors producing these commodities
	Reduced demand for commodities that are used jointly with the sources of environmental impacts (complements)	Motor vehicles manufacturing (combustion engine)	Decreased labour in sectors producing these commodities
	Increased demand for commodities that can be used instead of commodities that are sources of environmental impacts (substitutes)	Renewable power generation	Increased labour in sectors producing these commodities
	Indirect change in demand for intermediate goods intensively used in sectors impacted or for stimulated investment commodities.	Solar panels; Energy efficient appliances	Increased (decreased) labour in sectors producing these commodities
	Indirect change in final demand, through changes in prices	Energy intensive sectors	Changes in labour in sectors producing these commodities
Changes in macroeconomic conditions	Multiplier on final demand associated with stimulus from broad policy packages	Public investments in energy efficiency infrastructure	Economy-wide positive impacts on labour
	Crowding out of investments in other sectors	Reduced resources for other investments	Decreased labour in sectors producing these commodities
	Decreased taxation (or increased other government expenditures) thanks to the extra revenues from environmental taxes or from phasing out fossil-fuel subsidies	Feed-in tariffs; Subsidies to R&D	Changes in labour in all affected sectors
	Increase taxation (or decreased other government expenditures) to finance extra public expenditures for investment	Expenditures in subsidies to renewable energy	Decreased labour in all sectors affected by the increased tax or reduced government spending
	Changes in primary factor supply (capital, labour, land, etc.)	Increase in employment, in reaction to higher wages from carbon revenues recycling	Overall change in labour supply of workers

Changes in international trade	Changes in exports and imports from changed relative competitive position vis-à-vis international competitors in a world of varying stringency of green growth policies	Reduced exports of energy-intensive trade-exposed commodities such as iron and steel	Decreased labour in sectors producing these commodities
	Change in trade balances and in real exchange rates induced by changes in exports and imports (terms of trade effect)	Reduction of oil export revenues in large energy exporting countries (e.g. Russia and the Middle East)	Changes in labour in all sectors

Source: Adapted from Chateau et al. (2018)

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