Sectoral Study

TVET for Sustainable Construction

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Discussion Paper: Skills for a Just Transition to a Green Future
Sectoral Study: TVET for Renewable Energies
Sectoral Study: TVET for Sustainable Construction
Sectoral Study: TVET for Sustainable Mobility
Vision Paper: What TVET can and must do in a Just Transition to a Green Economy

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AfDB	African Development Bank
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMZ	German Federal Ministry for Economic Cooperation and Development
CCHC	Capital City Housing Corporation
CHP	Combined heat and power
DC	Development cooperation
EDGE	Excellence in Design for Greater Efficiencies
EU	European Union
FCDO	Foreign, Commonwealth & Development Office
GDP	Gross domestic product
GHGs	Greenhouse gas emissions
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HVAC	Heating, ventilation and air-conditioning
ILO	International Labour Organization
ISEP	Instituts Supérieurs d'Enseignement Professionnel (training institutions at the interface between vocational and university education)
LNOB	Leave no one behind
NESP	Nigerian Energy Support Programme
PESEREE III	Programme d'Enseignement Supérieur pour les Energies Renouvelables et l'Efficacité Energétique (Higher Education Programme for Renewable Energy and Energy Efficiency)
PV	Photovoltaic
RPL	Recognition of Prior Learning
SCGJ	Skill Council for Green Jobs (India)
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
ToC	Theory of change
TVET	Technical and Vocational Education and Training
WASH	Water, sanitation and hygiene

Abstract

The global consequences of climate change and growing social injustice are increasingly underlining the urgency of the transition to a just and Green Economy (Just Transition) in order to conserve resources and reduce CO_2 emissions. Countries will need to put enormous effort into collaborating across borders and many industries and economic sectors, such as the construction sector, will be affected. The world is experiencing an unprecedented construction boom due to population growth and increasing urbanisation. More than half (56%) of the world's population is already living in cities, and the number is growing by 200,000 people every day. **The construction, management, and maintenance of buildings worldwide are major contributors to climate change**, with the construction sector being responsible for almost 40% of annual energy-related CO_2 emissions.

The shift towards more sustainable buildings and construction methods is therefore a key factor in achieving the Sustainable Development Goals (SDGs) set out in the 2030 Agenda in the partner countries of German development cooperation (DC). The goal of sustainable construction should be to adopt construction methods that minimise the consumption of energy and resources. The construction sector will have to undergo a profound change in terms of the technology to be deployed and in terms of utilisation concepts. **This will have a direct impact on the training and qualifications required of future workers all along the construction value chain. The training, reskilling, and upskilling of professionals at all skill levels will therefore have to be adapted.**

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the sector project Technical and Vocational Education and Training (TVET), launched by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, is therefore publishing five studies on the topic of *Skills for a Just Transition to a Green Future.* **The present study examines how partner countries of German DC can be supported in aligning TVET with a Just Transition in the construction sector**. Substantial changes in the content of TVET courses are analysed in order to develop action-oriented recommendations for the transition to green construction, especially for project planners and implementers in DC.

The study is based on a review of the available literature and on the outcomes of interviews with representatives of government institutions, DC projects and companies in selected partner countries. Based on an analysis of technological developments in the construction sector, of the anticipated demand for skilled workers, and of examples of projects in four countries – India, Mongolia, Nigeria and Somalia – the study develops recommendations for future project planning and implementation.

The author concludes that projects need to pursue **cross-sectoral and integrated approaches to project design more vigorously**. The design of TVET measures in terms of organisation and personnel should be more closely interlinked with advice on regulatory framework conditions to ensure that the promotion of the sustainable construction sector is better aligned with employment-oriented TVET. To this end, it is important

to strengthen institutional capacities for the involvement of the private sector and for the early identification and formulation of qualification needs – especially in the local construction sector. The transition will affect occupations at all skill levels along the construction value chain. **An interface with institutions of higher education should therefore be taken into account in the project design** for training content to be better coordinated between qualification levels.

The author recommends a two-pronged strategy to support the development of Green Job profiles and curricula. First, **(non-formal) upskilling opportunities for workers with professional experience need to be created quickly** to meet the current needs of the industry. And second, **national TVET institutions should be supported in adapting and developing relevant basic TVET programmes** so that the transition process is not derailed in the medium term due to a shortage of skilled workers. It is assumed that existing job profiles and curricula will have to be enriched with relevant learning content on **the concepts of a circular economy and life cycles, and on the use of local construction materials**. At the same time, TVET programmes should also **give greater consideration to cross-sectoral skills**.

The study also recommends supporting selected TVET institutions in becoming inclusive centres for green building. For this, **didactic principles must be included in the design concept** for a practice-oriented model to be promoted. The **capacities of teachers** will also have to be strengthened to enable them to **identify typical tasks and workflows in a company** in cooperation with the private sector, and to **design lessons based on skill levels**.

In the spirit of a Just Transition, care should be taken to ensure that measures also reach people who have no access to initial and continuting TVET in the construction sector. To this end, **tailor-made education and training programmes** should be offered that take a holistic approach to **teaching green, practice-oriented and entrepreneurial skills**. This also applies to the promotion of women, who are usually underrepresented in the construction sector. However, due to the traditional gender roles and prevailing prejudices in the sector, a more **comprehensive approach is needed to create more and better employment opportunities for women in the construction sector**.

1 Introduction

The production process of compressed earth bricks, Senegal. © GIZ Senegal/Fatou Ndoye

Climate change, biodiversity loss and rising social inequality pose threats to the stability of our economy, society and governance and to our very existence. To conserve resources and reduce CO_2 emissions, we urgently need to transform our economic model into a Green Economy. This endeavour will take tremendous efforts that transcend all national borders. The transition to a Green Economy will do more than simply benefit the climate; it will also create many new jobs in Green Sectors and in industry as a whole. For instance, it is estimated that 25 million new jobs in renewables will be created by the year 2030.

German development cooperation (DC) is committed to a Just Transition to a Green Economy that takes account of the needs of everyone involved. But how can we shape this Just Transition? This exact question is currently at the heart of development debates. After all, not everyone will be a winner under this transition. Industrial sectors that harm the climate will no longer be needed. Many people will lose their jobs and have to find a new job in a different line of work. These people must not be left behind (in keeping with the *leave no one behind* (LNOB) principle). In fact, everyone must be given the opportunity to take part in and benefit from the transition, especially those who did not have this opportunity in the past or who will lose their job as part of the transition. Therefore, decent jobs must quickly be created in the new Green Sectors to provide new income opportunities for as many people as possible and avoid leaving people behind in poverty.

Policy-makers have the task of designing the foundation for a Just Transition early on. This work includes the legislative framework and labour market policy instruments, such as financial incentives for companies, along with accompanying social benefits.

Technical and Vocational Education and Training (TVET) plays a vital role here because it will be the vehicle through which new skilled workers will be trained to perform Green Jobs. TVET ensures that people remain employable in the Green Economy and can actively advance the transition with their skills.

Therefore, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Sector Project Technical and Vocational Education and Training (TVET) is publishing five studies on *Skills for a Just Transition to a Green Future* on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The first study developed theses and recommendations for the design of DC interventions related to Green Skills. They include supporting partner countries in aligning TVET with a Just Transition (GIZ, 2022). The three practical studies, addressing the renewable energy, green construction, and sustainable mobility sectors, are primarily geared towards project planners and implementers in DC. The studies offer action-oriented recommendations on ways that Green TVET can support the Just Transition to a Green Economy in partner countries. The policy vision paper focuses on the development of the future economy and illustrates how TVET in partner countries must be adapted to meet new training needs. In doing so, it draws on the combined findings of the three sectoral studies.

This sectoral study delves into the transition to green, i.e. more sustainable, construction[1]. It starts by analysing conceptual and technological developments that will take on more significance in green construction in the future. The study moves on to analyse changes caused by technological trends related to the demand for skilled workers and the skills and qualifications these workers need. This includes exploring how TVET will have to adjust to these new requirements so that they can be incorporated into recommendations about project design and TVET measures in DC. The study then distils lessons learned in international cooperation based on examples of projects undertaken in selected German DC partner countries. Finally, building on this analysis and the lessons learned, the study draws up tangible recommendations for designing German DC projects and programmes that seek to promote green construction in partner countries. Continuing along the same lines, it defines specific recommendations for DC projects in TVET.

A detailed literature review was performed for the purposes of this study. Interviews with representatives of existing DC projects from various partner countries and other people, including those from research networks and academia, have also been incorporated.

[1] Green construction is increasingly used to describe sustainable construction. This study uses the terms synonymously.

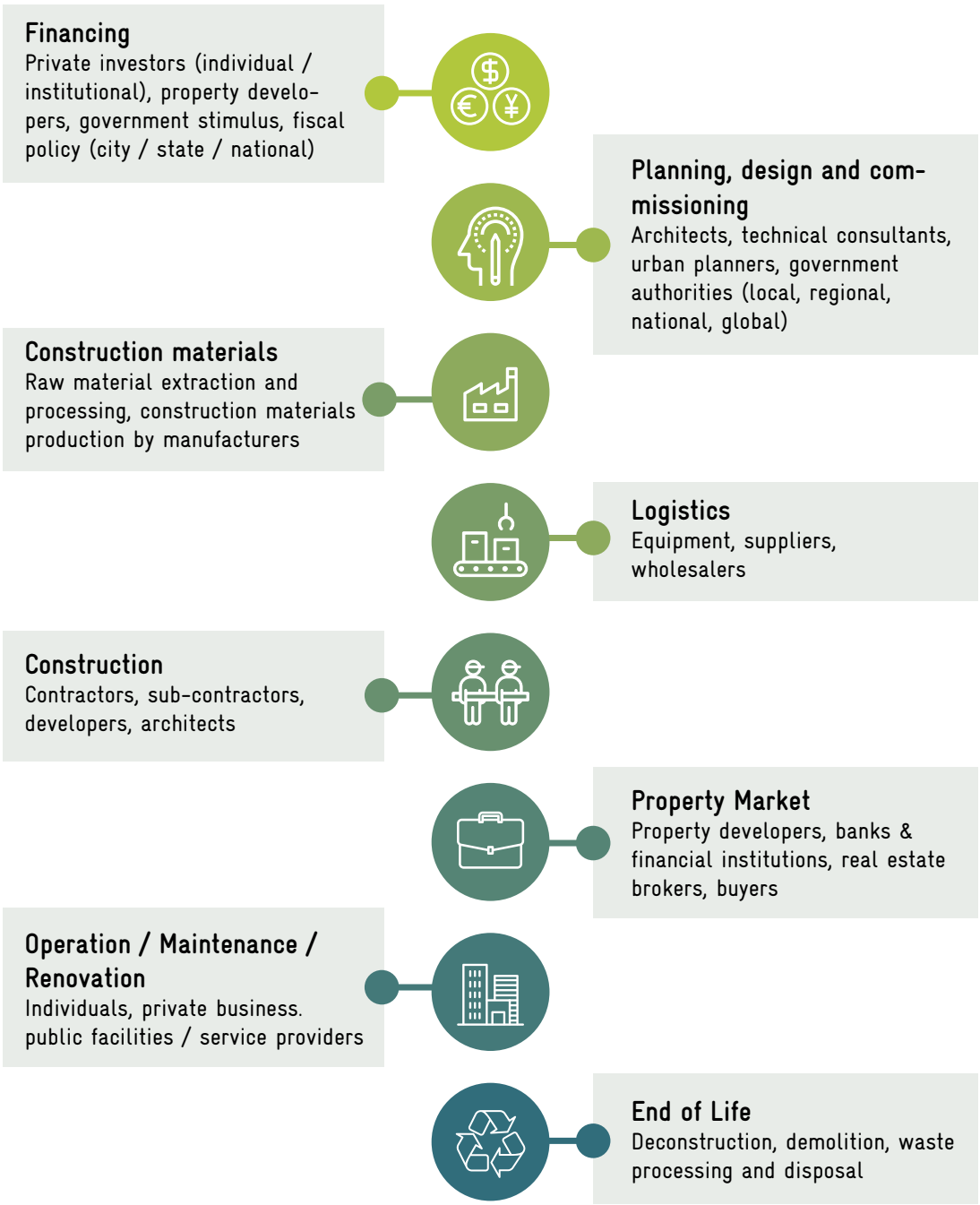
2 The relevance of the construction sector in the context of sustainability

The world is experiencing an unparalleled construction boom due to population growth and rising urbanisation. Today, more than half of all people (56%) live in urban areas (World Bank, 2023), with this figure set to increase to two thirds by 2030. This development is happening at a rapid pace: the urban population is growing by 200,000 people a day worldwide. These people need affordable housing, along with transport and supply infrastructure (DESA, 2022). The total floor area of buildings will double by 2060, with most new buildings likely to be in the Global South, mainly in Africa and Asia (UN Environment, 2017). An increase in built-up area often means a loss of biodiversity and an increase in emissions. Around the globe, new construction and the operation and maintenance of buildings and constructional infrastructure are already making a significant contribution to the accelerating pace of climate change and to biodiversity loss. (Roth et al., 2021). Buildings are thought to be responsible for close to 40% of annual energy-related CO_2 emissions (WGBC, 2019). One reason for this is the construction process itself, which is resource- and emission-intensive because of the material utilization and transportation involved. Each year, 11% of global CO_2 emissions come from the production of building materials and construction activity. Construction also consumes a tremendous amount of mineral resources. In Germany, for instance, the construction sector is responsible for 90% of domestic resource consumption by volume (Vogdt, 2022). Another reason is that building operation and maintenance make a substantial contribution to global CO_2 emissions (WEF & The Boston Consulting Group, 2016). Buildings are responsible for 40% of annual primary energy consumption. For example, the use of air-conditioning systems and electric fans for cooling alone accounts for almost 20% of total global electricity consumption in buildings. Forecasts suggest that this will triple by the year 2050 (IEA, 2022).

Therefore, the next generation of sustainable buildings and infrastructure must strike a better balance between benefits and resources consumed (Feifer et al., 2018). Climate researchers are calling for CO_2 emissions from buildings to be halved in each of the following decades in order to keep the climate crisis at tolerable levels. **Green, sustainable construction must therefore concentrate on minimising energy and resource consumption, reducing environmental pollution and improving a building's overall efficiency**. Ideally, this process will focus on all phases of a building's life cycle, from design to demolition. Particular features include choosing an environmentally friendly location (e.g. in terms of transport links for residents), using environmentally sound building materials (ideally, biodegradable materials), avoiding land sealing, reducing energy consumption during operation (e.g. through thermal insulation or optimised use of solar energy) and opting for sustainable drainage methods.

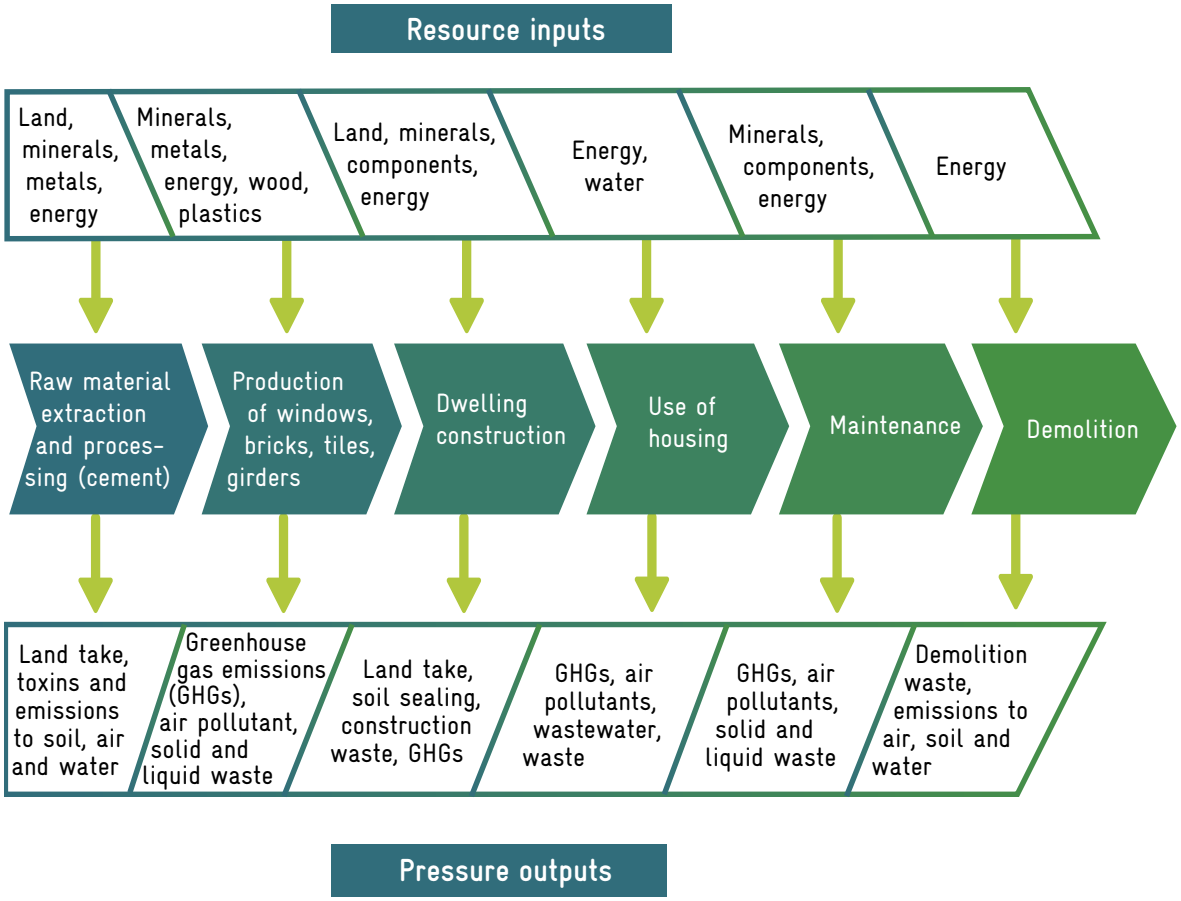
The transition to green construction is also contingent on changes in other areas, such as urban planning and architecture. The implementation of new, lower-emission planning and design strategies as well as deployment of new technologies and more sustainable building materials is crucial here (GIZ, 2021). However, construction value chains are inherently complex and include many different sectors of the economy and areas that are closely intertwined (see figure 1). They comprise a large number of different materials and pieces of equipment and involve various types of labour, such as manual and machinery work. Moreover, they are reliant on multi-stage relationships with subcontractors.

Figure 1: Stages of the construction value chain (One Planet network, 2012)



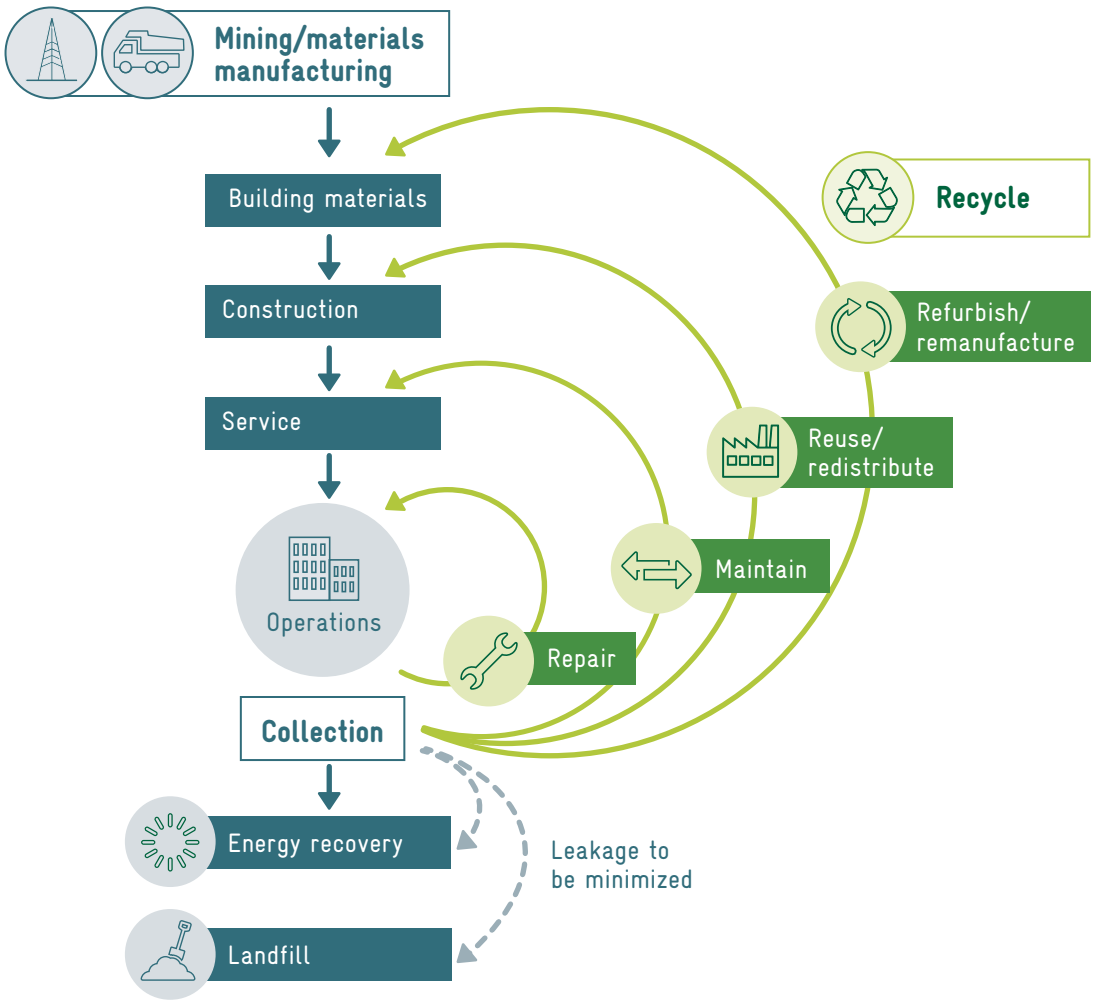
Resources such as energy, minerals, and water are needed throughout the different stages of the construction value chain. Their use has varying impacts on the environment and climate (see figure 2).

Figure 2: Environmental impacts on the value chain (Bahn-Walkowiak et al., 2012)



Green construction projects thus rely on 'greening' the entire value chain to be successful. This means that individual companies acting more sustainably will not be enough; what needs to be created is a more sustainable value chain throughout. That is why in the future – as sustainability issues become increasingly important for buildings – competition will mean rivalry among the value chains formed by each company rather than between individual companies. For this reason, it is essential for companies to demonstrate integrity and work together along the value chain. This approach will also influence the competitiveness of the companies involved.

Figure 3: Circular economy principles in the construction value chain (Vogdt, 2022)



In the interests of the circular economy, the transition to green construction requires that construction, use, dismantling or demolition and recycling are viewed as a loop so that resource consumption and environmental impacts are reduced (see figure 3) (Vogdt, 2022). In this process, construction must not be viewed in isolation. Rather, its ties with sectors such as energy and mobility must be considered (see also the sectoral studies on renewable energies and sustainable mobility).

The transition towards more sustainable buildings and infrastructure is therefore a key factor in achieving a number of the *Sustainable Development Goals* (SDGs) set out in the 2030 Agenda. Worldwide, the building sector has the potential to make energy savings of 60% for heating and cooling alone (OECD/IEA, 2016). By virtue of their potential to reduce emissions, more sustainable buildings can primarily contribute towards SDG 13 on climate action and towards improving access to affordable and clean energy through greater energy efficiency and the use of renewable energies (SDG 7).

For this reason, sustainable construction must aim to decrease the amount of energy and resources used by adopting appropriate ways of building. But sustainable construction principles should not only be implemented in new buildings; they should also be used to modernise existing buildings.

Along with the environmental aspects of sustainable construction, a building's socio-cultural impacts are also important. A structure must always be considered in the context of urban planning and the landscape. Other functional and people-related elements must also be taken into account during planning (**Indinger**, 2021). Along with having environmental impacts, measures to reduce buildings' energy consumption can therefore unleash other positive effects. For instance, they can help to make housing more available and more affordable by lowering capital and operational costs. At the same time, they can contribute towards a greater sense of well-being as a result of more comfortable living and working spaces. This means that sustainable buildings can help to improve people's health and well-being (**SDG 3**) as well as reduce social inequality (**SDG 10**) and promote more sustainable cities and communities (**SDG 11**) (**WGBC**, n.d.) (For more detailed contextual information, see Annex 1).

At the same time, the transition to a more sustainable building sector may unlock potential economic and employment benefits through the construction and refurbishment of buildings and the local production of more sustainable building materials (**SDG 8**). The International Labour Organization (ILO), for instance, believes that the construction sector, in particular, can create additional jobs during the transition to a Green Economy. However, its ramifications for the labour market are closely linked to the context in each country, not least due to key state regulation and the sector's dependence on economic trends (**ILO**, 2019).

In the interests of ensuring a Just Transition, the move to green construction must thus go beyond reducing emissions from the production and manufacturing of buildings. In fact, sustainable (green) construction must comprise all three pillars of sustainability – the economy, the environment and society – so that it is geared towards achieving environmental and climate policy goals and has a clear idea of the needs of people who until now had been marginalised or whose jobs are at risk from the transition.

3 Technological developments in the construction sector and their relevance in the context of DC

3.1 New technologies and their impacts in the construction sector

Technological progress is considered to be moving at a slow pace in the construction sector compared with other industries. Efficiency and productivity gains have been relatively minor to date (WEF & The Boston Consulting Group, 2016). Construction – traditionally an energy-intensive sector – must undergo radical change in terms of the technologies used and building utilisation plans if it is to meet the Sustainable Development Goals (SDGs). This has direct ramifications for the skills needed by the workforce in the future (GIZ, 2022). Yet, the construction industry's sheer size means that even isolated changes can have an impact and even individual DC projects can trigger significant changes. But an integrated approach is essential to make the construction sector greener throughout the entire value chain and to systematically mainstream change in the long term.

New technologies and digitalised process chains are exerting such a strong influence on the construction sector that there is tremendous potential to better harness the potential of energy efficiency and resource conservation measures (GIZ, 2022). The spectrum of technologies is just as diverse as construction itself. Technological trends that are playing an increasingly influential role in green construction have gained a foothold when building everything from homes to desalination plants. Moreover, a wealth of traditional building techniques have been lost or are mastered by only a few people today. These techniques can be highly effective in local contexts, especially when combined with modern methods. Examples include façade design, planting and building geometry, which can make significant contributions towards energy efficiency, along with the production and use of locally manufactured sustainable building materials (GIZ, 2021).

The next section will present selected technological developments in the construction sector that are highly relevant to development cooperation (DC). These technologies' different stages of development are key to how quickly they are disseminated. The more mature a technology is, the faster it is expected to be scaled up because it is cheaper and less demanding to install, operate and maintain, and thus requires less in terms of supporting infrastructure (Gerber Architekten & Burohappold Engineering, n.d.).

Green construction is not a new paradigm. In fact, it has always brought together affordable housing, environmental protection, and sustainable economic and social development. However, sustainability efforts dictate that a more comprehensive look is taken at the long-term implementation of plans and technologies that will require a number of stakeholders to gain new Green Skills. **The curriculum-based acquisition of these skills must therefore be designed in such a way that broad sustainability skills and specific technological skills support the scaling up of green construction.** The conditions in each DC partner country must be taken into account in this context.

3.2 Trend towards modular and digital construction

The concept of *prefab homes* and *modular housing construction* has become much more prominent since the 20th century. Back in 1624, one of the first documented prefab houses made out of wood panels was shipped from England to the USA as accommodation for ships' crews. Systematic building prefabrication began in the early 20th century. Today it includes the latest digital developments such as artificial intelligence, machine learning, and digital twins[2] (Goulding & Rahimian, 2019).

Prefabricating buildings entails manufacturing components in a factory and transporting them to the building site for assembly. Prefabricated construction has more rigorous requirements in terms of construction management but its high quality means that it can provide a very solid foundation for a more sustainable building sector. Prefab buildings and building components are the most important form of technological progress in the construction sector. They have benefits such as better quality, shorter construction times, year-round manufacturing regardless of the weather, and efficiency gains thanks to automation, reduced resource and energy consumption, and lower-emission manufacturing. It is important to make sure that potentially longer transport distances do not erase any potential emissions savings made during manufacturing.

DC has an opportunity here to share Germany's very advanced knowledge of prefabrication methods with partner country stakeholders by embarking on joint demonstration projects and training measures. For instance, this can take the form of a public-private partnership with international companies. In this way, the lower energy consumption associated with prefab methods can help to achieve climate targets and create Green Jobs (Goulding & Rahimian, 2019).

[2] A digital twin is the virtual representation of a building or a system. This representation shows its entire life cycle, is updated using real-time data, and uses simulation, machine learning, and conclusions to support decision-making.

3.3 Trend towards self-sufficient energy supply through renewables

Tomorrow's homes and infrastructure will require specific pathways to advance innovative and green construction. Using solar, low-energy design and the Passive House concept can improve energy efficiency, increase the use of renewable energy sources and renewable and environmentally friendly raw materials, and respond better to use aspects and user acceptance. Ideally, this approach also has similar costs to conventional design and construction methods. Low-energy design is an approach that keeps energy consumption low through good insulation, energy-saving technical appliances, and the like. Passive Houses are so well insulated that they lose hardly any heat to their surroundings. Particularly effective thermal insulation in external walls, the roof, and the floor slab minimises heat loss. Passive Houses use 'passive' energy sources that already exist to offset any heat that still escapes.

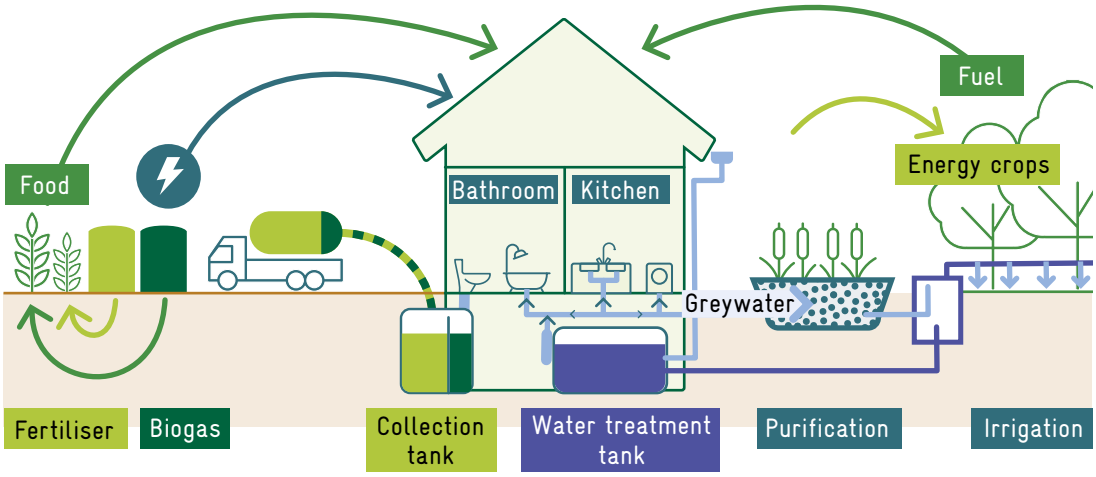
In an ideal scenario, green buildings do not just consume far less energy by opting for smart building technology for heating, cooling and electricity generation purposes; they also use their surface areas to generate energy (e.g. by installing photovoltaic panels or wind turbines on roofs). This can be achieved by integrating photovoltaic cells into a facade or using them as transparent modules for windows and skylights, for instance. Additionally, wind turbines installed on top of high-rise buildings can harness the air stream that is almost constant at that height above ground level. These kinds of self-sufficient buildings are being constructed in Germany, for instance, in partnerships between industry, property developers and public research institutions, such as the Fraunhofer Institute for Building Physics and the Institute for Smart Construction – Sustainable Building & Building Materials at Bauhaus University Weimar. Often, these buildings even exceed conventional sustainability standards thanks to their integration of renewable energy sources into the building's structure, their use of smart and energy-efficient distribution systems for heating and cooling and their provisions for using natural air flow rather than air-conditioning systems.

Within this series of studies, the trend towards renewable energies, especially photovoltaics, is mainly addressed in the *Sectoral Study: TVET for Renewable Energies*. However, this trend is also relevant for the transition to green construction. Skilled construction workers both install new systems and retrofit existing ones. The work may involve relatively simple systems that are largely isolated from the building, but also photovoltaic systems that are integrated into the building (Dabija, 2020). Human resources capacity with the required skills must be created in the construction sector to effectively unlock the potential of solar energy (Hachem-Vermette, 2020).

3.4 Trend towards more integrated water, wastewater and waste disposal systems

Water is a core issue addressed by the SDGs and an increasingly scarce commodity in the majority of current and potential DC partner countries. The construction sector has to become better at conserving resources and water. This process will involve advancing and refining construction materials and techniques as well as making economical use of water on building sites. For this reason, future skilled workers must be made (more) aware of this issue and of better ways to recycle resources in general during their training. Alternatives to large-scale resource-intensive systems might include local circular systems where water is heated by renewable energies generated on-site or water is made directly available through local desalination systems using parabolic concentrators, for example (Drück et al., 2020). Figure 4 shows an example of how greywater can be reused and recycled.

Figure 4: From greywater disposal to the use of the substances it contains (Holzapfel & Konsorten, n.d.)



Text box 1: Greywater use

Greywater is gently used water from showers, baths or wash hand basins. Simple means can be used to upgrade greywater on-site to the quality of service water. A system first collects water from showers, baths and wash hand basins in a greywater recovery unit. In a two-step treatment process, greywater first undergoes biological treatment before any remaining dirt particles are removed using membrane filtration. Reusing greywater also helps to reduce wastewater volumes since drinking water is used twice, which has both potential environmental and economic benefits.

3.5 Trend towards innovative thermal insulation and ventilation systems

The amount of energy expended to operate buildings plays a pivotal role in achieving the SDGs. After all, running buildings, especially their heating and cooling systems, accounts for up to 28% of global energy-related CO_2 emissions. The energy needed to heat and cool rooms should be kept to a minimum. Thermal insulation is also intended to protect building components against condensation and mould. It also helps to create a pleasant indoor climate for people. The ideal combination is one where traditional local thermal insulation and ventilation systems are coupled with 'optimal building geometry' and modern building technologies.

Bricklaying practical training at a TVET school in Ulaanbaatar, Mongolia. © GIZ Mongolia

Text box 2: Technical trends in thermal insulation and ventilation systems

- Movable and fixed sun shading (factors to consider include: maintenance and repair expenditure, influence of weather conditions, unsuitable for use in strong winds).
- Solar control glass
- Phase-change materials: Phase-change materials improve the thermal performance of lightweight building components. They are frequently used as micro-encapsulated elements added to walls or ceilings. Paraffins and salt hydrates are primarily used for this purpose (Vogdt, 2022).
- Passive cooling: Building components are cooled or activated using pipes that transport water or air into parts of the building with a large thermal mass. The components absorb energy from ambient air and transport it away using the cooling medium (Vogdt, 2022)
- Heat is transported using non-translucent (opaque) components.
- Heat and energy recovery systems
- Measurement and control technology to save energy
- Ventilation using the building envelope and mechanical ventilation (Dunst, 2022)

The use of phase-change materials to insulate buildings is a good example of innovation. Unlike materials conventionally used for this purpose, which stop the flow of heat using air pockets and fibre-based materials, phase-change materials absorb and release heat by alternating between a liquid and solid state.

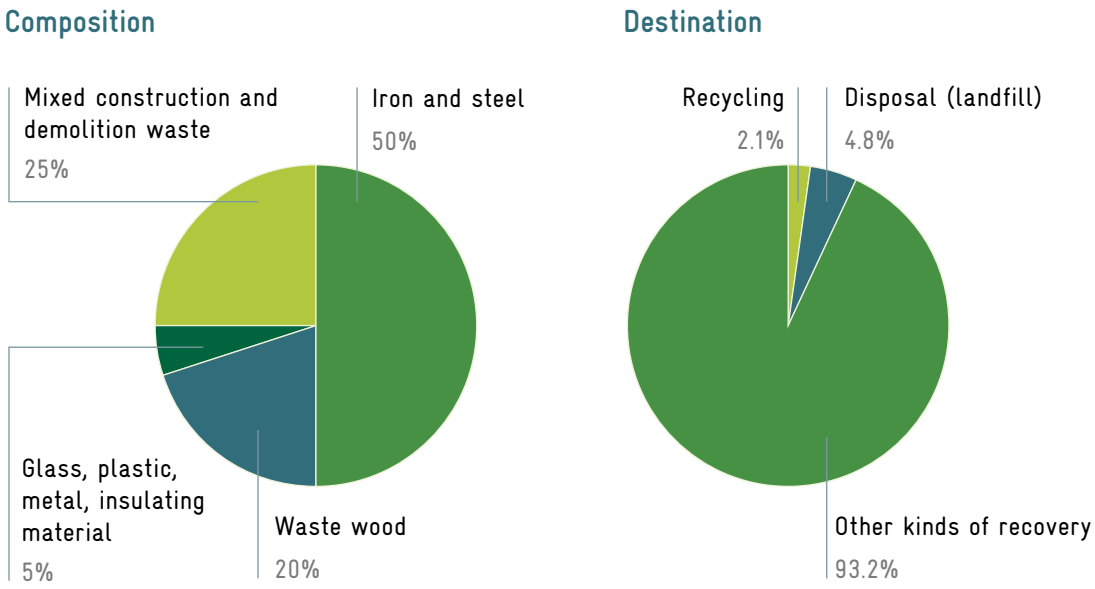
3.6 A consistent circular economy is essential to sustainable construction

Sustainability plays an increasingly important role when setting up building sites. Some stakeholders (Schach & Otto, 2022) are calling for building sites to be of high environmental quality and generate zero emissions, creating what are known as zero-emissions building sites. In general, DC partner countries are still even further away from this prospect than industrialised countries (Gorse et al., 2022).

Building materials are especially crucial here. For instance, global consumption of Portland cement, the leading component in concrete, has reached record high levels. Manufacturing Portland cement has considerable negative impacts on the environment. For one thing, it accelerates climate change by releasing around 0.8 tonnes of CO_2 per tonne

of cement. For another, the use of mineral and non-renewable raw materials places a heavy burden on ecosystems. Opting for more sustainable materials such as fly ash (a waste material from coal-fired power plants) and slag (a waste material from steel manufacturing) can reduce these environmental impacts and strengthen the circular economy (Das & Neithalath, 2019). Additionally, the environmentally sound manufacturing and use of construction materials (e.g. cement, steel and paint) should be encouraged. Initiatives such as *urban mining* can also help to decrease resource consumption (Schanda, 2021).[3] Figure 5 indicates the potential resource savings that can be made by recycling and using circular economy approaches, taking Germany as an example. Less than 5% of Germany's construction waste is consigned to landfill. More than 95% is sent for recovery or recycling.

Figure 5: The composition and destination of construction waste in Germany in 2012 (Friedrichsen, 2018)



The use of biodegradable materials in sustainably produced building materials is also worth mentioning. Compared with recycled products, biodegradable materials have the benefit of being degradable without leaving any residues or pollutants thanks to their natural origins. Examples include biodegradable paint containing milk proteins, calcium compounds and natural materials, and insulating materials made out of hemp (Indinger, 2021).

Sustainable construction and the circular economy need standardised evaluation methods to assess the use of green building materials and set minimum standards. Local building material production and the construction sector must follow these sustainability standards. Yet, many countries often still lack binding standards.

[3] Urban mining refers to the idea of reusing or recycling raw materials, used materials and waste products stored in buildings as a 'mine' at the end of their life, for instance during demolition, rather than disposing of or landfilling them.

For this reason, the construction sector has to consider the following questions when evaluating sustainability. For future DC projects, these elements should also be analysed as early as the planning phase, for instance to integrate local production methods into TVET projects (Roth et al., 2021):

- What local building materials and products are available? How big is the local construction sector?
- What local building techniques and traditions exist?
- How were/are buildings built in the local area? Are there building techniques/traditions worth keeping?
- How are building materials bought? (Is a local sustainable market structure already in place?)
- Who is employed in the local construction sector? (Demand for skilled workers/ training needs)
- To what extent is building waste disposed of or recycled using sustainable methods? Where does it end up?

3.7 Trend towards green infrastructure

Green infrastructure encompasses both natural ecosystems and 'greened' ecosystems in urban, suburban, and rural settings. Green infrastructure is a network (or ecosystem) of natural areas that benefits people and the natural environment. The green infrastructure approach to planning helps to balance environmental, social, and economic goals. It also includes factors such as having soil of sufficient quality and quantity available to absorb water and using products and technologies, such as permeable paving, rain barrels, and cisterns that mimic the functions of natural ecosystems. Environmentally friendly construction initiatives frequently focus on the structure of the building itself and generally comprise programmes addressing energy efficiency, building materials, ways to reduce water consumption in buildings, and internal systems (e.g. heating, cooling, and lighting).

Green infrastructure practices are complementary elements integrated into the building envelope, e.g. green roofs and green walls. However, their integration beyond the building into site design and the construction of conventional infrastructure, such as parking spaces, will also be vital. Such an approach can increase effects to mitigate and adapt to climate change and improve the quality of life in communities. Developing green infrastructure includes steps such as planting trees, creating green spaces, and restoring wetlands rather than installing a new and costly water treatment system. Incorporating green infrastructure practices into property construction and design may be less costly than traditional approaches. Green infrastructure has been shown to reduce project delivery costs, long-term maintenance costs, and/or total life cycle costs, depending on its scale and the approach taken.

Promoting sustainable construction trends in partner countries.

Over the past 30 years, the trend towards greener construction has become increasingly widespread around the globe. Demand is growing more and more, first in industrialised countries and, since the 2010s, in developing countries and emerging economies, too. **However, to what extent and how quickly these trends take hold in developing countries and emerging economies, too, is highly dependent on each country's political, economic, and institutional context.**

It has become clear that developing an entire 'ecosystem' is critical to mainstreaming green building beyond flagship projects (Gou, 2020). **Single measures are not enough. Rather, green construction must be promoted across many areas of policy-making, the economy, and society. Ways of doing this could include** introducing rating systems, developing environmentally friendly products and systems, facilitating growth for consulting firms that advise on environmentally friendly construction, and creating financial opportunities for commercial investors. Coordinating cooperation between the private sector, government bodies, and civil society is essential for the promotion of this sector to be effective.

Since consumer prices for fossil fuels are comparatively low, many partner countries have yet to experience much financial pressure from the private sector to deploy new technologies and systems that conserve resources. **Creating an enabling policy and regulatory environment for environmentally friendly construction is thus a key step in driving demand for sustainable construction.** One option might be to introduce standards and building codes that promote energy efficiency and green construction. DC projects have previously supported green construction by advising government institutions and sectoral organisations on national regulations.

4 Demand for skilled workers and Green Skills

Hard-hat workers in high-visibility vests is the image that comes to mind for many people when they think of construction. It is important to distinguish between construction as an industry or sector and construction as an occupation. In general, human capital and raw materials are the most important resources used in construction. Building firms employ workers in a large number of trades. They include skilled and unskilled construction trades such as gas fitters/plumbers, carpenters, and labourers, as well as professional service and office occupations such as material testers, architects, designers and engineers, sales and logistics staff, transport and quality inspection workers, and project managers.

Within the sector, green services encompass many activities related to the construction of new green buildings, retrofitting residential and commercial buildings, and adding green technologies to infrastructure. The residential sector comprises many different types of contractors, e.g. large construction groups, property agents, small companies that have specialised in areas such as installing renewable energy systems, tradespeople and micro-enterprises and, in many countries, workers who earn their money as day labourers on construction sites.

4.1 Demand for skilled workers for a transition to green construction

The construction sector is often the easiest place to find work in urban areas and offers income opportunities for a large number of people. Prior to the COVID-19 pandemic, the construction sector is estimated to have accounted for roughly 7.7% of global employment (ILO, 2021) and 13.4% of global GDP in 2020. This sector will continue to grow in the future, primarily in Asia and Africa, owing to population and economic growth, ongoing urbanisation trends, and urban infrastructure investment programmes. Asia is forecast to see annual growth of 7.4% by 2026, with annual growth in Africa projected to stand at 5.7% (Webuild, 2021).

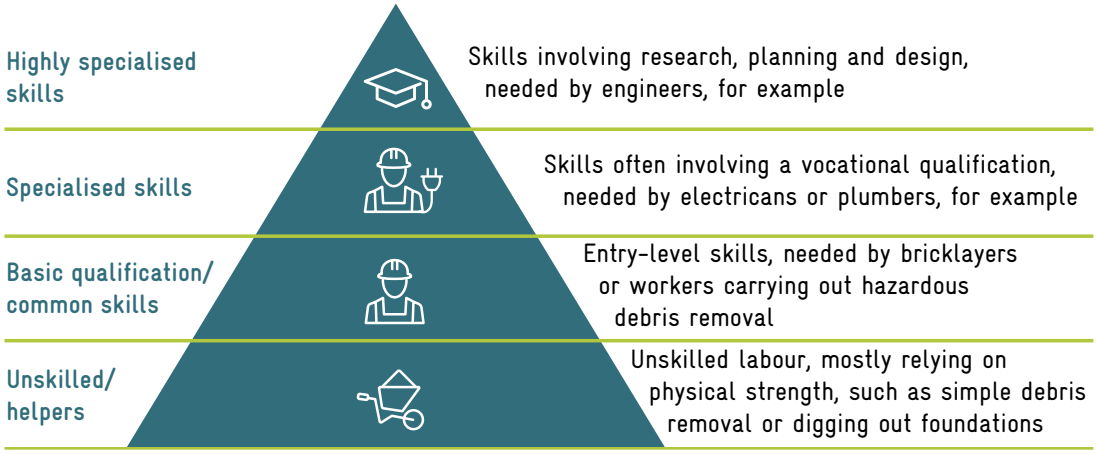
National political ambitions to mitigate climate change and reduce demand for fossil fuels are already discernible in many Development Cooperation (DC) partner countries. **Since the construction sector accounts for a large proportion of the energy countries need, demand for green construction will continue to grow in many DC partner countries – and with it, the need for skilled workers.** Self-sufficient energy supply is also becoming more and more critical amidst increasing volatility in global energy prices because of geopolitical crises.

Partner countries are expected to experience growth primarily in the following areas:

- The construction of new energy-efficient buildings, including residential, commercial, institutional, and industrial buildings;
- The remodelling, retrofitting, or post-commissioning of existing buildings to improve their energy and/or resource efficiency;
- The construction of buildings related to the generation or transmission of renewable energies from sources such as solar, wind, biomass, geothermal, and hydropower;
- The installation and maintenance of renewable energy systems.

This rising demand will extend to all skill levels. In general, construction requires highly qualified skilled workers such as architects, inspectors and engineers to plan and monitor building projects. To implement these projects, a whole range of skilled workers who have received Technical and Vocational Education and Training (TVET) will be needed in turn, for instance electricians and gas fitters/plumbers. As a rule, a number of semi-skilled trades will also be needed, for instance people working as bricklayers or removing hazardous construction waste. However, the majority of people working on building sites are generally unskilled workers who primarily perform physical labour (e.g. digging out foundations and transporting building materials). Analyses of building sites in India and South-East Asia, for instance, have demonstrated that more than 80% of people working on them are unskilled, while just 5% are semi-skilled and highly skilled workers (see figure 6; Global Shelter Cluster, 2019). **The transition to green construction is not expected to change the proportional composition of labour on construction sites much in the short term.**

Figure 6: Skills pyramid for construction projects (author's own graphic; based on Global Shelter Cluster, 2019)



Nonetheless, a few occupations will become more important. Table 1 shows the occupational profiles that are central to the transition to green construction along the value chain of a construction project. This shows that higher or lower skill levels vary in their importance, depending on the segments of the value chain. While higher education qualifications are primarily key in planning and design, technical skills are mainly important when performing construction and maintenance tasks.

Table 1: Examples of occupations along the green construction value chain (based on ILO, 2011)

Occupational groups along the value chain	Examples of occupations
Planning, designing and advising	• Construction company managers and business functions • Architects, civil/structural/environmental engineers • Heating, ventilation and air-conditioning (HVAC), electrical, mechanical, sanitary, renewable energy and building services engineers/designers • Surveyors • Energy, water efficiency and waste management analysts, consultants and advisors
Construction, installation and maintenance	• Building site managers and site engineers
	Refurbishment/construction **Insulation** • Bricklayers, carpenters, plasterers, glaziers, roofers, painters/decorators and semi-skilled workers **Efficient heating, ventilation and air-conditioning** • Plumbers and heating installers/maintenance engineers • HVAC installers • Electricians and IT technicians **Energy efficiency** • Electricians and installers of energy management systems (at domestic level, mostly responsible for helping people to choose energy-efficient appliances and lighting technologies) **Water efficiency** • Gas fitters/plumbers
	Building-level renewable energy systems **Heating/cooling systems** • Installers/mainstreaming engineers for solar thermal systems • Installers/mainstreaming engineers for wood pellet and other biomass heating systems • Installers/mainstreaming engineers for mass heating (large buildings or district heating) and combined heat and power (CHP) systems • Heat pump installers/mainstreaming engineers **Electricity** • Installers/mainstreaming engineers for photovoltaic systems • Installers/mainstreaming engineers for small-scale wind turbines
Supervision, controlling	• Energy auditors • Inspectors, certifiers and quality controllers
Enabling occupations	• TVET school teachers for building-related subjects • Policymakers and local authority administration • Urban planners • Researchers into building-related disciplines • Financial services providers

Manufacturing and distribution	• Manufacturers and distributors of green building materials and products • IT and systems technicians
Green building clients	• Energy and building managers • Public-sector officials working in procurement and management of buildings • Householders and tenants[4]

A Just Transition in the construction sector

Considering the growing importance of individual occupational profiles, it is clear that there will be additional demand for skilled workers across all qualification levels. **On the other hand, demand for occupations in conventional areas of construction that are less energy-efficient and green may decline.** They include occupations such as bricklayers, roofers, and skilled workers who install and maintain conventional energy systems running on gas or oil. **Workers with little training and marginalised groups are especially vulnerable to change because they lack access to the education and training they need, to adjust to the new requirements of green construction.** Quantitative employment effects must be identified at an early stage to avoid developing TVET opportunities that address growing areas of construction only. Workers in declining areas must also be given the opportunity to find new work through continuing education and retraining (and other additional supplementary labour market measures)**. Thus one key recommendation and requirement for the design of future projects is to draw up specific local demand forecasts for skilled workers that also take into account the dwindling employment effects.**

However, it must not be forgotten that the majority of people working on construction sites perform unskilled tasks and do not have formal qualifications. To ensure a Just Transition, it is vital that these people are not neglected. Building sites are often the first port of call for people who have moved to urban areas in search of work or who cannot find other jobs because of their lack of education. Often, these people are taken on temporarily by (sub)contractors and provided with brief training on-site (e.g. bricklayers' assistants). In many countries, construction workers are itinerant workers who are hired only for the duration of a project, in other words, until a specific building is completed, and subsequently change employer and location. The construction sector also remains the industry with the lowest worker wages and qualifications (Nowak, 2015)**. Workers are often denied access to advancement to safer and better-paid tasks on the building site because many of the small subcontracted firms cannot afford to provide systematic on-the-job training. External training is not available either, because a certain level of prior education is required or because of opportunity costs** (ILO, 2016).

Up to 75% of workers in emerging economies and developing countries are generally engaged in informal employment. This rate is as high as around 93% in countries such as India (97% of women and 89% of men) (Santamouris & Vasilakopoulou, 2021). Informal jobs frequently do not meet the criteria for dignified, decent work. Around the world, construction site workers often comprise 40% self-employed workers,

[4] Not occupations in the strict sense of the word, but key stakeholders on the demand side

30% informal workers, and 30% workers with formal employment contracts. In other words, about 70% of people work outside of a formal wage employment relationship, which means they are often subject to exploitation. They often find themselves without access to labour law, contractual certainty, and social security. In Rwanda, for example, many small entrepreneurs report that they have performed work on construction sites that they were not subsequently paid for (Hartrich, 2018).

Moreover, shortcomings in occupational health and safety and a lack of safety equipment and training make these groups particularly vulnerable to accidents and health risks such as skin cancer from sun exposure, hearing disorders, and poisoning. For instance, close to 60% of informal workers on construction sites in India report having suffered accidents at work. Informal subcontractors are often denied legal means, as well. For instance, they cannot take legal recourse if their customer is unwilling to pay (Hartrich, 2018).

Women in the construction sector

In most countries, women are the exception in the construction industry and make up just a very small fraction of people working on construction sites (Hartrich, 2018). In Brazil, for instance, only 204,291 (2.6%) of the 7.8 million people working in the construction sector in 2011 were women (Nowak, 2015). In many countries, though, the small number of women in the sector primarily perform unskilled tasks, such as transporting materials.

Construction is one of the most male-dominated industries in the world. Traditional role models, male-dominated hierarchical structures, and discriminatory stereotypes and clichés still pose enormous challenges to improving employment opportunities for women in the construction sector. In Nigeria, for instance, surveyed construction companies considered women suitable to perform work in certain areas only, which do not include physical and manual labour (see figure 7).

Expansion of TVET academies' (*Instituts Supérieurs d'Enseignement Professionnel*, ISEP) cooperation with potential employers (Higher Education Programme for Renewable Energy and Energy Efficiency, PESEREE III), Senegal. © GIZ Senegal/PESEREE

Figure 7: Suitability of construction tasks for women in Nigeria (Adeyemi et al., 2006)

Construction tasks	Extremely unsuitable (0)	Some what unsuitable (1)	Some what suitable (2)	Suitable (3)	Very suitable (4)	Score	Rank
Project supervision	0	0	8	45	17	219	5
Estimating & tendering	0	0	4	15	51	257	2
Administration	0	0		14	56	266	1
Preparation of working drawings	0	0	2	47	21	229	3
Block laying	25	29	16	0	0	61	10
Reinforcement placing	46	23	1			25	14
Concreting	16	21	33	0	0	87	8
Excavation	48	22	0	0	0	22	16
Operating equipment	27	20	23	0	0	86	9
Demolition	46	24	0	0	0	24	15
Carpentry	39	31	0	0	0	31	13
Plumbing	42	23	5	0	0	33	12
Electrical works	25	34	11	0	0	56	11
Site Reconnaissance	0	3	36	25	6	178	7
Setting out	0	0	10	43	17	217	6
Progress evaluation	0	0	2	53	15	223	4

The position of women is degraded through social attribution and frequent sexual assaults in the construction industry (Madikizela & Haupt, 2010). There is also a lack of work-family balance. These two factors hinder women's entry into this industry and the acquisition of construction expertise (see figure 8). This is true in Europe, as well. For instance, the GMB trade union in the UK does not expect gender parity to be reached until 2219 (GMB, 2019), even though the UK's construction sector, like Germany's, has a relatively high proportion of women in a Europe-wide comparison.

Figure 8: Career barriers for women in the construction sector (Navarro-Astor et al., 2017)

Career barriers		No. of studies
1.	Work-family balance	32
2.	Gender stereotypes	28
3.	Allocation of posts and activities	25
4.	Promotion	24
5.	Working conditions	23
6.	Sexist culture	22
7.	Harassment and lack of respect	21
8.	Recruitment and selection	19
9.	Lack of recognition	13
10.	Pay	11
11.	Social networks	9
12.	Other	7

'Greening' this sector will not automatically improve the situation facing women in the construction industry. New technologies do offer an opportunity to make the sector more attractive to women and break with traditional role models. However, comprehensive and concerted efforts that go far beyond the construction sector are needed to improve women's employment opportunities in the sector. Section 7 lists examples of measures that TVET cooperation projects can support in this area.

4.2 Changes in skills demands

The required skills will change across all levels of qualification as new technological developments, integrated planning, and interdisciplinary design become increasingly important and work processes in construction become more automated. This process involves a shift away from traditional manual labour and towards greater emphasis on digital and technical skills, such as computer-assisted design and energy auditing. All areas of expertise in construction occupations will be affected. These include:

- Technical skills combined with new technologies, sustainable methods and materials (e.g. knowledge in the field of innovative technologies, the use of local natural building materials, methods to conserve materials, and recycling)
- Energy-related skills (e.g. on renewable energy systems, climate-sensitive design, and energy auditing)

- Skills related to certification and building codes
- Project management skills (e.g. sustainable construction site management and a life cycle perspective including building maintenance and demolition)

Both technical skills and a whole range of interdisciplinary skills (James Relly et al., 2022) will be needed to adapt to the aforementioned developments in the construction sector:

- Interdisciplinary skills to coordinate work and perform tasks across sectors
- Self-learning competences to adapt to technical changes and engage in lifelong learning

Electrical training at a TVET school in Darkhan-Uul, Mongolia. © GIZ Mongolia

- Basic knowledge of environmental protection and sustainability
- Soft skills such as communication, teamwork, and a problem-solving focus which are needed to advise customers on new products or coordinate work processes across industries
- Entrepreneurial skills to identify new business areas and win clients
- Digital literacy skills to cope with the increasingly digital nature of work processes, and marketing and communication methods.

Text box 3: Demand for Green Skills in Ghana

The availability of skilled workers and professionals adequately trained in green and energy-efficient construction is essential to the transition to a sustainable construction sector. For example, to expand photovoltaic (PV) systems, special upskilling or reskilling programmes will be needed so that the necessary preparatory work to the building has been done to enable the solar panels to be installed. The case of Ghana shows that such programmes can fail due to a lack of political coordination. The country has introduced tax incentives for photovoltaic systems but lacks the workers to carry out the preparatory building work needed to install this technology. The demand for skilled workers and professionals is so great that workers have to be recruited from abroad.

The skills needed relate to:

- The legal frameworks (rules and standards) for PV systems
- The set-up, installation, and way that solar modules and PV systems work
- Practical experience in planning, assembly, commissioning, and energy management
- The set-up, installation, and way that storage modules work (different storage options)
- Maintenance and repair, fire safety/firefighting, and occupational health and safety

The transition to green construction will have varying impacts in terms of the skills and qualifications needed at all skill levels. Nonetheless, it is expected that fewer new occupational profiles will have to be created in construction. Rather, existing occupational profiles may be adapted to meet the new requirements (ILO, 2019). The TVET and higher education systems must adjust their courses to reflect the specific new technical skills that are needed and enshrine interdisciplinary skills in a series of additional courses. Table 2 shows which educational means and modalities are central to imparting skills relevant to green construction for occupational clusters along the value chain.

Table 2: Central pathways to imparting skills for the transition to green construction (based on ILO, 2011)

Clusters of occupations along the value chain	Main educational formats and adaptations needed to provide new Green Skills
Planning, designing and advising	• Adaptation of university degrees • Development of specialised Master's degrees and other forms of continuing education in energy efficiency, building codes and energy certification • Continuing education offered by professional associations • In-company training • Certification institutions
Construction, installation and maintenance	• Adaptation of TVET courses/new TVET courses • Adaptations to the formal apprenticeship system • Continuing education offered by industry associations and workers' organisations • In-company training • Active labour market training for unemployed people • Entry-level training by public-benefit organisations
Supervision, controlling	• University courses (degrees and continuing education) • Technical education complemented by certified working experience • Training and examination related to certification
Enabling occupations	• Training for teachers • Higher education for urban planners • Training for policymakers and financial services providers
Manufacturing and distribution	• Compliant with the requirements of supplier industries
Green building clients	• Short courses in green procurement • Information campaigns • Higher education in energy management

The most significant changes are expected to be seen at higher qualification levels as workers will have to familiarise themselves with technologies and design principles that are undergoing considerable change. Architects and engineers, for example, will find that their work alters substantially. They will have to keep up with the latest trends in new green technologies, design principles, and increasingly far-reaching digitalisation.

Highly qualified skilled professionals with university degrees will primarily be needed to plan, monitor, and certify construction work. Relevant higher education training programmes need to be adjusted accordingly. The highly practical nature of these professions presents an opportunity to forge links between (higher) TVET and higher education. Such an approach can promote permeability between these systems and allow teaching content to be coordinated, e.g. between engineering degree programmes and corresponding training programmes for skilled workers. In this regard, TVET projects can provide advice to the institutions responsible at system level (see Section 6.3).

TVET has an important role to play in the transition to green construction. It mainly has to train skilled workers who are key to installing and maintaining a number of newer technologies, including electricians and gas fitters/plumbers. Semi-skilled workers are expected to see fewer changes in terms of the skills they need than highly skilled workers. However, they also need to learn about new technology-specific knowledge and work processes so that they can install and maintain new technologies, e.g. renewable energy systems.

Training courses must be tailored to the new requirements in terms of technical and interdisciplinary skills. TVET institutions should cooperate with building companies to develop courses to train today's and tomorrow's skilled workers, for example by integrating green modules into traditional TVET curricula. New green modules may teach knowledge and skills in areas such as sustainable materials, energy certification strategies, energy use/efficiency, water use, environment and health, resources, and solar thermal systems. Non-formal, short courses are especially suited to this purpose. These courses are easier to adjust to changes in the local construction industry and can respond more flexibly to local changes in demand.

Nevertheless, relevant skills should also be embedded in basic TVET courses, and occupational profiles and curricula should be adapted, not least to impart new interdisciplinary skills. Providing a solid understanding of conventional technologies and materials remains essential in the short to medium term given that demand is still limited in most partner countries. This may offer an opportunity: linking up established building processes, traditional craftsmanship, and modern building innovations could give rise to innovative local adaptations.

More specific recommendations for measures on how VET cooperation can promote green building are set out in Chapters 6 and 7. These recommendations are based on literature research and an analysis of project examples from selected partner countries shown in the next section.

5 Lessons learned from projects in selected partner countries

The following section illustrates selected project approaches taken by international and German development cooperation (DC) that promote the transition to green construction. During the research process, it became clear that systematic project experience has not been gathered to date on either the TVET cooperation front (supply of skilled workers) or the economic development front in green construction (demand for skilled workers). Most interventions are limited to individual areas and isolated measures, so supply and demand are not examined together. In general, the organisational and legal framework conditions for sustainable construction are judged to be unsatisfactory in the countries examined. Adjusting sustainability standards for construction in terms of building materials, building design and construction methods, certifications, and also professional qualifications and training require investments that often pose a challenge for the private sector without government incentives. Therefore, it is all the more important to incorporate strengthening the policy and regulatory framework conditions to promote green construction into interventions (see Section 6.1)

Examples of projects from the following countries in Asia and Africa, the two priority continents for German DC, were chosen: Mongolia, India, Nigeria, and Somalia. This selection reflects smaller and larger economies in the regions that have different requirements in terms of green construction and different experiences with implementing green building practices. Bearing this in mind, the following section presents both project approaches and the context in each country so that lessons can subsequently be learned for the design of future DC projects.

5.1 Mongolia – Capacity building in all sectors of green construction

Mongolia has an extreme climate with short summers and long, very cold winters. Some 1.5 million of the country's 3.2 million residents (2019) live in the capital, Ulaanbaatar. Ulaanbaatar's building stock is outdated. Heating to some of the buildings is supplied by a coal-fired district heating network. Another large proportion, especially small buildings and yurts on the outskirts whose number has increased considerably in recent years, are heated using coal-burning stoves. Approximately 800,000 people are currently estimated to be living on the outskirts of the city (GIZ, 2023). With harmful air pollution and demand for energy rising, improving energy efficiency in the building sector was specified as a key goal of Mongolia's Action plan of Green development policy back in 2014.[5] The first regulations governing the energy efficiency of buildings

[5] Enhancing energy efficiency is also one of the main goals of the 2020 Green Development Strategic Action Plan for Ulaanbaatar.

were also adopted with support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Mongolian legislation is still not driving efforts to develop a sustainable construction sector because low energy prices in the country are thwarting an increase in demand for energy-efficient construction. The government, administrations, and the private and finance sector lack effective implementation, certification, and monitoring capacity. This meant, for instance, that the finance sector was unable to draw on state investment funds for the energy-efficient retrofitting of buildings because building projects could not be certified. Even though the basic political will to take action is there, key levers for boosting demand for green skilled workers in the construction sector are lacking.

Industrial mechanics course at a TVET school in Southgobi, Mongolia. © GIZ Mongolia

GIZ supported administrative capacities at the Municipality of Ulaanbaatar in improving the integration of energy efficiency considerations into the construction sector as part of Energy-Efficient Building Refurbishment in Mongolia, a project cofinanced by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Swiss Agency for Development and Cooperation (SDC). This project worked at the micro, meso, and macro level to provide integrated support for the sector. Along with delivering policy and process-based advice to the government on how to introduce regulatory and financial framework conditions, the project also fostered the transfer of technology and knowledge at the micro level with replicable pilot projects. At the meso level, the project selected an approach that aims to empower stakeholders throughout the entire green construction ecosystem to design and build energy-efficient buildings. It carried out capacity building measures with public and private institutions, service providers, and lending institutions to reach as many segments of the value chain as possible.

- Together with the Municipality of Ulaanbaatar, the project conducted information campaigns and awareness-raising events for interested members of the general public to make people more aware of the issue.
- It also worked in conjunction with the Municipality of Ulaanbaatar to develop short training courses for public employees involved in public investment management. This training included a variety of modules on investment management, developing strategy documents, project management, and life-cycle costing.
- To train future public sector staff at national level, the project also worked with the National Academy of Governance to develop modules on energy efficiency and public investment management for different disciplines and qualification levels.
- The project partnered with the *Mongolian Banking and Finance Academy* to develop a continuing education programme with six modules on financing energy efficiency measures for buildings. The goal here was to give the private sector access to financing instruments.
- Trainings were developed to upskill engineers from the private sector to work as energy auditors for refurbishment and new construction projects so that a certification system based on EU standards could be implemented.
- The *Mongolian Construction Designers Association* received support in developing seven modules on energy-efficient construction. These modules were included as electives in their nationally recognised training programme.

A declaration of intent to build capacity related to the international Excellence in Design for Greater Efficiencies (EDGE) standard was signed with *Capital City Housing Corporation (CCHC)*. In 2020, a model house was built as a joint pilot project and subsequently received certification. To this end, CCHC trained people working on the construction project in energy-efficient building design and construction methods.

The example shows the importance of taking an overall view of the building sector as an ecosystem when promoting green construction. Policy initiatives and legislation are important, but effective implementation and monitoring mechanisms are essential. Projects and programmes that aim to promote green construction should therefore involve capacity building activities for different segments within the ecosystem, along with policy and process-based advice. This includes building institutional and technical skills within public administrations and the construction, finance, and certification industries, and raising awareness among stakeholder representatives and the general public.

5.2 India – Improving the availability of skilled workers for green construction

India faces pressing environmental challenges due to rapid population growth, rising energy consumption and greenhouse gas emissions, and deteriorating air quality. Its existing buildings account for 40% of national energy demand (ORF, 2020). It is assumed that a more energy-efficient building stock can reduce national energy demand by between 20% and 30%. Along with the lack of legal framework conditions and financial incentives for the private sector, a shortage of skilled workers has been identified as a structural obstacle to scaling up energy-efficient buildings (information taken from interview with Skill Council for Green Jobs (SCGJ), 2020).

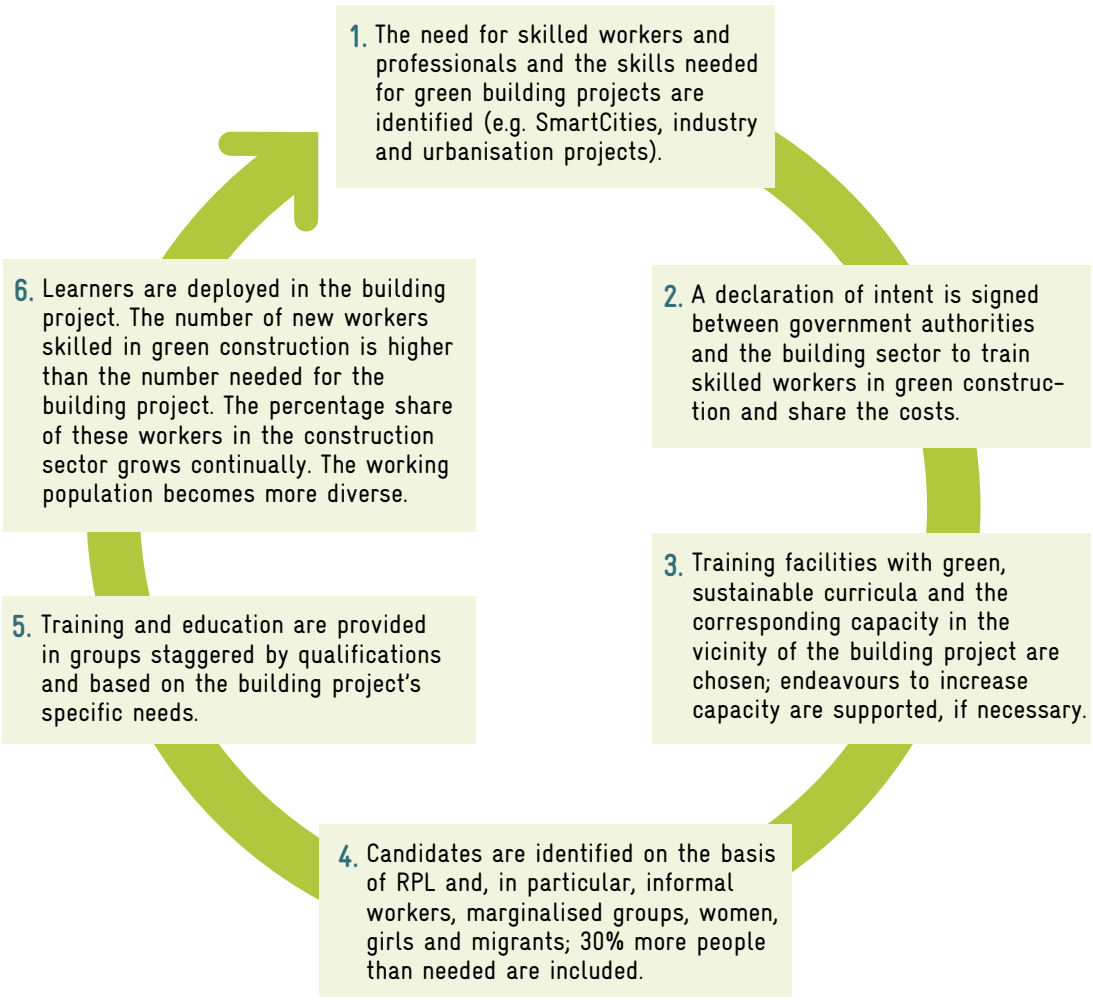
The Skill Council for Green Jobs (SCGJ) was established in 2015. It identified the construction sector as one of the key intervention sectors for green job growth. *Sector skill councils* are independent bodies that play a vital role in mediating between the needs of industry and the training on offer. Their task is to identify qualification needs and develop qualification and skills standards within these sectors. They are also responsible for standardising accreditation, examination, and certification procedures in accordance with the National Skills Qualification Framework.

SCGJ included micro and small enterprises in needs assessments as a means of identifying qualification gaps at lower qualification levels, as well. It found that the lack of fully trained skilled workers hits micro and small enterprises especially hard. Labour costs account for a large proportion of their total costs (more than 50% in the case of wall insulation). These enterprises often cannot afford time-intensive on-the-job training. They cannot compete for green building projects and become unprofitable. The dissemination of green building methods is slowing down (SCGJ, 2020.). The Council has drawn up a strategy to develop courses to train skilled workers in the construction sector in partnership with the private sector and (higher and vocational) educational institutions in order to close these gaps in the availability of professional skills. Closely involving private sector companies through declarations of intent and by addressing pressing needs for skilled workers, e.g. in investment programmes, is essential here.

Figure 9 shows the roadmap for SCGJ to implement projects to build Green Skills in India with various approaches. It starts by identifying gaps in the spectrum of competences provided by skilled workers, including the needs of often disadvantaged groups. Declarations of intent are then drawn up with private sector stakeholders (including a statement on the costs to be covered by the partners), and candidates for training are selected. People without formal certification of their work experience will also gain access through a system of *Recognition of Prior Learning* (RPL). Learners will then receive training at educational institutions with close ties to the project. The number of suitable candidates accepted should be 30% higher than the number of learners that the partner companies need. Each company can finally select candidates for an internship.

This example shows the challenge that TVET faces in finding the right timing to develop courses for green construction. On the one hand, the construction sector often does not need Green Skills across the board yet. On the other hand, the availability of skilled workers increases work productivity and thus the profitability of green construction. It increases market opportunities especially for small companies that cannot afford their own training programmes. It is not yet clear to what extent the strategy to train 30% more skilled workers in close cooperation with green construction companies than there is demand for their own construction projects can lead to green construction becoming more widespread.

Figure 9: Roadmap for training skilled green construction workers in India (authors' own diagram based on SCGJ, 2020.)



5.3 Nigeria – Gradual integration into national educational systems

Nigeria is Africa's most populous country. It also has the seventh-largest population in the world. In light of the country's rapid population growth, its construction sector is projected to have considerable growth potential, with an average annual growth rate of 3.1% forecast between 2023 and 2026 (GlobalData, 2022). Along with major infrastructure projects, Nigeria has mainly witnessed growth in private construction. The residential sector, particularly owner-occupied buildings and housing projects in gated communities designed by property developers, is currently considered the most dynamic segment within the Nigerian construction industry. Energy-efficient construction is thought to hold significant potential for energy savings (IFC, 2022). However, this potential is not being harnessed due to a lack of regulation and financial incentives.

The Nigerian Energy Support Programme (NESP) has been funded by the European Union and BMZ and implemented by GIZ in partnership with *Nigeria's Federal Ministry of Works and Housing* since 2013 (Geissler et al., 2018). Its primary objective, along with expanding renewable energies, was to develop and implement a legal framework for energy efficiency in buildings, particularly the Nigerian *Building Energy Efficiency Code*. In the first phase, the programme advised a variety of policy and regulatory stakeholders on introducing new laws and rules. However, Nigeria lacked the skilled workers and professionals to plan, implement, and certify energy-efficient construction projects.

In partnership with the *National Power Training Institute of Nigeria*, the programme developed the first energy efficiency training courses for engineers, architects, and technicians (GIZ, n.d.). These courses included advanced training in energy management and in energy audits, and a course on energy-efficient building design for architects and engineers. Twelve educational institutions in Nigeria offer these and other courses.

Based on case studies, needs assessments, and market analyses, the programme will now work in partnership with the private sector to develop competence standards for energy auditors and course modules while taking account of the national framework of reference for curricula. Uniform standards for audits and certification will also be developed.

This example demonstrates how projects promoting the regulatory framework for green construction and developing short-term training measures for skilled workers should design them with a view to their later integration into the formal educational system. In a next step, education and training standards can then be defined and systematically mainstreamed into (vocational) education systems to ensure that qualifications are comparable and of high quality.

5.4 Somalia – Community-based approaches to green construction

Somalia already faces considerable environmental pollution caused by humans and as a result of climate change. The associated challenges are tremendous and they are intensifying at a rapid pace. Somalia's population is distributed unevenly for geographical reasons and because of the related extreme water shortage. The population is heavily concentrated in major cities (e.g. Mogadishu). The number of people, especially young people, living in rural areas has declined sharply.

The *Water and Sanitation Sector Needs Assessment and Investment Programme* (AfDB, n.d.) has been implemented since 2015 as part of the programme *Improving Access to Water and Sanitation Sector Services in Somalia*. It is being implemented by the African Development Bank (AfDB) in partnership with the Somali Ministry of Energy and Water Resources, the UK Foreign, Commonwealth & Development Office (FCDO), and the International Organization for Migration. The programme aims to improve access to water, sanitation and hygiene (WASH) services in rural parts of Somalia. It also seeks to contribute towards a reduction in the mortality rate for WASH-related diseases among children aged under five. For this reason, the programme intends to build sustainable water supply and sanitation systems. The programme chose a community-based approach that included the target group in the process through local dialogue events with communities, local authorities, and educational institutions (a 'community of practice'). These focus group discussions identified gaps in the capacity that communities will need to operate and maintain infrastructure. Among other things, the programme selected economically disadvantaged craftspeople and mechanics to receive short-term training in how to install and maintain infrastructure (AfDB, 2015).

This example shows that it is possible to provide decentralised support for green construction in rural areas in combination with various development goals (e.g. access to water, health care). The close involvement of local communities through *communities of practice* has proven a beneficial means of better incorporating cultural conditions and local needs. The participation of citizens, community decision-makers, cooperatives, and micro and small enterprises has clearly been shown to foster community development. Citizens become co-owners and take on responsibility for planning, installation, and operation of the construction projects. This step is critically important for guaranteeing the long-term sustainability and maintenance of infrastructure.

6 Recommendations for designing green construction projects

German development cooperation (DC) already has many years of experience of supporting a sustainable construction sector in partner countries. However, research found little experience of projects systematically promoting the need for green construction throughout the value chain. Such interventions mainly occur in energy projects seeking to unlock potential energy savings in the building sector by developing standards and regulatory frameworks (e.g. in Mongolia). Individual measures also support the development of lower-emission local building materials (e.g. in India). Sustainable urban development projects and programmes (e.g. Improving quality of life with green cities in Costa Rica, Connective Cities, an international community of practice for sustainable urban development) increasingly address green construction, as well. When it comes to employment promotion and TVET programmes, German DC is traditionally involved in expanding TVET systems. Education for the construction sector is a key element within many projects (e.g. in Somalia and Nigeria). However, little information was found on projects that systematically pursue green construction through TVET interventions alongside traditional training for the construction sector.

This presents an opportunity for German DC. Its high energy-related emissions make the construction sector a key area in the fight against climate change around the globe. Strong urbanisation in many partner countries will further intensify the need to make the construction sector more sustainable in order to reach the targets of the Paris Climate Agreement. At the same time, greening the construction sector also opens up opportunities for social and economic development in partner countries. **The sector can only reach its potential, though, if adequate numbers of skilled workers are available. This requires initial and continuing TVET that is geared towards the labour market and that empowers people to perform work properly with due consideration for occupational health and safety**. In this regard, the transition to green construction can create jobs if it is underpinned by supporting TVET measures.

It is important to remember that the transition to a green construction sector needs to take a holistic approach. **Regulatory, macroeconomic, and policy framework conditions are traditionally a major driver of demand in the construction sector. Clear government regulation is needed to provide a fixed regulatory framework for competition and encourage the private sector to adopt more sustainable ways of building**. Lessons learned by projects, for instance those in Mongolia and China, have demonstrated that demand for workers skilled in green construction can mainly be created through national building standards and regulations. Stringent efficiency standards for buildings and the implementation of mandatory building codes, for instance, are essential to making the building stock more energy-efficient. Indeed, building codes

are among the most effective policy measures, as a recent cost-benefit study on various decarbonisation measures found (Otto, 2021).

The following recommendations provide guidance when designing future international development projects that support greening the construction sector and developing Green Skills for construction.

6.1 Integrated project design as a means of strengthening regulatory framework conditions

Cross-sectoral, integrated approaches facilitate better coordination between the promotion of sustainable construction and support for employment-oriented TVET. These approaches can also coordinate the availability of skilled workers and demand on the labour market more efficiently. This can minimise the risk of a shortage of skilled workers slowing down the expansion of green construction (e.g. in the case of state investment programmes) or the risk that skilled workers who have received training in green construction do not find jobs.

Therefore, future DC projects that advise partner countries on regulatory framework conditions in the construction sector should be linked more closely with TVET (and employment promotion) measures as early as the project design phase. For instance, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has long advised national and sectoral institutions on developing instruments to enhance energy efficiency in the building sector. Such measures include providing support to develop and implement regulatory and normative framework conditions in the building sector (e.g. development of energy efficiency standards for buildings), developing financial instruments and incentive schemes for the private sector (a good system that creates financial incentives or factors in the costs of environmental damage by imposing higher prices on fossil fuels could be highly effective), and capacity building measures for key actors in policymaking and administration. Future projects may involve components to develop education and training for skilled workers that are tailored to the national education system (e.g. training energy auditors). In the past, a few projects have already pursued an interdisciplinary approach by structurally mainstreaming a higher education component into the project design (e.g. in Energy-efficient pilot project in Ukraine). Other projects developed individual TVET measures for caretakers and craftspeople to improve the quality of energy-saving measures and building maintenance.

Integrated project design is not always an option. **This is why stand-alone programmes and projects can be linked, at least at the personnel or structural level, through joint work packages or working groups to strengthen interaction.**

As early as the project design phase, TVET projects that support training skilled workers in green construction should be linked with projects and activities that advise governments and stakeholders on framework legislation and sustainable building standards. For instance, work packages can be drawn up for joint labour

market and needs analyses and coordinated by working groups that include staff from both projects. Another option is to jointly develop advanced training modules and training materials on green construction. In India, for instance, training modules on the sustainable management of construction and demolition waste, sustainable urban planning and green building strategies were developed for political and administrative decision-makers with support from the GIZ project Climate Smart Cities in partnership with the National Institute of Urban Affairs, the German Institute of Urban Affairs, and the Technical University of Berlin. At the TVET level, cooperation projects in this field can also contribute their teaching and technical expertise.

6.2 Gathering labour market data

Impacts on employment cannot be achieved through a single measure alone. They require a large number of different coordinated instruments and measures to train skilled workers, promote this transition within the labour market and labour market policy, and develop the private sector (integrated approach to employment).

In many partner countries, however, the challenge involved in closely dovetailing these measures is that no current data is available about the sectors, the need for skilled labour, qualification requirements, and courses. Many DC partner countries lack reliable labour market information systems, especially on green construction. Research into the labour market and TVET is frequently not established, either. **Therefore, future employment promotion and TVET projects should support partner countries in gathering labour market information for the construction sector and in introducing systems for early identification of the skills needed for value creation in green construction**. It is important not to underestimate the resources needed to develop these instruments, primarily at the national level, or the importance of closely involving the private sector (e.g. through sectoral committees, see also Section 6.4). As the project in India showed, highly aggregated data is not enough. Rather, detailed analyses are needed at the local level. **Therefore, the local construction sector (primarily the informal sector) should receive particular support in the form of simple instruments (e.g. visual inspection of construction sites, surveying tradespeople and clients). This will allow local qualification forecasts and skill requirements to be drafted and the qualifications needed to be specified**.

It is imperative here to partner with local associations representing the private sector and employees in a systematic multi-stakeholder approach. Even though the interests of large companies and formal workers in the construction sector are widely represented in many partner countries, too, such structures are lacking for the micro and small enterprises that often serve as subcontractors (sequa, 2013). The same is true of informal workers. If appropriate, projects should therefore consider introducing supporting capacity building measures for private sector and employee organisations during the project design phase.

6.3 Integrating Green Skills throughout the entire value chain

Efforts to promote green construction need to look at the entire construction value chain given the different industry and service sectors associated with green construction (see figure 1). Upgrading and updating individual occupations is not enough to adequately mainstream green construction in the long term. **Low-emission process and supply chains might provide the frame of reference to systematically identify green occupations** and then define occupational groups, as shown in Table 1.

Interface with higher education

It is evident that, along with TVET, higher education is especially critical to making the construction sector more sustainable. Highly qualified skilled workers with university degrees are needed to plan and design buildings, perform monitoring, and provide certification. Having higher education programmes with a practical focus is crucial to develop strategies that can be implemented at the local level. **As a consequence, it makes sense to include an interface with higher education when designing TVET projects at the system level.** The goal here should be to improve subject-specific communication and the coordination and alignment of training content among skilled workers with technical and higher education qualifications. Permeability between education systems should also be strengthened through more efficient recognition of qualifications in order to allow people with practical work experience to move on to higher qualification levels. **At the institutional level, TVET institutions can forge partnerships with technical universities**, for instance to develop joint pilot projects or work together on sharing workshops and machinery for practical training.

Awareness-raising and informational campaigns to strengthen demand

At the same time, when looking at the central occupational clusters, it is essential not to overlook the importance of fostering demand for workers with green building skills. **For this reason, clients must be made more aware of sustainable construction. These clients primarily include public decision-makers and private owners.** In most partner countries, building owners have little interest in green construction and lack an understanding of its benefits. Cost is the primary concern for building owners and users. One major obstacle is that potential clients worry that sustainable construction may be too costly, so they give preference to conventional solutions (ORF, 2020). Awareness-raising and marketing measures and activities would thus be a necessary first step. This can take the form of targeted education and outreach activities, e.g. through workshops, seminars and information campaigns and through training programmes, such as short-term green procurement courses for public stakeholders. Joint demonstration projects (see Text box 4 and Section 7.2) are another option.

Text box 4: From green construction demonstration projects to developing training

The GIZ Constructing climate-smart buildings project, which is part of the Indo-German Energy Programme, works with India's *Ministry of Housing and Urban Affairs* to promote climate resilience and thermal comfort in affordable housing. It does so by opting for sustainable, climate-neutral building designs, building methods, and materials. Six partner clusters developed lighthouse buildings for each climate zone in India. These buildings served as examples of affordable housing and provided a basis for replicable building designs and construction methods.

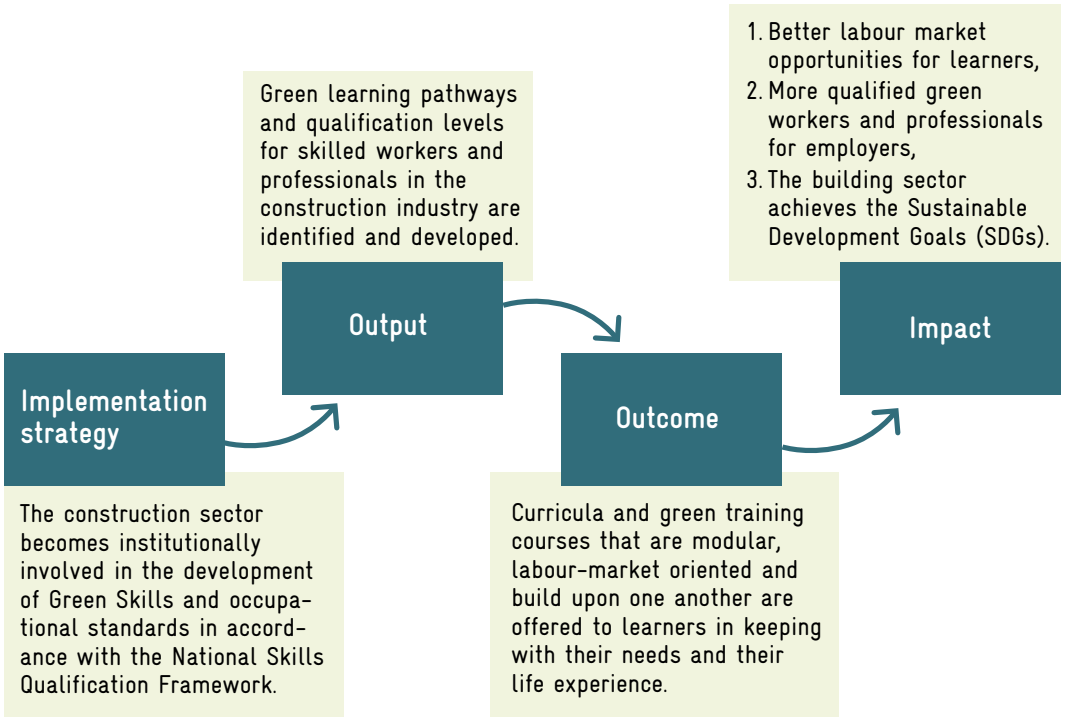
The project leverages several approaches to scale up green building design and construction methods: lighthouse projects, the development of action plans, standards and guidelines for thermal comfort in affordable housing and training programmes for different stakeholders. It also includes short-term training for the general public, government and business representatives, technical government officials, and tradespeople, along with special programmes for engineering, design, and architecture students. This training deals with topics such as thermal comfort, relevant standards, analysis tools, and new materials and technologies adapted to India's climate zones (GHTC, 2023).

6.4 Involving the private sector

Practical training promises to provide trainees with an easier transition to the world of work. This is why involving the business community, employers, and employees in steering, designing, and monitoring TVET is a principle commonly adopted by German TVET cooperation.

The private sector should also be involved in the transition to green construction. A large number of diverse sectors of the economy and stakeholders participate in creating value when producing buildings (Syben, 2009). New methods and technologies have yet to be established and standardised everywhere. **So the knowledge and experience that companies have is a particularly important success factor and should be more closely integrated when designing TVET.** Figure 10 is a diagram showing how the private sector's institutional involvement in the design of training programmes helps to make future trainees more employable.

Figure 10: The impacts of TVET in the field of green construction (based on UNDP, 2021)



Associations and organisations are involved in steering and designing TVET in varying ways. Sectoral committees representing government institutions, the private sector, employees, and academia are one option that has found widespread use. Industry and trade associations and private sector interest groups are key institutions in these committees that represent the needs of the business community in TVET (see the project example from India in Section 5). **With this in mind, DC projects must take account of local structures to involve the private sector. Capacity building measures should be provided at the system level, if appropriate, to establish or strengthen sectoral committees.**

The sustainable construction industry remains poorly developed and organised in many partner countries. **Cooperation formats with individual companies** are thus a suitable option to strengthen the perspective of the private sector when designing TVET measures. One way to make short-term courses to train skilled workers more practical is to involve **international companies, for example through public-private partnerships**, in their design. Cooperation with international enterprises in the green construction sector may, for example, take place when planning and building demonstration projects, with international companies committing to providing practical training for local skilled workers (e.g. those working for subcontractors). TVET projects can

deliver corresponding support for the development and implementation of training programmes. One key aspect here is that international businesses must strictly adhere to legal requirements (e.g. building codes, occupational health and safety, and inclusion rules) in order to serve as role models and demonstrate that sustainable construction is feasible in the local context, too.

In many partner countries, micro and small enterprises build (or at least jointly build as subcontractors) a large proportion of the simpler residential buildings, especially in poor neighbourhoods or rural areas (ILO, 2016). These companies are frequently isolated from developments in green construction because of the costs of external training and their informal methods of recruiting workers. Often, they only have access to a limited local market where there is not yet sufficient demand for Green Skills. In particular, their needs and traditional recruitment channels must not be disregarded when designing green education courses so that green building practices can still be promoted among these companies. Systematically involving them is often challenging, though, because of the lack of organisation in the sector. Moreover, there is evidence that many micro-enterprises do not want to engage in cooperation and share their knowledge due to the limited nature of the market and tough competition (Hartrich, 2018). As the project example from Somalia shows, the community of practice approach can be beneficial here (see Section 7).

6.5 Theory of change approach

Sustainable construction projects have an inherent degree of uncertainty in terms of demand for green occupations. After all, the success of sustainability and emissions reduction measures is not certain in the short term. The long life of buildings means it may take a long time to see results of these measures. Sustainability measures are also often more cost-intensive than conventional ways of building in the construction phase and only pay for themselves over the life cycle of the buildings. Therefore, the private sector is often sceptical of green building codes.

Additionally, an excessive focus on modern technologies and building practices during the transition from traditional to green building and business practices can give rise to opposition. One example might be if this transition puts local jobs in the construction and building materials industry at risk (e.g. in local building materials production when prefabricated construction methods are promoted). Efforts to change traditional role models and cultural realities in the construction sector should also consistently consider potential social opposition.

Project decisions are therefore usually made under conditions of risk. In order to minimise risks in project planning and implementation, it makes sense to combine traditional 'logical' process chains with the benefits of the *theory of change* (ToC) approach when designing future green construction projects. This is one approach to managing processes of change in the construction sector. Consistently involving local private sector, political, and social stakeholders can help to identify social and economic risks in the transition to green construction at an earlier stage.

The project design should clearly indicate (Serrat, 2017):

1. What specific problem related to the transition to Green TVET and underlying result complexities is expected to improve in the short term, medium term, and long term (external context)?

2. Which target group do you want to influence in this transition process, and which target group benefits the most (beneficiaries)?

3. What sustainable benefits does greener TVET aim to achieve and in what time frame (impacts)?

4. When will the target group reap the benefits (time span)?

5. Are mechanisms that achieve a fair transition to more sustainable construction known (leverage of interventions)?

ToC diagrams can illustrate short-term to long-term impacts over the different time frames in a results-oriented manner, even going beyond the end of the project. Clearly showing these impacts aids communication with partner institutions, the private sector, local stakeholders, and target groups to sustainably mainstream green building practices (Barbrook-Johnson & Penn, 2022).

Table 3 provides one example of how the impacts of recommended measures to promote green construction using a ToC approach can be demonstrated.

More girls are choosing TVET: An Industrial Mechanics course at a TVET school in Dornod, Mongolia. © GIZ Mongolia

Table 3: The results of individual measures using the ToC approach (Table by FAKT)

Stakeholders	Recommendations	Inputs	Outputs	Results
Educational institutions	Integrate digital technologies into educational programmes	Support when integrating digital skills and technologies	Workers have been prepared to use advanced technologies in the industry	The construction sector is modernised
Educational institutions	Establish partnerships with educational providers	Resources and support for curriculum development	Training on Green Skills is available	The building industry is more able to adopt sustainable practices
Private sector	Involve international enterprises as role models	Technical expertise	Sustainable construction practices are rolled out more	Less environmental pollution caused by construction/Improved Green Skills
Private sector/local authorities	Adapt to local climate conditions	Technical support and capacity building for demonstration projects	Climate-friendly construction practices are more effective and accepted	Greater community resilience to climate change
Private sector/local authorities	Promote the use of traditional and local materials and designs	Support for the implementation of circular economy principles	Less environmental pollution from construction	Increased quality of life in communities
Government bodies	Support the policymaking and legislative development process	Technical and financial support	Building codes and rules promoting sustainability are implemented	Less environmental pollution from construction and greater resilience to climate change
Marginalised groups	Targeted educational and training opportunities	Programmes and support customised to specific needs	These groups are more involved and better represented in the construction industry	Better employment and income opportunities for marginalised groups/increase in the number of workers/ professionals skilled in green construction
Informal employment	Recognition of Prior Learning (RPL) strategies for informal workers	Recognition and validation of existing skills	Informal workers are more involved in formal training and the labour market	Better working conditions and income opportunities/increase in the number of workers skilled in green construction

7 Recommendations for TVET interventions in the green construction sector

New, more sustainable technologies and building methods are a key element when designing curricula for the transition to green construction. **A multi-level approach should be taken when designing Technical and Vocational Education and Training (TVET) interventions related to green construction. This approach should include developing occupational standards and curricula (macro level), implementing them in partnership with TVET centres (meso level), and designing practice-oriented/module-based training units (micro level).** The following overview summarises the most important measures when designing Green TVET related to sustainable construction.

Macro level

- Support for greening occupational profiles and curricula
- Recognition of Prior Learning (RPL)
- Support for the development and implementation of policy and regulatory measures that promote Green Skills

Meso level

- Supporting and equipping TVET facilities for green construction as examples of good practice
- Promotion of partnerships to develop demonstration projects
- Training on sustainable management for school managers
- Training for teachers and trainers in the latest green construction concepts and practices

Micro level

- Strengthening teachers' skills to integrate green construction concepts and practices into their curricula.
- Support for creating communities of practice with local communities, educational facilities, and the private sector
- Development of specific training programmes for disadvantaged groups

In the interest of ensuring a Just Transition, it is important to make sure that measures also reach people who are unable to benefit from new employment opportunities in the green construction sector because they do not have access to training. In the construction sector, these people include women as well as unskilled and informal workers. Until now, these groups have had very little chance of gaining employment in the construction sector (see Section 4.2). Best-practice measures that can be supported by TVET cooperation projects are presented below.

Special training courses for disadvantaged target groups

As outlined above, the construction labour market is often characterised by informal employment and precarious working conditions. People with few or no qualifications are often affected, as they do not have access to better employment opportunities and are forced to do unskilled work on construction sites.

In urban settings, many of these people perform simple tasks as 'subcontractors'. They often lack the technical expertise needed to perform higher-value jobs. Furthermore, a lack of investment capital and formal evidence of their skills mean that they are frequently excluded from major contract awards (Hartrich, 2018). **To avoid leaving these people behind, it is vital to offer customised courses and training programmes that focus on teaching a combination of green, practical, and entrepreneurial skills.** The goal must be to support disadvantaged groups in finding better jobs in the sustainable construction sector. These skills can be developed, for example, through short-term courses on more sustainable production of local building materials, enhanced by learning content on entrepreneurial and financial topics (e.g. on financial management and contract award processes for construction services). A target group-oriented approach that combines training with other measures, such as business development or mentorship programmes, is particularly suitable here. Continuing education on occupational health and safety should also be integrated into courses given the high number of occupational accidents on construction sites, especially among low-skilled workers.

All measures should consider the specific needs of the target group in order to reduce opportunity costs for learners. One option might be to hold courses outside regular working hours. Non-formal training has proven beneficial because it can be adapted quickly and flexibly to the needs of the target groups, which makes it particularly useful for the informal sector.

Creation of a system to recognise prior learning

Many workers, especially those in the informal sector, have learned a range of practical skills on the job or in non-formal educational settings. They lack formal evidence of their skills, which is why they often lack access to better employment or entry into the formal education system. At the national level, DC projects can therefore support relevant institutions (e.g. examination or certification bodies) in **setting up a system for the *Recognition of Prior Learning*** (RPL).

Promoting women in the construction sector

In many countries, the few women working on construction sites primarily perform unskilled jobs (Hartrich, 2018). Therefore, women can also be among the main beneficiaries of the measures outlined above. Specially adapted short-term qualification programmes that teach simple, sustainable construction skills for entry into the construction sector can be developed for women seeking employment.

However, a more comprehensive approach is needed to create more and better employment opportunities for women in the construction sector given the widespread nature of traditional role expectations and prejudice in the construction sector. Such measures may include:

- Promoting the qualification of women as trainers and teachers to create role models
- Promoting a safe and gender-transformative work environment through supporting measures to combat gender discrimination and sexual harassment. For example, information campaigns or learning content on gender equality in TVET programmes can help to raise awareness of the problem and reduce prejudice among potential clients.
- Specially customised training on starting a business and self-employment to enable women to generate income through their own small businesses.
- Digital formats such as open-access digital learning platforms create opportunities to expand access for women, if the content, learning venues, and timing can be tailored to their individual needs. Online courses also allow networks to be developed and information to be exchanged.
- If possible, advisory measures on introducing quotas for women-owned companies in green construction projects, e.g. by adapting public procurement guidelines and introducing target quotas for recruitment in private companies and public institutions.

7.1 Developing green occupational profiles and curricula for green construction

Standards need to be introduced and policy reforms implemented at the policy level (macro level). It is recommended that TVET cooperation projects support the development of occupational profiles and curricula for green building. The following elements must be addressed:

Identifying the need for change based on value creation in construction

The occupations in the green construction sector with occupational profiles and curricula in need of adaptation should be systematically selected on the basis of the value they create for construction. Low-emission process and supply chains can serve as the frame of reference to systematically develop green occupations.

The need to adapt occupational profiles must be based on a specification of Green Skills related to certain disciplines and tasks. This specification should be aligned with the occupations' concrete tasks and problems (problem- and action-oriented). To this end, DC projects should initially support the analysis of new or changing work processes and the associated requirements and skills of the workforce. Involving stakeholders from the private sector, public administration, academia, and civil society in mapping this information is crucial. The need to adapt or develop new occupational profiles and curricula can thus be identified while taking into account the different qualification levels. Later on in the process, tasks can be specified as a basis for developing occupational profiles and curricula.

Content of occupational profiles and curricula

The requirements involved in adapting qualification programmes vary depending on the qualification level. The assumption here is that green construction requires adjustments to existing occupational profiles rather than the development of brand-new occupational profiles. Trade skills should serve as the foundation for vocational construction skills and be enhanced by new skills in green building design, construction methods and technologies.

In general, the changes should be specifically tailored to each occupational profile. However, it is expected that **occupational profiles and curricula will need to add relevant learning content first and foremost on circular economy designs, the life cycle concept, and the use of local building materials** (Thiébat, 2019). The implementation of this knowledge can help to reduce the environmental impact of construction, promote local value chains, and improve community stability. The main topics are how to:

- Promote the use of traditional and local materials and ways of building
- Minimise the consumption of natural resources when designing, building, operating, and demolishing buildings/infrastructure (circular economy)
- Maintain efficiency over a predefined period (durability)
- Guarantee adaptability to changes in the building's use over a certain period of time (flexibility)
- Guarantee that building components can be dismantled and recycled (life cycle concept)

TVET should incorporate **basic interdisciplinary topics** (e.g. environmental and climate awareness, occupational health and safety, digitalisation, project management, and business start-ups), even in occupational profiles that do not require major changes to technological and process-related skills. **Green interdisciplinary skills** are not exclusively related to a particular occupation or a particular task. Rather, they are relevant in many work contexts. Therefore, they can play a role in general education and should be integrated into the curricula for all types of TVET and occupational areas in keeping with the guiding principle of **TVET for sustainable development.**[6] Ideally, TVET for sustainable development should be taught as part of a specific core subject and not as

[6] The central goal of TVET for sustainable development is to apply the notion and principles of sustainability to activities in the work context. It is based on a comprehensive concept of agency in the workplace, which includes work-related, social, and private actions (BMBF).

separate parallel content. In this way, learners can understand how their field or occupation contributes to and helps to solve sustainability challenges.

Digital literacy skills should also be integrated at all qualification levels and in all occupational fields. Technological trends in sustainable construction require increasing digitalisation of the construction sector, for example when calculating energy efficiency savings from using different building materials. Contract-award procedures are increasingly handled online and require that online applications are handled safely and securely. Furthermore, the growing need for skilled workers to engage in *life-long learning* means that digital literacy skills are needed to use online learning opportunities and platforms. Curricula should thus have a digital component that covers technological developments in the subject area and overarching methodological skills.

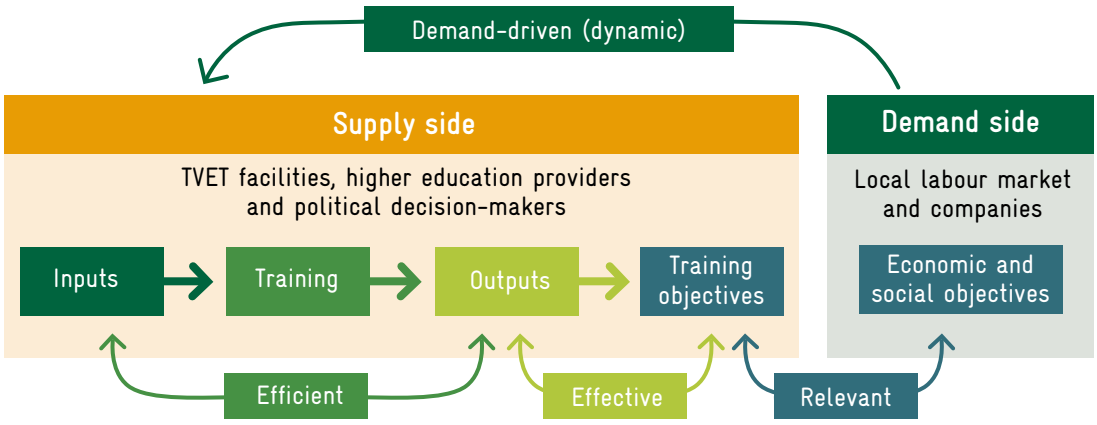
Timing and strategy for greening occupational profiles and curricula

Vocational qualifications in the construction industry can only offer career prospects if they are future-oriented and in demand from construction companies. However, the skills needed in the workplace are constantly changing with new technological developments and ways of working. Comprehensive and practice-oriented TVET systems such as the dual system of TVET are thus common in German-speaking countries. They support training that is of high quality and relevance by taking a highly practical approach, thereby improving trainees' prospects on the labour market.

In partner countries without such practical training systems, the content of initial and continuing TVET must be coordinated even more closely with the private sector to facilitate a flexible response to new qualification requirements. The faster and more radical these changes, the greater and more frequent the need to revise qualifications. This process includes adapting existing initial TVET programmes and developing new occupational profiles, where appropriate.

At the same time, though, adjustments should not only be 'reactive' in response to demand. A lack of technical skills may, for instance, result in faulty use, installation or maintenance work, thus reducing the effectiveness and driving up the cost of green building design and new green technologies. This may undermine the acceptance of new methods and technologies and slow down the transition to green construction. Forward-looking training also fosters innovative local technological adaptations, which may be needed for their widespread dissemination. Skilled workers with the right qualifications are thus needed to introduce and scale up new technologies. They should receive training in anticipation of developments to accelerate the transition to Green Sectors of the economy in the medium term (Pavlova, 2019; Vidican Auktor, 2020). Therefore, any revision of occupational profiles and curricula in the construction sector must be geared towards the needs of the private sector while also including social and economic objectives (in this case, the greening of the sector) (see figure 11).

Figure 11: Processes of demand-driven TVET
(Johanson & Adams, 2004)



As a strategic proposal, it is therefore recommended that TVET cooperation projects pursue a two-pronged strategy:

Firstly, the rapid development of (non-formal) training for workers with on-the-job experience can be supported to meet the industry's pressing needs, e.g. to meet demand for skilled workers triggered by major investment programmes. A strong connection between theory and practice must be ensured here. Based on lessons learned in other Green Sectors that are already more established, DC projects may, for example, enter into partnerships with private sector firms to help them develop and deliver short-term training for local skilled workers on how to use new construction methods and technologies. They may provide support, for example, on how to design content and teaching methods and provide continuing training courses for in-company trainers. It is important to make sure here that modules are developed in such a way that they can later be integrated into formal education and certification systems.

Secondly, DC projects can assist national TVET institutions in adapting and developing initial TVET programmes. To this end, detailed needs analyses must be drawn up in close cooperation with the private sector (see paragraph on identification). Together with civil society and the private sector, national qualification frameworks and curricula should be adapted for relevant occupations and incorporate the new skills that are needed.

New modules on green building methods and technologies can be integrated if changes in the skills needed are relatively minor. In the event of considerable changes in the skills needed by occupational profiles as a result of the transition to green construction, existing profiles must be revised to incorporate the new skills needed across all areas. **It should be noted here that, ideally, (green) interdisciplinary skills should be incorporated throughout all modules rather than addressed by adding more modules** (Syben, 2009).

7.2 Supporting Green TVET institutions and demonstration projects

At the institutional level, it is recommended that TVET projects support TVET institutions in becoming comprehensively sustainable centres that lead by example in the field of green construction. At the institutional level, German TVET cooperation traditionally promotes the construction and modernisation of TVET facilities. As many other studies have shown, Green TVET institutions are needed to implement Green TVET in a holistic manner (see e.g. ILO, 2015; UNESCO-UNEVOC, 2017). TVET institutions with their own sustainable building strategy can model good practice for learners, especially when providing training in building occupations, and promote a change in awareness of green practice in the work context (*'green campus concept').* Several objectives, including longer-term ones, have to be taken into account here. After all, missed opportunities to embrace sustainability when investing in construction work can only be made up for later at a high cost.

Future-proof buildings and infrastructure should exceed emission efficiency requirements and other local sustainability quality standards. This concerns, for example, reduction in environmental and health impacts, optimisation of building-related life cycle costs, and urban integration. Once construction work is completed, the building's sustainability must be documented in a transparent way in keeping with defined criteria and yardsticks for assessment.

With a view to taking a holistic approach, didactic considerations should also be included in the planning process. TVET institutions are a key venue for learning. The design of buildings, workshops, learning spaces, and campuses can enrich the experience for learners. One primary opportunity here is to include buildings on campus as demonstration and learning projects within lessons to deliver hands-on learning experiences. **Didactic principles must therefore be incorporated into comprehensive design plans when planning and designing TVET facilities.**

It is also important not to overlook the increasingly digital nature of (not only) the construction sector. These centres should also be designed with the growing demand for subject-specific and interdisciplinary digital skills in mind. **In this vein, centres must be equipped with the digital technologies used in the construction sector and teachers must be trained accordingly.** At the same time, their capacity to offer digital learning opportunities should be strengthened. For instance, educational and platform technologies with adaptive learning environments allow learners to take advantage of continuing education opportunities even after they have gained their qualifications.

As experience in other Green Sectors has shown, by comprehensively integrating sustainability into learning content, buildings, campuses, and everyday life, TVET facilities can be regional examples of good practice that may have substantial spillover effects and serve as demonstration projects for local communities and the private sector. This can be reinforced by developing joint demonstration projects.

Developing joint demonstration projects

Local demonstration projects have proven a useful way of convincing potential clients of the benefits and feasibility of sustainable construction projects. **The use of environmentally friendly and sometimes traditional construction technologies and practices can help to increase their effectiveness and acceptance in the construction industry and local communities**. In India, for instance, sustainable lighthouse buildings with construction methods and materials adapted to local climate zones were developed with support from the GIZ *Climate Smart Buildings* project. This gave rise to 100 demonstration projects that enhance the visibility of the benefits of climate-friendly construction in a variety of regions. As a result, the private sector and clients can see that the practical implementation of sustainability standards is feasible and profitable.

Working in partnership with TVET institutions, the private sector, and academia, TVET cooperation projects can therefore foster the development of pilot and demonstration projects that help to disseminate sustainable construction on a broader scale. TVET institutions can provide technical support during planning and implementation by providing research and development capacity. The joint development of short-term programmes to train staff working for companies involved in developing and building the model projects would also be possible. As the example in India illustrates, joint demonstration projects are also a suitable way of designing training measures for stakeholders based on the lessons learned (see Text box 4).

7.3 Strengthening the skills of teachers to deliver lessons in green construction

Training on designing curricula

Developing practical skills and enshrining green principles in educational materials are key to designing vocational curricula for Green TVET in the construction sector. **At the implementation level, TVET cooperation projects can support teachers and trainers in differentiating learning objectives for each training module, specifying the skills needed, and developing didactic strategies and methods for teaching.**

Training should make connections to vocational tasks and problems. Practical training units are needed where learners can demonstrate their hands-on skills. Specific requirements and processes for realistic work situations that include occupational and trade practices should be integrated into training activities, keeping cost and time expenditure at a reasonable level. **TVET cooperation projects can support teachers by providing training in didactics and teaching methods for skill-based teaching and by promoting adequate equipping of workshops for practical teaching purposes.**

It is important to note that teachers and trainers are agents of change for the green transition and serve as role models for learners. They must exemplify everyday sustainable working practices at TVET institutions so these practices can be transferred into the working lives of learners. Teachers and trainers must therefore be made aware of

behaviours that conserve resources and protect the climate, especially through information events and continuing TVET.

Creating and supporting communities of practice

The practical nature of training is essential to providing skills geared towards the labour market. Teachers should be familiar with the latest developments, practices, and strategies. **TVET projects should therefore support teachers in establishing cooperation formats with the local private sector and, for example, jointly identifying typical work tasks, work processes or customer orders in the companies.** The established construction industry should not only be involved; the specific needs of (informal) micro and small enterprises must also be identified.

Establishing communities of practice with local communities and other educational facilities would be one option for cooperation formats, for instance in the form of local dialogue events at TVET facilities. **Such dialogue platforms should not just maintain contact with the industry to gain feedback on the demand for skilled workers with training and curricula but should routinely initiate community-based projects on green construction.** Local networking between schools, society, and industry creates an opportunity to integrate the notion of sustainable construction into the local context, identify potential risks, reduce opposition, and strengthen TVET institutions.

Network of TVET academies (*Réseau des Instituts Supérieurs d'Enseignement Professionnel*, RISEP) providing practice-oriented short-term training programmes (PESEREE II), Senegal. © GIZ Senegal/PESEREE

8 Conclusion

Construction must become more sustainable. That much is clear, given population growth and sometimes rapid urbanisation in many parts of the world. Buildings are responsible for a large proportion of global energy consumption and greenhouse gas emissions. Their share of global consumption is estimated at up to 40%. Moreover, the construction of buildings consumes a large proportion of mineral resources and the land they use disrupts ecosystems in the long term. In light of this, environmentally friendly and sustainable building practices are a crucial element in the global response to climate change and environmental protection.

Construction and operation of buildings must become more resource-efficient and emissions must be reduced. Buildings must also be embedded in existing ecosystems in a more sustainable manner. Green design strategies, technologies, and construction methods are constantly being developed and adapted. They require that energy efficiency and circular economy principles are more strongly incorporated into the planning and design of buildings, that decentralised energy generation is integrated, and that local building materials and new construction methods are used to a greater extent.

The pressure to make the construction sector more sustainable and more just will intensify in many of partner countries of German development cooperation (DC) as well. Despite increasing political ambitions to mitigate climate change, most partner countries so far lack the political, regulatory, and financial conditions to support systematically greening the building sector. An adequate number of appropriately skilled workers are simply essential. They are important for scaling up green building practices because a high standard of qualification enhances quality and thus confidence in new technologies and construction methods in the green building sector. It also promotes innovations and adaptations that can be implemented at the local level.

German DC has many opportunities to support partner countries in the transition to green construction. For a long time now, German DC has supported individual measures, such as policy advice on energy-efficient refurbishment of buildings. However, a comprehensive and systematic approach to promoting the green construction sector has been lacking to date. In general, it appears that green construction continues to be overshadowed by renewable energy and sustainable mobility projects in DC and is still not given enough attention considering its relevance to the climate and society. More emphasis should be placed on delivering comprehensive systematic support, including training skilled workers.

As the study found, future DC projects to promote green construction should pursue an integrated and interdisciplinary project design. Policy and process-based advice on strengthening regulatory and policy frameworks remains an important driver. However, having the capacity to implement laws and standards in a binding manner is imperative. This study has shown that new knowledge and skills need to be developed in many areas and across all qualification levels. It is not enough to make individual occupations within the construction sector greener. Endeavours to green the sector should be

consistently oriented toward value creation in construction and Green Skills along the entire value chain. This includes continuing education for public administrators, courses for financial industry stakeholders, information campaigns for the general public, and appropriate initial and continuing TVET for skilled workers responsible for planning, construction, and certification.

Both Technical and Vocational Education and Training (TVET) and higher education are pivotal in this regard. When designing projects, **integrating capacity building measures across many areas, even beyond individual sectors**, is recommended to promote TVET in a comprehensive manner. Interfaces can arise between TVET and employment promotion projects, technology promotion/policy advice, and higher education. These aspects can be connected by opting for an integrated project design or institutionalising cooperation formats across individual projects.

Many challenges lie ahead for TVET in the transition to green construction. Existing occupational profiles and curricula must be adapted to meet the new skill requirements across all qualification levels. This necessitates a detailed needs analysis that specifies the skills required for different areas and tasks. Curricular elements for interdisciplinary Green Skills should be developed for all occupational profiles. Training measures should also be designed to re- and upskill current workers. Therefore, this study makes a range of recommendations for developing TVET interventions across the macro, meso, and micro levels.

At the macro level, supporting partner countries in greening occupational profiles and curricula is recommended. Two strategies can be taken here. Firstly, training for existing skilled workers can be developed in partnership with the private sector to meet current industry needs. This training should be designed in such a way that it can be incorporated into the national education system at a later stage. Secondly, TVET institutions should be supported in adding Green Skills to relevant initial TVET courses.

At the institutional level, promoting and equipping TVET facilities as examples of good green building practice in a way that incorporates sustainable and didactic aspects as early as the planning stage is recommended. This includes providing courses for school managers on sustainable management and training teachers and trainers in the latest green building strategies and practices. Partnerships with the private sector and academia for demonstration projects may also be supported.

At the implementation level, it is recommended to support teachers and trainers in terms of didactics and methodology to enable them to better integrate green construction plans and practices into curricula and lessons. Action-oriented learning plans that are geared towards typical occupational tasks and problems are recommended in this context. In the interests of taking a multi-stakeholder approach that is geared towards the labour market, teachers should also be encouraged to develop cooperation formats with the local private sector and communities to involve them in greening TVET.

Disadvantaged groups must not be overlooked. The transition to green construction creates an opportunity to provide disadvantaged groups with better access to skills so that they can also benefit from better employment opportunities in the interests of a Just Transition. This is why TVET institutions should be supported in developing training programmes that are specifically tailored and adapted to the needs of disadvantaged groups.

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10 Annex

The dimensions and principles of sustainable construction

According to the Guideline for Sustainable Building of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB, 2016), the overarching concept of a policy of sustainable and future-enabled development – based on the three dimensions of sustainability: environment, economy and socio-culture – is the starting point for developing principles and assessment criteria for sustainable building.

This concept simultaneously addresses environmental, economic and socio-cultural requirements as equally important aspects and includes future generations in the analysis. Furthermore, the concept also underlines the responsibility of the individual and, in particular, the function of the public sector in leading by example (BMUB, 2016).

Build4Skills trainee recovering moulded bricks, Senegal. © GIZ Senegal/Fatou Ndoye

Figure 12: Protected assets and protection goals in general and for the construction sector in particular (BMUB, 2016)

		ECOLOGY	ECONOMY	SOCIO-CULTURAL ASPECTS
PROTECTED ASSETS	Sustainability in general	• Natural resources • Natural environment	• Capital/assets • Economic performance	• Human health • Social and cultural values
	Sustainable building	• Natural resources • Global and local environment	• Capital/assets	• Health • User satisfaction • Functionality • Cultural value
PROTECTION GOALS	Sustainability in general	• Protection of natural resources/sustainable use and management of natural resources • Efficiency improvement • Reduction of pollution exposure/environmental influences • Protection of atmosphere, soil, groundwater and waters • Promotion of environmentally compatible production	• Reduction of life cycle costs • Reduction of subsidy volume • Reduction of debt • Promotion of responsible entrepreneurship • Creation of sustainable consumption patterns • Creation of dynamic and co-operative international economic conditions	• Protection and promotion of human health • Reinforcing inclusion and solidarity • Protection of cultural assets and values • Equal opportunities • Protection of capacity to work and jobs • Fight against poverty • Education/training • Equal rights • Integration • Safety/liveable environment
	Sustainable building	• Protection of natural resources • Protection of the ecosystem	• Decreasing life cycle costs • Improvement of economic efficiency • Protection of capital/assets	• Protection of health, safety and comfort • Maintenance of functionality • Protection of aesthetic and urban development quality

Glossary

Blue infrastructure	Visibly 'blue' infrastructure in the form of water. Examples might include new artificial ponds, water bodies, and water features. This category also includes existing natural water bodies. The example of 'water features' shows that individual pieces of infrastructure cannot always be clearly allocated to one category. These features can be classified as both blue and grey infrastructure.
Downcycling	When materials used to build and operate buildings find a new life after their original use, it is called recycling: a waste product is turned into a secondary raw material. When the material no longer has its original quality or ability to be processed as before it was recycled, it is called downcycling. By contrast, upcycling creates higher-quality products, such as jewellery made out of old flip-flops or toothbrush holders made out of tennis balls.
Emissions	The discharge of various, mostly harmful, substances and radiation from industrial installations and other sources into the environment. These include car exhaust fumes, sewage, electric waves and radiation, but also noise. The source is called the emitter; the consequence of the emission is referred to as *immission*, i.e. the input into a specific environmental compartment.
Energy efficiency	An indication of how effectively an energy conversion chain or device converts the energy put into it. Avoiding any unnecessary energy consumption is particularly efficient. Conventional incandescent lamps, for example, are not very efficient because they convert most of the energy into heat rather than light. One measure of energy efficiency is the efficiency rating, which indicates the ratio of energy expended to usable energy. It ranges between 0% and 100%.
Grey infrastructure	Technical water infrastructure with its systems that drain, discharge, create reservoirs, and treat wastewater (e.g. pipes and sewer overflows), systems for using service water in and around the building (e.g. for flushing toilets, cooling, and irrigation), and underground infiltration systems (e.g. infiltration trenches). For the most part, they are located underground or inside buildings.
Green infrastructure	Visibly 'green' infrastructure that can be located in public or private spaces. This infrastructure is often used for evaporation and/or infiltration, such as unpaved open spaces, greenery on buildings (e.g. green roofs, walls, façades and grassed tracks), and infiltration swales; it even serves to purify water in systems such as constructed wetlands or retention soil filters. However, it often has an aesthetic purpose too.
Recycling	Recycling can be further differentiated according to what happens to the residual materials and products after use: reuse means the product is treated and then put to the same use. In the case of repurposing, it is put to a different use.

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