International Labour Organization

Towards sustainable construction and green jobs in the Gaza Strip

Green Jobs Programme

ILO Regional Office for Arab States

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Ahmed Muhaisen and Johan Ahlbäck

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First published [2012]

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ISBN 978-92-2-126303-6 (print)
ISBN 978-92-2-126304-3 (web pdf)

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Abstract[1]

In response to the diverse challenges facing the Gaza strip, the International Labour Organization (ILO), in cooperation with other organizations and agencies, are working towards promoting Sustainable Construction and Green Jobs in Gaza. Sustainable construction provides opportunities to address and alleviate several challenges and needs currently experienced in Gaza, including the increasing housing demand, limited availability of construction materials, insufficient energy and water provision, inadequate sanitation, as well as severe unemployment. This assessment has been carried out to study the feasibility, opportunities and challenges relating to sustainable construction in Gaza in relation to these needs. Special focus has been given to three core areas, namely building materials, energy and water, and to explore ways to promote green jobs in these.

The assessment revealed that applying different sustainable construction methods, materials, technologies and applications in Gaza is often feasible and can contribute to considerable improvements in materials, energy and water efficiency in buildings. Innovative solutions with potentials in Gaza include increasing the use of local and recycled construction materials in buildings where possible; increasing energy-efficiency of buildings through improved insulation, energy-efficient appliances and architectural design, and by adopting renewable energy sources; as well as increasing water efficiency through the use of rainwater, desalination and greywater recycling.

Sustainable construction can also facilitate the creation of new employment opportunities for green jobs in the construction sector in Gaza. Introducing new methods, practices and technologies can generate jobs for architects, engineers and construction workers, while also boosting employment in utility provision and other related sectors. In order to optimize the employment impact of a transition towards sustainable construction, measures should be taken to further develop skills at all levels of education and training related to sustainable construction, improve working conditions and occupational safety and health in the sector, engage in social dialogue and raise public awareness, as well as employ value-chain development and promote start-up businesses and small and medium-sized enterprises in the construction sector in Gaza.

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1. Introduction

The Green Jobs Initiative is a joint global initiative by the United Nations Environment Programme (UNEP), the International Labour Organization (ILO), the International Organization for Employers (IOE) and the International Trade Union Confederation (ITUC) launched in 2007 in response to increasing challenges of climate change and environmental degradation and the need to provide decent work for all. The Green Jobs Initiative supports a concerted effort by international organizations, national and local governments and stakeholders, in collaboration with employers and workers, to promote economic growth and employment creation that integrates the environmental, economic and social pillars of sustainable development[2].

ILO Green Jobs Programme

The world today is facing two defining challenges. The first is to provide jobs that can deliver economic growth, decent working conditions and social development for all. This includes lifting over 1.3 billion people (four out of ten workers in the world) and their families above the poverty line and providing decent job opportunities for the 500 million young people entering the labour market over the next 10 years. The second is to avert dangerous climate change and prevent a progressing deterioration in natural resources jeopardizing the standard of living of current and future generations. These two challenges are intimately linked and should be tackled together.

Green jobs offer a way of generating decent work whilst simultaneously achieving environmentally sustainable economic and social development. Green jobs reduce the environmental impact of enterprises and economic sectors, ultimately to levels which are sustainable. They contribute to reducing the need for energy and raw materials, to avoiding greenhouse gas emissions, to minimizing waste and pollution, and to restoring ecosystems like clean water, flood protection and biodiversity. For the ILO, the notion of green jobs summarizes the transformation of economies, enterprises, workplaces and labour markets into a sustainable, low-emission economy providing decent work.

The Green Jobs Programme of the ILO promotes worldwide the creation of green jobs. By doing so, the programme pursues two objectives: one on hand, to address the employment and social dimension of environmental policies and ensure decent work for the present and future generations and on the other hand, to mainstream environmental concerns into the world of work and change in the long term consumption and production patterns. Both efforts are necessary to build the ground for a just transition to a green economy.

Economically and in terms of resource-use and negative impacts on the environment, one of the most important sectors globally is construction and more generally the on-going extension and maintenance of the built environment. Altogether, the built environment generates close to 80% of all carbon dioxide (CO2) and a significant amount of other greenhouse gases emitted into the atmosphere. Buildings alone are responsible for 25 to 40% of global energy use, and 30 to 40% of global greenhouse gases, while the construction sector and related activities are also main contributors of local and regional air pollutants, such as carbon monoxide, lead, sulphur oxides and nitrogen oxides. In addition, and especially in developing countries, poor waste management and sewage systems in urban areas are major sources of water and soil contamination and release significant amounts of methane (CH4) and chlorofluorocarbons (CFCs) into the atmosphere[3]. Therefore, increasing attentions has been focused on 'greening the built environment', including building more environmentally friendly buildings and refurbishing existing buildings to bring them in

[2] UNEP and ILO (2008): *Green Jobs: Towards Decent Work in Sustainable, Low-Carbon World*
[3] World Bank (2011): *Towards a Partnership for Sustainable Cities.*

line with good environmental practice. Promoting such efforts has shown not only to bring environmental and economic benefits emanating from reduced environmental impact and emissions and increased efficiencies, but also to generate new employment opportunities and green jobs in the construction sector as well as in interlinked activities[4].

In line with global efforts and initiatives, the ILO is working together with other organizations and agencies towards promoting sustainable construction and green jobs in Gaza. Greening the construction sectors is considered an effective strategy to advance a development path that promotes job creation and decent work while at the same time safeguarding environmental sustainability in Gaza. Additionally, sustainable construction can also address and alleviate some of the needs and challenges currently facing Gaza, including increasing housing demand, limited availability of construction materials, insufficient energy and water provision, inadequate sanitation, as well as very high unemployment.

Sustainable or green construction employs innovative design concepts that ensure the best utilization of local and natural resources with minimum adverse effects to the environment. It uses local and recycled materials, exploits renewable energy and rainwater and produces less sewage water and pollution. Sustainable construction involves adopting a range of different sustainable solutions, including architectural planning and insulation that reduces heating and cooling needs, using energy-efficient appliances for lighting and cooking, and adopting renewable energies for electricity provision and water heating; using alternative and recycled materials in construction processes to increase materials efficiency and reduce waste; as well as making use of rainwater tanks, water recycling and water-efficient designs and appliances to reduce water consumption. Such measures could considerable reduce both the resource demand and environmental impact of the construction and building sector in Gaza, leading towards a more sustainable development path in the long-term. Sustainable construction also holds the promise of generating green jobs and decent work in the construction sector in Gaza, which is considered a positive response strategy to the high unemployment rate. Green Jobs are defined as decent work that reduces the environmental impact of enterprises and economic sectors ultimately to levels that are sustainable or involve jobs that conserve or rehabilitate the environment. Specifically, but not exclusively, this includes jobs that protect the ecosystem and biodiversity; reduce energy, materials and water consumption through high-efficiency strategies; de-carbonize the economy; and minimize or altogether avoid the generation of all forms of waste and pollution.

Applying sustainable or green construction methods and practices in Gaza can generate new job opportunities in a number of fields, both in occupations similar to those in conventional construction, as well as in a number of entirely new occupations that can be described as green jobs. These jobs are found throughout the construction sector involving all stages of the value-chain, from planning and designing sustainable and green buildings; manufacturing, installation and maintenance of sustainable construction materials and products as well as the actual construction of green buildings; to controlling the performance and functioning of finished buildings. Sustainable construction also involves several functions and jobs in the broader enabling environment, including policy-makers, urban planners and skills providers and researchers. The table below provides an

[4] ILO (2011 Draft): *Formulating Projects and Studies Concerning Labour Issues in Greening the Sectors of the Built Environment.*

overview of the core occupations which are involved in the sustainable construction value-chain relevant to the sector in Gaza, and which will be further highlighted in this assessment.

Core occupations in Sustainable Construction[5]	
Conceiving, Planning, Designing and Advising	Construction company managers and business functions
	Architects and civil/structural/environmental engineers
	Architectural technicians and technical drawing specialists
	HVAC, electrical, mechanical, sanitary, renewable energy and building-service engineers
Manufacturing, Construction, Installation, Maintenance	Manufacturing and Recycling Manufacturers of Compressed Earth Block (CEB) materials, recyclers and collectors, manufacturers of solar water heaters (SWH), manufacturers and distributors of other green building material and products
	Construction and Insulation Building site supervisors, site engineers/architects, construction workers, bricklayers, carpenters, plasterers, glaziers, masons, roofers and semi-skilled occupations
	Energy-efficiency and Renewable energies Plumbers and heating installers/maintenance, HVAC installers, electricians, installers/maintenance of solar thermal systems (SWH) and solar photovoltaic (PV)
	Water conservation Plumbers, engineers and semi-skilled occupations
Controlling	Energy auditors
	Buildings-inspectors, certifiers and quality controllers
Enabling	Policy makers
	Urban planners
	Financing
	Educators and training providers
	Researchers

The purpose of this assessment is to study the potentials of sustainable construction and green jobs in Gaza, and explore avenues for further collaborative efforts in this area. The assessment focuses on three core areas – materials, energy and water – and the purpose is to assess the needs and requirements in Gaza in these areas, as well as the feasibility and challenges regarding different sustainable construction solutions aimed to address these. Special emphasis will also be put on the potentials for employment creation and the needed skills following an implementation of such solutions.

In the chapter below, the assessment will firstly provide an overview of the current situation in Gaza following the blockade and the on-going conflict with Israel, with specific emphasis on the construction sector, including skills provision and training. Secondly the three main thematic areas relevant to sustainable construction – materials, energy and water – are studied with focus on needs, feasibility and potential employment creation. Finally, a number of recommendations for collaborative effort to promote sustainable construction and green jobs in Gaza are set forward based on the findings of the assessment, including buildings codes and regulations, financial incentives, skills training as well as value-chain and enterprise development.

The assessment has been prepared based on available relevant reports and publications, scientific research, interviews with stakeholders and field visits to construction and work sites. The collected data has been filtered and cross-correlated with different sources, and reproduced in a way to serve the purposes of the assessment. Special attention has been given to prepare the assessment to the best possible degree of accuracy acknowledging the unavailability of quantitative and accurate data in some cases.

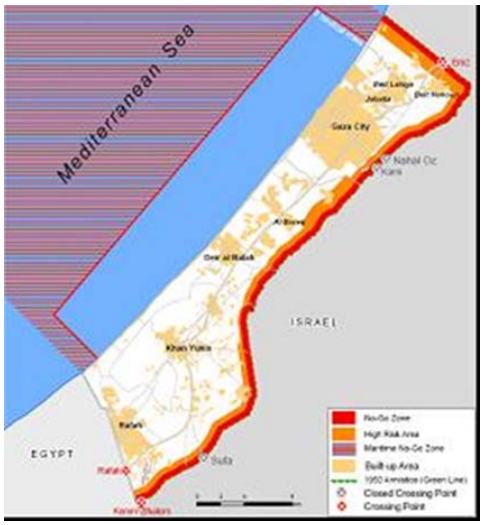
[5] Table adapted from ILO (2011): *Skills and Occupational Needs in Green Building*

2. Construction in the Gaza strip

2.1 Background

The Gaza strip is a narrow land area located in the South-eastern Mediterranean Sea, with a length of about 41 km and a width ranging from 6 to 12 km. There are approximately 1.6 million inhabitants living in the Gaza strip in an area comprising 360 km2, which makes it one of the most densely populated areas in the world. The Gaza strip is linked to the outside world through five border crossings; four with Israel and one with Egypt. All materials and goods required for the people in the Gaza strip are officially to enter through the Israeli border crossings, whereas the Egyptian crossing is only for persons' movement. Access to the Mediterranean Sea is limited to three nautical miles along the Gaza coastline.

Gaza Strip Source: OCHA March 2011



Israel has imposed a strict blockade on the Gaza strip since the Hamas Movement took power over the strip in June 2007. The blockade included the closure of all crossings that link the Gaza strip with Israel, preventing the movement of people and the entry of goods and materials, with the exception of some basic humanitarian necessities. The blockade has resulted in a severe deterioration in the social and economic situation in the Gaza strip[6]. On December 27 2008 Israel launched a military assault on the Gaza strip known as the Cast Lead Operation that lasted for 23 consecutive days. This war had a destructive effect on all aspects of life in Gaza and contributed considerably to worsen already deteriorated economic and social conditions. According to UN sources, about 1,440 people were killed and more than five thousands wounded, many of which were civilians. The infrastructure was also significantly damaged as thousands of residential houses, public and commercial buildings were completely or partially destroyed. Public facilities and services, including healthcare, education, water and energy provision etc. were also heavily devastated.

The combined effect of the Israeli war and the blockade, the latter of which is still in force, has deteriorated most infrastructures in Gaza, so that facilities have become inadequate and many are not functioning at all, while public services have been reduced to a minimum. There is currently an acute shortage of energy, drinking and irrigation water, sewage water treatment and housing services in Gaza. Hence, development and economic growth in Gaza is severely challenged and consequently unemployment and poverty is widespread.

It is estimated that the need for housing and shelters is currently about 75,000 units[7]. This has resulted in thousands of people in the Gaza Strip lacking access to appropriate shelters and still live in crowded or unfit residences. The lack of building materials due to the blockade has halted overcoming this problem. The high unemployment rate, which is about 40% of the total work force[8], is also one of the consequences of the failure in the industrial and construction sectors, which has

[6] The Hague International Model United Nations (2011): *Dismantling the blockade of the Gaza Strip*
[7] USSD (2011): *Assessing Housing Needs in the Gaza Strip*
[8] UNDP (2010): *Gaza – Early Recovery and Reconstruction Needs Assessment*

deepened the economic crisis forcing many people to become more dependent on foreign aid. The energy situation has severely deteriorated and is unable to meet people's everyday needs. There is a shortage of about 35% (100 MJ) of the required electricity[9]. As a result, people suffer from daily power cuts lasting up to 8 hours. The water and sewage treatment sectors are also among the most imminent problems currently facing Gaza. It has become evident that the Gaza Strip suffers from a crisis in both the quantity and quality of available water. The minimum water requirement of inhabitants cannot be met, and about 95% of water supplied to households is contaminated and undrinkable[10]. This has resulted in the spread of many diseases, such as diarrhoea and other water-borne diseases, especially among children. Due to the inadequate sewage water treatment facilities and networks, a considerable amount of untreated sewage water is also dumped directly into the sea and in the environment. As a result, significant hazards to human health and environment have been widely recognized.

2.2 The construction sector in Gaza

It is generally agreed by local and international organizations concerned with the housing situation in Gaza that there is a significant shortage of needed housing units to meet the development needs of the growing population. The combined effects of rapid population growth, the blockade and the destruction of houses during and prior to the Cast Lead Operation is considered as the main reasons for the inadequate housing situation. According to a recent USSD report (August 2011) the total housing needs in the Gaza strip is estimated to be about 75,000 units; 75% of which is due to natural population growth, 13% due to the destruction of houses in Israeli military operations, and 12% accounted for replacing substandard units and easing overcrowding.

Considerable efforts have been carried out by various organizations to overcome the housing crisis in Gaza, however, insignificant outcomes have been achieved to date. This failure is mainly due to the lack of construction materials and infrastructure facilities available in the Gaza strip. As a result, thousands of people have no access to safe and permanent shelters, which is considered a basic human need. Many of the displaced people from the war, who number around 100,000, still live either in emergency shelters or with host families[11].

Emergency shelter provided to displaced and homeless people due tot he war on Gaza

A further challenge facing the construction of needed residential housing units in Gaza, both in the short-term and long-term, is the expected increase in demand for scarce resources, such as materials, energy and water. Already now, the residential sector in Gaza constitutes up to 70% of the total energy needs, while domestic water consumption is at pars with irrigation needs. Conventional construction methods used in Gaza also consume large amounts of energy and

[9] http://penra.gov.ps
[10] EWASH, How Gaza's Blockade Impacts on Water and Sanitation, 2011
[11] USSD, Shelter Advocacy Fact Sheet 3, 2011

materials and generate vast amounts of waste. Combined with the rapid population growth in Gaza, the current approach to construction will inevitably increase demands for these resources to levels that are unsustainable, while further causing degradation to the vulnerable environment in Gaza.

The challenges facing the construction sector are also reflected in the employment rates. In 2005 the housing construction sector in Gaza provided direct employment for a total of 22,200 workers. Following the imposition of the blockade restricting the availability of construction materials, and the consequential decline in construction activities in Gaza, this number had dropped to only 4,800 by the end of 2009. The number of jobs in the construction sector in Gaza is slowly however increasing following a limited easing of the restrictions in the blockade since the beginning of 2010, the approval and implementation of a number of construction and infrastructure projects funded by international organizations, as well as increased activity in smuggling construction materials through the tunnels beneath the border with Egypt. In the last quarter of 2010, the recorded number of people working in the construction sector in Gaza had thus increased to 7,900, or to slightly over a third of 2005 levels[12].

Apart from the overall employment situation in the construction sector in Gaza, the substandard working conditions also present a clear problem. Internationally recognized occupational safety and health standards and practices are generally neither applied nor monitored. Basic workers' rights are not sufficiently respected and in some instances child labour is also exploited in the construction sector – especially in the provision of construction materials through the tunnels. Overall, there is a need to improve working conditions in all construction related activities in Gaza, including those instigated by international organizations, the public sector as well as private entrepreneurs.

2.3 Skills provision and training in construction in Gaza

There are several centres in Gaza that provide technical and vocational training to students in the field of construction. These centres belong to various organizations including governmental, international, NGOs and private organizations. Four governmental training centres are distributed along the Gaza strip, namely the Imam Shafi, Dir-albalh, Khan Younis and Rafah training centres[13]. They provide training courses to students who have finished at least ten years of their normal school education. These training courses range from few months to two years, after which the students receive a certificate of completion. The centres provide courses on construction related works such as plastering and tiling, air conditioning, carpentry, general electrical installations, aluminium fabrication, metal works and plumbing. The students usually spend about 70 percent of their course time in practical training and 30 percent on learning theoretical backgrounds.

The United Nations Relief and Works Agency (UNRWA) has two training centres, which are Gaza Training Centre (GTC)[14] and Kahn Younis Training Centre. They are widely recognized as the most professional for providing technical and vocational training in Gaza, however their training is mainly limited to refugee students, with few exceptions to non-refugees. They offer courses related to building construction, including plumbing and central heating, carpentry and furniture making,

[12] OCHA, Easing the blockade – assessing the humanitarian impact on the population of the Gaza Strip, 2011
[13] http://www.mol.ps/center-p.html
[14] http://www.gtc.edu.ps/Default.aspx

smithery and welding, and building finishing decoration. The period of study is two years, most of it directed at improving practical skills. In addition, there are also some other training centres such as Gaza training centre, which belongs to the World Council of Churches offering similar courses.

It is estimated that only about 150 - 200 students are trained annually on building construction related works in the local vocational and technical training centres. Traditionally, occupational skills in construction in Gaza have been transferred from one generation to another through practical training and skills gained on the worksites, rather than in centres. This type of training ensures regular income to the worker, in addition to being trained practically without spending long periods in a training centre without regular income. Therefore, many prefer to start working in construction as unskilled workers, and then gradually attain further skills by the time.

In addition to the training centres, there are also some community colleges and universities that grant degrees in specializations related to building construction. The community colleges, such as the University College of Applied Science[15] offer courses in various fields related to building construction including architecture, civil engineering, surveying, decoration and aluminum fabrication. The students attend the courses after finishing secondary school and spend two years to get a diploma certificate in their specializations. Among the local universities, the Islamic University of Gaza[16], Palestine University[17] and College of Science and Technology in Kahn Younis[18] offer bachelor's degrees in specializations such as architecture, civil, environmental, and electrical engineering and building construction. The students usually spend from four to five years studying to get their BSc degrees in one of these construction related fields. It is estimated that about 70 - 100 students graduate annually from the community colleges with a diploma certificate, while about 300 - 350 architects and engineers usually graduate from the local universities in specializations related to building construction activities.

The training in the field of building construction provided by the various vocational centres in the Gaza strip is considered beneficial and partially contributes to allocate technical staff that can work efficiently in their various specializations. However, the quality of the training offered is still less than desirable and needs improvements to respond to the current needs and requirements in Gaza. There is room for improvements in the curricula so as to link it with current technologies and updated pedagogical approaches that are prevalent in other countries. Also, the trainers need to be updated with the latest knowledge and practices in their fields through more oriented training courses. Laboratories and equipment needed for training are in most cases below needed requirements, which is reflected negatively in both training efficiency and the acquired skills of students. The higher education provided by community colleges and universities in Gaza in the fields of building construction is relatively acceptable and fulfills to a large extent the community's needs. Nonetheless, improvements in the infrastructure of this education, especially in terms of available laboratories and equipment, are still required.

Overall, skills provision and training in the field of construction sufficiently enables the introduction of practices, technologies and solutions used in sustainable construction. Altogether 500 – 650 students are provided training in construction related fields in Gaza; 150 – 200 in vocational training,

[15] http://www.ccast.ps
[16] http://www.iugaza.edu.ps/ar
[17] http://up.edu.ps/ar
[18] http://www.cst.ps/site/

70 – 100 in community colleges and 300 – 350 at university level. There is however a need to support the introduction of new training that is better adapted to sustainable construction, which requires renewing curricula, upgrading trainers' skills and providing appropriate equipment for this, in all levels of education and training relevant to the field. Currently, no vocational training centres offer any courses on sustainable construction, energy-efficiency or renewable energies, and the teaching in this field on higher levels is also very limited.

3. Potentials for sustainable construction in Gaza

3.1 Building materials

Most building materials for newly constructed houses have traditionally been imported from outside the Gaza strip, especially from Israel. Such materials include cement, gravel, reinforced steel bars, aluminum, wood, marble etc. However, since the start of the blockade, only limited amounts of construction materials have been obtained through the Israeli border crossings, especially after the Cast Lead Operation in late 2008. As a result, the Gaza strip has been suffering from a scarcity of building materials to reconstruct about 6,200 houses, which were significantly damaged or completely destroyed in the Israeli war on Gaza[19]. The building materials are also needed to build new houses to meet the housing demand generated by the population growth, which is currently estimated to be more than 75,000 housing units.

In May 2010, following the attack on a Turkish flotilla seeking to break the siege, Israel started to ease the restrictions on building materials entering Gaza, especially for projects implemented by international organizations, such as UNRWA and the United Nations Development Programme (UNDP). The average monthly amount of restricted construction materials (steel, cement and gravel) that Israel allowed into Gaza between October 2010 and February 2011 was 20,000 tons, which equalled about 7.6% of the average monthly amount (264,000 tons) brought into Gaza before the closure[20].

Construction in Gaza using tunnel materials

These materials are however still banned from reaching the private and local public sectors. Instead the private sector usually applies materials imported illegally from Egypt through the underground tunnels. In late 2010, the average
monthly amount of construction materials brought in through the tunnels amounted to 98,000 tons, or almost five times the amount imported officially through the border crossings. Apart from the steel, cement and gravel brought in officially through the border crossings, or illegally through the tunnels, a number of specialized construction materials are still very hard to come by in Gaza. These include heavy weight steel bars, needed for the construction of tall buildings; bitumen, which is needed for asphalt making; and silo cement, required for making tiles and ready cement in large volumes[21].

Although tunnel materials have caused a small building boom in Gaza, there is still dissatisfaction with their cost and worries about their quality. The cost of the tunnel materials are usually heavily inflated, as it is up to three times the equivalent market price if there was free access to construction materials. Also, the quality of tunnel material is widely considered less than desirable, compared to

[19] USSD, Shelter Advocacy Fact Sheet2, 2011
[20] http://gazagateway.org/?p=1976
[21] OCHA 2011

the materials officially imported from Israel. It should also be noted that the regulations of most international organizations prevent them from utilizing tunnel materials[22].

3.1.1 Recycled construction materials

Using recycled materials is considered one of the ways to create sustainable or green buildings, as utilizing such materials ensures reduction of embodied energy and consumption of natural resources, which consequently reduces negative environmental impacts. Furthermore, a vast amount of recyclable rubble has been generated in Gaza as a result of buildings destroyed in numerous past conflicts. Therefore, considerable attention has been given in recent years by international and local organizations in the Gaza strip to recycle and reuse rubble in the construction sector. Recycling activities increased especially after the Israeli disengagement from the settlements in the Gaza strip in 2005, where about 400,000 tons of concrete rubble was collected from destroyed buildings of Israeli settlers. In addition to this, the Israeli war on Gaza in late 2008 generated about 600,000 tons of concrete rubble as a result of the extensive destructions of houses and public buildings[23].

Rubble of the IUG laboratory building destroyed in 2008

The main recycling activities were focused on producing aggregate from crushed concrete rubble. Besides environmental concerns, recycling of rubble has in recent years gained further interest and use as alternative construction materials, following the imposition of the blockade and limited availability of conventional materials.

To date, the produced aggregate resulting from recycled rubble has mainly been used in concrete mixes and road constructions. Tests carried out to examine the performance of these aggregates showed acceptable results compared with international standards. In addition, some factories started to crush block-rubble and reuse stones to produce new construction blocks and interlocks. In late 2010 the average monthly amount of aggregates produced through recycling was approximately 38,000 tons. It is estimated that there are about 30 - 50 small rubble crushers in Gaza used to produce aggregate for concrete mixes and blocks manufacturing. The number of workers needed for each crusher is about six, which means that the overall number of workers directly involved in rubble recycling is 180 - 300. In addition, there are about the same number of people working indirectly in collecting the rubble and crushed blocks from streets and destroyed buildings in Gaza.

[22] USSD, Shelter Advocacy Fact Sheet2, 2011

[23] Amran El Kharouby, post-war rubble removal and potential use of recycled construction rubble in Gaza governorate, The Islamic University Journal, Vol.19, No.1, pp 197-212 , 2011

The small rubble crushers are usually manufactured locally with a unit price estimated to be about 3,500 – 4,000 US Dollars. The machine consists mainly of a small container with hammers inside that are used to crush the big pieces of rubble into small aggregates. The rubble is generally transported to the crusher using trucks or animal carriages, and the produced aggregate is then trucked to nearby sieves before it is accumulated in preparation to be sold. Most small-scale rubble crushers are privately owned, run by individuals who started to work in the business after the building materials crisis began. Block factories distributed along the Gaza strip, also produce small aggregates for their own use in manufacturing of blocks. In addition, there are two large-scale rubble crushers (one in Rafah and the other in Kahn Younis) operated by UNDP for producing aggregate that can be used in road constructions and concrete mixes.

Using recycled materials, in addition to aggregates smuggled through the tunnels, have led to an increase in construction activities in Gaza. Although the quality of recycled materials is considered less than that of the tunnel materials, their low market price make them preferable for many people who build their homes at their own expenses. Nonetheless, the amount of rubble being crushed in Gaza, and consequently employment in these activities, has been declining in recent months and is expected to reach zero in the near future, as the available raw material (i.e. rubble) is gradually exhausted[24].

Apart from rubble, there are some other local traditional materials in Gaza that can be recycled and reused as building materials, such as mud and sand. In addition, other materials such as wood, steel sheets, plastic bottles and car tires can also be reused, with some adaptation, as a substitute to concrete blocks and new building materials. However, due to the limited amounts of these materials, and their questionable quality, they are not relied upon in broader terms in the construction sector.

3.1.2 Local building materials

Using local construction materials usually ensures more sustainable and environmentally friendly building solutions, as they require less energy in production and transportation and in most cases are recyclable. This approach has become more essential in the Gaza strip in the last few years due to the serious lack of imported building materials and the great need for shelters for displaced people. There are two types of local materials that have traditionally been used for constructing buildings in Gaza; mud and sand.

For a long time in the past, mud was used to build shelters especially for farmers and poor people. Since mud is cheap, does not require advanced technology to use, is recyclable and thermally and acoustically efficient, governmental and private institutions have called for reviving mud construction as a temporary solution for the housing problem and the imminent need for shelters. Accordingly, some mud buildings have already been built by individuals and public and

Shelter built by UNRWA in the north province using CEBs

[24] OCHA 2011

private sectors. The evaluation of these buildings has shown some success on the scale of a few single cases. However, due to various drawbacks of mud construction in terms of water resistance, durability and need for continuous maintenance, in addition to the limited amount of mud available in the Gaza strip, and the devastating effect on the agricultural land due the excessive use of it, mud construction in larger extent has been discouraged[25].

Another way of utilizing local materials in Gaza has been through using compressed earth blocks (CEB), which are made mainly from sand, small amounts of clay and some other combining additives. The blocks are manufactured locally with relatively simple technology. This type of building construction has overcome most of mud constructions' disadvantages, as CEBs are more durable, requires less maintenance and use little amount of clay and much of sand, which is widely available in the Gaza strip. In the same time, CEBs are thermally efficient and use minimum amount of energy for manufacturing and construction[26].

The ILO in cooperation with other organizations implemented in 2010 a project to support compressed earth block shelters and promote creating green jobs for workers and engineers. The project focused on skills development and technical supervision of earth construction projects and contributed to allocate trained staff who can work effectively in these types of constructions[27]. Although these CEB shelters were considered a temporary solution, they were overall accepted by residents, compared to other types of shelters proposed to accommodate them, such as mud buildings, tents and caravans.

Apart from the CEB-project mentioned above, there are a few interlock factories in Gaza that have started producing CEB blocks mechanically instead of manually. CEB components that are mechanically produced, are very similar to those manually produced, while the quality maybe slightly better. It is estimated that the current number of workers involved in CEB constructions in these interlock factories in Gaza is about 10 - 15 people.

3.1.3 Sustainable materials use and job creation

Sustainable materials use, including utilizing local materials such as CEBs and recycled materials in an efficient way, is desirable in the construction sector in Gaza at large due to a number of benefits, as they need less energy for materials production, transportation and construction. They are more environmentally friendly in terms of consuming natural resources compared to conventional construction materials, while their adoption also lessens the dependence on imported or smuggled construction materials. The high level of thermal and acoustic insulation especially provided through CEBs, also makes materials like these more advantageous for residential buildings.

In addition to these benefits, sustainable materials use is also preferred for creating new job opportunities. Utilizing local and recycled materials is considered more labour-intensive than using conventional construction materials, as producing the bricks and the construction is to a large extent carried out manually and locally. As can be seen from the table below, this provides additional job

[25] Ahmed S. Muhaisen. Study the experience of building with mud in Gaza Strip. Omron and Urban techniques Journal, Mesilla University, Algeria, 2010
[26] Field visit to work sites and interview with Emad Al Khaldi, director of architectural Heritage company, 2010
[27] ILO, The Gaza Employment Crisis, 2009

opportunities for architects, engineers and workers in Gaza who are involved in the manufacturing and construction processes of alternative materials as well as in recycling operations and collection.

Core occupations in Sustainable Materials Use in Buildings	
Planning and Designing	Architects and civil/structural/environmental engineers
	Architectural technicians and technical drawing specialists
Manufacturing, Construction, Installation, Maintenance	Manufacturing of local construction materials Manufacturers and distributors of Compressed Earth Blocks (CEB)
	Recycling Collectors, recycling specialists, materials transport
	Construction Building site supervisors and site engineers/architects specialized knowledge in local and recycled construction materials, bricklayers, masons, other construction workers
Controlling	Buildings-inspectors and quality controllers
Enabling	Educators and training providers

Utilizing local materials such as CEBs or recycled materials in buildings requires extensive planning and architectural design. Therefore sufficient skills development and training is needed for architects and engineers, especially in the planning phase of constructions. Skills development and training, although to a lesser extent, is also needed for workers and labourers, in both manufacturing alternative materials and recycling as well as in the construction process using such materials.

3.1.4 Summary

- Obtaining construction materials in the Gaza strip is still considered to be one the main challenges for building shelters and new housing units.
- The Israeli building materials are only limited to international organizations.
- Tunnel materials can be a substitute option for the private and public local sectors, but special attention to their quality and price should be taken, including the conditions under which they are delivered (most international organizations are not allowed to utilize tunnels materials).
- Recycled materials secure part of the required needs for construction materials, with lesser impact on the environment. Although recycled rubble has been used extensively, its large-scale availability is receding.
- Using local materials contributes to overcome the shortage of imported materials, and provide efficiency gains through transport and energy savings.
- Compressed earth blocks (CEB) construction is accepted as an alternative building material; taking into consideration its environmental benefits and the siege status that has been implemented on the Gaza strip.
- Sustainable materials use is more labour-intensive than using conventional construction materials, providing new job opportunities in architectural planning, materials manufacturing and recycling, as well as in construction processes.

3.2 Energy

The Gaza strip has almost no conventional energy sources, wherefore it is almost totally dependent on the electricity and fossil fuel imported from Israel. As a result of the combined effects of the conflict with Israel, blockade, and weak economic situation, the Gaza strip has been suffering from a severe energy deficit and a worsening balance between supply and demand in recent years.

It is evident that using fossil fuels to produce energy has adverse impacts on the environment and human health through emissions of greenhouse gases and local and regional air pollutants. Therefore there is a tendency globally to improve energy-efficiency in buildings where possible and reduce the dependence on conventional types of energy in favour of renewable energy resources. The Gaza strip is rich in solar energy, which is abundant during the entire year as a result of the territory's location near the hot dry region of the world. It is believed that solar energy can be used in different applications in buildings, which may contribute to overcome the energy problems, especially in the residential sector, currently facing Gaza.

3.2.1 The electricity situation in the Gaza

Since 1967 the Gaza strip has predominantly been dependent on the Israeli electric company for electricity supply. However, after the establishment of Gaza Company for Electricity Generation (Gaza Power Plant) in 2002 a considerable part of the electricity demand has also been provided locally. The Gaza power plant has a total design capacity of 140 MW, which is generated by 6 turbines; four 24-MW diesel-fuelled combustion turbines and two 22-MW steam units. The required fuel is bought from Israel and provided to the power plant by the Palestinian authority of energy and natural resources[28].

Electricity network in the Gaza Strip

In June 2006, however, the power plant was directly targeted by six Israeli air force missiles. The missile strike caused major damage to the plant and led to a cut of about half of the electricity supply for the residents of the Gaza strip. Although the plant was later repaired, and some improvements in the electricity supply occurred, the harsh effects of the plant damage can still be felt, and the power generation in the plant has still not returned to its full design capacity. Auxiliary damages caused to the electricity distribution networks in the hostilities in 2008 have further impaired the provision of electricity in Gaza.

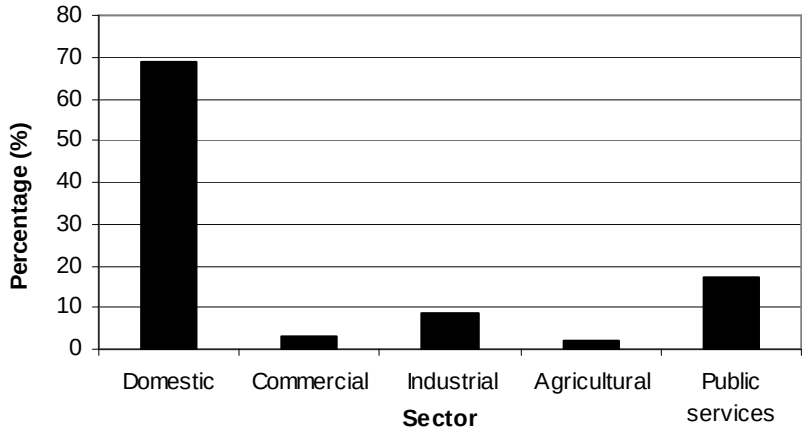
[28] http://penra.gov.ps

It is estimated that the number of workers involved in energy provision in Gaza power plant is about 100 – 150 people. In addition, there are about 400 - 500 workers employed by the electricity distribution company for maintaining the electricity network in the Gaza strip[29].

The total electricity load supplied to the Gaza Strip today is about 197 MW coming from three sources as follows: the Gaza power plant (60 MW), the Israeli electric company (120 MW) and Egypt (17 MW)[30]. The actual requirements for electricity in the Gaza strip are however estimated to be about 300 MW, which means that there is a shortage of about 100 MW (34% of the total needs). As a result of the electricity load shortage, the electric current is cut off at least eight hours per day, causing disruptions in economic activities and all aspects of live. It should further be noted that the electricity demand increases by about 10 - 15 MW annually as a result of the natural population growth and the expansion in various sectors, including the housing and domestic sectors, thus further aggravating the electricity shortage.

The distribution of the total annual electricity consumption in the Gaza strip among various sectors clearly reveals that the domestic and residential sector consumes the main bulk of electricity; about 70% of the total consumption. The public services sector, which includes all governmental buildings, municipality services and streets lighting, consumes the second biggest amount with an average of 17%, while the industrial sector only uses 6.5% of the total consumption, and the commercial and agricultural sectors significantly less. This indicates that the residential and domestic sector should be the focus of any plan to reduce the per-capita electricity demand in Gaza in the future[31].

The electricity consumption of the different sectors in the Gaza strip:



A number of strategic projects to improve the electricity situation in Gaza have been suggested and developed by the Palestinian Authority. These include connecting the Palestinian electricity network with that of Egypt through the Seventh Connection Project. This is a regional project aiming to connect the electricity networks of seven countries, namely Egypt, Libya, Jordan, Lebanon, Syria, Iraq, Turkey and Palestine. Another planned measure is to obtain more electrical load from Israel through the Line 161 Project, which is expected to provide the Gaza strip with 300 MW if completed.

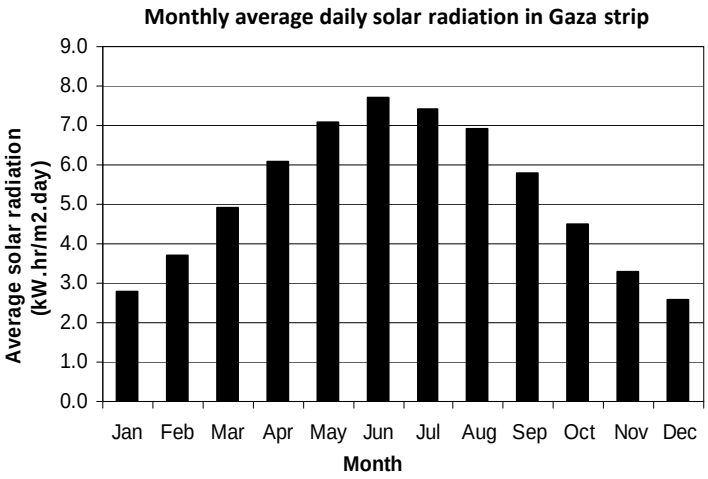
[29] http://www.gedco.ps/main.php
[30] EUNIDA, Damage Assessment and Needs Identification in the Gaza Strip. 2009
[31] Ahmed Muhaisen. The Energy Problem in Gaza-strip and its Potential Solution. Conference Proceedings. International Conference in Energy and Environmental Protection in Sustainable Development (ICEEP). Palestine Polytechnic University (PPU). 8 - 10 May 2007

Supplying Gaza power plant with Egyptian natural gas, which will help to exploit the plant fully and achieve maximum a capacity of 140 MW, has further also been suggested[32].

Implementing any of these projects could ensure adequate electricity supply in Gaza for several years in the future. However, this would not be an easy undertaking and may not be achievable as long as the Israeli-Palestinian conflict continues. Even if this could be achieved, it should be noted that using fossil fuel to generate electricity produces large amounts of greenhouse gas emissions and causes adverse effects to the human health as well as the environment, both globally and locally. This further emphasizes the need to have alternative energy resources that are safe, clean, and contribute to create a green built environment in Gaza. Using renewable energy resources available in the Gaza strip in the domestic housing sector, especially solar energy, as well as improving energy-efficiencies in buildings as far as possible, is therefore proposed as part of an overall solution to the electricity problems in Gaza.

3.2.2 Potentials for renewable energy in the Gaza strip

The main renewable energy sources applicable to the Gaza strip are solar and wind energy, and to a lesser extent other renewable sources such as wave, geothermal and biogas energies. Solar energy is abundant in the Gaza strip with a considerable amount provided throughout the year as a result of its location near the hot dry region of the world. Solar energy can be used in different applications which contribute to reduce the dependence on fossil fuel and create more sustainable and green buildings. Simple thermal collectors or solar water heaters (roof flat-plate collectors) are very common in the Gaza strip and are generally used to heat water for domestic purposes. It is estimated that about 70 percent of residential buildings in the Gaza strip are integrated with solar water heating systems[33]. Generally, people rely on solar collectors almost completely to supply hot water for the different domestic applications, especially in the summer. The bulk of solar water heaters in Gaza are locally manufactured and sold at reasonable prices.



The Solar Water Heater (SWH) systems used in Gaza are generally manufactured or assembled locally. There are many enterprises involved in the local SWH industry in Gaza, especially in manufacturing, refurbishing, installation and maintenance related jobs. The number of enterprises in Gaza that manufacture SWH systems is estimated to be about ten, with a combined annual manufacturing capacity of approximately 2,500 - 3,000 complete units. The number of SWH refurbishing enterprises in Gaza is about 50. The refurbishing enterprises usually refurbish second

[32] Interview with Alderdisawi, Jamal, the manager of the public relations in the Gaza electricity distribution company (GEDC).
[33] http://pea-pal.tripod.com/renewable_energy_department.htm

hand systems obtained either locally from the Gaza strip or imported from Israel and then resell them with relatively low prices. The installation works and maintenance is usually carried out by plumbers who mostly install the systems completely in buildings. The number of professional plumbers is estimated to be about 150 - 200 in the Gaza strip. The total number of workers involved in SWH related jobs can be estimated at 400 - 500 in various specializations.

Although, there are some parts of the SWH system that are produced locally, the raw materials and main fittings are imported from Israel and in some cases from Egypt through the tunnels. This means that producing SWHs in Gaza cannot be sustained without the imported materials. Currently, the importation of such materials from Israel is nonetheless allowed.

In general, producing more sophisticated solar thermal systems such as evacuated tubes, or combined solar water and space heating systems are not performed in the Gaza strip. This is referred mainly to the limited technology and techniques available in the Gaza strip, in addition to the lack of trained workers who can work on that. It should also be mentioned that most people in Gaza are not aware of such systems, which also can be considered one of the reasons for the scarcity of these in the Gaza strip.

Photovoltaic panels (PV) have been used in various places around the world to generate electricity. It is a safe technology, generally considered to be one of the most environmentally friendly methods to generate electricity, and has great potentials in the Gaza strip. Currently, however, PVs are not generally utilized in buildings in Gaza, and the majority of Gaza's population has very limited information about them. Exploiting PV technology could help to substantially reduce the dependence on the electricity purchased from Israel or that generated by the Gaza power plant. However, introducing PV systems in Gaza faces many obstacles. The main barriers are the high initial costs, as currently the price of the generated electricity unit through PV is estimated to be about 3 - 5 times more than that of the grid along the life time of the PV system[34] (25 years). Considering the economic situation in Gaza, any increase in the household electricity costs is unlikely to gain public support. Furthermore, there is a lack of trained technicians who are qualified to install and perform maintenance of PV systems in buildings, as well as a general lack of awareness among the public of the potential benefits of solar power. It should also be mentioned that PV systems are not readily available or manufactured locally in Gaza. This means that they would have to be imported from outside, which, due to the ongoing blockade, can be a cumbersome process. Other applications of solar energy such as solar cooking, solar crop drying and solar lighting have been tried in the Gaza strip, however, these are only limited to a few separate cases.

[34] Assad Abu-Jasser, 2010. A Stand-Alone Photovoltaic System, Case Study: A Residence in Gaza. Journal of Applied Sciences in Environmental Sanitation, 5 (1): 81-91

Currently there are no any training centres, colleges or universities in Gaza that provide practical training on manufacturing SWHs. This also applies to PV panels in terms of production and installation. However, in the West Bank the situation is relatively better in terms of the availability of training centres and experience in using such technologies. There are many private companies that are specialized in energy saving and production related activities such as, Engineering Centre For Water & Renewable Energy Co.[35] and Masader for Energy Systems[36]. In addition, there are some research centres that belong to universities in the west bank such as Centre for Energy Researches in An- Najah National University[37] and enewable Energy and Environmental Research Unit at Palestine Polytechnic University[38].

Taking these facts into account, any measures to further develop the local SWH industry or introduce PV systems in Gaza would require interventions to develop needed skills for production, installation and maintenance of SWH and PV technology, as well as interventions to reduce the initial costs, improve availability, and raise public awareness. Considering the high costs of especially PV panels, measures to introduce this technology in buildings in Gaza could initially be limited to public buildings, such as schools and hospitals, and then progressively, once availability is broader and costs lower, be expanded to also cover residential buildings.

Whit regards to wind energy, available wind speeds and free land area in the Gaza strip is not sufficient enough for commercial or tangible productions of wind energy. The low annual average wind speed (3.8 m/s) may be just adequate to run small residential wind turbines installed on buildings to generate electricity, especially when connected in a hybrid system with PV panels. There are other renewable resources that have been examined by students and researchers in local universities in Gaza to generate electricity, such as wave, geothermal and biogas energies. These resources are still under development and have thus far not shown good reliability, especially in terms of available technology and equipment, in addition to their high initial costs of utilization.

3.2.3 Improving energy-efficiency and conservation in Buildings

The majority of buildings in the Gaza strip are made of reinforced concrete for the main skeletons, a single layer of hollow blocks for the external walls, and single glazing windows. This type of construction has been prevalent in the Gaza strip, with very little improvements, for decades. It has been confirmed that this construction method is inefficient in terms of energy consumption of buildings both for heating and cooling. This is referred to the high heat transmittance values (U-value) of these materials compared with other constructions and materials[39]. It is estimated that using for example heat insulation in walls could save about 30% of the building's energy requirements with regards to heating, ventilation and air-conditioning (HVAC). This rate of saving would further increase if the roof was also insulated and double or triple glazing was used for windows. Applying passive solar techniques in buildings, such as shading devices, green cover and orientation, could also contribute significantly to save energy in buildings. Further possibilities to reduce energy consumption in buildings can be achieved through passive climatic design elements,

[35] http://www.ecwre.com/index.php
[36] http://www.msader.ps/Default.aspx
[37] http://www.najah.edu/ar/page/1419
[38] http://reeru.ppu.edu
[39] Guidelines for Energy Efficient Building Design, The Ministry of Local Government, 2004

such as wind towers, solar chimneys, which can be integrated into buildings with relatively insignificant variations in building design, cost or need for special materials.

Using energy efficient appliances can also considerably contribute to lessen the energy consumed in buildings. For example using compact florescent lighting (CFL) of light emitting diode (LED) systems can save up to 70 percent of the electricity needed for inside lighting in individual households or office and commercial spaces, compared to conventional lightning systems. Similar energy-efficient alternatives are also available for refrigerators, washers, computers and others. These kind of efficient appliances are generally available in the Gaza strip, with relatively higher initial prices compared with conventional appliances. The overall costs of these appliances are however considerably lower when energy savings taken into account.

Although the materials and appliances for achieving considerable energy-savings in buildings, such as thermal insulation and double-glazing windows and energy-efficient lightning are generally available in Gaza, and in spite of the importance of such measures, they are only to a limited degree taken into consideration by designers, builders and householders. This can be referred to various reasons, including the involved people's lack of awareness of these measures or potential savings that can be achieved, the lack of laws that oblige applying such systems, as well as the overall priority of meeting the housing demand with emphasis primarily on costs and speed, rather than long-term energy-savings in the buildings.

3.2.4 Sustainable energy use and job creation

Exploiting renewable energy, in addition to applying energy conservation and efficiency measures in residential buildings, is highly recommended to improve the overall energy situation in Gaza. Buildings that adopt sustainable energy applications contribute to minimize the dependence on inadequate conventional energy sources in Gaza, reduce the adverse environmental effects caused by burning fossil fuels, as well as help easing the energy crisis. Using solar water heaters, PV panels, thermal insulation, passive solar architectural designs and energy-efficient domestic appliances are among the distinctive features of sustainable energy use in buildings.

Adopting sustainable energy use in constructing new houses or through the refurbishment of existing houses can also help to create green jobs opportunities for workers, technicians, electricians and engineers involved in energy generation and conservation processes in the construction sector. New employment opportunities can be created in the fields of energy-efficient architecture and building insulation, construction, installation and maintenance of solar water heaters, installations and maintenance of PV panels, metalwork, electrical works and appliance maintenance. It should be mentioned that several of these jobs, except for those connected to solar water heaters, are not usually applied in conventional constructions in Gaza. Considering that the use of renewable energies in Gaza is still very new, there would be a need to focus on training workers on different aspects of sustainable energy use in buildings, including training on manufacturing, installation, operation and maintenance. There is also a need for further researchers in Gaza specializing in this field.

Core occupations in Sustainable Energy Use in Buildings

Planning and Designing	Architects and civil/structural/environmental engineers
	HVAC, electrical, mechanical, renewable energy and building-service engineers
Manufacturing, Construction, Installation, Maintenance	Manufacturing Manufacturers of solar water heaters (SWH), manufacturers and distributors of other green building materials and products
	Insulation/weatherization Building site engineers/architects, carpenters, plasterers, glaziers, roofers and semi-skilled occupations
	Energy-efficiency and Renewable energies Plumbers and heating installers/maintenance, HVAC installers, electricians, installers/maintenance of solar thermal systems (SWH) and solar photovoltaic (PV)
Controlling	Energy auditors
	Buildings-inspectors, certifiers and quality controllers
Enabling	Educators and training providers
	Researchers

3.2.5 Summary

- The available electricity supply in Gaza, obtained from Israel, Gaza power plant and Egypt, is insufficient to meet the development needs of people in the Gaza strip.

- There is currently a shortage of about 100 MW in the available electrical load. This shortage is further increasing every year.

- The domestic and residential sector consumes the largest amount of electricity in the Gaza strip (approximately 70%), followed by the public sector (17%), while other sectors consume considerably less.

- The potentials of using renewable energy resources in the Gaza strip are encouraging, especially in the use of solar energy. This however requires carrying out measures to develop local renewable energy technologies, make them more cost-efficient, especially with regards to PV technology, as well as focus on skills development and public awareness.

- Improving energy-efficiency and conservation in buildings through improved insulation, architectural solutions and energy-efficient appliances can achieve considerable energy savings. Materials for applying such measures are available in Gaza, although efforts should be made to enhance needed skills among workers, strengthen regulations in the field, and raise public awareness of the potential benefits involved in such measures.

- Using renewable energy resources combined with energy-efficiency and conservation measures in buildings infer considerable job opportunities for workers, technicians and engineers; both in the construction sector as well as in other sectors.

3.3 Water and sanitation

The Gaza strip has been suffering from a crisis in the water and sanitation sector over a longer period. This has been reflected badly on people's life and health, and deepened the humanitarian and economic problems prevailing for many years in Gaza. Innovative solutions are severely required to provide people with clean and safe water and to treat sewage water in environmentally friendly ways. Therefore, sustainable use of existing water resources and reuse of sewage water should be given special considerations also in the construction and building sector in Gaza.

3.3.1 Water status

Groundwater from the coastal aquifer, which Gaza shares with Israel, is the main source of water in the Gaza strip for the various needs (residential, agricultural and industrial). The only surface water reaching Gaza is the Wadi Gaza, which originates in the Negev desert in a catchment area of 3,500 km2 with an estimated annual flow of 20-30 million cubic metres per year. At present, however, water from Wadi Gaza is diverted towards artificial recharge and irrigation within Israel, which means that only minimal amounts of the high winter flow reaches Gaza[40]. Rainwater in winter is considered a secondary source of water in Gaza, especially for agricultural purposes. The annual average amount of precipitation in Gaza is however low (317 mm/year) due to the location of the Gaza strip in the semi-arid zone[41]. In spite of the great need for water, rainwater is not efficiently utilized by the private or public sector. A common wrong practice is to drain rainwater into the sewage water drainage system. This practice coupled with the increased urban built areas has led to increase the amount of reusable rainwater that is lost.

The combined effects of many factors, including low rainfall rate, rapid population growth and unwise use of water, have led to excessive extraction of groundwater in the Gaza strip[42]. It is estimated that the annual amount of water pumped from the coastal aquifer in Gaza is about twice that of natural replenishment. In 1990, the total available freshwater in Gaza was 57 million cubic metres, whereas today it is only 35 million cubic metres[43]. The rate of depletion of available freshwater in Gaza is further expected to intensify as a consequence of climate change, due to expected decrease in precipitation and increase in evaporation as well as increased incidences of extreme weather phenomena, including droughts and heat waves[44]. Furthermore, due to over-extraction, saltwater intrusion is also increasingly occurring because of the pressure differences between the groundwater elevation and sea water level. This has resulted in about 95% of pumped water from the aquifer is currently polluted and considered unfit for drinking purposes[45]. It should be mentioned that water facilities have been further deteriorated because of the siege on the Gaza strip, causing increased water losses[46]. Currently up to 45% of the produced water in Gaza is non-revenue water (NRW), out of which 40% is caused by physical losses and 5% by unregistered connections and meter losses. Israel prohibits the entry of materials and equipment required to

[40] Strategic Foresight Group, The Blue Peace, 2011
[41] CMWU, Annual Report on Water Status in the Gaza Strip, 2010
[42] Reyad Tawfik Hussein, Water Demand Management in Gaza City, Master Thesis, IUG, 2005
[43] Strategic Foresight Group, The Blue Peace, 2011
[44] AFED, Water – Sustainable Management of a Scarce Resource, 2010
[45] http://www.btselem.org/gaza_strip/20100823_gaza_water_crisis
[46] Heinrich Böll Foundation, Water as a human right: The understanding of water in the Arab countries of the Middle East - A four country analysis, 2004

rehabilitate and develop the water infrastructure, which negatively affects the quality and quantity of available drinking water[47].

According to an examination of 180 wells in the Gaza strip carried out by the Costal Municipalities Water Utility (CMWU) in 2009, the level of Chloride in 93% of them was between 1000 and 2000 mg/litre, which is about four to eight times the value (250 mg/litre) recommended by the World Health Organization (WHO). Another examination conducted by United Nations Environmental Programme (UNEP) showed that the concentration of Nitrates is about six times the recommended value (50 mg/litre). CMWU referred the high level of Nitrates in the ground water to the intensive use of agricultural pesticides, in addition to the existence of septic tanks to dispose the domestic wastewater in the areas where there is no wastewater collection system.

3.3.2 Water consumption

The daily water consumption per capita in the Gaza strip is about 80 - 90 litres, which is less than the minimum value (100 - 150 litters) recommended by WHO[48]. The shortage of available water quantity coupled with its poor quality has led many people to buy potable water from private desalination stations. Currently Gaza has small public and private desalination plants that produce a combined total of roughly 3,000 cubic metres of water per day (1 MCM/year). In addition there are also some 20,000 home desalination plants currently in operation in Gaza[49]. The price of one cubic meter of desalinated water from private service providers is however approximately 50 NIS (appr. 13 USD), which is about ten times that of the grid water provided by CMWU. Due to the high level of poverty and unemployment, many people cannot afford this high price of clean water. Therefore, many are forced to use polluted water exposing themselves to diseases. According to the Palestinian water authority about 40% of disease incidence cases in the Gaza strip are related to polluted drinking water. Diarrhoea is one of these diseases which cause, according to a UN study in 2009, about 12% of the children deaths in the Gaza strip. Furthermore, it has been estimated that more than half of all children in Gaza aged 6–36 months suffer from anaemia, some of which may be associated with exceptionally high instances of nitrates in the water[50].

3.3.3 Sanitation situation

Sewage water collection and treatment is considered one of the most serious infrastructure problems in the Gaza strip. There are four treatment plants currently operational in the north, Gaza, Khan Younis and Rafah provinces[51]. They are designed to treat collected sewage water to the level allowed for discharge in the

Untreated sewage discharge in Gaza

[47] UNDP, Gaza Early Recovery and Reconstruction Needs Assessment, 2010
[48] http://www.btselem.org/gaza_strip/20100823_gaza_water_crisis
[49] Strategic Foresight Group, The Blue Peace, 2011
[50] UNDP, Human Development Report 2009/2010, Occupied Palestinian Territories – Investing in Human Security for a Future State, 201
[51] EUNIDA, Damage Assessment and Needs Identification in the Gaza Strip. 2009

Mediterranean Sea. However, the treatment plants do not work efficiently, due to the shortage of spare parts and materials required to repair them. Additionally, the increased growth of population exceeding the expansion of treatment plants has resulted in plants operating beyond their designed capacity. As a result, a significant amount of sewage water is poured into lagoons, wadis and the sea without proper treatment, causing environmental degradation, water contamination, increased disease incidence as well as affecting the coastal fisheries. The sewage water networks were considerably damaged in the Israeli war on Gaza, which worsened the sanitation problem in the Gaza strip

About 60% of households in the Gaza strip are connected to a sewage network, whereas the rest usually apply leaky cesspits or empty raw sewage directly into the environment[52]. Gaza valley is one of the important natural areas in the Gaza strip. However, due to the unavailability of sewage networks, neighbouring built areas use primitive channels to dump sewage water into the valley to be channelled directly to the sea. This has been causing serious degradation to the natural environment in the Gaza valley as well as the marine environment. It has been reported that swimming in the polluted sea water, especially near the waste water discharging points, is not safe and can cause the spread of many diseases, such as skin and eye infections. Also, eating seafood obtained from such places may seriously threaten human health.

3.3.4 Improving water-efficiency and supplies in buildings

Enormous efforts have to be made to improve the water situation in the Gaza strip. This will involve improving efficiencies in irrigation, investing in large-scale desalination plants as well as improving wastewater treatment and sanitation systems. A number of water-related improvements can however also be achieved in the construction and building sector that can alleviate the overall strain on the water balance as well as improve the quality of drinking water in the domestic sector. Such sustainable water management measures include improving residential plumbing systems, installation of rainwater tanks and home desalination and water purification systems as well as investigating possibilities for greywater reuse.

Generally, rainwater is not effectively harnessed for domestic purposes in the Gaza strip. Rainwater is usually drained into the main drainage system, especially in relatively built-up areas. In such areas, very few buildings have tanks for rainwater collection to be reused as a way to achieve sustainability and to contribute to ease the water crisis in the Gaza strip.

There are two types of rainwater collecting tanks: underground tanks and tanks applied above the ground. Underground residential rainwater tanks are usually made of reinforced concrete, and not generally applied in Gaza. In addition to the fact that, they need free land adjacent to the building to be constructed, which is in limited supply in Gaza, they are also very expensive. Above-the-ground rainwater tanks are usually made locally of plastic, and are considerably more common than underground tanks, primarily due to the lower costs. In addition to tanks, either underground or above the ground, rainwater collection systems generally also require pumps to transfer the collected water to roof tanks, especially if it is to be used for domestic purposes. In agricultural and rural areas, rainwater is more effectively used, especially for irrigation purposes. It is a common

[52] EWASH, Wastewater in the Occupied Palestinian Territory, 2011

practice by farmers to have a pit in the ground covered with plastic sheets to collect rainwater, especially from the roofs of greenhouses and other farming constructions. This type of rainwater collection is significantly cheaper than having concrete or plastic enclosed tanks.

Due to polluted drinking water, purchasing drinkable water from private desalination plants in addition to having residential small purification systems have become very popular in the Gaza strip. The number of home desalination plants is rapidly increasing, due to the fact that there is no visible or permanent solution to the contaminated water situation in Gaza. Home desalination systems are usually imported from Israel and, in some cases, from Egypt through the tunnels. There have been some attempts carried out by students in local universities to run home desalination plants using a small solar PV system. The attempts thus far have been successful; both in terms of water desalination and energy-saving, and such mixed systems should be further considered for broader use in buildings.

Reusing greywater collected from washing basins, baths and washers is also widely considered as one of the main strategies to reduce potable water consumptions in buildings. It is estimated that about 60% of consumed water by a typical household is turned into greywater. According to a study carried out in Israel, reusing greywater results in saving up to 30& of potable water consumption in a residential building[53]. Greywater can be used in agriculture for irrigation, toilet flushing, car washing, and in some cases charging the ground water reservoir. Recycling of greywater is a relatively simple process, and can contribute to both reducing overall water consumption and minimising wasted water. Although greywater has fewer contaminants than black water, the hazards associated with its use should nonetheless be carefully considered and efficient standards and monitoring needs to be applied.

There are various methods of greywater recycling that differ in terms of complexity depending on the final use of water and available technology. Usually, in rural areas and developing countries, low technology or natural systems, which mainly depend on slow sand filtration, are used. Such systems can be established locally using available building materials and techniques, especially, in rural areas and in buildings with gardens or free land. Advanced recycling plants are usually safer and require less land areas to be installed compared with sand filtration systems. The technology and techniques for such advanced systems are however currently not generally available in Gaza nor are they broadly known by the public.

3.3.5 Sustainable water management and job creation

Applying measures for sustainable water management in the construction and building sector can help to alleviate the water situation in Gaza. Additional work is required to take full advantage of the available water resources in Gaza, including collection of rainwater and grey water in separate drainage systems, making underground and roof water tanks, pumps installation and water insulation. Applying such measures can also create new job opportunities for construction workers, plumbers and engineers. It is estimated that applying sustainable water management measures, would result in at least doubling the plumping related works in buildings. In addition, such measures

[53] E. Friedler, R. Kovalio and N.I. Galil. On-site greywater treatment and reuse in multi-storey buildings. Water Science & Technology Vol 51 No 10 pp 187–194 Q IWA Publishing 2005

would contribute to create more job opportunities for unskilled workers, especially in digging the ground for construction of underground tanks, construction related works, and the installation of such systems. Maintaining collection systems would also be another opportunity to support continuous labour demand for workers and technicians.

Core occupations in Sustainable Water Use in Buildings	
Planning and Designing	Architects and civil/structural/environmental engineers
	Sanitary and building-service engineers
Manufacturing, Construction, Installation, Maintenance	Manufacturing
	Manufacturers and distributors of rainwater tanks, desalination and purification equipment and greywater recycling
	Construction
	Building site engineers/architects, construction workers, sanitation and plumbing technicians
	Water conservation
	Plumbers, engineers, metal works and semi-skilled occupations
Controlling	Buildings-inspectors, certifiers and quality controllers
Enabling	Educators and training providers

3.3.6 Summary

- The water and sanitation situation has considerably deteriorated in the Gaza strip during the last decades, and is considered as one of the most pressing challenges facing the Gaza strip. The situation has worsened as a consequence of rapid population growth and the limited possibilities to import necessary equipment for repair and extension of relevant infrastructure.

- Currently about 95% of water in the Gaza strip is polluted and not safe for drinking, while overall freshwater availability is rapidly being depleted due to over-extraction.

- Only 60% of households in Gaza are connected to a sewage network, while the rest often apply leaky cesspits or discharge raw sewage directly into the environment.

- Currently, buildings in Gaza waste large quantities of water due to insufficient and old plumbing systems, while potential rainwater and greywater is not utilized effectively.

- Sustainable construction can provide some solutions to the pressing water and sewage situation in Gaza, through improving plumbing systems, supporting small scale desalination and water purification, as well as applying systems for rainwater collection and greywater recycling. All these measures should be further explored and considered for both residential and public buildings.

- Applying sustainable water management measures in construction, would contribute to generate new job opportunities, especially for plumbers, technicians and unskilled workers in Gaza.

4. Conclusions: Promoting sustainable construction and green jobs in Gaza

Promoting sustainable construction in Gaza could be a sustainable pathway for alleviating several challenges and needs currently experienced in Gaza. A number of sustainable construction solutions to improve the efficiency of materials, energy and water use in construction and buildings are feasible in Gaza, despite the current blockade and conflict with Israel. Such solutions include using local and recycled construction materials in buildings where possible, applying energy-efficient designs and adopting renewable energy sources in residential buildings, as well as increasing water efficiency through the use of rainwater, desalination and greywater reuse. Sustainable construction can also facilitate the creation of new job opportunities and the improvement of working standards in the construction sector in Gaza. New opportunities for architects, engineers, electricians, plumbers and construction workers with different specializations can be gained in the construction sector as well as in other related sectors. This section will look further into different strategies and tools to promote sustainable construction and green jobs in Gaza.

The extent to which sustainable construction practices and technologies are deployed on a large scale, and the extent to which additional employment is generated through this, is largely shaped by public policy, and by how householders and businesses respond to this policy. While the cost of constructing new efficient buildings in terms of materials, energy and water are not necessarily significantly more than the cost of conventional structures, building regulations and other public interventions are centrally important in driving mass adoption of the techniques and technologies required. In both constructing new buildings and retrofitting existing buildings, national and local governments, as well as international organizations and other stakeholders, play a central role in overcoming behavioural and economic barriers to investments. Sustainable construction codes and regulations, financial incentives, skills training and occupational safety and health, as well as value-chain and enterprise development are among the strategies adopted to overcome barriers and create an enabling environment for sustainable construction. International organizations, in collaboration with local stakeholders, can play a key role in such strategies, providing the necessary resources, practices and expertise needed for their successful implementation.

4.1 Building codes and regulations

Since the advantages of sustainable construction and green buildings have been widely recognized, many organizations around the world have developed codes, standards and rating systems to ensure best creation of such innovative constructions and achieve the minimum requirements necessary to create green buildings, aiming to ensure best practice in sustainable building design, construction and operation[54]. Locally, the Palestinian Ministry of Local Government developed in 2004 a code entitled "guidelines for energy efficient building design"[55]. This was developed through a project funded by the Global Environment Facility (GEF) and UNDP program of assistance to the Palestinian

[54] Rating systems such as BREEM in UK and LEED in USA, use recognized measures of performance to evaluate a building's specification, design, construction and use. The measures include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes. They demonstrate the environmental credentials of the buildings against established benchmarks.

[55] Guidelines for Energy Efficient Building Design, The Ministry of Local Government, 2004

people (PAPP). The code was distributed to universities, engineering associations and concerned bodies as hard and soft copies. It focuses on various aspects related to energy efficient building design, providing information on topics such as, energy and architecture, thermal comfort, building climatic elements, thermal properties of materials and heating and cooling calculations. The code is considered a useful tool to acquire general information about the thermal performance of buildings and the recommended guidelines to reduce energy consumption in buildings.

The code for energy efficient building design cannot however be relied on as complete guidelines for green building design and operation, as it has some limitations. For instance, it does not consider relevant sustainable construction issues such as water use, waste management, embodied energy of building materials, active utilization of renewable energy. It should be also mentioned that the code was prepared as an instructional tool, rather than an obligatory guideline. Applying the code on newly constructed buildings is therefore not compulsory. The regulations of the responsible bodies, which are the engineering association and the local municipalities in the Gaza strip, do not require implementing the code for giving approval of building construction. With regard to the proposed green building design, the code will be useful, mainly in terms of examining the energy performance of buildings. However, other codes should be also taken into account for the uncovered subjects.

In order to further advance sustainable construction in the Gaza strip there would be a need to further develop building codes and regulations setting minimum standards regarding the environmental and efficiency performance of buildings, especially with regards to materials, energy and water use. In order to achieve optimal results, a development and eventual implementation of a green building code in Gaza, should be done in cooperation with governmental ministries, municipalities and private enterprises, as well as with international organizations active in the construction sector, using the existing building code for guidelines for energy efficient building design as a base, and building on experiences in other countries in the region, while adapting to the local context in Gaza. Regulations should further be complemented through monitoring, certification schemes and quality controls[56].

4.2 Financial incentives

Codes and regulation in sustainable construction are often insufficient if the availability of financial resources for entrepreneurs and end-consumers is lacking. Different fiscal and financial instruments are therefore often used to complement environmental regulations. The most common working principle is a price-based mechanism, which endeavours to incorporate external environmental costs and benefits arising from production and consumption activities into services and products prices by means of taxes, charges, subsidies, grants rebates and preferential loans.

Effective financial instruments to promote sustainable construction include subsidies targeting end consumers. Subsidies can be used to improve overall energy and water consumption in buildings through targeting them at residential investments in improved insulation (wall, roof and glazing), improvement or replacement of heating or cooling installation, installation of renewable energy-

[56] Different participatory strategies to promote sustainable construction through public policy and regulations are provided in ILO (2011 Draft): *Formulating Projects and Studies Concerning Labour Issues in Greening the Sectors of the Built Environment*; and (ILO 2010): *Green Jobs Creation through Sustainable Refurbishment in Developing Countries*.

based systems for water heating or electricity generation, improvement of plumbing system in large residential houses, and installation of rainwater tanks. Grants and preferential loans are also effective to promote sustainable construction enterprises, especially by targeting small and medium-sized enterprises (SMEs) and start-up companies entering the sector.

Currently, there are no effective financial incentives in place in Gaza to encourage end consumers to invest in sustainable construction or refurbishment, and limited financial resources available for enterprises trying to enter the market. Such incentives are particularly needed in order to encourage investments in energy-efficiency improvements and installation of renewable energy systems in residential houses, especially to lower the initial costs of photovoltaic (PV) solar panels, and also to support businesses and service providers in energy-efficient retrofitting, window glazing, and in manufacturing, installation and maintenance of renewable energy systems. The deployment of targeted financial instruments, including subsidies and grants, to support sustainable construction in Gaza should therefore be seriously considered, and could be supported through both national and local governmental bodies. Considering the fiscal situation in Gaza, it is important that international organizations and donors also play a key role in supporting such financial incentives.

4.3 Skills training for green jobs

An important aspect in creating an enabling environment for sustainable construction in Gaza is in skills provision and training. In many contexts, the availability of skills and training opportunities largely define the limits in what can be achieved in sustainable construction. Without sufficient high quality professional-level skills in sustainable construction among architects and engineers, the performance in terms of materials, energy and water consumption of new buildings intended to be green may be compromised, and designs that achieve high standards of efficiencies may be prohibitively expensive to build. Without sufficient skills in sustainable construction among skilled construction workers, ineffective practices and uneven quality may greatly slow the progress of green housing or retrofitting schemes. Inadequate skills and awareness among policymakers may also render schemes intended to promote sustainable construction ineffective.

While skills shortages can retard the development of sustainable construction, a strong supply of skills can itself help to drive sustainable construction forward, making skills-led strategies for green buildings viable. Initiatives that seek to develop sustainable construction skills at manual and professional levels have often created pools of skilled people with a strong interest in promoting, selling and delivering sustainable construction projects out of their own economic self-interest, either through broadening the services they already provide or through establishing new businesses. Skills for sustainable construction can therefore be a very good investment.

Skills gaps and further training needs in Gaza are found on all occupational skills levels relevant to sustainable material, energy and water-use in buildings. Further teaching and training on different sustainable construction solutions and technologies are needed for architects and construction and environmental engineers; for specialists in recycling, renewable energies and water conservation; different occupations installing and maintaining energy-efficiency and renewable energy systems; as well as for workers applying alternative materials and sustainable construction building designs. In order to meet these needs, it is recommendable that a broad skills strategy for sustainable

construction would be developed and that specific modules on sustainable construction are incorporated in the curricula of relevant vocational training centres, community colleges and university departments. To further support needed skills development, targeted training courses in specific fields of sustainable construction should be offered, and further complemented through different on-the-job training programs and schemes[57].

4.4 Decent work and occupational safety and health

Green jobs are by definition also decent work, i.e. good jobs which offer adequate wages, safe working conditions, job security and social protection, reasonable career prospects, and workers' rights, including freedom of association. There are today millions of jobs in sectors that are nominally in support of environmental goals but whose day-to-day reality is characterized by extremely poor practices, exposing workers to hazardous substances that endanger their health and lives and involve indecent labour conditions. Any measure related to green jobs, needs therefore to be fully attentive to these problems and work towards their improvement and assure that the green jobs created also are decent.

The need to emphasize decent work is of particular importance in the construction sector in Gaza. Currently there are neither proper standards in place nor any efficient monitoring of working conditions in the construction sector in Gaza. As sustainable construction is a relatively new field in Gaza, involving several new occupations and skills, opportunities also emerge for promoting enhanced working conditions and standards. On the other hand, a transition towards sustainable construction also involve new occupational hazards and considerations involved in handling alternative materials and installation, repairs and maintenance of new technologies. It is therefore strongly recommended that elements relating to decent work are incorporated in all measures promoting sustainable construction and green jobs in Gaza, and that this is done through effective collaboration with both workers' unions and employers' organizations. Such measures should target especially training and awareness-raising on occupational safety and health in construction, freedom of association, social protection as well as gender equality. All measures to promote decent work in construction should further be complemented through effective labour inspection as well as measures to support trade union activities[58].

[57] The ILO, in collaboration with the European Commission, has carried out extensive research on skills for green jobs, including ILO & EC (2011): *Comparative Analysis of Methods and Identification of Skills Needs on the Labour Market in Transition to the Low Carbon Economy*; ILO & EC (2011): *Skills and Occupational Needs in Green Building*; and ILO & EC (2011): *Skills and Occupational Needs in Renewable Energy*. The ILO has also developed specific skills training material in the field of sustainable construction, including ILO & LSES (2010): *Operation, Installation and Maintenance of Solar Water Heaters* (in Arabic) and ILO (2007): *Start Your Own Waste Recycling Business.*

[58] The ILO and other organizations have developed several publications and manuals regarding Decent Work and Green Jobs. Of particular importance to sustainable construction are: ILO (2011): *Promoting Decent Work in a Green Economy – ILO Background Note*; ILO (2011): *Climate Change and Labour: The Need for a "Just Transition"*; ILO (1995): *Safety, Health and Welfare on Construction Sites – A Training Manual*; and EU-OSHA (2011): *Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020.*

4.5 Value-chain and enterprise development

Promoting sustainable construction in Gaza can also be achieved through value-chain and enterprise development. Value-chain analysis is used to analyse economic sectors to understand the actors, processes and relationships within a given value chain, and provide a basis upon which to make evidence-based recommendations for interventions and policy. The Green Jobs Value-Chain Development methodology, developed by the ILO, seeks to integrate this approach with an assessment of the environmental and social outcomes generated by a given sector, with the aim of creating employment that is environmentally, socially and economically sustainable. Value-chain development can be combined with Life-cycle Analysis, as well as Employment-Intensive Methods, to further improve the environmental performance of different sectors as well as to optimize the employment output in these sectors[59].

A central element in value-chain development is the small and medium-sized enterprises (SMEs) that operate within them and that provide services to the end users. Especially in developing countries, small enterprises and start-up companies regularly lack sufficient capacities and knowledge of running businesses, and therefore often under-perform in terms of output, competitiveness and employment. Small enterprises typically also lack sufficient practices and have only limited knowledge of environmental standards and performance.

In order to support sustainable construction in Gaza, it is therefore recommended that comprehensive value-chain analysis, with focus on generating green jobs, is carried out in the sector. Such analyses can target the whole construction value-chain, thus identifying in more detail the needs and potentials for different sustainable construction interventions, or focus on relevant sub-sectors in Gaza, such as manufacturing of alternative building material or manufacturing, installation and maintenance of solar water heaters. Such analyses should be further complemented with targeted measures to support entrepreneurship training, capacity-building of existing SMEs as well as measures to promote the greening of existing businesses[60].

4.6 Social dialogue and awareness raising

Informed social dialogue and awareness raising are also essential for harnessing the development opportunities of sustainable construction and green jobs in Gaza. As both sustainable construction and green jobs are relatively new concepts in Gaza, lack of awareness among the key stakeholders and general public can be a constraint in introducing new methods, technologies and solutions in Gaza. Considering the multi-disciplinary nature of issues at hand and the multitude of actors involved in sustainable construction and green jobs, there is a need to work together with different international organizations and agencies, national and local government authorities, and other key stakeholders in identifying needed interventions and advancing the sector. Social dialogue, involving workers' and employers' organizations, is also crucial in promoting employment in the sector, especially with regards to identifying needed skills and enhancing occupational safety and health and

[59] See further ILO & ODI (2010 Draft): *Value Chain Development for Green Jobs – an ILO Guide.*

[60] Within green entrepreneurship, the ILO has integrated green modules within its training packages on Start Your Business (SYB), Simplified Start Your Business (SSYB), as well as Know About Business (KAB), which seek to provide support to entrepreneurs and SMEs in greening existing business activities and starting new business in green sectors. Further relevant research on the topic include: ILO (2011): *Mainstreaming environmental issues in sustainable enterprises: An exploration of issues, experiences and options*.

decent work. Equally important is raising public awareness on the potential economic, environmental as well as social benefits of sustainable construction. There is both a need to raise awareness in schools and through the media of environmental challenges relating to energy and water use, as well as to increase the public knowledge of different possibilities and solutions offered through sustainable construction to address these, especially with regards to new technology relating to energy-efficiency and renewable energies.

ISBN 978-92-2-126304-3