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CES-MED
CLEANER ENERGY SAVING MEDITERRANEAN CITIES

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# Jordan
## Municipality of Karak
# Sustainable Energy & Climate Action Plan (SECAP)

This Sustainable Energy and Climate Action Plan has been developed by the Consortium of Institute of Communication and Computer Systems (ICCS) – National Technical University of Athens (Greece) and National Energy Research Center (NERC) (Jordan) and it was led by the ICCS.

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human dynamics
public sector consulting

NERC
National Energy Research Center

ΕΜΠΕΥ
ICCS

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| | |
|---|---|
| BAU | Business As Usual |
| BEI | Baseline Emissions Inventory |
| EF | Emission Factor |
| HDD | Heating Degree Days |
| ICCS | Institute of Communications and Computer Systems |
| IEA | International Energy Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| JRC | Joint Research Center |
| LPG | Liquefied Petroleum Gas |
| MEMR | Ministry of Energy and Mineral Resources |
| NERC | National Energy Research Center |
| NTUA | National Technical University of Athens |
| SECAP | Sustainable Energy and Climate Action Plan |

# Executive Summary

Al-Karak lies 140 kilometers to the south of Amman on the ancient King's Highway. It is situated on a hilltop about 1,000 meters above sea level and is surrounded on three sides by a valley. Al-Karak has a view of the Dead Sea. Karak is the largest City in Greater Karak Municipality and it is considered its capital. Karak's main economic activities are around three sectors: Agriculture (cereals, fruits and vegetables), livestock and poultry farming and business activities.

The municipality's main development challenges include limited natural resources and a stagnant economy. In addition, Karak faces problems in the escalating energy bill and thus is trying to secure sources of renewable energy.

The local authority has agreed to participate in the CES MED activities from the launch of the project in the country. The SECAPs' launch in Karak was realized on the 21st of July 2016.

Karak municipality has committed to a 14% reduction of the municipality's GHG emissions as well as to an adaptation in climate change, in line with the national commitments for 2030. The involvement of all citizens and stakeholders of the municipality is considered crucial for achieving the set targets. The citizens are the most important resource for the city, especially in the GHG saving targets. The overall reduction target of Karak region is 59,009.75 tn $CO_2$ up to 2030 compared with the BAU scenario. This amount regards the 14% reduction target scenario according to the Intended Nationally Determined Contribution (INDC), supported by GIZ. Within the framework of potential participation in the Covenant of Mayors for Climate and Energy Initiative, another scenario of mitigation actions has been developed for Karak, reaching up to 40% against the calculated 2030 emissions (168,599.28 tn $CO_2$). The achievement of this scenario is conditional upon the funding availability from grants, international donors and financing institutions.

Regarding the total budget for the SECAP's implementation, for the 1st scenario (14%) the total cost is 94.5 million JOD, namely for the Municipality is 25.1 million JOD approximately whereas for the private sector is around 69.4 million JOD. For the 2nd scenario (40%) the total cost for the Municipality is calculated at 25.7 million JOD, while for the private sector has been estimated at 180.9 million JOD approximately, resulting in an overall budget of 206.6 million JOD.

The energy balance for Karak Municipality (Baseline Emissions Inventory) has been developed for 2014, in line with the CoM guidelines and utilizing the IPCC emission factor approach, for all the compulsory sectors and one optional, namely:

- Municipal Buildings, Equipment & Facilities;
- Municipal Public Lighting;
- Residential Buildings;
- Tertiary Buildings, Equipment & Facilities;
- Transport (Municipal / Public / Private);
- Solid Waste Management.

Although the agricultural sector is a significant contributor in the municipality's economy, it wasn't possible to identify separately reliable data on its energy consumptions, so as to include it in the Baseline Emission Inventory (BEI). To this end, it has been studied as part of the tertiary sector.

The highest energy consumer is the Residential sector, followed by the Tertiary sector and Private Transport, while the municipal sector consumptions are the lowest. The total energy consumption in Karak Municipality is presented in the following spider chart:

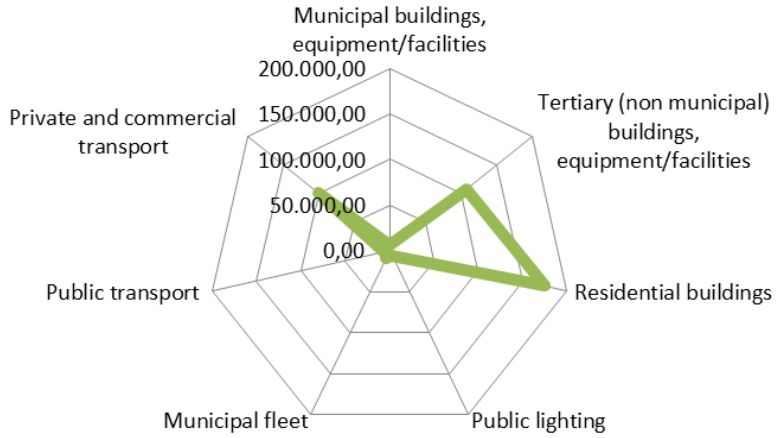



Figure 1: Energy consumption per sector in Karak Municipality

The Municipality, including the Municipal Buildings, the Public Lighting and the Municipal fleet consumes 20,193 MWh, while the fleet's consumption has the most significant contribution, as presented in the next figure.

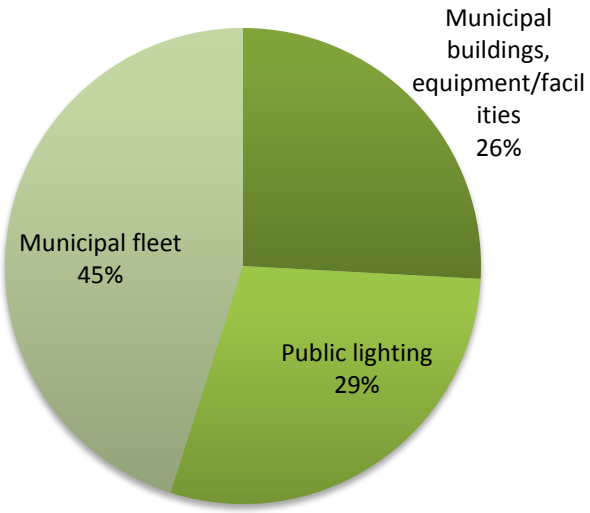



Figure 2: Energy consumption allocation of Karak Municipality's services

Regarding the total energy consumption, all the sectors in Karak Municipality consume 410,368 MWh. Each sector's contribution is presented in the following pie chart (Municipality share includes Municipal buildings, Municipal fleet and Public Lighting).

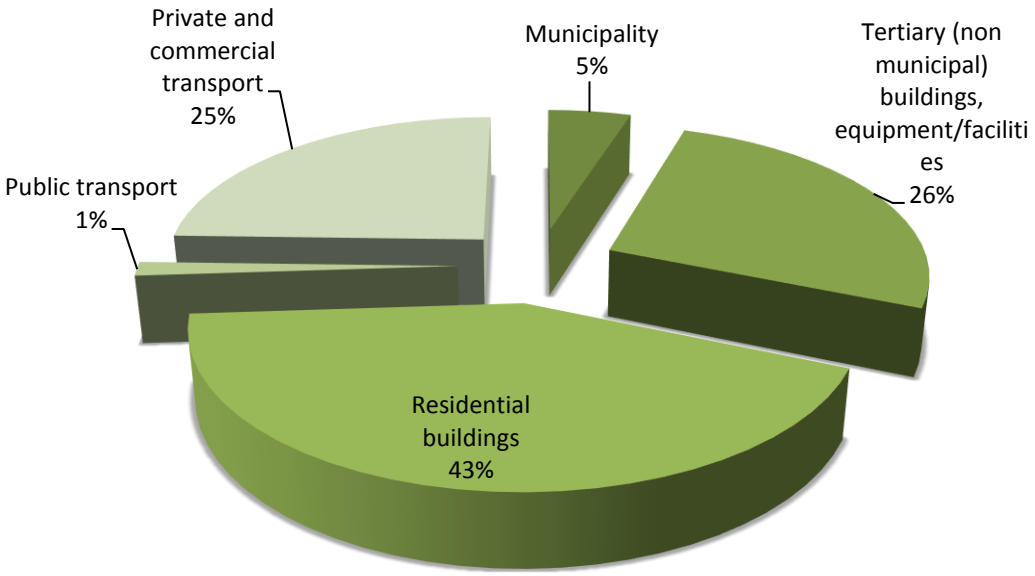



Figure 3: Energy consumption allocation per sector

A more detailed allocation of the calculated energy consumption in Karak Municipality is presented in the next figure per sector and per fuel.

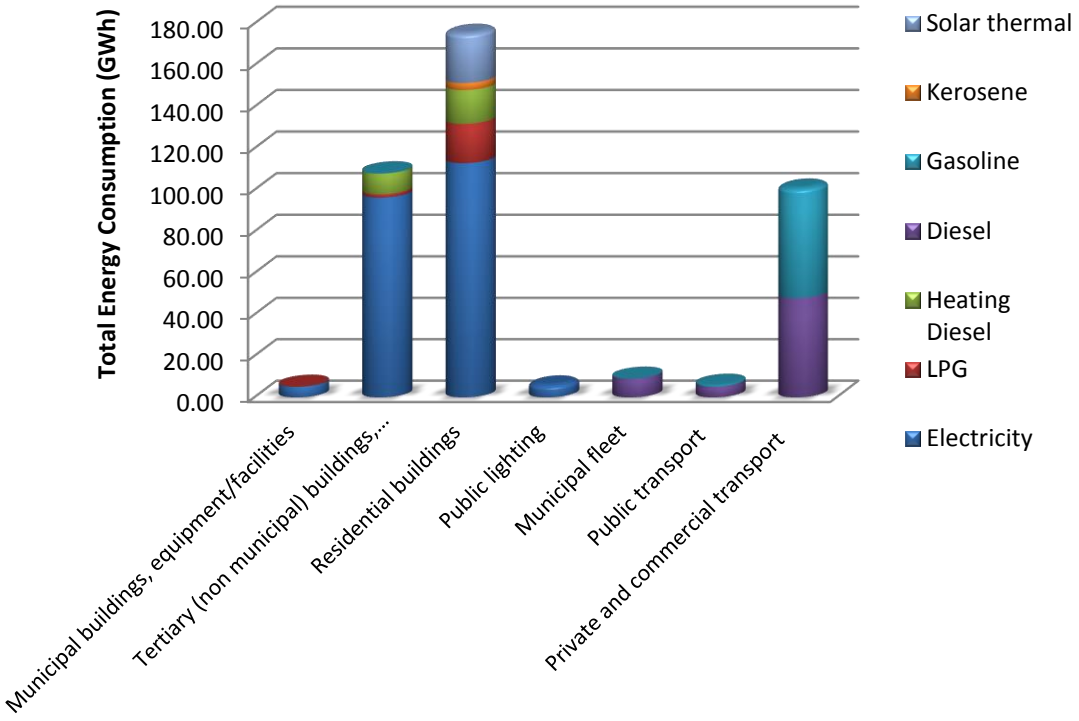



Figure 4: Energy consumption per sector and per fuel

The respective total emissions for the baseline year, including emissions from waste management, equal 250,892 tn $CO_2$ and they are presented in the following chart.

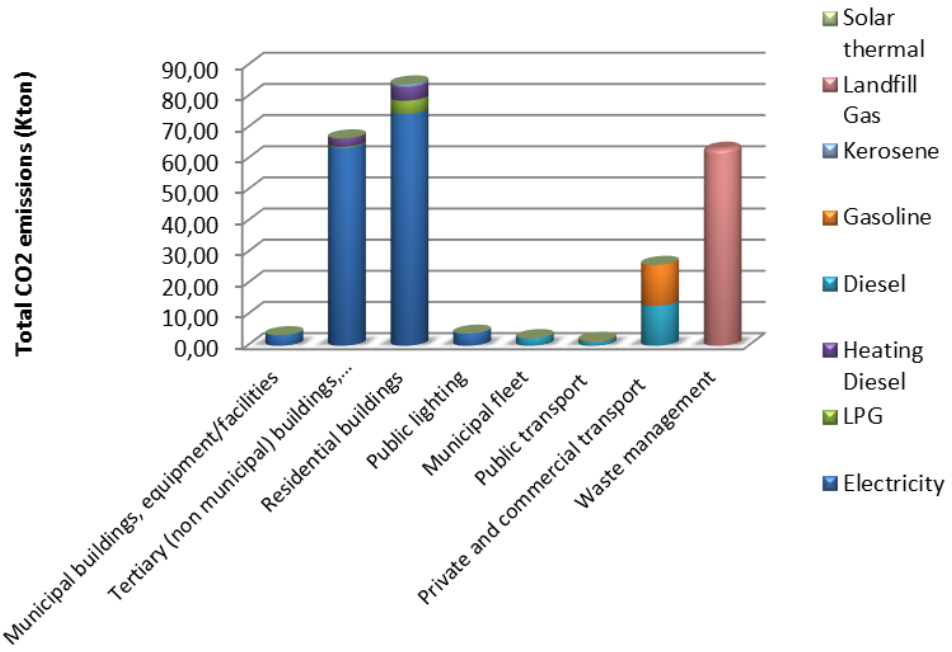



Figure 5: Total $CO_2$ emissions per sector & per fuel

In order to set the emission reduction targets, they have to be calculated against the Business as Usual (BAU) scenario, in line with the JRC guidelines for South Municipalities, considering that Jordan, as a country with developing economy, will face an increase in its energy demand due to the expected economic and population growth. Thus, the forecasted emissions under the BAU scenario for 2030 have been calculated to be 421,498 tn $CO_2$. As mentioned above, 2 different emission reduction target scenarios have been developed, one scenario for 14% and another one for 40%.

An overview table of the actions per sector, as well as the calculated emission reductions per action for both scenarios, is presented below.

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| Municipal buildings | 1.1 | Green procurement procedures for municipal buildings and facilities | 428,79 | | 282,57 |
| | 1.2 | Energy manager appointment in the municipality | 25.52 | | 16.82 |
| | 1.3 | Awareness raising activities for municipal employees | 81.67 | | 53.82 |
| | 1.4 | Adoption of bioclimatic principles in municipal buildings /Strict application of green building codes in municipal buildings | 433.89 (14%) | | 285.93 (14%) |
| | | | 1,041.34 (40%) | | 686.24 (40%) |
| | 1.5 | Efficient municipal buildings | 1,500.00 | 850.00 | 1,549.00 |
| | 1.6 | Promotion of recycling | | | 1,592.17 |
| | 1.7 | Waste management | | 14,400.00 | 31,338.00 |
| | 1.8 | PV plant 3 MW (for municipal buildings and street lighting) | | 5,098.00 | 3,359.58 |
| | 1.9 | Establishment of Energy Saving Department | | | 0.00 |
| | 1.10 | Web portal creation | | | 0.00 |
| | | Total | 2,469.87 (14%) | 20,348.00 | 38,477.90 (14%) |
| | | | 3,077.32 (40%) | | 38,878.21 (40%) |

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| Street Lighting | 2.1 | Street lighting upgrade | 3,893.50 | | 2,565.82 |
| | 2.2 | Astronomical timers | 1,479.79 | | 975.18 |
| | 2.3 | Green procurement procedures for the future lighting equipment | 1,996.54 | | 1,315.72 |
| | | Total | 7,369.82 | 0.00 | 4,856.71 |
| Residential Buildings | 3.1 | Awareness raising activities for modification of the residents' consumption behavior | 4,266.58 (14%) | | 2,811.68 (14%) |
| | | | 4,740.65 (40%) | | 3,124.09 (40%) |
| | 3.2 | Promotion of Green Buildings' concept / Strict application of the building code | 3,837.67 (14%) | | 2,529.02 (14%) |
| | | | 30,701.35 (40%) | | 20,232.19 (40%) |
| | 3.3 | Campaign for promoting high energy label equipment and other awareness activities | 4,266.58 (14%) | | 2,811.68 (14%) |
| | | | 7,110.97 (40%) | | 4,686.13 (40%) |
| | 3.4 | 2MW/10 MW Photovoltaics in residential rooftops | | 3,397.13 (14%) | 2,238.71 (14%) |
| | | | | 16,985.64 (40%) | 11,193.54 (40%) |
| | 3.5 | Replacing existing electric water heater with solar collectors | | 27,521.70 (14%) | 18,136.80 (14%) |
| | | | | 41,282.55 (40%) | 27,205.20 (40%) |
| | 3.6 | Replacement of existing lamps with LEDs | 1,210.56 (14%) | | 797.76 (14%) |
| | | | 3,631.68 (40%) | | 2,393.27 (40%) |
| | 3.7 | Replacement of existing air-conditioners with more efficient ones | 5,502.54 | | 3,626.17 |
| | 3.8 | Use of cool colors in rooftops | 489.11 | | 322.33 |
| | 3.9 | Replacement of single glazing with double | 351.82 | | 153.33 |
| | | Total | 19,924.87 (14%) | 30,918.83 (14%) | 33,427.48 (14%) |
| | | | 52,52812 (40%) | 58,268.19 (40%) | 72,936.25 (40%) |
| Tertiary buildings | 4.1 | Seminars and trainings on selected professional groups | 247.85 | | 163.33 |
| | 4.2 | 10% energy reduction campaign in commercial buildings-Energy friendly label | 165.23 | | 108.89 |
| | 4.3 | Promotion of green buildings concept | 401.28 (14%) | | 264.44 (14%) |
| | | | 4,681.61 (40%) | | 3,085.18 (40%) |
| | 4.4 | Campaign for promoting high energy label equipment | 660.93 | | 435.56 |
| | 4.5 | 10/20 MWp Photovoltaics in rooftops | | 16,985.64 (14%) | 11,193.54 (14%) |
| | | | | 33,971.28 (40%) | 22,387.07 (40%) |
| | 4.6 | Replacing existing electric water heater with solar collectors | | 47.31 (14%) | 31.18 (14%) |
| | | | | 78.86 (40%) | 51.97 (40%) |
| | 4.7 | Replacement of existing lamps with LEDs | 1,785.11 (14%) | | 1,176.39 (14%) |
| | | | 5,355.33 (40%) | | 3,529.16 (40%) |
| | 4.8 | Replacement of existing air conditioners with more efficient ones | 663.88 | | 437.50 |

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| | 4.9 | Use of cool colors in rooftops | 354.07 | | 233.33 |
| | 4.10 | Installation of lighting automations & thermostats | 627.00 | | 413.19 |
| | 4.11 | External shading installation | 265.55 | | 175.00 |
| | 4.12 | Upgrade water facilities | 4,600.86 | | 3,031.97 |
| | 4.13 | Awareness raising campaigns for pupils/ students | 89.42 | | 58.93 |
| | 4.14 | The 10% voluntary campaign for energy reduction in schools | 6.00 | | 3.95 |
| | | | 9,867.20 (14%) | 17,032.95 (14%) | 17,727.20 (14%) |
| | | Total | 17,717.76 (40%) | 34,050.14 (40%) | 34,115.04 (40%) |
| Municipal fleet | 5.1 | Replacement of old municipal diesel vehicles with new efficient vehicles | 1,079.00 | | 288.00 |
| | 5.2 | Installation of Global Positioning System devices for more efficient management of the fleet and better planning routes | 764.28 | | 203.91 |
| | 5.3 | Municipal fleet maintenance (for the existing & the new ones) | 993.56 | | 265.09 |
| | 5.4 | Eco-driving seminars for the drivers of the municipal fleet | 1,222.85 | | 326.26 |
| | | Total | 4,059.69 | | 1,083.26 |
| Private & Commercial Transport | 5.5 | Information events on the new vehicle technologies | 0.00 | | 0.00 |
| | | *Replacement of gasoline vehicles with Hybrid* | *2,661.73* | | *662.77* |
| | | *Replacement of diesel vehicles with new more efficient* | *1,609.16* | | *429.65* |
| | 5.6 | Improve public transportation/ promote the use of public transport | 4,436.22 | | 1,104.62 |
| | 5.7 | Promotion of walking and car sharing and carpooling campaigns | 3,726.42 | | 927.88 |
| | 5.8 | Improvement / development of parking infrastructure | 3,992.60 | | 994.16 |
| | 5.9 | Promotion of eco-driving for the private and commercial transport | 5,079.23 | | 1,308.17 |
| | 5.10 | Transportation master plan | 0.00 | | 0.00 |
| | | Total | 21,505.35 | | 5,427.24 |
| Public transport | 5.11 | Promotion of eco-driving for public transport's drivers | 405.62 | | 107.09 |
| | 5.12 | Promotion of new technology buses in the public transportation | 84.62 | | 22.59 |
| | 5.13 | Replacing the existing Taxi vehicles with Hybrid vehicles | 49.69 | | 12.37 |
| | | Total | 539.93 | | 142.06 |
| | | *Total transportation* | *26,104.98* | | *6,652.57* |
| Local Renewable | 6.1 | Wind Farm 3 MW | | 10,256.41 (both scenarios) | 6,758.97 (both scenarios) |
| | 6.2 | Wind farm 2 MW | | 6,837.61 (40%) | 4,505.98 (40%) |
| | | Total | | 17,094.02 (40%) | 11,264.96 (40%) |
| | | ***TOTAL*** ***14%*** | ***65,736.74*** | ***78,556.19*** | ***107,900.84*** |
| | | ***40%*** | ***106,798.00*** | ***129,760.35*** | ***168,703.74*** |

It should be highlighted at this point that the total reduction potential of the actions envisaged under the 14% scenario, reaches 25.37% of the BAU emissions. And an additional 14.5% is

achieved based on the actions suggested under the 40% reduction scenario.
Karak Municipality acknowledges that some of the actions are more important than the others since they seem to be of high priority. For this reason, these actions have been analyzed separately in details. Five "Project Fiches" have been developed and are presented in Chapter 5, while an overview is provided in the next table.

Table 1: Project fiches

| Project Fiches | Emissions reduction (tn $CO_2$) | Contribution to emissions reduction target | | Cost (JOD) |
|---|---|---|---|---|
| | | 1st scenario (14% target) | 2nd scenario (40% target) | |
| Replacing non efficient Lamps with LED Lamps for the street lighting | 2,566 | 4.35% | 1.52% | 3,378,000 |
| 3 MW PV Station installation | 3,360 | 5.69% | 1.99% | 2,500,000 |
| Replacing the old Municipal diesel vehicles with new efficient vehicles | 288 | 0.49% | 0.17% | 659,464 |
| Bio Waste Management | 31,338 | 53.11% | 18.59% | 9,000,000 |
| Making the Municipal Buildings Green | 1,549 | 2.62% | 0.92% | 1,288,056 |
| **Total** | **39,101** | **66,26%** | **23.19%** | **16,825,520** |

The fourth Chapter of the SECAP concerns the Adaptation to climate change. The last 20 years significant changes in the global climate have occurred which negatively affect life in many aspects. This section presents the current situation in Karak and the expected problems due to the climate change impacts. Subsequently a set of actions are proposed towards the city protection against the forecasted extreme weather events. Jordan has already launched the "Jordan's Third National Communication on Climate Change" report in 2014, which is dealing with the above mentioned topic. The national targets presented on this report are consistent with the SECAP actions. The total estimated budget for this set of actions is 2,200,000 JOD. An overview table of the actions per sector is presented below.

Table 2: Adaptation Actions

| Public health | Infrastructure | Built Environment | Economy | Biodiversity |
|---|---|---|---|---|
| Health action plan for the extreme events | Water management plan | Enforcement of building codes for more energy efficient and heat tolerant structures | Elaboration of water and ground water management plan | Educating the citizens |
| Provide access to public buildings during extreme events | Modelling predicted supply changes in the electricity from the locally available RES | Integrated land use planning with zoning system depending on the different areas | Adoption of integrated land use planning for the tertiary | Trees planting |
| Developing an early warning system to alert citizens in the case of extreme weather events | Mapping of sites with landslides and flood risks | Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises | | |
| Educational and awareness raising campaigns about health-related effects of extreme events | Developing guides and awareness raising campaigns for citizens on how to save water and energy, especially during crisis | Greening infrastructure such as buildings' roofs and walls | | |
| Regular cleaning and maintenance of the sewage and drainage system | Integration of sustainable drainage systems | Increasing the amount of shade and green areas in the city by planting trees and using green pavements to reduce the heat island effect | | |
| | | Building exemplary districts with adapted urban forms and buildings | | |
| | | White roofs (cool colors), shading and bioclimatic design | | |
| | | Rainwater collection and use | | |
| | | Adoption of methods to reduce water demand | | |

# Chapter 1: Introduction

## 1.1 Karak 2030 Targets

The Ministry of Planning and International Cooperation (MOPIC) is collaborating with the "Cleaner Energy Saving Mediterranean Cities - CES MED" project (financed under the EUROPAID Programme), in order to support selected municipalities in Jordan in their effort towards energy sustainability.

Karak Municipality has been selected as one of the three cities to be supported by the CES MED program at the national level. Karak acknowledges the need to counteract the increasing energy demand and its harmful impacts on the environment and thus the Municipality has agreed to the national target on the emission reductions. At the same time Karak Municipality has studied a 2$^{nd}$ scenario of setting a higher emission reduction target, within the framework of the Covenant of Mayors for Climate and Energy initiative, which is conditional upon the funding availability.

The overall target that has been set for 2030 is 14% $CO_2$ emissions reduction (according to the Intended Nationally Determined Contribution - INDC). The second scenario developed focuses on achieving an emission reduction of 40%. Under both scenarios, emphasis is placed on working closely with all community actors. The municipality will take all necessary measures on its facilities, establishing a good example for the community, while it will put efforts on collaborating with the public and achieving significant reductions from the residential, tertiary and transport sectors, with waste being also a priority for the local administration. The target of 40% is more challenging and there will be need of more intensive efforts from the Municipality and the Governmental Bodies while it is of utmost importance to attract more donors and funds.

## 1.2 Current status

### 1.2.1 Geographical location

Karak is the capital city of Karak Governorate in eastern Jordan. It lies 140km to the south of Jordan capital, Amman, while it is located on a hilltop 1,000 meters above sea level, surrounded on three sides by a valley, on the western edge of the Karak Plateau. Its area extends to 765 km$^2$. The boundaries of the Governorate are defined by the Dead Sea to the west, Wadi El Mujib to the north, Wadi El Hasa to the south, and the boundary of Ma'an Governorate to the east.

Greater Karak Municipality (GKM) was established in 1893 by an Ottomans Law and other rural councils were merged with it as the years passed. [1]


Figure 6: Karak map

The city is known for its Crusader castle, the Karak Castle, which is the largest one between the three castles in the region. It is a 12th century Crusader-era fortification which nowadays operates as a visitor attraction. The castle's construction began in 1142 and was completed after 20 years. It contains a maze of corridors and chambers. A characteristic picture of it is presented in Figure 7. [2]

Figure 7: Karak castle

### 1.2.2 Climate characteristics

The weather in Jordan is almost exclusively dry and sunny from May to October, where there is barely any rainfall. Jordan is a very sunny country, with over 310 days of sunshine a year. The rainy season begins at the end of November and continues till the end of March. Nonetheless, rainfall is sporadic even then, which is the main reason that Jordan faces such

severe water scarcity. The climate in Karak is warm with winters rainier than summers. The average annual temperature is 16.5°C and the average annual precipitation is 359 mm. [3]

Although the average wind speed is 2.1 km/h, winds can be relatively high on occasions, and when they blow from the desert, they are cold in winter and hot and dusty in the summer. Winds are predominantly from the west and southwest and they provide some cooling during the summer, especially on the higher areas around Karak. [4]

In the next table and graphs, data is presented regarding the monthly temperature and precipitation in Karak.

Table 3: Monthly temperatures and precipitation in Karak

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min Temp.(°C) | 3.1 | 4 | 5.8 | 9 | 12.2 | 14.9 | 16.8 | 17.2 | 15.1 | 12.4 | 8.4 | 4.4 |
| Max Temp.(°C) | 12.3 | 13.9 | 17.1 | 21.8 | 26.5 | 29.8 | 31.6 | 31.8 | 29.6 | 26.2 | 19.6 | 14.1 |
| Average Temp.(°C) | 7.7 | 8.95 | 11.45 | 15.4 | 19.35 | 22.35 | 24.2 | 24.5 | 22.35 | 19.3 | 14 | 9.25 |
| | | | | | | | | | | | | |
| Precipitation (mm) | 86 | 75 | 68 | 17 | 4 | 0 | 0 | 0 | 0 | 5 | 32 | 72 |

Considering the climate conditions in Karak area, and the average desired temperature for internal conditions to be 21°C, the heating degree days for the area are calculated to be approximately 1,892 HDD.

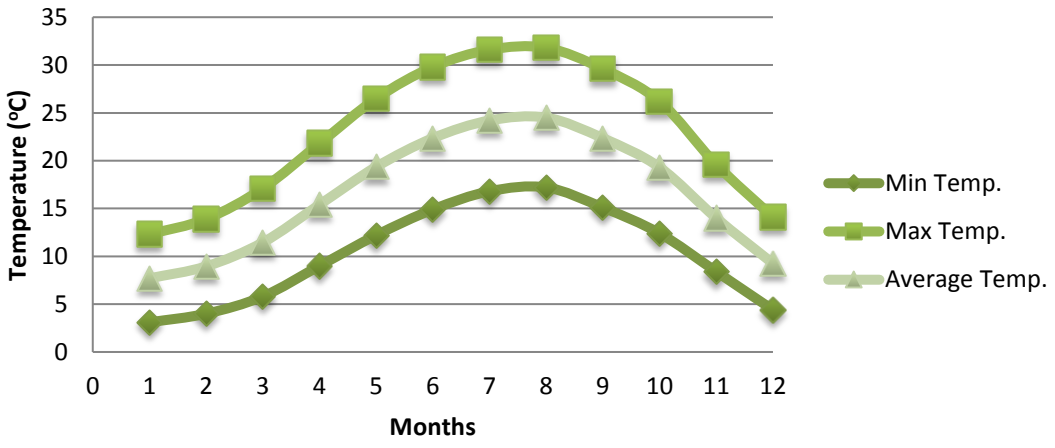



Figure 8: Monthly Temperatures in Karak

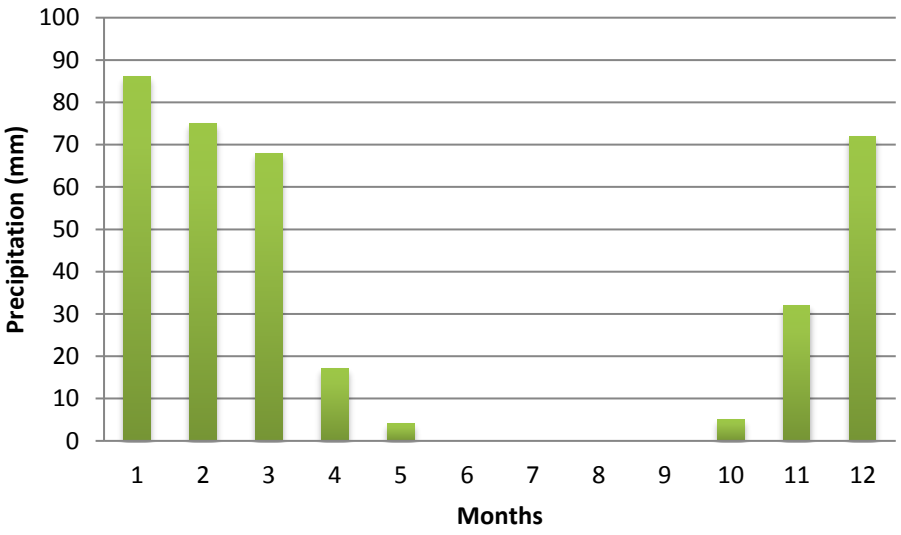



Figure 9: Monthly Precipitation in Karak

### 1.2.3 Demographic tendencies

According to the last population census of 2015, the population living in Karak Governorate was 315,998, consisting of 48% women and 52% men. For the same region, the population in 2004 was 203,595 which means that there has been a significant rise of 55% in only 11 years [5]. Concerning the population at the Karak Municipality level, this rises up to 114,000.

Also, Karak Governorate presents one of the highest Christian percentages in the country, approximately 25%, while the rest of the population is Muslim.

### 1.2.4 Employment

The employees in Karak Governorate comprise approximately 37% of its population over 15 years of age, according to the most recent population census. In the part of economically active citizens there is a 15% percentage that is currently unemployed and looking for a job. An important mention is that only a population percentage of 17% (ages under 15 not included) are economically active women. (2015) [5]

### 1.2.5 Education

Regarding the educational status of Karak Governorate's citizens, a percentage of 32% of the total population was enrolled in the education in 2015, the majority of which (69%) was in primary education and only 13% in the highest education levels (Diplomas, Masters, PhD etc.). Considering two population groups, the first one between 4 and 25 years old and the second one older than 25 years old, the following assumptions can be extracted:

- In the first age group, which comprises a little over than half the governorate's population (52%), almost 8.4% has not enrolled, while another 67% is currently following educational courses at all levels. The remaining 24.6% had enrolled in courses in the past, but has now either completed or terminated his education.
- In the second age group, almost 20% has received no education at all, another 1% is currently enrolled, while the rest of the population (79%) has received education. [5]

### 1.2.6 Infrastructures

The registered households in Karak Governorate are 63,490, of which there are 59,868 housing units in conventional buildings, according to the 2015 population census.

The Governorate provides a public network for access in water and drinking water. 99% of the housing units have access in the water network, of which however only 56% has access to drinking water. The remaining percentage uses, mainly, mineral water for drinking purposes. (2013)

In addition, it seems that there isn't a fully developed public sewage system and thus only 8% of the population has access in the public network. The rest of the housing units are being served by cesspools. (2013) [5]

Karak is accessed by the Desert Highway that connects Amman with the southern regions. The road network in the Governorate consists of 671 Km of paved and unpaved roads, of which 43% are primary roads, 25% secondary roads, and a final 32% village roads. Based on the data, it is evident that the road infrastructure can be further improved, also putting emphasis on increasing the number of parking lots in the city, which currently is not able to efficiently serve the increased numbers of citizens and visitors in the city center. [4]

### 1.2.7 Economy

Agriculture is one of the most important sectors of the regional economy, and it is the Department of Agriculture's aim that farming should continue to develop in a sustainable manner and provide further jobs and improved incomes. About a quarter of the land area of the region is considered suitable for agriculture, although less than 60% of this is actually used. The upland areas account for over 80% of agricultural production, the bulk of it being rain fed crops. Out of a total of over 20,000ha of upland farmland, 16,000ha is in arable production, 3,000ha is devoted to tree crops and a further 1,000ha produce vegetables. The best areas for rain fed agriculture lie fairly close to the Kings Highway, and farming becomes less viable further east as rainfall levels decline.

In addition, livestock and poultry account for a large part of the agricultural resource of the Governorate. The recent expansion of intensive chicken farming in the desert areas west of Al Qatranah, has made the area a large exporter of meat and eggs.

Extensive irrigated farming, predominantly vegetables is undertaken in the Ghor Safi area. Farming in the Dead Sea Escarpment is generally concentrated in the upper wadis, where seasonal rivers and perennial springs are used to support large areas of tree crops, principally olives, and also other crops such as vegetables and fruit. Wadi Al Karak and Wadis Al Mujib and Al Hasa have extensive areas of such planting. Much of the agricultural production of the area is consumed locally, although some surplus produce is sent to the market in Amman, including much of the output of the broiler chicken industry.

Water supplies for certain agricultural crops and forestry are supplemented in the Wadi Al Karak through the use of treated sewage effluent. [4]

### 1.2.8 Complementarity with municipal and national plans and other related actions

Karak's decision for the implementation of a SECAP study is in line with national legal framework, targets, and priority actions set. Abiding with the 14% emission reduction target

by 2030 is consistent with the national target for that period, as expressed through the Intended Nationally Determined Contributions (INDCs) submitted to the UNFCCC.

Under the current legal framework, the municipalities are entitled to the development of their energy policy plans, such as the current study on Sustainable Energy and Climate Action Plan for Karak. In addition, they can influence the energy consumptions related to their own use (buildings, vehicles, street lighting, solid waste and waste water management, water pumping etc.), as well as promote legislative measures for the adoption of the building codes in place, or the use of Solar Water Heaters (SWH).

Karak is also planning for a number of Renewable Energy projects, either in its facilities, or promoting such initiatives in the private sector. RE projects are endorsed by the Renewable Energy and Energy Efficiency Law (REEEL) No. 13 (2012), which is the basis for supporting schemes and other incentives for the private sector to invest in renewable energy.

The National Energy Efficiency Action Plan (NEEAP) is the umbrella regarding energy efficiency at the national level. Some of the most relevant actions for local authorities, as addressed in the NEEAP, include energy labels for home appliances and replacement of compact fluorescent lamps (CFLs) with LED lighting.

## 1.3 Vision for the future

Karak is a growing city that has significantly increased its population over the past years. This trend is expected to continue in the future, even at a lower rate. This population increase trend poses significant pressures on the existing and future infrastructures and the further development of the city.

Karak municipal authority is deeply committed to a sustainable future for the city, in order to make it prosperous for its citizens and sophisticated. This objective is expressed through the actions selected in this SECAP, focusing not only in reducing the energy consumption through energy efficiency, or producing more clean energy, but also on improving the existing infrastructures at the municipal, as well as the city level.

## 1.4 Organizational and financial aspects

### 1.4.1 Coordination with national and local authorities

During the SECAP implementation, Karak Municipality is going to coordinate closely with the affiliated ministries, namely the Ministry of Planning and International Cooperation (MoPIC), which is also the CES MED Focal Point, the Ministry of Environment, especially with regards to the Climate Adaptation actions, as well as the Ministry of Energy and Mineral resources, as relates to the energy efficiency and renewable energy projects and initiatives.

At the same time, Karak will exchange experience with the other two Jordanian cities that have benefitted from CES MED for the development of their SECAPs, namely ASEZA and Irbid, while it will share best practices and experience gained with other municipalities interested in realizing similar activities.

### 1.4.2 Adaptation of administrative structures

The departments that will be engaged with the SECAP are the Electrical division which will be responsible for the energy issues in Municipality, the Local Development Unit which will be responsible for the project development in Municipality and last but not least the Training and capacity building unit which will be responsible for municipal staff's capacity building.

### 1.4.3 Involvement of stakeholders and citizens

Having conducted the analysis of the energy consumption patterns in the territory, it should be highlighted that the municipality is responsible for only 5% of the consumptions realized at the city level. Thus, it is evident that the involvement of all citizens and stakeholders of the private sector is considered crucial for achieving the set targets, for either the 14% scenario, or more importantly the 40% reduction target scenario. A high level collaboration is expected with private investors interesting to realize small or larger scale RES investments in the city, while efforts for close contacts with associations from the tertiary and residential sector will be placed. Moreover, in all schools several programs for GHG emission reduction shall be incorporated.

### 1.4.4 Budget – SECAP financing sources

Regarding the total budget for the SECAP's implementation, for the 1$^{st}$ scenario (14%) the total cost is 94.5 million JOD, namely for the Municipality is 25.1 million JOD approximately whereas for the private sector is around 69.4 million JOD. For the 2$^{nd}$ scenario (40%) the total cost for the Municipality is calculated at 25.7 million JOD, while for the private sector has been estimated at 180.9 million JOD approximately, resulting in an overall budget of 206.6 million JOD.

It should be noted that the 1$^{st}$ scenario costs cover a maximum emission reduction target of 25.4% actually. In case the minimum 14% reduction target is set, this will reflect on the projects' selection and the set priorities, thus affecting the overall costs.

Any action to be implemented will have a clear budget and implementation plan and will be executed pending the approval of the yearly budget, as required by the municipal regulations.

# Chapter 2: Baseline Emission Inventory (BEI)

## 2.1 BEI Methodology

### 2.1.1 Baseline Year

According to the Covenant of Mayors Guidelines for South Signatories, in order to develop the energy balance sheet and consequently specify the $CO_2$ emissions, the year 1990 should be considered as the baseline year. In case where there isn't adequate data for this year, as baseline year should be considered the nearest year to 1990 for which there are complete and reliable data. Thus, for the Karak Municipality the baseline year has been set to 2014, since it was the year with the most sufficient and reliable data available. [6]

### 2.1.2 SECAP administrative body

Following a meeting of the consultants (consortium ICCS/NTUA and NERC) with the Karak representatives, it was made clear that their wish for the SECAP is to cover the administrative boundaries of Karak municipality, and not that of the whole governorate. All the figures provided on the municipal sector concern strictly Karak municipality.

### 2.1.3 Sectors to be included in the BEI

The sectors for which the appropriate data were gathered and calculations for the total energy consumption and $CO_2$ emissions are presented below:

A. Buildings, Equipment & Facilities
   - Municipal Buildings, Equipment and Facilities
   - Public lighting
   - Residential buildings
   - Tertiary buildings, equipment and facilities (non municipal)

B. Transport
   - Municipal fleet
   - Public transport
   - Private and Commercial transport

C. Solid waste management

The industry sector is not included because the collection of its actual data was impossible and it was considered that approaches based on national averages will not be representative of the actual consumptions. This decision was further enforced by the fact that the non ETS industrial sector is an optional sector according to the Guidelines, since the municipality has limited potential on actually reducing its consumptions through convincing the respective key stakeholders.

As regards agriculture, although there is agricultural activity in the region, it has not been possible to separate the consumptions for the specific sector from the tertiary one, and especially the pumping facilities' between irrigation and water pumping.

### 2.1.4 Emission factors and Conversion rates

The emission factors which are used in this SECAP were derived from the Covenant of Mayors Guidebook, with the only exception of the electricity emission factor, which is characteristic for the country. It was not possible to acquire the electricity emission factor for Jordan directly from the Ministry of Energy and Mineral Resources (MEMR), or any of the utilities servicing the country. Therefore, as the best approach to identify it was considered to be the utilization of available statistical data from the International Energy Agency (IEA) and MEMR. To this end, data regarding the emissions from fuel combustion for the generation of electricity and heat from the IEA [7] highlight publication, as well as data regarding the electricity generation from the annual MEMR [8] reports were used, and the EF results as follows:

$$EF = \frac{CO_{2\ emissions\ tot}}{Total\ Electricity\ Production}$$

The available data for 2014 (the baseline year) are presented in the next table:

Table 4: Electricity Emission Factor

| | 2014 |
|---|---|
| $CO_2$ Emissions (tn) | 12,000,000 |
| Electricity Generation (GWh) | 18,207 |
| Electricity Emission Factor (tn/MWh) | **0.659** |

Emissions Factors for each source are gathered in table below.

Table 5: Emission Factors & Conversion Rates

| | Emission Factors (tn $CO_2$/MWh) | Conversion Factors |
|---|---|---|
| Electricity | 0.659 | Not applicable |
| LPG | 0.227 | 13.1 MWh/tn |
| Heating Oil (diesel) | 0.267 | 10 KWh/lt |
| Diesel | 0.267 | 10 KWh/lt |
| Gasoline | 0.249 | 9.2 KWh/lt |
| Kerosene | 0.259 | 790 kg/m3 |
| | | 12.2 MWh/tn |
| Solar (thermal/ PV) | 0 | Not applicable |

Furthermore, emissions from the waste management were calculated according to the IPCC method. Landfilling process creates methane emissions ($CH_4$) which are converted to $CO_2$ emissions according to the equivalence "*1 tn $CH_4$ = 25 tn $CO_2$*".

## 2.2 Energy Consumption

The total amount of energy consumed in Karak Municipality is 410.37 GWh. The allocation of this energy consumption among the different sectors, by fuel type, is presented in the next table. Further analysis of the consumptions per sector is provided in the following sections.

Table 6: Total Energy consumption per sector

| MWh Sector | Electricity | LPG | Heating Oil | Diesel | Gasoline | Kerosene | Solar thermal |
|---|---|---|---|---|---|---|---|
| Municipal Buildings, Equipment, Facilities | 5,104.60 | 117.59 | | | | | |
| Public Lighting | 5,872.16 | | | | | | |
| Residential Buildings | 112,872.60 | 18,864.00 | 16,308.58 | | | 3,373.30 | 23,785.77 |
| Tertiary Buildings, Equipment, Facilities | 96,351.65 | 1,553.33 | 9,931.21 | | 320.01 | | |
| Municipal fleet | | | | 9,000.00 | 98.57 | | |
| Public Transport | | | | 5,037.00 | 999.01 | | |
| Private & Commercial Transport | | | | 47,891.65 | 52,886.65 | | |

### 2.2.1 Municipal Buildings, Equipment & Facilities

This sector includes buildings such as the Municipal Hall, libraries, cultural buildings and health buildings (30 buildings). The initial data given for electricity was provided in the form of annual costs in JOD (Jordanian Dinar, the currency of Jordan), and were appropriately transformed into energy. As for the Liquefied Petroleum Gas, in line with the respective invoices, municipal buildings consume 561 cylinders of 16 kg each. According to the IPCC 2006 guidelines, the calorific value of Liquified Petroleum Gas is 13.1 MWh/tn. More specifically, the consumed energy from LPG is calculated as follows:

$$561\ cylinders * 0.016\ tn * 13.1 \frac{MWh}{tn} = 117.59 MWh$$

The numbers provided in the next table concern electricity, diesel, gasoline and LPG consumptions of this sector in MWh.

Table 7: Energy consumption in Municipal Buildings & Facilities per fuel

| Site Type | Electricity (MWh) | Diesel (MWh) | Gasoline (MWh) | LPG (MWh) | **Total (MWh)** |
|---|---|---|---|---|---|
| **Municipal Buildings** | 5,104.60 | 0.00 | 0.00 | 117.59 | **5,222.19** |
| - Municipal hall | | | | | |
| - Libraries | | | | | |
| - Cultural buildings | | | | | |
| - Health Buildings | | | | | |

According to the above presented data, the electricity consumption in the municipal buildings' and facilities has the lion's share, while LPG use rises up to only 2%, since it is predominantly being consumed for space and water heating, as well as cooking purposes in health buildings.

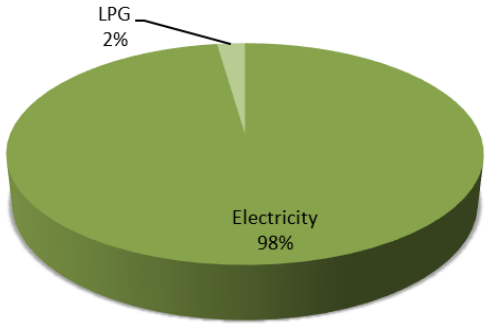



Figure 10: Energy consumption per fuel in Municipal Buildings

### 2.2.2 Municipal public lighting

As far as the municipal public lighting is concerned, this sector is related to the street lighting and public areas' lighting. The electricity consumption for this sector is **5,872.16 MWh** according to the data from bills that were provided. A detailed table with an analysis of the consumptions per geographical area is provided in Appendix A.

### 2.2.3 Residential Buildings

*Electricity*

Karak's households consume electricity for lighting and electrical appliances such as refrigerator, air conditions and others, as well as in space and water heating.

Accurate electricity consumption data from the utility servicing the area is not available. For this reason, approaches based on the national average level have been utilized in order to estimate the electricity consumptions. More specifically, according to NERC's expert opinion, the average household's daily electricity consumption is 12 kWh. This number derives from the calculation that there are approximately 4.4 persons per household and the daily electricity consumption is 2.8 KWh per capita. In addition the number of people per households is calculated from the division of population in Karak with the number of electricity subscriptions. Furthermore, the electricity consumption per capita (2.8 KWh) is the total household electricity consumption divided by the population in Karak. Considering the amount of houses in Karak municipality to be 25,770, the overall consumption is calculated to be 112,873 MWh.

The initial assumptions for the specific consumption indicators used are also verified through the International Energy Agency (IEA), according to which the annual electricity consumption in the residential sector is 0.996 MWh/capita in Jordan which is very close to the calculated 0.990 MWh/capita in Karak municipality.

*Liquefied Petroleum Gas*

LPG is mainly used in cooking and space heating. A smaller amount is also consumed in water heating. According to NERC's expert opinion and verified by Karak municipality's technical service, the households consume around 200 cylinders (16 kg/cylinder) daily for 3 months for

space heating and 200 cylinders daily during the whole year for cooking. According to the IPCC 2006 guidelines, the calorific value of Liquefied Petroleum Gas is 13.1 MWh/tn, and it is thus calculated that the residential sector consumes:

$$(200cylinders * 30days * 3months + 200cylinders * 30days * 12months) * 16kg = 1{,}440{,}000kgr\ LPG$$

$$1{,}440tn * \frac{13.1MWh}{tn} = 18{,}864MWh$$

*Kerosene*

Many households in Karak Municipality use kerosene for heating purposes. The gas stations provided data at the Municipal level, which was 350.000 lt annualy. Kerosene's density, 790 kg/m$^3$, and net calorific value, 12.2 MWh/tn, were used in order to calculate the consumption as follows:

$$350m^3 * 790\frac{kgr}{m^3} = 276{,}500kg$$

$$276.5tn * 12.2\frac{MWh}{tn} = 3{,}373.30MWh\ kerosene$$

*Diesel (heating oil)*

There is also an amount of diesel which is consumed by the residents for space and water heating. This consumption was calculated based on a report with Energy Facts & Figures (2015) from the Ministry of Energy and Mineral Resources. [8] Therefore, since the diesel consumption in households for 2014 is given 81.8 ktoe at a national level, this number will be adjusted to the municipal level. In addition the rate used to convert tons of oil equivalent (toe) to MWh is: "1 ktoe=11,630 MWh", according to the SECAP guidelines. [6]Consequently the diesel consumption in Karak's municipality residential sector is:

$$81.8\ ktoe * 11{,}630\ \left(\frac{MWh}{ktoe}\right) = 951{,}334\ MWh$$ Diesel at national level

$$\frac{951{,}334 * 114{,}000\ \text{inhabitants}}{6{,}650{,}000\ inhabitants(Jordan)} = 16{,}308.58\ MWh\ Diesel\ in\ Karak\ Municipality$$

Since the Heating Degree Days in Karak are very close to that of Jordan in average, no correction of the above figure considering the HDD takes place.

*Solar thermal*

In addition, a great number of households own solar water heaters thus they consume solar power in order to heat water. In order to determine this energy production, data from the Ministry of Energy and Mineral Resources (2014) at a national level are used, namely 1,400,000 MWh production from SWH in households for the entire country.

Subsequently, the solar thermal energy produced per capita was calculated, based on the population owning solar heaters. According to Department of Statistics the 10.88% of Jordan population has solar heaters (723,746 inhabitants), thus the specific production per capita is 1.934 MWh per SWH owner. From national statistics it is known that 10.79% of Karak Governorate population own solar heaters as well. It was assumed that the percentage is the same between the Governorate and Karak Municipality, thus the population with SWH is 12,296 at the municipal level.

Based on the above, the solar thermal consumption at the municipal level is calculated to be 23,786 MWh in 2014.

*Summary*

Gathering all the data of the residential sector, it seems that residents consume 5 distinct energy sources. In the figure below, the final consumption per fuel type for this sector is presented.

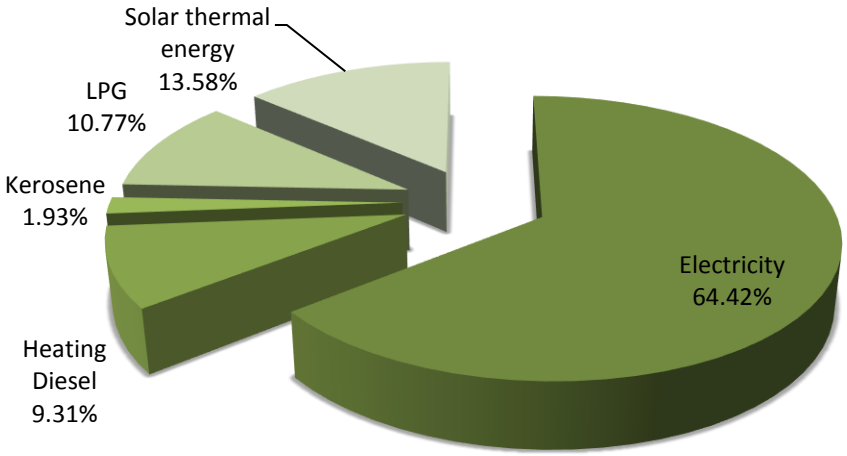



Figure 11: Energy consumption per fuel in Residential Sector

### 2.2.4 Tertiary Buildings, Equipment & Facilities

Tertiary sector includes a number of buildings such as hotels, offices, restaurants, shops, educational buildings, churches, hospitals and water management facilities as well, which provide services to Karak's citizens. It should be noted that water management facilities include facilities for drinking water (water pumping) and irrigation. The number provided was impossible to be disaggregated in order to separate the drinking water from the irrigation facilities for agricultural activities. The data derived from bills that the Municipality provided. In case of two subsectors, offices and shops, a correlation was used based on electricity consumption in Sahab Municipality, the share of population occupied in these sectors and the respective operational hours. The total energy consumption which refers to electricity, diesel, LPG and gasoline was 108,156 MWh in the tertiary sector. In the table below the collected data are presented.

Table 8: Energy consumption in tertiary sector per type of building

| Types of Buildings in the Tertiary Sector | Electricity (MWh) | Diesel (MWh) | Gasoline (MWh) | LPG (MWh) | Total (MWh) |
|---|---|---|---|---|---|
| Hotels | 83.00 | 140.00 | NA | 52.40 | **275.40** |
| Offices | 1,825.63 | NA | NA | NA | **1,825.63** |
| Educational buildings (Universities) | 8,752.47 | 426.84 | NA | NA | **9,179.31** |
| Shops | 5,150.83 | NA | NA | NA | **5,150.83** |
| Restaurants | 380.06 | NA | NA | 1,432.16 | **1,812.22** |
| Schools | 119.00 | 72.00 | 33.12 | NA | **224.12** |
| Hospitals (3) | 3,071.26 | 8,294.84 | 154.69 | 68.78 | **11,589.57** |
| Masjids | 261.40 | NA | NA | NA | **261.40** |
| Churches (5) | 27.00 | NA | NA | NA | **27.00** |
| Water management facilities | 76,681.00 | 997.53 | 132.20 | NA | **77,810.73** |
| **Total (MWh)** | **96,351.65** | **9,931.21** | **320.01** | **1,553.33** | **108,156.20** |

In the next chart, it is obvious that the consumption's allocation in the tertiary sector is dominated by water management facilities.

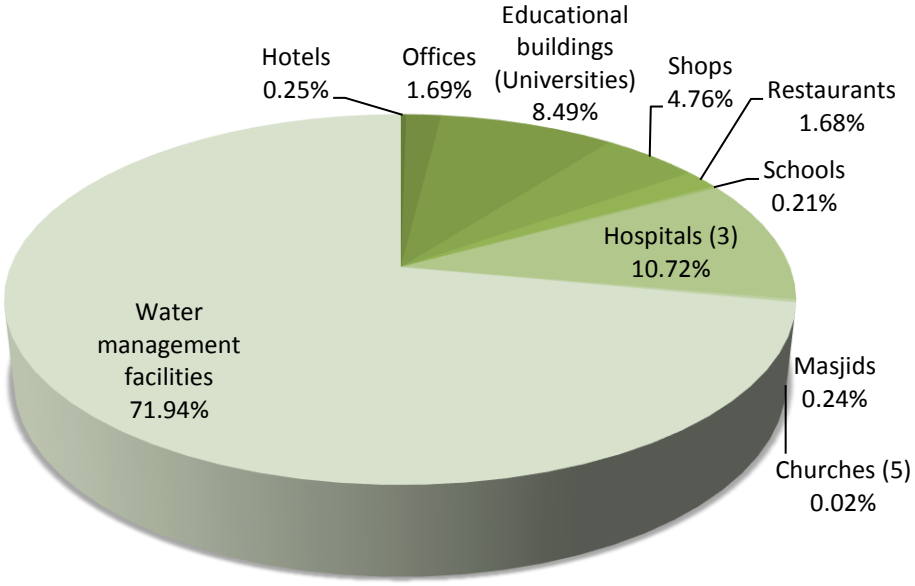



Figure 12: Energy consumption in tertiary sector per type of building

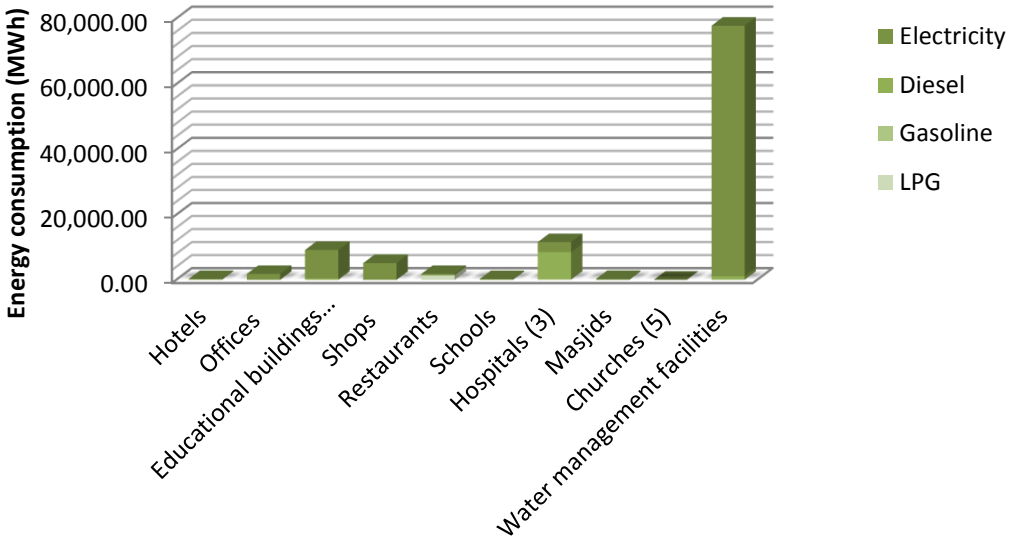



Figure 13: Energy consumption in tertiary sector per type of building and fuel

### 2.2.5 Buildings' & facilities Synopsis

The consumed energy allocation for all the buildings and facilities in Karak Municipality is presented in the next figure.

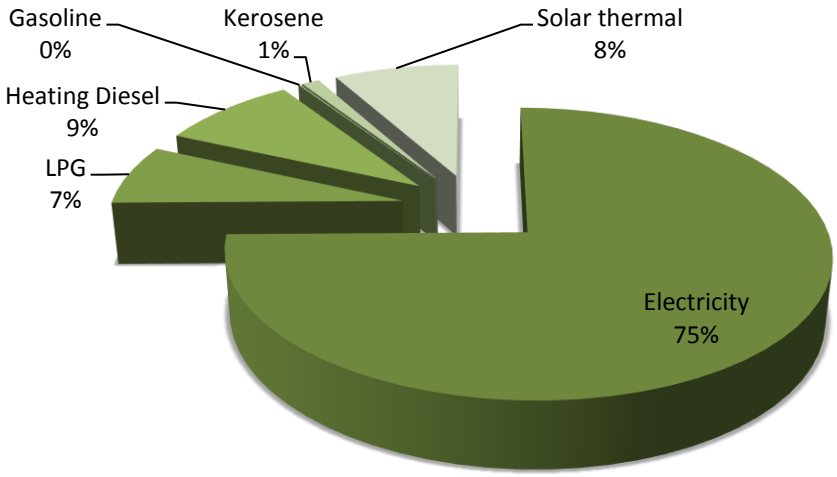



Figure 14: Energy consumption in buildings and facilities per fuel

### 2.2.6 Transport

#### *2.2.6.1 Municipal fleet*

As far as the consumption of the municipal vehicles is concerned, the available data, followed by the vehicles' type, was collected and is presented in the next table. Karak's municipal fleet has 111 vehicles which use diesel and gasoline.

Table 9: Energy Consumption in Municipal fleet of Karak

| Type of Municipal vehicles | Number of vehicles | Diesel (MWh) | Gasoline (MWh) | Total (MWh) |
|---|---|---|---|---|
| Passenger Vehicles | 4 | 0 | 98.57 | **9,098.57** |
| Pick-Up | 36 | 9,000.00 | 0 | |
| Garbage vehicles | 32 | | | |
| Light trucks < 4 tns | 9 | | | |
| Medium to large trucks > 4 tns | 3 | | | |
| Electricity Maintenance Crane | 2 | | | |
| Rollers | 2 | | | |
| Loaders | 9 | | | |
| Waste water trucks | 1 | | | |
| Tractor | 9 | | | |
| Other vehicles | 4 | | | |

### *2.2.6.2 Public Transport*

Public transport refers to buses and taxis that serve Karak's citizens. The data available for the sector included the average consumption per type of vehicle according to the total distance travelled within municipal limits. The results are summarized in the table below. Further analysis is presented in Appendix B.

Table 10: Energy consumption in Public Transport

| Vehicle Type | Number of vehicles | Diesel (MWh) | Gasoline (MWh) | Total (MWh) |
|---|---|---|---|---|
| Buses | 23 | 5,037.00 | | **6,036.01** |
| Taxis | 7 | | 999.01 | |

### *2.2.6.3 Private and Commercial Transport*

The previous methodological approach and assumptions was used in this sector too. In Appendix B is presented the detailed analysis per vehicle category. The registered private and commercial vehicles are 17,815 and the total consumption, regarding Diesel and Gasoline, is 100,778.30 MWh.

Table 11: Energy consumption in Private and Commercial Transport

| Vehicle Type | Number of vehicles | Diesel (MWh) | Gasoline (MWh) | Total (MWh) |
|---|---|---|---|---|
| Motorcycles | 37 | - | 74.55 | **100,778.30** |
| Small Passenger cars | 11,438 | - | 52,812.11 | |
| Medium Passenger Cars | 231 | 1,264.73 | - | |
| Cargo Vehicles | 2,417 | 13,233.08 | - | |
| Trailer Head | 246 | 1,459.09 | - | |
| Trailer | 1 | 53.38 | - | |
| Semi-Trailer | 2 | | | |
| Construction vehicles | 260 | 4,626.38 | - | |
| Agricultural Vehicles | 383 | 6,815.01 | - | |
| Van | 2,800 | 20,440.00 | - | |
| **Total** | **17,815** | **47,891.65** | **52,886.65** | |

In the next figure is presented the proportion between Diesel and Gasoline in the Private and Commercial vehicles.

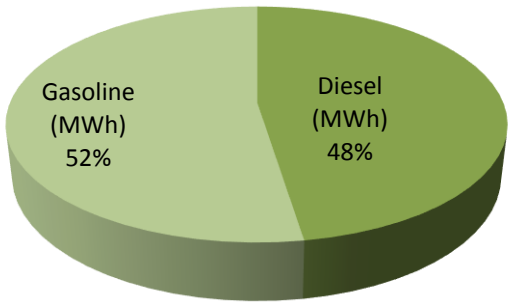



Figure 15: Energy consumption in Private and Commercial vehicles per fuel.

### 2.2.7 Final Energy Consumption

In the next table all the energy consumptions within Karak city are presented, totaling 410,368 MWh.

Table 12: Total Energy Consumption in Karak city

| Sector | FINAL ENERGY CONSUMPTION [MWh] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fossil fuels | | | | | | | | Renewable energies | | | | | Total |
| | Electricity | Heat/cold | Natural gas | Liquid gas | Heating oil | Diesel | Gasoline | Lignite | Coal | Other fossil fuels | Plant oil | Biofuel | Other biomass | Solar thermal | Geothermal | |
| **BUILDINGS. EQUIPMENT/FACILITIES AND INDUSTRIES** | | | | | | | | | | | | | | | | |
| Municipal buildings. equipment/facilities | 5,104.60 | | | 117.59 | | | | | | | | | | | | 5,222.19 |
| Tertiary (non municipal) buildings. equipment/facilities | 96,351.65 | | | 1,553.33 | 9,931.21 | | 320.01 | | | | | | | | | 108,156.20 |
| Residential buildings | 112,872.60 | | | 18,864.00 | 16,308.58 | | | | | 3,373.30 | | | | 23,785.77 | | 175,204.25 |
| Public lighting | 5,872.16 | | | | | | | | | | | | | | | 5,872.16 |
| Industry – Non-ETS | | | | | | | | | | | | | | | | 0.00 |
| Industry – ETS (not recommended) | | | | | | | | | | | | | | | | 0.00 |
| **Subtotal** | **220,201.01** | **0.00** | **0.00** | **20,534.92** | **26,239.79** | **0.00** | **320.01** | **0.00** | **0.00** | **3,373.30** | **0.00** | **0.00** | **0.00** | **23,785.77** | **0.00** | **294,454.8** |
| **TRANSPORT** | | | | | | | | | | | | | | | | |
| Municipal fleet | | | | | | 9,000.00 | 98.57 | | | | | | | | | 9,098.57 |
| Public transport | | | | | | 5,037.00 | 999.01 | | | | | | | | | 6,036.01 |
| Private and commercial transport | | | | | | 47,891.65 | 52,886.65 | | | | | | | | | 100,778.30 |
| **Subtotal** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **61,928.65** | **53,984.23** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **115,912.88** |
| **OTHER** | | | | | | | | | | | | | | | | |
| Agriculture. Forestry. Fisheries | | | | | | | | | | | | | | | | 0.00 |
| **TOTAL** | **220,201.01** | **0.00** | **0.00** | **20,534.92** | **26,239.79** | **61,928.65** | **54,304.24** | **0.00** | **0.00** | **3,373.30** | **0.00** | **0.00** | **0.00** | **23,785.77** | **0.00** | **410,367.68** |

## 2.3 Local electricity production

In Karak municipality there are photovoltaic panels producing electricity. The total installed capacity of these PVs is 90KWp with 19% capacity factor. Based on these facts, it is calculated that the electricity production from these Renewable Energy Sources is 153MWh.

## 2.4 $CO_2$ emissions

### 2.4.1 Energy related emissions

In the previous sections the energy consumptions in Karak municipality were described, in line with which the $CO_2$ emissions will be calculated in this section, using the IPCC emission factors.

*Electricity*

In order to calculate the local emission factor for electricity, the following equation is used:

$$EFE = \frac{(TCE - LPE - GEP) * NEEFE + CO2LPE + CO2GEP}{TCE}$$

Where [9]:

EFE: Local emission factor for electricity (tn/MWh)
TCE: Total electricity consumption in the local authority ($MWh_e$)
LPE: Local electricity production ($MWh_e$)
GEP: Green electricity purchased by the local authority ($MWh_e$)
NEEFE: National or European emission factor for electricity (tn/$MWh_e$)
CO2LPE: $CO_2$ emissions due to the local production of electricity (tn)
CO2GEP: $CO_2$ emissions due to production of certified green electricity purchased by the local authority (tn)

$$EFE = \frac{(220{,}201.01 - 153 - 0) * 0.659 + 0 + 0}{220{,}201.01} = 0.6585 \approx 0.659 \text{ tn } CO_2/\text{MWh}$$

As calculated from the above, due to the very low electricity production from PVs, the emission factor for electricity remains basically the same.

*Heating Oil (Diesel)*

According to the SECAP guidelines the $CO_2$ emission factor for the diesel used in heating is 0.267 tn/MWh.

*Diesel*

According to the SECAP guidelines the $CO_2$ emission factor for the diesel used in vehicles is 0.267 tn/MWh. No biodiesel is being blended.

*Gasoline*

According to the SECAP guidelines the $CO_2$ emission factor for gasoline is 0.249 tn/MWh.

*LPG*

According to the SECAP guidelines the $CO_2$ emission factor for liquefied petroleum gas is 0.226 tn/MWh.

*Kerosene*

According to the SECAP guidelines the $CO_2$ emission factor for kerosene is 0.259 tn/MWh.

*Solar thermal*

The solar thermal power hasn't emissions thus its emission factor is zero according to the guidelines.

### 2.4.2 Non energy related emissions

Apart from the $CO_2$ emissions released from the daily activities there is also a significant amount of Greenhouse Gases derived from waste management. In order to calculate these emissions, the IPCC default method was used as it appears below. [10]

$$\textbf{Methane emissions (Gg/yr)} = (MSW_T \bullet MSW_F \bullet MCF \bullet DOC \bullet DOC_F \bullet F \bullet 16/12\text{-}R) \bullet (1\text{-}OX) \quad \textbf{(1)}$$

Where:

- $MSW_T$ total MSW generated (Gg/yr)
- $MSW_F$ fraction of MSW disposed to solid waste disposal sites
- MCF methane correction factor (fraction)
- DOC degradable organic carbon (fraction) (kg C/ kg SW)
- $DOC_F$ fraction DOC dissimilated
- F fraction of $CH_4$ in landfill gas (IPCC default is 0.5)
- 16/12 conversion of C to $CH_4$
- R recovered $CH_4$ (Gg/yr)
- OX oxidation factor (fraction – IPCC default is 0)

The IPCC default method assumes that all the potential of $CH_4$ emissions are released during the same year the waste is disposed of. The method introduces various specific default values and recommendations, for use in countries with lack of statistical data for Solid Waste.

The calculation of the degradable correction factor (DOC) is based in the following equation.

$$\textbf{DOC=0.4*A+0.17*B+0.15*C+0.3*D} \quad \textbf{(2)}$$

Where:

- A Percentage of paper and textiles in SW
- B Percentage of garden and park waste and other organic putrescibles in SW
- C Percentage of Food waste in SW
- D Percentage of wood and straw waste in SW

The form of this suggested equation wasn't followed directly because in the case of Karak municipality there was a different composition of solid waste. New factors were found in order to calculate the DOC.

The total quantity of solid waste for 2014 was 109,500 tn. The entire amount is landfilled because there is no recycling. Waste composition, as well as the results from the calculations is presented in the next two tables.

Table 13: Solid waste composition in Karak, 2014

| Solid waste composition | Percentage | Quantity(tn) |
|---|---|---|
| Paper and Cardboard | 11% | 12,045 |
| Glass | 2% | 2,190 |
| Metal | 2% | 2,190 |
| Plastic | 16% | 17,520 |
| Organic Waste | 62% | 67,890 |
| Other | 7% | 7,665 |
| **Annual Quantity of Solid waste (tn)** | 100% | 109,500 |

Table 14: Waste Emissions Calculation factors

| Variables | Values |
|---|---|
| MSWt: | 109.50 Ggr |
| MSWf: | 1 |
| MCF: | 0.4 |
| DOC: | 0.1708 |
| DOCf: | 0.5067 |
| F: | 0.5 |
| 16/12: | 1.3333 |
| R: | 0 |
| OX: | 0 |

Where DOCf=0.014*T+0.28 (T: average temperature in Karak, 16.19$^{o}$C)

All things considered, 2,527.26 tn of methane are released due to the waste management. This quantity equals to 63,181.47 tn of equivalent $CO_2$ (According to the guidelines the factor which was used for the conversion is 25).

### 2.4.3 Final $CO_2$ emissions

The emissions of $CO_2$ for the sectors that have been described in the previous sections are available, in total, in the following table.

Table 15: Total $CO_2$ emissions for the Karak city

| Sector | CO2 emissions [t] / CO2 eq. emissions [t] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fossil fuels | | | | | | | | Renewable energies | | | | | Total |
| | Electricity | Heat/cold | Natural gas | Liquid gas | Heating Oil | Diesel | Gasoline | Lignite | Coal | Other fossil fuels | Biofuel | Plant oil | Other biomass | Solar thermal | Geothermal | |
| **BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES** | | | | | | | | | | | | | | | | |
| Municipal buildings, equipment/facilities | 3,363.93 | | | 26.69 | | | | | | | | | | | | 3,390.63 |
| Tertiary (non municipal) buildings, equipment/facilities | 63,495.73 | | | 352.61 | 2,651.63 | | 79.68 | | | | | | | | | 66,579.66 |
| Residential buildings | 74,383.04 | | | 4,282.13 | 4,354.39 | | | | | 873.68 | | | | 0.00 | | 83,893.25 |
| Public lighting | 3,869.76 | | | | | | | | | | | | | | | 3,869.76 |
| Industry – Non-ETS | | | | | | | | | | | | | | | | 0.00 |
| Industry – ETS (not recommended) | | | | | | | | | | | | | | | | 0.00 |
| **Subtotal** | 145,112.47 | 0.00 | 0.00 | 4,661.43 | 7,006.02 | 0.00 | 79.68 | 0.00 | 0.00 | 873.68 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 157,733.29 |
| **TRANSPORT** | | | | | | | | | | | | | | | | |
| Municipal fleet | | | | | | 2,403.00 | 24.54 | | | | | | | | | 2,427.54 |
| Public transport | | | | | | 1,344.88 | 248.75 | | | | | | | | | 1,593.63 |
| Private and commercial transport | | | | | | 12,787.07 | 13,168.78 | | | | | | | | | 25,955.85 |
| **Subtotal** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16,534.95 | 13,442.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 29,977.02 |
| **OTHER** | | | | | | | | | | | | | | | | |
| Agriculture, Forestry, Fisheries | | | | | | | | | | | | | | | | 0.00 |
| **OTHER NON-ENERGY RELATED** | | | | | | | | | | | | | | | | |
| Waste management | | | | | | | | | | | | | | | | 63,181.47 |
| Waste water management | | | | | | | | | | | | | | | | 0.00 |
| Other non-energy related | | | | | | | | | | | | | | | | 0.00 |
| **TOTAL** | 145,112.47 | 0.00 | 0.00 | 4,661.43 | 7,006.02 | 16.534,95 | 13,521.76 | 0.00 | 0.00 | 873.68 | 0.00 | 0.00 | 63,181.47 | 0.00 | 0.00 | 250,891.78 |

## 2.5 Results' Graphical Analysis

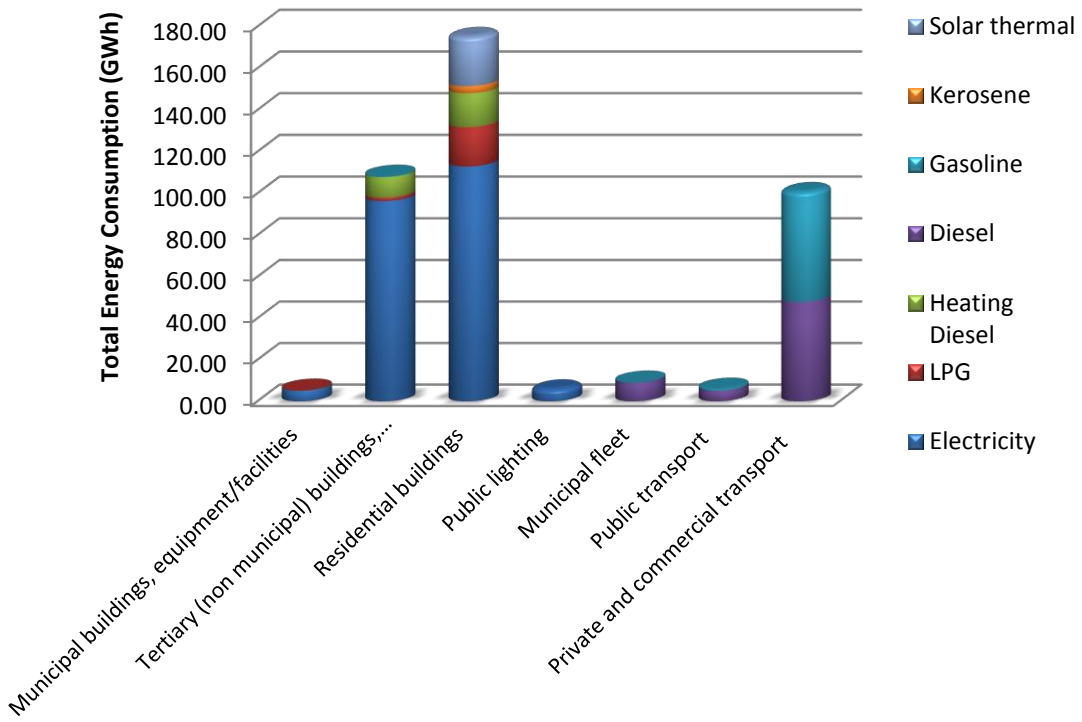



Figure 16: Final Energy consumption per sector and per fuel.

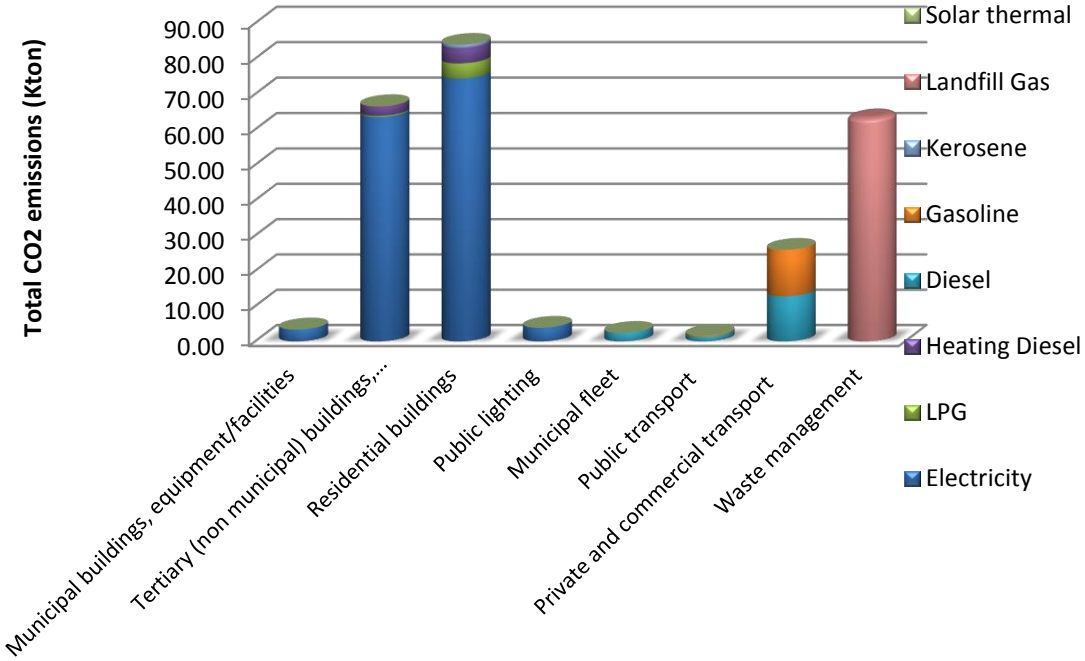



Figure 17: Total $CO_2$ emissions per sector and per fuel.

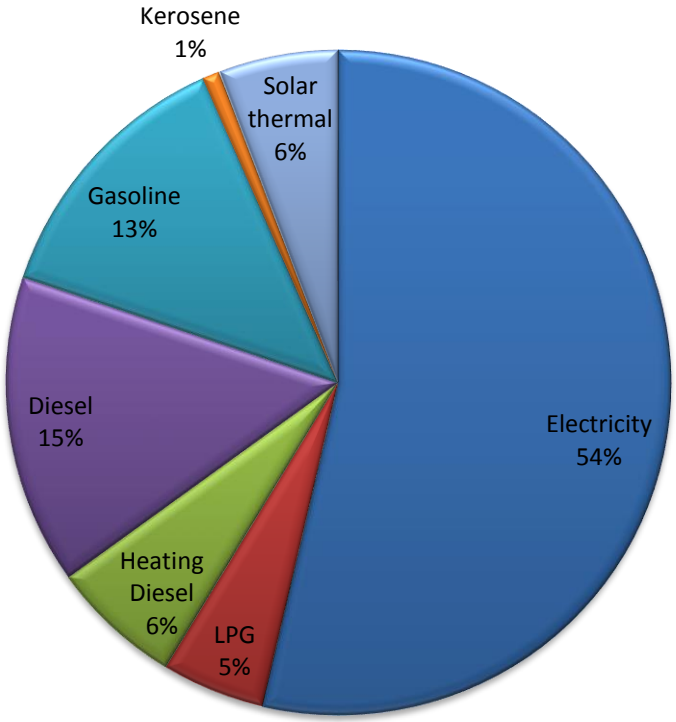



Figure 18: Final Energy Consumption per fuel.

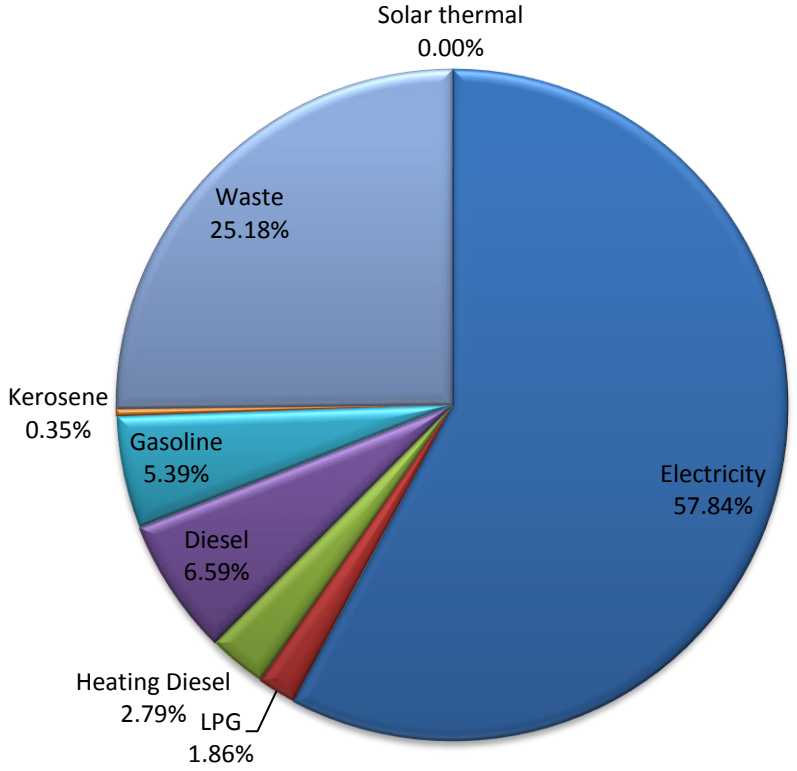



Figure 19: Total CO2 emissions per fuel.

# Chapter 3: SECAP Actions

## 3.1 Target for 2030

The Municipality of Karak is called upon to take double role in the efforts towards $CO_2$ reduction, both as a demonstrator giving the good example to its citizens, as well as a triggering power and coordinator for all activities in the area. The first role, giving the good example, should be realized through the adoption of actions to reduce the emissions resulting from the buildings/ facilities / vehicles etc. under its direct responsibility. Emissions from waste are another sector under the direct responsibility of Karak Municipality. Nevertheless, the municipal direct related emissions are only a relatively low percentage of the total. Therefore, it should act as a triggering power and coordinator of the activities to be realized by the private sector in a series of activity fields. According to the BEI, the sectors contributing the most to the carbon footprint are the Residential (33.44%), the Tertiary (26.54%) and the Private & Commercial Transport (10.35%). Thus the Municipality should focus on the actions through which the citizens will be encouraged and take the appropriate measures in order to reduce the $CO_2$ emissions from their activities. At the same time actions in the other sectors will be suggested as well.

In this respect, the first step is the calculation of the Business as Usual (BAU) scenario, in line with the JRC guidelines for South Municipalities, considering that Jordan, as a country with its economy under development, will face an increase in its energy demand due to the expected economic and population growth. Considering the use of the BAU scenario for the calculation of the 2030 emission levels and in turn the respective reduction target, the following calculations are realized according to the guidelines.

$$Emissions_{CO_2}^{2030} = Emissions_{CO_2}^{Baseline\ year} \times k$$

In Karak, the emissions for the baseline year, 2014, were 250,891.78 tn $CO_2$. The national coefficient k for the baseline year of 2014 in Jordan is 1.68. Therefore, the forecasted emissions for 2030 are

$$Emissions_{CO_2}^{2030} = 250{,}891.78 \times 1.68 = 421{,}498.19\ tn\ CO_2$$

The emission reduction target for Karak Municipality according to the Intended Nationally Determined Contribution (INDC) is 14% (59,009.75tn $CO_2$) up to 2030 compared with the BAU scenario. However, according to Covenant of Mayors the target should be at least 40% against the calculated 2030 emissions, thus 168,599.28 tn $CO_2$.

As a result, the current study focuses on the development of two parallel action scenarios that will allow Karak to achieve either one of the above targets set. It should be highlighted that the actions in both scenarios are the same and the main differences are in the enforcement level of a series of legislative activities (strict enforcement or voluntary), especially in the building sector, as well as the penetration level of renewable energy actions. Jordan has already developed the “Energy Efficient Building Code” which provides the minimum requirements for designing an energy efficient building (green building). The Code is not mandatory so the first scenario will be based in adopting a few measures in the buildings, while the application field in these buildings, both existing and new, will be relatively limited.

On the other hand, in order for the 40% target to be achieved, strict measures are needed which should be enforced through the development and implementation of the respective legislative framework.

Calculations for both scenarios have been realized based on the suggested actions and it is envisaged that in the first scenario, the total $CO_2$ reduction could reach a maximum of 25.37%, thus satisfying the INDC target of 14%, whereas the respective number under the strict implementation of the legislative framework could be 40.02%. Therefore the first target seems to be technically achievable in the next years, and the second one depends on the intensive effort of Municipality and government in order to attract additional financing and broadly engage the private sector investors.

Each sector's contribution in the overall reduction target is presented in the next Figures.

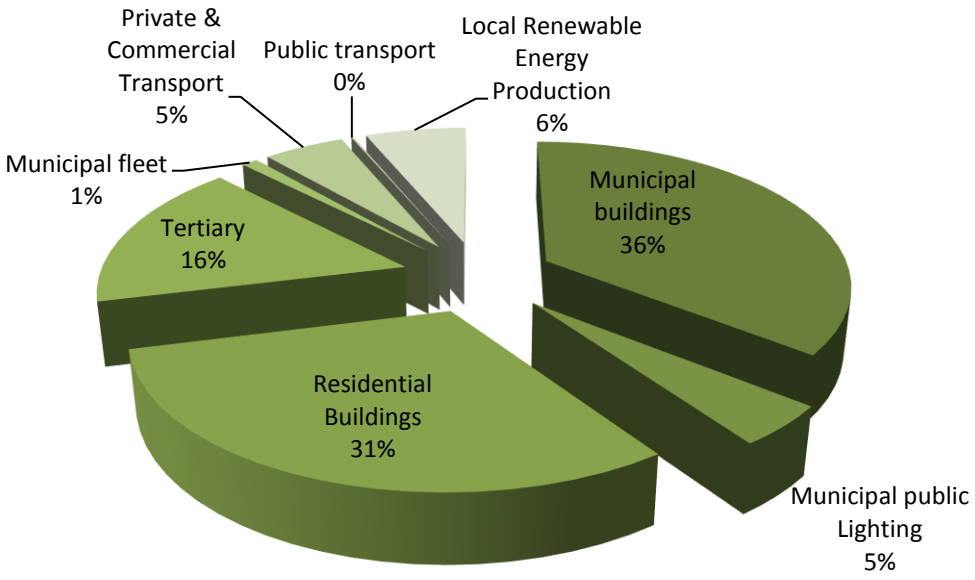



Figure 20: Sectors' contribution in the 1st Scenario's attainment (INDC target – Reduction potential of 25.37%)

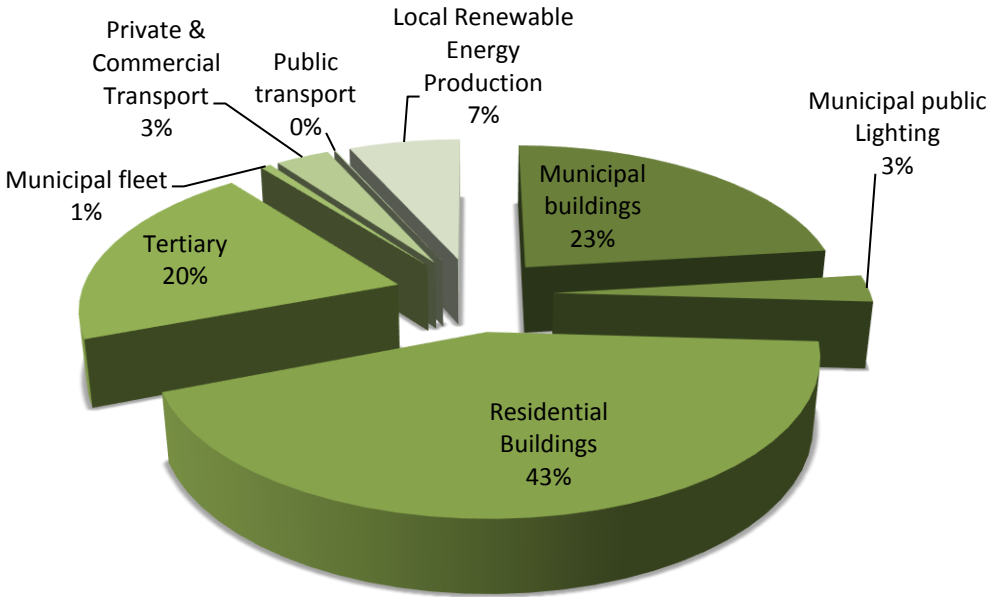



Figure 21: Sectors' contribution in the 2nd Scenario's attainment (CoM reduction target – Reduction potential of 40.02%)

In the next sections a more detailed analysis per action for each sector is provided. It should be noted that for awareness raising activities conducted by the municipality, besides the implementation cost born by the municipality and its potential funding sources, the amount of the private funds mobilized is reported as well where relevant. This cost doesn't participate in the calculation of the NPV value. Moreover, it should be clarified that externalities costs are not considered in the calculation of the NPV; this results sometimes in actions with a negative NPV from the strict economic calculation, although their overall impact could be considered positive if additional benefits were considered.

## 3.2 Municipal Buildings, Equipment/Facilities

This sector contributes in the carbon footprint with only 1.35%. Nevertheless the possible actions to be implemented in the Municipal Buildings could set an example for the citizens and the employees. Municipality acknowledged the measures which best fit its needs so as to achieve energy savings and emission reductions. In the following sections, a comprehensive set of actions is being analysed.

The suggested actions for this sector consist of energy conservation and green energy production measures. Focus has been placed on energy saving activities and PVs on buildings' roofs, since these are considered to be easily implemented, unlike the bigger RES facilities requiring more time and more free spaces available.

Apart from these categories of actions, there are also some envisaged actions which target the user through awareness raising activities. These actions aim to make the inhabitants' behavior environmental friendly, as well as to properly educate the new generations in environmental and energy related issues.

An overview of this sector's actions and achieved reductions is presented in the table below.

Table 16: Actions in Municipal Buildings, Equipment/Facilities

| Action No. | Action | Emission Reductions (tn $CO_2$) | |
|---|---|---|---|
| | | 1st Scenario 14% target | 2nd Scenario 40% target |
| 1.1 | Green procurement procedures for municipal buildings | 282.57 | |
| 1.2 | Energy manager appointment in the municipality | 16.82 | |
| 1.3 | Awareness raising activities for municipal employees | 53.82 | |
| 1.4 | Adoption of bioclimatic principles in new municipal buildings /Strict application of green building codes in new municipal buildings | 285.93 | 686.24 |
| 1.5 (F) | Efficient municipal buildings | 1,549.00 | |
| 1.6 | Promotion of recycling | 1,592.17 | |
| 1.7 | Waste management | 31,338.00 | |
| 1.8 | 3 MW PV plant (for municipal buildings and street lighting) | 3,359.58 | |
| 1.9 | Creation of Energy Saving Department | 0.00 | |
| 1.10 | Web portal creation | 0.00 | |
| | Total | **38,477.90** | **38,878.21** |

### 3.2.1 Green procurement procedures for municipal buildings

Green procurement is the procedure where the municipality seeks to purchase goods and services with a reduced environmental impact throughout their life cycle. Selecting products of high efficiency that minimize the environmental impacts, it is possible to consume less energy thus reduce the $CO_2$ emissions and achieve monetary savings. The action is envisaged to be applied in all new office equipment that the municipality plans to purchase for their increasing needs and for the gradual substitution of old, inefficient one. Especially for high energy consuming office equipment, high efficiency products will be targeted, while minimum efficiency standards and requirements will be set in all relevant municipal tenders. An average estimation of 5% savings achieved against the BAU consumptions is envisaged.

In the next table, calculations regarding the cost, the savings and the financial viability of the action are presented.

Table 17: Action 1.1 in numbers

| Green procurement procedures | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 917,200 |
| Annual Energy Savings (MWh) | 428.79 |
| Annual Emission Reduction (tn $CO_2$) | 282.57 |
| Funding Source | Own funds |
| Net Present Value (NPV) | <0 |

### 3.2.2 Energy manager appointment in the municipality

One of the prerequisites of the municipality's adhesion to the Covenant of Mayors is the creation of the municipal administrative structures, in order to establish the working team to implement and monitor the progress of the SECAP activities. In this respect, this action focuses not only on the satisfaction of the above mentioned prerequisite, but goes well beyond it.

The energy manager will not only be the responsible person to monitor the energy consumptions and provide the necessary solutions when a problem is identified, but will act proactively in order to ensure the good coordination of the whole municipal team for the proper implementation of the envisaged SECAP actions.

The benefits related to the energy manager's appointment are considered multi-dimensional since strong coordination of the overall initiative is required, although strictly economic indicators are not encouraging. In case a member of the existing municipality staff is appointed to this position, this will have a positive NPV for the municipality.

Table 18: Action 1.2 in numbers

| Energy manager appointment in the municipality | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 420,000 |
| Annual Energy Savings (MWh) | 25.52 |
| Annual Emission Reduction (tn $CO_2$) | 16.82 |
| Funding Source | Own funds |
| Net Present Value (NPV) | <0 |

### 3.2.3 Awareness raising activities for municipal employees

A significant step to achieve the planned targets is to have properly communicated the municipality's intentions to the people working within those buildings. In this respect, this action comprises of a set of targeted awareness raising activities towards the municipal employees. The aim of these activities is to encourage the municipal employees to change their behavior and habits in order to achieve the envisaged results.

The set of awareness raising and training actions to be realised for the municipal employees includes the following:

- Training workshops and seminars for the team members directly involved in the SECAP implementation and monitoring. This activity aims at the capacity building regarding SECAP development and project implementation of the employees directly involved in the SECAP implementation team. These workshops and seminars could be targeted on how to attract financing from international donors, to manage the project implementation or even focus on the exchange of best practices and ideas with other municipalities in Jordan and abroad that face the same challenges. Workshops on the latest available know how in terms of energy efficiency and RES technologies are envisaged as well.
- Development and circulation of promotional material through the employees' e-mails on the benefits of energy efficiency and how simple behavior changes impact the total consumption.
- Municipal contest for the administrative building with the highest energy savings achieved (in terms of %) due to users' behavior change. This contest prize could be any incentive provided to the employees, such as two additional days off that year or the development of posters with the pictures and names of the employees that contributed to the goal. The aim would be to achieve energy savings through strictly behavioral change, such as turning off the lights, the A/C and office equipment when leaving the office, not leaving open windows with the A/C on etc. This measure could be used during the first couple of years, when the rest of the energy efficiency interventions will be gradually taking place.

This action will be realized in Project fiche's #5 framework. (Energy savings and emission reduction are calculated separately from the fiche.

Table 19: Action 1.3 in numbers

| Awareness raising activities for municipal employees | |
|---|---|
| Duration | 2018-2023 |
| Total Implementation Cost (JOD) | 20,000 |
| Annual Energy Savings (MWh) | 81.67 |
| Annual Emission Reduction (tn $CO_2$) | 53.82 |
| Funding Source | Own funds |
| Net Present Value (NPV) | <0 |

### 3.2.4 Adoption of bioclimatic principles in new municipal buildings /Strict application of green building codes in new municipal buildings

Due to the expected economic and population growth in site of 2030 horizon, citizens' needs will be increased, therefore the municipality's services should be extended. As a result, new buildings will be constructed to meet city's needs and consequently there will be an increase in energy consumption, as envisaged in the BAU scenario. In order to mitigate this increase, the construction of new buildings under the two different scenarios should be either based

on the partial adoption of bioclimatic principles (1st scenario), or strictly abide with the Energy Efficient Building Code.

According to these, under the 1st scenario it is envisaged that in 50% of the new municipal buildings to be constructed, a series of measures to curtail the building's energy consumption by 25% against a conventional building, will be applied. These measures include the adoption of natural lighting and ventilation, insulation in exterior surfaces, as well as shading in the glazing. In addition to the above, the use of cool colors especially in roofs will also contribute significantly to the reduction of energy losses. Moreover the building's orientation should be taken into consideration.

All the above measures (plus other appropriate bioclimatic principles where it is possible), as well as strict application of the existing Energy Efficient Building Code will be implemented in all new buildings under the 2nd scenario, so as to reduce the expected increase in energy and $CO_2$ emissions.

Table 20: Action 1.4 in numbers

| **Adoption of bioclimatic principles in municipal buildings /Strict application of green building codes in municipal buildings** | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 – 2030 | |
| Total Implementation Cost (JOD) | 400,000 | 800,000 |
| Annual Energy Savings (MWh) | 433.89 | 1.041,34 |
| Annual Emission Reduction (tn $CO_2$) | 285.93 | 686,24 |
| Funding Source | Own and governmental funds | |
| Net Present Value (NPV) | >0 | >0 |

### 3.2.5 Efficient municipal buildings

The current state of Karak's existing municipal buildings includes LED lighting units and new efficient ACs in all of them. On the other hand, none of the buildings' envelope is thermally insulated and the windows are of single glazing. Consequently there are thermal losses which increase the energy consumption. Thus, the Municipality envisages making these buildings efficient and green through actions in the building envelope, namely applying insulation of walls and roofs and use of double glaze windows. It is estimated that due to these measures the energy savings in the air conditioning systems will be 35%.

Moreover the Municipality wants to exploit the solar potential of the region via the installation of 500 KW PV panels in roofs and thus cover a part of the electricity consumption with renewable energy. The substitution of the electricity production source with alternative ones will contribute to the $CO_2$ reduction as well. The calculations are based in the BAU scenario.

These actions constitute a priority for the municipality, and for this reason are developed in detail in the project fiche "Making the Municipal Buildings Green".

Table 21: Action 1.5 in numbers

| Efficient municipal buildings | |
|---|---|
| Duration | 2018 - 2023 |
| Total Implementation Cost (JOD) | 1,687,353 |
| Annual Energy Savings (MWh) | 1,500 |
| Annual Energy Production (MWh) | 850 |
| Annual Emission Reduction (tn $CO_2$) | 1,549 |
| Funding Source | Own funds, Donors & Government |
| Net Present Value (NPV) | >0 |

### 3.2.6 Promotion of recycling

As waste contributes with a 25% to the total municipal emissions, Karak Municipality is dedicated to actively implement awareness activities to promote the recycling context. The target is to achieve 15% recycling rates by 2030. The promotional campaign will include info days, promotional material like leaflets and posters or even messages in local media (TV, radio, social media) regarding the benefits of recycling and instructions on how to do it.

The municipality will also ensure that the proper infrastructure (recycling bins and vehicles) is available for the waste sorting and collection on the streets, including recycling of electrical devices. Furthermore, in order to lead by example, the municipality will install recycling bins in all municipal buildings and facilities, promoting the use of recycled paper for the local administration.

Table 22: Action 1.6 in numbers

| Promotion of recycling | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 1,000,000 |
| Annual Emission Reduction (tn $CO_2$) | 1,592.17 |
| Funding Source | Own funds |
| Net Present Value (NPV) | <<0 |

### 3.2.7 Waste management

The total amount of waste collected is 300 tn/day in Karak Municipality. The solid waste issue has gained significant attention in the recent years, not only due to its environmental impacts, but also for its social and economic consequences. The Municipality is committed to work on reducing waste to be collected as the major solution to reduce energy consumption generated by waste management. It is also planning to separate the biomass to produce bio-fertilizer. Biological treatment will be used to treat the biomass and produce bio-fertilizer. The bio-fertilizer plant of 2 MWp will convert the bio organic waste to bio gas and fertilizer.

As this action considered being a priority for the Municipality, it is further analyzed in project fiche “Bio Waste Management”.

Table 23: Action 1.7 in numbers

| Waste management | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 9,000,000 |
| Annual Energy Production (MWh) | 14,400.00 |
| Annual Emission Reduction (tn $CO_2$) | 31,338.00 |
| Funding Source | Own and EU funds |
| Net Present Value (NPV) | >0 |

### 3.2.8 3 MW PV plant (for municipal buildings and street lighting)

It is well known that Jordan has a great solar potential. Municipality wants to take advantage of this benefit and install a big PV plant of 3MW to cover the electricity consumption in the street lighting and municipal buildings. By doing so, its dependency on the grid will be reduced through a renewable source of energy, thus achieving $CO_2$ reductions as well.

This action constitutes a priority for the Municipality and is described in detail in the "3 MW PV Station installation" project fiche. Key data on the investment are also presented in the table below.

Table 24: Action 1.8 in numbers

| PV plant 3 MW | |
|---|---|
| Duration | 2017-2019 |
| Total Implementation Cost (JOD) | 2,500,000 |
| Annual Energy **Production** (MWh) | 5,098.00 |
| Annual Emission Reduction (tn $CO_2$) | 3,359.58 |
| Funding Source | Municipal Budget |
| Net Present Value (NPV) | >0 |

### 3.2.9 Establishment of Energy Saving Department

The creation of an Energy Saving Department is proposed, to be staffed with 2 or 3 people according to the municipality's needs. These employees should be technically qualified on energy related issues, so as to promote appropriate activities related to energy savings and support citizens. Citizens will turn to this department in order to be informed for new practices and to receive techno-economic advices regarding their energy related investments. In addition to the above, this department can support the activities of the energy manager and undertake the responsibility for monitoring the SECAP actions' progress, in close collaboration with the employees directly involved with their implementation. The implementation of this action is not considered to derive direct energy savings and $CO_2$ reduction benefits, but it is seen as a supplementary one to the rest of the actions in the sector.

Table 25: Action 1.9 in numbers

| Establishment of Energy Saving Department | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 1,260,000 |
| Funding Source | Own funds |

### 3.2.10 Web portal creation

The creation of a web portal regarding energy savings could be a tool for the Energy Saving Department so as to interact with the citizens. The aim is to inform inhabitants about the municipality's actions and events related to the SECAP implementation, new measures for energy savings as well as funding sources. Moreover the webpage will host a discussion forum where they could exchange their opinions, find out solutions to their questions and keep in touch with the Energy Saving Department's staff. No direct energy savings have been allocated to this action, but it is considered to be a significant contribution in encouraging citizens to adopt the "green" practices and as a major tool in the promotion of all related awareness raising activities by the municipality. This website can be a dedicated site linked to the municipal one, or be integrated within it.

Table 26: Action 1.10 in numbers

| Web portal creation | |
|---|---|
| Duration | 2018 – 2019 |
| Total Implementation Cost (JOD) | 3,000 |
| Funding Source | Own funds |

## 3.3 Municipal Public Lighting

The municipal public lighting includes street lighting and public areas' lighting. It is estimated that with the appropriate upgrades of this system there will be significant energy savings and respective emission reductions.

An overview of this sector's actions is presented in the table below, while a detailed analysis with calculations for each action follows in the next paragraphs.

Table 27: Actions in Municipal Public Lighting

| Action No. | Action | Emission Reductions (tn $CO_2$) |
|---|---|---|
| 2.1 (F) | Street lighting upgrade | 2,565.82 |
| 2.2 | Astronomical timers | 975.18 |
| 2.3 | Green procurement procedures for future lighting equipment | 1,315.72 |
| | Total | **4,856.71** |

### 3.3.1 Street lighting upgrade

Various types of lamps are used for street lighting, more specifically: High Pressure Sodium and Mercury Vapor. The Municipality wants to replace all of the existing lamps (25,000 lamps in total) with LEDs which are more efficient and provide great luminosity quality. This action will ensure great monetary savings for Karak and significant reduction in electricity consumption.

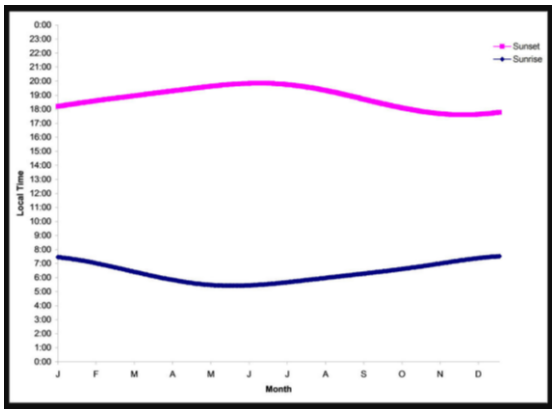
The action constitutes part of the "Replacing non efficient Lamps with LED Lamps for the street lighting" project fiche, where a more detailed analysis of the related costs and calculated energy savings is provided. Key data on the action is presented in the below table.

Table 28: Action 2.1 in numbers

| Street lighting upgrade | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 3,378,000 |
| Annual Energy Savings (MWh) | 3,893.50 |
| Annual Emission Reduction (tn $CO_2$) | 2,565.82 |
| Funding Source | Own and EU funds |
| Net Present Value (NPV) | >0 |

### 3.3.2 Astronomical timers

The operation of street lighting is controlled by photocells. These devices could be replaced with astronomical timers which are more accurate and precise compared to photocells. This action will reduce the electricity consumption by 15%, as explained in the following figure which shows the sunrise and sunset timing where the photocell acts little before/after timing and counts for loss of around 365 hours of operation per year.




*Source: http://file.scirp.org/Html/4-6401175_24420.htm*

Figure 22: Timing for sunset and sunrise in Jordan

The astronomical timers' use would also help in precise timing for switching and programming the actual operation after 20 min of sun set and almost 30 min before sun rise which is an acceptable trimming as light will be still there.

Key data on the investment are presented in the table below.

Table 29: Action 2.2 in numbers

| Astronomical timers | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 51,000 |
| Annual Energy Savings (MWh) | 1,479.79 |
| Annual Emission Reduction (tn $CO_2$) | 975.18 |
| Funding Source | Own funds |
| Net Present Value (NPV) | >>0 |

### 3.3.3 Green procurement procedures for future lighting equipment

Green procurement constitutes the procedure where the municipalities seek to procure goods with reduced environmental impact throughout their life cycle and high efficiency standards. In this way selection of products that minimize environmental impacts takes place, emphasizing on highly energy efficient equipment. This action is envisaged for the future lighting equipment purchases within the 2030 horizon, since it is expected that the network will expand due to the city's growth. Key data on the action is presented in the table below and have been calculated against the BAU scenario.

Table 30: Action 2.2 in numbers

| Green procurement procedures for the future lighting equipment | |
|---|---|
| Duration | 2020 - 2030 |
| Total Implementation Cost (JOD) | 2,295,000 |
| Annual Energy Savings (MWh) | 1,996.54 |
| Annual Emission Reduction (tn $CO_2$) | 1,315.72 |
| Funding Source | Own funds |
| Net Present Value (NPV) | >0 |

## 3.4 Residential Buildings

This sector includes the energy consumption of all the private residents regarding the activities in each household (lighting, heating, use of electric appliances etc.). This consumption constitutes 42.69% of the total consumption with 33.44% contribution to the $CO_2$ emissions.

The initial actions are informational and they will be realized by Karak Municipality. Since the Municipality does not have the possibility of direct interventions in terms of projects' realization, a series of actions will be planned aiming at encouraging the inhabitants to take the proposed measures in order to reduce their energy consumption and carbon emissions.

An overview of this sector's planned actions is presented in the next table.

Table 31: Actions in Residential Buildings

| Action No. | Action | Emission Reductions (tn $CO_2$) | |
|---|---|---|---|
| | | 1st Scenario 14% target | 2nd Scenario 40% target |
| 3.1 | Awareness raising activities for modification of the residents' consumption behavior | 2,811,68 | 3,124.09 |
| 3.2 | Promotion of Green Buildings' concept / Strict application of the building code | 2,529.02 | 20,232.19 |
| 3.3 | Campaign for promoting high energy label equipment | 2,811.68 | 4,686.13 |
| 3.4 | 2MW/5 MW Photovoltaics in residential rooftops | 2,238.71 | 5,596.77 |
| 3.5 | Replacing existing electric water heater with solar collectors | 18,136.80 | 27,205.20 |
| 3.6 | Replacement of existing lamps with LEDs | 797,76 | 2,393.27 |

| | | | |
|---|---|---|---|
| 3.7 | Replacement of existing air-conditioners with more efficient ones | 3,626.17 | |
| 3.8 | Use of cool colors in rooftops | 322.33 | |
| 3.9 | Replacement of single glazing with double | 153.33 | |
| | **Total** | **33,427.48** | **72.936,25** |

### 3.4.1 Awareness raising activities for modification of the residents' consumption behavior

The initial step is that the municipality should organize frequently within the 2030 horizon, awareness raising campaigns for the residents of Karak. Citizens' engagement is of utmost importance since almost the 43% of the total energy consumption is due to the residential sector. The aim is to enhance the environmental consciousness of the citizens through the following activities:

- Organization of "Energy days", in line with its participation in the Covenant of Mayors initiative. In these energy days the importance of energy saving and protecting the environment will be stressed, through simple actions such as modification of the energy behavior, changing incandescent lamps with fluorescent or LED lamps, importance of purchasing high energy class appliances, installation of solar panels for water heating in existing buildings etc.
- Projection of freely available environmental documentaries.
- Participation in "Earth hour" event by WWF, where people across the world turn their lights off for one hour on a designated day.

Two different penetration levels were assumed for the 1st and the 2nd scenario respectively.

Related calculations on the action in terms of initial cost and emission savings are presented in Table 32 below. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 32: Action 3.1 in numbers

| **Awareness raising activities for modification of the residents' consumption behavior** | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2025 | |
| Total Implementation Cost (JOD) | 60,000 | 75,000 |
| Annual Energy Savings (MWh) | 4,266.58 | 4,740.65 |
| Annual Emission Reduction (tn $CO_2$) | 2,811.68 | 3,124.09 |
| Funding Source | Own funds, governmental funds | |
| Net Present Value (NPV) | >>0 | |

### 3.4.2 Promotion of Green Buildings' concept / Strict Application of the Building Code

The lack of mandatory application of the Energy Efficient Building Code in Jordan is one of the key issues behind the moderate energy behavior of buildings in the country. This action is focusing only in new buildings, and has been developed around the two aforementioned scenarios.

The 1st scenario envisages the promotion of specific elements of the green buildings' concept that can lead to a reduction of approximately 25% against contemporary buildings and be applied in around 20% of the new buildings to be constructed. This 20% penetration level has

been considered an average rate with which citizens adopt such types of measures, following the intensive awareness raising activities to be realized by Karak Municipality. Also, the Municipality will proceed in consultations with the building constructors and try to establish voluntary agreements with them in order that they apply some minimum energy efficiency standards in the new constructions, to be commonly agreed. Customised sets of potential interventions and actions will be suggested to the citizens through info days and awareness activities in the local media (local newspapers, TV and radio), as well as distribution of dissemination material (flyers, brochures etc.), in line with the action described above. These interventions will be mainly focusing on the need to install shadings in the southern glazing and roof insulation, as well as paint the buildings' facade and roofs with cool colours, that reduce thermal absorption. Low cost efficient technologies will be promoted as well, such as the use of energy efficient lamps (e.g. LEDs). The green municipal building will serve as a demonstration basis of these technologies and the existing potential for energy and cost reductions.

The 2nd scenario focuses on the legislative adoption of the existing Energy Efficient Building Code, and its compulsory use for all new residential buildings. The penetration level of the current scenario is considered to cover 100% of the new buildings to be constructed within the 2030 horizon, while the envisaged savings against a contemporary building and the BAU scenario are approximately 40%.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 33: Action 3.2 in numbers

| Promotion of Green Buildings' concept / Strict application of the Building Code | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2019 - 2030 | |
| Total Implementation Cost (JOD) | 250,000 | 300,000 |
| Private Funds Mobilized (JOD) | 17,523,600 | 87,618,000 |
| Annual Energy Savings (MWh) | 3,837.67 | 30,701.35 |
| Annual Emission Reduction (tn $CO_2$) | 2,529.02 | 20,232.19 |
| Funding Source | Own funds, Governmental funds, Private funds | |
| Net Present Value (NPV) | <<0 | <<0 |

### 3.4.3 Campaign for promoting high energy label equipment

Another important activity the municipality should organize is the campaign for promoting among the residents the purchase and use of high energy label equipment. The old equipment (refrigerators, stoves, vacuum cleaners etc.) consumes greater amounts of energy compared to new, more technologically advanced. The aim is to inform the residents about the benefits of goods with a reduced environmental impact throughout their life cycle, emphasizing also on the monetary benefits for the users themselves, since when selecting energy efficient products this leads in less energy consumption as well. As presented in the previous sections, dedicated awareness raising activities should also take place in order to disseminate the advantages of purchasing such electrical appliances. Indicative awareness raising campaigns

include brief spots on the local TV and radio, posters, info days etc. Two different penetration levels were assumed for the 1st and the 2nd scenario respectively.

Key data on the action and its expected impact is presented in the table below.

Table 34: Action 3.3 in numbers

| Campaign for promoting high energy label equipment | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2023 | |
| Total Implementation Cost (JOD) | 100,000 | 150,000 |
| Private Funds Mobilized (JOD) | 3,247,000 | 5,411,700 |
| Annual Energy Savings (MWh) | 4,266.58 | 7,110.97 |
| Annual Emission Reduction (tn $CO_2$) | 2,811.68 | 4,686.13 |
| Funding Source | Own funds, Governmental funds, Private funds | |
| Net Present Value (NPV) | >0 | >0 |

### 3.4.4 2 MW/10 MW Photovoltaics in residential rooftops

As mentioned before, the solar energy potential is very high in the region. The households have the opportunity to install PV panels in the buildings' rooftops in order to substitute a part of the current electricity consumption with "green" energy from Renewable Energy Sources. Overall, 2 MW (1st scenario) and 10MW (2nd scenario) of PV panels respectively under each scenario are expected to be installed within the 2030 horizon. In that way, and since electricity from solar energy has zero emission factor, the $CO_2$ emissions will be reduced. Key data on the action are presented in the table below.

Table 35: Action 3.4 in numbers

| 2/10 MW Photovoltaics in residential rooftops | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2030 | |
| Private Funds Mobilized (JOD) | 2,000,000 | 10,000,000 |
| Annual Energy **Production** (MWh) | 3,397.13 | 16,985.64 |
| Annual Emission Reduction (tn $CO_2$) | 2,238.71 | 11,193.54 |
| Funding Source | Private funds, Loans | |
| Net Present Value (NPV) | >>0 | >>0 |

### 3.4.5 Replacing existing electric water heater with solar collectors

A standard permanent need in every household is the use of hot water for personal hygiene and house chores. Subsequently, currently a significant share of electricity consumption is consumed for this activity. At the same time, although the use of solar water heaters in the country is quite extensive, it is considered that it could be further strengthened in the future. In order to mitigate the emissions derived from this activity's electricity consumption the solution is to exploit the solar energy potential replacing the electric water heaters with solar water heaters.

A penetration level of the SWH in 30% (for the 14% target) and 45% (for the 40% target) respectively of the existing households currently using an electric water heater is envisaged, considering that Karak will work towards this direction with its citizens through awareness raising activities and dedicated events. Data on the energy savings from the use of a SWH per household have been retrieved from the "Jordan third national communication on climate change".

Table 36: Action 3.5 in numbers

| Replacing Existing Electric Water Heaters with Solar Collectors | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2025 | |
| Private Funds Mobilized (JOD) | 7,276,600 | 10,915,000 |
| Annual Energy **Production** (MWh) | 27,521.70 | 41,282.55 |
| Annual Emission Reduction (tn $CO_2$) | 18,136.80 | 27,205.20 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | >>0 | >>0 |

### 3.4.6 Replacement of existing lamps with LEDs

Currently, the use of LED lamps in the residential sector is relatively limited. The use of LED technology is suggested, since it can lead in energy and monetary savings on one hand, while these lamps provide great luminosity quality on the other. Their cost is higher from the conventional ones, but they have long life expectancy and a quite positive cost benefit ratio.

There are two scenarios envisaged for this action, focusing on lighting in existing buildings. Under the 1st scenario, it is expected that through the awareness raising activities citizens will be encouraged to implement measures like this with a penetration level of 30%, thus contributing to the energy savings and $CO_2$ reduction in the region.

Under the 2nd scenario, it is considered that Karak will take upon legislative action to ban the use of mercury and low efficiency lamps in the area. Thus, the penetration level for high efficient lamps such as LEDs has been considered 100%. Key data on the action are presented in the next table.

Table 37: Action 3.6 in numbers

| **Replacement of existing lamps with LEDs** | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2025 | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 1,237,000 | 3,711,000 |
| Annual Energy Savings (MWh) | 1,210.56 | 3,631.68 |
| Annual Emission Reduction (tn $CO_2$) | 797.76 | 2,393.27 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | >0 | >0 |

### 3.4.7 Replacement of existing air-conditioners with more efficient ones

The hot climate in the region evokes the intense use of cooling systems in buildings and as a result a quite big percentage of electricity consumption is due to this need. In order to cut

down the energy consumption the replacement of the existing A/Cs with units of higher energy class is suggested. Since A/Cs can constitute a significant part of the household's electricity bill, it is considered that within the 2030 horizon and following intensive awareness raising activities by the Municipality, the residents who are going to install/replace an A/C unit, will prefer one with relatively high performance standards. An overall penetration level of 25% of the action in existing households is assumed.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. The negative NPV means that the replacement of an existing operational appliance with a new isn't financially viable. However, in case the appliance has to be replaced due to operational failure etc., and only the additional cost of a highly efficient unit against a conventional one is considered, then the NPV for the additional cost realized against the envisaged savings is positive.

Table 38: Action 3.7 in numbers

| Replacement of existing conditioners with more efficient ones | |
|---|---|
| Duration | 2018 - 2025 |
| Private Funds Mobilized (JOD) | 5,154,000 |
| Annual Energy Savings (MWh) | 5,502.54 |
| Annual Emission Reduction (tn $CO_2$) | 3,626.17 |
| Funding Source | Private funds |
| Net Present Value (NPV) | <0 |

### 3.4.8 Use of cool colors in rooftops

As mentioned above, the share of electricity consumption by cooling systems in residences is very high due to the region's hot climate. Another measure to partially curtail the electricity consumption for cooling, besides the previous one, is the use of cool colors in rooftops or even the external walls in order to reflect a higher percentage of the absorbed heat, thus maintaining the inner temperature at lower levels. Use of cool colors and/or materials is a technology easily applied on the building, since its use is like any other regular paint. The energy savings from such an action are usually allocated in the top building floor and reach 20% of the electricity consumption for cooling purposes. The penetration level of this action in existing buildings is considered to be 10%. The Municipality's role once again is to communicate to the citizens the benefits of this action, also utilizing the demonstrative projects and other awareness activities to be conducted.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. Additional financial benefits (tax deductions, small grants etc.) towards the citizens realizing an energy efficiency investment with a negative NPV at the local or national level could be considered, in order to motivate them.

Table 39: Action 3.8 in numbers

| Use of cool colors in rooftops | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 549,700 |
| Annual Energy Savings (MWh) | 489.11 |
| Annual Emission Reduction (tn $CO_2$) | 322.33 |
| Funding Source | Private funds |
| Net Present Value (NPV) | <0 |

### 3.4.9 Replacement of single glazing with double

A supplementary action with limited but not negligible savings is glazing replacement. In Karak, although summers are very hot, in winter heating systems are required to achieve thermal comfort inside buildings. These heating systems consume LPG, Diesel and Kerosene and it is feasible to reduce their consumption by 15%, by reducing the building's heating losses via replacement of the single glazing with double. This action can also have impact in the electricity consumption, especially if it is to be combined with the installation of shading in the windows.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. Additional financial benefits (tax deductions, small grants etc.) towards the citizens realizing an energy efficiency investment with a negative NPV at the local or national level could be considered, in order to motivate them.

Table 40: Action 3.9 in numbers

| Replacement of single glazing with double | |
|---|---|
| Duration | 2018 - 2025 |
| Private Funds Mobilized (JOD) | 12,885,000 |
| Annual Energy Savings (MWh) | 351.82 |
| Annual Emission Reduction (tn $CO_2$) | 153.33 |
| Funding Source | Private funds |
| Net Present Value (NPV) | <<0 |

## 3.5 Tertiary Sector

This sector includes the energy consumption of commercial buildings, stores, offices, companies, schools, hospitals, hotels etc. regarding the activities in each one (lighting, heating, use of electric appliances etc.). This consumption constitutes the 26.36% of the total consumption, with 26.54% contribution to the $CO_2$ emissions.

The initial actions are informational and they will be realized by Karak Municipality. Municipality does not have the possibility of direct interventions in terms of projects' realization, thus a series of actions will be planned aiming at encourage building managers/owners to take the proposed measures in order to reduce their energy consumption and carbon emissions.

An overview of this sector's planned actions is presented in the next table.

Table 41: Actions in Tertiary Sector Buildings

| Action No. | Action | Emission Reductions (tn $CO_2$) | |
|---|---|---|---|
| | | Scenario 1 14% | Scenario 2 40% |
| 4.1 | Seminars and trainings on selected professional groups | 163.33 | |
| 4.2 | 10% energy reduction campaign in commercial buildings-Energy friendly label | 108.89 | |
| 4.3 | Promotion of green buildings concept/ Strict Application of the Building Code | 264.44 | 3,085.18 |

| | | | |
|---|---|---|---|
| 4.4 | Campaign for promoting high energy label equipment | 435.56 | |
| 4.5 | 10MW/20 MWp Photovoltaics in rooftops | 11,193.54 | 22,387.07 |
| 4.6 | Replacing existing electric water heater with solar collectors | 31.18 | 51,97 |
| 4.7 | Replacement of existing lamps with LEDs | 1,176.39 | 3,529.16 |
| 4.8 | Replacement of existing air conditioners with more efficient ones | 437.50 | |
| 4.9 | Use of cool colors in rooftops | 233.33 | |
| 4.10 | Installation of lighting automations & thermostats | 413.19 | |
| 4.11 | External shading installation | 175.00 | |
| 4.12 | Upgrade water facilities | 3,031.97 | |
| 4.13 | Awareness raising campaigns for pupils/ students | 58.93 | |
| 4.14 | The 10% voluntary campaign for energy reduction in schools | 3.95 | |
| | **Total** | **17,727.20** | **34,115.04** |

### 3.5.1 Seminars and trainings on selected professional groups

Lifelong learning activities are a key for the continuous evolvement of citizens and the society. Based on this fact, and taking into consideration the contribution of the tertiary sector on the municipality's carbon footprint, the municipality intends to organize a series of seminars to targeted professional groups in order to promote the concept of energy management and energy saving practices and provide advice on ways to improve the energy efficiency of the related buildings and facilities at low cost.

Karak is orientated towards the realization of a series of seminar rounds, where in each seminar a different group of interested stakeholders will participate. These seminars will be differentiated depending on the type of the group of stakeholders being represented, so different solutions will be suggested for small buildings/ shops/ companies, and alternative options will be provided for medium or large size ones.

Since key energy consumers in buildings of the tertiary sector are mainly HVAC and lighting, which consumption is highly determined by the energy behavior of the buildings' and facilities' users, suggested technical solutions per group of stakeholders may include simple modification of the users' energy behavior, installation of automations and thermostats, use of cool colors, replacement of lamps with LEDs etc.

An overall reach out level of 15% is considered for the above mentioned activities. Key data on the action is provided in the following table.

Table 42: Action 4.1 in numbers

| Seminars and trainings on selected professional groups | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 150,000 |
| Annual Energy Savings (MWh) | 247.85 |
| Annual Emission Reduction (tn $CO_2$) | 163.33 |
| Funding Source | Own funds, Governmental funds |

### 3.5.2 The 10% voluntary campaign for energy reduction in tertiary buildings

This campaign's aspiration is to establish environmental consciousness through the voluntary commitment of its citizens. It is designed in the form of a promotional campaign to increase the sense of responsibility towards the environment and the community among the citizens, while at the same time it will offer visibility benefits to those participating.

Karak Municipality will launch this program as a voluntary campaign, where shops and business owners can participate in order to reduce their facilities' energy and carbon footprint, and more importantly to reduce their electricity bill. Stakeholders who would like to participate will have to fill a form, potentially via the Municipality's website, and submit the last year's electricity bills for the respective building/facility. Moreover, participants will attend informational and educational events organized by Karak with advice on how to reduce building's energy consumption with simple actions. All the participants will also receive informational material as well. At the end of the year, participants will submit their electricity bills once more in order to prove at least a 10% of energy savings.

Subsequently, the Municipality will organize a ceremony to provide the "Energy friendly business label" to those who achieved the target of 10% reduction, while it will publish their brands' names in the local newspapers and /or magazines, as an example of good practices. A penetration level of 5% has been assumed for this initiative.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 43: Action 4.2 in numbers

| The 10% voluntary campaign for energy reduction in tertiary buildings | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 20,000 |
| Annual Energy Savings (MWh) | 165.23 |
| Annual Emission Reduction (tn $CO_2$) | 108.89 |
| Funding Source | Own funds & Governmental funds |

### 3.5.3 Promotion of green buildings concept/ Strict application of the Building Code

In line with the respective action of the residential sector, this action is targeted towards the new buildings to be constructed in the tertiary sector until the 2030 horizon, and has been developed around the two aforementioned scenarios.

The 1st scenario envisages the promotion of specific elements of the green buildings' concept that can lead to a reduction of approximately 20% against contemporary buildings and be applied in around 15% of the new buildings to be constructed. This 15% penetration level has been considered an average rate, following the intensive awareness raising activities to be realized by Karak Municipality. Also, the Municipality will proceed in consultations with the building constructors and try to establish voluntary agreements with them in order that they apply some minimum energy efficiency standards in the new constructions, to be commonly agreed. Customised sets of potential interventions and actions will be suggested to the citizens through info days and awareness activities in the local media (local newspapers, TV and radio), as well as distribution of dissemination material (flyers, brochures etc.). Emphasis will be placed on the optimal orientation of the building, the need for increased natural

lighting and natural ventilation, the inclusion of a minimum level of insulation in the buildings' exterior surfaces (walls and roof), as well as shading in the glazing. In addition to the above, the use of cool colors will also contribute significantly to the reduction of energy losses.

The 2nd scenario focuses on the legislative adoption of the existing Energy Efficient Building Code, and its compulsory use for all new tertiary buildings. The penetration level of the current scenario is considered to cover 100% of the new buildings to be constructed within the 2030 horizon, while the envisaged savings against a contemporary building and the BAU scenario are approximately 30%. This percentage has been considered on the basis that in tertiary buildings there is usually additional equipment use that is not affected by the building's behavior.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 44: Action 4.3 in numbers

| Promotion of green buildings concept/ Strict application of the Building Code | | |
|---|---|---|
| | Scenario 1<br>14% | Scenario 2<br>40% |
| Duration | 2019 - 2030 | |
| Total Implementation Cost (JOD) | The cost is included in the respective action in the Residential Sector | |
| Private Funds Mobilized (JOD) | 1,832,000 | 13,361,000 |
| Annual Energy Savings (MWh) | 401.28 | 4,681.61 |
| Annual Emission Reduction (tn $CO_2$) | 264.44 | 3,085.18 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | <<0 | <<0 |

### 3.5.4 Campaign for promoting high energy label equipment

Another important activity the municipality should organize is the campaigns for promoting high energy label equipment in the tertiary sector. The old electrical appliances consume significant energy amounts compared to newer technological options available. The aim is to inform business owners/managers about the benefits of goods with a reduced environmental impact throughout their life cycle. Selecting products of higher efficiency that minimize the environmental impacts, it is possible to consume less energy thus reduce the $CO_2$ emissions and achieve monetary savings. As mentioned above, awareness raising activities should also take place in order to disseminate the advantages of purchasing such electrical appliances.

Table 45: Action 4.4 in numbers

| Campaign for promoting high energy label equipment | |
|---|---|
| Duration | 2018 - 2023 |
| Total Implementation Cost (JOD) | 100,000 |
| Private Funds Mobilized (JOD) | 503,000 |
| Annual Energy Savings (MWh) | 660.93 |
| Annual Emission Reduction (tn $CO_2$) | 435.56 |
| Funding Source | Private funds |
| Net Present Value (NPV) | >0 |

### 3.5.5 10/20 MWp Photovoltaics in rooftops

The solar energy potential for the country and Karak region is very high thus businesses will be encouraged to exploit this opportunity and install PVs in order to curtail a part of their electricity consumption. The utilization of rooftops is proposed for the installation of a total capacity of 10 MW of PVs (for the 14% target) and 20 MW respectively (for the 40% target). The produced electricity from Renewable Energy Sources like sun has zero emission factor. Consequently the substitution of electricity production source with alternative ones will contribute to the $CO_2$ reduction.

Table 46: Action 4.5 in numbers

| Photovoltaics in rooftops 10/15 MWp | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2030 | |
| Private Funds Mobilized (JOD) | 10,000,000 | 20,000,000 |
| Annual Energy **Production** (MWh) | 16,985.64 | 33,971.28 |
| Annual Emission Reduction (tn $CO_2$) | 11,193.54 | 22,387.07 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | >>0 | >>0 |

### 3.5.6 Replacing existing electric water heater with solar collectors

Several businesses activated in the tertiary sector, such as hospitals and hotels, utilize extensively water heating for covering theirs and their customers' needs. Since the penetration of SWH in the sector in the baseline year was negligible, there is a significant potential for electricity savings through the adoption of SWH. Two different penetration levels were assumed for the 1st and the 2nd scenario respectively.

Key data on the action are presented in the following table.

Table 47: Action 4.6 in numbers

| Replacing existing electric water heater with solar collectors | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2025 | |
| Private Funds Mobilized (JOD) | 12,500 | 20,800 |
| Annual Energy Production (MWh) | 47.31 | 78.86 |
| Annual Emission Reduction (tn $CO_2$) | 31.18 | 51.97 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | >0 | >0 |

### 3.5.7 Replacement of existing lamps with LEDs

Similarly to the respective action in the residential sector, there are two scenarios envisaged for this action, focusing on lighting in existing buildings. Under the 1st scenario, it is expected that through the awareness raising activities business owners and building managers will be encouraged to implement measures like this with a penetration level of 30%, thus contributing to the energy savings and $CO_2$ reduction in the region.

Under the 2nd scenario, it is considered that Karak will take upon legislative action to ban the use of mercury and low efficiency lamps in the area. Thus, the penetration level for high efficient lamps such as LEDs has been considered 100%.

Key data on the action are provided in the below table.

Table 48: Action 4.7 in numbers

| Replacement of existing lamps with LEDs | | |
|---|---|---|
| | 1st Scenario 14% | 2nd Scenario 40% |
| Duration | 2018 - 2025 | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 1,824,000 | 5,472,000 |
| Annual Energy Savings (MWh) | 1,785.11 | 5,355.33 |
| Annual Emission Reduction (tn $CO_2$) | 1,176.39 | 3,529.16 |
| Funding Source | Private funds | |
| Net Present Value (NPV) | >0 | >0 |

### 3.5.8 Replacement of existing air conditioners with more efficient ones

The hot climate in the region of Karak evokes the intense use of cooling systems in buildings and as a result, a very big percentage of electricity consumption especially in the tertiary sector is required in order to cover this need. In order to cut down the energy consumption, the replacement of the existing A/Cs with units of higher energy class until the 2030 horizon is suggested. This action leads to significant energy savings and $CO_2$ reduction. An overall penetration level of 25% of the action in existing tertiary sector businesses is assumed. Key data on the action are provided in the table below. The negative NPV for the replacement of an operational appliance means that this action is not viable. However, in case the appliance has to be replaced due to operational failure etc., and only the additional cost of a highly efficient unit against a conventional one is considered, then the NPV for the additional cost realized against the envisaged savings is positive.

Table 49: Action 4.8 in numbers

| Replacement of existing air conditioners with more efficient ones | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 746,000 |
| Annual Energy Savings (MWh) | 663.88 |
| Annual Emission Reduction (tn $CO_2$) | 437.50 |
| Funding Source | Private funds |
| Net Present Value (NPV) | <0 |

### 3.5.9 Use of cool colors in rooftops

The share of electricity consumption by cooling systems in tertiary buildings is very high due to the hot climate the region has. A measure to reduce this consumption is the use of cool colors in rooftops or even the external walls in order to protect the interior from the excessive heating thus maintain the inner temperature as low as it is possible. Use of cool colors and/or materials can be easily applied on the building, since its use is like any other regular paint. The energy savings from such an action are usually allocated in the top building floor and reach 20% of the electricity consumption for cooling purposes. The penetration level of this action

in existing buildings is considered to be 20%, since it is an action with significant monetary savings. The Municipality's role once again is to communicate to the citizens the benefits of this action, also utilizing the demonstrative projects and other awareness activities to be conducted.

Related calculations on the action in terms of initial cost and emission savings are presented in the table below. As mentioned before, potential financial motives at the local or national level could be offered to the investors realizing such actions, in order to curtail part of the initial cost and make it more attractive to them.

Table 50: Action 4.9 in numbers

| Use of cool colors in rooftops | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 553,000 |
| Annual Energy Savings (MWh) | 354.07 |
| Annual Emission Reduction (tn $CO_2$) | 233.33 |
| Funding Source | Private funds |
| Net Present Value (NPV) | <0 |

### 3.5.10 Installation of lighting automations & thermostats

Light and heat automations are one of the most cost effective and simple options for the proper control and reduction of the energy related costs in the tertiary sector, as it is a very usual phenomenon for the users to leave cooling equipment/lights etc. turned on upon their departure, or adjust the thermostat in improper temperatures, resulting in unnecessary consumptions. A solution to this is the installation of automations such thermostats, timers, movement sensors etc. In this way, the occupants are being monitored and consumptions outside the normal office working hours are being avoided. Since automations are considered a value for money investment, it has been assumed that the penetration of the action within the 2030 horizon will reach 25%.

Key data on the action are provided in the table below.

Table 51: Action 4.10 in numbers

| Installation of lighting automations & thermostats | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 9,000 |
| Annual Energy Savings (MWh) | 627.00 |
| Annual Emission Reduction (tn $CO_2$) | 413.19 |
| Funding Source | Private funds |
| Net Present Value (NPV) | >0 |

### 3.5.11 External shading installation

The sunlight coming through windows increases the buildings' indoor temperature and consequently the use of A/Cs and other cooling systems during the summer months, when the climate conditions in Karak are especially challenging. Installation of shadings in existing buildings constitutes a significant measure since it can prevent part of the heating due to sunlight and thus limit the energy consumption of the cooling systems. It is considered that such an investment can lead to significant energy savings and improvement of the living

conditions in these buildings. A penetration level of 20% in the existing buildings has been considered until 2030.

Table 52: Action 4.11 in numbers

| External shading installation | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 18,100 |
| Annual Energy Savings (MWh) | 265.55 |
| Annual Emission Reduction (tn $CO_2$) | 175.00 |
| Funding Source | Private funds |
| Net Present Value (NPV) | >0 |

### 3.5.12 Upgrade water facilities

Jordan has one of the highest levels of water scarcity globally. The water demand is high due to the agriculture and domestic use and in parallel the grid has many defects. It has been recorded that water losses are higher than 50%, a percentage which means that the grid necessitates improvement in order to mitigate the very significant water loss, as well as energy losses through water pumping. An efficient measure is the installation of a SCADA system. In case of a damage/leakage in the grid the amount of lost water is huge until someone detect the problem and locate it. SCADA includes sensors installed in different parts of the grid as well as a central system which receives data from them. In that way water level, pumping rate and pressure will be monitored and thus it will be feasible to detect the possible leakages and immediately restore grid's functionality. SCADA may save a 20% of electricity consumption for pumping water and is proposed to be installed gradually in the water grid.

Table 53: Action 4.12 in numbers

| Upgrade water facilities | |
|---|---|
| Duration | 2018-2025 |
| Private Funds Mobilized (JOD) | 4,000,000 |
| Annual Energy Savings (MWh) | 4.600,86 |
| Annual Emission Reduction (tn $CO_2$) | 3.031,97 |
| Funding Source | Private funds and Loans |
| Net Present Value (NPV) | >0 |

### 3.5.13Awareness raising campaigns for pupils/ students

Apart from the suggested actions above, this action has been designed as a supplementary action for schools. Awareness raising activities will be designed and carried out by the education department of the municipality, utilizing also available educational material. Schools will be educating the students through lessons and thematic energy days, where dedicated professionals will be invited as well to explain the benefits for the environment and the significance of preserving energy. Moreover, through all awareness raising and capacity building activities realised, schoolchildren will put the corner stone for building an environmental consciousness and adopt an energy efficient behavior in their houses and as adults.

The action includes the development of explanatory brochures, the implementation of a thematic energy day, excursions to energy saving projects in the municipality to show case

the technologies and their results, as well as a drawing or essay contest on what the environment and energy means to them. Through activities and games, students can be informed about the climate change and its intense repercussion in environment and form a proper energy behavior while developing environmental consciousness.

Table 54: Action 4.13 in numbers

| Awareness raising campaigns for pupils/ students | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 30,000 |
| Annual Energy Savings (MWh) | 89.42 |
| Annual Emission Reduction (tn $CO_2$) | 58.93 |
| Funding Source | Own funds |

### 3.5.14 The 10% voluntary campaign for energy reduction in schools

Another set of action focusing on schools is the 10% commitment campaign since students will have already embraced the basic practices from the previous awareness raising. This ambitious action will be realised to promote the environmental consciousness and personal responsibility against the environment and society among the students.

This campaign is a voluntary action, where schools choose to commit to a target of at least 10% reduction. This action is strictly based on modification of the energy behavior of the students and the teachers, without any investments on energy efficiency equipment. This campaign can also take the form of a contest between the different participating schools, on identifying the one achieving the highest energy saving percentage.

The achieved energy savings will be validated against the energy bills and the meters' readings, while the schools that achieve the commitment will receive an honorary praise. The school to win the contest and its students will receive the School Energy Cup by the Mayor in an open ceremony, while the financial resources saved for the municipality will be invested in the school for simple energy efficient projects (automations etc.).

This campaign will be rolled out at the same time with the one targeting the business sector, minimizing the organizational burden to the possible minimum.

Table 55: Action 4.14 in numbers

| The 10% voluntary campaign for energy reduction in schools | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 20,000 |
| Annual Energy Savings (MWh) | 6.00 |
| Annual Emission Reduction (tn $CO_2$) | 3.95 |
| Funding Source | Own funds |

## 3.6 Transport

The share of the Transportation sector, including the municipal fleet, private and commercial transport and public transport is 28.25% out of the total energy consumption in Karak Municipality, with 11.95% contribution in $CO_2$ emissions. The proposed actions are presented in the next table and a more detailed analysis for each one is following.

Table 56: Actions in Transport

| Action No. | | Action | Emission Reductions (tn $CO_2$) |
|---|---|---|---|
| 5.1 (F) | Municipal fleet | Replacement of old municipal diesel vehicles with new efficient vehicles | 288.00 |
| 5.2 | | Installation of tracking and monitoring system for more efficient management of the fleet and better planning routes | 203.91 |
| 5.3 | | Municipal fleet maintenance | 265.09 |
| 5.4 | | Eco-driving seminars for the municipal fleet drivers | 326.26 |
| 5.5 | Private & Commercial Transport | Information events on the new vehicle technologies | 0.00 |
| | | *Replacement of gasoline vehicles with Hybrid* | 662.77 |
| | | *Replacement of diesel vehicles with new more efficient* | 429.65 |
| 5.6 | | Improve public transportation/ promote the use of public transport | 1,104.62 |
| 5.7 | | Promotion of walking and car sharing and carpooling campaigns | 927.88 |
| 5.8 | | Improvement / development of parking infrastructure | 994.16 |
| 5.9 | | Promotion of eco-driving for the private and commercial transport | 1,308.17 |
| 5.10 | | Transportation master plan | 0,00 |
| 5.11 | Public | Promotion of eco-driving for public transport's drivers | 107.09 |
| 5.12 | | Promotion of new technology buses in the public transportation | 22.59 |
| 5.13 | | Replacing the existing Taxi vehicles with Hybrid vehicles | 12.37 |
| | | Total | **6,652.57** |

### 3.6.1 Replacement of old municipal diesel vehicles with new efficient vehicles

Municipal fleet consists of 107 vehicles of which 20 pick-ups and 10 garbage vehicles are considered old (more than 15 years). These vehicles consume more diesel since their engine is old and of low efficiency and consequently they need to be replaced with new ones. This is a way to contribute to fuels savings and $CO_2$ reduction.

This action constitutes a priority for the municipality, and for this reason is developed in detail in the project fiche “Replacing the old Municipal diesel vehicles with new efficient vehicles”.

Table 57: Action 5.1 in numbers

| Replacement of old municipal diesel vehicles with new efficient vehicles | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 659,464 |
| Annual Energy Savings (MWh) | 1,079.00 |
| Annual Emission Reduction (tn $CO_2$) | 288.00 |
| Funding Source | Own funds & National Grants |
| Net Present Value (NPV) | <0 |

### 3.6.2 Installation of Global Positioning System devices for more efficient management of the fleet and better planning routes

The aim of this action is to increase operational efficiency while reducing environmental impact. Installation of GPS systems constitutes a great measure in order for the municipality to monitor the vehicles' routes and optimize them. GPS should be loaded with the best routes based on the services each vehicle offers. In that way the vehicles will consume less fuel which leads in monetary savings and $CO_2$ reductions.

Table 58: Action 5.2 in numbers

| Installation of Global Positioning System devices for more efficient management of the fleet and better planning routes | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 33,600 |
| Annual Energy Savings (MWh) | 764.28 |
| Annual Emission Reduction (tn $CO_2$) | 203.91 |
| Funding Source | Own funds and EU Funds |
| Net Present Value (NPV) | >0 |

### 3.6.3 Municipal fleet maintenance

Regular and proper maintenance of the municipal fleet can yield significant energy savings, ensure the proper operation of the vehicles and prevent costly damages. The vehicles are already maintained but the target of this action is to create a plan so as to realize the maintenance in a better organized manner, giving priority to those that are in more frequent use, while ensuring that all related service works are conducted on time. Moreover these measures proposed to be implemented during the forthcoming years as well, for every new acquisition. Therefore, this action is focused on the existing fleet, as well as any new vehicles to be purchased.

Table 59: Action 5.3 in numbers

| Municipal fleet maintenance (for the existing & the new ones) | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 321,600 |
| Annual Energy Savings (MWh) | 993.56 |
| Annual Emission Reduction (tn $CO_2$) | 265.09 |
| Funding Source | Own funds |
| Net Present Value (NPV) | >0 |

### 3.6.4 Eco-driving seminars for the municipal fleet drivers

Eco-driving comprises a set of actions, something like "behavioral changes", regarding the way someone drives. The adoption of these principles by the municipal fleet's drivers is considered a good way to decrease the fuel consumption. The effectiveness depends upon the seminars and trainings Municipality will organize, as well as their repeatability to ensure that every single driver will understand the tips and implement the advices.

Related calculations on the action in terms of initial cost and emission savings are presented in next table. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 60: Action 5.4 in numbers

| Eco-driving seminars for the drivers of the municipal fleet | |
|---|---|
| Duration | 2018 - 2023 |
| Total Implementation Cost (JOD) | 30,000 |
| Annual Energy Savings (MWh) | 1,222.85 |
| Annual Emission Reduction (tn $CO_2$) | 326.26 |
| Funding Source | Own funds |
| Net Present Value (NPV) | >>0 |

### 3.6.5 Information events on the new vehicle technologies

Private and commercial vehicles have the larger share in energy consumption between the other transports. It is proposed that the Municipality will organize awareness raising activities in order to inform the citizens about new technology's cars and the double fuel cars followed by their economic and environmental benefits. The next step will be citizens purchasing these cars instead of conventional ones, for instance replacing gasoline cars with hybrid or diesel vehicles with more efficient ones.

Table 61: Action 5.5 in numbers

| Information events on the new vehicle technologies | |
|---|---|
| Duration | 2018 – 2025 |
| Total Implementation Cost (JOD) | 100,000 |
| Private Funds Mobilized (JOD) | 4,700,000 |
| Annual Energy Savings (MWh) | 4,270.89 |
| Annual Emission Reduction (tn $CO_2$) | 1,092.42 |
| Funding Source | Own and Governmental funds, Private funds |
| Net Present Value (NPV) | <<0 (for Hybrids), >0 (for diesel) |

### 3.6.6 Improve public transportation/ promote the use of public transport

The envisaged master plan aims to identify the routes which are not adequately serviced so as to establish new ones or enhance the frequency of the existing routes. The general approach is to connect the highways, establish bus stops near schools and other points of interest regularly visited by citizens. One of the municipality's priorities is to increase pupils' mobility while ensuring safety, thus ease congestion made by parents' cars picking up their children. Additional modifications to increase the transit possibilities for workers will be realized according to the master plan suggestions.

On the other hand, there should be efforts to promote the use of the improved public transport by the inhabitants via awareness raising events thus achieving energy savings and $CO_2$ reductions.

Table 62: Action 5.6 in numbers

| Improve public transportation/ promote the use of public transport | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 200,000 |
| Annual Energy Savings (MWh) | 4,436.22 |
| Annual Emission Reduction (tn $CO_2$) | 1,104.62 |
| Funding Source | Own & Governmental Funds |

### 3.6.7 Promotion of walking and car sharing and carpooling campaigns

This action is focused on a different series of activities that will promote walking across the municipality. Such activities include:

- Installation of walking signs throughout the city, informing the citizen on the distance and time required to reach the municipality's key sites. Optionally, the signs could also include info on the calories required to cross such a distance.
- Improvement of the pavements and making them friendlier for walking. This can be achieved with better maintenance (replacement of damaged or broken flagstone tiles), enlargement of the pavement where considered feasible or even planting of trees and flowers.
- Creation of pedestrian roads, especially in the commercial zone, or close to low circulation roads.
- Renovation of parks or other public areas (squares etc.) which will offer shade and resting spots, making them more attractive to the citizens.
- Large scale awareness campaign on walking, presenting the benefits for the health and the environment.

The cost of the proposed actions is significant high and there will be need for funding, since it constitutes an infrastructure action. However it will contribute to the enhancement of living conditions. Additional indirect benefits should be considered for the project's profitability such as attraction of residents and tourists to the municipality and improvement of quality of life. Therefore, it is considered necessary for the city, even though it brings no economic profit directly to the municipal authorities. For more convenience, a mobile application could also be developed.

In other cases, where the distances are larger, for instance the commutes, it would be a great alternative way for people working together (or in nearby buildings) to arrange driving to work in groups, using one car. Here, it might be useful the municipal website which can serve to let people with same transport habits to communicate and organize their trips.

Table 63: Action 5.7 in numbers

| Promotion of walking and car sharing and carpooling campaigns | |
|---|---|
| Duration | 2018 - 2025 |
| Total Implementation Cost (JOD) | 30,000 |
| Annual Energy Savings (MWh) | 3,726.42 |
| Annual Emission Reduction (tn $CO_2$) | 927.88 |
| Funding Source | Own and Governmental funds |

### 3.6.8 Improvement / development of parking infrastructure

Traffic congestion is a problem within Karak Municipality. Therefore, in order to decrease the time and fuel spent by the drivers in their attempt to find a parking space, the Municipality intends to improve/extend the existing parking infrastructure and develop new ones where required. More specifically, the plan is to develop large parking lots in the outskirts of the center, and have municipal shuttles to the center and the industrial center.

Table 64: Action 5.8 in numbers

| Improvement / development of parking infrastructure | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 320,000 |
| Annual Energy Savings (MWh) | 3,992.60 |
| Annual Emission Reduction (tn $CO_2$) | 994.16 |
| Funding Source | Own and Governmental funds |

### 3.6.9 Promotion of eco-driving for the private and commercial transport

As it is mentioned in the municipal fleet's actions, the principles of eco-driving are a measure which can lead in significant decrease of fuel consumption. The role of the municipality here is to organize awareness raising activities and regular trainings for the drivers of private and commercial transport so as to make the citizens be aware its environmental and economic benefits.

Table 65: Action 5.9 in numbers

| Promotion of eco-driving for the private and commercial transport | |
|---|---|
| Duration | 2018 - 2023 |
| Total Implementation Cost (JOD) | 40,000 |
| Annual Energy Savings (MWh) | 5,079.23 |
| Annual Emission Reduction (tn $CO_2$) | 1,308.17 |
| Funding Source | Own and Governmental funds |

### 3.6.10 Transportation master plan

The transportation master plan is the key to success for all activities envisaged in the transportation sector, so that the activities are coherent and not simply segmented ideas. In this respect, this master plan constitutes the city's blueprint for planning, developing and operating its walking, cycling, transit and road networks over the coming decades.

The plan has a twofold objective. On one hand to improve mobility and access in the city in a way that is safe and convenient and on the other hand to do so by minimizing auto congestion, air pollution, and noise. Key areas of focus for the current plan will include integrating the concept of complete streets, updating modal share targets, advancing strategies to improve walking and cycling, and supporting transit-oriented development. The plan will also identify a number of modifications to road and transit infrastructure priorities to account for adjustments in growth patterns, emerging issues and strategic opportunities.

The implementation of this study is not considered to derive direct energy savings and $CO_2$ reduction benefits, but it is seen as a prerequisite for the rest of the actions in the sector.

Table 66: Action 5.10 in numbers

| Transportation master plan | |
|---|---|
| Duration | 2018 - 2023 |
| Total Implementation Cost (JOD) | 100,000 |
| Funding Source | Own & Governmental funds |

### 3.6.11 Promotion of eco-driving for public transport's drivers

Focusing now on the Public Transportation sector, the first proposed action is the promotion of eco driving. Similarly with the two previous sectors, public transport's drivers may be encouraged to adapt eco-driving principles in order to reduce fuel consumption and $CO_2$ emissions from the public fleet. This can be achieved through raising awareness activities and trainings realized by the municipality.

Table 67: Action 5.11 in numbers

| Promotion of eco-driving for public transport's drivers | |
|---|---|
| Duration | 2018 – 2023 |
| Total Implementation Cost (JOD) | 5,000 |
| Annual Energy Savings (MWh) | 405.62 |
| Annual Emission Reduction (tn $CO_2$) | 107.09 |
| Funding Source | Own funds |

### 3.6.12 Promotion of new technology buses in the public transportation

Karak Municipality will be in close collaboration with the public transportation companies' representatives, in order to promote as much as possible new technology vehicles that are highly efficient. Replacing old buses with new more efficient is a way to achieve energy savings and emissions' reduction since these vehicles consume less fuel while they perform same or even better compared to the previous ones.

This action has no cost for the municipality and is expected to contribute significantly in its carbon footprint's reduction.

Table 68: Action 5.12 in numbers

| Promotion of new technology buses in the public transportation | |
|---|---|
| Duration | 2018 - 2030 |
| Total Implementation Cost (JOD) | 50,000 |
| Private Funds Mobilized (JOD) | 18,400 |
| Annual Energy Savings (MWh) | 84.62 |
| Annual Emission Reduction (tn $CO_2$) | 22.59 |
| Funding Source | Private funds |
| Net Present Value (NPV) | >0 |

### 3.6.13 Replacing the existing Taxi vehicles with Hybrid vehicles

The inefficiencies of today's transportation systems can translate into deteriorating service, excess cost, energy use and environmental impact. The old taxis which consume gasoline, should be replaced with Hybrids in order to achieve higher energy efficiency and thus fuel and

monetary savings. This action is envisaged through the provision of the respective legislative framework that supports exemptions for replacing taxis with Hybrid cars.

Table 69: Action 5.16 in numbers

| Replacing the existing Taxi vehicles with Hybrid vehicles | |
|---|---|
| Duration | 2018 - 2030 |
| Private Funds Mobilized (JOD) | 2,100 |
| Annual Energy Savings (MWh) | 49.69 |
| Annual Emission Reduction (tn $CO_2$) | 12.37 |
| Funding Source | Private funds |
| Net Present Value (NPV) | >0 |

## 3.7 Local Renewable Energy Production

Besides the above mentioned small scale RES projects by private investors and Karak Municipality, there are also plans for a big scale Renewable Energy Project which will significantly contribute to the region's $CO_2$ reduction. More specifically a Wind Farm of 3MW is planned to be installed in Karak Municipality. Furthermore, in order for the 40% (2nd scenario) to be achieved, another wind farm is proposed to be installed since the wind potential in Karak region is adequate for a project like this to operate.

In the next table, figures about the respective electricity production and $CO_2$ reduction are presented.

Table 70: RES projects

| | Electricity Production (MWh) | Emission Reduction (tn $CO_2$) |
|---|---|---|
| Wind Farm 3MW (planned) -included in both scenarios | 10,256.41 | 6,758.97 |
| Wind Farm 2MW (proposed) -included in 2nd scenario (40%) | 6,837.61 | 4,505.98 |
| Total (40%) | 17,094.02 | 11,264.96 |

## 3.8 Actions' Overview

In the next table the complete list of the SECAP Actions is presented followed by the respective energy savings/production and the CO2 reduction.

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| Municipal buildings | 1.1 | Green procurement procedures for municipal buildings and facilities | 428,79 | | 282,57 |
| | 1.2 | Energy manager appointment in the municipality | 25.52 | | 16.82 |
| | 1.3 | Awareness raising activities for municipal employees | 81.67 | | 53.82 |
| | 1.4 | Adoption of bioclimatic principles in municipal buildings /Strict application of green building codes in municipal buildings | 433.89 (14%) | | 285.93 (14%) |
| | | | 1,041.34 (40%) | | 686.24 (40%) |
| | 1.5 | Efficient municipal buildings | 1,500.00 | 850.00 | 1,549.00 |
| | 1.6 | Promotion of recycling | | | 1,592.17 |
| | 1.7 | Waste management | | 14,400.00 | 31,338.00 |
| | 1.8 | PV plant 3 MW (for municipal buildings and street lighting | | 5,098.00 | 3,359.58 |
| | 1.9 | Establishment of Energy Saving Department | | | 0.00 |
| | 1.10 | Web portal creation | | | 0.00 |
| | | Total | 2,469.87 (14%) | 20,348.00 | 38,477.90 (14%) |
| | | | 3,077.32 (40%) | | 38,878.21 (40%) |
| Street Lighting | 2.1 | Street lighting upgrade | 3,893.50 | | 2,565.82 |
| | 2.2 | Astronomical timers | 1,479.79 | | 975.18 |
| | 2.3 | Green procurement procedures for the future lighting equipment | 1,996.54 | | 1,315.72 |
| | | Total | 7,369.82 | 0.00 | 4,856.71 |
| Residential Buildings | 3.1 | Awareness raising activities for modification of the residents' consumption behavior | 4,266.58 (14%) | | 2,811.68 (14%) |
| | | | 4,740.65 (40%) | | 3,124.09 (40%) |
| | 3.2 | Promotion of Green Buildings' concept / Strict application of the building code | 3,837.67 (14%) | | 2,529.02 (14%) |
| | | | 30,701.35 (40%) | | 20,232.19 (40%) |
| | 3.3 | Campaign for promoting high energy label equipment and other awareness activities | 4,266.58 (14%) | | 2,811.68 (14%) |
| | | | 7,110.97 (40%) | | 4,686.13 (40%) |
| | 3.4 | 2MW/10 MW Photovoltaics in residential rooftops | | 3,397.13 (14%) | 2,238.71 (14%) |
| | | | | 16,985.64 (40%) | 11,193.54 (40%) |
| | 3.5 | | | 27,521.70 | 18,136.80 |

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| | | Replacing existing electric water heater with solar collectors | | (14%) | (14%) |
| | | | | 41,282.55 (40%) | 27,205.20 (40%) |
| | 3.6 | Replacement of existing lamps with LEDs | 1,210.56 (14%) | | 797.76 (14%) |
| | | | 3,631.68 (40%) | | 2,393.27 (40%) |
| | 3.7 | Replacement of existing air-conditioners with more efficient ones | 5,502.54 | | 3,626.17 |
| | 3.8 | Use of cool colors in rooftops | 489.11 | | 322.33 |
| | 3.9 | Replacement of single glazing with double | 351.82 | | 153.33 |
| | | | 19,924.87 (14%) | 30,918.83 (14%) | 33,427.48 (14%) |
| | | Total | 52,52812 (40%) | 58,268.19 (40%) | 72,936.25 (40%) |
| Tertiary buildings | 4.1 | Seminars and trainings on selected professional groups | 247.85 | | 163.33 |
| | 4.2 | 10% energy reduction campaign in commercial buildings-Energy friendly label | 165.23 | | 108.89 |
| | 4.3 | Promotion of green buildings concept | 401.28 (14%) | | 264.44 (14%) |
| | | | 4,681.61 (40%) | | 3,085.18 (40%) |
| | 4.4 | Campaign for promoting high energy label equipment | 660.93 | | 435.56 |
| | 4.5 | 10/20 MWp Photovoltaics in rooftops | | 16,985.64 (14%) | 11,193.54 (14%) |
| | | | | 33,971.28 (40%) | 22,387.07 (40%) |
| | 4.6 | Replacing existing electric water heater with solar collectors | | 47.31 (14%) | 31.18 (14%) |
| | | | | 78.86 (40%) | 51.97 (40%) |
| | 4.7 | Replacement of existing lamps with LEDs | 1,785.11 (14%) | | 1,176.39 (14%) |
| | | | 5,355.33 (40%) | | 3,529.16 (40%) |
| | 4.8 | Replacement of existing air conditioners with more efficient ones | 663.88 | | 437.50 |
| | 4.9 | Use of cool colors in rooftops | 354.07 | | 233.33 |

| | | Action | Energy Savings (MWh) | Energy production (MWh) | Emission Reduction (tn) |
|---|---|---|---|---|---|
| | 4.10 | Installation of lighting automations & thermostats | 627.00 | | 413.19 |
| | 4.11 | External shading installation | 265.55 | | 175.00 |
| | 4.12 | Upgrade water facilities | 4,600.86 | | 3,031.97 |
| | 4.13 | Awareness raising campaigns for pupils/ students | 89.42 | | 58.93 |
| | 4.14 | The 10% voluntary campaign for energy reduction in schools | 6.00 | | 3.95 |
| | | | 9,867.20 (14%) | 17,032.95 (14%) | 17,727.20 (14%) |
| | | Total | 17,717.76 (40%) | 34,050.14 (40%) | 34,115.04 (40%) |
| Municipal fleet | 5.1 | Replacement of old municipal diesel vehicles with new efficient vehicles | 1,079.00 | | 288.00 |
| | 5.2 | Installation of Global Positioning System devices for more efficient management of the fleet and better planning routes | 764.28 | | 203.91 |
| | 5.3 | Municipal fleet maintenance (for the existing & the new ones) | 993.56 | | 265.09 |
| | 5.4 | Eco-driving seminars for the drivers of the municipal fleet | 1,222.85 | | 326.26 |
| | | Total | 4,059.69 | | 1,083.26 |
| Private & Commercial Transport | 5.5 | Information events on the new vehicle technologies | 0.00 | | 0.00 |
| | | *Replacement of gasoline vehicles with Hybrid* | *2,661.73* | | *662.77* |
| | | *Replacement of diesel vehicles with new more efficient* | *1,609.16* | | *429.65* |
| | 5.6 | Improve public transportation/ promote the use of public transport | 4,436.22 | | 1,104.62 |
| | 5.7 | Promotion of walking and car sharing and carpooling campaigns | 3,726.42 | | 927.88 |
| | 5.8 | Improvement / development of parking infrastructure | 3,992.60 | | 994.16 |
| | 5.9 | Promotion of eco-driving for the private and commercial transport | 5,079.23 | | 1,308.17 |
| | 5.10 | Transportation master plan | 0.00 | | 0.00 |
| | | Total | 21,505.35 | | 5,427.24 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Public transport | 5.11 | Promotion of eco-driving for public transport's drivers | | 405.62 | | 107.09 |
| | 5.12 | Promotion of new technology buses in the public transportation | | 84.62 | | 22.59 |
| | 5.13 | Replacing the existing Taxi vehicles with Hybrid vehicles | | 49.69 | | 12.37 |
| | | Total | | 539.93 | | 142.06 |
| | | *Total transportation* | | *26,104.98* | | *6,652.57* |
| Local Renewable Energy Production | 6.1 | Wind Farm 3 MW | | | 10,256.41 *(both scenarios)* | 6,758.97 (both scenarios) |
| | 6.2 | Wind farm 2 MW | | | 6,837.61 (40%) | 4,505.98 (40%) |
| | | Total | | | 17,094.02 (40%) | 11,264.96 (40%) |
| | | ***TOTAL*** | ***14%*** | ***65,736.74*** | ***78,556.19*** | ***107,900.84*** |
| | | | ***40%*** | ***106,798.00*** | ***129,760.35*** | ***168,703.74*** |

Regarding the costs, for the 1st scenario (14%) the total cost for the Karak Municipality derives 25.1 million JOD approximately whereas for the private sector is 69.4 million JOD approximately. For the 2nd scenario (40%) the total cost for the Municipality derives 25.7 million JOD approximately and for the private sector derives 180.9 million JOD approximately, without considering the costs for the big scale RES projects.

It should be noted that in line with the actions described above, the 1st Scenario ensures the reduction of emissions by 25.37%, while the 2nd Scenario envisages an overall reduction of 40.02% of the BAU emissions. In order to achieve the 40% target, the Karak Municipality and the Government should place intensive and consecutive efforts towards the strict implementation of the SECAP and seek for agreements and grants with national and international organizations.

## 3.9 Monitoring

Monitoring of the Municipality's progress against the set targets is very significant, especially since it has to be realised in a frequent basis. The following table includes the suggested indicators to monitor each action's progress against the initial objectives, in order any deviations from the target to be noticed quickly, and appropriate correction measures to be taken.

These indicators will be also utilised during the production of the actions' monitoring report in line with the Covenant of Mayors requirements, as well as common practice, in order to demonstrate the achieved progress and results.

| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| **Municipal buildings** | | | |
| 1.1 | Green procurement procedures for municipal buildings | • Number of equipment bought with green procurement procedures | • Equipment number/year |
| 1.2 | Energy manager appointment in the municipality | • Years that the Energy Manager is appointed and active<br>• Quantity of municipal infrastructure under his supervision<br>• Energy savings under his supervision | • Number of years<br>• Number and % of municipal infrastructure being supervised<br>• KWh |
| 1.3 | Awareness raising activities for municipal employees | • Number of training seminars that were implemented<br>• Municipal employees that were trained | • Number of seminars<br>• Number of employees |
| 1.4 | Adoption of bioclimatic principles in municipal buildings /Strict application of green building codes in municipal buildings | • Number of new buildings with bioclimatic principles | • Number of buildings |
| 1.5 | Efficient municipal buildings | • Installed capacity of PVs<br>• Percentage of installed capacity compared to the initial target<br>• Insulation | • KWp<br>• % out of 500 KWp<br>• $m^2$ of roof insulation<br>• $m^2$ of wall insulation |

| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| | | • Double glazing | • $m^2$ of windows |
| 1.6 | Promotion of recycling | • Total amount of recycled waste in the Municipality<br>• Number of implemented actions to promote recycling<br>• Available infrastructure in terms of recycle bins coverage | • tn/year<br>• Number of seminars, leaflets and other actions<br>• Number of recycle bins per square km area |
| 1.7 | Waste management | • Construction completion state<br>• Total amount of solid waste deposited in landfill<br>• Electricity Production<br>• Biofertilizer Production | • %<br>• tn<br>• MWh<br>• tn |
| 1.8 | PV plant 3 MW (for municipal buildings and street lighting | • Installed PV capacity<br>• Percentage of installed capacity against the initial target | • KWp<br>• % out of 3 MWp |
| 1.9 | Establishment of an Energy Saving Department | • Number of people served by the Energy Department<br>• Employees in the Energy Saving Department | • Number of people<br>• Number of employees |
| 1.10 | Web portal creation | • Number of visits in the site<br>• Average time a user spent in the site | • Number of visits<br>• Min/visit |
| | **Street Lighting** | | |
| 2.1 | Street lighting system upgrade | • Lamps that were replaced with energy efficient ones | • Number of lamps |
| 2.2 | Astronomical timers | • Percentage of astronomical timers against initial target | • % |
| 2.3 | Green procurement procedures for the future lighting equipment | • Number of devices that were bought with green procurement procedures | • Device number/year |
| | **Residential Sector** | | |
| 3.1 | Awareness raising activities for modification of the residents' consumption behavior | • Number of seminars & information days<br>• Attendants in each event | • Number of activities<br>• Number of people attending each event |

| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| 3.2 | Promotion of Green Buildings' concept / Strict application of the building code | • Number of promotion actions<br>• Average attendance<br>• Share of new Green buildings in total new buildings<br>• Average energy savings of green building/$m^2$ | • Number of seminars, leaflets etc.<br>• People attended each action<br>• %<br>• KWh/$m^2$ |
| 3.3 | Campaign for promoting high energy label equipment and other awareness activities | • Number of promotion actions<br>• Average attendance | • Number of seminars, leaflets etc.<br>• Number of people attending each event |
| 3.4 | 2MW/10MW Photovoltaics in residential rooftops | • Installed PV capacity on roofs<br>• Percentage of installed capacity against the initial target | • MWp<br>• % out of 2MWp or 10MWp |
| 3.5 | Replacing existing electric water heater with solar collectors | • Increase of solar water heaters installation | • Number of solar water heaters |
| 3.6 | Replacement of existing lamps with LEDs | • Number of lamps replaced with LEDs | • Number of lamps replaced each year |
| 3.7 | Replacement of existing air-conditioners with more efficient ones | • Number of A/Cs replaced with new ones | • Number of A/Cs |
| 3.8 | Use of cool colors in rooftops | • Surface that cool colors have been applied<br>• Number of buildings using cool colors | • $m^2$<br>• Number of buildings |
| 3.9 | Replacement of single glazing with double | • Surface of double glazing | • $m^2$ |
| | **Tertiary** | | |
| 4.1 | Seminars and trainings on selected professional groups | • Number of awareness raising seminars<br>• Attendants in each event | • Number of activities<br>• People attending each activity |
| 4.2 | 10% energy reduction campaign in commercial buildings-Energy friendly label | • Total reduction % against the initial energy consumption<br>• Total energy savings | • %<br>• kWh |

| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| 4.3 | Promotion of green buildings concept | • Number of buildings refurbished to become 'Green'<br>• Number of promotion actions<br>• Average attendance | • Number of buildings<br>• Number of seminars, leaflets etc.<br>• Number of people attending each action |
| 4.4 | Campaign for promoting high energy label equipment | • Number of promotion actions<br>• Average attendance | • Number of seminars, leaflets etc.<br>• Number of people attending each event |
| 4.5 | 10 MW/20 MW Photovoltaics in rooftops | • Installed PV capacity on roofs<br>• Percentage of installed capacity against the initial target | • MWp<br>• % out of 10MWp or 20MWp |
| 4.6 | Replacing existing electric water heater with solar collectors | • Number of solar water heaters installed | • Number of solar water heaters |
| 4.7 | Replacement of existing lamps with LEDs | • Number of lamps replaced with LEDs | • Number of lamps replaced each year |
| 4.8 | Replacement of existing air conditioners with more efficient ones | • Number of A/Cs replaced with new ones | • Number of A/Cs |
| 4.9 | Use of cool colors in rooftops | • Surface that cool colors have been applied<br>• Number of buildings using cool colors | • $m^2$<br>• Number of buildings |
| 4.10 | Installation of lighting automations & thermostats | • Area covered by lighting automations<br>• Area covered by thermostats | • $m^2$ |
| 4.11 | External shading installation | • Area of shadings installed | • $m^2$ |
| 4.12 | Upgrade water facilities | • Number of SCADA systems installed | • Number of systems |
| 4.13 | Awareness raising campaigns for pupils/ students | • Number of implemented campaigns<br>• Students reached from the campaigns | • Number of campaigns<br>• Number of students |
| 4.14 | The 10% voluntary campaign for energy reduction in schools | • Total energy consumption in schools<br>• Average consumption per m2 in each school | • kWh<br>• $kWh/m^2$ |

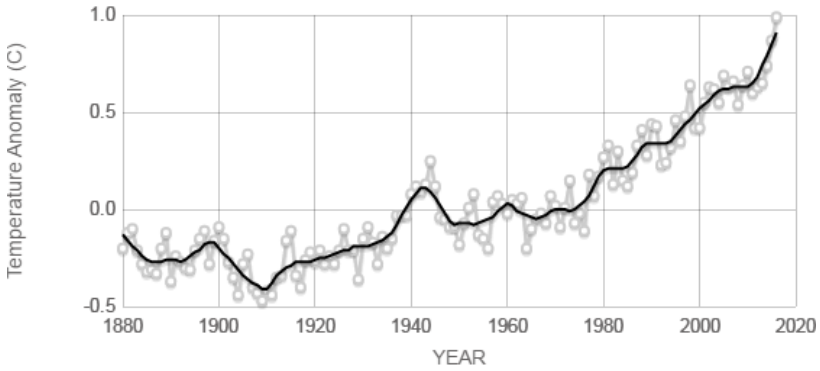
| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| | | • Savings achieved per participating school in kWh and % | • kWh and % |
| **Transport** | | | |
| 5.1 | Replacement of old municipal diesel vehicles with new, more efficient vehicles | • Number of vehicles replaced<br>• Fuel saved at an annual basis | • Number of vehicles<br>• MWh and lt of Gasoline and Diesel |
| 5.2 | Installation of tracking and monitoring system for more efficient management of the fleet and better planning routes | • Total distance covered by municipal vehicles per year<br>• % of distance reduction at an annual basis<br>• Estimated savings | • km<br>• % of total km reduced<br>• kWh and Lt of diesel and gasoline |
| 5.3 | Municipal fleet maintenance (for the existing & the new ones) | • Number of cars maintained<br>• Maintenance coverage percentage | • Number of cars<br>• % of maintained cars against the total |
| 5.4 | Eco-driving seminars for the drivers of the municipal fleet | • Number of seminars implemented<br>• Percentage of municipal drivers that attended the seminars | • Number of seminars<br>• % out of total number of drivers |
| 5.5 | Information events on the new vehicle technologies<br>*Replacement of gasoline vehicles with Hybrid*<br>*Replacement of diesel vehicles with new more efficient* | • Number of events<br>• Attendants in each event | • Number of events<br>• Number of people attending each activity |
| 5.6 | Improve public transportation/ promote the use of public transport | • Number of bus routes with increased itineraries<br>• Estimated people outreach | • Number of bus routes<br>• Number of events, leaflets etc. |
| 5.7 | Promotion of walking and car sharing and carpooling campaigns | • Length/surface of pavements constructed/refurbished<br>• Number of walking signs installed<br>• Number of parks etc. renovated<br>• Number of awareness raising activities | • km/ $km^2$<br>• Number of signs<br>• Number of public areas<br>• Number of activities |

| | Action | Key Performance Indicators | Measurement units |
|---|---|---|---|
| 5.8 | Improvement / development of parking infrastructure | • Number of parking lots constructed | • Number of parking lots |
| 5.9 | Promotion of eco-driving | • Number of seminars implemented<br>• Number of drivers attending the seminars | • Number of seminars<br>• Number of drivers |
| 5.10 | Transportation master plan | • Development of the transportation plan study<br>• Percentage of the city area covered by the public transport | • YES/NO<br>• % in total area |
| 5.11 | Promotion of eco-driving for public transport's drivers | • Number of seminars implemented<br>• Percentage of drivers that attended the seminars | • Number of seminars<br>• % out of total number of drivers |
| 5.12 | Promotion of new technology buses in the public transportation | • Number of buses replaced with new | • Number of buses |
| 5.13 | Replacing the existing Taxi vehicles with Hybrid vehicles | • Number of Hybrid Taxis | • Number of Hybrid Taxis |
| **Local Renewable Energy Production** | | | |
| 6.1 | Wind farm 3 MW (planned) | • Operation<br>• Electricity Production | • YES/NO<br>• MWh |
| 6.2 | Wind Farm 2 MW (proposed) | • Plans for installation<br>• Operation<br>• Electricity Production | • YES/NO<br>• YES/NO<br>• MWh |

# Chapter 4: Adaptation to climate change

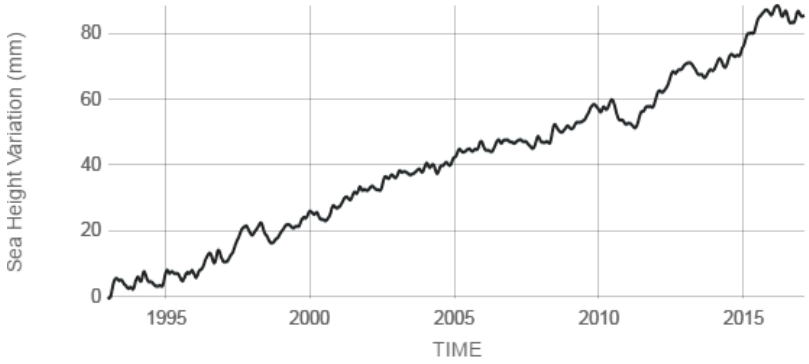
## 4.1 Introduction on climate change impact

During the last 20 years studies and observations have shown significant changes in the global climate which negatively affect life in many aspects. Indicatively in the next two figures the rise in the temperature and sea level are presented.




Source: climate.nasa.gov

Figure 23: Land-ocean temperature variation




Source: climate.nasa.gov

Figure 24: See level variation

In addition in the next figure the global temperature variation is presented from 1884 to 2016 in a worldwide map. [11]

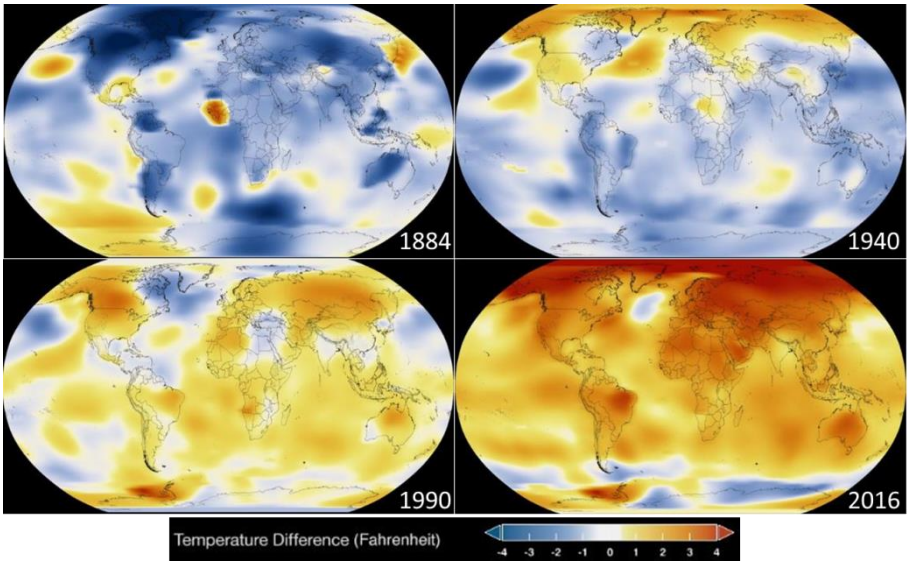



Figure 25: Global temperature variation

More specifically, the Mediterranean region is rich in a large variety of complex climatic phenomena, caused by its morphology and its geographical location. The location of the Mediterranean Sea in a transitional band between subtropical and midlatitude regimes produces a large climate variability at multiple timescales and a strong seasonal variability of precipitation in many areas [12]. The Mediterranean has been identified as one of the most prominent "Hot-Spots" in future climate change projections [13]. The water cycle and its extremes are one of the major concerns, since there are many countries that are over exploiting the water resources, a problem that is expected to deteriorate in the future. Episodes of extreme precipitation are also taking place and disastrous floods are a major threat for the region and especially the coastal areas. In addition to the above, phenomena taking place especially in the Southern Mediterranean Countries, such as cultivation of marginal land, overgrazing and firewood harvesting, put more pressure on the environment [12].

The Mediterranean region has experienced drastic changes in its climate over the years and according to Luterbacher et al. [14], has shown large climate shifts in the past. Twenty thousand years ago, cold steppes (with sparse forests) extended from the south of Spain to Caucasus. In the northern part of the Mediterranean basin, the temperature of the coldest month was 15°C lower than it is today (Peyron et al., 1998). Less water was available for vegetation. Over the last 2000 years, the climate over the Mediterranean has experienced a sequence of humid/dry and warm/cold periods that have produced effects on environmental conditions.

In the Figure 26 presented below, the seasonal mean temperature for the period 1961-1990 is being depicted in panels A-D, while the total precipitation maps for the same period are depicted in panels E-H.

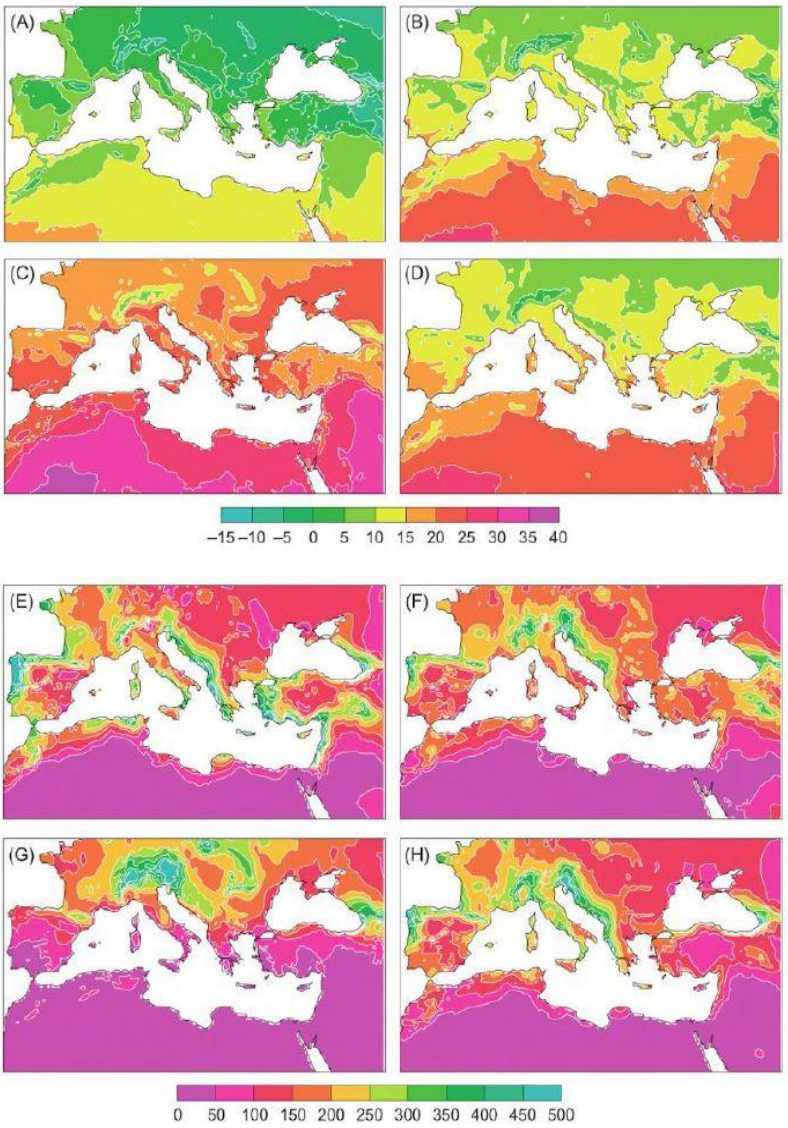



Figure 26: Seasonal (winter: December – January – February; spring: March – April – May; summer: June – July – August; autumn: September – October – November) mean temperature (°C, panels A-D) and total precipitation (mm per season, panels E-H) maps for the period 1961 -1990 based on CRU data

*Source: Lionello, 2012*

The increase of the projected temperatures in the Mediterranean region in the period 2071 - 2100 compared to 1961-1990 is at least 3 degrees in the South countries and could be even higher, depending the season, as presented in the figure below [13].

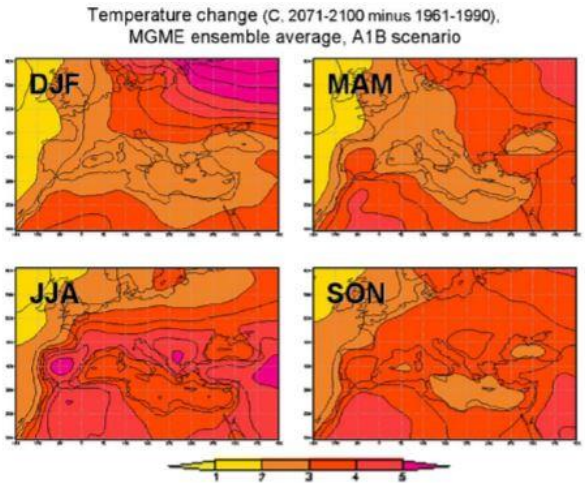



Figure 27: Multi Global Model Ensemble (MGME) average change in surface air temperature for the four seasons, 2071–2100 minus 1961–1990. Units are °C. DJF is December–January–February, MAM is March–April–May, JJA is June–July–August, SON is September–October–November

According to an EIB report of 2008, for the Mediterranean region, climate experts anticipate during the 21st century:

- An increase in air temperature in the range of 2.2 C° to 5.1 C° for the countries of Southern Europe and the Mediterranean region over the period 2080 – 2099 with respect to the period 1980 – 1999;
- A significant decrease in rainfall, ranging between -4 and -27 % for the countries of Southern Europe and the Mediterranean region (while the countries of Northern Europe will report a rise between 0 and 16 %);
- Increase in drought periods manifested by a high frequency of days during which the temperature would exceed 30 °C. Extreme events, such as heat waves, droughts or floods, are likely to be more frequent and violent.
- An increase of the sea level which, according to some specific studies, could be around 35 cm up to the end of the century.

Giannakopoulos et al. (2005) underlines that in line with the results of the projection scenarios, the most significant temperature increases in the 21st century are expected in Eastern Egypt and especially the Nile Delta, Lebanon, Israel and the Maghreb. It is therefore evident that the more vulnerable Mediterranean areas will be those of North Africa adjacent to desert areas, the major deltas (such the Nile one), the coastal areas (Northern rim and Southern rim of the Mediterranean basin), as well as the high-demographic growth and socially vulnerable areas (Southern and Eastern rim, densely populated cities and suburbs).

In the Mediterranean region, 50% of the urban population lives in an altitude of less than 10 meters from the sea level, in areas which are vulnerable to sea level rise. In addition to the above, tourist destinations in these areas are vulnerable not only due to the sea level rise, but also due to the temperature increase encountered [15].

The impacts of climate change on the Mediterranean environment will relate particularly to [16]:

- Water, via a change of its cycle due to a rise in evaporation and a decrease in rainfall. This water problem will be of crucial importance with regard to the issue of sustainable development in the region;
- Soil, via the acceleration of already existing desertification phenomena;
- Land and marine biological diversity (animal and plant), via a displacement northward and in altitude of certain species, extinction of less mobile or more climate sensitive species, and emergence of new species;
- Forests, via a rise in fire hazards and parasite risks.

These impacts will exacerbate already existing pressures on the natural environment connected with anthropogenic activities, such as agriculture and fishery (reduction of yields), tourism attractiveness (heat waves, water scarcity), coastal areas and infrastructures (significant exposure to the action of waves, coastal storms and other extreme weather events, rise in sea level), human health (heat waves), the energy sector (water needs for power plants, hydropower and increased consumption).

In line to the above, the Southern and Eastern Mediterranean Countries (SEMCs) appear to be more vulnerable to climate change than the Northern Mediterranean Countries (NMCs).

Indeed, they are, on the one hand, more exposed to accelerated desertification, soil aridity and water scarcity and, on the other hand, presenting economic structures that are more strongly dependent on natural resources, as well as technical and financial capacities that are too limited to help implement large-scale adaptation options [16].

The Mediterranean, and more especially the Southern and Eastern rim, is and will be more affected by climate change than most other regions of the world in the course of the 21st century. The impacts of the rise in temperatures, the decrease in rainfall, the multiplication of the number and intensity of extreme events and the possible rise in sea level overlap and amplify the already existing pressures of anthropogenic origin on the natural environment.

Through the crucial issue of scarcity of water resources, their impacts are fraught with consequences in the 21st century for human activities, in particular agriculture, fishery, tourism, infrastructures, urbanised coastal areas and hydropower production. In order to minimize as much as possible the economic losses and damages, several adaptation options must be thought out and implemented.

Energy lies at the heart of the climate change issue. On the one hand, it is the main GHG emitting sector, and CO2 emissions in the future are likely to increase much more rapidly than the global average. On the other hand, hydropower production—relatively significant in certain countries (13% of power production in the SEMCs)—is affected by the climate as well as by the plant cooling constraints. Lastly, the energy demand (in particular, electricity) which is growing at a very high pace in the region, is likely to be further accelerated by the additional demand necessary to lessen the impacts of climate change (water desalination, air-conditioning of buildings, etc.).

## 4.2 National and Regional Strategy on Climate Change Adaptation

Jordan has started developing national plans and signing conventions about environmental, energy and climate strategies since 1991. Lately Jordan committed to international environmental convention UNFCC and initiated with its support a National Economic and Environmental Development Study (NEEDS) for Climate Change which aims at identifying financing needs to implement adaptation and mitigation measures. In addition, linkages with financial and regulatory instruments are identified to support the implementation of adaptation and mitigation measures. The study is based on three axes: Selection of key sectors for climate change mitigation and adaptation measures, Assessment of the financing needs in parallel with finding financial instruments, raising awareness and facilitating informed consensus among government agencies on the policy actions required to mobilize finance and investment in mitigation and adaptation measures. [17]

## 4.3 Climate data and Clima projections

***Current situation***

Jordan's climate is characterised by the variation from a Mediterranean-like climate in the west to a desert-like climate in the east and south, but the land is generally arid. The southern stretch of the Wadi Araba is the hottest and driest part of the geographical zone. The map in Figure 28 below clearly shows that the hottest parts of the country are those closest to the coastal regions of the Dead Sea and along the Wadi Araba. The mean annual average temperature at the Test and Demonstration Center site is 25 °C, with variations in summer up to 44 °C and in winter down to 4 °C. The average winter humidity is about 65%, and in summer it is typically below 40% and can drop to as low as 15%.

Regarding precipitation, Jordan experiences very low amounts (Figure 29) with average annual rainfall to be below 50mm. Therefore, there is severe scarcity of the country's water sources. Actually, Jordan is the third poorest country in the world in terms of per-capita water resources with the current usage rate to be 145 $m^3$ annually per person.

Table 71 shows climate data for Karak, which is similar to that at the Test and Demonstration Center site to the north of the city.

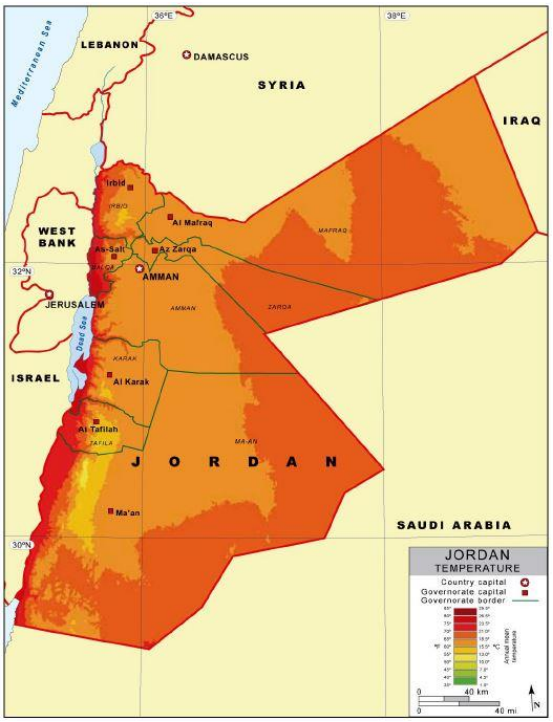



Figure 28: Temperature Map of Jordan

*Source: Bestcountryreports.com*

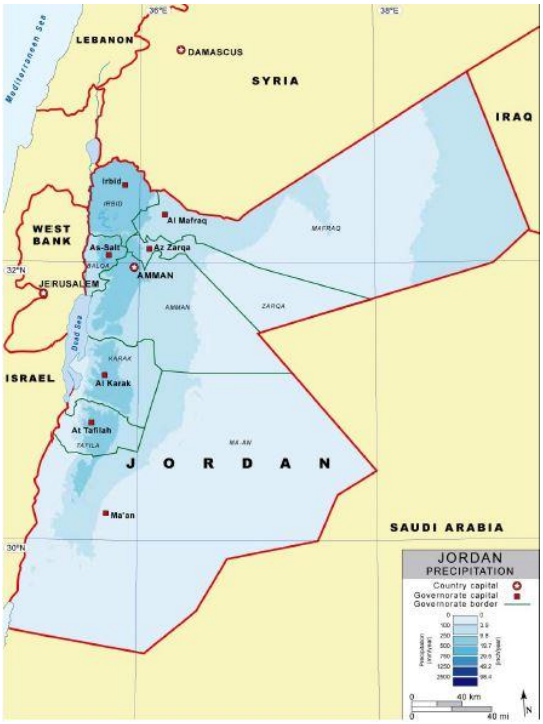



Figure 29: Precipitation Map of Jordan

*Source: Bestcountryreports.com*

Table 71: Climate data for Karak, Jordan

| Month | Mean temperature( °C) | | Mean total rainfall (mm) |
|---|---|---|---|
| | Daily minimum | Daily maximum | |
| January | 3.1 | 12.3 | 86 |
| February | 4 | 13.9 | 75 |
| March | 5.8 | 17.1 | 68 |
| April | 9 | 21.8 | 17 |
| May | 12.2 | 26.5 | 4 |
| June | 14.9 | 29.8 | 0 |
| July | 16.8 | 31.6 | 0 |
| August | 17.2 | 31.8 | 0 |
| September | 15.1 | 29.6 | 0 |
| October | 12.4 | 26.2 | 5 |
| November | 8.4 | 19.6 | 32 |
| December | 4.4 | 14.1 | 72 |

As far as the wind is concerned, the prevailing winds in the country are westerly to south-westerly. However hot, dry and dusty winds frequently occur, blowing from the south-east as well. Known locally as the *kham-sin*, these winds blow most often in the early and late summer and can last for several days at a time before terminating abruptly as the wind direction

changes and much cooler air follows. In the Wadi Araba the predominant wind direction is from the north-west – blowing directly down the rift valley. This contributes to the very low levels of humidity in the southern parts of the valley because the wind blows over large tracts of extremely arid terrain.

Table 72: Karak region - Average wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Wind speed (Km/h) | 61 | 56 | 78 | 63 | 93 | 74 | 74 | 37 | 39 | 48 | 78 | 74 |

*Source: [http://www.myweather2.com/City-Town/Jordan/Karak/climate-profile.aspx](http://www.myweather2.com/City-Town/Jordan/Karak/climate-profile.aspx)*

Regarding the Temperature and Rainfall the last 114 years in Jordan, the next Figures present the historical data trends in the region and the increase and decrease respectively are obvious. [18]

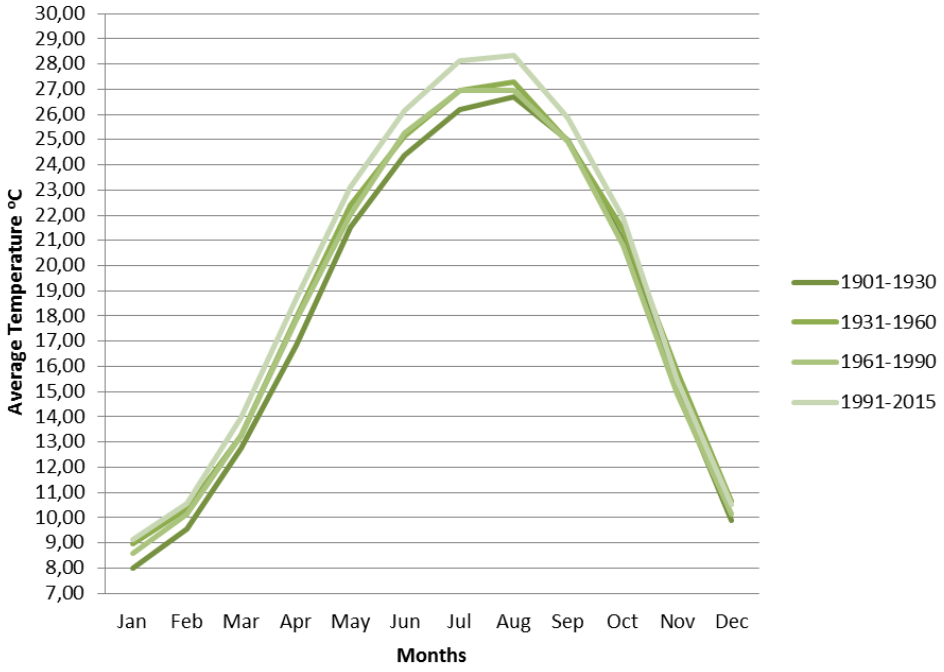



Figure 30: Average Temperature between 1901-2015 in Jordan

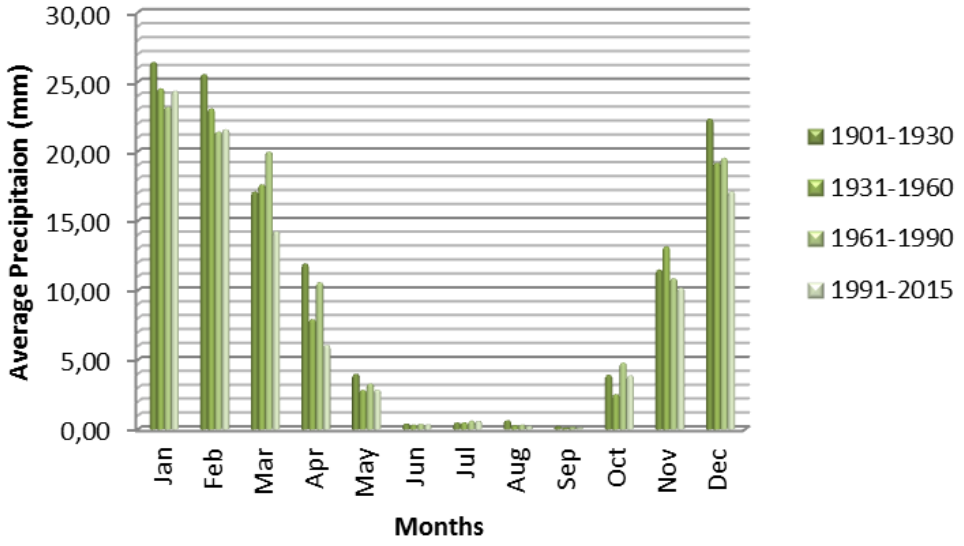



Figure 31: Average Precipitation between 1901-2015 in Jordan

***Climate change Projections***

Trends show that the mean, maximum and minimum temperature tends to increase by 0.02, 0.01 and 0.03 °C per year respectively. Furthermore, annual precipitation tends to significantly decrease at a rate of 1.2 mm per year. On the other hand the relative humidity tends to increase by an average of 0.08%/year. The number of days of dust storm tends to decrease significantly by 0.09 days/ year and 0.06 days/year for visibility less than 1km and 5km. The projections' results totally agree with previous work of Second National Communication (SNC) to UNFCCC and are consistent with IPCC-AR5 [19].

## 4.4 Adaptation Scoreboard

The adaptation scoreboard is part of the SECAP template developed by the JRC. The municipality is intended to realize a self-assessment of its adaptation status, putting a grade from A to D, in line with its progress.

Climate Adaptation Chapter Suggested Structure – CES MED Internal Guidelines

More specifically:

- "A", corresponds to completion level of 75 - 100%.
- "B", corresponds to completion level of 50-75%.
- "C", corresponds to completion level of 25-50%. Finally,
- "D", corresponds to completion level of 0-25%.

The municipality will put one of these four grades to each one of the adaptation cycle specific steps, as presented in the following table.

Table 73: Municipality's score in the Adaptation Cycle Specific Steps (SECAP template)

| Adaptation Cycle Steps | Actions | Grade |
|---|---|---|
| Step 1: Preparing the ground for Adaptation | Adaptation commitments defined/integrated into the local climate policy | B |
| | Human, technical and financial resources identified | D |
| | Adaptation team (officer) appointed within the municipal administration and clear responsibilities assigned | C |
| | Horizontal (e.g. across departments) coordination mechanisms in place | D |
| | Vertical (e.g. across governance levels) coordination mechanisms in place | D |
| | Consultative and participatory mechanisms set up, fostering the multi stakeholder engagement in the adaptation process | C |
| | Continuous communication process in place | C |
| Step 2: Assessing risks and vulnerabilities to climate change | Mapping of the possible methods and data sources for carrying out a Risk &Vulnerability Assessment conducted | A |
| | Assessment of climate risks and vulnerabilities undertaken | A |
| | Possible sectors of actions identified and prioritized | A |
| | Available knowledge periodically reviewed and new finding integrated | B |
| Steps 3 and 4 – Identifying, assessing and selecting adaptation options | Full portfolio of adaptation actions compiled, documented and assessed | B |
| | Possibilities of mainstreaming adaptation in existing policies and plans assessed, possible synergies and conflicts identified | B |
| | Adaptation actions developed and adopted | D |
| Step 5: Implementing | Implementation framework set with clear milestones | D |
| | Adaptation actions implemented and mainstreamed as defined in the SECAP document | D |
| | Coordinated action between adaptation and mitigation set | D |
| Step 6: Monitoring and evaluation | Monitoring framework in place for adaptation actions | C |
| | Appropriate monitoring and evaluation indicators identified | C |
| | Regular monitoring of the progress and reporting to the relevant decision makers | D |
| | Adaptation strategy and/or Action Plan updated, revised and readjusted according to the findings of the monitoring and evaluation procedure | D |

## 4.5 Risk Assessment and Vulnerability Analysis

In order to conduct a risk assessment and vulnerability analysis, as a first step, the climate hazard types should be identified. These hazard types in general and for the Maghreb and Mashreq countries in particular, are presented in the Table below, while those applicable for Karak have been identified.

Table 74: Climate Hazard Types

| General Climate Hazard Types | Applicable for Karak region |
|---|---|
| Extreme heat | √ |
| Extreme cold | |
| Landslides | √ |
| Storms | |
| Droughts | √ |
| Sea level rise | |
| Floods | √ |
| Extreme precipitation | |
| Forest fires | |
| Ice and snow | |

The municipalities are called in to assess the impact that each climate hazard type has on a series of Vulnerable/ Impacted sectors, such as:

- Health
- Infrastructure (Energy, Water, Transport)
- Built environment
- Economy (Tourism, Agriculture and Forestry)
- Biodiversity (Coastal areas, Green zones/ forests)

These sectors have been identified as the most relevant for the Maghreb / Mashreq region, utilizing info from Future Cities Adaptation Compass Tool, Mayors' Adapt, as well as the European Climate Adaptation Platform website.

Karak Municipality has filled in Table 75 below, in order to conduct the vulnerability analysis, based on sources such as the Future Cities Adaptation Compass Tool and UNFCCC, as well as the CES MED Internal Guidelines for the Climate Adaptation Chapter.

Table 75: Vulnerability analysis (based on the Future Cities Adaptation Compass tool)

| | Receptors | Extreme weather event | Potential effects | Who/What is affected |
|---|---|---|---|---|
| Population | Public Health | Extreme heat | - Deaths due to cardiovascular diseases<br>- Spread of vector born and infectious diseases<br>- Altered allergic pattern<br>- Heat stress | Everyone, but especially elderly people, babies, children, workers in outdoor environments and sensitive groups of people |
| | | Landslides | - Injuries and deaths | All people living or working in the area |
| | | Droughts | - Asthma and cardiovascular diseases<br>- Accumulation of trace elements | All people living or working in the area |
| | | Floods | - Injuries and deaths<br>- Water-borne diseases<br>- Asthma and respiratory allergies | All people living or working in the area |
| Infrastructure | Transport | Extreme heat | - Rail and road network damages<br>- Change in behavior patterns<br>- Air quality problems<br>- Higher maintenance costs | Roads, rail roads, public transport, people mobility |
| | | Landslides | - Damages<br>- Mobility difficulties in afflicted areas | Roads, rail roads, public transport, people mobility |
| | | Droughts | - Difficult transport of bulk material | Waterways, water management |
| | | Floods | - Damages<br>- Mobility difficulties in afflicted areas | Roads, rail roads, public transport, people mobility |
| | Energy | Extreme heat | - Altered electricity peaks/demand<br>- Damages<br>- Cooling problems<br>- Reduction of efficiency yield from conventional power plants and distribution grid<br>- Higher maintenance costs | Conventional power plants, electricity providers and consumers |

| Receptors | | Extreme weather event | Potential effects | Who/What is affected |
|---|---|---|---|---|
| | | Landslides | - Damages<br>- Operational difficulties | All facilities in the electricity generation (including RES such as PVs), as well as the electricity transmission and distribution grid |
| | | Droughts | - No/lower production from hydro power plants<br>- Energy supply and demand patterns' shift<br>- Higher maintenance costs<br>- Cooling problems | Conventional and renewable energy facilities (hydro, PVs, etc.) |
| | | Floods | - Damages<br>- Operational difficulties | All facilities in the electricity generation, transmission and distribution grid in the affected areas |
| | Water | Extreme heat | - Higher water demand<br>- Water quality issues<br>- Higher maintenance costs | Public health, water infrastructures |
| | | Landslides | - Damages<br>- Water quality issues | Public health, water infrastructures |
| | | Droughts | - Water scarcity<br>- Water quality issues<br>- Higher maintenance costs | Public health, water infrastructures |
| | | Floods | - Water quality issues<br>- Water management issues<br>- Damages<br>- Higher maintenance costs | Public health, water infrastructures |
| | Social | Extreme heat | - Higher electricity demand to cover cooling needs<br>- Changes in behavior patterns, e.g. living outdoors<br>- Burdening of the health care facilities due to the increased number of patients in hospitals | Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities |
| | | Landslides | - Damages in social facilities in afflicted areas | Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities |

| Receptors | | Extreme weather event | Potential effects | Who/What is affected |
|---|---|---|---|---|
| | | Droughts | - Difficulties in meeting water demand for athletic facilities (e.g. swimming pools) and green public spaces | Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities |
| | | Floods | - Flooding of social facilities in afflicted areas<br>- Burdening of the health care facilities due to the increased number of patients in hospitals | Hospitals, schools, public places, municipal facilities, athletic facilities |
| Built Environment | Building stock and material | Extreme heat | - Concrete's damages<br>- Increased cooling demands<br>- Higher maintenance costs<br>- Urban heat island effect | All building infrastructure |
| | | Landslides | - Extensive damages | All building infrastructure in afflicted areas |
| | | Droughts | - Higher water demand | All building infrastructure |
| | | Floods | - Damages<br>- Higher maintenance costs | All building infrastructure in afflicted areas |
| Economy | Tourist | Extreme heat | - Increased demand for cooling<br>- Lower touristic flows during the impacted seasons<br>- Higher water demand | Tourists, tourist infrastructure, tourist related economy |
| | | Landslides | - Lower touristic flows<br>- Damages in touristic infrastructure | Tourists, tourist infrastructure, tourist related economy |
| | | Droughts | - Increased pressure on water resources, escalating water scarcity issues<br>- Increased water supply costs | Tourists, tourist infrastructure |
| | | Floods | - Damages in touristic infrastructure and related costs for repairs | Tourists, tourist infrastructure |
| | Agriculture | Extreme heat | - Changes in growth cycle<br>- Damages / loss of harvest<br>- Livestock loss and impacts on health<br>- Lower crop yields | Farmers, food industry, consumers |

| | Receptors | Extreme weather event | Potential effects | Who/What is affected |
|---|---|---|---|---|
| | | Landslides | - Damages / loss of harvest in afflicted areas / loss of livestock<br>- Potential property loss in afflicted areas<br>- Loss of soil resources | Farmers, food industry, consumers |
| | | Droughts | - Damages / loss of harvest<br>- Lower crop yields<br>- Livestock loss and impacts on health<br>- Land degradation | Farmers, food industry, consumers |
| | | Floods | - Damages / loss of harvest in afflicted areas / loss of livestock | Farmers, food industry, consumers |
| Biodiversity | Coastal zone ecosystems | Extreme heat | - Increased coral bleaching<br>- Migration of coastal species towards higher altitudes<br>- Reduction of vulnerable fishing stock<br>- Altered flora and fauna, new and invasive species | Ecosystem, fish industry, consumers |
| | | Landslides | - No effects | - |
| | | Droughts | - Increase of coastal water salinity<br>- Loss of species<br>- Altered flora and fauna, new and invasive species | Ecosystem |
| | | Floods | - Loss of species<br>- Altered flora and fauna, new and invasive species | Ecosystem |

Table 76: Risk assessment

| | Receptors | Weather Sensitivity | Future Risk | Impact |
|---|---|---|---|---|
| Population | Public Health | Extreme heat | - Increased number of deaths<br>- Reinforcement of heat stress<br>- Increased infectious diseases<br>- Altered allergic patterns<br>- Chronic respiratory diseases<br>- Vector Born Diseases (VBD)<br>- Skin diseases Melanoma and sunburn | High |
| | | Landslides | - Increased number of injuries and deaths<br>- More respiratory problems | Medium |
| | | Droughts | - Increased allergic incidents<br>- Decreased air quality<br>- More respiratory problems<br>- Consumption and use of unsafe (contaminated) water for drinking due to water scarcity<br>- Malnutrition<br>- Food shortages | High |
| | | Floods | - Limitations to the healthcare access<br>- Increased numbers of injuries and deaths<br>- Epidemics of water and food-borne diseases | High |
| Infrastructure | Transport | Extreme heat | - Damages on road and rail network<br>- Modification of transport frequency and means<br>- Air quality problems<br>- Higher maintenance costs | Low |
| | | Landslides | - Damages on road and rail network<br>- Modification of transport frequency and means<br>- Higher maintenance costs | High |
| | | Droughts | - Difficult transport of bulk material | Low |
| | | Floods | - Damages<br>- Mobility problems | High |
| | Energy | Extreme heat | - Blackouts and inability to cover demand load<br>- Damages, especially in the thermal power plants | High |
| | | Landslides | - Damages in the transmission and distribution grid<br>- Damages in any power generating plants, including RES (PVs) in afflicted areas | High |

| | Receptors | Weather Sensitivity | Future Risk | Impact |
|---|---|---|---|---|
| | | Droughts | - Blackouts and inability to cover demand load<br>- Higher maintenance costs<br>- Cooling problems in power plants | High |
| | | Floods | - Damages / power cuts | Medium |
| | Water | Extreme heat | - Water scarcity<br>- Water quality issues | Medium |
| | | Landslides | - Water scarcity due to infrastructure damages<br>- Water quality issues due to infrastructure damages | Medium |
| | | Droughts | - Water scarcity<br>- Water quality issues | High |
| | | Floods | - Increased damages and related maintenance costs<br>- Water management issues<br>- Water quality issues | High |
| | Social | Extreme heat | - Increased needs for air conditioned public spaces | Medium |
| | | Landslides | - Damages<br>- Mobility problems<br>- Increase in the numbers of people burdening the health care facilities | Medium |
| | | Droughts | - Increased numbers of people presenting respiratory problems and burdening the health care facilities<br>- Inability to cover the water demand<br>- Difficulties in the operation of certain facilities due to lack of water (e.g. swimming pools) | Medium |
| | | Floods | - Damages<br>- Increased maintenance costs<br>- Flooding at the city level of the afflicted public building infrastructure (schools, hospitals, etc.) - Difficulties in providing the envisaged services | High |
| Built Environment | Building stock and material | Extreme heat | - Concrete's damages<br>- Increased cooling demands<br>- Higher maintenance costs<br>- Urban heat island effect | Low |
| | | Landslides | - Damages | Low |
| | | Droughts | - Higher water demand | Medium |
| | | Floods | - Damages<br>- Increased maintenance costs | Medium |

| | Receptors | Weather Sensitivity | Future Risk | Impact |
|---|---|---|---|---|
| | | | | |
| Economy | Tourist | Extreme heat | - Change of the tourism season – lower touristic flows<br>- Reduction of the tourism related economy | Medium |
| | | Landslides | - Potential damage to touristic infrastructures and sites | Low |
| | | Droughts | - Increased water supply costs<br>- Potential increase of indirect costs for the tourists (infrastructure related) and reduction of touristic flows | Low |
| | | Floods | - Damages to touristic facilities<br>- Potential effects on the touristic flows, in areas with flooding history | High |
| | Agriculture | Extreme heat | - Changes in growth cycle<br>- Damages / loss of harvest<br>- Livestock loss and impacts on health<br>- Lower crop yields<br>- Increased fire risks | High |
| | | Landslides | - Damages/ loss of harvest<br>- Loss of soil and reduction of cultivated lands | Medium |
| | | Droughts | - Damages / loss of harvest<br>- Lower crop yields<br>- Livestock loss and impacts on health<br>- Land degradation<br>- Increased fire risks | High |
| | | Floods | - Damages/ loss of harvest in afflicted areas<br>- Livestock loss<br>- Surface soil erosion | High |
| Biodiversity | Coastal zone ecosystems | Extreme heat | - Loss of specific species (fish, etc.) | High |
| | | Landslides | - No expected risks | - |
| | | Droughts | - Increase of coastal water salinity | Medium |
| | | Floods | - Soil erosion | High |

## 4.6 Adaptation Actions

The municipality, having compiled the vulnerability analysis and risk assessment, needs to identify a specific set of actions that will allow it to adapt to the situation it faces. A list of adaptation actions, identified from the international literature and best practices available,

are presented in the following tables, for each one of the five sectors studied above. Of course, these lists are not exhaustive and the consultants can look for additional measures, depending also on the local needs and situation; however, they are considered a good starting point.

For each one of the five sectors, a further distinction of the adaptation actions in four categories is realized:

- Strategic actions. Actions regarding the formulation of action plans, or strategic policy planning documents, that set the basis for all the actions to come in the specific sector.
- Alert /Communication actions. These are focusing on alerting the citizens on a situation, such as an extreme climate event or hazard (high temperatures, floods, tsunamis etc.).
- Educational actions. The focus in this case is given on increasing the awareness raising level of the citizens on a specific threat or situation that the municipality is faced and requires the citizens' collaboration in one way or another.
- Technical actions. Activities that are directly addressing in a technical the specific climate hazard.

### 4.6.1 Public Health

The first sector to be examined, Public Health is of utmost importance since it has direct impacts on population and their living. Table 77 below focuses on a set of suggested adaptation actions on the population and public health.

Table 77: Suggested adaptation actions for population and public health

| Actions' characteristic | Adaptation Actions |
|---|---|
| **Strategic** | Health action plan for the extreme events that Karak is facing e.g. heat etc. (heat health action plan) - Collaboration with the regional medical services to increase preparedness level |
| | Provide access to air conditioned public buildings during heat waves or other extreme events, for those citizens that lack the infrastructure to protect themselves (people living in underground apartments during floods, or lacking AC during extreme temperatures etc.) |
| **Alert / Communication** | Developing an early warning system to alert citizens in the case of extreme weather events |
| **Educational** | Educational and awareness raising campaigns about health-related effects of extreme events |
| **Technical** | Regular cleaning and maintenance of the sewage and drainage system |
| | Frequent monitoring of water and air quality |

#### *Health action plan for the extreme events*

The health action plan should include the framework for the implementation, coordination and evaluation of extreme events response activities in order to reduce the health impacts. It aims to provide measures for a successful coordination between government departments, health care professionals such as emergency medical personnel, health center staff, and hospital staff, and community groups. The proposed effective actions will ensure that health care and social systems are ready to act and strengthen the health and well-being. Preventive measures for those high-risk target groups will be also considered, such as not working outside

in high temperatures for workers/technicians, or modification of their working hours during heat waves etc. The estimated cost for this action is 80,000 JOD and it is planned to start in 2018 and be finalized within one year.

### *Provide access to public buildings during extreme events*

There is a part of the population which lacks the infrastructure to protect themselves during extreme weather events. The Municipality may provide air-conditioned spaces in public buildings for those who have not ACs in their residences so as to eliminate the health impacts due to high temperatures. Moreover, public buildings may be provided as well, to citizens living in underground apartments, in case of floods. The estimated cost for this action is 15,000 JOD in an annual basis, since existing buildings and structures will be utilized, and only the administrative and energy cost for the action has been considered, and it is planned to start in 2018 for the whole 2030 horizon and beyond.

### *Developing an early warning system to alert citizens in the case of extreme weather events*

Following the forecasting of an extreme event, immediate notification of the public and all those participating in the response is critical to ensure safety. The warning system should include early meteorological announcements followed by protection and medical advices. The aim is to alert those citizens who are most at risk so as to take the appropriate precautions. These extreme weather events take into account heat waves, floods, droughts, as well as landslides in specific areas. This action should be realized in coordination to a national action at this level, or cooperation with other municipalities, as it is a high cost and difficulty activity for Karak municipality.

### *Educational and awareness raising campaigns about health-related effects of extreme events*

Campaigns should include information and advices for citizens on how they can protect themselves in case of extreme heats, floods, landslides, vector borne diseases etc. so as to prevent impacts and infections. The aim is to communicate the risks disseminating public messages through media, informational material and social media. Special efforts should be made to reach vulnerable population such as elderly people, children, citizens with chronic diseases and employees working outdoors. The estimated cost for this action is 30,000 JOD and it is planned to start in 2020 and end in 2022.

### *Regular cleaning and maintenance of the sewage and drainage system*

A rise in temperature due to climate change will increase microorganisms' growth. In addition, floods as a result of extreme rainfall leads to disruption of water purification and contamination with sewage disposal systems, leading to increase the probability of epidemics. Subsequently the regular cleaning and maintenance of the sewage and drainage system is vital in order to mitigate the health risks. The estimated annual cost for this action is 80,000 JOD and it is planned to start in 2019 until the 2030 horizon.

### 4.6.2 Infrastructure

The next section regards infrastructure and actions to mitigate the climate impacts on them are presented.

Table 78: Suggested adaptation actions for infrastructure

| Actions' characteristic | Adaptation Actions |
|---|---|
| **Strategic** | Water management plan |
| | Modelling predicted supply changes in the electricity from the locally available RES |
| | Mapping of sites with landslides and flood risks |
| **Educational** | Developing guides and awareness raising campaigns for citizens on how to save water and energy, especially during crisis |

#### *Water management plan*

The expected reduced precipitation, the temperature increase and the evaporation will result in less recharge and less replenishment of surface water and groundwater reserves. In addition the water demand is increased and contributes in reducing per capita shares. An important action is to develop a plan so as to manage the water supply systems in order for instance to detect leakages, organize regular maintenance and notify the Municipality when such incidents take place. The estimated cost for this action is 80,000JOD and it is planned to start in 2020 and be completed within the same year.

#### *Modelling predicted supply changes in the electricity from the locally available RES*

A certain part of electricity consumption in Karak, but also in all Jordan, depends on Renewable Energy Sources. The extreme weather events may cause malfunctions in the energy supply leading in major problems in the city (e.g. patients who lives in their homes under technical assistance). Subsequently, problems should be predicted via prediction models in order for Municipality to plan what actions should take to face the situation in each case. The estimated cost for this action is 100,000 JOD and it is planned to start in 2020 and end within one year.

#### *Mapping of sites with landslides and flood risks*

Another strategic action is the systematic mapping of sites that face landslide or flood risk. Since prevention is the basic tool to avoid future destructions, Karak Municipality will invest on the mapping of its whole territory, determining the areas with low, medium and high risk for phenomena such as the above. Basic aim of this exercise, depending on the extent of the afflicted areas, is potentially to ban the establishment of infrastructures in areas with high risk, or to require specific permits for building in these areas and only if certain high standards are to be followed in the construction. The estimated cost for this action is 150,000 JOD, and is expected to be initiated in 2022, and run for 2 years.

### *Developing guides and awareness raising campaigns for citizens on how to save water and energy, especially during crisis*

As part of the mitigation actions envisaged in the previous chapter, Municipality is going to implement numerous awareness raising activities and campaigns for the citizens, in order to make them more aware on how to save energy. These actions could be further enhanced with water saving advice, especially during heat waves, droughts or other extreme weather events that require savings in these resources. The cost for this action can be covered through the dedicated amount in the mitigation actions, and is expected to have the same duration.

## 4.6.3 Built Environment

The next section is about the actions to be implemented in order to enhance the built environment and protect it from the future climate repercussions.

Table 79: Suggested adaptation actions for built environment

| Actions' characteristic | Adaptation Actions |
|---|---|
| **Strategic** | Enforcement of building codes for more energy efficient and heat tolerant structures |
| | Integrated land use planning with zoning system depending on the different areas |
| **Educational** | Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises |
| **Technical** | Greening infrastructure such as buildings' roofs and walls |
| | Increasing the amount of shade and green areas in the city by planting trees and using green pavements to reduce the heat island effect |
| | Building exemplary districts with adapted urban forms and buildings |
| | White roofs (cool colors), shading and bioclimatic design |
| | Rainwater collection and use |
| | Adoption of methods to reduce water demand |
| | Using water resistant construction materials |

### *Enforcement of building codes for more energy efficient and heat tolerant structures*

In Karak Municipality, as well as Jordan in general, building codes are applicable for new structures; however, these codes are not strictly enforced, since their implementation remains somehow optional. Therefore, the legislative framework is there, and Municipality should work towards promoting its use or decide its strict enforcement. Moreover, techniques on how to protect infrastructure from floods (e.g. minimum floor heights, water proofing etc.) are also required. This action has been suggested as part of the mitigation actions across all building infrastructure in the territory. The estimated cost and duration for this action has been considered in the mitigation actions.

### *Integrated land use planning with zoning system depending on the different areas*

This action is basically the integration in the land use planning of the mapping of the region conducted before, depending the high, medium and low risk for phenomena such as flooding and landslides for characterizing certain zones. This action will be realized internally by the Municipality upon the completion of the mapping.

### *Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises*

Karak Municipality should organize educational campaigns in order to inform inhabitants about the risks and climate hazards on the region and propose the appropriate measures via guidebooks or other material. Thus citizens will be able to modify their residences and businesses and convert them to more safe places which could resist floods and heat. Since Karak Municipality is going to implement a series of awareness activities in the mitigation and adaptation thematic fields, it is the Municipality's intention to group where possible these activities for better coordination.

### *Greening infrastructure such as buildings' roofs and walls*

A green roof is covered with vegetation and between other purposes it serves to provide insulation and help to lower air temperatures. It also contributes in mitigating the heat island effect and in cleaning the air in parallel with decreasing stress of the inhabitants. The development of demonstrative projects for this purpose by the Municipality is envisaged within the 2030 horizon. The estimated cost for this action is 60,000 JOD, while the action is planned to start in 2023.

### *Increasing the amount of shade and green areas in the city by planting trees and using green pavements to reduce the heat island effect*

In order to adapt to the high temperatures, the Municipality could create shade and green areas in places where a lot of people gather or pass through their day. Trees and parks can contribute in reducing the heat island effect and provide outdoor thermal comfort as well as a shaded and breezy place for the people passing to rest. In addition, the chosen material for the construction of sidewalks should be heat absorbing so as to prevent the extra heating from the ground to be reflected. In that way, citizens will feel euphoria and will be partially protected by a heat stroke. The estimated cost for this action is 400,000 JOD for the application of the above in selected parts of the city, and it is planned to start in 2020 and end in 2030.

### *Building exemplary districts with adapted urban forms and buildings*

A great way to attract more citizens so as to adapt the measures is to build exemplary districts with adapted urban forms and buildings to perform as a demonstration project. Karak Municipality in this way can lead by example its citizens and comprise the basis and reference for similar future works in the country. The action is envisaged at demonstrative scale upon the receipt of the related funds. Since the Municipality already has plans for buildings and will implement such activities, the estimated cost for this action is for transforming them into

green neighborhoods, namely the additional cost is 500,000 JOD, and it is planned to start in 2019 and run until 2030, depending on fund availability.

### *White roofs (cool colors), shading and bioclimatic design*

The main measures to adapt for a building are those which can prevent temperature increase. Cool colors in rooftops or even the external walls reflect a percentage of the absorbed heat, thus maintaining the inner temperature at lower levels. Shadings can also contribute to the preservation of indoor thermal comfort since they block the sunlight to pass through glazing. Taking also into consideration the general bioclimatic designs, such as building orientation, construction materials etc. is also a way to maintain the desirable temperature inside the building. This action has already been suggested as a measure for the mitigation of energy consumption and related emissions.

### *Rainwater collection* and use

Collecting rainwater is an excellent way to conserve the fresh water. Using rain barrels, rainwater collection systems with big tanks underground (to avoid evaporations) can lead to significant water savings. This water could be used for domestic purposes like gardening, washing vehicles and equipment, flushing toilets etc. This action envisages rainwater collection in selected municipal buildings at first, as a pilot study. The estimated cost for this action in selected Municipal buildings is 20,000 JOD and it is planned to start in 2019 and be finalized by 2020. Depending on the action's results, potential multiplication in other buildings will be considered.

### *Adoption of methods to reduce water demand*

Since water scarcity is a major problem for Jordan in general, and Karak especially, a solution is to adopt methods to reduce its use. Using proper showerheads, toilet flushes with adjustable flow, wash machines only when they are full are easy activities to follow in order to save water and adapt to the increasing problem of water scarcity. The estimated cost for this action is 10,000 JOD for implementation of such measures in selected Municipal buildings. Potential replication of the results is also envisaged, including awareness raising (to be combined with previous actions) targeting the residents. The action is planned to start in 2018 and be finalized within the year.

## 4.6.4 Economy

Climate changes and extreme events affect the economy sector and create problems that have to be addressed promptly.

Table 80: Suggested adaptation actions for economy

| Actions' characteristic | Adaptation Actions |
|---|---|
| **Strategic** | Elaboration of water and ground water management plan |
| | Adoption of integrated land use planning for the tertiary sector |

### *Elaboration of water and ground water management plan*

This action has been also considered above, in the infrastructure section. The water management plan to be developed should target the economic sectors in the region as well.

### *Adoption of integrated land use planning for the tertiary sector*

Integrated land use planning is a strategy to prevent climate impacts such as flooding, drought, water scarcity and heat stress, as well as to avoid exposure of valuable elements to risks. The planning for the tertiary sector proposes that construction in flood areas should be avoided if possible, urban development should be planned in low hazard areas, development of buildings, housing, economical values etc. in flood risk areas should be restricted and storm water services should be planned. This action can be considered part of the urban planning and zoning system suggested above, under the Built Environment, with specific emphasis on the building permits issued for accommodation and different types of services.

## 4.6.5 Biodiversity

Biodiversity – the variety of life on the planet – is essential for the economy and for people well-being, but one of the main environmental challenges facing the planet is the loss of it. Conserving biodiversity and maintaining nature's capacity to deliver the related goods and services is became a priority at global scale.

Table 81: Suggested adaptation actions for biodiversity

| Actions' characteristic | Adaptation Actions |
|---|---|
| **Educational** | Educating the citizens |
| | Trees planting |

### *Educating the citizens*

A significant measure is citizens' education regarding the importance of biodiversity for their wellbeing. People have to realize that their actions and activities are connected directly with the state of the environment thus affecting their own living conditions. Campaigns should be organized so as to inform inhabitants how they can adopt an environmental friendly behavior and protect their natural habitat. The estimated cost for this action is considered as part of other awareness raising activities to be conducted by the Municipality.

### *Trees planting*

An important action towards the protection of biodiversity is the tree planting and the expansion of green areas with friendly drought-tolerant plants. Trees not only contribute to the preservation of the natural habitat of fauna but they can also prevent floods and soil erosion. Moreover, they are significant actors in air cleaning which means that more trees and plants can reduce more the greenhouse gasses. This action focuses on motivating and coordinating voluntary initiatives from the residents, perhaps with the financial support of certain companies activated in the city, in the form of a sponsor.

# Chapter 5: Project Fiches

## 5.1 #1 - Replacing non efficient Lamps with LED Lamps for the street lighting

### Replacing non efficient Lamps with LED Lamps for the street lighting - # No 1

#### 1. General Presentation

| Location | Start date | Project Lifetime |
|---|---|---|
| Al-Karak governorate | TBD | TBD |

**Project Owner / Lead Actor**

Al-Karak Greater Municipality

**Contact person**

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**Summary of the Action**

Street lighting in Karak Municipality consumes 5,872 MWh of electricity per year, which represents an overall annual cost of 684,694 JOD/yr. Various types of lamps are used for street lighting, more specifically: High Pressure Sodium and Mercury Vapor. According to the Municipality Staff, the entire service requires around **25,000 lamps** and is controlled by timers. An analysis of the street lighting system's current situation is presented in the table below.

| Type | Quantity | Power (Watts) | Electricity Consumption (MWh) |
|---|---|---|---|
| Mercury Vapor Lamps | 17,500 | 145 | 3,239 |
| High Pressure Sodium Lamps | 7,500 | 275 | 2,633 |

For the calculation of the electricity consumption in the above table, the same operational hours for both types of lamps have been considered.

The Municipality wants to launch a process to change all the lamps in the city and improve the overall performance of the street lighting system.The recommendation is to replace:

- the Mercury Vapor Lamps with 50W LED Lamps (saving 65.5% of energy consumption) and
- the High Pressurre Sodium Lamps with 90W LED Lamps (saving 67.3% of energy consumption).

Consequently, it derives that 3,894 MWh will be saved annualy which leads in 453,894 JOD (594,719€) annual cost saving, taking into consideration that 1 KWh of electricity costs 0,1166 JOD and using the conversion rate 1 JOD=1,31€. The specific lamp sizes were selected in order to ensure the proper light quality on the road network.

The costs of the purchase are:

- 120JOD per lamp for the 17,500 LED lamps of 50W, namely 2.1 million JOD and
- 170 JOD per lamp for the 7,500 LED lamps of 90W, thus 1.275 million JOD.

It derives that the total cost for the equipment is 3,375,000 JOD (4,421,250€). The human resources cost for the removal of the old lamps and placement of the new ones will be covered by the contractor, including conducting awareness sessions with the community which will cost an additional amount of around 3,000 JOD.

In addition, assuming the life expectancy of the lamps that equals 14 years, for the current operational hours, the Net Present Value is positive and high. For the calculation of the NVP, i has been considered equal to 8%.

Moreover the $CO_2$ emissions reduction, based on the electricity emission factor for Karak (0.659 tn/MWh) is 2,566 tn $CO_2$, which means that the lamps replacement will reduce the overall emissions of the territory by 0.61%.

| General Objectives of the Project | Principal partners and stakeholders |
|---|---|
| Replacing low efficiency street lamps to reduce energy consumption and cost, while improving street lighting quality. Reduction in electricity consumption will reduce GHG linked to this electricity consumption. | 1. Karak Greater Municipality.<br>2. Local Energy Company. |

| Ultimate beneficiaries of the project | Link to municipal development plans / urban plans / other municipal or city programs |
|---|---|
| Karak Greater Municipality | The street lighting improvement is one of the change processes to be promoted to demonstrate possible reduction in energy consumption in public services. Even if street lighting remains a rather small consumption center, it is highly symbolic to demonstrate that the right choice can result in more than 50% energy consumption reduction. |

| Estimated investment cost needed | |
|---|---|
| EUR: | 4,425,180 |
| JOD: | 3,378,000 |

## 2. Technical Description

| Area(s) of intervention (sectors as specified in the SEAP proposed by CoM) | Main adopted Technology & Equipment |
|---|---|
| Municipal Street Lighting | LED technology |

| Site / Place | Status of the action | | | |
|---|---|---|---|---|
| All the street lighting for the Karak Greater Municipality. | New (x) | Planned | Under implementation | Following previous action |

| Start date | Project Lifetime | Previous or linked studies |
|---|---|---|
| TBD | TBD | No previous studies |

| | |
|---|---|
| Engineering Studies | Not available |
| Implementation plan / Construction plan | Within 2 months from the acquirement of the equipment. |
| Other previous studies | Not available |
| Environmental impact assessment | Not applicable |

## 3. Organization and procedures

| Formal approval | Legal responsible body |
|---|---|
| Karak Municipality needs to decide for the implementation of the plan. The action is to be included in the municipality's SECAP | Karak Greater Municipality. |

| Staff allocated to prepare, implement and monitor the action | Municipal / City Staff Training Needs |
|---|---|
| The concerned staff in the municipality | The street lighting team needs to receive a proper training on the technical maintenance of LED lamps |
| **Technical Assistance Needs** | **Role of Partners** |
| TOR and supervision required from a consultation company for the implementation phase. | TBD |

## 4. Cost Estimates

| | | | |
|---|---|---|---|
| **Initial and start-up expenses** | 4,425,180€<br>3,378,000 JOD | **Net Present Value (NPV)** | **Return of Investment (IRR)** |
| **Operational Costs (approx.)** | | 477,822€ (14 years life time) | 10% |
| **Annual Income (approx.)** | 594,719€<br>453,984 JOD | 364,750 JOD | |

## 5. Funding Sources

| Funding Source | Fund |
|---|---|
| **Local Authority's own resources** | |
| **National Funds and Programs** | |
| **International Financial Institutions** | |
| **EU Funds & Programs and other external funds** | |
| **Public-Private Partnerships** | |
| **Lined up Private Investments** | |
| **Loans and Potential Borrower** | |
| **Expected Annual Cost Savings to City Budget** | |
| **Other** | |

## 6. Projected Energy Estimates in 2030

| Energy Savings (MWh/a) | Renewable Energy Production (MWh/a) |
|---|---|
| 3,893.5 | No renewable energy production is foreseen by the action |
| **$CO_2$ Reduction (tn $CO_2$/a)** | |
| **Target Year** | 2030 |
| **Net reduction on the Territory** | 2,566 (tn CO2/a) |
| **Reduction as related to BAU Scenario** | 0.61% |
| **Per Capita calculated reduction** | 22.5 kg $CO_2$ |

## 7. Summary of Related Awareness Raising (AR) Actions

| Awareness Raising related to the Action |
|---|
| |

| Awareness raising related to the Community |
|---|
| Raise awareness in the population to highlight collective benefits of improved street lighting. |

## 8. Assumptions and risks

- As tests have already been implemented and as the technology is now mature enough, risks are rather limited.
- Quality of tender documents – to get quality products and the guaranteed lifetime and light output of the product.
- Bad behavior of kids could lead to the destruction of some lamps.

## 9. Key success factors

1. High cost of electricity means that any saving will be a significant incentive
2. The time length of LED lamps (3 to four times higher than usual lamps) makes the investment more attractive.
3. No increase has been considered in the electricity price. Thus over a period of 14 years, where the increase of electricity price is certain, this means that the investment will be even more attractive financially.

## 10. Next Steps

TBD

## 11. Annexes / References to Annexes

Not available

## 5.2 #2 - 3 MW PV Station installation

### 3 MW PV Station installation - # No 2

#### 1. General Presentation

| Location | Start date | Project Lifetime |
|---|---|---|
| Al-Karak governorate | Apr/2017 | 2 years (Implementation duration) |

**Project Owner / Lead Actor**

Al-Karak Greater Municipality

**Contact person**

Eng. Fatima Kafaween
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**Summary of the Action**

A wheeling PV on-grid system will be installed to cover the electricity consumption in street lightings and municipal buildings.
The capacity of the PV station will be 3 MWp, with capacity factor of 19,4%, namely 1,700 production hours per year; thus the estimated energy production will be 5,098 MWh. Considering also that 1 KWh costs 0.12 JOD (1 JOD=1.31€), the total monetary savings are calculated to be 611,798 JOD annually (801,456€).
The annual payment to the contractor for the first 3 years will be 720,000 JOD per year and the fourth year 340,000 JOD. The total estimated cost of the project derives 2,500,000 JOD (3,275,000€). The municipality will not be involved in the company's bid value. According to the agreement, the company will run for four years the PV plant and the municipality will pay the value of the monthly energy bill to it, after which the project will become municipal property.
The plan is to develop solar PV station connected to the grid on a free land located within the municipality region with capacity of 3 MW. The municipality has already signed an agreement with a local energy company in line with the above. In the next table the flow cost analysis is presented:

| | year0 | year1 | year2 | year3 | year4 | year5 | year6 | year7 | year8 | year9 | year10 | year11 | year12 | year13 | year14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saving | | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 |
| Capital cost | | JD -720.000 | JD -720.000 | JD -720.000 | JD -340.000 | | | | | | | | | | |
| Total | | JD -108.202 | JD -108.202 | JD -108.202 | JD 271.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 | JD 611.798 |
| Intrest Rate % | 8,00% | | | | | | | | | | | | | | |
| NPV | JD 2.938.391 | 3.849.292 € | | | | | | | | | | | | | |
| IRR | 74% | | | | | | | | | | | | | | |

| General Objectives of the Project | Principal partners and stakeholders |
|---|---|
| 1- Cover the electricity consumption for the municipality and street lighting by renewable source of electricity.<br>2- Reduce the $Co_2$ gas emission by reducing the electricity. | 1. Karak Greater Municipality.<br>2. Local energy company |

| Ultimate beneficiaries of the project | Link to municipal development plans / urban plans / other municipal or city programs |
|---|---|
| Karak Greater Municipality | The SEAP is built on two drivers: reduce energy consumption and develop energy production. Solar energy offers significant potential and is pretty easy to develop. The project will also contribute to creating a "new energy culture" promoted by the Municipality, which means that any citizen can be an energy producer beyond being an energy consumer. |

**Estimated investment cost needed**

| | |
|---|---|
| **EUR:** | 3,275,000 |
| **JOD:** | 2,500,000 |

## 2. Technical Description

| Area(s) of intervention (sectors as specified in the SEAP proposed by CoM) | Main adopted Technology & Equipment |
|---|---|
| RES generation | Wheeling Photovoltaic system (on-grid system) consists of electrical panels, inverter and main Board distribution. |

| Site / Place | Status of the action | | | |
|---|---|---|---|---|
| Free land on AlJoun Area (located within Karak Greater Municipality region). | New | Planned | Under implementation (x) | Following previous action |

| Start date | Project Lifetime | Previous or linked studies |
|---|---|---|
| April/2017 | 2 years | Based on the energy service provider assessments |

| | |
|---|---|
| **Engineering Studies** | Not available |
| **Implementation plan / Construction plan** | TBD |
| **Other previous studies** | Not needed |
| **Environmental impact assessment** | Not applicable |

## 3. Organization and procedures

| Formal approval | Legal responsible body |
|---|---|
| The project approved by the municipal manager. | Karak Greater Municipality. |
| **Staff allocated to prepare, implement and monitor the action** | **Municipal / City Staff Training Needs** |
| The concerned staff in the municipality | Training for the technical staff in the municipality about the operation and maintenance. |
| **Technical Assistance Needs** | **Role of Partners** |
| Local contractor | Technical partners (new electricity company, local companies dealing with PV installation and electric equipment maintenance) will be engaged in the program in order to ensure that a proper network of services can follow on PV development and maintenance. |

## 4. Cost Estimates

| | | | |
|---|---|---|---|
| **Initial and start-up expenses** | 943,200€ annually for first three years<br>445,400€ for the fourth year<br>720,000 JOD annually for first three years<br>340,000 JOD for the fourth year | **Net Present Value (NPV)** | **Return of Investment (IRR)** |
| **Operational Costs (approx.)** | | 3,849,292 € (14 years) | 74% |
| **Annual Income (approx.)** | 801,456€<br>611,798 JOD | 2,938,391 JOD<br>(14 years ) | |

## 5. Funding Sources

| Funding Source | Fund |
|---|---|
| **Local Authority's own resources** | Municipal Budget |
| **National Funds and Programs** | |

| | |
|---|---|
| **International Financial Institutions** | |
| **EU Funds & Programs and other external funds** | |
| **Public-Private Partnerships** | |
| **Lined up Private Investments** | |
| **Loans and Potential Borrower** | |
| **Expected Annual Cost Savings to City Budget** | |
| **Other** | |

## 6. Projected Energy Estimates in 2030

| Energy Savings (MWh/a) | Renewable Energy Production (MWh/a) |
|---|---|
| Not relevant | 5,098 |
| **$CO_2$ Reduction (tn $CO_2$/a)** | |
| **Target Year** | 2030 |
| **Net reduction on the Territory** | 3,360 (tn CO2/a) |
| **Reduction as related to BAU Scenario** | 0.80% |
| **Per Capita calculated reduction** | 29,47 kg $CO_2$ |

## 7. Summary of Related Awareness Raising (AR) Actions

**Awareness Raising related to the Action**

A training and Awareness day will be held for municipal employees and the local community in Al-Karak.

**Awareness raising related to the Community**

Adequate awareness raising actions will be necessary to help people understand the value of electricity production through PV and the benefit both for individual producers and for the entire city of such a move. Awareness should also insist on the fact that Solar PV development doesn't mean that electricity will become abundant. Some actions may include publicity campaigns (traditional media and online social networks) to spread awareness about the development of PV throughout the city, followed up with a town forum event to explain the project and answer questions that residents may have. It will also be important to educate women about the importance of energy conservation in the home so as to develop better consumption habits at the household level.

## 8. Assumptions and risks

The key challenge will be to organize a proper maintenance system in order to ensure adequate production yields securing. Also as renewable electricity production will grow, the grid should be maintained and upgraded to support integration of local production in varying intensity and quantity. Grid upgrade and proper network management will become more and more important.

## 9. Key success factors

1. High cost of energy means that any saving will be a significant incentive.
2. A lot of efforts can be made without heavy investment.
3. Municipality determination to act in a comprehensive way on the issue.

## 10. Next Steps

TBD

## 11. Annexes / References to Annexes

Not available

## 5.3 #3 - Replacing the old Municipal diesel vehicles with new efficient vehicles

### Replacing the old Municipal diesel vehicles with new efficient vehicles- # No 3

#### 1. General Presentation

| Location | Start date | Project Lifetime |
|---|---|---|
| Al-Karak Governorate | TBD | TBD |

**Project Owner / Lead Actor**

Al-Karak Greater Municipality

**Contact person**

Eng. Fatima Kafaween
Eng.fatima@yahoo.com

**Summary of the Action**

The municipal fleet of Karak consumed 900,000 lt diesel (9,000MWh) in 2014. The following table shows the types and numbers of utilized diesel municipal vehicles, according to municipal records:

| Type of Municipal Cars | Number of vehicles | Diesel Consumption (Lit/year) |
|---|---|---|
| Pick-Up | 36 | 289.878 |
| Garbage vehicles | 32 | 296.088 |
| Light trucks < 4 tns | 9 | 72.469 |
| Medium to large trucks > 4 tns | 3 | 24.156 |
| Electricity Maintenance Crane | 2 | 16.104 |
| Rollers | 2 | 16.104 |
| Loaders | 9 | 72.469 |
| Waste water trucks | 1 | 8.052 |
| Tractor | 9 | 72.469 |
| Other vehicles | 4 | 32.209 |
| **Total** | **107** | **900.000** |

Based on a previous study conducted by GIZ for the Solid waste collection and disposal fleet, the average daily traveled distance for one garbage vehicle is around 65 km/day, and since there are 32 garbage trucks working in parallel, the total traveled distance is estimated to be 2080 km/day. Among these 32 garbage trucks, there are 10 vehicles considered old (more than 15 years); this increases the fuel consumption due to the lower engine efficiency. Therefore, the total fuel consumed by the garbage cars reaches 296,088 Lit/yr, comprising 32.90% of the overall diesel consumption in the municipal vehicles. On the other hand, it can be noted that there are 36 pickup vehicles, accounting for 32.21% of the overall municipal diesel consumption, among which 20 vehicles are considered old and non-efficient and need to be replaced with new efficient ones. Regarding the calculated energy savings, in the next table are presented the respective values.

| Type | Number | To be replaced | Diesel consumption for old vehicles ( < 70 km/hr) (lt/km) | Diesel consumption for new efficient vehicles (<70 km/hr) (lt/km) | Fuel saving per vehicle | Fuel Saving (lt/year) | Monetary Saving (JOD/year)* | Monetary saving in the Maintenance (JOD/year) |
|---|---|---|---|---|---|---|---|---|
| Pick-Up | 36 | 20 (55.56%) | 0.18 | 0.12 | 33.33% | 53,681 | 23,727 | 5,112 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Garbage vehicles | 32 | 10 (31.25%) | 0.39 | 0.15 | 60.62% | 56,086 | 24,790 | 1,695 |
| | | | | | **Total:** | **109,767 lt**<br>**1,097.67MWh** | **48,517 JOD**<br>**63,557€*** | **6,807 JOD**<br>**8,917 €**** |

*1 lt diesel=0.442 JOD

**1JOD=1.31€

As far as the costs are concerned, the total investment is calculated as follows:

| Type | New vehicle price (JOD) | Salvage value (JOD | Final cost (JOD) |
|---|---|---|---|
| 20 Pick-Ups | 22,750 | 5,666 | 341,676 |
| 10 Garbage vehicles | 45,000 | 13,221 | 317,788 |
| | | **Total:** | **659,464 JOD**<br>**863,898€** |

In addition, regarding the $CO_2$ emissions, there will be a reduction of 293 tn based on the emission factor for diesel which is 0.267 tn $CO_2$/MWh.

| General Objectives of the Project | Principal partners and stakeholders |
|---|---|
| 3- Reduce the fuel consumption of the municipal vehicles.<br>4- Reduce the $CO_2$ gas emissions by reducing the diesel consumption.<br>5- Reduce climate change repercussions. | 1- Karak Greater Municipality.<br>2- Royal Scientific Society/National Energy Research Center |

| Ultimate beneficiaries of the project | Link to municipal development plans / urban plans / other municipal or city programs |
|---|---|
| Karak Greater Municipality | This measure is in line with the vision of the Karak municipality to make it green and efficient by reducing the GHG emission in all city sectors including the transportation sector. |

| Estimated investment cost needed | |
|---|---|
| **EUR:** | 863,898 |
| **JOD:** | 659,464 |

## 2. Technical Description

| Area(s) of intervention (sectors as specified in the SEAP proposed by CoM) | Main adopted Technology & Equipment |
|---|---|
| Municipal fleet | New vehicles with improved systems |

| Site / Place | Status of the action | | | |
|---|---|---|---|---|
| Karak Greater Municipality. | New (X) | Planned | Under implementation | Following previous action |

| Start date | Project Lifetime | Previous or linked studies |
|---|---|---|
| **TBD** | TBD | Not available |
| **Engineering Studies** | Not applicable for the specific action | |

| | |
|---|---|
| **Implementation plan / Construction plan** | TBD |
| **Other previous studies** | GIZ study for the waste collection assessment. |
| **Environmental impact assessment** | Not applicable |

## 3. Organization and procedures

| **Formal approval** | **Legal responsible body** |
|---|---|
| Need to be approved by the municipality | Karak Greater Municipality. |
| **Staff allocated to prepare, implement and monitor the action** | **Municipal / City Staff Training Needs** |
| The concerned staff in the municipality | Not needed |
| **Technical Assistance Needs** | **Role of Partners** |
| The concerned staff in the municipality | Not available |

## 4. Cost Estimates

| | | | |
|---|---|---|---|
| **Initial and start-up expenses** | 863,898€<br>659,464 JOD | **Net Present Value (NPV)** | **Return of Investment (IRR)** |
| **Operational Costs (approx.)** | | <<0 | |
| **Annual Income (approx.)** | 72,474€<br>55,324JOD | NPV calculations have been realized for i=8% Current prices have been used for the diesel fuel savings, without considering potential increase | <<0 |

## 5. Funding Sources

| **Funding Source** | **Fund** |
|---|---|
| **Local Authority's own resources** | TBD Later |
| **National Funds and Programs** | |
| **International Financial Institutions** | |
| **EU Funds & Programs and other external funds** | |
| **Public-Private Partnerships** | |
| **Lined up Private Investments** | |
| **Loans and Potential Borrower** | |
| **Expected Annual Cost Savings to City Budget** | |
| **Other** | |

## 6. Projected Energy Estimates in 2020

| **Energy Savings** | **Renewable Energy Production** |
|---|---|

| (MWh/a) | (MWh/a) |
|---|---|
| 1,097 MWh/a (109,767lit/a Diesel) | Not Relevant |
| **$CO_2$ Reduction (tn $CO_2$/a)** | |
| **Target Year** | 2030 |
| **Net reduction on the Territory** | 288 tn $CO_2$ /year |
| **Reduction as related to BAU Scenario** | 0.07% |
| **Per Capita calculated reduction** | 2.57 kg |

## 7. Summary of Related Awareness Raising (AR) Actions

**Awareness Raising related to the Action**

Not needed

**Awareness raising related to the Community**

Adequate awareness raising actions will be necessary to help people understand the value of reduced energy and fuel by improving the privately owned vehicles, as well as their impact in terms of financial savings

## 8. Assumptions and risks

The daily distance travelled for the garbage vehicles is assumed based on the GIZ study to calculate the diesel consumption, since there is no available data or bills for diesel consumption

## 9. Key success factors

1 - High cost of fuel means that any saving will be a significant incentive.

2- Even though the action is not attractive with strict financial criteria, it is considered a one way solution upon the completion of the vehicles' lifetime and the need for their substitution

## 10. Annexes / References to Annexes

Not available

## 5.4 #4 - Bio Waste Management

### Bio Waste Management - # No 4

#### 1. General Presentation

| Location | Start date | Project Lifetime |
|---|---|---|
| Al-Karak Governorate | TBD | 20 years |

**Project Owner / Lead Actor**

Al-Karak Greater Municipality

**Contact person**

Eng. Fatima Kafaween
Eng.fatima@yahoo.com

**Summary of the Action**

The solid waste issue gained significant attention in recent years, not only due to its environmental impacts, but also for its social and economical consequences. The Municipality service operates 30 trucks with compactors (on the municipality perimeter). This service collects 109,500 tons/year. This represents 2.63 kg per capita / per day in the city and in the municipality.

Waste composition breakdowns as follows: 62% organic-waste – 27% carton and plastic, the remaining part (11 %) being a mix that cannot be recycled.

The total amount of waste collected represents around 300 tons/day from the municipality region and goes every day to the Al-Karak Landfill. The methane currently released to the atmosphere is 2,527 ton/yr. This quantity equals to 63,181 ton/yr of equivalent CO2, according to the guidelines where the conversion factor from methane to carbon dioxide equivalent is 25.

***Short-term actions***

The Municipality is committed to work on reducing waste to be collected as the major solution to reduce energy consumption generated by waste management.

The Municipality will continue developing public awareness to reduce waste generation, promote recycling and separation. The idea is to draw experience from the pilot project to then be extended to the entire city.

***Long-term actions***

The municipality is planning to separate the biomass to produce bio-fertilizer. Biological treatment will be used to treat the biomass and produce bio-fertilizer.

The bio-fertilizer plant will reduce about 31,338 tn Co2 eq annually by converting the bio organic waste to bio gas and fertilizer.

| $CO_2$ Saving from the project | |
|---|---|
| Annual $CO_2$ emission from the municipal solid waste (tn $CO_2$/year) | 63,181 |
| Annual $CO_2$ emission from Municipal Bio (Organic) Waste | 39,172 (62% of total emissions) |
| Typical $CO_2$ emission reduction by Biogas (%)* | 80% |
| $CO_2$ emissions from utilizing the biogas in electricity generation (tn $CO_2$/year) | 7,834 20% of the organic waste emissions |
| Annual $CO_2$ saving (Tn $CO_2$ / year) | 31,338 |

Also the municipality will separate the glass and sell it to be recycled.

The total investment for the plant, regarding costs for 2 MWp biogas plant for biofertilizer (purification and filling) and solid waste separation plant, equals 9,000,000 JOD (11,790,000 €**), with operational cost 1,524,300 JOD (1,996,833€). The expected income from electricity and fertilizer generation is 3,375,000 JOD (4,421,250 €). More specifically, the income is calculated as follows:

Income from electricity=2,000KWp (plant capacity)*7,200h(operation)*0.06 JOD/KWh=864,000 JOD

Income from fertilizer=45% (fertilizer production rate from biomass)*186 tn of biomass daily*300days of operation*100 JOD/tn of fertilizer= 2,511,000 JOD

*Source: DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

** 1 JOD=1.31€

| General Objectives of the Project | Principal partners and stakeholders |
|---|---|
| 6- Reduce the harmful effect of the untreated solid waste on the climate.<br>7- Create new job opportunities.<br>8- Reduce the $CO_2$ and CH4 gas emissions. | 1- Karak Greater Municipality.<br>2- Royal Scientific Society/National Energy Research Center |
| **Ultimate beneficiaries of the project** | **Link to municipal development plans / urban plans / other municipal or city programs** |
| Karak Greater Municipality | According the municipal vision to make the municipality green. |
| **Estimated investment cost needed** | |
| **EUR:** 11,790,000 | |
| **JOD:** 9,000,000 | |

## 2. Technical Description

| Area(s) of intervention (sectors as specified in the SEAP proposed by CoM) | Main adopted Technology & Equipment |
|---|---|
| Waste management | Anaerobic fermentation digesters, biogas treatment units and CHP unit. |

| Site / Place | Status of the action | | | |
|---|---|---|---|---|
| Al Karak city | New (x) | Planned | Under implementation | Following previous action |

| Start date | Project Lifetime | Previous or linked studies |
|---|---|---|
| TBD | 20 years | Not available |

| | |
|---|---|
| **Engineering Studies** | Not available |
| **Implementation plan / Construction plan** | 1- Separation the solid waste.<br>2- Design the biogas plant.<br>3- Installation the biogas plant.<br>4- Operation the plant. |

| | |
|---|---|
| **Other previous studies** | Not available |
| **Environmental impact assessment** | An environmental impact assessment study will be done before the implementation stage. |

## 3. Organization and procedures

| **Formal approval** | **Legal responsible body** |
|---|---|
| To be discussed with the Municipality | Karak Greater Municipality. |
| **Staff allocated to prepare, implement and monitor the action** | **Municipal / City Staff Training Needs** |
| Responsible staff from the municipality | Need awareness training for the benefits of the project. |
| **Technical Assistance Needs** | **Role of Partners** |
| Need the experience of the National Energy Research Center. | To prepare the initial assessment, tendering, supervising on the installation and commissioning. |

## 4. Cost Estimates

| | | **Net Present Value (NPV)** | **Return of Investment (IRR)** |
|---|---|---|---|
| **Initial and start-up expenses** | 11,790,000€<br>9,000,000 JOD | | |
| **Operational Costs (approx.)** | 2,002,073 € (including maintenance)<br>1,528,300 JOD (including maintenance) | 12,013,284 € | |
| **Annual Income (approx.)** | Electricity production= 1,131,840€<br>Fertilizer production = 3,289,410 €<br>Total=4,421,250€<br>Electricity production=864,000JOD<br>Fertilizer production =2,511,000 JOD<br>Total=3,375,000 JOD | 9,170,445 JOD | 20% |

## 5. Funding Sources

| **Funding Source** | **Fund** |
|---|---|
| **Local Authority's own resources** | Will be determined later |
| **National Funds and Programs** | |
| **International Financial Institutions** | |
| **EU Funds & Programs and other external funds** | |
| **Public-Private Partnerships** | |
| **Lined up Private Investments** | |
| **Loans and Potential Borrower** | |
| **Expected Annual Cost Savings to City Budget** | |

| | |
|---|---|
| **Other** | |

## 6. Projected Energy Estimates in 2030

| Energy Savings (MWh/a) | Renewable Energy Production (MWh/a) |
|---|---|
| Not applicable | 14,400 |

| $CO_2$ Reduction (tn $CO_2$/a) | |
|---|---|
| **Target Year** | 2030 |
| **Net reduction on the Territory** | 31,338 ton $CO_2$ |
| **Reduction as related to BAU Scenario** | 7.43% |
| **Per Capita calculated reduction** | 274.9kg/a |

## 7. Summary of Related Awareness Raising (AR) Actions

**Awareness Raising related to the Action**

A training and Awareness day will be held for municipal employees in Al-Karak.

**Awareness raising related to the Community**

A training and Awareness day will be held for the local community in Al-Karak in order to show the benefits of using the solid organic wastes to generate energy

## 8. Assumptions and risks

As tests have already been implemented and as the technology is now mature enough, risks are rather limited.

The payback period for implementing such project is long; however this is reasonable considering the project's scale.

Bio-fertilizer production goals may not be achieved and a feasibility study is required for the estimation of the existing potential.

## 9. Key Success Factors

1- The potential of biomass is high.
2- The technology will improve the environment.

## 10. Next Steps

TBD

## 11. Annexes / References to Annexes

Not available

## 5.5 #5 - Making the Municipal Buildings Green

### Making the Municipal Buildings Green - # No 5

#### 1. General Presentation

| Location | Start date | Project Lifetime |
|---|---|---|
| Al-Karak governorate | TBD | TBD |

**Project Owner / Lead Actor**

Al-Karak Greater Municipality

**Contact person**

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**Summary of the Action**

Karak Municipality wants to make its municipal buildings efficient and green. This can be through actions in the building envelope, namely walls, roofs and windows. Some of the best options in order to make the buildings more efficient are the insulation of walls and roofs and the use of double glaze windows.

According to the municipality staff, all municipal buildings have already installed efficient lighting units (LED technology) and new AC units, where the latter constitute about 50% of the annual energy consumption in the municipal buildings. Also it was considered that the municipal buildings' envelope does not have thermal insulation, while their windows are of single glaze type and present air infiltration. This means that improving the building envelope (thermally insulating the walls and roofs and replacing the single glaze windows with double glaze ones) will reduce the heat losses in the buildings and thus reduce the energy consumed in the AC units for heating and cooling. Moreover the municipality wants to take benefit of the solar potential of the region to increase the local production of renewable electricity. By doing so it will reduce its dependency on the grid, through the installation of PVs wherever possible on the municipal buildings' roofs. The total available roof area is around 5,000 $m^2$, almost half of the total roof area, according to Municipality Staff (detailed calculations are provided below).

More specifically:

- Regarding the PV system, as it is mentioned above, the total available roof area is 5,000 $m^2$, thus the maximum installed capacity of panels is 500KW. It is also calculated that, assuming a 19.4% capacity factor for Karak region, namely a total of 1,700 production hours annually, the estimated annual electricity production is 850MWh. Moreover the annual monetary savings, based on the fact that 1 KWh costs 0.12 JOD and 1 JOD=1.31€. will be 102,025 JOD (133,652€).
- As for the building's envelope, in the next figure are presented the respective savings, considering also the energy consumption forecast in 2030 (Baseline as Usual Scenario – BAU), calculated based on the increase coefficient for Jordan of 1.68 (baseline year 2014).

| Energy consumption in the municipal buildings (MWh) | Share percentage of air conditioning system in the overall building consumption | Energy Saving in the air conditioning system due to the building envelope measures | Energy savings (MWh/year) |
|---|---|---|---|
| 5,104.6 | 50% | 35% | 1,500 |

Thus based on the previous rates, it derives that municipality can save 152,891 JOD (200,287€).

As far as the investments are concerned, the costs for the above projects have been calculated as follows, depending on estimations:

- PV systems

The equipment & installation cost is approximately 1,000 JOD per installed KW, thus the total cost is 500,000 JOD (655,000€).

- Buildings' envelope

For this section a detailed table is provided below:

| Municipal buildings | No. of buildings | No. of floors for each building | Total Buildings area, assuming 1 floor=400 $m^2$ ($m^2$) | Total external walls area, assuming 1 wall=20m*3m ($m^2$) | Area of windows ($m^2$) | Area of walls without windows ($m^2$) | Area of roofs ($m^2$) |
|---|---|---|---|---|---|---|---|
| Single floor buildings | 22 | 1 | 8,800 | 5,280 | 792 | 4,488 | 8,800 |
| Multi floors buildings | 5 | 3 | 6,000 | 3,600 | 540 | 3,060 | 2,000 |
| **Total** | **27** | | **14,800** | **8,880** | **1,332** | **7,548** | **10,800** |

- Cost of double glaze windows: 98 JOD/$m^2$ -> Total cost for double glaze windows: **130,536 JOD (171,002€)**
- Cost of external walls insulation: 40 JOD/$m^2$ -> Total cost for wall insulation: **301,920 JOD (395,515€)**
- Cost of roof insulation: 32 JOD/$m^2$ -> Total cost for roof insulation: **345,600JOD (452,736€)**

The overall cost for the buildings' envelope enhancement is approximately **778,056 JOD (1,019,253€).**

- Awareness raising activities

Awareness activities include capacity building, brochures & SMS distribution, and awareness raising workshop, thus the total envisaged cost is around 10,000 JOD (13,100€)

The total investment for the implementation of all the proposed measures is **1,288,056 JOD (1,687,353€)** with high Net Present Value, considering an interest rate of 8%.

In addition there will be a reduction of **1,549 tn $CO_2$** since the electricity emission factor for Karak equals 0.659 tn $CO_2$/MWh.

| General Objectives of the Project | Principal partners and stakeholders |
|---|---|
| 1. Improve the building envelope to reduce the thermal losses and energy consumption in the buildings.<br>2. Develop renewable electricity production in order to reduce dependency on electricity grid.<br>3. Develop technical capacity locally to promote the technology and provide support to any investor willing to develop solar PV in Karak. | 1. Municipality services<br>2. Local business |
| **Ultimate beneficiaries of the project** | **Link to municipal development plans / urban plans / other municipal or city programs** |
| Karak Greater Municipality | The SEAP is built on two drivers: reduce energy consumption and develop energy production. Solar energy offers significant potential and is pretty easy to develop. The project will also contribute to creating a "new energy culture" promoted by the Municipality, which means that any citizen can be an energy producer beyond being an energy consumer. |
| **Estimated investment cost needed** | |
| **EUR:** 1,687,353 | |
| **JOD:** 1,288,056 | |

## 2. Technical Description

| Area(s) of intervention (sectors as specified in the SEAP proposed by CoM) | Main adopted Technology & Equipment |
|---|---|

| | |
|---|---|
| Municipal buildings | 1. Solar Photo voltaic cells<br>2. Thermal insulation<br>3. Double glaze Windows |

| Site / Place | Status of the action | | | |
|---|---|---|---|---|
| Karak city | New (x) | Planned | Under implementation | Following previous action |

| Start date | Project Lifetime | Previous or linked studies |
|---|---|---|
| TBD | TBD | No previous studies |

| | |
|---|---|
| **Engineering Studies** | Not needed |
| **Implementation plan / Construction plan** | TBD |
| **Other previous studies** | Not available |
| **Environmental impact assessment** | Not needed |

## 3. Organization and procedures

| Formal approval | Legal responsible body |
|---|---|
| Karak Municipality needs to decide for the implementation of the plan. | Karak Greater Municipality. |
| **Staff allocated to prepare, implement and monitor the action** | **Municipal / City Staff Training Needs** |
| The concerned staff in the municipality | The team which will be assigned to the unit need to receive a proper training on two subjects:<br>1. Technical questions related PV development<br>2. Project management |
| **Technical Assistance Needs** | **Role of Partners** |
| TOR and supervision need from a consultation company for the implementation phase. According to the laws and instructions of MPWH | Technical partners (electricity company, local companies dealing with PV installation and electric equipment maintenance) will be engaged in the programme in order to ensure that a proper network of services can follow on PV development and maintenance. |

## 4. Cost Estimates

| | | | |
|---|---|---|---|
| **Initial and start-up expenses** | 1,687,353€<br>1,288,056 JOD | **Net Present Value (NPV)** | **Return of Investment (IRR)** |
| **Operational Costs (approx.)** | | 1,065,724€ (14 years lifecycle) | 18% |
| **Annual Income (approx.)** | 274,080€<br>209,221 JOD | 813,530 JOD (14 years) | |

## 5. Funding Sources

| Funding Source | Fund |
|---|---|

| | |
|---|---|
| **Local Authority's own resources** | TBD later |
| **National Funds and Programs** | |
| **International Financial Institutions** | |
| **EU Funds & Programs and other external funds** | |
| **Public-Private Partnerships** | |
| **Lined up Private Investments** | |
| **Loans and Potential Borrower** | |
| **Expected Annual Cost Savings to City Budget** | |
| **Other** | |

## 6. Projected Energy Estimates in 2030

| Energy Savings (MWh/a) | Renewable Energy Production (MWh/a) |
|---|---|
| 1,500 | 850 |

| $CO_2$ Reduction (tn $CO_2$/a) | |
|---|---|
| **Target Year** | 2030 |
| **Net reduction on the Territory** | 1,549 (tn CO2/a) |
| **Reduction as related to BAU Scenario** | 0.37% |
| **Per Capita calculated reduction** | 13.59 kg |

## 7. Summary of Related Awareness Raising (AR) Actions

**Awareness Raising related to the Action**

A training and awareness day will be held for municipal employees and the local community in Al-Karak to disseminate info on what is energy efficient behaviour and as a guideline on how to be energy efficient in buildings.

**Awareness raising related to the Community**

Adequate awareness raising actions will be necessary to help people understand the value of electricity production through PV and the benefit both for individual producers and for the entire city of such a move. Awareness should also insist on the fact that Solar PV development doesn't mean that electricity will become abundant. Some actions may include publicity campaigns (traditional media and online social networks) to spread awareness about the development of PV throughout the city, followed up with a town forum event to explain the project and answer questions that residents may have. It will also be important to educate women about the importance of energy conservation in the home so as to develop better consumption habits at the household level.

## 8. Assumptions and risks

- For the building envelope measures, the awareness about the importance of the conditioned spaces' insulation is highly needed, since any open external window or door will affect the heating/cooling demand.
- For the PV systems, the key challenge will be to organize a proper maintenance system in order to ensure adequate production yields.
- As renewable electricity production will grow, the grid should be maintained and upgraded to support integration of local production in varying intensity and quantity. Grid upgrade and proper network management will become more and more important.

## 9. Key success factors

1. High cost of energy means that any saving will be a significant incentive.
2. Thermal comfort and quality of work will be achieved easier with energy efficient building envelope.

## 10. Next Steps

TBD

## 11. Annexes / References to Annexes

Not available

## Chapter 6: Citizens Awareness Promotion Plan

# Karak

# A sustainable future for an attractive city

### Preparing and including the "Awareness Raising Actions" component in the SECAP

In addition to the requirement linked to the public consultation of the SEAP, a Citizen Awareness Promotion Plan (CAPP) has to be elaborated by the municipality as part of the Sustainable Energy Action Plan document (SEcAP).

**Identification of CAPP actions through participatory training workshops**

*The CES-MED project has conducted a tailored communication and CAPP training workshop for the local authority and it communication team in coordination with (and attended by) the Focal Point and the SECAP Consultants. Prior to conducting the workshop, which was led by CES-MED key communication expert (KE), three parts "Communication Kit" was handed on to the local authority and SEAP Consultant, who were asked to get acquainted with its content prior to conducting the training.*

*The "Communication Info Kit" (annex1) includes:*

- *Part 1: the "CAPP Guidelines" document: a tailored comprehensive manual prepared by CES-MED for the use of cities/municipalities on how to identify, plan and conduct awareness raising actions (Arabic, English and French versions)*

  (http://www.ces-med.eu/publications/recommendations-and-guidelines-development-citizens-awareness-promotion-plan-capp)

- *Part 2 includes;*
  - *PPT Presentation of the CAPP Guidelines*
  - *Presentation of "how to prepare and implement a communication and an awareness campaign" showing techniques, materials and models*

- *Pools of benchmark examples and references to best practices from across the world towards citizen engagement and behaviour change, with adaptation to the CES-MED cities context*

- *Part 3: consists of 4 Tables to assess CAPP conditions and identify actions.*
  - *Table 1 is used to conduct a rapid investigation to identify awareness situation, levels and needs linked to behavioural change in the city; and to initiate discussions with the workshop participants towards the identification of target audiences and the SECAP CAPP actions.*
  - *Table2: presents the content of a plan to implement a CAPP action related to a Pilot Project.*
  - *Table 3 presents the proposed actions related to the general sustainable energy challenges and to the city.*
  - *Table 4: presents the proposed CAPP actions linked to each SECAP priority projects.*

*During the workshop, the "Communication Kit" material was explained. The following discussions, assessment and analysis addressed awareness raising conditions and challenges, communication concepts and CAPP methodologies, tools, techniques before examining and multiple benchmark applications.*

*A practical exercise was then conducted to specify the SECAP's CAPP actions, whereby the local authority general awareness raising needs and SECAP's priority actions (proposed in the Project Fiches) were looked over and proposed. In doing so, the template tables were "draftly" filled by the participants and the KE.*

*Following the workshop, the participants have thoroughly reviewed the tables and finalized them with CES-MED KE and the SECAP Consultants, prior to including them in the SECAP (below).*

***The Communication Info Kit and specially the CAPP Guidelines are to be used as reference work manuals for the subsequent detailed planning and implementation of the CAPP actions proposed in the in the SECAP document and other similar awareness raising actions.***

# Preparation of a COMMUNITY AWARENESS PROMOTIONAL PLAN (CAPP)

## Template 1- Situation analysis of Irbid

**Aim**

The questions in the attached templates cover various areas of actions and levels of awareness linked to behavioural change. It has been used to conduct a quick investigation on the awareness situation and level of perception of the citizens in the city concerning renewable energy and energy saving.

The exercise of filling the templates has identified and assessed the conditions in the municipalities prior to preparing a CAPP and to answers a number of questions, including:

1) Who are the target audience of a CAPP?
2) What are the priority issues to be addressed by the CAPP (that also could be identified by the SECAP as priority actions)?
3) What is the level of awareness of energy key problems? And what are the first issues to raise awareness about?
4) What are previous awareness raising actions, so that he CAPP can build on them?
5) What is the situation as related to public consultation, based on which a public consultation is to be designed?

The exercise of filling the template helped pointing out how raising awareness can be utilized as a tool for improved energy policy to facilitate implementation of its actions; it has allowed initiating discussions in the Communication Workshop and helped identifying appropriate campaigns and actions.

**Specific objectives:**

(i) Provide the necessary information about the current conditions and the situation regarding awareness of energy saving and renewable energy,

(ii) Help to identify the most appropriate a) **awareness raising campaigns** that would accompany the SECAP vision/strategy and b) the **awareness raising actions** that would accompany the priority actions determined in the SECAP.

**Steps to follow:**

(i) The SECAP team of the municipality has filled the templates based on their understanding and perception of the of the city's inhabitants. They were free to seek the opinion of a limited number of persons to help fill the answers.

(ii) The filled templates were discussed in the "CES-MED Communication Workshops", which were led by CES-MED Communication Expert and attended by the SECAP consultant and the SECAP municipal team. In parallel, the vision/strategy of the city

and the proposed pilot actions in the SECAP were reviewed as part of the workshop exercise.

The outcome guided the selection of the most appropriate awareness raising campaigns and actions of the SECAPs including the ones related to priority projects.

| I. Identification of the target audience and the importance they give to Sustainable Energy (audience targeted by the awareness raising campaigns and actions) | | | |
|---|---|---|---|
| Age group | Very important | Important | Not important |
| Youth | X | | |
| Middle Age | | X | |
| Seniors | X | | |
| Other | X | | |

| II. Identification of priority issues to be addressed by a sustainable energy action and their level of importance | | | |
|---|---|---|---|
| **Issue** | **Level of importance** | | |
| | **Very important** | **Important** | **Not important** |
| Expensive oil prices | X | | |
| Availability/lack of energy | | X | |
| Availability of transport | | X | |
| Waste management | X | | |
| Clean environment | X | | |

| III. Identification of level of awareness (energy problems) and education of energy related issues | | | |
|---|---|---|---|
| | **Very aware (through media or research)** | **Aware but not convinced** | **Not Aware** |
| Impact on environment | X | | |
| Cost of energy | | | X |
| Waste of energy | X | | |
| Climate change | | X | |
| Ways to save energy consumption | X | | |
| Existence of renewable energy | X | | |

| IV. Previous awareness actions conducted by the city/municipality or by other actors | |
|---|---|
| Has the city or local authority done previous actions | NO |
| If yes, who conducted the actions (the city/municipality, NGO, national authority…) | |
| If yes, describe the action | |
| If yes, what was the budget and how did you fund it | |
| If yes, outcome, impact and feedback | |

| I. Public consultation | |
|---|---|
| Does the city practice public consultation? | YES |
| Has the city done public consultations for SEAP? | YES |
| Is it part of the legislative process? | Don't know |
| Foreseen consultation(s) | Sessions with members of the local community and local community institutions |
| Does the city liaise with national institutions, stakeholders? | YES |

**Situation analysis**

From this study, regarding the target audience and its profile, it appears that the groups that are aware and informed about energy challenges are mostly the young people as well as the senior population. They have been identified as the ones giving high importance to sustainable energy, are well aware about issues related to this sector and open to any innovative information. It is therefore essential to involve them in awareness actions and get their full involvement as future ambassadors of sustainable energy in their community.

The middle-aged target group has very little interest in the topic of sustainable energy and doesn't seem to evaluate its importance. they would, therefore, need more persuasion to change their opinion and behaviour, all the more so, because they hold the purchasing power. We need to enhance their awareness about appliance energy efficiency characteristics, standards and labels and benefits of more efficient products as costs saving conduct; this might prove to be a very effective way to anticipate the barriers that affect their choices and preferences for their environmental behaviours.

The template shows that in general, environmental and financial motivations such as the expensive price of oil, the waste management issues and the cleanliness of the environment rank highest. While concerns about transport availability and lack of energy are perceived as less important.

In the survey analysis, we find that despite the fact that Karak faces problems in the escalating energy bill, the citizens are not aware of the cost of energy; While concerns about healthy environment, ways to save energy as well as energy efficiency upgrades have significant importance and value.

The municipality of Karak has not conducted any awareness raising actions and campaigns related to sustainable energy towards the civil society; However, regarding public consultations, being part of the legislation of the city, the municipality has carried out the one concerning its SECAP, and more sessions are foreseen.

# Template 3.1

## Identification of CAPP CAMPAIGN TOPIC related to sustainable energy challenges

Once the Sustainable Energy challenges and priorities, general awareness raising priorities, and specific awareness raising needs related to SEAP actions have been identified, the CAPP's main areas of intervention and activities can be defined. The table below portrays the challenges, priorities and related AR activities.

| Challenges: | Priorities: | Awareness Raising Priorities, Topic & Activities of CAPP Campaign |
|---|---|---|
| **Increase in energy consumption.** | Reduce the city's energy consumption and bills and cost of electricity subsidies<br><br>Reduce domestic and commercial use of energy, and therefore, costs on citizens and residents' bills.<br><br>Mitigate pollution and reduce the greenhouse gas emissions impacts. | **Topic**:<br>**Energy-saving measures are simple and can be applicable by all and beneficial to all.**<br><br>**Activities**:<br><br>Provide practical instructions to citizens, in homes, public and private institutions, commercial sector on how to reduce energy consumption. In?<br><br>Explain and clarify harmful effects of greenhouse gas emissions through raising awareness campaigns. |
| **High energy costs with traditional energy system** | Increase reliance on alternative and renewable energy to reduce energy costs.<br><br>Reduce the impact of greenhouse gas emissions. | **Topic**:<br>**Conduct energy audits and facilitate financing for renewable energy**<br><br>**Activities**:<br>Set a department within the municipality to provide energy advice to the citizens, raise their awareness and encourage them to save energy in homes.<br>Explain and clarify harmful effects of greenhouse gas emissions through raising awareness campaigns.<br>Promote financing programmes in renewable energies and how to benefit from those (exhibitions of solar houses, trade fairs for the general public and technical conferences for professionals of the building sector). |

| | | |
|---|---|---|
| **Solid Waste Management** | Construction of a sanitary landfill.<br><br>Implement integrated sustainable waste management service in view of improving quality of life and reducing cost of waste management<br><br>Reduce waste consumption. | **Topic:**<br><br>**Making the city clean from waste.**<br><br>**Activities:**<br><br>Explain the negative effects of waste accumulation and its health impact on the citizens and on the beauty of the city in general.<br><br>Promote the need to support local authorities in solid waste management programmes<br><br>Increase the awareness for reducing the thrown amount of waste at the source and efficient ways to re-use and recycle. |

# Template 3.2

## CAPP activities as related to SECAP Priority Actions of Karak

This template will guide the municipality in the implementation of a strategy and the identification of adequate awareness raising activities according to the target group and its needs and related to the priority actions identified in the SEAP.

| SECAP Priority Actions | Related CAPP Activities: |
|---|---|
| 1- **Energy conservation project in Municipal buildings and facilities** | **Target Audience:**<br>- Civil society<br>- Public and private institutions.<br>- Municipality staff<br>- Professionals and service providers in energy sector in the private and public sectors<br><br>**Key Message:**<br>- The impact of energy conservation is vital for the city and the climate.<br>- Training and education will help energy rationalization and consumption within municipal buildings.<br><br>**Objectives:**<br>- Building a pioneering and realistic model that achieves the concept of energy conservation and optimal use of resources<br>- Reduce electricity consumption in municipal buildings and facilities<br>- Build technical capacity and promote the concept of energy conservation and environmental conservation in all sectors and to all target groups of the project.<br>- Promote the project and the strategic vision of the city at local, national and international level in the clean energy sector.<br>**Communication Tools:**<br>Create awareness and promote the project in the local media and social media networks to alert citizens on municipality action.<br>Give practical tips and install instruction signs in the offices in Karak Municipality and the private sector concerning energy efficiency best practices as a daily reminder for the employees.<br>Educate municipal staff about the benefits of green life, renewable energy, and energy efficiency applications in their life through training programs in order to build their capacity<br>Launch campaigns on being an eco-citizen: Explain the side effect of greenhouse gas emission and the usage of renewable energies technologies through messages conveyed by television, the radio and the written press. |

| | |
|---|---|
| | Hold meetings with the community members to promote the municipal action and the implementation of energy conservation in the city.<br>Training in schools on using the energy correctly. |
| **2- Project to rationalize energy consumption for street lighting** | **Target Audience:**<br>- Civil society<br>- Visitors and tourists in the city<br>- Municipal staff<br>- Private and public operators<br>- Professionals in energy sector<br>- Educational institutions represented by the Directorate of Education and local universities.<br><br>**Key Message:**<br>- Consuming energy more responsibly will have a beneficial impact on the environmental and physical level of the city.<br><br>**Objectives:**<br>- Promote the importance of relying on energy-saving devices.<br>- Promote the use of similar installation and equipment in the common urban regions (Public and Private).<br>- Use available resources from the legislation and components of the street lighting network to generate solar energy and data transmission and to overcome the scarcity of land in the city.<br>- Raise local, national and international awareness in the field of rationalizing energy consumption, preserving the environment and building the necessary capacities to maintain the street lighting system and enhance its role in the framework of safety and environment and exploitation of available resources.<br>**Communication Tools:**<br>Distributing fact sheets that will include data on the importance of the project, its target, the advantages of LED, savings expected in %, to alert citizens on municipality action. The actions will be accompanied by strong visual campaign in the municipal and local media.<br>Distribute labels and stickers at public places, encouraging responsible actions such as “turning the lights off when not in use”.<br>Meetings with the community members to promote the municipal action and expanding the usage of energy-saving lighting in households through distribution of LED lamps.<br>Raising awareness of the importance of replacing the old lighting units with other modern energy-saving and their physical and environmental impact. |

| | |
|---|---|
| **3- Building a wind farm to produce electricity** | **Target Audience:**<br>- Civil society<br>- Visitors and tourists in the city<br>- Private and public operators<br>- Municipal staff<br><br>**Key Message:**<br>- Wind power will move up the future of your city<br><br>**Objectives:**<br>- Increase municipal and local residents' reliance on alternative energy to cover their consumption of energy.<br>**Communication Tools:**<br>Create awareness with demonstration posters in the municipality and local media (Wind turbines can produce strong visual campaigns).<br>Organise field trips to existing wind energy projects, inviting wind energy developers to give presentations, disseminating wind energy fact sheets, and demonstrating the financial benefits of wind turbines have aided them in implementing wind energy.<br>Keep the public involved and foster a cooperative relationship between residents, local government, and wind energy developers would be helpful.<br>Raise awareness in schools with a drawing competition addressing the importance of tackling climate change, and how everyone can make a difference using kids as enthusiastic advocates for renewable wind-powered energy. |
| **4- Installation of PV system on municipal buildings** | **Target Audience:**<br>- Civil society<br>- Educational institutions represented by the Directorate of Education and local universities.<br>- Municipal staff<br><br>**Key Message:**<br>- Solar Panels bloom where the sun shines<br>- Solarizing Karak<br><br>**Objectives:**<br>- Increase municipal and local residents' reliance on alternative energy to cover your consumption of energy.<br>**Communication Tools:**<br>Creating an info center to advise citizens about Photovoltaic systems that will be providing opportunities for public education, including forums and workshops.<br>Develop a media campaign to ensure wide communication towards Karak Municipality citizens (social media, text messages, municipal website) |

| | |
|---|---|
| | Raise local awareness about solar energy by creating and distributing information materials, such as brochures and website content.<br>Develop solar fact sheets, brochures, or guides on the benefits of solar energy with answers to common questions and concerns. |
| **5- Solid waste management** | **Target Audience:**<br>- Civil society<br>- Tourism, health sector and, industries<br>- Municipal staff, students, and employees working in the central city and potential users of this service.<br>- Ministry of Municipalities, Ministry of Finance and Ministry of Planning.<br><br>**Key Message:**<br>- Reducing waste is shared responsibility to descrease environmental impact<br><br>**Objectives:**<br>- Processing of an integrated waste sorting plant.<br>- Transform the Municipality of Karak into a leading municipality in the field of solid waste management.<br>**Communication Tools:**<br>Hold awareness campaigns and seminars to explain the negative effects on solid waste accumulation.<br>Encourage and strengthen the involvement of the population in the source separation of recyclable waste at households and other establishments such as schools and malls.<br>Create institutional pro le on social medias through which information on public services and events, pressing local issues are published with the aim of sensitizing the population to the necessary solutions.<br>Involve the community by hiring neighbourhood “champions” who travel door to door to advise and train neighbours on proper household waste disposal methods or a “cleaning day” event.<br>Educational kits - with a view to teaching young people how to recycle and reuse waste. |

**Recommendations:**

These tables have been thought and prepared by the communes and municipalities. In this approach, they aim to promote in a particularly innovative and ambitious way local communities' response to current challenges identified in the SEAPs and SECAPs, notably in the management of energy and the promotion of renewable energies. They allow us as well to identify the most appropriate communication actions to reach the local community.

In the case of Karak specifically, the involvement of all citizens and stakeholders of the municipality is considered crucial for achieving the set targets. The citizens are the most important resource for the city. More than ever, applying the energy saving methods should be a collective responsibility and commitment conveyed through: targeted and long-term awareness campaigns and actions for the sake of the city; Increased awareness towards national authorities to get their responsiveness in local sustainable policy issues; empowerment of the municipality staff through awareness workshops in order to get their exemplary engagement.

Awareness-raising should be carried out on several fronts to encourage, motivate and alert civil society:

Firstly, students' awareness about environmental problems and solutions can be increased through education; some activities in a university campus involving the students as part of their learning process (composting, cleaning etc.) in order to gain knowledge, motivate the youth and change its behaviour; Knowing that young people are likely to share new informations with families, other adults, and community.

Engage customers on comprehensive renewable energy and energy efficiency programs and make sure that local residents have access to reliable information about planning issues and other topics of interest. Besides simply being repositories of information on clean energy, the city is in a position to educate and inform its community about the general benefits of this alternative energy, as well as promote its goals and policies that the local government have adopted. connect citizens to existing material, as there is a need for public education and outreach around the energy subject; "lack of interest or lack of awareness of efficient energy development" is a very commonly reported challenge.

Establish a strong and comprehensive communication methodology adjusted to all stakeholders (Professional, head teachers, youth movements, religious leaders, associations...) to facilitate the planning and implementation of the SECAPs; stick to the vision slogan in every communication; and highlight the goal aimed at and attain it (A sustainable future for an attractive city); Therefore, it is essential to understand the degrees in motivations across demographic groups to be able to tailor effective energy efficiency messages.

Give the civil society enough empowerment to get it involved, learn to behave responsibly in relation to the environment, and actually become aware of its adherence to this cause; It is strongly recommended that the municipality of Karak relies on the the role of university

students and academia, as partners in setting the sustainable and environmentally friendly future vision.

For that, it is essential to implement and empower a communication cell within the municipality, strengthen its capabilities and its human resources. It can then adopt a comprehensive communication strategy adjusted to all stakeholders (Professional, head teachers, youth movements, religious leaders, associations...) and carry its actions at the level of the municipality, in order to build a sustainable awareness plan adapted to the project of the city and connect with its citizens in regard to specific measures in the policy of the city on how to reduce energy; Build a proper Website of the city as well as social networks, promoting them as communication tools between the municipality and its citizens to create cohesion and therefore persuasion concerning the ongoing projects and the future ones.

Take the citizens in an organized tour to some installations that could be used as teaching tools through educational and outreach elements, such as information kiosks at installation sites, real-time online tracking of power generation on the city solar website, and tours of installation facilities.

Express a clear political commitment to involve individual target groups in future planning procedures to adapt/improve measures according to specific demands; set up a permanent forum with representatives of the various target groups; set the example and encourage citizens to master their consumption, know about renewable and efficient energy, and encourage their production and use; communicate and promote at the city/authority zone level about actions and measures toward energy saving and energy efficiency that could influence the customer consumption and buying behaviour and improve the quality of life in the city;

Educate the audience by offering helpful energy efficiency tips to reduce cost and usage through entertainment, talk shows, special guests and things happening; This will convey a resonance regarding the populations' own energy consumption (e.g. using energy efficiency to save money in the long term); and will make people aware of the positive effect their actions can have on their global and local environments.

Create an online, one-stop information portal for renewable energy for citizens. This site can provide links to information resources; local policies, regulations, and permitting information; a calendar of events for workshops or educational events; profiles of and contact information for local solar/PV installers; or information on local demonstration projects.

Last but not least, empower the communication cell within the municipality, plan to set up its structure, strengthen its capabilities and its human resources, in order to: build a sustainable awareness plan adapted to the project of the city and connect with its citizens in regard to specific measures in the policy of the city on how to reduce energy; Establish a strong and dynamic communication methodology to facilitate the planning and implementation of SECAPs.

# Appendix

## Appendix A

| Public Lighting in Karak city (KWh) | |
|---|---|
| AL GHOUER | 170.424 |
| AL THANEH | 376.056 |
| AL MAMOUNIEH | 126.216 |
| AL SBEHAT | 233.868 |
| KEMNE | 42.336 |
| AL BAWAB | 1.572 |
| RAKEEN | 159.336 |
| BTEER | 234.960 |
| AL MARJ | 271.464 |
| AL LGOUN | 35.184 |
| AL MREGA | 18.096 |
| MAROUD | 219.528 |
| EAST ADAR | 160.044 |
| AL MANSHEYE | 476.760 |
| AL GDEDE | 222.516 |
| ZAHOUM | 415.752 |
| AL RASHDEYEH | 191.604 |
| AL ADNANIEH | 438.084 |
| AL ABDALI | 11.520 |
| MOUMYA | 47.628 |
| GREFLE | 215.496 |
| SAMRAA | 147.216 |
| AENOUN | 31.980 |
| BARDE | 188.148 |
| ALBGEE | 45.720 |
| MDEIN | 173.364 |
| SAAKA | 68.676 |
| WADI BN HAMMAD | 5.736 |
| ALSHAHABEY | 322.644 |
| OM ROMANE | 10.800 |
| ALMSHERFEH | 138.036 |
| ALWASEEH | 520.404 |
| ALHAWEH | 150.996 |
| **Total (MWH):** | **5.872,16** |

## Appendix B

| Public Transport | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle Type | Vehicles in Governate | Vehicles in Karak Municipality | Lit/km (@50 km/hr) | Lit/hr (@50 km/hr) | Fuel type | Driving time within Karak Region plus stops (hr) | Type's total fuel consumed (Lit/day) | Annual Gasoline (1000 Lit/year) | Annual Diesel (1000 Lit/year) |
| Buses | 65 | 23 | 0,16 | 8 | Diesel | 7,5 | 1.380 | | 504 |
| Taxis | Up to 20 Taxis just | 20 | 0,11 | 5,67 | Gasoline | 7,5 | 850 | 310 | |

| Private and Commercial Transport | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle Type | Vehicles in Governate | Vehicles in Karak Municipality | Lit/km (@50 km/hr) | Lit/hr (@50 km/hr) | Fuel type | Driving time within Karak Region plus stops (hr) | Type's total fuel consumed (Lit/day) | Annual Gasoline (1000 Lit/year) | Annual Diesel (1000 Lit/year) |
| Motor cycle | 103 | 37 | 0,05 | 2,40 | Gasoline | 0,25 | 22,20 | 8,10 | |
| Small Passenger cars | 31.705 | 11.438 | 0,11 | 5,50 | Gasoline | 0,25 | 15.727,25 | 5.740,45 | |
| Medium Passenger Cars | 641 | 231 | 0,12 | 6,00 | Diesel | 0,25 | 346,50 | | 126,47 |
| Cargo Vehicles | 6.701 | 2.417 | 0,12 | 6,00 | Diesel | 0,25 | 3.625,50 | | 1.323,31 |
| Trailer Head | 681 | 246 | 0,39 | 19,50 | Diesel | 0,25 | 1.199,25 | | 437,73 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Trailer | 2 | 1 | 0,39 | 19,50 | Diesel | 0,25 | 14,63 | | 5,34 |
| Semi-Trailer | 5 | 2 | | | | | | | |
| Construction vehicle | 721 | 260 | 0,39 | 19,50 | Diesel | 0,25 | 1.267,50 | | 462,64 |
| Agricultural Vehicle | 1.061 | 383 | 0,39 | 19,50 | Diesel | 0,25 | 1.867,13 | | 681,50 |
| Van | 7.760 | 2.800 | 0,16 | 8,00 | Diesel | 0,25 | 5.600,00 | | 2.044,00 |
| **Total** | **49.380** | **17.815** | | | | | **29.669,95** | **5.748,55** | **5.080,98** |

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The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies.

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