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MINARET II

Empowering Municipal Governance for Climate Resilience Using WEF Nexus Approach

Sustainable Energy and Climate Action Plan (SECAP)

Ajloun Greater Municipality

MINARET II is supported by the Nexus Regional Dialogues Programme which is implemented by the GIZ and co-funded by the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ), and implemented by Royal Scientific Society/National Energy Research Centre. The project is implemented at municipal level targeting Jordan, Lebanon and Tunisia.

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Executive Summary

Ajloun is the capital town of Ajloun Governorate, a hilly town elevated from 800-1000 m above sea level in the north of Jordan, located 76 kilometers northwest of Amman. The city is also known by its castle, Ajloun castle, which standing 1,250 meters above sea level. Karak's main economic activities are around three sectors: Agriculture (Olive, grape and fruit) and Tourism.

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

Ajloun municipality has committed to a 40% 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 Ajloun region is 56,799.2 tn CO2 up to 2030 compared with the BAU scenario. 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 Ajloun, reaching up to 40% against the calculated 2030 emissions (141,998 tn CO2). 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, the total cost for the Municipality is calculated at 6.4 Million JOD, while for the other sectors has been estimated at 23.7 million JOD approximately, resulting in an overall budget of 30.1 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.

The highest energy consumer is the Transportation sector, followed by the Residential sector, while the municipal sector consumptions are the lowest. The total energy consumption in Ajloun Municipality is presented in figure 1:

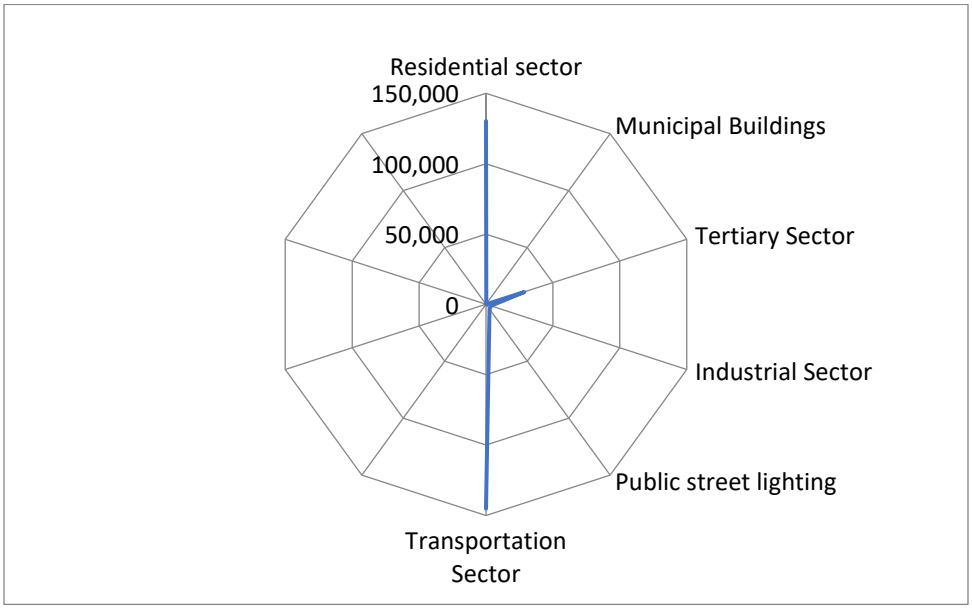


Figure 1 Energy consumption per sector in Karak Municipality

The Municipality, including the Municipal Buildings, the Public Lighting and the Municipal fleet consumes 6,537 MWh, while the public buildings has the most significant contribution, as presented in Figure 2.

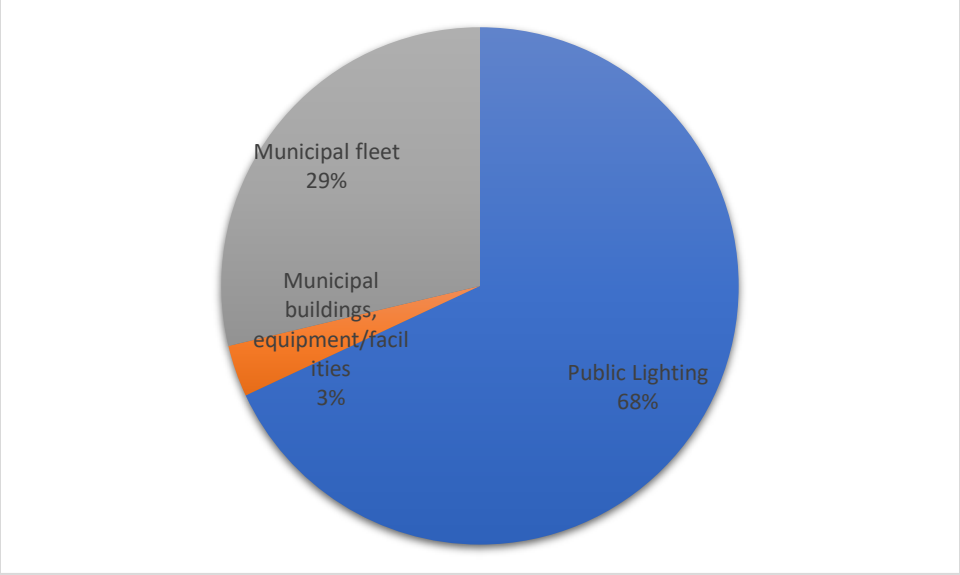


Figure 2: Energy consumption allocation of Ajloun Municipality's services

Regarding the total energy consumption, all the sectors in Ajloun Municipality consume 312,208 MWh. Each sector's contribution is presented in the following pie chart.

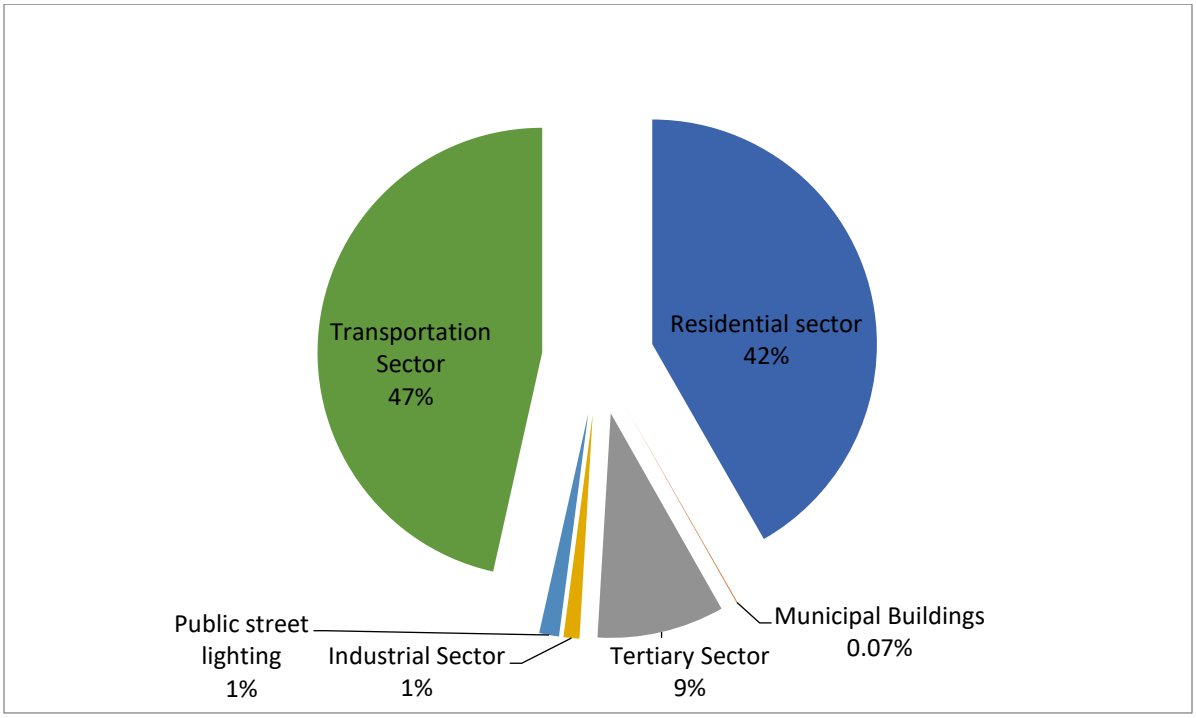


Figure 3: Energy consumption allocation per sector

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

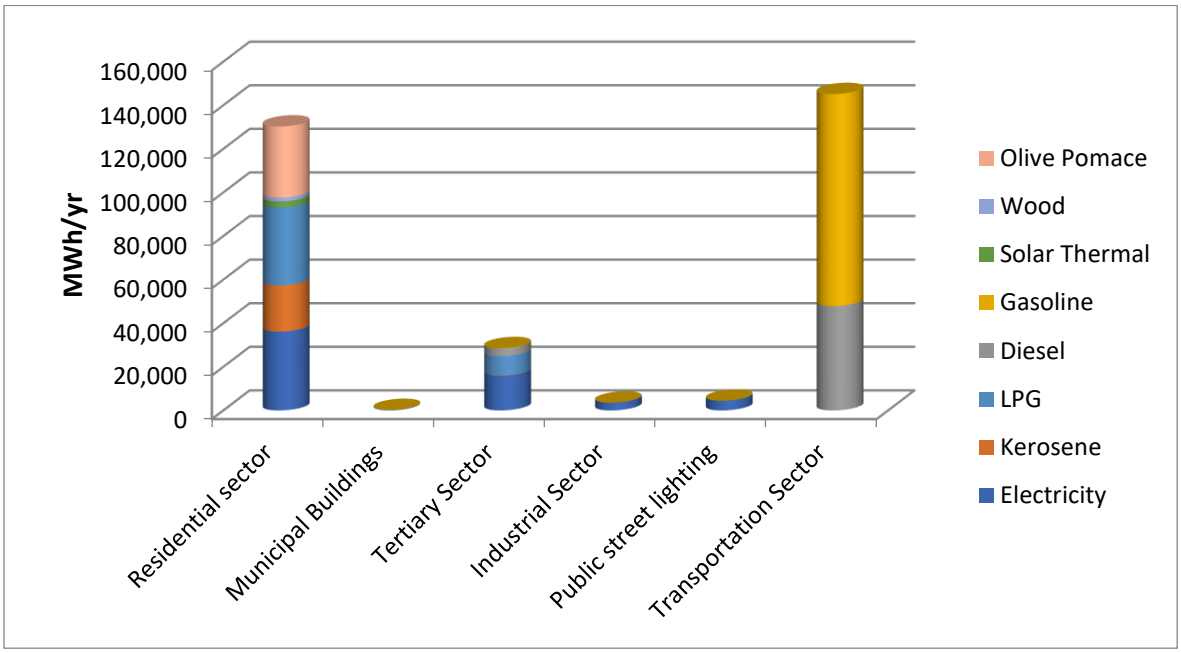


Figure 4: Energy consumption per sector and per fuel

The respective total emissions for the baseline year, including emissions from waste management, equal 250,892 tn CO2 and they are presented in the following chart.

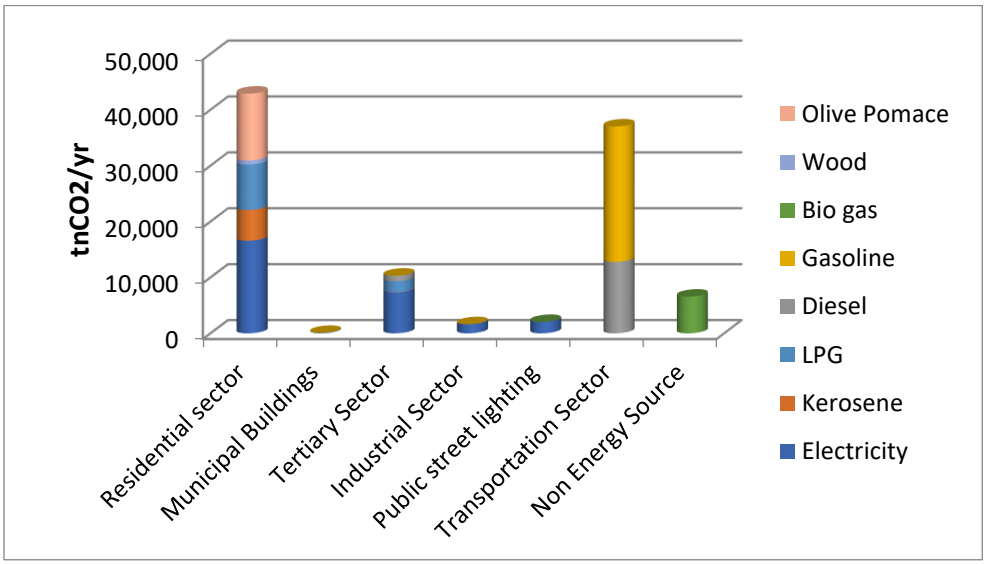


Figure 5: Total CO2 emissions per sector & per fuel

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 141,998 tn CO2.

An overview table of the actions per sector, as well as the calculated emission reductions per action is presented in Table 1.

Table 1: Summary of the actions per sector and the emission reduction per action

		Action	Energy Savings (MWh)	Energy production (MWh)	Emission Reductions (tn CO2) in 2030
Municipal buildings	**1.1**	Green procurement procedures/manual for municipal purchasing	23.6		8.85
	1.2	Energy manager appointment in the municipality	1.477		0.546
	1.3	Awareness raising activities for municipal employees	5.9		2.59
	1.4	Adoption of bioclimatic principles in new municipal buildings /Strict application of green building codes in new municipal buildings	59		22.12
	1.5	763 KW PV plant (for municipal building) to cover 30% of the total electricity consumption		1,374	629
	1.6	Creation of Energy Saving Department	0		0
	1.7	Replacement of single glazing with double glazing	9.24		2.24
	1.8	Replacing old inefficient lighting with LED lighting system	27.6		12.6
	1.9	Replacing old inefficient AC systems with energy saving AC	5.6		2.8
		Total	**132.417**	**1,374**	**680.7**
Street Lighting	**2.1**	Street lighting upgrade	3,243.8		1,486
	2.2	Astronomical timers	838.6		384
	2.3	Green procurement procedures for future lighting equipment	1959.8		897.6
		Total	**6,042.2**		**2,767.6**
Residenti al	**3.1**	Awareness raising activities for modification of the residents' consumption behavior	6,607		2,222

	3.2	Promotion of Green Buildings' concept / Strict application of the building code	42,857		10,294
	3.3	Campaign for promoting high energy label equipment	3,036		1,392
	3.4	4 MW Photovoltaics in residential rooftops		7,468	5,816
	3.5	Replacing existing electric water heater with solar collectors	5,407.4		2,963.2
	3.6	Replacement of existing lamps with LEDs	1,566		717
	3.7	Installing wall insulation for residential buildings	5,895.3		1,861.7
	3.8	Replacement of existing wood and olive pomace space heating with efficient air-conditioners	11,570		4,512.3
	3.9	Replacement of single glazing with double	5,304.6		2,058.4
	3.1	Utilize smart technology to control the electrical appliances remotely	89.6		42
		Total	**82,332.9**	**7,468**	**31,878**
Tertiary buildings	**4.1**	10% electrical energy reduction campaign in commercial buildings	64		23.1
	4.2	Promotion of Green Buildings' concept / Strict application of the building code	1,850.8		477.8
	4.3	Awareness raising campaigns for pupils/ students	359.8		13.1
	4.4	Installing solar PV systems for the water pumping plants and the worship places		5,706	2,613.8
	4.5	Replacement of single glazing with double in the public schools	30.4		7.5
	4.6	Replacement of existing lamps with LEDs	2,398		1098.3
	4.7	Replacing existing electric water heater with solar collectors	9,136		4,184.6
	4.8	Replacing inefficient refrigerators with more efficient ones in the commercial markets	421.4		193.2
		Total	**14,260.4**	**5,706**	**8,611.4**
Municipal fleet	**5.1**	Replacement of old municipal diesel vehicles with new efficient vehicles	39.2		10.4

	5.2	Installation of tracking and monitoring system for more efficient management of the fleet and better planning routes	220.8		58.9
	5.3	Municipal fleet maintenance	286.6		76.4
	5.4	Eco-driving seminars for the municipal fleet drivers	353.4		94.3
	5.5	Carry out an audit of the municipality's fleet of vehicles and implement the actions recommended through a program contract.	383.6		102.4
Private and commercial fleet	**5.6**	Activate online shopping and delivering services to reduce the traffic during the peak period	74.8		18.6
	5.7	Transfer all government departments and institutions to one complex near to the population centers in the city	10,029.60		2587.6
	5.8	Promotion of walking and car sharing and carpooling campaigns using Social media applications	6,747.40		1,803.9
	5.9	Information events on the new vehicle technologies and establish electricity charging stations for the electric cars within the municipality			0
	5.10	- Replacement of gasoline vehicles with Hybrid	6,595.4		1,642.2
	5.11	- Replacement of diesel vehicles with new more efficient	1,943.2		318.8
	5.12	Improvement / development of parking infrastructure	7,238		1,842.4
Public and	**5.13**	Developing alternative roads to reduce the traffic near the centralized areas	3,048.4		776.9
	5.14	Improve public transportation/ promote the use of public transport	8,051.40		2049.2
	5.15	Replacing the existing Taxi vehicles with Hybrid vehicles	1,275		317.5
		Total	**46,286.8**	**0**	**11,699.5**
	6.1	Planting trees (increasing green areas)			1,300

It should be highlighted at this point that the total reduction potential of the actions envisaged reaches 40.1% of the BAU emissions.

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 Ajloun 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 National Adaptation plan" report in 2021, which is dealing with the above-mentioned topic. The national targets presented on this report are consistent with the SECAP actions. An overview table of the actions per sector is presented below.

Table 2: Adaptation Actions

Public health	Infrastructure	Built Environment	Economy	Biodiversity
Improved understanding of the potential risk on health sector due to climate change	Regulations and incentive measures in residential buildings	Improving readiness for climate related disaster risk reduction in urban areas	Enhancing local adaptive capacity to climate change impacts	Improving conservation measures and enforcement for climate threatened species and habitats
Provide access to air-conditioned public buildings during heat waves or other extreme events	Plan for a network of public chargers for electric vehicles	Integrated land use planning with zoning system depending on the different areas	integrating climate adaptation into national poverty reduction policies	Establishment of a fire management plan
Developing an early warning system to alert citizens in the case of extreme weather events	Modelling predicted supply changes in the electricity from the locally available RES	Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises	Integrating climate change impacts and adaptation into education curricula	Trees planting
Educational and awareness raising campaigns about health-related effects of extreme events	Improving rainfall early warning systems and reducing flood risks	Supporting urban green infrastructure interventions for climate resilience	Improving irrigation system efficiency	

Regular cleaning and maintenance of the sewage and drainage system	Promote water-harvesting techniques at all levels of economic development and water use	Improving building efficiency for adapting to increased heat in urban centers.	Improving sustainable productivity of food chains	
		Adoption of methods to reduce water demand		

Chapter 1: Introduction

1.2: Current status

1.2.1 Geographical location

Ajloun is the capital town of Ajloun Governorate, a hilly town elevated from 800-1000 m above sea level in the north of Jordan, located 76 kilometers northwest of Amman. Its area extends to 148 km^2, the organizational area is only 20.26 km^2, and the reason is due to the limited ownership and the expansion of forest areas, which amounted to 60%, compared with the private lands, which amounted to 38%, and the lands of the municipalities, which are just around 2%.

The governorate is bordered to the north and west by Irbid Governorate, which is 32 km from the city and to the east by Jerash Governorate, 20 km away from the city of Jerash, and it is bordered to the south by Al-Balqa Governorate, 72 km from the city of Salt [1].

Greater Ajloun Municipality was established in 1920.

Figure 6: Jordan map showing Ajloun location.

Figure 7: Ajloun map.

The city is also known by its castle, Ajloun castle, which standing 1,250 meters above sea level. Ajloun Castle is a 12th Century fortress that was built under the rule of the sultan and military leader Salaheddin. The castle is set on top of Mount 'Auf and provides visitors with astonishing views of the Jordan Valley and surrounding desert. Over the years, the castle has undergone many

[1] Wikipedia: https://ar.wikipedia.org/wiki/%D8%B9%D8%AC%D9%84%D9%88%D9%86

rebuilds and although much of the original features no longer exist, there are many chambers, carvings, and towers. A characteristic picture of it is presented in Figure 8.

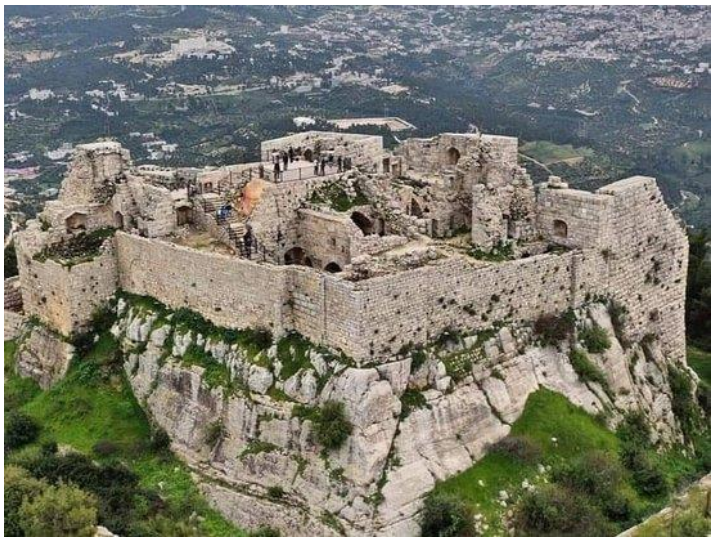


Figure 8: Ajloun castle.

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.

Ajloun region is characterized by a unique climate in the Kingdom, where the climate is moderate in summer and very cold in winter, cold temperatures in winter reach below zero Celsius during cold winter days. The average annual temperature is 16.7 °C, and around 467 mm of precipitation falls annually.

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

Table 3: Monthly temperatures and precipitation in Ajloun.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature °C	7.6	8.8	12.1	16.1	20.4	23.6	25.5	25.6	23.5	19.9	14	9.4
Min. Temperature °C	3.4	4.1	6.6	9.7	13.6	16.8	19.1	19.5	17.6	14.4	9	5
Max. Temperature °C	12.3	13.9	17.8	22.4	27.3	30.8	32.9	32.9	30.4	26	19.5	14.4
Precipitation / Rainfall mm	53	54	36	17	6	0	0	0	1	7	20	36
Humidity (%)	69	66	56	49	43	44	48	52	52	50	53	63
Rainy days (d)	6	6	5	2	1	0	0	0	0	1	3	4
avg. Sun hours (hours)	6.8	7.5	8.8	10.2	11.6	12.1	11.9	11	10.2	9.4	8.4	7.2

Considering the climate conditions in Ajloun 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 1,068 HDD[2].

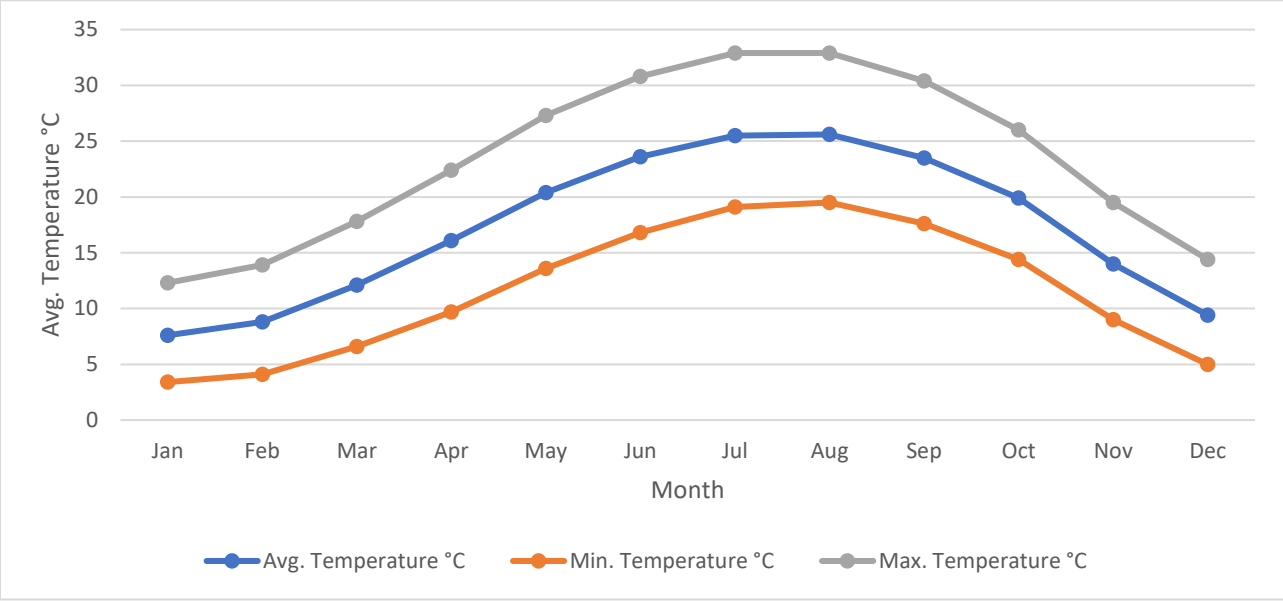


Figure 9: Monthly temperatures in Ajloun.

[2] CLIMATE-DATA.ORG: https://en.climate-data.org/location/5592/

The warmest month of the year is August, with an average temperature of 25.6°C, January is the coldest month of the year.

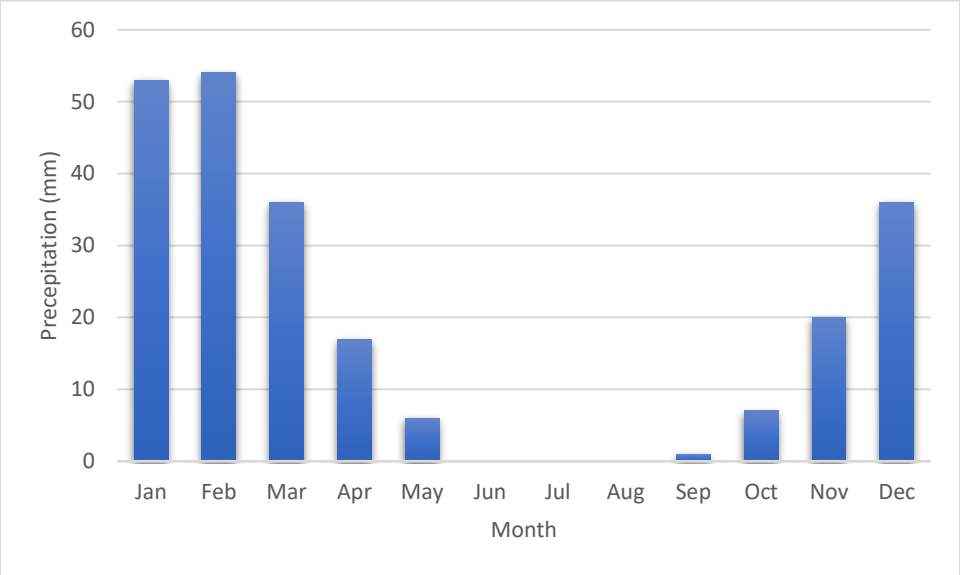


Figure 10: Monthly Precipitation in Ajloun.

1.2.3 Demographic tendencies

According to the last population census of 2020, the population living in Ajloun Governorate was 199,400, consisting of 48.5% men and 51.5% women[3]. For the same region, the population in 2004 was 118,725, which means that there has been a significant rise of 68% in only 16 years. Concerning the population at Ajloun Municipality level, this rises up to 66,959 in 2020 and the number of families was 13,512 at the same year[4].

1.2.4 Employment

The employees in Ajloun Governorate comprise approximately 28.5% of its population over 15 years of age, according to the most recent population census. In the part of economically active citizens, a 15.2% percentage is currently unemployed and looking for a job. An important mention is that only a population percentage of 8.8% (ages under 15 not included) are economically active women.

[3] Ministry of interior: https://moi.gov.jo/AR/Pages/%D9%84%D9%88%D8%A7%D8%A1_%D9%82%D8%B5%D8%A8%D8%A9_%D8%B9%D8%AC%D9%84%D9%88%D9%86

[4] Department of Statistics: http://dosweb.dos.gov.jo/

1.2.5 Education

The total illiteracy rate among the population amounted to more than 11.2%, rising to 16.4% among females and 6% among males in 2004. During the past decade, this percentage decreased significantly, due to the massive expansion of education programs, whether at the level of the Kingdom or at the level of Ajloun Governorate. The current illiteracy rate in Ajloun Governorate is estimated at 8.8% as a general average, and it rises among females to 13.1%, while it drops to 4.5% among males, and this total percentage is generally higher than the illiteracy rate in the Kingdom, which is estimated at 7.3%.

90% of the males' population of the governorate and 81% of females are educated with qualifications ranging between primary and higher university degrees. As for the governorate average, it is in the range of 85.6%, which shows that education in all its forms is higher for males than for females.

More than 53% of the total population of the governorate hold a certificate below high school, whether it is intermediate, basic or vocational, which indicates that more than half of the educated in the governorate are in the lowest degree of academic degrees.

There are 28% of the total learners hold a general secondary certificate, and this percentage is equal for males with females, with a slight increase for males. However, only 19% of the total learners have higher education levels (Diplomas, Masters, PhD, etc.).

1.2.6 Infrastructures

The registered households in Ajloun Governorate are 41,638 of which there are 40,972 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 63.3% has access to drinking water. The remaining percentage, mainly, uses collecting water wells and filtered mineral water for drinking purposes.
In addition, it seems that there isn't a fully developed public sewage system and thus only 38% of the population has access in the public network. The rest of the housing units are being served by absorbency holes.
The road network in the Governorate consists of 319 Km of paved and unpaved roads, of which 42.3% are rural roads, 40.1% secondary roads, and 17.6% highways. Based on the data, it is evident that the road infrastructure can be further improved.

1.2.7 Economy

Data and indicators for the agricultural sector in the governorate indicate that it is a sector has developmental potentials, as it represents 5% of the cultivated areas in Jordan, and the percentage of the area planted with fruit trees represent around 8% of Jordan lands.

In 2008, Olive, grape and fruit farms constituted a total area of 141.4 km^2 that is 34% of the area of Ajloun governorate.
The following are the detailed indicators of the status of the agricultural sector in Ajloun governorate compared to the Kingdom:

Table 4: Agro-plant production.

	Ajloun Governorate	Jordan	Governorate percentage
Areas planted with field crops (Km^2)	6.574	705.594	0.9%
Area planted with fruit trees (Km^2)	130.140	1,632.929	8%
Areas planted with vegetables (Km^2)	1.804	520.760	0.3%
Total planted areas (Km^2)	138.518	2,859.283	4.8%

Table 5: Livestock statistics in Ajloun.

	Ajloun Governorate	Jordan	Governorate percentage
Number of lambs	37,020	2,311,150	2%
Number of cows	1,740	69,740	2%
Number of goats	69,960	836,470	8%
Total livestock of the above species	108,720	3,217,360	3%

Regarding the tourism sector, Ajloun Governorate possesses competitive elements in the field of natural, recreational and recreational tourism, in addition to archaeological, historical and religious sites, which are a destination for internal and external tourism, the most prominent of these sites are: Ajloun Castle, Mar Elias, Rajeb.

The number of tourists to the tourist sites in Ajloun reached, according to the statistical bulletins of the Ministry of Tourism and Antiquities for the years 2013-2014, about (429,816) tourists, of whom (138,723) are foreign tourists, and the number of tourists was in 2014 (208,973) tourists.

Regarding for the number of tourist's facilities in the governorate, there are 10 facilities includes: tourist offices and restaurants, tourist car rental offices, and the number of the workforce in these activities is 39 workers.

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 CO2 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 Ajloun Municipality the baseline year has been set to 2019, since it was the year with the most sufficient and reliable data available.

2.1.2 SECAP administrative body

Following a meeting of the consultants (NERC) with the Ajloun representatives, it was made clear that their wish for the SECAP is to cover the administrative boundaries of Ajloun municipality, and not that of the whole governorate. All the figures provided on the municipal sector concern strictly Ajloun 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 CO2 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 and Tourism transport
- Private and Commercial transport

C. Solid waste management

There are no industrial facilities in Ajloun, therefore, the industry sector is not included. 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, which is considered to be 0.4585 kgCO2/KWh[5].

Emissions Factors for each source are gathered in table below.

Table 6: Emission Factors & Conversion Rates

	Emission factor tn (Co2/ MWh)	Conversion factors
Electricity	0.458	Not Applicable
Diesel	0.267	10 KWh/lt
Gasoline	0.249	9.2 KWh/lt
LPG	0.227	13.1 MWh/tn[6]
Kerosene	0.259	12.2 MWh/tn
Olive Pomace	0.367	4.3 MWh/tn
Wood	0.414	4.6 MWh/tn
Solar thermal	0	Not Applicable

Furthermore, emissions from the waste management were calculated according to the IPCC method. Landfilling process creates methane emissions (CH4) which are converted to CO2 emissions according to the equivalence "*1 tn CH4 = 25 tn CO2*".

2.2 Energy Consumption

The total amount of energy consumed in Ajloun Municipality is 315,040 GWh. The allocation of this energy consumption among the different sectors, by fuel type, is presented in Table 7. Further analysis of the consumptions per sector is provided in the following sections.

[5] Jordan's Second Biennial Update Report (SBUR), Dec 2020.

Table 7: Total Energy consumption per sector

MWh/ Sector	Electricity	Kerosene	Diesel	Gasoline	LPG	Solar Thermal	Wood	Olive Pomace	Total
Residential sector	36,143	21,233	12	0	35,799	2,706	1,740	32,625	130,258
Municipal Buildings	132	0	0	0	79				211
Tertiary Sector	15,908	147	3,632	74	8,807				28,569
Industrial Sector	3,558	0	0	0					3,558
Public street lighting	4,448	0	0	0					4,448
Transportation Sector	0	0	47,868	97,296					145,164
Total	60,189	21,380	51,512	97,371	44,685	2,706	1,740	32,625	312,208

2.2.1 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 **4,448 MWh** according to the data from bills that were provided.

2.2.3 Residential Buildings

Electricity

Ajloun's households consume electricity for lighting and electrical appliances such as refrigerator, air conditions and others, as well as in space and water heating.
Irbid Distribution Electricity Company (IDECO), which is the utility servicing the north region provided accurate electricity consumption data for each consumer. The total number of subscribers in Ajloun Municipality is 13,100, which is responsible for consuming about 60% of the total electricity consumption with an annual average electricity consumption of 2,759 KWh per subscriber, while the total annual electricity consumption equals 36 GWh.

Liquefied Petroleum Gas

LPG is mainly used in cooking and space heating. A smaller amount is also consumed in water heating. According to the gas utility services in Ajloun, Total number of cylinders that have been sold for the customers in 2019 were 275000 cylinders. The cylinders sold for different sectors across the municipality, but mainly for the Residential and commercial sector. Based on the energy balance brochure provided by MEMR 2019, Residential sector utilizes 80% of the LPG supplied by the utility services and the remaining amount is used by the commercial sector. Following these assumptions, the residential sector used 219366 cylinders in 2019, while the commercial sector consumed 54842 cylinders.

Each cylinder contains 12.5 Kg of LPG. Therefore, the total LPG consumption in residential sector was calculated using the following equation:

$$219366\ Cylinders * \frac{12.5\ kg}{Cylinder} * \frac{ton}{1000\ Kg} * \frac{13.1\ MWh}{ton}$$

Kerosene

Many households in Ajloun Municipality use kerosene for heating purposes. Based on the quantities of Kerosene consumed in Ajloun governate in 2019 and the population ratio within the municipality, the amount of the kerosene consumed in the residential sector was determined after subtracting the given amounts which consumed in the Tertiary sector (15350 Liter/year). Depending on the conversion factor of the kerosene, which is 0.0096 MWh/lt, kerosene was estimated in different sectors as follows:

$$Population\ Percentage = \frac{\text{Ajloun Municipality Population}}{Ajlun\ Governorate\ Population} = \frac{66959}{199400} = 0.336$$

$$Ajlun \text{ municipality kerosene consumption (m3)} = 0.336 * \text{Ajloun Governorate consumption (6632 m3)} = 2227000\ Litre$$

$$Residential\ sector \text{ kerosene consumption (L)} = 2227000 - 15350 \text{ (Tertiary Sector)} = 2211650 \text{ Litre}$$

$$Residential\ sector \text{ kerosene consumption (MWh)} = 2211650\ (L) * 0.0096\left(\frac{MWh}{L}\right) = 21{,}233\ MWh$$

Diesel

The municipality data implies that 2 % (equals to 262 housing units) of the houses in Ajloun is heated by central heating units (Diesel boiler). It was assumed that these units will be operated for 750 hours during winter. As a rule of thumb, we need 3.5 KW heating load for each 20 square meters, therefore, assuming that every housing unit has an area of 200 m^2 (80 m^2 to be heated), a total heating demand of 14 KW would be required. Further calculations to determine the energy required to cover the demand for each housing unit is calculated based on the following equations, (assuming 0.85 boiler efficiency).

$$Input\ power\ required\ (KW) = \frac{KW\ output\ (14\ KW)}{Boiler \text{ efficiency (0.85)}} = 16.5\ KW$$

$$Energy\ Consumed\ (KWh) = Kw\ required\ * Number\ of\ hours\ = 12{,}413\ KWh$$

$$Diesel\ consumption\ (liters) = \frac{Energyconsumed\ (12{,}413\ KWh)}{Conversion\ factor\ (\frac{10KWh}{L})} = 1{,}241\ L$$

Solar thermal

A number of households own solar water heaters that uses solar energy to heat water. According to the municipality focal point, the total number of installed solar water heaters is 2000 at the Governorate level. Therefore, it is assumed, based on the population ratio (0.33) in the city, the total number of installed solar water heaters for houses in Ajloun City is 660 Solar systems.

On top of this, in order to determine the energy production, we divided the year into two seasons, summer and winter seasons, then the amount of energy required to rise the water temperature through the temperature difference across the seasons (48 °C for winter and 50 °C for summer) was determined following the equation below:

$$Heat\ gain\ from\ temprature\ difference = Hot\ water\ demand\ (200\ L) * Cp\left(1\frac{Kcal}{Kg.c}\right) * Temprature\ difference$$

Then the answer is to be converted from Kcal to KWh using 860.42 Kcal/KWh.

Based on the above, the solar thermal total generated energy in the governate is calculated to be 8200 MWh in 2019. at the municipal level this value is 2706 MWh, based on the population ratio.

Wood and Olive Pomace

The geographical nature of Ajloun supply the resident of the region with nature-based resources that used for heating purposes during winter. Olive pomace followed by wood are among the main sources that assist people to cover their heating demand. The municipality focal points provided us with the quantities sold within the municipality boarder as submitted by the agriculture representatives in the governate. The residential sector consumes quarter of the total energy consumed in the region

Summary

Gathering all the data of the residential sector, it seems that residents consume 7 distinct energy sources. The final consumption per fuel type for this sector is presented in Figure 11.

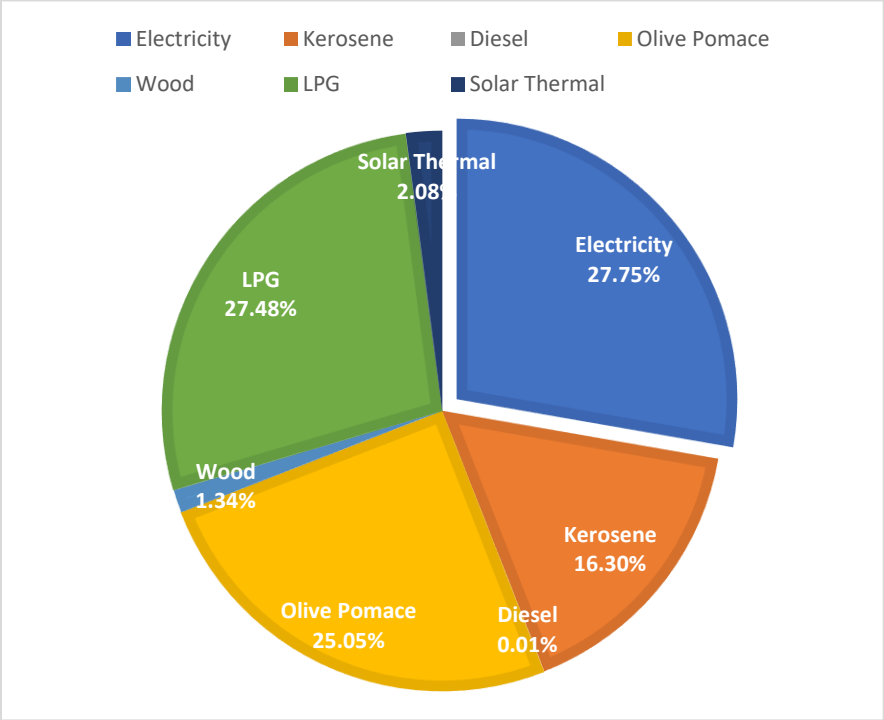


Figure 11: Energy consumption per fuel in Residential Sector

2.2.4 Tertiary Buildings, Equipment & Facilities

Tertiary sector includes a number of buildings such as Commercial buildings, Public and governmental buildings, Hotels, Agricultural facilities, and water and waste management facilities, which provide services to Ajloun's citizens. It should be noted that water management facilities include facilities for drinking water (water pumping) and irrigation. The data derived directly from IDECO (Irbid District Electricity Company) which includes all subscribers consumptions. The total energy consumption which refers to electricity, diesel, LPG and gasoline were 30,456 MWh in the tertiary sector. The collected data are presented in Table 8.

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

Types of Buildings in the Tertiary Sector	Electricity (MWh)	LPG (MWh)	Diesel (MWh)	Kerosene	Gasoline	Total (MWh)
Commercial buildings	6,681	8,759	NA	NA	NA	15,440
Public & Governmental buildings	6,684	127	5,662	147	74	12,473
Tourism	28	NA	NA	NA	NA	28

Agricultural	87	NA	0	NA	NA	87
Water & Waste Management Facilities	2,428	NA	NA	NA	NA	2,428
Total	15,908	8,886	5,662			30,456

In the next chart, it is obvious that the consumption's allocation in the tertiary sector is dominated by Commercial Buildings followed by the Public buildings.

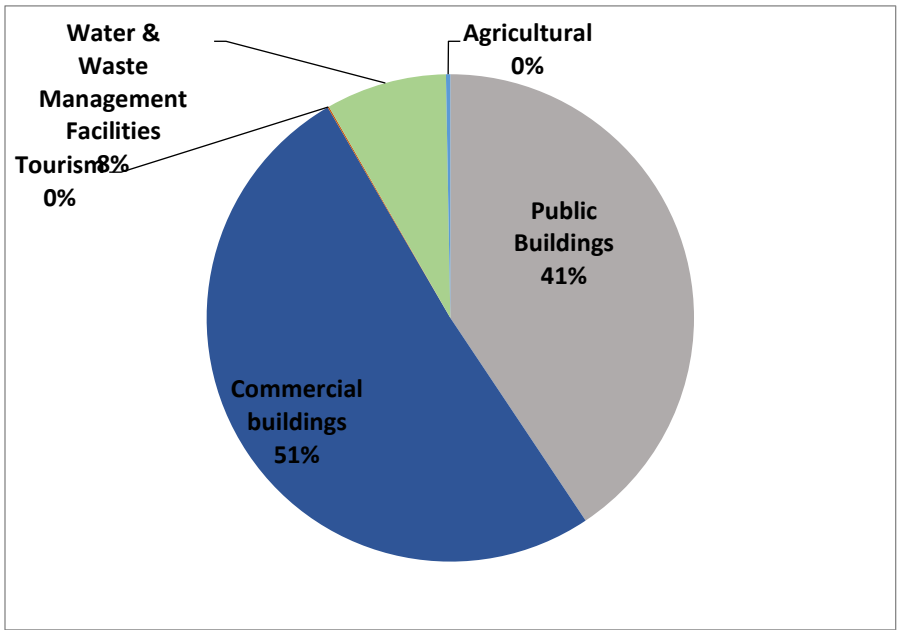


Figure 12: Energy consumption in tertiary sector per type of building

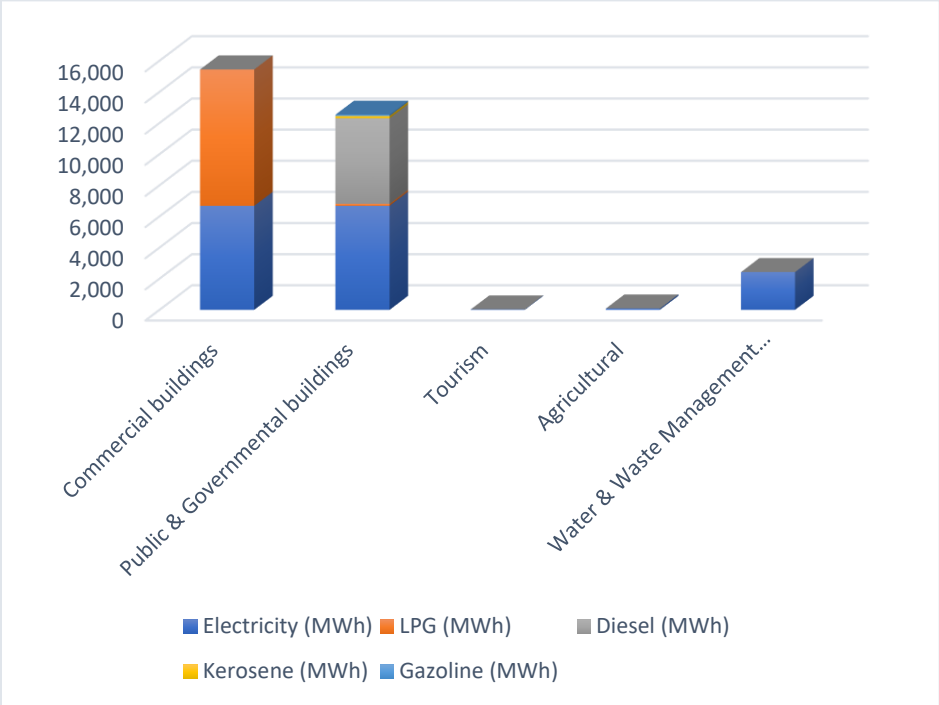


Figure 13: Energy consumption in tertiary sector per type of building and fuel

2.2.5 Buildings' & facilities Synopsis

The consumed energy allocation for all the buildings and facilities in Ajloun Municipality is presented in Figure 14.

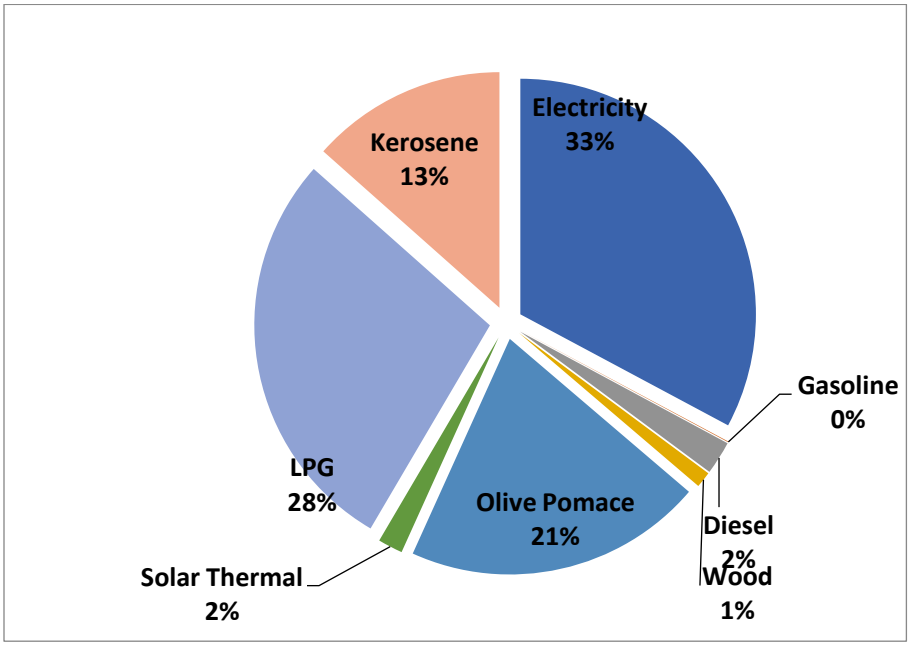


Figure 14: Energy consumption in buildings and facilities per fuel.

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 presented in the Table 9. Ajloun's municipal fleet has 42 vehicles which use diesel and gasoline. The total number of vehicles and their consumption were provided by the municipality. The fleets include 18 light vehicles (Pickup), 12 waste transportation vehicles, and 12 heavy vehicles.

Table 9: Energy Consumption in Municipal fleet of Ajloun

Type of Municipal vehicles	Number of vehicles	Diesel		Gasoline		Total
		Lit	(MWh)	Lit	(MWh)	(MWh)
Waste transportation Vehicles and heavy vehicles	24	151,814	1,518	0	0	1,518
Small Passengers Vehicles	18	34,718	347	1,374	13	360
Total	42	186,532	1,865	1,374	13	1,878

2.2.6.2 Public and Tourism Transport

Public transport refers to buses and taxis that serve Ajloun'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. It has been assumed that the taxis are moving for 6 days per week with 4 hours daily at 40 Km/ hr speed. On the other hand, the Buses tracked has been checked to measure the total distance covered within the municipality border at 50 Km/hr speed considering the stops during the trips. Rate of consumption for various transportation means is listed in the Table 10 below:

Table 10: Rate of consumption for various transportation vehicles

rate of consumption	Lit/km (@50 km/hr)
Buses and tourism buses	0.16
Taxi, service, and tourism cars	0.11
Large buses	0.39

The results are summarized in the Table 11 below.

Table 11: Energy consumption in Public Transport

Vehicle Type	Number of vehicles passing the Ajloun municipality borders	Distance traveled within Ajloun borders per year (km)	Distance traveled within Ajloun borders per day (km)	Daily Fuel consumption (Lit/day)	Annual Diesel Fuel consumption (Lit/year)	Annual Gasoline Fuel consumption (Lit/year)	Diesel (MWh)	Gasoline (MWh)	Total (MWH)
Buses	143	2,656,335	10,417	1,667	425,014		4,250	0	4,250
Taxis	68	3,405,440	10,880	1,196.8		374,598.4	0	3,446	3,446
Large buses	6	100,980	388	151	39,382		394	0	394

tourism buses *	22,857	15,238	42	7	2,438		24	0	24
Tourism cars*	250,000	166,667	457	50		18,333	0	169	169
Total	965	6,344,660	22,183	3,072	466,834	392,932	4,668	3,615	8,283

** This number is considered as the total number of trips performed by the tourism bus each trip takes 40 min within the municipality.*

2.2.6.3 Private and Commercial Transport

The previous methodological approach and assumptions was used in this sector too. The registered private and commercial vehicles are 17,184 and the total consumption, regarding Diesel and Gasoline, is 135,000 MWh. The private vehicles were assumed to move for a half hour daily for 2.5-6 days per week based on the vehicle type.

Table 12: Energy consumption in Private and Commercial Transport

Vehicle Type	Diesel (MWh)	Gasoline (MWh)	Total (MWh)
Motorcycles	0	135	135,003
Passengers Cars	0	93,534	
Pick-up	28,360	0	
Cargo Vehicles	11,272	0	
Van	0	0	
2-axle Truck	165	0	
Trailers	272	0	
Construction Vehicle	1,099	0	
Agricultural Vehicle	165	0	
Ampulance/Civil defence Vehicles	0	0	
Total	41,334	93,669	

Figure 15 shows the proportion between Diesel and Gasoline in the Private and Commercial vehicles.

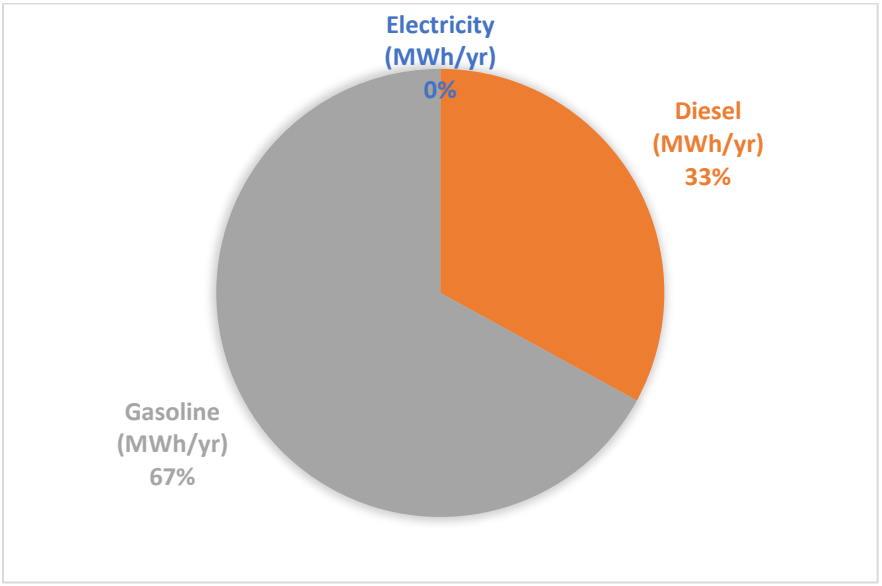


Figure 15 :Energy consumption in Private and Commercial vehicles based on the fuel type.

2.2.7 Final Energy Consumption

Table 13 shows all the energy consumptions within Ajloun Municipality, totaling 315,004 MWh.

Table 13 :Total Energy Consumption in Ajloun city

Sector			FINAL ENERGY CONSUMPTION [MWh]											
			Electricity			Fossil fuels							Renewable energies	Total
						Kerosene	LPG	Diesel	Gasoline	Wood	Olive Pomace	Solar thermal		
Residential sector			36,143			21,233	35,799	12		1,740	32,625	2,706		**130,258**
Municipal Buildings			132			0	79	0	0					**211**
Tertiary Sector			15,908			147	8,807	3,632	74					**28,569**
Industrial Sector			3,558											**3,558**
Public street lighting			4,448											**4,448**
Transportation Sector	Urban Road Transportation	Municipal Fleets						1,865.32	13					**1,878**
		Public Transportation						4,668	3,615					**8,283**
		Private Transportation						41,334	93,669					**135,003**

	Urban Rail Transportation											**0**
	Local Ferries											**0**
Total		**60,955**			**21,380**	**44,685**	**51,512**	**97,371**	**1,740**	**32,625**	**2,706**	**312,208**

2.3 Local electricity production

Decentralized renewable energy systems is prevailing, especially the PV systems mounted on the households' roof-top. In Ajloun municipality, and according to data provided by the municipality focal point, there are 1100 PV systems. The data received from IDECO shows that Ajloun municipality facilities export 1924 MWh of electricity to the grid excluding the amount consumed during the day.

2.4 CO2 emissions

2.4.1 Energy related emissions

In the previous sections, the energy consumptions in Ajloun municipality were described, while the CO2 emissions will be calculated in this section.

2.4.2 Final CO2 emissions

The emissions of CO2 for the sectors that have been described in the previous sections are available, in total, in Table 14.

Table 14: Total CO2 emissions for the Ajloun city

Sector	Total CO2 emissions [tnCO2/year]											
	Electricity		Fossil fuels						Renewable energies			Total
				Kerosene	LPG			Diesel	Gasoline	Wood	Olive Pomace	Solar thermal	
Residential sector	16,572			5,499	8,126			3	0	720	11,972	0	**42,894**
Municipal Buildings	61			0	18			0	0			0	**78**
Tertiary Sector	7,294			38	1,999			970	18			0	**10,319**
Industrial Sector	1,631			0				0	0			0	**1,631**
Public street lighting	2,039			0				0	0			0	**2,039**

Transportation Sector	Urban Road Transportation	Muncipal Fleets	0			0				498	3			0	**501**
		Public Transportation	0			0				1,246	900			0	**2,147**
		Private Transportation	0			0				11,036	23,324			0	**34,360**
	Urban Rail Transportation		0			0				0	0			0	**0**
	Local Ferries		0			0				0	0			0	**0**
Sub-Total			**27,066**	**0**		**5,529**	**10,144**			**14,296**	**28,536**	**720**	**11,972**	**0**	**98,263**
Non-Energy Sources															
Waste Water treatment Plant													0		0
Livestock breeders													605		605
Solid waste													5,959		5,959
Sub-Total													6,564		6,564
Total			27,597	0	0	5,538				13,754	24,245	720	6,564	0	100,543

2.5 Results' Graphical Analysis

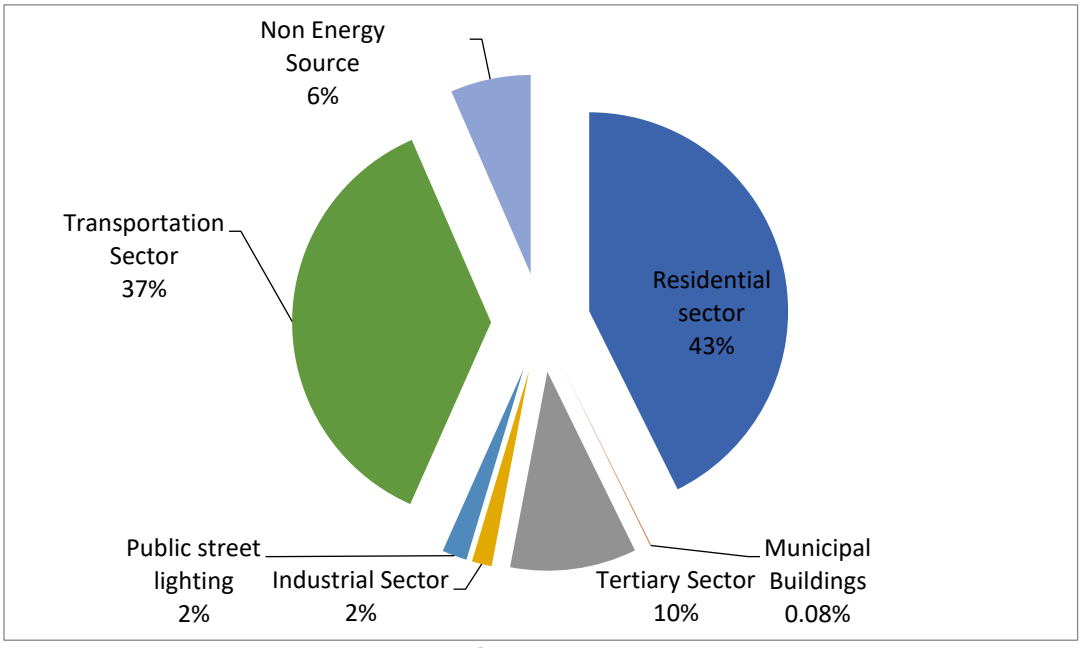


Figure 16: Total CO2 emissions per sector.

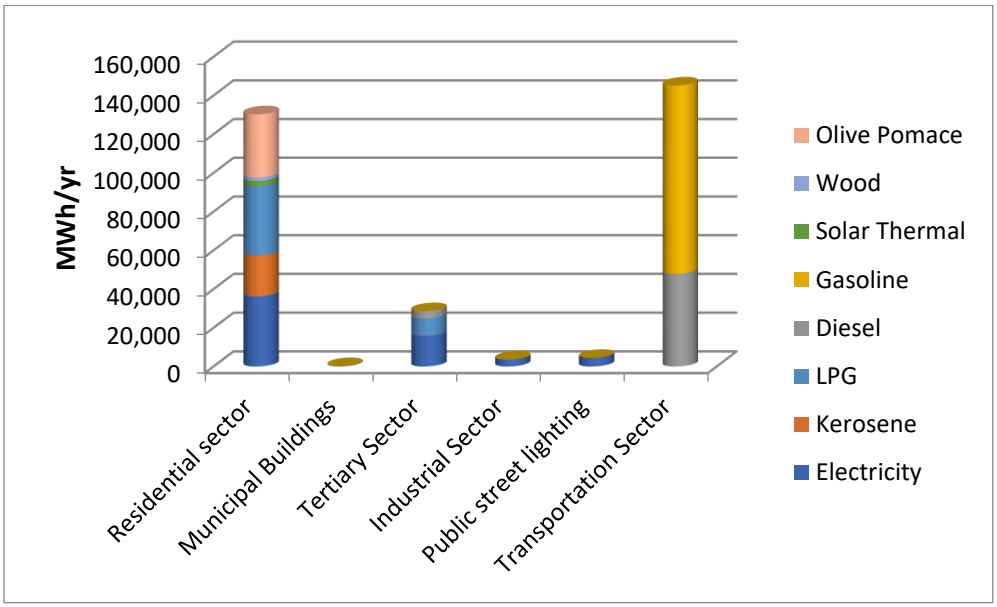


Figure 17: Final Energy consumption per sector and per fuel.

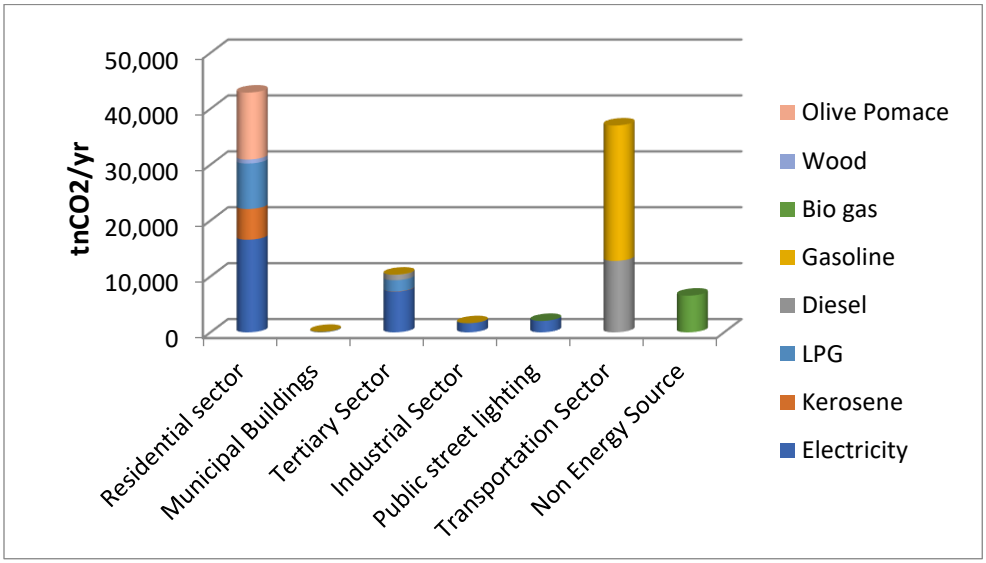


Figure 18: Total CO2 emissions per sector and per fuel.

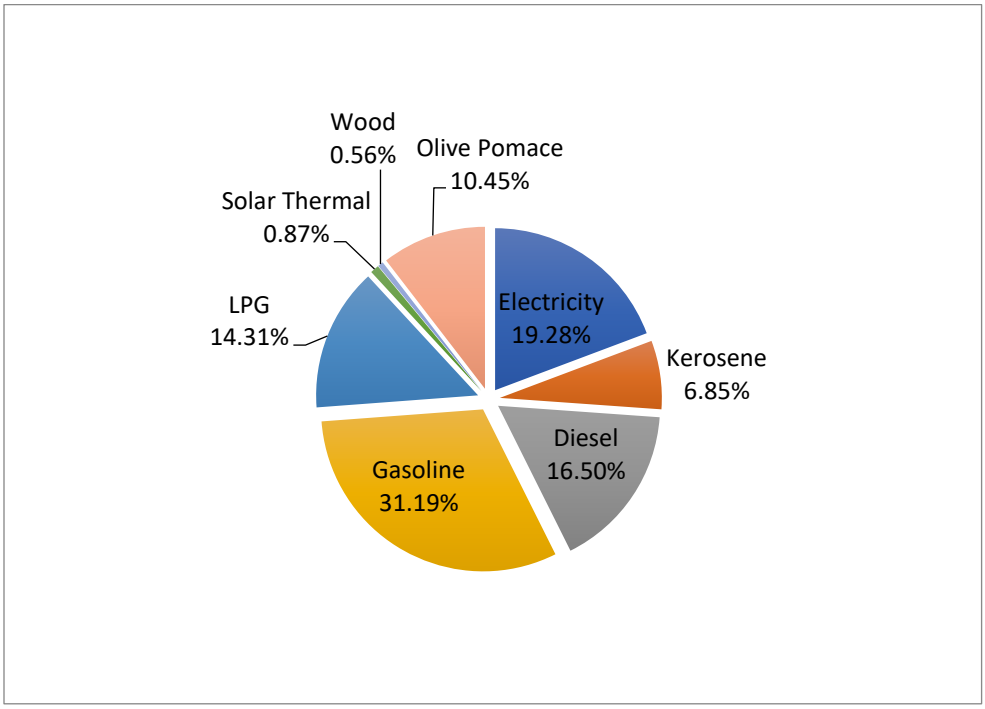


Figure 19: Final Energy Consumption per fuel.

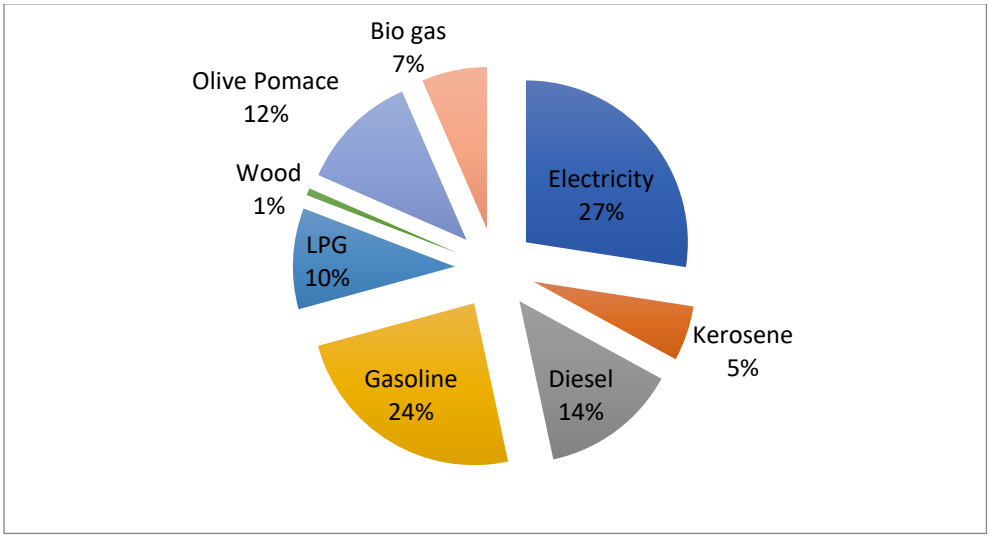


Figure 20: Total CO2 emissions per fuel.

Chapter 3: SECAP Actions

3.1 Target for 2030

The Municipality of Ajloun can play a dual role in CO2 reduction efforts, serving as both a demonstrator and a catalyst for all activities in the area. The first role, setting a good example, should be realized through the implementation of actions to reduce emissions from buildings/facilities/vehicles/etc. under its direct responsibility. Emissions from waste are another area where Ajloun Municipality has direct responsibility. Nonetheless, municipal direct related emissions account for a small proportion of total emissions. As a result, it should serve as a catalyst and coordinator for the private sector's activities in a variety of activity fields. According to the BEI, the sectors that contribute the most to the carbon footprint are residential (42%), transportation (37%), and tertiary (10%). As a result, the Municipality should concentrate on actions that will encourage citizens to reduce CO2 emissions from their activities. At the same time, actions in other sectors will be suggested.

In this regard, the first step is to calculate the Business as Usual (BAU) scenario in accordance with the JRC guidelines for South Municipalities, considering that Jordan, as a developing country, will face an increase in energy demand due to expected economic and population growth. Considering the use of the BAU scenario for calculating 2030 emission levels and, consequently, the respective reduction target, the following calculations are carried out in accordance with the guidelines (You may add the reference here).

$$Emission_{CO_2}^{2030} = Emission_{CO_2}^{Baseline\ year} * k$$

In Ajloun, the emissions for the baseline year, 2019, were 101,427 tn CO2. The national coefficient k for the baseline year of 2019 in Jordan is 1.40. Therefore, the forecasted emissions for 2030 are

$$Emission_{CO_2}^{2030} = 101{,}427 * 1.40 = 141{,}998\ tn\ CO_2$$

According to the Covenant of Mayors, Ajloun Municipality's emission reduction target should be at least 40% lower than the calculated 2030 emissions, which equals to 56,799.2 tn CO2.

Achieving the targets depend on the intensive effort of Municipality and government in order to attract additional financing and broadly engage the private sector investments. Each sector’s contribution in the overall reduction target is presented in Figure 21 below.

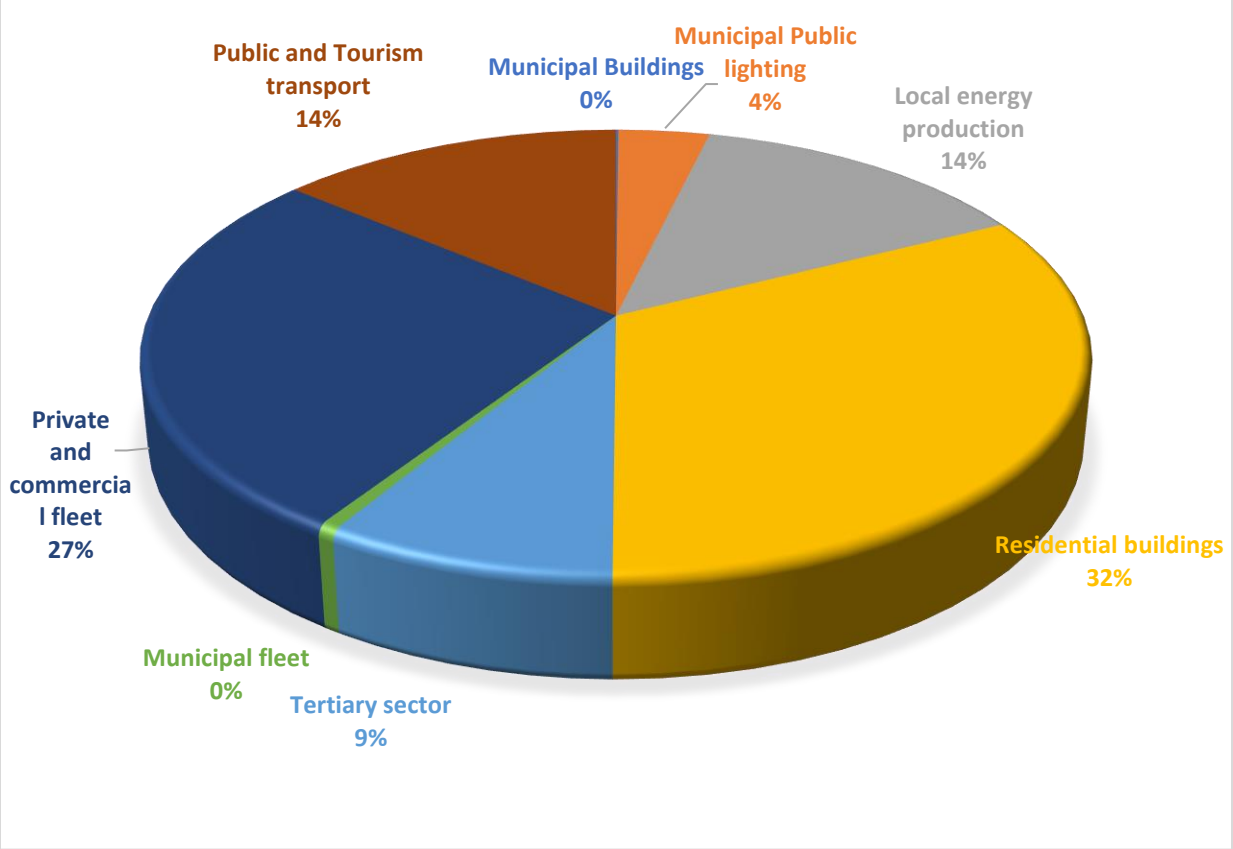


Figure 21: Sectors' contribution (CoM reduction target)

The following sections provide a more detailed analysis of each action for each sector. It should be noted that for municipal awareness-raising activities, in addition to the municipality's implementation costs and potential funding sources, the amount of private funds mobilized is also reported, where applicable. This expense is not factored into the NPV calculation. Furthermore, externalities costs are not considered in the calculation of the NPV; this results in actions with a negative NPV from the strict economic calculation, even though their overall impact could be considered positive if additional benefits are considered.

3.2 Municipal Buildings, Equipment/Facilities

This sector contributes only 0.01% to the carbon footprint. Nonetheless, the potential actions to be implemented in Municipal Buildings could serve as a model for citizens and employees. The municipality recognized the measures that best meet its needs in terms of energy savings and emission reductions. A comprehensive set of actions is examined in the following sections.

Energy conservation and green energy production measures are the main recommended actions for this sector. The emphasis has been placed on energy-saving activities and rooftop PVs systems

because these are thought to be easier to implement than larger RES facilities that require more time and more available free space.

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 environmentally 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 15 below.

Table 15: Actions in Municipal Buildings, Equipment/Facilities

Action No.	Action	Emission Reductions (tn CO2) in 2030
1.1	Green procurement procedures/manual for municipal purchasing	8.85
1.2	Energy manager appointment in the municipality	0.546
1.3	Awareness raising activities for municipal employees	2.59
1.4	Adoption of bioclimatic principles in new municipal buildings /Strict application of green building codes in new municipal buildings	22.12
1.5	763 KW PV plant (for municipal building) to cover 30% of the total electricity consumption	629
1.6	Creation of Energy Saving Department	0.00
1.7	Replacement of single glazing with double glazing	2.24
1.8	Replacing old inefficient lighting with LED lighting system	12.6
1.9	Replacing old inefficient AC systems with energy saving AC	2.8
	Total	680.7

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. By selecting high-efficiency products with low environmental impact, it is possible to consume less energy, reduce CO_2 emissions, and save money.

The action is intended to be applied to all new office equipment that the municipality plans to purchase to meet their growing needs and to gradually replace old, inefficient ones. High efficiency products will be targeted, particularly for high energy consuming office equipment, while minimum efficiency standards and requirements will be set in all relevant municipal tenders. An average savings of 8% against BAU consumptions is anticipated. Table 16 presents calculations for the cost, savings, and financial feasibility of the action.

Table 16: Green Procurement Procedures - Calculation Summary

Green Procurement Procedures	
Duration	2023- 2024
Total Implementation Cost (JOD)	20,000
Annual Energy Savings (MWh)	23.6
Annual Emission Reduction (tn CO2)	8.85
Funding Source	Own funds
Net Present Value (NPV)	NA

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 17: Energy manager appointment in the municipality – Calculation Summary

Energy manager appointment in the municipality	
Duration	2023- 2030
Total Implementation Cost (JOD)	100,000
Annual Energy Savings (MWh)	1.477
Annual Emission Reduction (tn CO2)	0.546
Funding Source	Own funds
Net Present Value (NPV)	<0

3.2.3 Awareness raising activities for municipal employees

A significant step toward meeting the planned targets is effectively communicating the municipality's intentions to the people who work in those buildings. This action includes a series of targeted awareness-raising activities aimed at municipal employees. The goal of these activities is to motivate municipal employees to change their habits and behaviors in order to achieve the desired results. The following are among the awareness-raising and training activities planned for municipal employees:

- Training workshops and seminars on SECAP implementation and monitoring are required for team members. This activity aims to build the capacity of personnel directly involved in SECAP implementation. It could focus on attracting international donor funding, managing project implementation, or even exchanging best practices and ideas with other municipalities in Jordan and around the world facing similar challenges.

- The development and distribution of promotional material on the benefits of energy efficiency and how simple behavioral changes impact total consumption via various communication channels plays an important role in motivating municipal staff and the community. In this regard, the municipality could devise an appropriate incentive scheme to reward personnel who work efficiently to achieve the greatest energy savings. This reward could be any incentive provided to the employees, such as two additional days off that year or the creation of posters with the pictures and names of the employees who contributed to the goal.

Table 18 : Awareness raising activities for municipal employees – Calculation Summary

Awareness raising activities for municipal employees	
Duration	2023- 2028
Total Implementation Cost (JOD)	20,000
Annual Energy Savings (MWh)	5.9
Annual Emission Reduction (tn CO2)	2.59
Funding Source	Own funds
Net Present Value (NPV)	<0

3.2.4 Adoption of bioclimatic principles in new municipal buildings /Strict application 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.

According to these, 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 conventional buildings, will be applied. These measures include the adoption of natural lighting and ventilation, insulation in exterior surfaces, as well as shading in the glazing. Moreover, the building's orientation should be taken into consideration.

All the above measures (plus other appropriate bioclimatic principles where possible), as well as strict application of the existing Energy Efficient Building Code will be implemented in all new buildings, so as to reduce the expected increase in energy and CO2 emissions.

Table 19 : Adoption of bioclimatic principles in municipal buildings – Calculation Summary

Adoption of bioclimatic principles in municipal buildings /Strict application of green building codes in municipal buildings	
Duration	2023- 2030
Total Implementation Cost (JOD)	800,000
Annual Energy Savings (MWh)	59
Annual Emission Reduction (tn CO2)	22.12
Funding Source	Own and governmental funds
Net Present Value (NPV)	>0

3.2.5 (763) KW 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 PV plant of 763 KW to cover part of the electricity needed for street lighting and municipal buildings. By doing so, the dependency on the grid will be reduced through using a renewable source of energy, thus achieving CO2 reductions as well. This action constitutes a priority for the Municipality and is described in detail in the "763 KW PV Station installation" project fiche. Key data on the investment are also presented in the Table 20.

Table 20: PV systems – Calculation Summary

763 KW PV plant (for municipal buildings and street lighting)	
Duration	2023- 2030
Total Implementation Cost (JOD)	450,000
Annual Energy Production (MWh)	1374
Annual Emission Reduction (tn CO2)	629
Funding Source	Municipal Budget
Net Present Value (NPV)	>0

3.2.6 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 CO2 reduction benefits, but it is seen as a supplementary one to the rest of the actions in the sector.

Table 21: Establishment of Energy Saving Department – Calculation Summary

Establishment of Energy Saving Department	
Duration	2023- 2030
Total Implementation Cost (JOD)	200,000
Funding Source	Own funds

3.2.7 Replacement of single glazing windows with double glazing

The current situation of Ajloun's existing municipal buildings includes almost LED lighting units and old 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 using of double glaze windows. It is estimated that due to these measures the energy savings in the air conditioning systems will be 20%.

Table 22: Replacement of single glazing with double glazing – Calculation Summary

Replacement of single glazing with double glazing	
Duration	2023- 2030
Total Implementation Cost (JOD)	15,000
Annual Energy Savings (MWh)	9.24
Annual Emission Reduction (tn CO2)	2.24
Funding Source	Own funds
Net Present Value (NPV)	<<0

3.2.8 Replacing old inefficient lighting with LED lighting system

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 hand. Their cost is higher from the conventional ones, but they have long life expectancy and a quite positive cost benefit ratio. Key data on the action are presented in Table 23.

Table 23: Replacing old inefficient lighting with LED lighting system – Calculation Summary

Replacing old inefficient lighting with LED lighting system	
Duration	2023- 2030
Total Implementation Cost (JOD)	3,000
Annual Energy Production (MWh)	27.6
Annual Emission Reduction (tn CO2)	12.6
Funding Source	Own funds
Net Present Value (NPV)	>0

3.2.9 Replacing old inefficient AC systems with energy saving AC

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 CO2 reduction. The municipality will replace all of its existing AC systems with more efficient systems. Key data on the action are provided in Table 24. 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 24: Replacing old inefficient AC systems with energy saving AC – Calculation Summary

Replacing old inefficient AC systems with energy saving AC	
Duration	2023- 2030
Total Implementation Cost (JOD)	14,000
Annual Energy Production (MWh)	5.6
Annual Emission Reduction (tn CO2)	2.8
Funding Source	Own funds
Net Present Value (NPV)	<0

3.3 Municipal Public Lighting

The municipal public lighting includes street 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 25 below, while a detailed analysis with calculations for each action follows in the next paragraphs.

Table 25: Actions in Municipal Public Lighting

Action No.	Action	Emission Reductions (tn CO2)
2.1	Street lighting upgrade	1,485.6
2.2	Astronomical timers	384
2.3	Green procurement procedures for future lighting equipment	897.6
	Total	2,767.2

3.3.1 Street lighting upgrade

Various types of lamps are used for street lighting, more specifically: High Pressure Sodium, Mercury Vapor, and LEDs. The Municipality is currently replacing old inefficient lamps with LEDs which are more efficient and provide great luminosity quality. This action will ensure great monetary savings for Ajloun 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 Table 26.

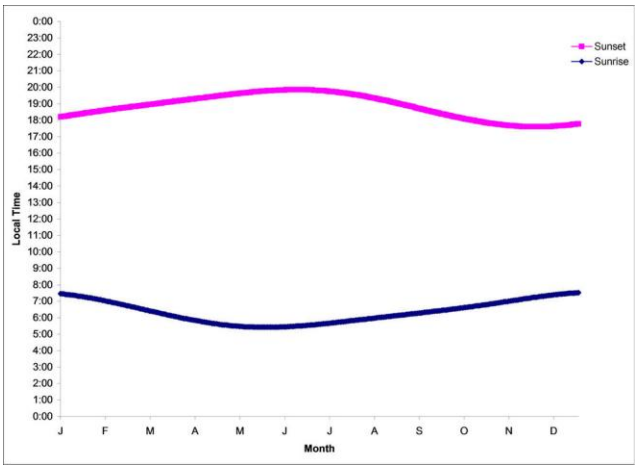
Table 26: Street lighting upgrade – Calculation Summary

Street lighting upgrade	
Duration	2023- 2030
Total Implementation Cost (JOD)	17,000
Annual Energy Savings (MWh)	3,243.8
Annual Emission Reduction (tn CO2)	1485.6
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 13%, as explained in the following Figure 22, 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.

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 Table 27.



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

Figure 22: Timing for sunset and sunrise in Jordan

Table 27: Astronomical timers – Calculation Summary

Astronomical timers	
Duration	2023- 2030
Total Implementation Cost (JOD)	29,000
Annual Energy Savings (MWh)	838.6
Annual Emission Reduction (tn CO2)	384
Funding Source	Own funds
Net Present Value (NPV)	>>0

3.3.3 Green Procurement Manual 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 Table 28 below and have been calculated against the BAU scenario.

Table 28: Green procurement Manual for the future lighting equipment – Calculation Summary

Green procurement Manual for the future lighting equipment	
Duration	2020- 2030
Total Implementation Cost (JOD)	4,353,113
Annual Energy Savings (MWh)	1959.8
Annual Emission Reduction (tn CO2)	897.6
Funding Source	Own funds
Net Present Value (NPV)	>0

3.4 Residential Buildings

This sector includes the energy consumption of all buildings in residential sector regardless the activities in each household (lighting, heating, use of electric appliances etc.). This consumption constitutes 42% of the total energy consumption, and around 43% of the CO2 emissions.

The initial actions are informational and they will be realized by Ajloun 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 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 Table 29.

Table 29: Actions in Residential Buildings

Action No.	Action	Emission Reductions (tn CO2) in 2030
3.1	Awareness raising activities for modification of the residents' consumption behavior	2,222
3.2	Promotion of Green Buildings' concept / Strict application of the building code	10,294
3.3	Campaign for promoting high energy label equipment	1,392
3.4	4 MW Photovoltaics in residential rooftops	5,816
3.5	Replacing existing electric water heater with solar collectors	2,963.2
3.6	Replacement of existing lamps with LEDs	717
3.7	Installing wall insulation for residential buildings	1,861.7
3.8	Replacement of existing wood and olive pomace space heating with efficient air-conditioners	4,512
3.9	Replacement of single glazing with double	2,058.4
3.10	Utilize smart technology to control the electrical appliances remotely	42
	Total	31,878.3

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

The initial step is that the municipality should organize frequently during the years up to 2030, awareness raising campaigns for the residents of Ajloun. Citizens' engagement is of utmost importance since almost the 42% of the total energy consumption is being consumed by the residential sector. The aim is to enhance the environmental consciousness of the citizens through the following activities:

- Organization of "Energy info 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 addressed, through simple actions such as changing of the energy consumption behavior, replacing incandescent lamps with more efficient one such as LED lamps, purchasing high-energy efficiency appliances, installation of solar collectors 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.

Related calculations on this action in terms of initial cost and emission savings are presented in Table 30 below. As an awareness raising activity, it is considered that the action is exponentially beneficial to the municipality against the related costs.

Table 30: Awareness raising - Calculation Summary

Awareness raising activities for modification of the residents' consumption behavior	
Duration	2023- 2030
Total Implementation Cost (JOD)	75,000
Annual Energy Savings (MWh)	6,607
Annual Emission Reduction (tn CO2)	2,222
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 enforcement of the Energy Efficient Building Code and other related building codes in Jordan is one of the key issues behind low energy performance in buildings in the Jordan. This action is focusing only in new buildings, and has been developed around the two aforementioned scenarios.

The action focuses on the enforcement 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 Table 31. As an awareness-raising related activity, it is thought to be exponentially beneficial to the municipality in comparison to its associated costs.

Table 31: Promotion of Green Buildings' concept - Calculation Summary

Promotion of Green Buildings' concept / Strict application of the Building Code	
Duration	2020- 2030
Total Implementation Cost (JOD)	300,000
Private Funds Mobilized (JOD)	122,309,000
Annual Energy Savings (MWh)	42,857
Annual Emission Reduction (tn CO2)	10,294
Funding Source	Own funds, governmental funds, Private funds
Net Present Value (NPV)	<<0

3.4.3 Campaign to promote high-energy labeled equipment

Another important activity that the municipality should organize is a campaign to encourage residents to buy and use high energy label equipment. Older equipment (refrigerators, stoves, vacuum cleaners, etc.) consumes more energy than newer, more technologically advanced equipment. The aim is to educate residents about the benefits of goods with a lower environmental impact throughout their life cycle, with an emphasis on the monetary benefits for the users themselves, because choosing energy efficient products leads to less energy consumption. As presented in the previous sections, dedicated awareness raising activities should also take place in order to disseminate the advantages of purchasing such efficient appliances. Indicative awareness raising campaigns include brief spots on the local TV and radio, posters, info days etc. Key data on the action and its expected impact is presented in the Table 32.

Table 32: Campaign for promoting high energy label equipment - Calculation Summary

Campaign for promoting high energy label equipment	
Duration	2023- 2028
Total Implementation Cost (JOD)	100,000
Private fund mobilized	2,310,500
Annual Energy Savings (MWh)	3,036
Annual Emission Reduction (tn CO2)	1,392
Funding Source	Own funds, governmental funds, Private funds
Net Present Value (NPV)	>0

3.4.4 (4 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 part of the current electricity consumption with "green" energy from Renewable Energy Sources. Overall, 4 MW of PV panels are expected to be installed within the 2030 horizon. In that way, and since electricity from solar energy has zero emission factor, the CO2 emissions will be reduced. Key data on the action are presented in the Table 33.

Table 33: 4 MW Photovoltaics in residential rooftops - Calculation Summary

4 MW Photovoltaics in residential rooftops	
Duration	2020- 2030
Private fund mobilized	1,867,000
Annual Energy Production (MWh)	7,468
Annual Emission Reduction (tn CO2)	5,816
Funding Source	Private funds, Loans
Net Present Value (NPV)	>>0

3.4.5 Replacing existing electric water heater with solar collectors

The use of hot water for personal hygiene and house chores is a standard permanent need in every household. As a result, a significant portion of electricity consumption is currently consumed for domestic hot water. At the same time, while the use of solar water heaters in the country is widespread, it is thought that it could be expanded in the future.

Solar water heaters are the best choice to replace electric water heaters in order to reduce emissions caused by their use. It is expected that at least 50% of existing households will install solar water heaters rather than electric ones by 2030. As a result, motivating people through targeted awareness campaigns is critical to meeting this goal.

Table 34: Replacing existing electric water heater with solar collectors - Calculation Summary

Replacing existing electric water heater with solar collectors	
Duration	2023- 2030
Total Implementation Cost (JOD)	1,500,000
Annual Energy Savings (MWh)	5,407.4
Annual Emission Reduction (tn CO2)	2,963.2
Funding Source	Private funds
Net Present Value (NPV)	>>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 cost savings on one hand, while these lamps provide great luminosity quality on the other hand. Their cost is higher from the conventional ones, but they have long life expectancy and a quite positive cost benefit ratio.

There is only one scenario envisaged for this action, focusing on lighting in existing buildings. it is expected that through the awareness raising activities citizens will be encouraged to implement measures like this. Thus, the penetration level for highly efficient lamps such as LEDs has been considered to be 60% in 2030. Key data on the action are presented in the next Table 35.

Table 35: Replacement of existing lamps with LEDs - Calculation Summary

Replacement of existing lamps with LEDs	
Duration	2023- 2030
Total Implementation Cost (JOD)	170,000
Annual Energy Savings (MWh)	1,566
Annual Emission Reduction (tn CO2)	717
Funding Source	Private funds
Net Present Value (NPV)	>>0

3.4.7 Installing wall insulation for residential buildings

Building space heating and cooling load are the largest contributors to total energy consumption. Wall insulation has a significant impact on how much energy buildings consume. It has a direct impact on HVAC energy consumption. Ajloun city is located in a high-altitude area with long and cold winters. According to the simulation results developed to determine the savings in the cooling and heating load for a single-family house in Ajloun, wall insulation could reduce the heating load by 35% during the winter. The total savings that could be realized through this action are summarized below, assuming a total penetration of 20% by 2030.

Table 36: Installing wall insulation for residential buildings - Calculation Summary

Installing wall insulation for residential buildings	
Duration	2023- 2030
Total Implementation Cost (JOD)	2,100,000
Annual Energy Savings (MWh)	5895.3
Annual Emission Reduction (tn CO2)	1861.7
Funding Source	Private funds
Net Present Value (NPV)	>>0

3.4.8 Replacement of existing wood and olive pomace space heating with efficient air-conditioners

The cold climate of the region necessitates the extensive use of heating systems in buildings. Residents of Ajloun primarily heat their homes with wood and olive pomace. it is expected that in the near future, air conditioning systems will gradually replace traditional heating methods. Shifting from wood and pomace to ACs will result in a noticeable increase in household electrical bills, which could be offset by using rooftop PV systems, given that the emission factors for burning wood is much higher than heat pump air conditioner. Calculation of CO2 reduction assumes that every single house consumes around one ton (1000 kg) of wood in winter (4 months per year), and 20% of existing houses (around 2600 houses) in Ajloun City will replace wood by efficient air conditions by 2030. Through purposeful awareness campaigns, the municipality can play an important role in motivating people to switch from wood/pomace to ACs as their primary source of space heating.

Table 37 below shows related calculations for the action in terms of initial cost and emission savings.

Table 37: Replacement of existing wood and olive pomace space heating - Calculation Summary

Replacement of existing wood and olive pomace space heating with efficient air-conditioners	
Duration	2023- 2030
Private fund mobilized (JD)	1,560,000
Annual Energy Savings (MWh)	11,570
Annual Emission Reduction (tn CO2)	4,512
Funding Source	Private funds
Net Present Value (NPV)	<0

3.4.9 Replacement of single glazing with double

Replacement of single glazing is an important action that would result in significant energy savings. Ajloun City experiences bitterly cold winters, necessitating high energy consumption to meet the required heating demand and achieve desired thermal comfort inside buildings. Installing double-glazed windows instead of single-glazed windows saves approximately 18% of the energy required for space heating. This action is expected to have an impact on 30% of residential buildings.
Related calculations on the action in terms of initial cost and emission savings are presented in Table 38.

Table 38: Replacement of single glazing with double – Calculation Summary

Replacement of single glazing with double	
Duration	2023- 2030
Private fund mobilized (JOD)	2,800,000
Annual Energy Savings (MWh)	5,304.6
Annual Emission Reduction (tn CO2)	2,058.4
Funding Source	Private funds
Net Present Value (NPV)	<<0

3.4.10 Utilize smart technology to control the electrical appliances remotely

A smart home refers to a convenient home setup where appliances and devices can be automatically controlled remotely from anywhere with an internet connection using a mobile or other networked device. Devices in a smart home are interconnected through the internet, allowing the user to control functions such as security access to the home, temperature, lighting, and electrical appliances remotely. Smart home appliances come with self-learning skills so they can learn the homeowner's schedules and adjust as needed. Smart homes enabled with lighting control allow homeowners to reduce electricity use and benefit from energy-related cost savings.

Installing smart systems would help the owner monitor and reduce their demand and control their consumption behavior, and hence improve the energy efficiency. The following calculations assumed that the system will save 5% of the lighting and AC consumption with a penetration level of 10% in the residential sector.

Table 39: Utilize smart technology to control the electrical appliances remotely – Calculation Summary

Utilize smart technology to control the electrical appliances remotely	
Duration	2023- 2030
Private fund mobilized	850,000
Annual Energy Savings (MWh)	89.6
Annual Emission Reduction (tn CO2)	42
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. According to BEI results, energy consumption in this sector constitutes 9% of the total consumption in the city, with 10% contribution to the total CO2 emissions.

The first actions will be informative and will be initiated by Ajloun Municipality. Because the municipality does not have the ability to intervene directly in project implementation, a series of actions will be planned to encourage building managers/owners to implement the proposed measures to reduce energy consumption and carbon emissions.

An overview of this sector's planned actions is presented in Table 40.

Table 40: Actions in Tertiary Sector Buildings

Action No.	Action	Emission Reductions (tn CO2)
4.1	10% electrical energy reduction campaign in commercial buildings	23.11
4.2	Promotion of Green Buildings' concept / Strict application of the building code	477.8
4.3	Awareness raising campaigns for pupils/ students	13.1
4.4	Installing solar PV systems for the water pumping plants and the worship places	2,613.8
4.5	Replacement of single glazing with double in the public schools	7.5
4.6	Replacement of existing lamps with LEDs	1098.3
4.7	Replacing existing electric water heater with solar collectors	4,184.6
4.8	Replacing inefficient refrigerators with more efficient ones in the commercial markets	193.2
	Total	8,611.4

3.5.1 Campaign for energy reduction in tertiary buildings

The aim of this campaign is to raise awareness on energy savings benefits among the building owners or operators through their voluntary participation. It is designed as a promotional campaign to increase citizens' sense of responsibility toward the environment and the community, while also providing visibility benefits to those who participate.

Ajloun Municipality will launch this program as a voluntary campaign in which shops and business owners can participate in order to reduce the energy and carbon footprint of their facilities, as well as their electricity bill. Participants must fill out a form, possibly on the Municipality's website, and submit the previous year's electricity bills for the respective building/facility. Furthermore, participants will attend Ajloun-organized informational and educational events that will provide advice on how to reduce building energy consumption through simple actions. All participants will also receive educational materials. Participants will submit their electricity bills again at the end of the year to demonstrate at least a 10% energy savings.

Following that, the Municipality will hold a ceremony to award the "Energy friendly business label" to those who met the 10% reduction target, as well as publish the names of their brands in local newspapers and/or magazines as an example of good practices. For this initiative, a penetration level of 5% has been assumed. Table 41 below shows related calculations on the action in terms of initial cost and emission reduction.

Table 41: Voluntary campaign for energy reduction in tertiary buildings – Calculation Summary

Voluntary campaign for energy reduction in tertiary buildings	
Duration	2023- 2030
Private fund mobilized	20,000
Annual Energy Savings (MWh)	64
Annual Emission Reduction (tn CO2)	23.11
Funding Source	Own funds & Governmental funds

3.5.2 Promotion of green buildings concept/ Strict application of the Building Code

In line with the residential sector's action, this action is addressing new buildings that will be built in the tertiary sector until the 2030 horizon. This action focuses on enforcing the existing Energy Efficient Building Code for all new tertiary buildings. The current scenario's penetration level is expected to cover 100% of new buildings built within the 2030 horizon, with savings of approximately 30% compared to BAU scenario.

Table 42 below shows related calculations for the action in terms of initial cost and emission savings.

Table 42: Promotion of green buildings concept – Calculation Summary

Promotion of green buildings concept/ Strict application of the Building Code	
Duration	2022- 2030
Private fund mobilized	The cost is included in the respective action in the Residential Sector
Annual Energy Savings (MWh)	1850.8
Annual Emission Reduction (tn CO2)	477.8
Funding Source	Private funds
Net Present Value (NPV)	<<0

3.5.3 Awareness 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.

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 43: Awareness raising campaigns for pupils/ students – Calculation Summary

Awareness raising campaigns for pupils/ students	
Duration	2023- 2030
Total Implementation Cost (JOD)	30,000
Annual Energy Savings (MWh)	359.8
Annual Emission Reduction (tn CO2)	13.1
Funding Source	Own funds

3.5.4 Installing PV system to cover the worship places and the water pumping plants demand

Electricity consumption constitutes 15% of the total demand in the tertiary sector. Relying on the solar energy is an effective way to cover the demand within these areas. In order to cut down the energy consumption, the installation of the solar PV systems until the 2030 horizon is suggested. This action leads to significant energy savings and CO2 reduction. An overall penetration level of 50% of the action in existing worship and water pumping plants is assumed. Key data on the action are provided in Table 44.

Table 44: Worship and water pumping plants PV systems – Calculation Summary

Worship and water pumping plants PV systems	
Duration	2023- 2030
Private Funds Mobilized (JOD)	1,033,000
Annual Energy Production (MWh)	5,706
Annual Emission Reduction (tn CO2)	2,613.8
Funding Source	Donation/Gov. funds
Net Present Value (NPV)	>>0

3.5.5 Replacement of single glazing with double in the public schools

Replacement of single glazing is an important action that would result in significant energy savings. Ajloun City experiences bitterly cold winters, necessitating high energy consumption to meet the required heating demand and achieve desired thermal comfort inside buildings. Installing

double-glazed windows instead of single-glazed windows saves approximately 18% of the energy required for space heating. Therefore, applying this action in the public schools would decrease the energy consumption and improve the buildings thermal performance.

Related calculations on the action in terms of initial cost and emission savings are presented in Table 45 below.

Table 45: Replacement of single glazing with double – Calculation Summary

Replacement of single glazing with double	
Duration	2023- 2030
Private fund mobilized	22,500
Annual Energy Savings (MWh)	30.4
Annual Emission Reduction (tn CO2)	7.5
Funding Source	Gov. funds
Net Present Value (NPV)	<0

3.5.6 Replacement of existing lamps with LEDs

Currently, the use of LED lamps in the Tertiary sector is relatively limited. The use of LED technology is suggested, since it can lead in energy and cost savings on one hand, while these lamps provide great luminosity quality on the other hand. Thus, the penetration level for highly efficient lamps such as LEDs has been considered to be 50% by 2030. Key data on the action are presented in Table 46.

Table 46: Replacement of existing lamps with LEDs - Calculation Summary

Replacement of existing lamps with LEDs	
Duration	2023- 2030
Private fund mobilized	262,000
Annual Energy Savings (MWh)	2,398
Annual Emission Reduction (tn CO2)	1098.3
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.7 Replacing existing electric water heater with solar collectors

Several businesses active in the tertiary sector, such as hospitals and hotels, utilize extensively water heating for covering their 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. 40% penetration level has been assumed to install 10,689 SWH systems during the period from 2023-2030.

Key data on the action are presented in Table 47 below.

Table 47: Replacing existing electric water heater with solar collectors - Calculation Summary

Replacing existing electric water heater with solar collectors	
Duration	2023- 2030
Private fund mobilized	6,400,000
Annual Energy Savings (MWh)	9,136
Annual Emission Reduction (tn CO2)	4,184.6
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.8 Replacing inefficient refrigerators with more efficient ones in the commercial markets

Commercial refrigeration systems differ from the home refrigerators especially in the capacity size, technology, and setup. They are typically more powerful than residential units and may have the compressors and condensers in a different location. Commercial markets in Ajloun are small sized stores with an average consumption of 4575 KWh/year. Refrigeration and lighting are the only energy consumers within the commercial markets in Ajloun. It is assumed that this action will reach out 30% of commercial building/shops stock by 2030.

Key data on the action are provided in Table 48 below.

Table 48: Replacing inefficient refrigerators - Calculation Summary

Replacing inefficient refrigerators with more efficient ones in the commercial markets	
Duration	2023- 2030
Private fund mobilized	270,000
Annual Energy Savings (MWh)	421.4
Annual Emission Reduction (tn CO2)	193.2
Funding Source	Private funds
Net Present Value (NPV)	>0

3.6 Transport

The share of the Transportation sector, including the municipal fleet, private and commercial transport as well as public transport is 46% out of the total energy consumption in Ajloun Municipality, with 37% contribution in CO2 emissions. The proposed actions are presented in Table 49 and a more detailed analysis for each action is illustrated in the following sections.

Table 49: Actions in Transportation sector – Calculation Summary

Action No.		Action	Emission Reductions (tn CO2)
5.1	Municipal fleet	Replacement of old municipal diesel vehicles with new efficient vehicles	10.4
5.2		Installation of tracking and monitoring system for more efficient management of the fleet and better planning routes	58.9
5.3		Municipal fleet maintenance	76.4
5.4		Eco-driving seminars for the municipal fleet drivers	94.3
5.5		Carry out an audit of the municipality's fleet of vehicles and implement the actions recommended through a program contract.	102.4
5.6	Private and commercial fleet	Activate online shopping and delivering services to reduce the traffic during the peak period	18.6
5.7		Transfer all government departments and institutions to one complex near to the population centers in the city	2587.6
5.8		Promotion of walking and car sharing and carpooling campaigns using Social media applications	1803.9
5.9		Information events on the new vehicle technologies and establish electricity charging stations for the electric cars within the municipality	0.0
5.10		- Replacement of gasoline vehicles with Hybrid	1,642.2
5.11		- Replacement of diesel vehicles with new more efficient	318.8
5.12		Improvement / development of parking infrastructure	1842.4
5.13	Public and Tourism	Developing alternative roads to reduce the traffic near the centralized areas	776.9
5.14		Improve public transportation/ promote the use of public transport	2049.2
5.15		Replacing the existing Taxi vehicles with Hybrid vehicles	317.5
		Total	11,699.5

3.6.1 Replacement of old municipal diesel vehicles with new efficient vehicles

The municipal fleet consists of 47 vehicles, including 16 pick-ups, 13 garbage trucks, and 14 heavy vehicles, the majority of which are considered old (more than 15 years). These vehicles consume more diesel because their engines are old and inefficient, and they must be replaced with new ones. This action constitutes a priority for the municipality, and for this reason it is developed in detail in the project fiche "Replacing the old Municipal diesel vehicles with new efficient vehicles". The action proposes replacing eight old pickup trucks with new ones in order to reduce fuel consumption and carbon emissions.

Table 50: Replacement of old municipal diesel vehicles with new ones – Calculation Summary

Replacement of old municipal diesel vehicles with new efficient vehicles	
Duration	2023- 2030
Total Implementation Cost (JOD)	200,000
Annual Energy Savings (MWh)	39.2
Annual Emission Reduction (tn CO2)	10.4
Funding Source	Own funds & National Grants
Net Present Value (NPV)	<0

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

This action aims to improve operational efficiency while lowering environmental impact. The installation of GPS systems is a significant step in allowing the municipality to monitor and optimize the routes of its vehicles. GPS should be programmed with the best routes based on the services provided by each vehicle. As a result, the vehicles will use less fuel, resulting in financial savings and CO2 emission reductions. The system should be installed on 30 municipal vehicles at a cost of 780 JD per vehicle over a seven-year period.

Table 51: Installation of Global Positioning System – Calculation Summary

Installation of Global Positioning System for more efficient management of the fleet and better planning routes	
Duration	2023- 2030
Total Implementation Cost (JOD)	23,000
Annual Energy Savings (MWh)	220.8
Annual Emission Reduction (tn CO2)	58.9
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 result in significant energy savings, ensure proper vehicle operation, and prevent costly damage. The vehicles are already maintained, but the goal of this action is to develop a plan to better organize the maintenance, giving priority to those that are used more frequently and ensuring that all related service work is completed on time. Furthermore, these measures are proposed to be implemented for each new acquisition in the coming years. As a result, this action is focused on both the existing fleet and any new vehicles that will be purchased.

Table 52: Municipal fleet maintenance - Calculation Summary

Municipal fleet maintenance (for the existing & the new ones)	
Duration	2023- 2030
Total Implementation Cost (JOD)	140,500
Annual Energy Savings (MWh)	286.6
Annual Emission Reduction (tn CO2)	76.4
Funding Source	Own funds
Net Present Value (NPV)	>0

3.6.4 Eco-driving seminars for the municipal fleet drivers

Eco-driving is a set of actions that, like "behavioral changes," influence how drivers drive. These principles are thought to be a good way for municipal fleet drivers to reduce fuel consumption. The effectiveness of seminars and trainings is determined by drivers' participation and commitment to ensure that every single driver understands and follows the recommendations. Table 53 summarizes the associated calculations for the action in terms of initial cost and emission savings.

Table 53: Eco-driving seminars for the municipal fleet drivers - Calculation Summary

Eco-driving seminars for the drivers of the municipal fleet	
Duration	2023- 2030
Total Implementation Cost (JOD)	30,000
Annual Energy Savings (MWh)	353.4
Annual Emission Reduction (tn CO2)	94.3
Funding Source	Own funds
Net Present Value (NPV)	>>0

3.6.5 Carry out an audit of the municipality's fleet and implement the actions recommended through a program contract.

This action aims to carry out an audit on the energy consumption of the Municipality's fleet. This audit will serve to define an action plan for reducing consumption, but also to optimize overall expenses related to maintenance, oil change, etc. The gains linked to this action are generated by the implementation of the recommended action plan. The audit as well as the action plan covers the entire fleet of vehicles. The expected energy and cost saving resulted from this action are summarized in Table 54.

Table 54: Carry out an audit of the municipality's fleet – Calculation Summary

Carry out an audit of the municipality's fleet and implement the actions recommended through a program contract.	
Duration	2023
Total Implementation Cost (JOD)	14,000
Annual Energy Savings (MWh)	383.6
Annual Emission Reduction (tn CO2)	102.4
Funding Source	Own funds
Net Present Value (NPV)	<0

3.6.6 Enable online shopping and delivery services to reduce the traffic during the peak period

Delivery personnel typically drive small cars and bikes to deliver orders for customers, and in some cases, they deliver multiple orders for different customers. As a result, enabling online delivery applications would effectively reduce traffic and fuel consumption. As a result, the environment will benefit from lower carbon emissions generated by the transportation sector. As a result, the vehicles will use less fuel, resulting in financial savings and CO2 reductions. Employing 10 drivers in the beginning to cover Ajloun's municipality region and provide them with motor cycles would be beneficial for both the municipality and the people. It will reduce the traffic, lower the carbon emission, and create job opportunities. Table 55 summarizes the action cost and benefits.

Table 55: Enable online shopping and delivery services – Calculation Summary

Enable online shopping and delivery services to reduce the traffic during the peak period	
Duration	2023
Total Implementation Cost (JOD)	15,000
Annual Energy Savings (MWh)	74.8
Annual Emission Reduction (tn CO2)	18.6
Funding Source	Own funds
Net Present Value (NPV)	<0

3.6.7 Transfer all government departments and institutions to one complex near to the population centers in the city

One of the main transportations and traffic problems in Ajloun city is the distance between government departments and institutions, which forces people to drive or take public transportation to get from one place to another to complete their government and civil affairs. This issue will let people drive more, causing traffic jams on the connecting streets. One of the best solutions is to consolidate all related government departments and institutions into a single complex near the city's population centers in order to avoid or minimize using transportation. For the purposes of

calculating avoided emissions, it was assumed that 5% of journeys made by private and public vehicles in the city could be avoided.

Table 56: Transfer all government departments and institutions to one complex – Calculation Summary

Transfer all government departments and institutions to one complex near to the population centers in the city	
Duration	2023-2030
Total Implementation Cost (JOD)	750,000
Annual Energy Savings (MWh)	10,029.6
Annual Emission Reduction (tn CO2)	2587.6
Funding Source	Own, governmental and external funds

3.6.8 Using social media campaign to promote walking, car sharing, and carpooling

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. The signs could optionally include information on the number of calories required to cover such a distance.
- Improvements to the pavements to make them more walkable. This can be accomplished through improved maintenance (replacement of damaged or broken flagstone tiles), pavement expansion where feasible, and even tree and flower planting.
- Construction of pedestrian roads, particularly in commercial areas or near low-traffic roads.
- Renovation of parks or other public areas (squares, for example) to provide shade and resting areas, making them more appealing to citizens.
- Walking awareness campaign, highlighting the health and environmental benefits.

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.

As a result, it is considered essential for the city, despite the fact that it provides no direct economic benefit to the municipality. A mobile application could also be created for added convenience.

Table 57: Using social media campaign to promote walking, car sharing, and carpooling – Calculation Summary

Using social media campaign to promote walking, car sharing, and carpooling	
Duration	2023-2030
Total Implementation Cost (JOD)	200,000
Annual Energy Savings (MWh)	6747.4
Annual Emission Reduction (tn CO2)	1803.9
Funding Source	Own and Governmental funds

3.6.9 Information events on the new vehicle technologies and establish electricity charging stations for the electric cars within the municipality

Private and commercial vehicles consume the most energy when compared to other modes of transportation. It is proposed that the Municipality organize awareness raising activities to inform citizens about electric vehicles and hybrid, in addition to the economic and environmental benefits of these vehicles. Electric vehicles are beneficial for the municipalities as they can reduce greenhouse gas emissions, improve air quality, and when combined with EV charging infrastructure.

Accelerated electric vehicles adoption gives local governments and municipalities the chance to meet sustainability goals, reduce the carbon emissions, and attract more visitors to the city. Furthermore, according to the Free Zones Vehicle Sector, in 2022, the demand for electric vehicles has risen by 250 percent, compared with last year. The demand for the electric vehicles will increase next year, noting that the market share of electric vehicles was 30 percent of the total of vehicles cleared in 2022. Therefore, establishing Electric charging stations is a must to encourage the municipality's residents to buy electric vehicles.

Table 58: Information events on the new vehicle technologies - Calculation Summary

Information events on the new vehicle technologies	
Duration	2023-2030
Total Implementation Cost (JOD)	100,000
Annual Energy Savings (MWh)	6595.4+1943.2
Annual Emission Reduction (tn CO2)	1642.2+318.8
Funding Source	Own and Governmental funds, Private funds
Net Present Value (NPV)	<<0 (for Hybrids), >0 (for diesel)

3.6.10 Improvement / development of parking infrastructure

Traffic congestion is a problem within Ajloun 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 59: Development of parking infrastructure - Calculation Summary

Improvement / development of parking infrastructure	
Duration	2023-2030
Total Implementation Cost (JOD)	320,000
Annual Energy Savings (MWh)	7238
Annual Emission Reduction (tn CO2)	1842.4
Funding Source	Own and Governmental funds

3.6.11 Developing alternative roads to reduce the traffic jam in the city center

One of the easiest ways to improve traffic congestion is to remove the issue of congestion arising from too many people trying to travel at once on any given road. Which can be done by designing alternative routes to the same destination, this can help reduce the number of vehicles in high traffic areas. This allows all streets to share the load of traffic and reduces the number of times drivers wait in it and hence reduces high fuel consumption within the traffic period. The alternative road length is proposed to be 2 Km across the city center, it will reduce the traffic and saves the resident's time. It is expected that the speed will increase from 20 Km/h to 60 Km/h which mean less carbon emission. The carbon emission will be reduced by 25% when increasing the speed[7].

Table 60: Developing alternative roads to reduce the traffic jam in the city center - Calculation Summary

Developing alternative roads to reduce the traffic jam in the city center	
Duration	2023-2030
Total Implementation Cost (JOD)	100,000
Annual Energy Savings (MWh)	3,048.4
Annual Emission Reduction (tn CO2)	776.9
Funding Source	Own and Governmental funds

3.6.12 Improve public transportation/ promote the use of public transport

This action aims to identify routes that are unserved in order to establish new ones or increase the frequency of existing ones. The overall strategy is to connect highways and establish bus stops near schools and other points of interest frequented by citizens. One of the municipality's priorities is to improve students' mobility while also ensuring their safety, thereby reducing traffic congestion caused by parents' cars picking up their children. Also, to increase the coverage of the public transit in order to increase its durability. On the other hand, there should be efforts to

[7] Adriano Alessandrini, et. Al, Driving style influence on car CO2 emissions, CTL Centre for Transport and Logistics, Sapienza University of Rome.

promote the use of the improved public transport by the inhabitants via awareness raising events thus achieving energy savings and CO2 reductions.

Table 61: Improve public transportation – Calculation Summary

Improve public transportation/ promote the use of public transport	
Duration	2023-2030
Total Implementation Cost (JOD)	200,000
Annual Energy Savings (MWh)	8051.4
Annual Emission Reduction (tn CO2)	2049.2
Funding Source	Own and Governmental funds

3.6.13 Replacing the existing Taxi vehicles with Hybrid vehicles

Inefficiencies in today's transportation systems can result in decreased service, increased costs, increased energy consumption, and negative environmental impact. To achieve higher energy efficiency and thus fuel and monetary savings, old taxis that use gasoline should be replaced with hybrids. This action is planned as a result of a provision in the relevant legislative framework that allows for exemptions for replacing taxis with hybrid vehicles.

Table 62: Replacing the existing Taxi vehicles with Hybrid vehicles – Calculation Summary

Replacing the existing Taxi vehicles with Hybrid vehicles	
Duration	2023-2030
Annual Energy Savings (MWh)	1275
Annual Emission Reduction (tn CO2)	317.5
Funding Source	Private funds

3.7 Agriculture Sector

3.7.1 Planting trees (increasing green areas)

Planting forest trees will contribute in reducing the GHG through absorbing the CO2 emission. The forest trees absorb the co2 through the photosynthesis. The municipality will plant forest trees and support planting such trees by the local community to contribute in reducing the CO2 emissions.

Table 63 below illustrates the information that present the action.

Table 63: Planting Trees (increasing green areas)

Planting Trees (increasing green areas)	
Duration	2023-2030
Total Implementation Cost (JOD)	420,000
Number of Trees	60,000
CO2 Captured (Tn CO2)	1,300
Funding Source	Own and external funds

Chapter 4: Adaptation to climate change

4.2 Introduction on climate change impact

The Earth's climate is changing and the global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse (heat-trapping) gases emitted globally and on the remaining uncertainty in the sensitivity[8] of the Earth's climate to those emissions. With significant reductions in the emissions of greenhouse gases (GHGs), global annual averaged temperature rise could be limited to 2°C or less. However, without major reductions in these emissions, the increase in annual average global temperatures, relative to preindustrial times, could reach 5°C or more by the end of this century.

Observed changes over the 20th century include increases in global air and ocean temperature, rising global sea levels, long-term sustained widespread reduction of snow and ice cover, and changes in atmospheric and ocean circulation as well as regional weather patterns, which influence seasonal rainfall conditions. These changes are caused by extra heat in the climate system due to the addition of greenhouse gases to the atmosphere. These additional greenhouse gases are primarily input by human activities such as the burning of fossil fuels (coal, oil, and natural gas), deforestation, agriculture, and land-use changes. These activities increase the amount of 'heat-trapping' greenhouse gases in the atmosphere. The pattern of observed changes in the climate system is consistent with an increased greenhouse effect. Other climatic influences such as volcanoes, the sun and natural variability cannot alone explain the timing and extent of the observed changes.

As a result, countries across the world take actions necessary to anticipate and plan for future changes in climate to protect human health and the environment. Furthermore, they ensure their programs, policies, rules, enforcement and compliance assurance activities, and operations consider current and future impacts of climate change and how those impacts will disproportionately affect certain communities. Through climate change adaptation planning and implementation, nations across the world will continue to protect human health and the

[8] https://climateknowledgeportal.worldbank.org/overview

environment by reducing risks from climate change impacts while also working to reduce greenhouse gas emissions. This could be achieved by developing and implementing measures to protect its workforce, facilities, supply chains, and procurement processes from risks posed by climate change [9].

Adaptation is defined as the adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers as well to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. The Paris Agreement on Climate Change in 2015 has identified the global goals on adaptation, which include enhancing the adaptive capacity, resilience and reducing the vulnerability in order to contribute to sustainable development[10].

4.2 Climate change profile in Jordan

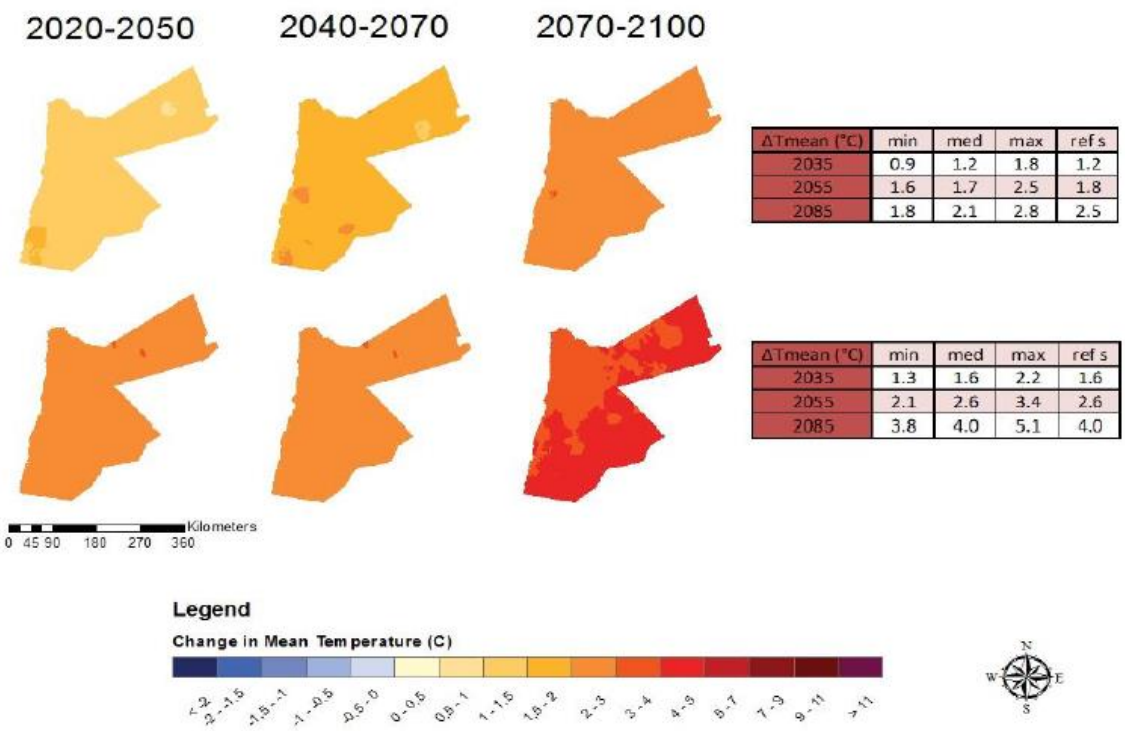
Jordan is located in West Asia region, and characterized by dry to semi-dry climate conditions with an annual precipitation that falls under 50 millimeters in most areas. Jordan faces several challenges with the need to import of around 90% of its energy; while severe aridity and water scarcity make it environmentally sensitive to climate change. Climate-related hazards are affecting Jordan, such as extreme temperatures, droughts, flash floods, storms, and landslides. These hazards are increasing in frequency and intensity due to climate change. Flooding has caused serious implications in the last years, where lives have been lost, and several square kilometers of agricultural lands were destroyed in addition to sever damages to infrastructure. Landslides and erosion problems have occurred as well, and they were concentrated on the steep slopes of mountains and wadis. Climate change affects various sectors including agricultural, coastal areas, biodiversity, urban systems, society, water, and health sectors, where adaptation options are required to mitigate its effects.

Based on long historical data obtained from Ministry of Water and Irrigation (MWI) and Jordanian Meteorology Department (JMD), climatic variables are changing significantly at both national and station level indicating that climate change is becoming more apparent. Based on the tests, the annual precipitation tends to decrease significantly by time in a rate of 1.2 mm per year until 2100. On the contrary, the mean, maximum and minimum air temperature tends to increase significantly by 0.02, 0.01, and 0.03 °C/year, respectively.

In 2070-2100, average temperature increase could be between +2.1°C and +4°C. Figures below present the results for the mean, minimum and maximum annual temperature, for the three-time horizons considered. In addition, the dynamic projections predict a drier climate, in 2070-2100, the cumulated precipitation could decrease on average 15% and by – 21%. The decrease would be more marked in the western part of the country.

[9] U.S. Environmental Protection Agency Climate Adaptation Action Plan, October 2021.

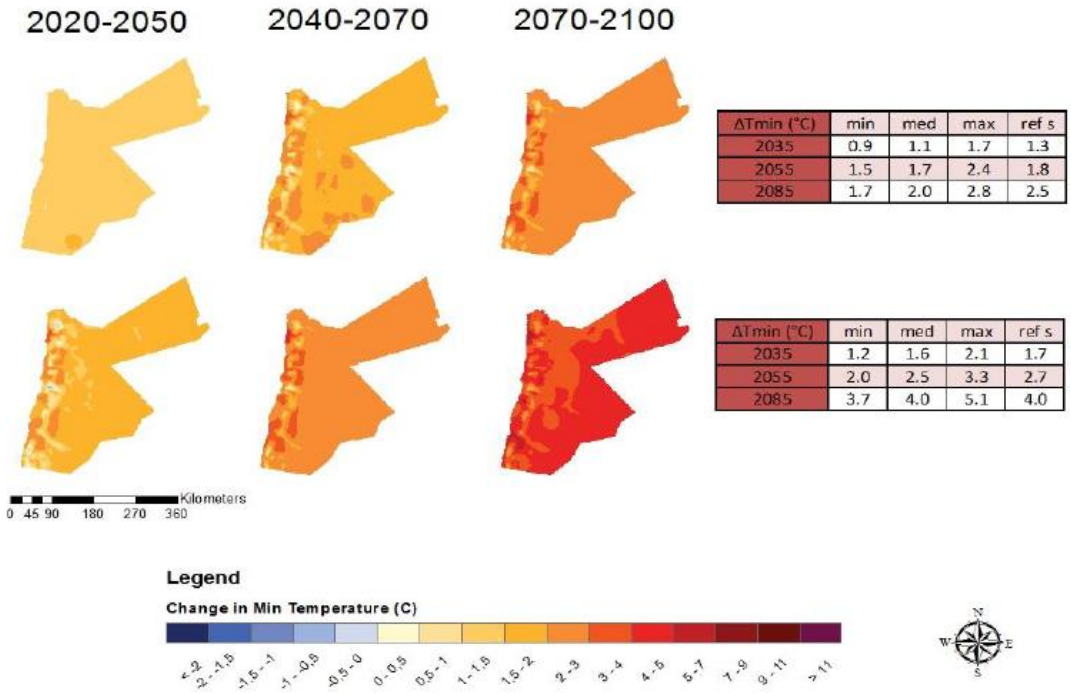
[10] The National Climate Change Adaptation Plan of Jordan, 2021.



ΔTmean (°C)	min	med	max	refs
2035	0.9	1.2	1.8	1.2
2055	1.6	1.7	2.5	1.8
2085	1.8	2.1	2.8	2.5

ΔTmean (°C)	min	med	max	refs
2035	1.3	1.6	2.2	1.6
2055	2.1	2.6	3.4	2.6
2085	3.8	4.0	5.1	4.0

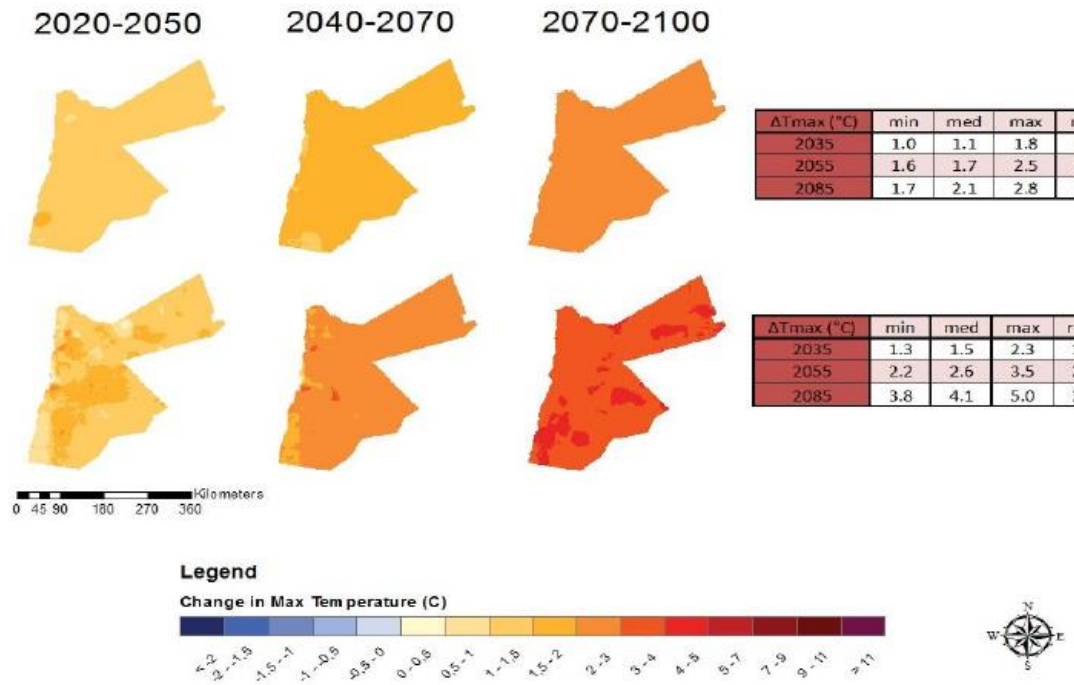
Figure 23: Changes in annual mean temperature (°C) over Jordan, reference model, for 2035, 2055 and 2085 times-horizons



ΔTmin (°C)	min	med	max	ref s
2035	0.9	1.1	1.7	1.3
2055	1.5	1.7	2.4	1.8
2085	1.7	2.0	2.8	2.5

ΔTmin (°C)	min	med	max	ref s
2035	1.2	1.6	2.1	1.7
2055	2.0	2.5	3.3	2.7
2085	3.7	4.0	5.1	4.0

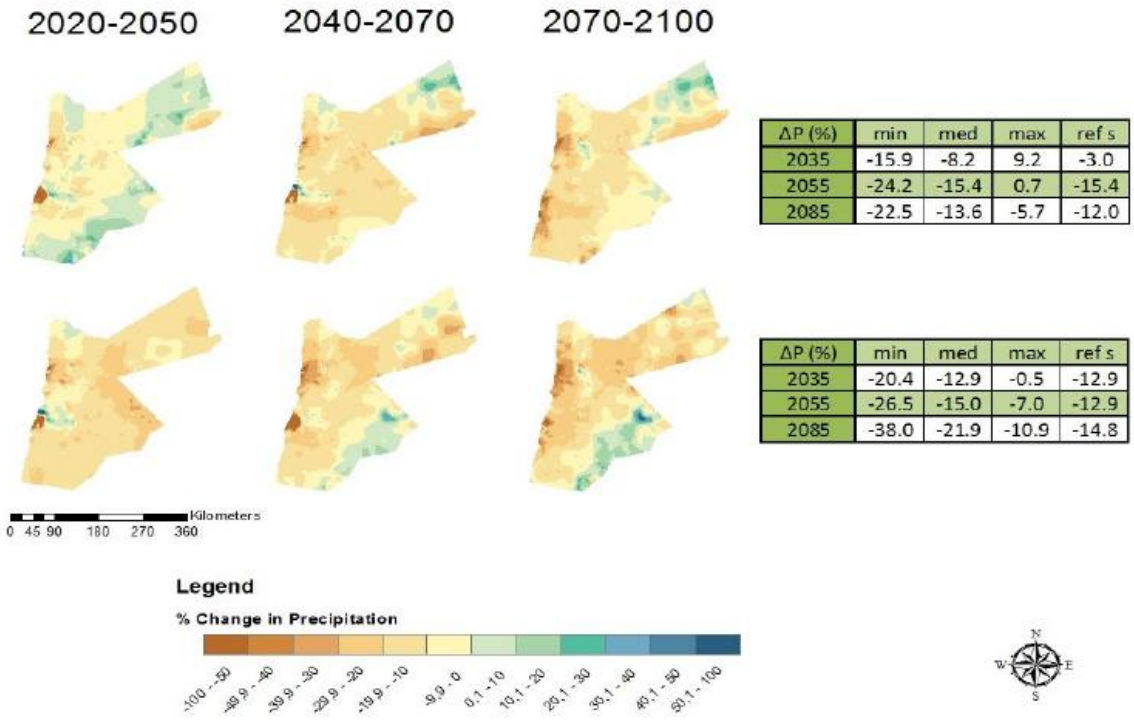
Figure 24: Delta annual minimum temperature (°C) over Jordan, reference model, for 2035, 2055 and 085 times-horizon



ΔTmax (°C)	min	med	max	ref s
2035	1.0	1.1	1.8	1.1
2055	1.6	1.7	2.5	1.7
2085	1.7	2.1	2.8	2.5

ΔTmax (°C)	min	med	max	ref s
2035	1.3	1.5	2.3	1.5
2055	2.2	2.6	3.5	2.5
2085	3.8	4.1	5.0	3.9

Figure 25: Changes in annual maximum temperature (°C) over Jordan, reference model, for 2035, 2055 and 2085 times-horizons



ΔP (%)	min	med	max	ref s
2035	-15.9	-8.2	9.2	-3.0
2055	-24.2	-15.4	0.7	-15.4
2085	-22.5	-13.6	-5.7	-12.0

ΔP (%)	min	med	max	ref s
2035	-20.4	-12.9	-0.5	-12.9
2055	-26.5	-15.0	-7.0	-12.9
2085	-38.0	-21.9	-10.9	-14.8

Figure 26: Changes in annual precipitation (mm) over Jordan, reference model, for 2050, 2070 and 2100 times-horizons

The future projections indicated a warmer summer, drier autumn and winter with medium confidence. The warming would be more significant in summer, and the reduction of precipitation more important in autumn and winter than in spring, with for instance median value of precipitation decrease reaching -35% in autumn in 2070-2100. The dynamic projections predict more heat waves with high confidence and the analysis of summer temperature, monthly values and the inter-annual variability reveal that some thresholds could be exceeded. For instance, in pessimistic but possible projections, for a summer month, the average of maximum temperature for the whole country could exceed 42-44°C.

The future projections also indicate more droughts, where the maximum number of consecutive dry days would increase in the reference model of more than 30 days for the 2070-2100 period. In contrast, annual values still show possible heavy rainy events at the end of the century. More intense droughts would be (partly) compensated by rainy years, in a context of a general decrease of precipitation. Potential evaporation would increase. Finally, the future projections indicate no trend for intense precipitations or strong winds with low confidence. The number of days with

heavy rain (>10 mm) does not evolve significantly, nor does the maximum wind speed or the direction of winds[11].

4.3 National climate change strategies

The Ministry of Environment (MoEnv) is the focal point to the United Nations Framework Convention on Climate Change (UNFCCC). Although, the Ministry was established in 2003, but the Government of Jordan had initiated its efforts toward climate change since 1999, where it was the first developing country that has submitted the First National Communication Report to the UNFCCC including a comprehensive vulnerability analysis.

4.3.1 Updated NDC (2021)

According to the Jordan First NDC, the Jordanian government has pledged to reduce GHG emissions by 1.5% in 2030 compared to business-as-usual without conditions and increase this pledge to 12.5% conditioned to international support. Jordan's updated 1st Nationally Determined Contributions (NDC) document enhances its commitment to the international climate change governance system by raising its macroeconomic GHG emission reduction target from 14% in the 1st NDC to 31% in the current updated NDC, both compared to Business As Usual (BAU) scenario. (Updated NDC).

4.3.2 National Vision and Strategy (NVS)

In 2015, the government launched Jordan's 2025 National Vision and Strategy (NVS). This is the reference for all development pathways in the country, "and sets a holistic economic and social framework based on equal opportunities for all". It contains over 400 policies, including ones on environment and climate.

4.3.3 Green Growth National Action Plan (2021-2025)

The Ministry of Environment has been taking solid actions to support Jordan's green growth transformation. In 2017, the Cabinet approved the National Green Growth Plan, which established green growth as a top national priority. The next step in implementing this vision, the Green Growth National Action Plan 2021-2025 was published. The development of this plan lies at the heart of continuous efforts and ambitions to support environmental and climate action in Jordan, while also achieving Jordan sustainable economic growth objectives.

The National Green Growth Action plan 2021-2025 targets 6 sectors; agriculture, energy, tourism, transport, waste and water sectors. The Energy Sector Green Growth Action National Action Plan 2021-2025 (GG-NAP) outlines a green growth framework and actions for the sector aligned with

[11] The National Climate Change Adaptation Plan of Jordan, 2021.

the National Green Growth Plan (NGGP), Jordan Vision 2025, and Nationally Determined Contributions (NDCs) under the Paris agreement.

4.3.4 Climate Change National Adaptation Plan (NAP) (2021)

The NAP document was prepared based on the Climate Vulnerability Assessment of the Third National Communication Report, and adopts the values and principles of the NAP Framework. It provides a clear vision for adaptation and identifies measures to be addressed in various sectors to guide institutions from different sectors such as governmental, academic, CBOs, and private sectors entities to implement adaptation initiatives, develop partnership relations and synergies with each other, to reach the required adaptation goals. The plan includes a description of sectoral adaptation programs and measures through enhancing the resilience of urban structure to climate change impacts and supporting sustainable urbanization.

Jordan has developed several laws, regulations and policy instruments that govern environmental protection. Some of them still work without being updated such as Air Protection Bylaw (2005), while some of them had already been updated to adapt to the national context and perspectives. In general, the Jordanian government has taken many measures to develop the regulatory and legislative framework through the issuance of several laws and legislations including:

- National Environment Protection Law No. (6) of year 2017. The NOU has recently endorsed the Instructions for year 2021 to manage and control the ODS and the ODS Alternatives (in particular HFCs). These Instructions issued pursuant to Article (4) and (30) of the National Environment Protection Law No. (6).

- Climate change bylaw No. 79 for the year 2019, the MoEnv declared this bylaw to ensure full engagement of all stakeholders including both technical and decision makers. The bylaw set the procedures for climate change projects, to be ratified by the national climate change committee that include stakeholders from all governmental entities. The committee has the right to invite and consult with experts when needed.

- Air Protection Bylaw No. (28) of 2005, which stated that any entity shall comply to the national regulations of the use of the substances under the control of Montreal Protocol.

- Jordan Environment Fund 2018 bylaw and its amendments, to encourage development initiatives aimed at the optimal use of environmental components and natural resources toward sustainable development.

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 Table 64.

Table 64 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	
	Human, technical and financial resources identified	
	Adaptation team (officer) appointed within the municipal administration and clear responsibilities assigned	
	Horizontal (e.g. across departments) coordination mechanisms in place	
	Vertical (e.g. across governance levels) coordination mechanisms in place	
	Consultative and participatory mechanisms set up, fostering the multi stakeholder engagement in the adaptation process	
	Continuous communication process in place	
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	
	Assessment of climate risks and vulnerabilities undertaken	
	Possible sectors of actions identified and prioritized	
	Available knowledge periodically reviewed and new finding integrated	
Steps 3 and 4 – Identifying,	Full portfolio of adaptation actions compiled, documented and assessed	

assessing and selecting adaptation options	Possibilities of mainstreaming adaptation in existing policies and plans assessed, possible synergies and conflicts identified	
	Adaptation actions developed and adopted	
Step 5: Implementing	Implementation framework set with clear milestones	
	Adaptation actions implemented and mainstreamed as defined in the SECAP document	
	Coordinated action between adaptation and mitigation set	
Step 6: Monitoring and evaluation	Monitoring framework in place for adaptation actions	
	Appropriate monitoring and evaluation indicators identified	
	Regular monitoring of the progress and reporting to the relevant decision makers	
	Adaptation strategy and/or Action Plan updated, revised and readjusted according to the findings of the monitoring and evaluation procedure	

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 Table 65, while those applicable for Ajloun have been identified.

Table 65 Climate Hazard Types

General Climate Hazard Types	Applicable for Ajloun region
Extreme heat	X
Extreme cold	
Landslides	X
Storms	
Droughts	X
Sea level rise	

Floods	X
Extreme precipitation	X
Forest fires	X
Ice and snow	X

Municipalities are requested to assess the impact of each type of climate hazard on a number of vulnerable/impacted sectors, such as:

- Health
- Infrastructure (Energy, Water, Transport)
- Built environment
- Economy (Tourism, Agriculture and Forestry)
- Biodiversity (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. Ajloun Municipality has filled in Table 66, 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.

4.5.1 Vulnerability analysis

Table 66 show the vulnerability analysis carried out for Ajloun City according to Future Cities Adaptation Compass tool.

Table 66 Vulnerability analysis

Receptors		Extreme weather event	Potential effects	Who/What is affected
Population	Public Health	Extreme heat	- Deaths due to cardiovascular diseases - Spread of vector born and infectious diseases - Altered allergic pattern - 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 - Accumulation of trace elements	All people living or working in the area
		Floods	- Injuries and deaths - Water-borne diseases - Asthma and respiratory allergies	All people living or working in the area
		Extreme Precipitation	- The spread of insects and diseases such as malaria.	All people living or working in the area
		Forest fires	- Choking occurrence and poisoning. - Death.	All people living or working in the area
Infrastructure	Transport	Extreme heat	- Road network damages - Change in behavior patterns - Air quality problems - Higher maintenance costs	Roads, public transport, people mobility
		Landslides	- Damages - Mobility difficulties in afflicted areas	Roads, public transport, people mobility
		Droughts	- Difficult transport of bulk material	Waterways, water management
		Floods	- Damages - Mobility difficulties in afflicted areas	Roads, public transport, people mobility
		Extreme Precipitation	- Damages. - Road sliding.	Roads, public transport
		Forest fires	- No effect	- No effect

	Energy	Extreme heat	- Altered electricity peaks/demand - Damages - Cooling problems - Reduction of efficiency yield from conventional power plants and distribution grid - Higher maintenance costs	Conventional power plants, electricity providers and consumers
		Landslides	- Damages - 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 - Energy supply and demand patterns' shift - Higher maintenance costs - Cooling problems	Conventional and renewable energy facilities (hydro, PVs, etc.)
		Floods	- Damages - Operational difficulties	All facilities in the electricity generation, transmission and distribution grid in the affected areas
		Extreme Precipitation	- Higher maintenance costs. - Network outage.	Electrical network.
		Forest fires	- Network outage.	Electrical network.
	Water	Extreme heat	- Higher water demand - Water quality issues - Higher maintenance costs	Public health, water infrastructures
		Landslides	- Damages - Water quality issues	Public health, water infrastructures
		Droughts	- Water scarcity - Water quality issues - Higher maintenance costs	Public health, water infrastructures

		Floods	- Water quality issues - Water management issues - Damages - Higher maintenance costs	Public health, water infrastructures
		Extreme Precipitation	- Extreme mismatches between water supply and demand. - Reduce the groundwater supply.	Water resources.
		Forest fires	- No effect	- No effect
	Social	Extreme heat	- Higher electricity demand to cover cooling needs - Changes in behavior patterns, e.g. living outdoors - 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
		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 - Burdening of the health care facilities due to the increased number of patients in hospitals	Hospitals, schools, public places, municipal facilities, athletic facilities
		Extreme Precipitation	- Damages in social facilities	Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities
		Forest fires	- Damages in social facilities	Hospitals, schools, public places,

				municipal facilities/infrastructure, athletic facilities
Built Environment	Building stock and material	Extreme heat	- Concrete's damages - Increased cooling demands - Higher maintenance costs - 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 - Higher maintenance costs	All building infrastructure in afflicted areas
		Extreme Precipitation	- Partial destruction of infrastructures	All building infrastructure
		Forest fires	- Fire in buildings.	All building infrastructure
Economy	Tourist	Extreme heat	- Increased demand for cooling - Lower touristic flows during the impacted seasons - Higher water demand	Tourists, tourist infrastructure, tourist related economy
		Landslides	- Lower touristic flows - Damages in touristic infrastructure	Tourists, tourist infrastructure, tourist related economy
		Droughts	- Increased pressure on water resources, escalating water scarcity issues - Increased water supply costs	Tourists, tourist infrastructure
		Floods	- Damages in touristic infrastructure and related costs for repairs	Tourists, tourist infrastructure
		Extreme Precipitation	- Reduced the length of tourist season	Tourists, tourist infrastructure, tourist related economy

		Forest fires	- Destruction of tourist facilities. - Lower touristic flows	Tourists, tourist infrastructure, tourist related economy
	Agriculture	Extreme heat	- Changes in growth cycle - Damages / loss of harvest - Livestock loss and impacts on health - Lower crop yields	Farmers, food industry, consumers
		Landslides	- Damages / loss of harvest in afflicted areas / loss of livestock - Potential property loss in afflicted areas - Loss of soil resources	Farmers, food industry, consumers
		Droughts	- Damages / loss of harvest - Lower crop yields - Livestock loss and impacts on health - Land degradation	Farmers, food industry, consumers
		Floods	- Damages / loss of harvest in afflicted areas / loss of livestock	Farmers, food industry, consumers
		Extreme Precipitation	- Destruction of food crops.	Food industry
		Forest fires	- Lower crop yields.	Farmers, food industry
Biodiversity	Coastal zone ecosystems	Extreme heat	- Increased coral bleaching - Migration of coastal species towards higher altitudes - Reduction of vulnerable fishing stock - Altered flora and fauna, new and invasive species	Ecosystem, fish industry, consumers
		Landslides	- No effects	- No effects
		Droughts	- Increase of coastal water salinity - Loss of species - Altered flora and fauna, new and invasive species	Ecosystem
		Floods	- Loss of species - Altered flora and fauna, new and invasive species	Ecosystem

		Extreme Precipitation	- Cut down trees	Forest and private trees
		Forest fires	- Reduce the green and forest areas.	Forest and private trees

4.5.2 Risk Assessment

Table 67 below illustrates the results of risk assessment and impact on vulnerable sectors.

Table 67: Risk assessment

Receptors		Weather Sensitivity	Future Risk	Impact
Population	Public Health	Extreme heat	- Increased number of deaths - Reinforcement of heat stress - Increased infectious diseases - Altered allergic patterns - Chronic respiratory diseases - Vector Born Diseases (VBD) - Skin diseases Melanoma and sunburn	Medium
		Landslides	- Increased number of injuries and deaths - More respiratory problems	Medium
		Droughts	- Increased allergic incidents - Decreased air quality - More respiratory problems - Consumption and use of unsafe (contaminated) water for drinking due to water scarcity - Malnutrition - Food shortages	Medium
		Floods	- Limitations to the healthcare access - Increased numbers of injuries and deaths - Epidemics of water and foodborne diseases	Low

		Extreme Precipitation	- Increased number of deaths - Reinforcement of heat stress - Increased infectious diseases - Altered allergic patterns - Chronic respiratory diseases - Vector Born Diseases (VBD)	Medium
		Forest fires	- Increased number of injuries and deaths - More respiratory problems.	High
Infrastructure	Transport	Extreme heat	- Damages on road network - Modification of transport frequency and means - Air quality problems - Higher maintenance costs	Medium
		Landslides	- Damages on road network - Modification of transport frequency and means - Higher maintenance costs	Medium
		Droughts	- Difficult transport of bulk material	Medium
		Floods	- Damages - Mobility problems	High
		Extreme Precipitation	- Damages on road network - Modification of transport frequency and means - Higher maintenance costs	High
		Forest fires	- Difficult transport of bulk material.	Low
	Energy	Extreme heat	- Blackouts and inability to cover demand load - Damages, especially in the thermal power plants	High
		Landslides	- Damages in the transmission and distribution grid - - Damages in any power generating plants, including RES (PVs) in afflicted areas	Medium

		Droughts	- Blackouts and inability to cover demand load - Higher maintenance costs - Cooling problems in power plants	Medium
		Floods	- Damages / power cuts	Medium
		Extreme Precipitation	- Damages in the transmission and distribution grid - Damages in any power.	High
		Forest fires	- Damages in the transmission and distribution grid - Damages in any power generating plants, including RES (PVs) in afflicted areas	High
	Water	Extreme heat	- Water scarcity - Water quality issues	High
		Landslides	- Water scarcity due to infrastructure damages - Water quality issues due to infrastructure damages	Medium
		Droughts	- Water scarcity - Water quality issues	Medium
		Floods	- Increased damages and related maintenance costs - Water management issues - Water quality issues	Low
		Extreme Precipitation	- Water scarcity - Water quality issues	Medium
		Forest fires	- No expected risks	- No expected risks
	Social	Extreme heat	- Increased needs for air conditioned public spaces	Medium
		Landslides	- Damages - Mobility problems - 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 - Inability to cover the water demand - Difficulties in the operation of certain facilities due to lack of water (e.g. swimming pools)	Medium
		Floods	- Damages - Increased maintenance costs - Flooding at the city level of the afflicted public building infrastructure (schools, hospitals, etc.) - Difficulties in providing the envisaged services	Low
		Extreme Precipitation	- Damages	Medium
		Forest fires	- Increased needs for protected places.	High
Built Environment	Building stock and material	Extreme heat	- Concrete's damages - Increased cooling demands - Higher maintenance costs - Urban heat island effect	Low
		Landslides	- Damages	Low
		Droughts	- Higher water demand	Medium
		Floods	- Damages - Increased maintenance costs	Medium
		Extreme Precipitation	- Concrete's damages. - Infrastructure Damages	Medium
		Forest fires	- Damages	High
Economy	Tourist	Extreme heat	- Change of the tourism season – lower touristic flows - Reduction of the tourism related economy	Medium
		Landslides	- Potential damage to touristic infrastructures and sites	Low

		Droughts	- Increased water supply costs - Potential increase of indirect costs for the tourists (infrastructure related) and reduction of touristic flows	Low
		Floods	- Damages to touristic facilities - Potential effects on the touristic flows, in areas with flooding history	High
		Extreme Precipitation	- Change of the tourism season – lower touristic flows - Reduction of the tourism related economy	Medium
		Forest fires	- Reduce the touristic flows	Medium
	Agriculture	Extreme heat	- Changes in growth cycle - Damages / loss of harvest - Livestock loss and impacts on health - Lower crop yields - Increased fire risks	High
		Landslides	- Damages/ loss of harvest - Loss of soil and reduction of cultivated lands	Medium
		Droughts	- Damages / loss of harvest - Lower crop yields - Livestock loss and impacts on health - Land degradation - Increased fire risks	High
		Floods	- Damages/ loss of harvest in afflicted areas - Livestock loss - Surface soil erosion	High
		Extreme Precipitation	- Damages/ loss of harvest. - Loss of soil and reduction of cultivated lands	High
		Forest fires	- Damages/ loss of harvest.	High
Biodi..	Green zones/ Forests	Extreme heat	- Fires and destruction of the ecosystem, flora and fauna	High

		Landslides	- Destruction of agricultural lands	Medium
		Droughts	- Fires and destruction of the ecosystem, flora and fauna	High
		Floods	- Soil erosion	High
		Extreme Precipitation	- Destruction of agricultural lands	Low
		Forest fires	- Reduce the green zones	Medium

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 68 below focuses on a set of suggested adaptation actions on the population and public health.

Table 68: Suggested adaptation actions for population and public health

Actions' characteristic	Adaptation Actions
Strategic	Improved understanding of the potential risk on health sector due to climate change
	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

a) Understanding of the potential risk on health sector due to climate change

This program aims at enhancing collective knowledge about the potential and observed impacts of climate change on health conditions for individuals and communities. The program measure should mobilize related institutions and experts to conduct studies and observations of climate impacts on health in terms of changing climate conditions or the emergence of climate related infectious diseases in Ajloun. Key measures to be applied under this program include:

- Building the needed capacities to conduct health vulnerability assessments
- Educating and informing the public of the needed measures to protect health from the adverse impacts of climate change
- Developing climate-informed disease control program and surveillance systems using meteorological services to target vector control in time and space
- Introducing new indicators that are useful for protecting health, such as Air Quality Index, UV index, in cooperation with the relevant institutions
- Developing new methods and tools for preparing for, coping with, and recovering from outbreaks of climate-sensitive diseases, such as early warning systems based on environmental information

b) 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.

c) 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 consider 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 Ajloun municipality.

d) 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.

e) 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.

4.6.2 Infrastructure

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

Table 69: Suggested adaptation actions for infrastructure

Actions' characteristic	Adaptation Actions
Strategic	Regulations and incentive measures in residential buildings
	Plan for a network of public chargers for electric vehicles
	Modelling predicted supply changes in the electricity from the locally available RES
Alert / Communication	Improving rainfall early warning systems and reducing flood risks

Technical	Promote water-harvesting techniques at all levels of economic development and water use (buildings, agriculture, industry, etc…) based on suitable local conditions.
	Promote the use of non-conventional water sources especially treated wastewater for non-domestic water use and harvest rainwater in the urban areas from rooftops and greywater reuse both at the institution level and at household level to support vulnerable households and communities

a) Regulations and incentive measures in residential buildings

This action involves a wholistic approach to ensuring that new residential buildings are sustainable and go beyond current national standards, including: Energy efficiency and renewable energy measures in new residential constructions, namely:
1. Building regulations that consider energy use in new constructions / major renovations of existing buildings (residential buildings) – going beyond the requirements of national legislation
2. Encouraging through financial support the use of renewable energy / efficient energy sources (residential buildings) - Typical measure usually includes solar PV or water heating, or biomass, or heat pumps.

b) Plan for a network of public chargers for electric vehicles

The aim of this measure is to support the planning of charging stations for electric vehicles (EV) in a city in which the objective is to maximize the number of serviced vehicles under a fixed budget for building the stations. Accelerated electric vehicles adoption gives local governments and municipalities the chance to meet sustainability goals, reduce the carbon emissions, and attract more visitors to the community. Furthermore, according to the Free Zones Vehicle Sector, in 2022, the demand for electric vehicles has risen by 250 percent, compared with last year. The demand for the electric vehicles will increase next year, noting that the market share of electric vehicles was 30 percent of the total of vehicles cleared in 2022. Therefore, establishing Electric charging stations is a must to encourage the municipality's residents to buy electric vehicles and to cover the increasing numbers during the next few years.

c) Modelling predicted supply changes in the electricity from the locally available RES

A certain part of electricity consumption in Ajloun, 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.

d) rainfall early warning systems

The programs aims at addressing one of the major acute threats of climate change in Jordan which is represented by the increasing frequency of flashfloods due to heavy and erratic rainfall that caused immediate risks on lives, livelihoods, economic assets and infrastructures. With such phenomena expected to increase in the future it is important to address this risk systematically.

e) Promote water-harvesting techniques

Water is a key resource for all developmental activities especially agriculture, industry and healthcare. In a future where climate change will multiply the expected scarcity of water resources due to increased population growth and economic development, it is essential that water efficiency measures become a necessary approach in water management to enhance climate resilience and improve productivity of water use. Key measures to be applied under this program include:

- Introducing water saving technologies in irrigation schemes such as drip, micro-spray, and night irrigation with careful consideration of environmental impacts on soil salination.
- Enhancing the use of water efficiency technology at household and business levels in urban and rural settings
- Enhancing the adaptive capacity of small farmers through water user associations for increasing use of reclaimed water for irrigation purposes.
- Increasing community awareness, behavioral change and adoption of water conservation measures through WASH centered community behavioral change initiatives.

f) Promote the use of non-conventional water sources and harvest the use of rainwater in urban areas

This program aims to increase the contribution on non-conventional water resources for augmentation of freshwater resources for irrigation, industrial and domestic use. This contribution will help to save more freshwater resources for drinking and sanitation practices that are associated with life at a warmer and more disease prone world.

4.6.3 Built Environment

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

Table 70: Suggested adaptation actions for built environment

Actions' characteristic	Adaptation Actions
Strategic	Improving readiness for climate related disaster risk reduction in urban areas

	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	Supporting urban green infrastructure interventions for climate resilience
	Improving building efficiency for adapting to increased heat in urban centers.
	Adoption of methods to reduce water demand

a) *Improving readiness for climate related disaster risk reduction*

This program aims at enhancing institutional readiness of municipalities and community organization to anticipate and manage climate related disaster and risks, especially in the form of floods in urban areas. This program include mapping of flood prone areas in cities and designing alternative runoff routes to minimize risks.

b) *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.

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

Ajloun 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 Ajloun 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.

d) *Supporting urban green infrastructure interventions for climate resilience*

This program aims at introducing and applying green infrastructure measures in urban areas to address climate change vulnerability and impact through sustainable interventions at neighborhood levels with community participation. One of the key measures is to introduce climate responsive building techniques and elements to reduce the effect of heat and reduce demand on energy for cooling and to promote Rainwater Harvesting in urban areas from rooftops.

e) Improving building efficiency for adapting to increased heat in urban centers

This program aims at improving the building resilience to climate change impacts through better insulation, sustainable cooling and energy efficiency measures among other interventions. The program requires modifications in building codes and other policy and regulatory approaches to improve efficiency in buildings.

f) Adoption of methods to reduce water demand

Since water scarcity is a major problem for Jordan in general, and Ajloun 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.

4.6.4 Economy

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

Table 71: Suggested adaptation actions for economy

Actions' characteristic	Adaptation Actions
Strategic	Enhancing local adaptive capacity to climate change impacts through local climate action plans
	integrating climate adaptation into national poverty reduction policies
Educational	Integrating climate change impacts and adaptation into education curricula
Technical	Improving irrigation system efficiency
	Improving sustainable productivity of food chains

a) Local climate action plans to enhance the local adaptive capacity

This program aims to increase local capacities at institutional and individuals' levels to undertake local climate vulnerability analyses and develop, in a community participation approach local climate adaptation plans at municipal and/or governorate levels. The program ensures engagement of local community in planning and designing of local climate change adaptation plans (community participatory approach). Moreover, it will enhance climate related basic services to

rural and vulnerable communities to reduce the negative impact of expected climate change effects.

b) integrating climate adaptation into national poverty reduction policies

This program aims to highlight the importance of addressing climate resilience and climate adaptation measures in socioeconomic development plans with special emphasis on poverty reduction plans and improving services and sustainable livelihoods for communities in poverty-stricken areas.

c) Integrating climate change impacts and adaptation into education curricula

This program will ensure that climate change is incorporated from an early age to ensure that communities are equipped to adapt to the impacts of climate change. The program will Raise the awareness through formal and informal education means in climate change, environment and sustainable development in the community and among children and young people. In addition to Develop an enhanced, unified, common entry level education curriculum that includes new themes on climate change and environment.

d) Improving irrigation system efficiency

Enhancing the efficiency of irrigation systems is the most important objective of a climate resilient agriculture in Jordan. This program aims to enhance this effectiveness through various interventions at policy and practice levels. Key measures to be applied under this program include

1. Develop a soil-water-plant monitoring program (e.g. crop/environment forecasting, RS and GIS, lysimetric, etc)
2. water harvesting techniques, maximizing treated waste water re-use in agriculture, improving water use efficiency and the augmentation of drip irrigation in irrigated areas
3. Improving soil water storage and retention to maximize plant water availability by maximizing infiltration of rainfall
4. Use of supplemental irrigation from harvested rainwater in the critical stages of crop growth achieved through on farm rainwater harvesting and management system
5. Reduce soil erosion through community management, use of Ecosystem based Adaptation (EbA) measures and harvesting of rainwater amongst small farmers in rural areas

e) Improving sustainable productivity of food chains

This program aims to improve the contribution of agricultural sector to food security and self-sufficiency under climate change conditions and against emergency conditions. The program targets the agricultural production and marketing value chain to ensure the continuity of affordable and sufficient food production to domestic markets while adapting to climate related challenges. Which could be achieved by Promoting efficiencies in the food chain and the reduction of post-

harvest losses and food waste in a sustainable manner, increasing the efficiency of nitrogen use, improving livestock productivity.

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 72: Suggested adaptation actions for Biodiversity

Actions' characteristic	Adaptation Actions
Strategic	Improving conservation measures and enforcement for climate threatened species and habitats
	Establishment of a fire management plan
Technical	Trees planting

a) Improving conservation measures and enforcement for climate threatened species and habitats

This program aims at identifying the key climate sensitive habitats and species in Ajloun and developing special conservation measures that take into considerations changes in climate conditions and niches of the different sensitive species to protect them from extinction. The program involves updating and identifying key ecosystems that are highly sensitive to climate change, establishing a clear research design to target indicator species of fauna, flora and ecosystems in order to better understand the climate effects and apply adaptation measures, and developing a recovery and restoration plans for highly threatened ecosystems and species of fauna and flora including the development of clear ex-situ conservation, captive breeding program and re-introduction and restoration program.

b) Establishment of a fire management plan

The municipality will adapt a firefighting plan in order to prevent the negative effect of the fire and conduct a quick control on the fire.

c) 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 will reduce more the greenhouse gasses. This action illustrated as an action in mitigation section.