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MINARET II

Empowering Municipal Governance for Climate Resilience Using WEF Nexus Approach

Sustainable Energy and Climate Action Plan (SECAP)

As Semqanieh 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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List of Abbreviations

BAU: Business as Usual
BEI: Baseline Emissions Inventory
CoM: Covenant of Mayors
EF: Emission Factor
HDD: Heating Degree Days
ICCS: Institute of Communications and Computer Systems
IEA: International Energy Agency
IPCC: Intergovernmental Panel on Climate Change
LPG: Liquefied Petroleum Gas
MEW: Ministry of Energy and Water
NERC: National Energy Research Center of Jordan
RSS: Royal Scientific Society.
SECAP: Sustainable Energy and Climate Action Plan
ME: Ministry of Environment.

Executive Summary

Semqanieh lies 45 kilometers southeast of Beirut. Its altitude ranges between 850 m and 950 m high. Bordering towns include Jdaidet Al- Chouf, Ain WaZein, and Mokhtara. Semqnieh is considered to be a tourist attraction in the Chouf area, containing many water springs and various plantation, which is managed by the Al-Chouf Cedar Society in cooperation with the Lebanese Ministry of Environment, UNDP and the World Conservation Union.

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

Al Semqanieh municipality has committed to a 40% reduction of the municipality's GHG emissions as well as to an adaptation in climate change 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. Within the framework of potential participation in the Covenant of Mayors for Climate and Energy Initiative, the scenario of mitigation actions has been developed for Semqanieh, reaching up to 40% against the calculated 2030 emissions (70,933.72 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 (40%), all actions will cost 20,535,680 EURO approximately from all entities (municipality, private and external funding).

The energy balance for Semqanieh Municipality (Baseline Emissions Inventory) has been developed for 2018, in line with the CoM guidelines and utilizing the IPCC emission factor approach, for all the compulsory sectors and one optional, mainly:

A. Buildings, Equipment & Facilities
   - Municipal Buildings, Equipment and Facilities
   - Public lighting
   - Residential buildings
   - Tertiary buildings, equipment and facilities (non-municipal)
   - Water and wastewater facilities.
B. Transport
   - Municipal fleet
   - Public transport
   - Private and Commercial transport
C. Solid waste management.
D. Livestock breeding.

Although the agricultural sector is a significant contributor in the municipality's economy, it wasn't possible to identify separately reliable data on its energy consumptions, so as to include it

in the Baseline Emission Inventory (BEI). To this end, it has been studied as part of the tertiary sector.

The highest energy consumer is the Residential sector, followed by the industrial sector and tertiary sector, while the municipal sector consumption is the lowest. The total energy consumption in Semqanieh Municipality is presented in the following chart:

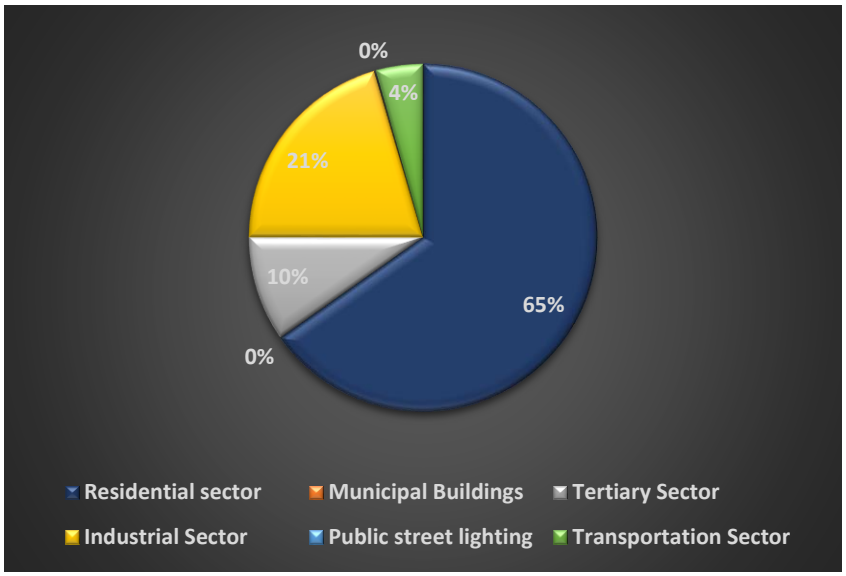


Figure 1 *Energy consumption per sector in Semqanieh Municipality*

The Municipality, including the Municipal Buildings, the Public Lighting and the Municipal fleet consumes 471 MWh, while the public street lighting has the most significant contribution, as presented in Figure 2.

A more detailed allocation of the calculated energy consumption in Semqanieh Municipality (All sectors) is presented in Figure 3 per sector and per fuel.

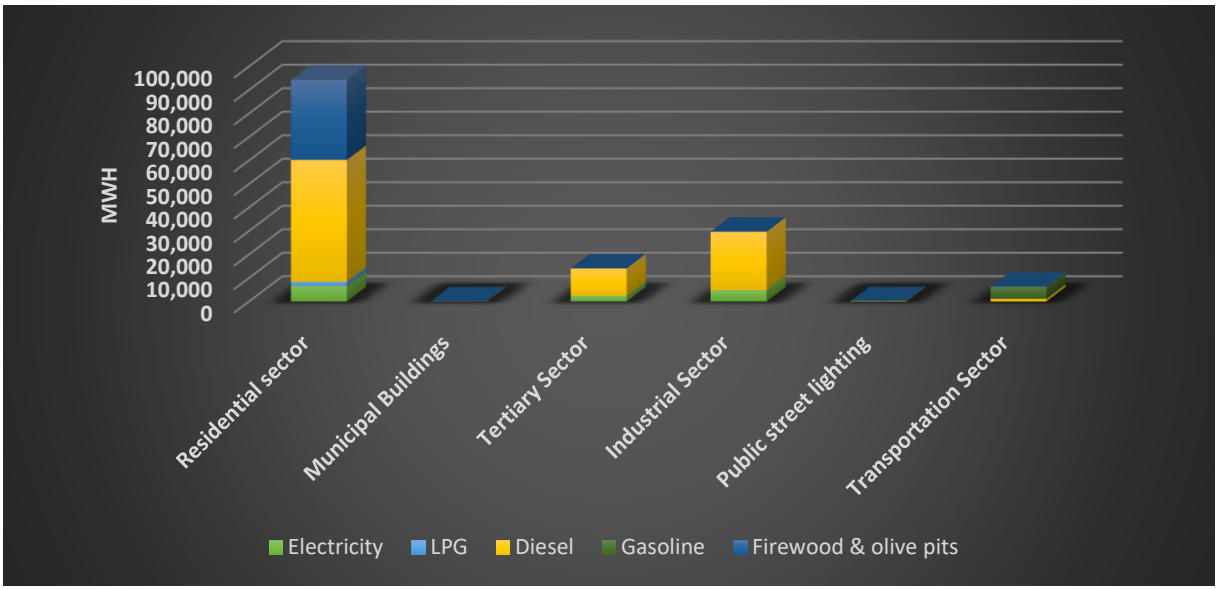


Figure 2 *Energy consumption per sector and per fuel*

The respective total emissions for the baseline year was equal to 49,604 tn CO2 and they are presented in the following chart.

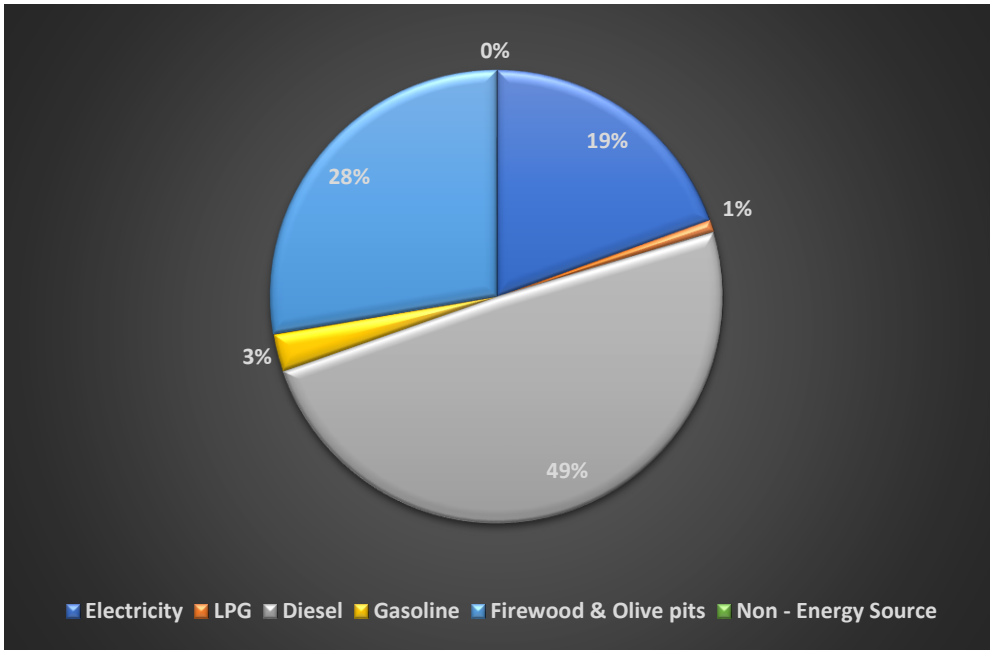


Figure 3 *Total CO_2 emissions per Fuel type*

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

Lebanon, 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 70,933.72 tn CO2, as mentioned above.

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

Table 1 summary of the mitigation actions

Action No.	Action	Emission Reduction (tn CO2)
Municipal Buildings		
3.2.1	Green procurement procedures for municipal buildings	3.32
3.2.2	Replacing the existing non-efficient lamps with LED Lamps Semqanieh municipal buildings	5.60
3.2.3	Energy manager appointment in the municipality	0.17
3.2.4	Awareness raising activities for municipal employees	0.62
3.2.5	PVs in municipal building's roof	41.5
3.2.6	Establishment of Energy Saving Department	0.0
3.2.7	Social media portal creation portal creation	0.0
Sub-Total		51.21
Street Lighting		
3.3.1	Street lighting upgrade	90
3.3.2	Astronomical timers	30
Sub-Total		120
Residential buildings		
3.4.1	Awareness raising activities for the community about (RE &EE)	1,483.6
3.4.2	Promotion of Green Buildings' concept	3,838.1
3.4.3	Campaign for promoting and replacing high energy label equipment	4,031.6
3.4.4	3.6 MW Photovoltaics in residential rooftops	3,547.8
3.4.5	Replacing existing electric water heater with solar collectors	1,612.6
3.4.6	Replacement of old diesel space heater with more efficient	6,450.6
3.4.7	Use of insulation bricks in rooftops	246.7
3.4.8	Replacement of single glazing with double	967.6
Sub-Total		22,178.6
Tertiary Sector		
3.5.1	Promotion of using insulation for buildings	507.82
3.5.2	Photovoltaics on rooftops	1500
3.5.3	Replacement of existing lamps with LEDs	59.95
3.5.4	Replacement of single glazing with double	142.38
3.5.5	Replacement of existing air conditioners with more efficient ones	14.24
3.5.6	Installation of lighting motion sensors	7.12

3.5.7	Awareness raising activities about RE&EE	173.23
3.5.8	Use of Solar Water Heaters	14.24
3.5.9	PV for WWTP	28.48
3.5.10	PV for water pumping station	6.17
3.5.11	The 100% commitment campaign for schools for PV	3.8
3.5.12	Upgrade water facilities	14.24
Sub-Total		2,471.67
Transport Sector		
3.6.1	Information events on the new vehicle technologies- Replacement of diesel vehicles with new more efficient	39
3.6.2	Traffic congestion reduction through the adoption of different timing of activities	12.12
3.6.4	Promotion of walking and car sharing and carpooling campaigns	97.3
3.6.5	Improvement / development of parking infrastructure	24.4
3.6.6	promotion of using schools' buses rather than private cars	12.12
3.6.7	awareness campaign for preventive maintenance for cars	12.12
3.6.8	Eco-driving for public transportation	73.37
3.6.9	Cycling promotion and creation of related infrastructure	60.61
Sub-Total		331.04
Local Renewable Energy Production		
3.7	PV Farm 300kW	353.3
Sub-Total		353.3
Waste management		
3.8.1	Awareness raising campaigns to reduce the amount of discarded food.	46
Sub-Total		46
Agriculture Sector		
3.9.1	Planting Trees	1,085
Sub-Total		1,085
Total		26,636.82

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 Semqanieh 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. Lebanon has already launched the "Lebanon's Third National Communication on Climate Change" report in 2016, which is dealing with the above-mentioned topic. The national targets presented on this report are consistent with the SECAP actions. The total estimated budget for this set of actions is more than 20,636.82 Euro. An overview table of the actions per sector is presented below.

Table 2 Adaptation Actions

Public Health	Infrastructure	Built Environment	Economy	Biodiversity
Health action plan for the extreme events that Semqanieh is facing e.g. heat etc. (heat health action plan) - Collaboration with the regional medical services to increase preparedness level	Water management plan	Enforcement of building codes formore energy efficient and heat tolerant structures	Elaboration of water and ground water management plan	Establishment of a fire management plan
Provide access to hated 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.)	Modelling predicted supplychanges in the electricity from the locally available RES	Integrated land use planning withzoning system depending on the different areas	Adoption of integrated land use planning for the tertiary sector	Educating thecitizens
Developing an early warning system to alert citizens in the case of extremeweather events	Mapping of siteswith landslides and flood risks	Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises		
Educational and awareness raising campaigns about health-related	Developing guidesand awareness raising campaignsfor citizens on how	Greening infrastructure such as buildings'roofs and walls		

effects of extreme events	to save water and energy,especially during crisis			
Regular cleaning and maintenance of the sewage and drainage system	Support rainwater harvesting systems	Increasing the amount of shade and green areas in the city by planting trees and using green pavements to reduce the heat island effect		
Frequent monitoring of water and air quality		White roofs (cool colors), shading and bioclimatic design. Rainwater collection and use. Adoption of methods to reduce waterdemand. Using water resistant construction materials.		Trees planting

Chapter 1: Introduction

1.1 Al-Semqanieh 2030 Targets

The overall national target for Lebanon that has been set for 2030 is 30% CO2 emissions reduction (according to the Intended Nationally Determined Contributions - INDCs). The second scenario developed focuses on achieving an emission reduction of 40% according to CoM requirements within boarders of Semqanieh Municipality. Under both scenarios, emphasis is placed on working closely with all community actors. The municipality will take all necessary measures on its facilities, establishing a good example for the community, while it will put efforts on collaborating with the public and achieving significant reductions from the residential, tertiary and transport sectors, with waste being also a priority for the local administration. The target of 40% is more challenging and there will be need of more intensive efforts from the Municipality and the Governmental Bodies while it is of utmost importance to attract more donors and funds.

1.2 Current Status

1.2.1 Geographical Location

Al-Semqanieh is a town located in the Chouf District of the Mount Lebanon Governorate, about 45 kilometers (28 mi) southeast of Beirut. Its altitude ranges between 850 m – 950 m high. Bordering towns include Jdaidet El Chouf, Ain waZein, and Mokhtara.

Figure 4 Al-Semqanieh map

Its most important water springs are: Al-Daya spring, Al Sofli spring, Al-Ghazar spring, Al-Souq spring and Marj al-Semqanieh spring. Its plantations are fruit trees and vines.

Figure 5 One of the most important springs in Semqanieh.

1.2.1 Climate Characteristics

Since there is a lack of weather data for Semqanieh area, the weather data for the nearest available area "Beit ed Dine City" were taken to be representative for Semqanieh.

In Beit ed Dine, the summers are long, warm, arid, and clear and the winters are cold, wet, and partly cloudy. Over the course of the year, the temperature typically varies from 4°C to 27°C and is rarely below 1°C or above 30°C.

The warm season lasts for 4.0 months, from June 7 to October 6, with an average daily high temperature above 24°C. The hottest month of the year in Beit ed Dine is August, with an average high of 27°C and low of 19°C.

The cold season lasts for 3.3 months, from December 6 to March 15, with an average daily high temperature below 14°C. The coldest month of the year in Beit ed Dine is January, with an average low of 5°C and high of 11°C.

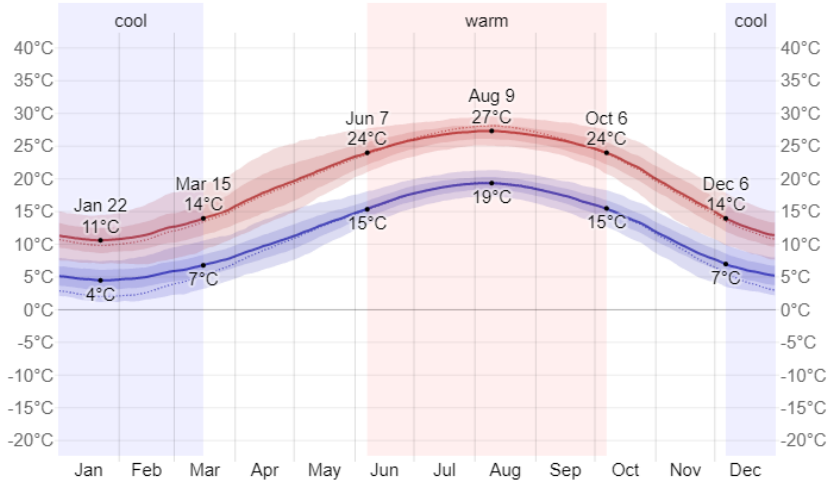


Figure 6 Temperature chart for Semqanieh

Figure 7 below shows you a compact characterization of the entire year of hourly average temperatures. The horizontal axis is the day of the year, the vertical axis is the hour of the day, and the color is the average temperature for that hour and day.

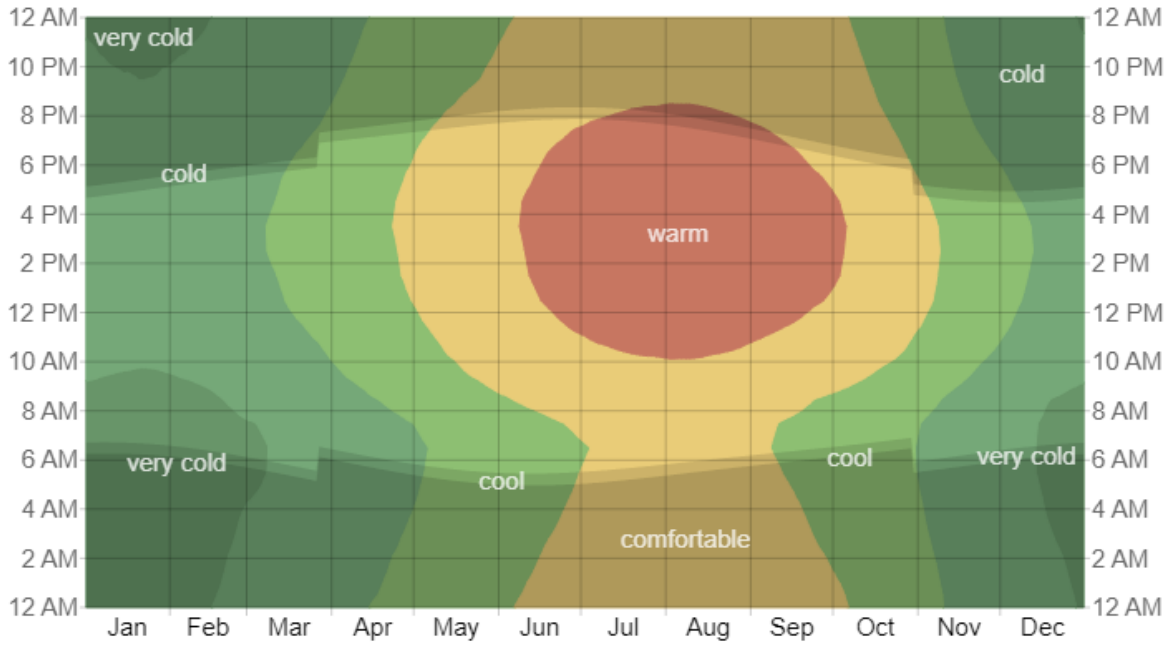


Figure 7 The compact characterization of the entire year of hourly average temperatures for Semqanieh

Clouds

In Beit ed Dine, the average percentage of the sky covered by clouds experiences significant seasonal variation over the course of the year.

The clearer part of the year in Beit ed Dine begins around May 14 and lasts for 5.1 months, ending around October 19.

The clearest month of the year in Beit ed Dine is July, during which on average the sky is clear, mostly clear, or partly cloudy 100% of the time.

The cloudier part of the year begins around October 19 and lasts for 6.9 months, ending around May 14.

The cloudiest month of the year in Beit ed Dine is January, during which on average the sky is overcast or mostly cloudy 42% of the time.

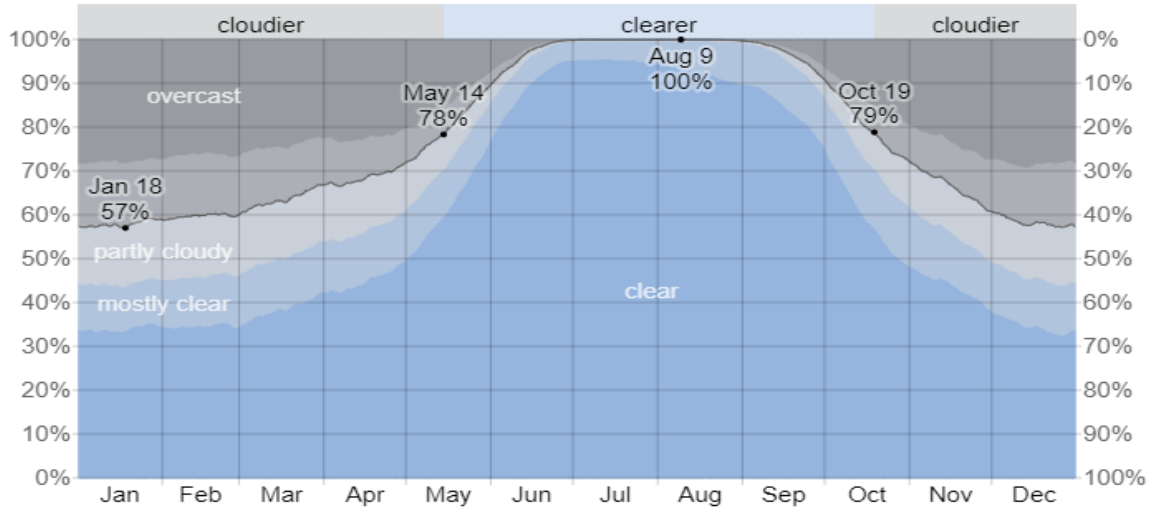


Figure 8 Cloud cover for Semqanieh

Precipitation

A wet day is one with at least 1.00 millimeters of liquid or liquid-equivalent precipitation. The chance of wet days in Beit ed Dine varies significantly throughout the year.

The wetter season lasts 5.0 months, from October 29 to March 29, with a greater than 15% chance of a given day being a wet day. The month with the most wet days in Beit ed Dine is January, with an average of 8.9 days with at least 1.00 millimeters of precipitation.

The drier season lasts 7.0 months, from March 29 to October 29. The month with the fewest wet days in Beit ed Dine is July, with an average of 0.0 days with at least 1.00 millimeters of precipitation.

Among wet days, we distinguish between those that experience rain alone, snow alone, or a mixture of the two. The month with the most days of rain alone in Beit ed Dine is January, with an average of 8.7 days. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 30% on January 17.

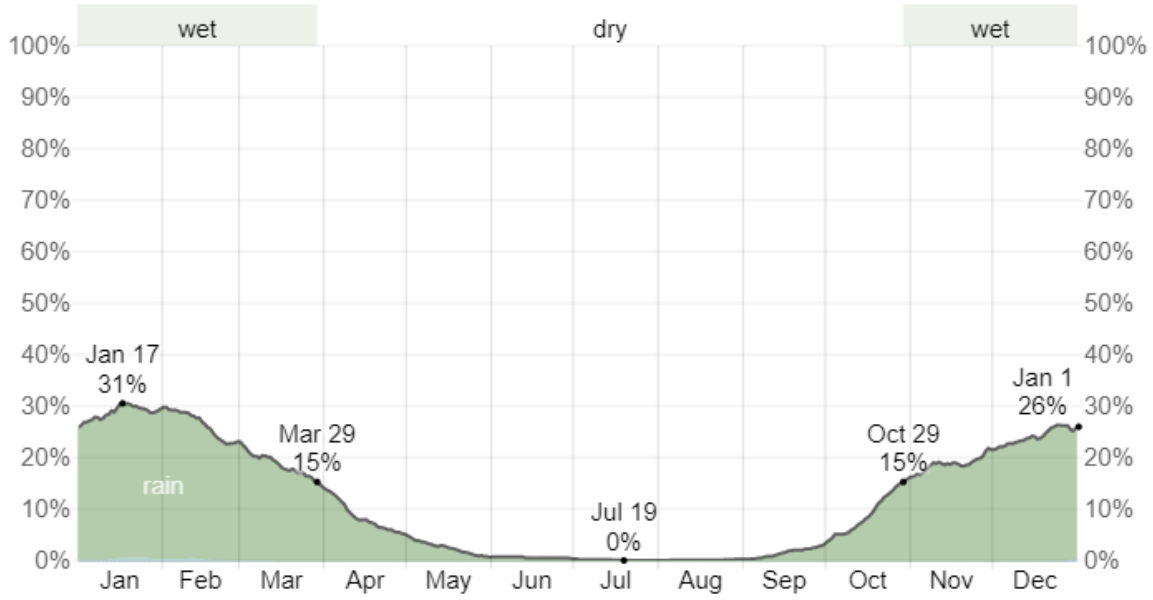


Figure 9 Daily chance of precipitation

Rainfall

To show variation within the months and not just the monthly totals, we show the rainfall accumulated over a sliding 31-day period centered on each day of the year. Beit ed Dine experiences significant seasonal variation in monthly rainfall.

The rainy period of the year lasts for 6.3 months, from October 11 to April 20, with a sliding 31-day rainfall of at least 13 millimeters. The month with the most rain in Beit ed Dine is January, with an average rainfall of 73 millimeters.

The rainless period of the year lasts for 5.7 months, from April 20 to October 11. The month with the least rain in Beit ed Dine is August, with an average rainfall of 0 millimeters.

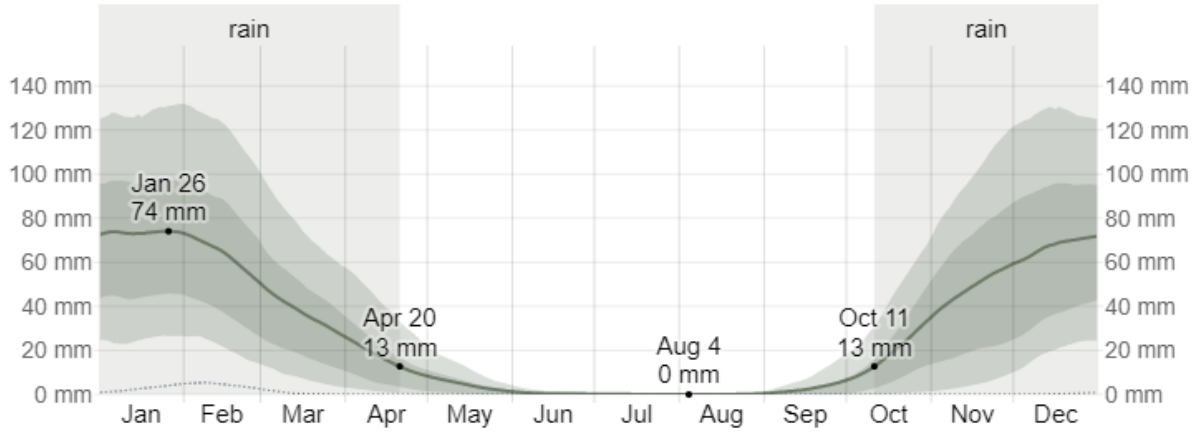


Figure 10 Average monthly rainfall.

Humidity

We base the humidity comfort level on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

Beit ed Dine experiences significant seasonal variation in the perceived humidity.

The muggier period of the year lasts for 2.6 months, from July 2 to September 19, during which time the comfort level is muggy, oppressive, or miserable at least 10% of the time. The month with the muggiest days in Beit ed Dine is August, with 11.7 days that are muggy or worse.

The least muggy day of the year is March 5, when muggy conditions are essentially unheard of.

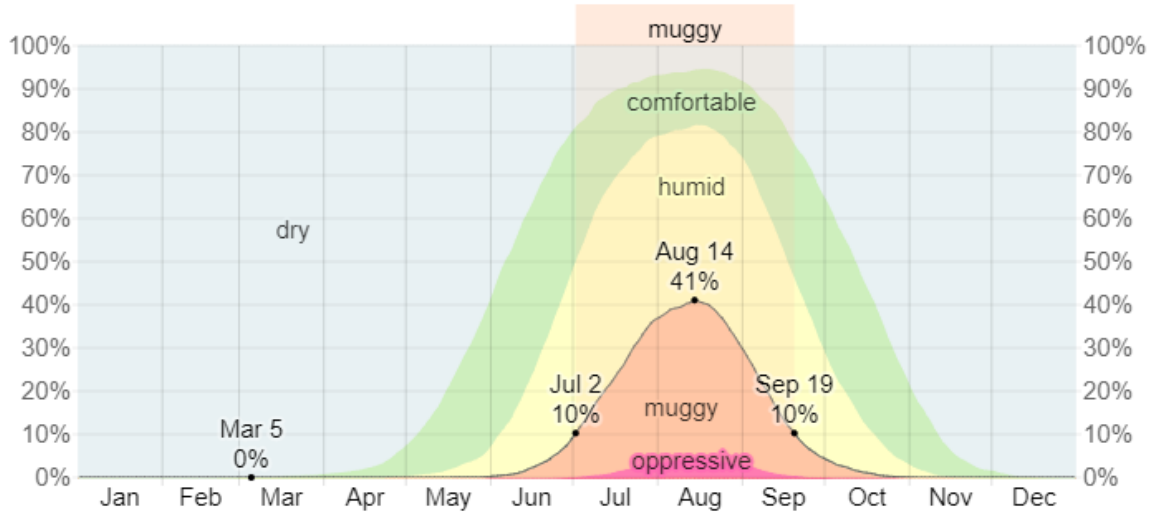


Figure 11 Humidity Comfort Levels

Wind

This section discusses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages.

The average hourly wind speed in Beit ed Dine experiences mild seasonal variation over the course of the year.

The windier part of the year lasts for 3.7 months, from December 13 to April 3, with average wind speeds of more than 3.3 meters per second. The windiest month of the year in Beït ed Dîne is February, with an average hourly wind speed of 3.8 meters per second.

The calmer time of year lasts for 8.3 months, from April 3 to December 13. The calmest month of the year in Beït ed Dîne is October, with an average hourly wind speed of 2.9 meters per second.

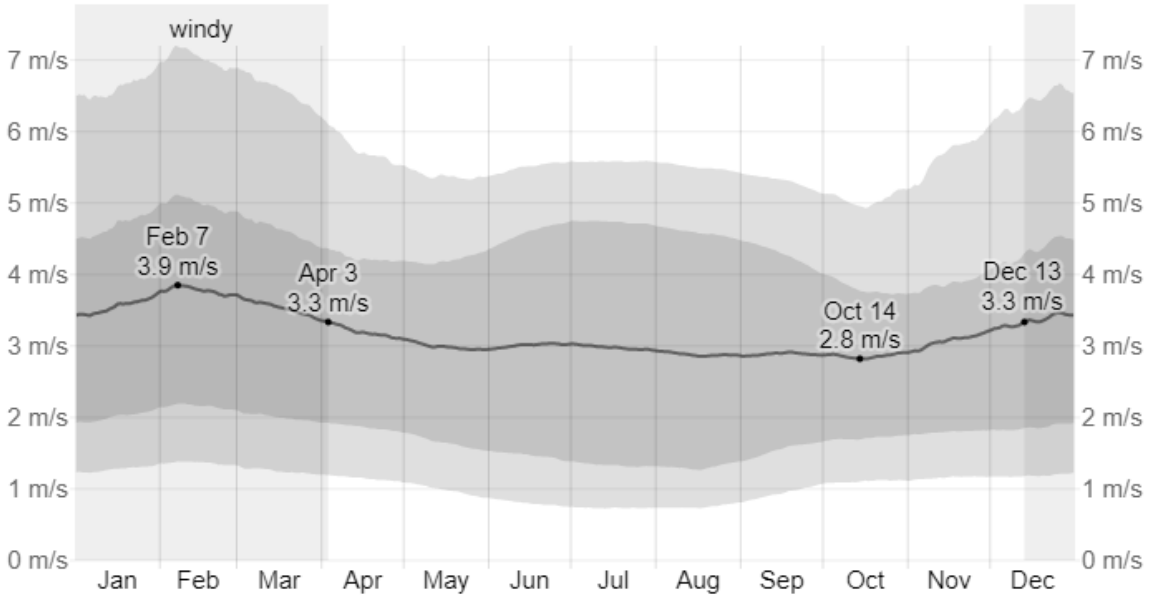


Figure 12 average wind speed for Semqanieh

The predominant average hourly wind direction in Beit ed Dine varies throughout the year.

The wind is most often from the east for 2.9 weeks, from November 12 to December 2, with a peak percentage of 32% on November 18. The wind is most often from the west for 11 months, from December 2 to November 12, with a peak percentage of 31% on January 1.

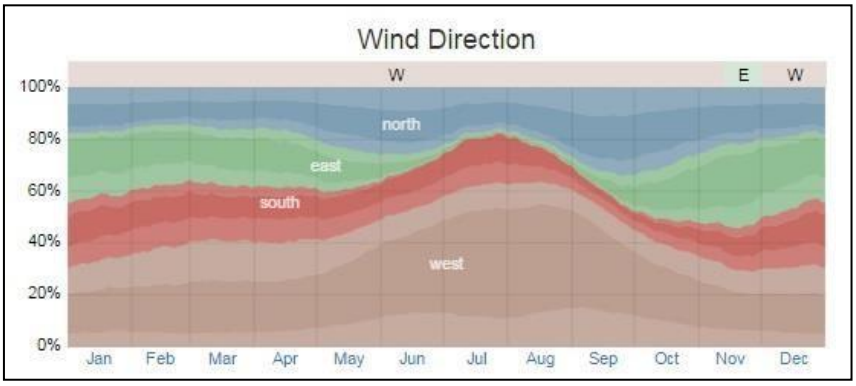


Figure 13 Wind direction for Al-Semqanieh.

Water Temperature

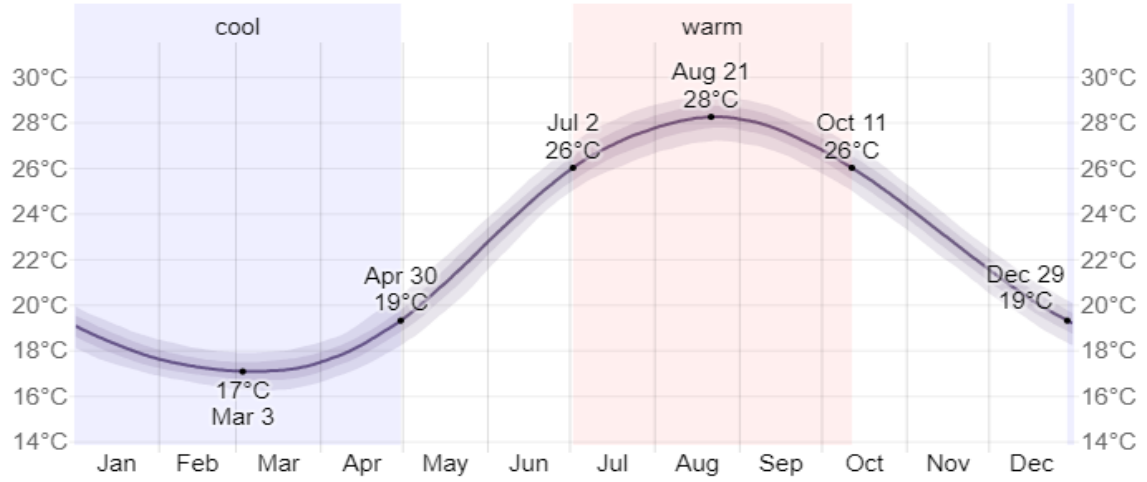
Beit ed Dine is located near a large body of water (e.g., ocean, sea, or large lake). This section reports on the wide-area average surface temperature of that water.

The average water temperature experiences extreme seasonal variation over the course of the year.

The time of year with warmer water lasts for 3.3 months, from July 2 to October 11, with an average temperature above 26°C. The month of the year in Beït ed Dîne with the warmest water is August, with an average temperature of 28°C.

The time of year with cooler water lasts for 4.0 months, from December 29 to April 30, with an average temperature below 19°C. The month of the year in Beit ed Dine with the coolest water is March, with an average temperature of 17°C.

Figure 14 Average Water Temp.



Solar Energy

This section discusses the total daily incident shortwave solar energy reaching the surface of the ground over a wide area, taking full account of seasonal variations in the length of the day, the elevation of the Sun above the horizon, and absorption by clouds and other atmospheric constituents. Shortwave radiation includes visible light and ultraviolet radiation.

The average daily incident shortwave solar energy experiences extreme seasonal variation over the course of the year.

The brighter period of the year lasts for 3.5 months, from May 8 to August 26, with an average daily incident shortwave energy per square meter above 7.5 kWh. The brightest month of the year in Beit ed Dine is June, with an average of 8.6 kWh.

The darker period of the year lasts for 3.4 months, from November 5 to February 17, with an average daily incident shortwave energy per square meter below 3.8 kWh. The darkest month of the year in Beit ed Dine is December, with an average of 2.7 kWh.

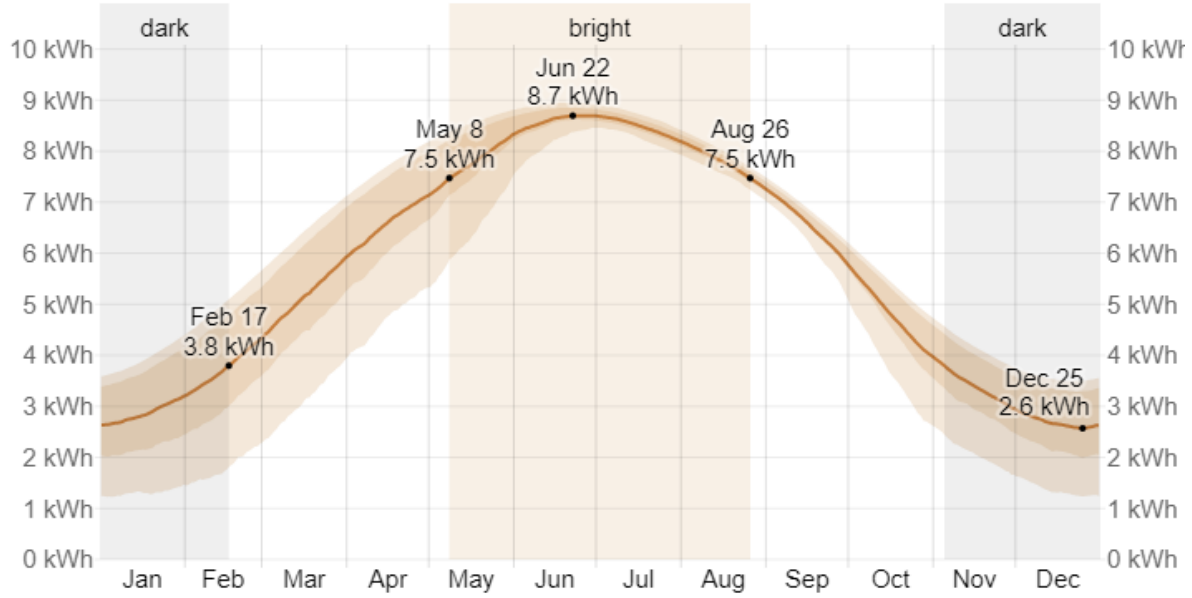


Figure 15 Average Solar Energy in Al-Semqanieh

1.2.2 Demographic Tendencies

According to the last population census of 1996, the population living in Al-Chouf Sweijani region (Semqanieh is town in Al-Chouf Sweijani) was 8,000. For the whole region, there is an annual increasing in population by a percentage of 1%.

The municipality estimated that the population for Semqanieh in 2018 is 17,000 citizens.

1.2.3 Employment

Based on the field statistics that was done in 2010, the employees who practice an economic activity in Al-Chouf Al-Sweijani region (Semqanieh is town in Al-Chouf Sweijani) comprise 33.82% of its population over 15 years of age, according to the most recent population census. In the part of economics active citizens there is a 5.43% that is currently unemployed and looking for a job.

1.2.4 Education

Regarding the educational status of Al-Chouf Al-Sweijani's citizens, a percentage of 27.15% of the total population was enrolled in the education in 1996, the majority of which (62.18%) was in primary education and only 22.76% in the highest education levels (Bachelor, Diplomas, Masters, PhD, etc.), The professionals were 7.01% and the illiterates were 6.64%.

There are five schools, one University & one Rehabilitation institute in Semqanieh Municipality.

1.2.5 Infrastructure

Electricity sector:

All villages in Al-Chouf Al-Sweijani region are connected with a general electrical line 220 volt. The electricity is not available all the time, whereas the minimizing may more than 18 hours during the day. And it turned out that 80% of the region's population have special electric generators.

Water sector:

Water resources in Semqanieh are from water ponds, local springs and artesian wells.

1.2.6 Economy

The agriculture and the tourism sectors are the most important economic sectors in Semqanieh. The agricultural land areas are 550 Acres, the neglected land areas are 350 Acres, Arid lands areas are 200 Acres. These statistics was done in 2005.

Al-Chouf Al-Sweijani region (Semqanieh is town in Al-Chouf Sweijani) is one of the most important regions that produce Olive trees and the average of the Olive trees in one Acres range from 15 to 20 trees. The other agricultural primary crops are fruits (Grape, pear, apple, cherries, Peaches, peach, Figs).

1.2.7 Complimentary with Municipal and National plans and Other Related Actions

Semqanieh's decision for the implementation of a SECAP study is in line with national legal framework, targets, and priority actions set. Abiding with the 30% emission reduction target by 2030 is consistent with the national target for that period, as expressed through the Intended Nationally Determined Contributions (INDCs) submitted to the UNFCCC.

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

Semqanieh is also planning for a number of Renewable Energy projects, either in its facilities, or promoting such initiatives in the private sector.

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

1.3 Vision for The Future

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

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

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 aren't adequate data for this year, as a baseline year should be considered the nearest year to 1990 for which there are complete and reliable data. Thus, for the Semqanieh Municipality the baseline year has been set to 2018, since it was the year with the most sufficient and reliable data available.

2.1.2 SECAP administrative body

Following a meeting of the consultant National energy Research Center (NERC) with the Semqanieh representatives, it was made clear that their wish for the SECAP is to cover the administrative boundaries of Al-Semqanieh municipality only.

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)
   - Water and wastewater facilities.
   - Industrial Sector

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

C. Solid waste management.
D. Livestock breeding.
E. Waste water treatment.

With regard to agriculture, although there is an agricultural activity in the region, it was not possible to separate the consumptions for this sector from the tertiary one, and especially the water pumping for irrigation.

2.1.4 Emission factors and Conversion rates

The emission factors which are used in this BEI were derived from the Covenant of Mayors Guidebook in Table 1. With the only exception of the electricity emission factor which depends on the energy mix of the country. It was not possible to acquire the electricity emission factor for Lebanon for 2018 from the Ministry of Environment, any of the utilities servicing the country, the International Energy Agency (IEA) or the Ministry of Energy and Water, so the emission factor used for this BEI is the last formal electricity emission factor for 2015 issued by the Lebanon Ministry of Environment. Emission Factors for each source are gathered in the Table 3 below.

Table 3 Emission Factors & Conversion Rates

	Emission Factor (tn CO_2/MWh) Factors (tn CO_2/MWh)	Conversion Factors
Electricity	0.681	---------
LPG	0.227	13.1 MWH/tn
Diesel	0.267	10 KWh/lt
Gasoline	0.249	9.2 KWh/lt
Solar (thermal/ PV)	0	---------
Wood	0.414	4.65 MWh/tone

Furthermore, emissions from the biomass were calculated according to the IPCC method. Waste separation process, Sewage Sludge and livestock breeding create 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 Semqanieh Municipality in 2018 was 145.259 GWh. The allocation of this energy consumption among different sectors, by fuel type, is presented in Table 2. Further analysis of the consumptions per sector is provided in the following sections.

Table 4 Total Energy consumption per sector

Sector	Electricity	Diesel	Gasoline	LPG	Solar Thermal	Firewood & olive pits	Total
	(MWh)						
Residential Sector	6,665	51,803	0	1,798	333	34,087	**94,686**
Municipal Buildings	6.5	138.52	0	0.3	0	0	**145**
Tertiary Sector	2,365	11,708	0	43.5	0	0	**14,116**
Industrial Sector	4,801	24,929	0	0	0	0	**29,730**
Public street lighting	127	127	0	0	0	0	**254**
Transportation Sector	0	1,111	5,217	0	0	0	**6,328**
Total	**13,965**	**89,816**	**5,217**	**1,842**	**333**	**34,087**	**145,259**

2.2.1 Municipal Buildings & Facilities

Al-Semqanieh municipality includes one municipal building in addition to a health care, making minimal contributions to the energy consumption at the city. As for the Diesel consumption for heating, in line with the respective invoices, the municipal buildings consume around 8,000 Lit per year for heating and consume around 4,000 L for electricity production.

Table 5 shows electricity and diesel consumption for municipality's Buildings.

Table 5 Energy consumption in Municipal Buildings & Facilities per fuel

	Electricity (MWh/year)	Diesel for electricity generation (MWh/yr)	Diesel for heating (MWh/yr)	Total MWh
Municipal Buildings	6.48	58.5	80	145.3

2.2.2 Municipal public lighting

As far as the municipal public lighting is concerned, this sector is related to the street lighting and public areas' lighting. The electricity consumption for this sector was 253 MWh according to the provided bills and the estimated diesel consumption to produce electricity to run the lights for 2018.

2.2.3 Residential Buildings

Electricity

Semqanieh's households consume electricity for lighting and electrical appliances such as refrigerators, air conditions and others. The annual consumed electricity in this sector was 6,665 MWh in 2018 according to the provided data from Lebanon Electricity Company.

Diesel

The diesel consumption in the residential sector was used for two purposes; space heating and producing electricity by private generators. According to the assumptions made for estimating the diesel consumption with the municipality staff, the diesel consumption for heating and producing electricity were 32,760 MWh and 19,043 MWh, respectively.

Liquefied Petroleum Gas (LPG)

LPG is mainly used in cooking. According to the interviews with some of household's owners, the households consume around 8 cylinders (10 kg/cylinder) during the whole year for cooking. According to the IPCC 2006 guidelines, the calorific value of Liquefied Petroleum Gas is 13.1 MWh/tn. Thus, the annual LPG consumption in residential sector for Semqanieh was around 32,048 bottles with annual energy consumption of 1,798 MWh.

Firewood & Olive pits

There is also an amount of firewood which is consumed by the residents for space heating. The wood quantities & olive pits used for heating were provided for 2018 and were as follows: 5,250-ton firewood and 2,250-ton olive pits. The amounts of energy consumed from these sources were 24,412 MWh & 9,675 MWh, respectively.

Solar thermal

In addition, number of households own solar water heaters, thus they consume solar power in order to heat water. Number of households who installed solar thermal collectors were 40 households. The total area of the solar collectors was estimated 160 m2. Thus, the annual solar thermal consumption at the municipal level is calculated to be 332.9 MWh.

Summary

Gathering all the data of the residential sector, it seems that residents consume 5 distinct energy sources. In Table 6 and Figure 16 below, the final consumption per fuel type for this sector is presented.

Table 6 Total energy consumption in the residential sector

MWh/year	Residential Sector
Electricity	6,665
Diesel	51,803
LPG	1,798
Firewood & Olive pits	34,087
Solar Thermal	333
Total (MWh)	**94,686**

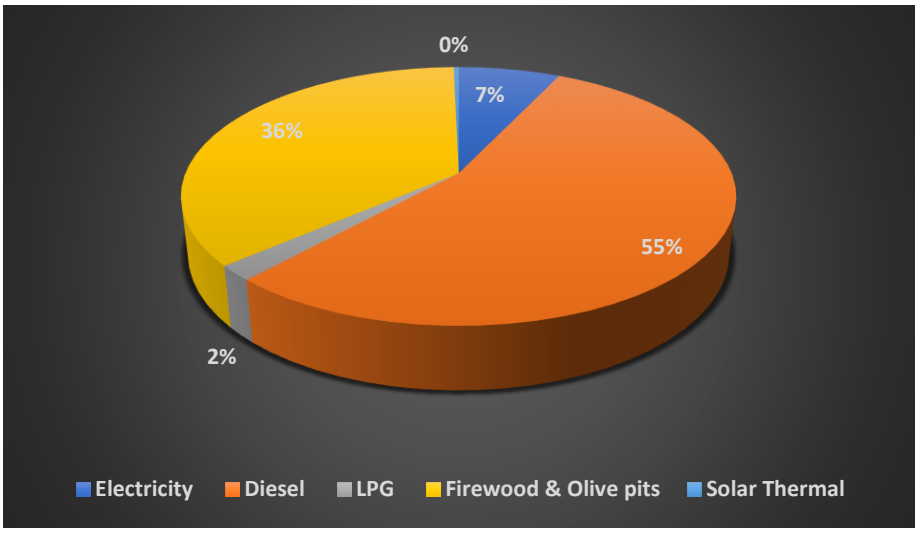


Figure 16 Energy consumption per fuel in Residential Sector

2.2.4 Tertiary Buildings, Equipment & Facilities

Tertiary sector includes all buildings that not referred to the municipal and industrial sectors, which includes the commercial buildings such as shops, restaurants, hotels, offices, hospitals. Also, this sector includes the educational buildings (Schools and Universities), public buildings and water management facilities as well, which provide services to Semqanieh's citizens.

In case of commercial buildings, it was estimated that each shop consumes around 4 bottles per shop according to a survey was made for this purpose. The number of total shops is 194 shops. Based on that, the annual LPG consumption at municipal level for commercial sector is calculated to be 43.5 MWh. The annual electricity consumption was given according to the provided data from Electricity Lebanon Company, with value of 1,118 MWh. The estimated diesel consumptions for electricity production and water heating were 3,195 MWh and 1,681 MWh, respectively. The collected data are presented in the table below.

Table 7 Energy consumption in tertiary sector per type of building

Types of Buildings in the Tertiary Sector	Electricity (MWh)	LPG (MWh)	Diesel (MWh)	Total (MWh)
Commercial buildings	1,118	43.5	4,876	6,038
Health Care buildings	30.5	0	1,756	1,786
Educational buildings (Schools)	1,216	0	5,076	6,292
Total	**2,364.5**	**43.5**	**11,708**	**14,116**

In the next charts, it is obvious that the consumption's allocation in the tertiary sector is dominated by commercial and educational buildings, equally.

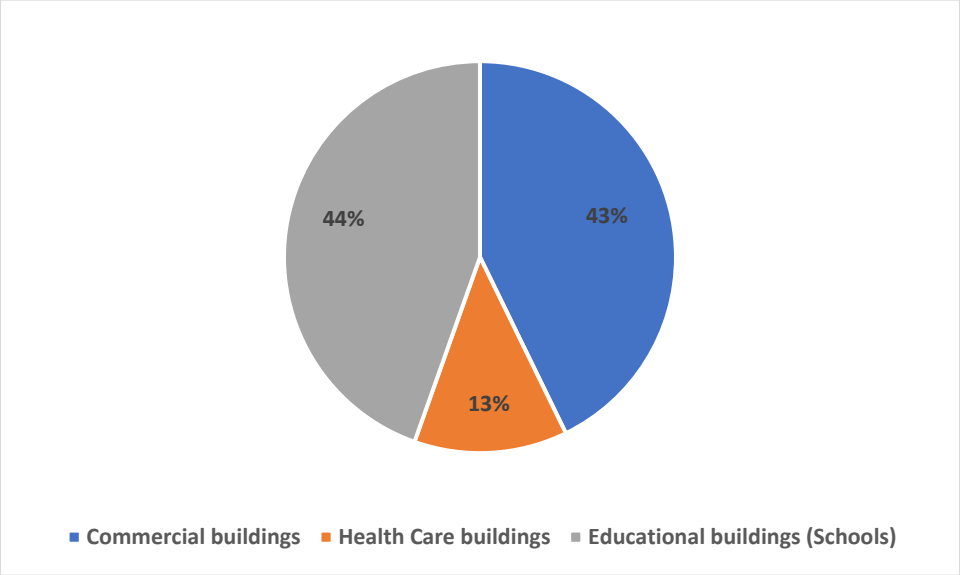


Figure 17 Energy consumption in tertiary sector per type of building

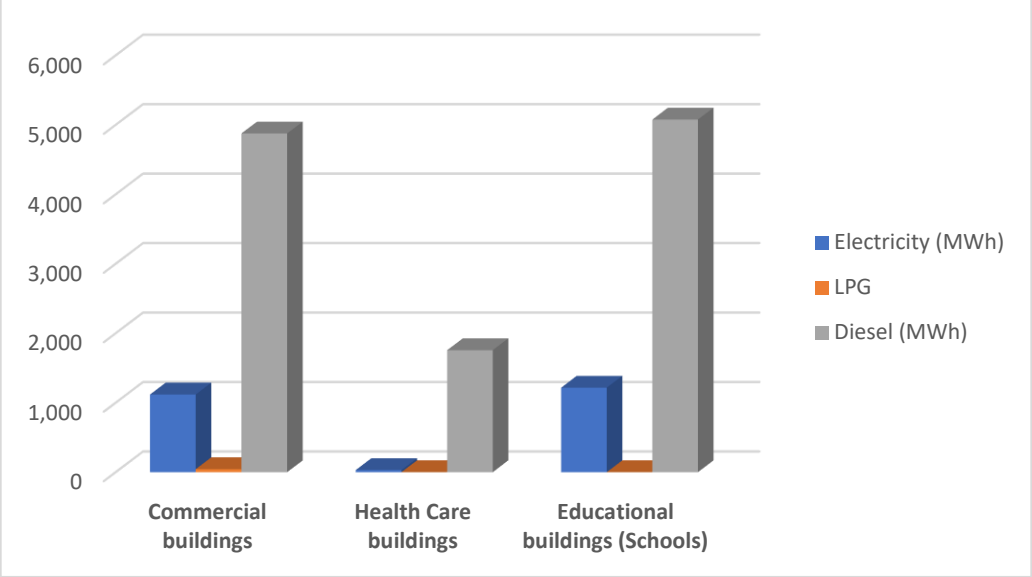


Figure 18 Energy consumption in tertiary sector per type of building and fuel

2.2.5 Buildings' & facilities Synopsis

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

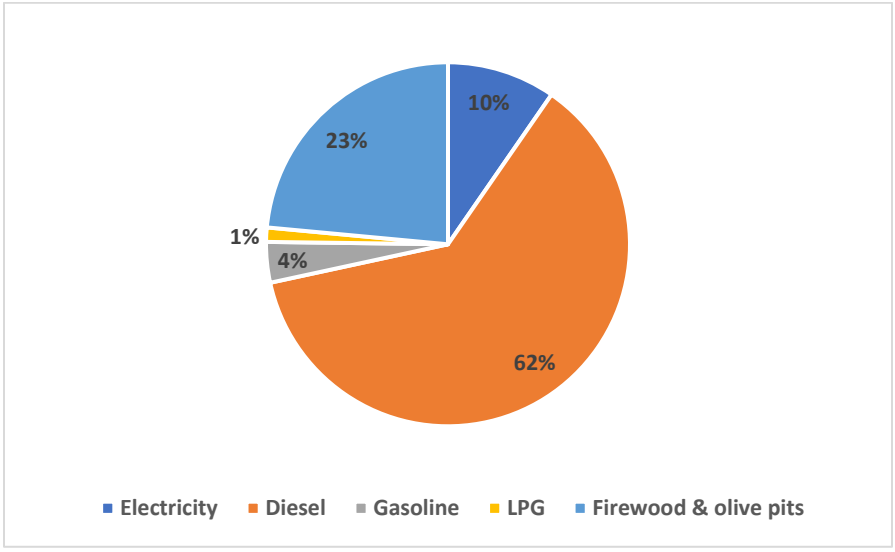


Figure 19 Energy consumption in buildings and facilities per fuel.

2.2.6 Transport Sector

2.2.6.1 Municipal Fleet

This category includes municipal cars and waste transportation. The municipality owns two Pickups, one gasoline fueled car and one gasoline fueled van.

As for waste transportation, the municipality has one truck to transport solid waste to a nearby waste sorting plant located in Kahlounieh. According to waste collection staff, the average annual diesel consumption for solid waste transportation is 1,014 Lit (equivalent to 10.14 MWh/yr).

Table 8 presents the municipal vehicles types, numbers and the annual fuel consumptions in Semqanieh municipality:

Table 8 Energy Consumption in Municipal fleet of Semqanieh

Type of Municipal vehicles	Number of vehicles	Diesel		Gasoline		Total
		Lit	(MWh)	Lit	(MWh)	(MWh)
Garbage Vehicle	1	1,014	10.14	----	----	10.14
Gasoline fueled Van	1	----	----	1,800	16.6	16.6
Diesel fueled pick-Up	1	2,500	25	----	----	25
Gasoline fueled pick-Up	1	----	----	2,200	20.2	20.2
Total	**4**	**3,514**	**35.14**	**4,000**	**36.8**	**71.94**

2.2.6.2 Public Transport

Public transport refers to buses and taxis that serve Semqanieh's citizens. The data available for this sector included the average consumption per type of vehicle according to the total distance travelled within municipal limits, as shown in Table 9 below.

Table 9 Energy consumption in Public Transport within Semqanieh borders

Vehicle Type	Number of vehicles	Gasoline (Lit/yr)	Diesel (Lit/yr)	Gasoline (MWh/yr)	Diesel (MWh/yr)	Total MWh
Buses	168	------	23,088	-------	230.88	230.88
Taxis	120	10,296	-------	94.7	-------	94.7
Total	**288**	**10,296**	**23,088**	**94.7**	**230.88**	**325.58**

2.2.6.3 Private and Commercial Transport

A detailed transportation survey for Semqanieh Municipality was done by performing data collection by questionnaires for representative sample, which were identified as follows:

1. Small passenger cars: The numbers of vehicles living within the municipality boundaries were 8,400 and the vehicles crossed the boundaries were 6,400 per day.
2. Medium passenger cars: The numbers of vehicles living within the municipality boundaries were 120 and the vehicles crossed the boundaries were 384 per day.
3. Motorcycles: The vehicles crossed the boundaries were 340 per day.
4. Pickups: The numbers of vehicles living within the municipality boundaries were 42 and the vehicles crossed the boundaries were 136 per day.
5. Trucks: The numbers of trucks living within the municipality boundaries were 10 and the vehicles crossed the boundaries were 196 per day.

Table 10 shows the final results and outputs regarding the diesel and gasoline consumptions, which the annual diesel consumption reaches 82,736 Lit (827 MWh/yr), while the annual gasoline consumption reaches 554,518 Lit (5,101 MWh/yr).

Table 10 Energy consumption in Private and Commercial Transport

Vehicle Type	Number of vehicles	Diesel (Lit/yr)	Gasoline (Lit/yr)	Diesel (MWh/yr)	Gasoline (MWh/yr)	Total (MWh)
Small passenger cars	14,800	43,929	494,208	439.296	4,546.7	**4,986**
Medium passenger cars	504	3,067	33,883	30.6696	311.7	**342.4**
Motorcycles	340	0	11,669	0	107.4	**107.4**
Pickups	178	5,366.4	6,864	53.664	63.1	**116.8**
Trucks	206	13,453.4	7,894	134.5344	72.6	**207.2**
Schools buses	94	16,920.0	0	169.2	0	**169.2**
Total	**16,122**	**82,735.8**	**554,518**	**827.364**	**5,101.5**	**5,929**

Figure 20 below presents the proportion between Diesel and Gasoline consumption in the Private and public vehicles.

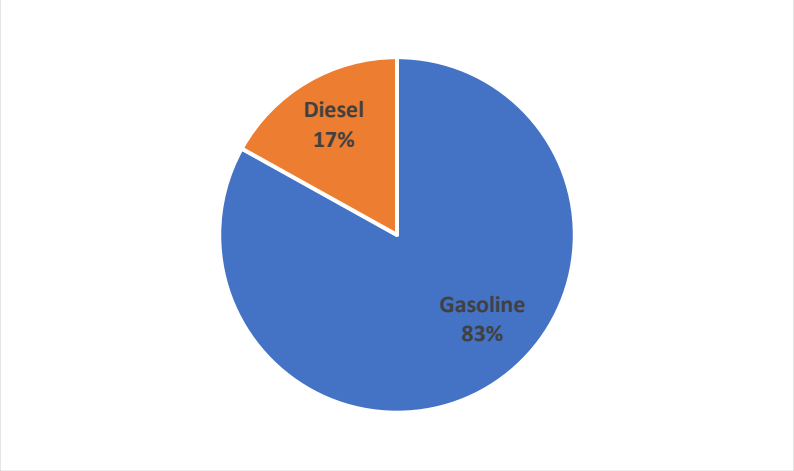


Figure 20 Energy consumption in Private and Commercial vehicles per fuel

Table 11 and Figure 21 summarize the overall transportation sector consumptions for diesel and gasoline fuels:

Table 11 Total energy consumption for transportation sector

Vehicle Type	Number of vehicles	Diesel (Liter/year)	Gasoline (Liter/year)	MWh Diesel	MWh Gasoline	Total MWh
Municipal Fleets	4	3,514	4,000	35.14	36.8	71.94
Public Transportation						
Taxis	120		10,296		94.7	94.7
Buses	168	23,088		230.88		230.88
Sub-total	**288**	**23,088**	**10,296**	**230.88**	**94.7**	**325.58**
Private Transportation						
Sub-total	**16,122**	**82,735.8**	**554,518**	**827.364**	**5,101.5**	**5,929**
Total	**16,414**	**109,338**	**568,814**	**1,093**	**5,233**	**6,327**

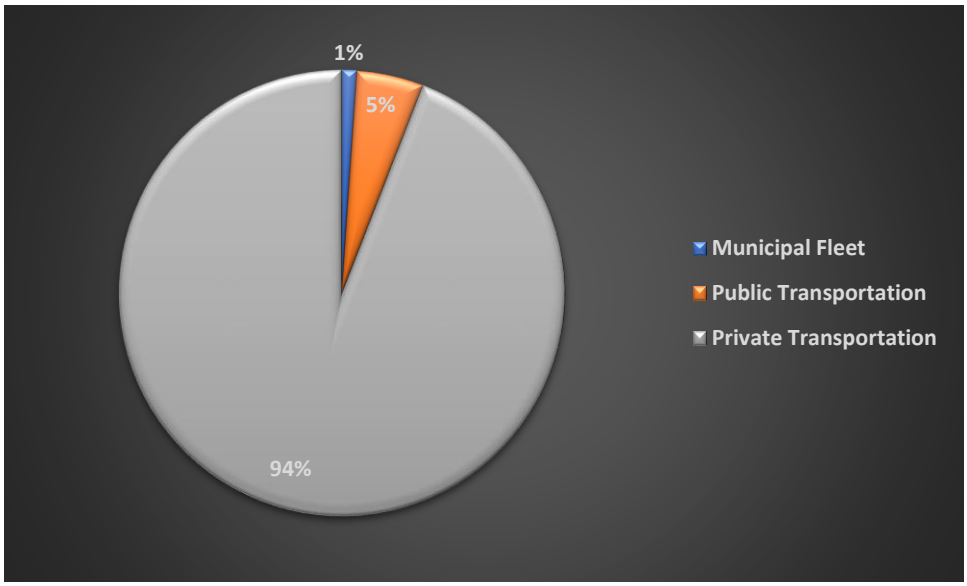


Figure 21 Energy consumption distribution in the transportation sector

2.2.7 Final Energy Consumption

In Table 12 all the energy consumptions within Al Semqanieh municipality are presented, with total energy consumption of 145.26 GWh.

Table 12 Total Energy Consumption in Semqanieh municipality.

Sector		FINAL ENERGY CONSUMPTION [MWh]						
		Electricity	Fossil fuels				Renewable energies	Total
			LPG	Diesel	Gasoline	Firewood & olive pits	Solar thermal	
Residential sector		6,665	1,798	51,803	0	34,087	333	**94,686**
Municipal Buildings		6.5	0.3	138.52	0	0	0	**145**
Tertiary Sector		2,365	43.5	11,707	0	0	0	**14,116**
Industrial Sector		4,801	0	24,929	0	0	0	**29,730**
Public street lighting		127	0	127	0	0	0	**254**
Transportation Sector	Municipal Fleet	0	0	35.14	36.8	0	0	**72**
	Public Transportation	0	0	230.88	94.7	0	0	**326**
	Private Transportation	0	0	827.36	5,101.5	0	0	**5,929**
Total		**13,964.5**	**1,841.8**	**89,797.9**	**5,233**	**34,087**	**333**	**145,258**

Figure 22 below shows the energy consumption distribution for all Semqanieh's sectors, which can be noted that residential and Industrial sectors are the main energy consumers in Semqanieh with 65% and 21%, respectively.

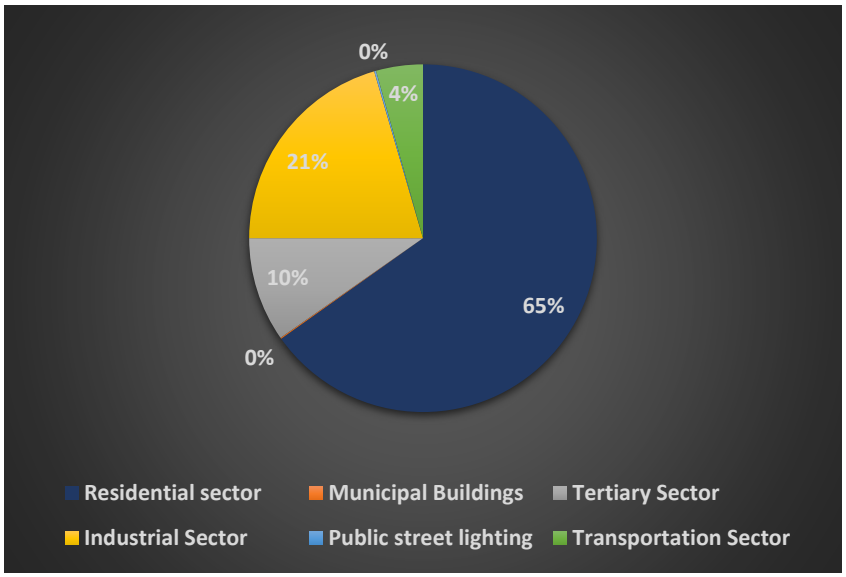


Figure 22 Energy consumption distribution for all sectors in Al Semqanieh

2.3 Local Electricity production

There is one type of electricity production in municipality of Semqanieh; which is Diesel generators, whereas there were no any installed photovoltaic systems till 2018. The total number of diesel generators used in Semqanieh reached 16 generators.

2.4 CO2 Emissions

2.4.1 Energy Related Emissions

In the previous sections, the energy related consumptions in Semqanieh municipality were described and the CO2 emissions can be calculated using the IPCC emission factors.

Electricity

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

EFE = ((TCE-LPE-GEP)*NEEFE+〖CO〗_2 LPE+〖CO〗_2 GEP)/TCE

Where:

EFE: Local emission factor for electricity (tn/MWh)

TCE: Total electricity consumption in the local authority (MWhe)

LPE: Local electricity production (MWhe)

GEP: Green electricity purchased by the local authority (MWhe)

NEEFE: National or European emission factor for electricity (tn/MWhe)

CO2LPE: CO2 emissions due to the local production of electricity (tn)

CO2GEP: CO2 emissions due to production of certified green electricity purchased by the local authority (tn)

EFE= ((53,665-39,701-0)*0.659+27,354+0)/53,665 = 0.681 tn CO2/MWh

As calculated from the above, due to the large contribution of electricity production from local generators, the emission factor for electricity will be higher than the national/European emission factor, with value of 0.681 tn CO2/MWh.

Diesel

According to the SECAP guidelines the CO2 emission factor for the diesel used in vehicles is 0.267 tn/MWh.

Gasoline

According to the SECAP guidelines the CO2 emission factor for gasoline is 0.249 tn/MWh.

LPG

According to the SECAP guidelines the CO2 emission factor for LPG is 0.227 tn/MWh.

Fire Wood

According to the SECAP guidelines, the CO2 emission factor for firewood is 0.41 tn/MWh.

Solar thermal

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

2.4.2 Non-Energy Related Emissions

Apart from the CO2 emissions released from the daily activities, also there is a significant amount of Greenhouse Gases derived from waste management and waste water treatment plants.

Here is the CO2 emission contribution of the biomass in the municipality:

A. Municipal solid waste

In order to calculate the emissions from municipal solid waste, the IPCC default method was used as it appears below:

Methane emissions (Gg/yr) = (MSWT ● MSWF ● MCF ● DOC ● DOCF ● F ● 16/12-R) ● (1-OX)..... (1)

Where:

- MSWT : Total MSW generated (Gg/yr)
- MSWF: Fraction of MSW disposed to solid waste disposal sites
- MCF: Methane correction factor (fraction)
- DOC: Degradable organic carbon (fraction) (kg C/ kg SW)
- DOCF: fraction DOC dissimilated
- F: fraction of CH4 in landfill gas (IPCC default is 0.5)
- 16/12: conversion of C to CH4
- R: recovered CH4 (Gg/yr)
- OX: oxidation factor (fraction – IPCC default is 0)

The IPCC default method assumes that all the potential of CH4 emissions releases during the same year the waste is disposed of. The method introduces various specific default values and recommendations, for use in countries with lack of statistical data for Solid Waste.

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

DOC=0,4*A+0,17*B+0,15*C+0,3*D.....(2)

Where:

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

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

The total quantity of solid waste for 2018 was 2,400 tn/year. Some the amount is thrown in open dumps because there is a recycling. Waste composition was identified based on the waste composition of a near municipality (Jdaidet El Chouf municipality). The results from the calculations is presented in Tables 13 & 14.

Table 13 Solid waste composition in Semqanieh, 2018

Solid waste composition	Percentage	Quantity(tn)
Paper and Cardboard	3%	72
Glass	3%	72
Metal	5%	120

Plastic	10%	240
Organic Waste	60%	1,440
Other	19%	456
Annual Quantity of Solid waste (tn)	100%	2,400

Table 14 Waste Emissions Calculation factors

Variables	Values
MSWt:	**2,400 tn/year**
MSWf:	**1**
MCF:	**0.4**
DOC:	**0.102**
DOCf:	**0.63**
F:	**0.5**
16/12:	**1.3333**
R:	**0**
OX:	**0**

Where DOCf = 0.014*T + 0.28 (T: average temperature in Semqanieh, 19.9 °C)

According to the available data on solid waste, it was found that 34.34 tn of methane has been released to the atmosphere. This quantity equals to 859 tn of equivalent CO2. (According to the guidelines, the factor, which was used for the conversion, is 25).

B. Waste Water Treatment Plant (WWTP)

In order to calculate the emissions from WWTP, the IPCC default method was used as it appears below:

CH4 emissions = (Ui*Ti,j*EFj)*(TOW-S)-R

Where:

- Ui : Fraction of population in income in inventory year
- Ti,j : Degree of utilization of treatment pathways or system
- EFi : Emission factor
- R : Amount of CH4 recovery in inventory year.
- S : Organic component removed in inventory year as sludge
- TOW : Total organics in waste water during inventory year

The calculation of the emission factor (EFi) is based on the following equation.

EFi = B◦ * MCFj,

Where:

- B◦ : Maximum CH4 production Capacity
- MCFj : Methane correction factor

The following equation was used to calculate the total organics in waste water in inventory year (TOW).

TOW= P * BOD * 0.001 * I * 365, Where:

- P : Population
- BOD : Biochemical Oxygen Demand (BOD)
- I : Correction factor for additional industrial BOD discharged into sewers

The plant treats daily about 5,000 m3 of waste water and the total quantity of sewage sludge for 2018 was 18,250 m3/yr, 20% are from Semqanieh municipality, on the other hand, the WWTP is operated under over load conditions. Waste composition, as well as the results from the calculations are presented in the next table:

Table 15 Sewage Emissions Calculation factors.

Factor	Value	Unit
Ui	**0.57**	**-**
Ti,j	**0.1**	**-**
EFi	**0.18**	**Kg CH_4 / Kg BOD**
R	**0**	**kg CH_4/a**
S	**0**	**kg BOD/a**
TOW	**246,959**	**kg BOD/a**
B_o	**0.6**	**kg CH_4/kg BOD**
MCF_j	**0.3**	**-**
P	**16,915**	**Person**
BOD	**40**	**g/person/day**

According to the available data on solid waste, it was found that 2.534 tn of methane has been released to the atmosphere. This quantity equals to 63.345 tn of equivalent CO2. (According to the guidelines, the factor, which was used for the conversion, is 25).

C. Livestock Breeding Sector

Based on the data from the municipality of Semqanieh, there is one sheep's farm contains 290 sheep and a chicken farm which contains 935 chicken. The CH4 emissions from these two farms is as shown in Table 16:

Table 16 Livestock emissions calculations factor

Animal type	Emissions factor (kg CH_4 / Head /Yr.)	CH_4 emissions (kg/yr.)	Co_2 equivalent (kg/yr.)
Sheep	0.15	43.5	1,087.5
Chicken	0.02	18.7	467.5

About 0.62 ton of methane were released due to these farms. This quantity equals to 1.55 ton of equivalent CO2. (According to the guidelines, the factor, which was used for the conversion, is 25).

2.4.3. Final CO2 emissions

The emissions of CO2 equivalent for the sectors that have been described in the previous sections are available, in total, in the following table.

Table 17 Total CO2eq emissions for Semqanieh Municipality.

Sector		CO_2 emission (tn CO_2/year)						
		Electricity	Fossil fuels				Renewable energies	Total
			LPG	Diesel	Gasoline	Firewood	Solar thermal	
Residential sector		4,539	408	13,832	0	13,474	0	**32,253**
Municipal Buildings		4.4	0.1	37	0	0	0	**41.5**
Tertiary Sector		1,610	10	3,126	0	0	0	**4,746**
Industrial Sector		3,269	0	6,656	0	0	0	**9,925**
Public street lighting		86	0	34	0	0	0	**120**
Transportation Sector	Municipal Fleet	0	0	14	5	0	0	**19**
	Public Transportation	0	0	61	24	0	0	**85**
	Private Transportation	0	0	221	1,270	0	0	**1,491**
Sub-Total		**9,508.4**	**418.1**	**23,981**	**1,299**	**13,474**	**0**	**48,680.5**
Non Energy Sources								
Waste Water treatment Plant								**63.3**
Livestock breeders								**1.55**
Solid waste								**859**
Sub-Total								**923.85**
Total		**9,508.4**	**418.1**	**23,981**	**1,299**	**13,474**	**9,508.4**	**49,604**

2.5 Results' Graphical Analysis

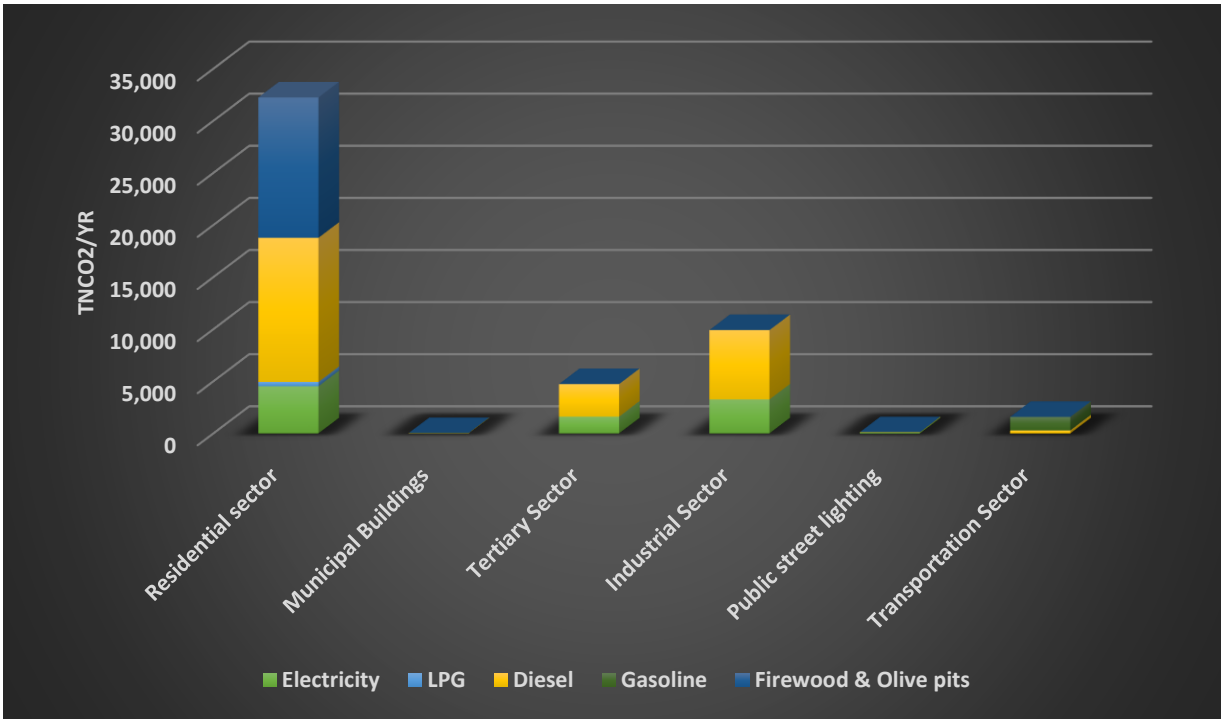


Figure 23 Total CO2 emissions per sector and per fuel.

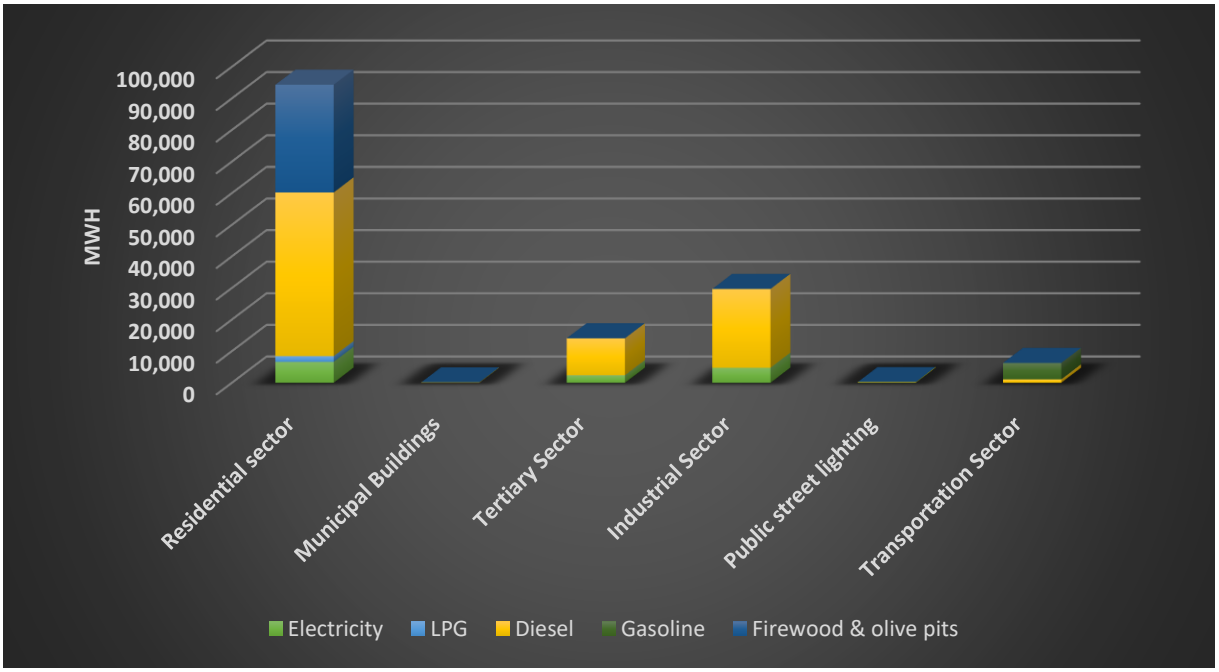


Figure 24 Final Energy consumption per sector and per fuel.

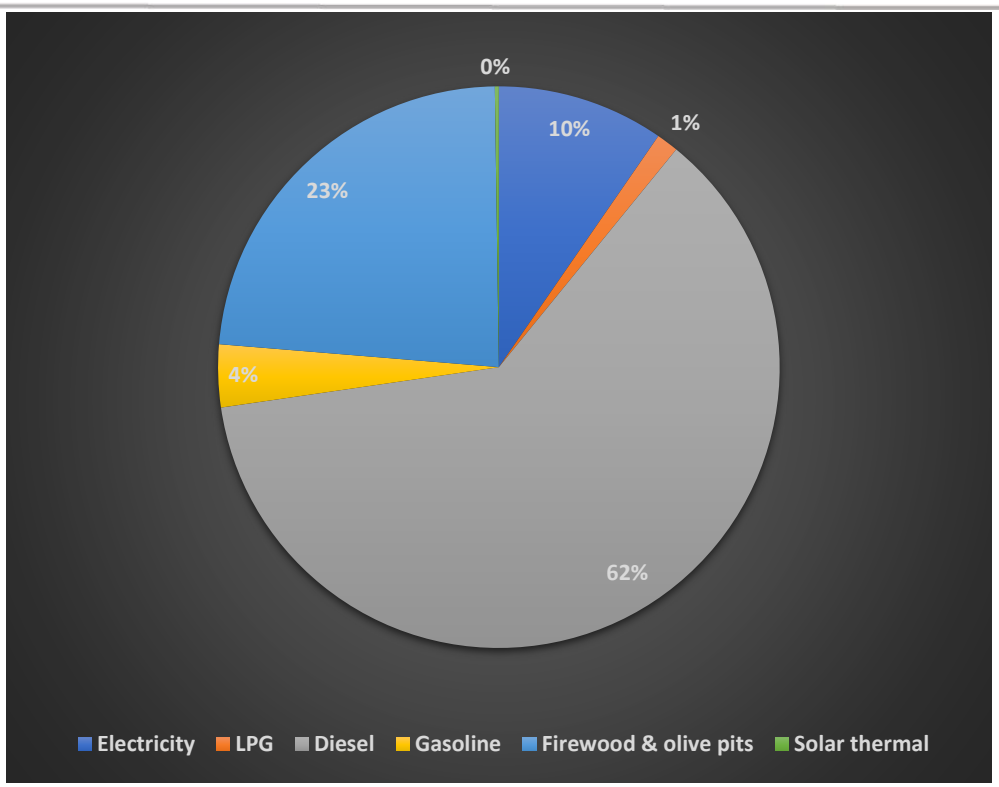


Figure 25 Final Energy Consumption per fuel.

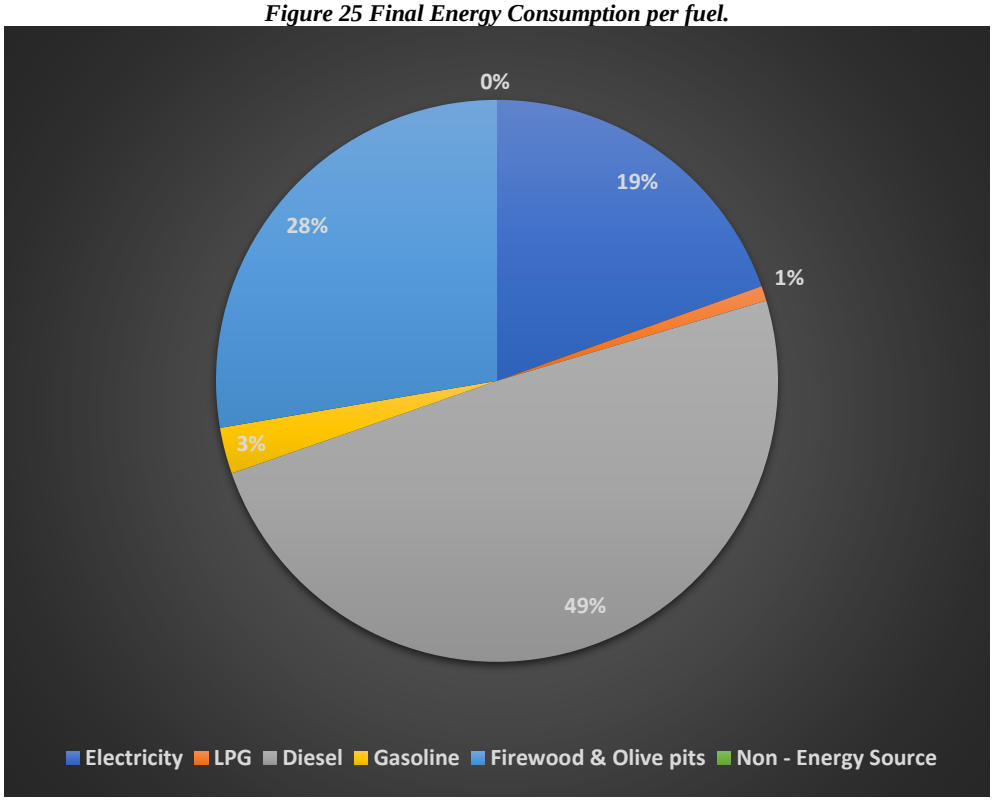


Figure 26 Total CO2 emissions per fuel.

Chapter 3: SECAP Actions

3.1 Target for 2030

The Municipality of Semqanieh is requested to take double role in the efforts towards CO2 reduction, both as a demonstrator giving the good example to its citizens, as well as a triggering power and coordinator for all activities in the area. The first role, giving the good example, should be realized through the adoption of actions to reduce the emissions resulting from the buildings/ facilities / vehicles etc. under its direct responsibility. Emissions from waste are another sector under the direct responsibility of Semqanieh Municipality. Nevertheless, the municipal direct related emissions are only a relatively low percentage of the total. Therefore, it should act as a triggering power and coordinator of the activities to be realized by the private sector in a series of activity fields. According to the BEI, the sectors contributing the most to the carbon footprint are the Residential (65.02%), the Industrial sector (20%), the Tertiary (9.57%) and the Private & Transportation (3.22%). Thus, the Municipality should focus on the actions through which the citizens will be encouraged and take the appropriate measures in order to reduce the CO2 emissions from their activities. At the same time, actions in the other sectors will be suggested as well.

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

$$Emissions2030 = EmissionsBaseline\ year \times k$$

In Semqanieh, the emissions for the baseline year, 2018, were 49,604 tn CO2 eq. The national coefficient k for the baseline year of 2018 in Lebanon is 1.43. Therefore, the forecasted emissions for 2030 are

$$Emissions2030 = 49{,}604 \times 1.43 = 70{,}933.72\ tn\ CO2\ eq$$

The emission reduction target for Semqanieh Municipality according to the Intended Nationally Determined Contribution (INDC) is 40% (28,373.5 tn CO2 eq) up to 2030 compared with the BAU scenario.

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

Calculations for 40% redaction have been realized based on the suggested actions. In the next sections a more detailed analysis per action for each sector is provided. It should be noted that for awareness raising activities conducted by the municipality, besides the

Implementation cost born by the municipality and its potential funding sources, the amount of the private funds mobilized is reported as well where relevant. This cost doesn't participate in the calculation of the NPV value. Moreover, it should be clarified that externalities costs are not considered in the calculation of the NPV; this result sometimes in actions with a negative NPV from the strict economic calculation, although their overall impact could be considered positive if additional benefits were considered.

3.2 Municipal Buildings, Equipment/Facilities

This sector has a carbon footprint of less than 1%. Nevertheless, the possible actions to be implemented in the Municipal Buildings could set an example for the citizens and the employees. Municipality acknowledged the measures, which best fit its needs so as to achieve energy savings and emission reductions. In the following sections, a comprehensive set of actions is being analyzed.

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

Apart from these categories of actions, there are also some envisaged actions, which target the user through awareness raising activities. These actions aim to make the inhabitants' behavior 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 on the table below.

Table 18 Actions in Municipal Buildings, Equipment/Facilities

Action No.	Action	Emission Reductions (tn CO_2) 40% target
3.2.1	Green procurement procedures for municipal buildings	3.32
3.2.2	Replacing the existing non-efficient lamps with LED Lamps Semqanieh municipal buildings	5.6
3.2.3	Energy manager appointment in the municipality	0.17
3.2.4	Awareness raising activities for municipal employees	0.62
3.2.5	PVs in municipal building's roof	41.5
3.2.6	Establishment of Energy Saving Department	0
3.2.7	Social media portal creation portal creation	0
Total		**51.21**

3.2.1 Green procurement procedures for municipal buildings

Green procurement is the procedure where the municipality seeks to purchase goods and services with a reduced environmental impact throughout their life cycle. By Selecting products of high efficiency that minimize the environmental impacts, it is possible to consume less energy thus reduce the CO2 emissions and achieve cost savings. The action is envisaged to be applied to all new office equipment that the municipality plans to purchase for their increasing needs and for the gradual substitution of old, inefficient one. Especially for high energy consuming office equipment, high efficiency products will be targeted, while minimum efficiency standards and requirements will be set in all relevant municipal tenders.

In Table 19, calculations regarding the cost, the savings and the financial viability of the action are presented.

Table 19: Action 3.2.1 in numbers

Green procurement procedures	
Duration	2023 – 2030
Total Implementation Cost (EURO)	24900
Total Energy Reduction (MWh)	4.87
Total Emission Reduction (tn CO_2)	3.32
Funding Source	Own funds
Net Present Value (NPV)	<0

3.2.2 Replacing the existing non-efficient lamps with LED Lamps

The current state of Al-Semqanieh existing municipal building includes Florescent lighting units. The municipality will replace all the fixtures and lamps with LED lighting lamps.

Table 20: Action 3.2.2 in numbers

Replacing the existing non-efficient lamps with LED Lamps	
Duration	2023
Total Implementation Cost (EURO)	2000
Total Energy Savings (MWh)	8.22
Total Emission Reduction (tn CO_2)	5.6
Funding Source	Donor
Net Present Value (NPV)	>0

3.2.3 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 21: Action 3.2.3 in numbers

Energy manager appointment in the municipality	
Duration	2023 – 2030
Total Implementation Cost (EURO)	26145
Annual Energy Savings (MWh)	0.25
Annual Emission Reduction (tn CO_2)	0.17
Funding Source	Own funds
Net Present Value (NPV)	<0

3.2.4 Awareness raising activities for municipal employees

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

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

- Training workshops and seminars for the team members directly involved in the SECAP implementation and monitoring. This activity aims to build the capacity of employees/team directly involved in the SECAP implementation in terms of SECAP development and project implementation. These workshops and seminars could be targeted on how to attract financing from international donors, to manage the project implementation or even focus on the exchange of best practices and ideas with other municipalities in Lebanon and abroad that face the same

challenges. Workshops on the latest available know-how in terms of energy efficiency and RES technologies are envisaged as well.

- Development and circulation of promotional material through the employees' e-mails on the benefits of energy efficiency and how simple behavior changes influence the total consumption.
- Municipal contest for the administrative building with the highest energy savings achieved (in terms of %) due to users' behavior change. This contest prize could be any incentive provided to the employees, such as two additional days off that year or the development of posters with the pictures and names of the employees that contributed to the goal achievement. The aim would be to achieve energy savings through strictly behavioral change, such as turning off the lights, the diesel space heaters and office equipment when leaving the office, not leaving open windows with the A/C on etc. This measure could be used during the first couple of years, when the rest of the energy efficiency interventions will be gradually taking place.

Table 22: Action 3.2.4 in numbers

Awareness raising activities for municipal employees	
Duration	2023-2023
Total Implementation Cost (EURO)	6225
Annual Energy Savings (MWh)	0.91
Annual Emission Reduction (tn CO_2)	0.62
Funding Source	Own funds + external fund
Net Present Value (NPV)	<0

3.2.5 PV plant for municipal building

So, the municipality intends to take advantage of this benefit by constructing a 45kWp PV system to offset some of the electricity consumed by municipal buildings and public lighting. As a result, its reliance on the grid will be reduced through the use of renewable energy, resulting in CO2 reductions.

Table 23: Action 3.2.5 in numbers

45kWp PV plant	
Duration	2023
Total Implementation Cost (EURO)	50,000
Annual Energy Production (MWh)	60.94
Annual Emission Reduction (tn CO_2)	41.5
Funding Source	Donor
Net Present Value (NPV)	>0

3.2.6 Establishment of Energy Saving Department

It is proposed to establish an Energy Saving Department, which would be staffed with at least one person based on the needs of the municipality. The assigned person/team should be technically qualified in energy-related issues in order to promote appropriate energy-saving activities and assist citizens. Citizens will get back to this department for information on new practices and for techno-economic advice on energy-related investments. In addition, this department can support the energy manager's activities and take responsibility for monitoring the progress of SECAP actions in close collaboration with the employees directly involved in their implementation. This action is not expected to result in direct energy savings or CO2 reductions, but it is seen as beneficial.

Table 24: Action 3.2.6 in numbers

Establishment of Energy Saving Department	
Duration	2023-2030
Total Implementation Cost (EURO)	22,410
Funding Source	Own Fund

3.2.7 Social media portal creation

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

Table 25: Action 3.2.7 in numbers

Web portal creation	
Duration	2023
Total Implementation Cost (EURO)	1000
Funding Source	Own funds

3.3 Municipal Public Lighting

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

An overview of this sector's actions is presented in Table 26 below, while a detailed analysis with calculations for each action follows in the next paragraphs.

Table 26: Actions in Municipal Public Lighting

Action No.	Action	Emission Reductions (tn CO_2)
3.3.1	Street lighting upgrade	90
3.3.2	Astronomical timers	30
	Total	**120**

3.3.1 Street lighting upgrade

Various types of lamps are used for street lighting, more specifically Metal halide. The Municipality wants to replace all of the existing lamps (with LEDs which are more efficient and provide great luminosity quality. This action will ensure significant reduction in electricity consumption and cost savings for the Municipality.

The key data on the action is presented in Table 27 below.

Table 27: Action 3.3.1in numbers

Street lighting upgrade	
Duration	2023 – 2025
Total Implementation Cost (EURO)	24000
Annual Energy Savings (MWh)	132.16
Annual Emission Reduction (tn CO_2)	90
Funding Source	Own and External fund
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 compared to photocells. This action will reduce the electricity consumption by up to 20%. Figure 27 depicts the sunrise and sunset timing where the photocell acts little before/after timing and counts for a loss of approximately 365 hours of operation per year.

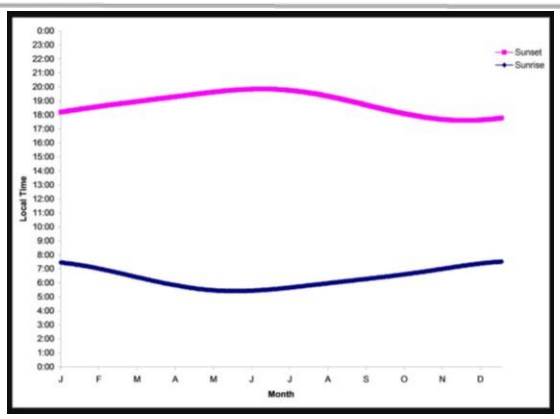


Figure 27 Timing for sunset and sunrise in Lebanon

The use of astronomical timers would also provide precise timing for switching and programming the actual operation after 20 minutes of sun set and nearly 30 minutes before sun rise, which is an acceptable trimming as light is still available.

Key data on the investment are presented in Table 28 below.

Table 28: Action 3.3.2 in numbers

Astronomical timers	
Duration	2024-2027
Total Implementation Cost (EURO)	1500
Annual Energy Savings (MWh)	44
Annual Emission Reduction (tn CO_2)	30
Funding Source	Own funds
Net Present Value (NPV)	>0

3.4 Residential Buildings

This sector includes the homes energy consumption related to lighting, heating, use of electric appliances etc. This consumption contributes to 65.02% of the total the CO2 emissions in the municipality.

The initial actions are informative and could be initiated by the Municipality. Because the Municipality does not have the ability to intervene directly in project implementation, a series of actions will be planned to encourage residents to implement the proposed measures to reduce their energy consumption and carbon emissions.

An overview of this sector's planned actions is presented in the Table 29 below.

Table 29: Actions in Residential Buildings

Action No.	Action	Emission Reductions (tn CO_2)
3.4.1	Awareness raising activities for the community about (RE &EE)	1,483.6
3.4.2	Promotion of Green Buildings' concept	3,838.1
3.4.3	Campaign for promoting and replacing high energy label equipment	4,031.6
3.4.4	3.6 MW Photovoltaics in residential rooftops	3,547.8
3.4.5	Replacing existing electric water heater with solar collectors	1,612.6
3.4.6	Replacement of old diesel space heater with more efficient	6,450.6
3.4.7	Use the insulation on rooftops	246.7
3.4.8	Replacement of single glazing with double	967.6
	Total	**22,178.6**

3.4.1 Awareness raising activities for activities for the community about (RE &EE)

The first step is to organize frequent awareness-raising campaigns for Semqanieh residents within the 2030 horizon, which can be initiated by the municipality. Citizens' participation is critical because the residential sector consumes the majority of total energy consumption. The following activities are intended to increase citizens' environmental awareness:

- Organization of "Energy info days"; in these energy days, the focus will be on the importance of energy saving and protecting the environment through simple actions such as changing of energy consumption behavior, replacing inefficient lamps with LED lamps, purchasing high energy efficiency class appliances, installation of solar panels for water heating in existing buildings etc.
- Projection of freely available environmental documentaries.
- Participation in "Earth hour" event by WWF, where people across the world turn their lights off for one hour on a designated day.

Related calculations on the action in terms of initial cost and emission savings are presented in Table 30 below.

Table 30: Action 3.4.1 in numbers

Awareness raising activities for activities for the community about (RE &EE)	
Duration	2023 – 2030
Total Implementation Cost (EURO)	2000
Annual Energy Savings (MWh)	2,178.56
Annual Emission Reduction (tn CO_2)	1,483.6
Funding Source	Own funds, external funds
Net Present Value (NPV)	>>0

3.4.2 Promotion of Green Buildings' concept

The lack of enforcement/availability of the Energy Efficient Building Code in Lebanon is one of the key issues behind the low energy performance of buildings. This action is focusing new and old buildings.

The promotion of specific elements of the green buildings' concept that can be applied in around 10% of the buildings to be constructed. This 10% penetration level has been considered an average rate with which citizens adopt such types of measures, following the intensive awareness raising activities to be realized by Manouba Municipality. Also, the Municipality will proceed in consultations with the building constructors and try to establish voluntary agreements with them in order that they apply some minimum energy efficiency standards in the new constructions, to be commonly agreed. Customized sets of potential interventions and actions will be suggested to the citizens through info days and awareness activities in the local media (local newspapers, TV and radio), as well as distribution of dissemination material (flyers, brochures etc.), in line with the action described above. These interventions will be mainly focusing on the need to install shadings in the southern glazing and roof insulation. Low cost-efficient technologies will be promoted as well, such as the use of energy efficient lamps (e.g. LEDs). The green municipal building will serve as a demonstration basis of these technologies and the existing potential for energy and cost reductions.

Related calculations on the action in terms of initial cost and emission savings are presented Table 31 below.

Table 31: Action 3.4.2 in numbers

Promotion of Green Buildings' concept	
Duration	2023 – 2030
Total Implementation Cost (EURO)	25000
Annual Energy Savings (MWh)	9,837.17
Annual Emission Reduction (tn CO_2)	3,838.1
Funding Source	Own funds, Governmental funds, Private funds
Net Present Value (NPV)	<<0

3.4.3 Campaign for promoting high energy label equipment

Another important activity the municipality should organize is a campaign for promoting among the residents the purchase and use of high-class energy labeled equipment. The old equipment (refrigerators, stoves, vacuum cleaners etc.) consumes greater amounts of energy compared to new ones. The aim is to inform the residents about the benefits of goods with a reduced environmental impact throughout their life cycle, emphasizing also on the cost benefits for the users themselves, since when selecting energy efficient products lead to less energy consumption as well. As presented in the previous sections, dedicated awareness raising activities should also take place in order to disseminate the advantages of purchasing such electrical appliances. Indicative awareness raising campaigns include brief spots on the local TV and radio, posters, info days etc.

Key data on the action and its expected impact is presented in the table 32 below.

Table 32: Action 3.4.3 in numbers

Campaign for promoting high energy label equipment	
Duration	2023 – 2027
Total Implementation Cost (EURO)	15,000
Annual Energy Savings (MWh)	10,247
Annual Emission Reduction (tn CO_2)	4,031.6
Funding Source	Own funds, external, Private and residential funds
Net Present Value (NPV)	>0

3.4.4 3.6 MW Photovoltaics in residential rooftops

As mentioned before, the solar energy potential is very high in the Lebanon. The households have the opportunity to install PV panels on buildings' rooftops in order to substitute all/part of the current electricity consumption with "green" energy from Renewable Energy Sources. A 3.6 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 significantly. The municipality will conduct activates for the communities to promote the installation of PV systems.

Key data on the action are presented in Table 33 below.

Table 33: Action .3.4.4 in numbers

3.6 MW Photovoltaics in residential rooftops	
Duration	2023 – 2030
Total Implementation Cost (EURO)	5,000,000
Annual Energy Production (MWh)	9,017.4
Annual Emission Reduction (tn CO_2)	3,547.8
Funding Source	Private funds, Loans
Net Present Value (NPV)	>>0

3.4.5 Replacing existing electric water heater with solar collectors

Hot water for domestic use is a constant requirement in every household. As a result, this activity currently consumes a significant amount of electricity and gas. Replacing existing electricity and gas water heating systems with solar water heaters will significantly reduce energy consumption and carbon emission. The size of solar water heaters that could be implemented through this action has been estimated cover around 50% of households by 2030 (about 2000 households), considering that Semqanieh will work towards this direction with its citizens through awareness raising activities and dedicated events.

Table 34: Action 3.4.5 in numbers

Replacing Existing Electric Water Heaters with Solar Collectors	
Duration	2023 – 2030
Total Implementation Cost (EURO)	1,500,000
Annual Energy Production (MWh)	4,098.82
Annual Emission Reduction (tn CO_2)	1,612.6
Funding Source	Private funds
Net Present Value (NPV)	>>0

3.4.6 Using efficient diesel space heaters instead of traditional

The use of efficient diesel space heaters in the residential sector is currently limited. So, instead of traditional space heaters, the proposal is to use efficient diesel space heaters. Their prices are slightly higher than traditional ones, but they are more durable, save energy, and reduce carbon emissions.

This action could be planned first through an intensive awareness campaign for citizens to promote the use of efficient heaters. Within the first three to four years, it is assumed that a penetration rate of 20% could be achieved, resulting in significant energy and emission reductions. This activity could be continued in the future until 2030 to reach a penetration rate of more than 50%.

Key data on the action are presented in Table 35.

Table 35 Action 3.4.6 in numbers

Using efficient diesel space heaters instead of traditional	
Duration	2023 – 2030
Total Implementation Cost (EURO)	1,000,000
Annual Energy Savings (MWh)	24,159.55
Annual Emission Reduction (tn CO_2)	6,450.6
Funding Source	Private funds
Net Present Value (NPV)	>0

3.4.7 Use the insulation on rooftops

As mentioned above, the share of space heating in residences is very high due to the region's cold climate. Another measure to partially curtail the energy consumption for heating, besides the previous one, is the use of insulting bricks on rooftops in order to reflect a higher percentage of the insulation, thus maintaining the inner temperature at higher levels. Use of insulting bricks and/or materials is a technology easily applied on the building. The energy savings from such an action are usually allocated in the top building floor and reach 5% of the energy consumption for heating purposes. The penetration level of this action in existing buildings is considered to be 10%. The Municipality's role once again is to communicate to the citizens the benefits of this action, also utilizing the demonstrative projects and other awareness activities to be conducted.

Related calculations on the action in terms of initial cost and emission savings are presented in Table 36 below.

Table 36: Action 3.4.7 in numbers

Use the insulation on rooftops	
Duration	2023 - 2030
Total Implementation cost (EURO)	1,500,000
Annual Energy Savings (MWh)	627.12
Annual Emission Reduction (tn CO_2)	246.7
Funding Source	Private funds
Net Present Value (NPV)	<<0

3.4.8 Replacement of single glazing with double

The climate in the region evokes the intense use of windows with double glass in buildings as a quite high percentage of energy consumption is due to this need. By replacing existing single-glazed windows with double-glazed ones, sizable energy and emission reduction can be realized. In this regard, the municipality can take the lead by demonstrating and publicizing some good examples of such action. It is assumed that a penetration rate of 10% of the existing houses will replace their exiting single-glazed windows with double-glazed ones.

Related calculations on the action in terms of initial cost and emission savings are presented in Table 37 below.

Table 37 Action 3.4.8 in numbers

Replacement of Single Glazing with Double	
Duration	2023 – 2030
Total Implementation Cost (EURO)	500,000
Annual Energy Savings (MWh)	2459.3
Annual Emission Reduction (tn CO_2)	967.6
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, Water management facilities etc. This consumption constitutes the 9.72% of the total energy consumption in the city, with 9.57% contribution to the CO2 emissions.

The initial actions are informative and will be carried out by Manouba Municipality. Since the municipality does not have the authority 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 38.

Table 38: Actions in Tertiary Sector Buildings

Action No.	Action	Emission Reductions ($tnCO_2$)
3.5.1	Promotion of using insulation for buildings	507.82
3.5.2	Photovoltaics on rooftops	1500
3.5.3	Replacement of existing lamps with LEDs	59.95
3.5.4	Replacement of single glazing with double	142.38
3.5.5	Replacement of existing air conditioners with more efficient ones	14.24
3.5.6	Installation of lighting motion sensors	7.12
3.5.7	Awareness raising activities about EE	173.23
3.5.8	use of Solar Water Heaters	14.24
3.5.9	PV for WWTP	28.48
3.5.10	PV for water pumping station	6.17
3.5.11	The 100% commitment campaign for schools for PV	3.8
3.5.12	Upgrade water facilities	14.24
	Total	2,471.67

3.5.1 Campaign to promote of using insulation for buildings

The goal of this campaign is to raise environmental awareness among buildings' owners/operators through their voluntary participation. It is designed as a promotional campaign to increase the sense of responsibility toward the environment and the community, while also providing visibility benefits to those who participate. The campaign will emphasize the significance of using insulation on wools and rooftops.

Related calculations on the action in terms of initial cost and emission savings are presented in table 39 below.

Table 39: Action 3.5.1 in numbers

The 10% voluntary campaign for energy reduction in tertiary buildings	
Duration	2023 - 2027
Total Implementation Cost (EURO)	150,000
Annual Energy Savings (MWh)	1,510.4
Annual Emission Reduction (tn CO2)	507.82
Funding Source	Own funds & external funds

3.5.2 2.5 MWp Photovoltaics on rooftops

The solar energy potential for the country and Semqanieh region is very high thus businesses will be encouraged to exploit this opportunity and install PV systems in order to curtail a part of their electricity consumption. To realize this action, it is proposed to install 2.4 MW_p solar PV systems on building's rooftops or any other available area suitable for PV installation. As known, the produced electricity from Renewable Energy Sources has zero emission. Consequently, the substitution of electricity consumed from the national grid with renewable energy source will significantly contributes to the CO2 reduction.

Table 40: Action 3.5.2 in numbers

Photovoltaics on rooftops- 2.5 MWp	
Duration	2023 - 2030
Total Implementation Cost (EURO)	3,000,000
Annual Energy Production (MWh)	4,200
Annual Emission Reduction (tn CO_2)	1,500
Funding Source	Private funds
Net Present Value (NPV)	>>0

3.5.3 Replacement of existing lamps with LEDs

A campaign to replace existing inefficient lamps with efficient LEDs is another important activity that the municipality should organize. The goal is to raise awareness among business owners/managers about the advantages of goods that have a lower environmental impact throughout their life cycle. As previously stated, awareness raising activities should be carried out in order to disseminate the benefits of purchasing LED lamps.

Table 41: Action 3.5.3 in numbers

Replacement of existing lamps with LEDs	
Duration	2023 - 2027
Total Implementation Cost (EURO)	140,000
Annual Energy Savings (MWh)	88
Annual Emission Reduction (tn CO_2)	59.95
Funding Source	Own, and Private funds
Net Present Value (NPV)	>0

3.5.4 Replacement of single glazing with double

As mentioned previously in the section of residential sector, this action can also be applied to the tertiary sector. It is assumed that a penetration rate of 10% of the existing buildings will replace their exiting single-glazed windows with double-glazed ones.

Key data on the action are provided in Table 42.

Table 42: Action 3.5.4 in numbers

Replacement of single glazing with double	
Duration	2023 - 2030
Total Implementing cost (EURO)	120,000
Annual Energy Savings (MWh)	423.48
Annual Emission Reduction (tn CO_2)	142.38
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.5 Replacement of existing air conditioners with more efficient ones

Replacement of existing inefficient air condition units by efficient ones will lead to a tangible energy savings and carbon reduction. It is assumed that around 25% percent of the existing buildings/facilities will adopt this action and start replacing their old ACs with new efficient ones.

Table 43: Action 3.5.5 in numbers

Replacement of existing air conditioners with more efficient ones	
Duration	2023 - 2030
Total Implementation cost (EURO)	110,000
Annual Energy Savings (MWh)	20.91
Annual Emission Reduction (tn CO_2)	14.24
Funding Source	Private funds
Net Present Value (NPV)	<0

3.5.6 Installation of lighting Motion sensors

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

Key data on the action are provided in Table 44 below.

Table 44: Action 3.5.6 in numbers

Installation of lighting Motion sensors	
Duration	2023 - 2030
Total Implementation cost (EURO)	3,000
Annual Energy Savings (MWh)	10.46
Annual Emission Reduction (tn CO_2)	7.12
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.7 Awareness raising activities about EE

Continuous campaigns are essential for citizens' and societies to ensure continued improvement. Based on this fact, and considering the tertiary sector's high contribution to the municipality's carbon footprint, the municipality intends to organize a series of seminars for targeted professional groups to promote the concept of energy management and energy saving practices, as well as provide advice on low-cost ways to improve the energy efficiency of related buildings and facilities.

Semqanieh municipality will continue its efforts in organizing series of seminars, where each seminar may involve group of interested participants from the sector to discuss available opportunities/solutions to improve the performance of their buildings/facilities. Users' energy-use behavior is an important factor in achieving significant reductions in building energy consumption. Since the energy consumption for air conditioning and lighting systems is highly influenced by users', seminars/workshops are essential for delivering appropriate messages that lead to changes in energy-use behavior. These messages may include but not limited to using equipment or appliances only when needed, installation of timers and sensors to control equipment operation, using efficient equipment and etc.

It is assumed that this action will lead to approximately 10% of carbon reduction in tertiary sector.

Table 45: Action 3.5.7 in numbers

Awareness raising activities about RE & EE	
Duration	2023 - 2030
Total Implementation cost (EURO)	10,000
Annual Energy Savings (MWh)	254.38
Annual Emission Reduction (tn CO_2)	173.23
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.8 Using of Solar Water Heaters

Hot water is used in a variety of tertiary sector businesses and activities, including schools, hospitals, universities, and hotels. Currently, they primarily use gas or electricity as a source of energy for water heating. The replacement of existing energy sources for water heating with solar water heaters will result in noticeable reductions in energy consumption and carbon emissions.

Key data on the action are presented in Table 46 below.

Table 46: Action 3.5.8 in numbers

Using of Solar Water Heaters	
Duration	2023 - 2027
Total Implementation cost (EURO)	750,000
Annual Energy Production (MWh)	53.33
Annual Emission Reduction (tn CO_2)	14.24
Funding Source	Own and External
Net Present Value (NPV)	>0

3.5.9 Installing PV for WWTP

As discussed in previous section for residential sector, solar PV systems can be utilized for this sector also. It is proposed that the existing waste water treatment plant (WWTP) can be powered by renewable energy from a 100 KWp photovoltaic (PV) system installed nearby.

Table 47: Action 3.5.9 in numbers

Installing PV for WWTP	
Duration	2023
Total Implementation cost (EURO)	200,000
Annual Energy Savings (MWh)	41.82
Annual Emission Reduction (tn CO_2)	28.48
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.10 Installing PV for Water Pumping Facility (WPF)

The responsible entity for the water pumping facility in cooperation with the municipality are encouraged to utilize solar energy to cover the WPF electricity consumption by installing solar PV systems. It is assumed that a 40 KW of r PV systems will be installed for this facility. This action will lead to a significant reduction in electricity consumption and carbon emission.

Table 48: Action 3.5.10 in numbers

Installing PV for Water Pumping Facility	
Duration	2023
Total Implementation cost (EURO)	100,000
Annual Energy Savings (MWh)	9
Annual Emission Reduction (tn CO_2)	6.17
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.11 The 100% commitment campaign for schools for installing PV

Public and private schools are encouraged to utilize solar energy to cover their electricity consumption by installing solar PV systems. It is assumed that a 40 KW of rooftop PV systems will be installed for some of these schools. This action could be scaled up in the future leading to significant reduction in electricity consumption and carbon emission.

Table 49: Action 3.5.11 in numbers

The 100% commitment campaign for schools for installing PV	
Duration	2023-2030
Total Implementation cost (EURO)	100,000
Annual Energy Savings (MWh)	5.58
Annual Emission Reduction (tn CO_2)	3.8
Funding Source	Private funds
Net Present Value (NPV)	>0

3.5.12 EE Measures for WWTP

The wastewater treatment plants for Semqanieh needs to be upgraded and use energy efficient equipment to fulfill the requirements to treat the wastewater from Semqanieh municipality.

Key data on the action are provided in Table 50 below.

Table 50: Action 3.5.12 in numbers

Upgrade water facilities	
Duration	2023-2030
Total Implementation cost (EURO)	125,000
Annual Energy Savings (MWh)	20.91
Annual Emission Reduction (tn CO_2)	14.24
Funding Source	External funds
Net Present Value (NPV)	>0

3.6 Transport

The share of the Transportation sector, including the municipal fleet, private and commercial transport and public transport is 4.35% out of the total energy consumption in Semqanieh Municipality, with 3.21% contribution in CO2 emissions. The proposed actions are presented in the next table and a more detailed analysis for each one is following.

Table 51 Actions in Transport

Action No.	Action	Emission Reductions ($tnCO_2$)
3.6.1	Information events on the new vehicle technologies replacement of diesel vehicles with more efficient ones	39
3.6.2	Traffic congestion reduction through the adoption of different timing of activities	12.12
3.6.3	Promotion of walking and car sharing and carpooling campaigns	97.3
3.6.4	Improvement / development of parking infrastructure	24.4
3.6.5	promotion of using schools' buses rather than private cars	12.12
3.6.6	awareness campaign for preventive maintenance for cars	12.12
3.6.7	Eco-driving for public transportation	73.37
3.6.8	Cycling promotion and creation of related infrastructure	60.61
	Total	331.04

3.6.1 Information events on the new vehicle technologies

Private and commercial vehicles have the larger share in energy consumption between the other transports. It is proposed that the Municipality will organize awareness raising activities in order to inform the citizens about new technology's cars and the dual fuel cars followed by their economic and environmental benefits. The next step will be for citizens to buy these cars instead of traditional ones, such as replacing gasoline vehicles with newer.

Table 52 : Action 3.6.1 in numbers

Information events on the new vehicle technologies	
Duration	2023 – 2027
Total Implementation Cost (EURO)	3,000,000
Annual Energy Savings (MWh)	156.62
Annual Emission Reduction (tn CO_2)	39
Funding Source	Own and external, Private funds
Net Present Value (NPV)	>0

3.6.2 Traffic congestion reduction through the adoption of different timing of activities

Traffic congestion is a problem within Semqanieh Municipality. Therefore, in order to decrease the time and fuel spent by the drivers in their attempt to arrange the public activities in different time. More specifically, the plan is to adopt the activities in different times to reduce the traffic especially in the center.

Table 53 : Action 3.6.2 in numbers

Traffic congestion reduction through the adoption of different timing of activities	
Duration	2024 - 2027
Total Implementation Cost (EURO)	0
Annual Energy Savings (MWh)	48.67
Annual Emission Reduction (tn CO_2)	12.12

3.6.3 Promotion of walking and car sharing and carpooling campaigns

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

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

The proposed actions are somewhat expensive, and funding will be required because they are infrastructure actions. It will, however, contribute to the improvement of living conditions. Additional indirect benefits, such as attracting residents and tourists to the municipality and improving quality of life, should be considered for the project's profitability. As a result, it is regarded as necessary for the city, despite the fact that it provides no direct economic benefit to the municipal authorities. A mobile application could also be created for added convenience.

In other cases, where the distances are greater, it would be a great alternative way for people working together (or in nearby buildings) to arrange driving to work in groups, using a single car. In this case, the municipal website may be useful in allowing people with similar transportation habits to communicate and organize their trips.

Table 54: Action 3.6.3 in numbers

Information events on the new vehicle technologies	
Duration	2023 – 2027
Total Implementation Cost (EURO)	8,000
Annual Energy Savings (MWh)	390.76
Annual Emission Reduction (tn CO_2)	97.3
Funding Source	External funds

3.6.4 Improvement / development of parking infrastructure

Traffic congestion is a problem within Semqanieh 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 55: Action 3.6.4 in numbers

Improvement / development of parking infrastructure	
Duration	2024 - 2027
Total Implementation Cost (EURO)	290,500
Annual Energy Savings (MWh)	98
Annual Emission Reduction (tn CO_2)	24.4
Funding Source	Own and external funds

3.6.5 Promotion of using schools' buses rather than private cars

The overarching goal of providing buses to schools is to improve student mobility and reduce fuel consumption. The municipality's role in this case is to encourage public schools to use buses for student mobility and to organize public awareness-raising activities to educate citizens about the environmental and economic benefits of using school buses.

Table 56: Action 3.6.5 in numbers

Promotion of using schools' buses rather than private cars	
Duration	2023-2029
Total Implementation Cost (USD)	12,000
Annual Energy Savings (MWh)	48.67
Annual Emission Reduction (tn CO_2)	12.12
Funding Source	Own and external funds

3.6.6 Awareness campaign for preventive maintenance for cars

Private and commercial vehicles have the larger share in energy consumption between the other transports. It is proposed that the Municipality will organize awareness raising activities in order to inform the citizens about preventive maintenance for cars and vehicles followed by their economic and environmental benefits. The next step will be citizens conduct preventive maintenance for their cars.

Table 57: Action 3.6.6 in numbers

Awareness campaign for preventive maintenance for cars	
Duration	2023 – 2028
Total Implementation Cost (EURO)	10,000
Annual Energy Savings (MWh)	48.67
Annual Emission Reduction (tn CO_2)	12.12
Funding Source	Own and external
Net Present Value (NPV)	>0

3.6.7 Promotion of eco-driving for public transport's drivers

Focusing now on the Public and private Transportation sector, the first proposed action is the promotion of eco driving. Similarly, with the two previous sectors, public and private transport's drivers may be encouraged to adapt eco-driving principles in order to reduce fuel consumption and CO2 emissions from the public and private fleet. This can be achieved through raising awareness activities and trainings realized by the municipality.

Table 58: Action 3.6.7 in numbers

Promotion of eco-driving for public and Private transport's drivers	
Duration	2023 – 2029
Total Implementation Cost (EURO)	3,000
Annual Energy Savings (MWh)	294.65
Annual Emission Reduction (tn CO_2)	73.37
Funding Source	Own and external funds

3.6.8 Cycling promotion and creation of related infrastructure

Semqanieh Municipality will build the necessary cycling infrastructure in order to promote as many new transportation approaches as possible that reduce energy consumption for transportation. This action almost comes at low/ no cost to the municipality and is expected to significantly reduce its carbon footprint.

Table 59: Action 3.6.8 in numbers

Cycling promotion and creation of related infrastructure	
Duration	2025-2027
Total Implementation Cost (EURO)	580,000
Annual Energy Savings (MWh)	243.41
Annual Emission Reduction (tn CO_2)	60.61
Funding Source	Private funds
Net Present Value (NPV)	>0

3.7 Local Renewable Energy Production

Besides the above-mentioned small-scale RES projects by private investors and Al-Semqnieh Municipality, there are also plans for a big scale Renewable Energy Project which will significantly contribute to the region's CO2 reduction. More specifically a PV Farm of 300kW is planned to be installed in Semqanieh Municipality.

In the next table figures about the respective electricity production and CO2 reduction are presented.

Table 60: Action 3.7

	Electricity Production (MWh)	Emission Reduction (tn CO_2)
PV Farm 0.3 MW	518.8	353.3

3.8 Waste Management

Waste management sector contribute ingenerating the CO2 emission in the total CO2 emissions in the municipality. The share of the waste generation sector, including the all types of waste is 1.86% contribution in CO2 emissions.

3.8.1 Awareness raising campaigns to reduce the amounts of discarded food

The awareness activities will target all the sectors of in the Municipality; tertiary, commercial residential and municipal employees. The awareness aims at reducing the generation of the organic content in the solid waste by 20% through the horizon of 2030.

This action is expected to contribute significantly in the municipality's carbon footprint's reduction.

Table 61: Action 3.8.1 in numbers

Awareness raising campaigns to reduce the amounts of discarded food	
Duration	2023-2030
Total Implementation Cost (USD)	24,000
Annual Emission Reduction (tn CO_2)	46
Funding Source	Private funds
Net Present Value (NPV)	<0

3.9 Agriculture Sector

3.9.1 Planting Forest Trees

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.

The table below illustrates the information that present the action.

Table 62 Action 8.1 in numbers

Planting Forest Trees	
Duration	2023-2030
Total Implementation Cost (EURO)	2,100,000
Number of Trees	50,000
CO2 reduced (Tn CO2)	1085
Funding Source	Own and external funds

3.10 Actions' Overview

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

Table 63 Summary of the mitigation actions

Action No.	Action	Emission Reduction (tn CO2)
Municipal Buildings		
3.2.1	Green procurement procedures for municipal buildings	3.32
3.2.2	Replacing the existing non-efficient lamps with LED Lamps Semqanieh municipal buildings	5.60
3.2.3	Energy manager appointment in the municipality	0.17
3.2.4	Awareness raising activities for municipal employees	0.62
3.2.5	PVs in municipal building's roof	41.5
3.2.6	Establishment of Energy Saving Department	0.0
3.2.7	Social media portal creation portal creation	0.0
Sub-Total		51.21
Street Lighting		
3.3.1	Street lighting upgrade	90
3.3.2	Astronomical timers	30
Sub-Total		120
Residential buildings		
3.4.1	Awareness raising activities for the community about (RE &EE)	1,483.6
3.4.2	Promotion of Green Buildings' concept	3,838.1
3.4.3	Campaign for promoting and replacing high energy label equipment	4,031.6
3.4.4	3.6 MW Photovoltaics in residential rooftops	3,547.8
3.4.5	Replacing existing electric water heater with solar collectors	1,612.6
3.4.6	Replacement of old diesel space heater with more efficient	6,450.6
3.4.7	Use of insulation bricks in rooftops	246.7
3.4.8	Replacement of single glazing with double	967.6
Sub-Total		22,178.6
Tertiary Sector		
3.5.1	Promotion of using insulation for buildings	507.82

3.5.2	Photovoltaics on rooftops	1500
3.5.3	Replacement of existing lamps with LEDs	59.95
3.5.4	Replacement of single glazing with double	142.38
3.5.5	Replacement of existing air conditioners with more efficient ones	14.24
3.5.6	Installation of lighting motion sensors	7.12
3.5.7	Awareness raising activities about RE&EE	173.23
3.5.8	Use of Solar Water Heaters	14.24
3.5.9	PV for WWTP	28.48
3.5.10	PV for water pumping station	6.17
3.5.11	The 100% commitment campaign for schools for PV	3.8
3.5.12	Upgrade water facilities	14.24
Sub-Total		2,471.67
Transport Sector		
3.6.1	Information events on the new vehicle technologies- Replacement of diesel vehicles with new more efficient	39
3.6.2	Traffic congestion reduction through the adoption of different timing of activities	12.12
3.6.3	Promotion of walking and car sharing and carpooling campaigns	97.3
3.6.4	Improvement / development of parking infrastructure	24.4
3.6.5	promotion of using schools' buses rather than private cars	12.12
3.6.6	awareness campaign for preventive maintenance for cars	12.12
3.6.7	Eco-driving for public transportation	73.37
3.6.8	Cycling promotion and creation of related infrastructure	60.61
Sub-Total		331.04
Local Renewable Energy Production		
3.7	PV Farm 300kW	353.3
Sub-Total		353.3
Waste management		
3.8.1	Awareness raising campaigns to reduce the amount of discarded food.	46
Sub-Total		46
Agriculture Sector		
3.9.1	Planting Trees	1,085
Sub-Total		1,085
Total		26,636.82

In terms of costs, all actions will cost approximately 20,535,680 EURO from all entities (municipality, private and external funding).

To meet the 40% target, Semqanieh Municipality and the Government should make concerted efforts to strictly implement the SECAP and seek agreements and funds from national and international funding agencies.

3.11 Monitoring

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

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

Table 64 suggested indicators to monitor each action's progress

Action		Key Performance Indicator	Measurement Units
Municipal Buildings			
3.2.1	Green procurement procedures for municipal buildings	• Number of equipment bought with green procurementprocedures	• Equipment number/year
3.2.2	Replacing the existing non-efficient lamps withLED Lamps Semqanieh municipal buildings	• Percentage of installed capacity compared to the initialtarget	• Number of LED units installed.
3.2.3	Energy manager appointment in themunicipality	• Years that the Energy Manager is appointed and active • Quantity of municipal infrastructure under hissupervision • Energy savings under his supervision	• Number of years • Number and % of municipal infrastructurebeing supervised • KWh
3.2.4	Awareness raising activities for municipalemployees	• Number of training seminars that were implemented • Municipal employees that were trained	• Number of seminars • Number of employees
3.2.5	PV (for municipal buildings)	• Installed PV capacity • Percentage of installed capacity against the initial target	• KWp • % out of 5 kWp
3.2.6	Establishment of an Energy Saving Department	• Number of people served by the Energy Department • Employees in the Energy Saving Department	• Number of people
3.2.7	Social media portal creation	• Number of followers in the portal.	• Number of followers

Street Lighting			
3.3.1	Street lighting system upgrade	• Lamps that were replaced with energy efficient ones	• Number of lamps
3.3.2	Astronomical timers	• Percentage of astronomical timers against initial target	• %
Residential Sector			
3.4.1	Awareness raising activities for the communityabout (RE &EE)	• Number of seminars & information days • Attendants in each event	• Number of activities • Number of people attending each event
3.4.2	Promotion of Green Buildings' concept	• Number of promotion actions • Average attendance • Share of new Green buildings in total new buildings • Average energy savings of green building/m^2	• Number of seminars, leaflets etc. • People attended each action • % • KWh/m^2
3.4.3	Campaign for promoting high energy labelequipment and other awareness activities	• Number of promotion actions • Average attendance	• Number of seminars, leaflets etc. • Number of people attending each event
3.4.4	3.6 MW Photovoltaics in residential rooftops	• Installed PV capacity on roofs • Percentage of installed capacity against the initial target	• MWp • % out of 3.6 MWp
3.4.5	Replacing existing electric water heater withsolar collectors	• Increase of solar water heaters installation	• Number of solar water heaters
3.4.6	Replacement of old diesel space heater with more efficient	• Number of diesel heaters replaced with efficient	• Number of diesel heaters replaced eachyear
3.4.7	Use of insulation bricks on rooftops	• Surface that insulation bricks have been applied • Number of buildings using insulation bricks	• m^2 • Number of buildings
3.4.8	Replacement of single glazing with double	• Surface of double glazing	• m^2
Tertiary			
3.5.1	Promotion of insulation for buildings	• Number of building installed insulations. • Number of promotion actions • Average attendance	• Number of buildings • Number of seminars, leaflets etc. • Number of people attending each action

3.5.2	Photovoltaics on rooftops	• Installed PV capacity on roofs • Percentage of installed capacity against the initial target	• MWp • % MWp
3.5.3	Replacement of existing lamps with LEDs	• Number of lamps replaced with LEDs	• Number of lamps replaced each year
3.5.4	Replacing single glace windows with doubleglass.	• Number of windows heaters replaced. • area of double glass were installed.	• Number of windows • m^2 of double glass
3.5.5	Replacement of existing air conditioners withmore efficient ones	• Number of A/Cs replaced with new ones	• Number of A/Cs
3.5.6	Installation of lighting motion sensors	• Number of motions sensors were installed	• Number of motions sensors
3.5.7	Awareness raising campaign about RE&EE	• Number of implemented campaigns • Number of audience attended	• Number of campaigns • Number of audience
3.5.8	Use of Solar Water Heaters	• Number installed SWHs	• Number of SWHs.
3.5.9	Installing PV for Waste water treatment plant	• Installed PV capacity in WWTP	• MWp
3.5.10	installing PV for water pumping station	• Installed PV capacity in WWTP	• MWp
3.5.11	100% commitment campaign for schools to install PV	• Installed PV capacity on schools' roofs • Percentage of installed capacity against the initial target	• MWp • % out of 100%.
3.5.12	Upgrade Water Facilities	• Number of EE systems installed. • Electrical energy reduced	• Number of systems • KWh.
		Transport	
3.6.1	Information events on the new vehicletechnologies	• Number of events • Attendants in each event	• Number of events • Number of people attending each activity
3.6.2	Traffic congestion reduction through theadoption of different timing of activities	• Appointment of each event arranged.	• Date and time
3.6.3	Promotion of walking and car sharing andcarpooling campaigns	• Length/surface of pavements constructed/refurbished • Number of walking signs installed • Number of parks etc. renovated	• km/ km^2 • Number of signs • Number of public areas • Number of activities

		• Number of awareness raising activities	
3.6.4	Improvement / development of parkinginfrastructure	• Number of parking lots constructed	• Number of parking lots
3.6.5	promotion of using schools buses rather thanprivate cars	• Number of students that are use schools' buses.	• Number of students
3.6.6	awareness campaign for preventive maintenance for cars	• Number of seminars were held. • Number of attendances	• Number of seminars • Number of people attending each action
3.6.7	Promotion of eco-driving for publictransportation	• Number of seminars implemented • Number of drivers attending the seminars	• Number of seminars • Number of drivers
3.6.8	Cycling promotion and creation of relatedinfrastructure	• Number of bicycles were bought	• Number of bicycles
Local Renewable Energy Production			
3.7	300 Kw PV Farm	• Installed PV capacity • Percentage of installed capacity against the initial target	• MWp • % out of 300 kWp
Waste Management			
3.8	Awareness raising campaigns to reduce theamounts of discarded food	• Number of seminars implemented • number of audience that attended the seminars	• Number of Seminars. • Number of audience
Agriculture			
3.9	Planting trees	• Number of planted trees	• Number of trees

Chapter 4: Adaptation to Climate Change

4.1 Introduction on climate change impact

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

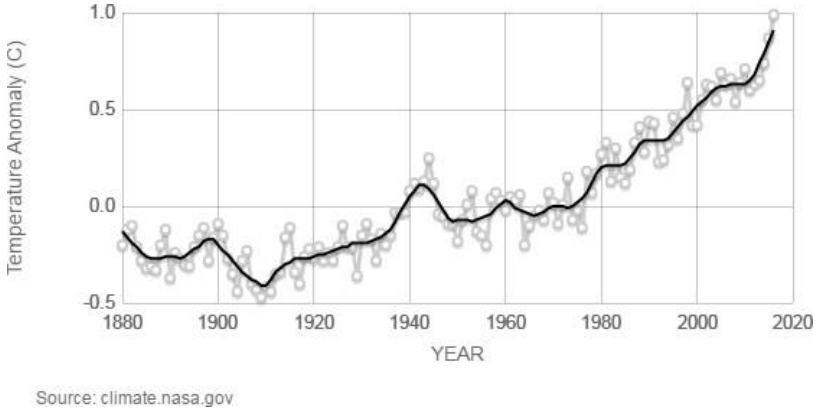


Figure 28 Land-ocean temperature variation

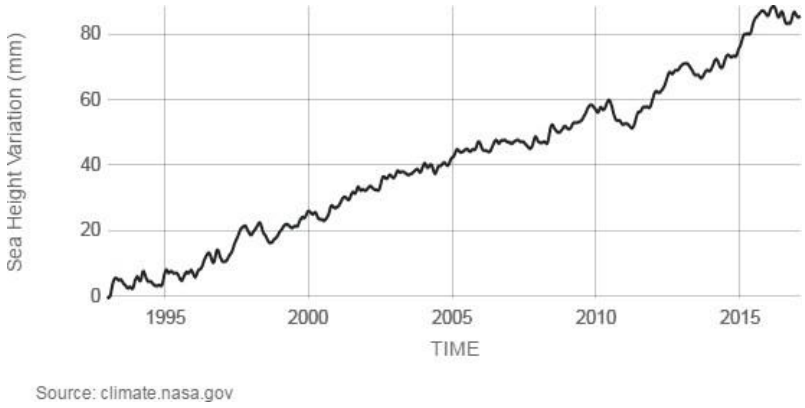


Figure 29 Sea level variation

In addition, in the next figure the global temperature variation is presented from 1884 to 2018 in a worldwide map.

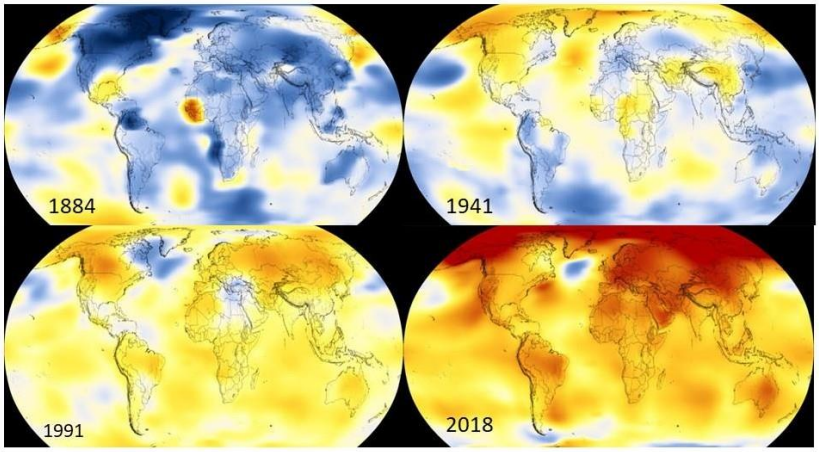


Figure 30 Global temperature variation

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

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

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

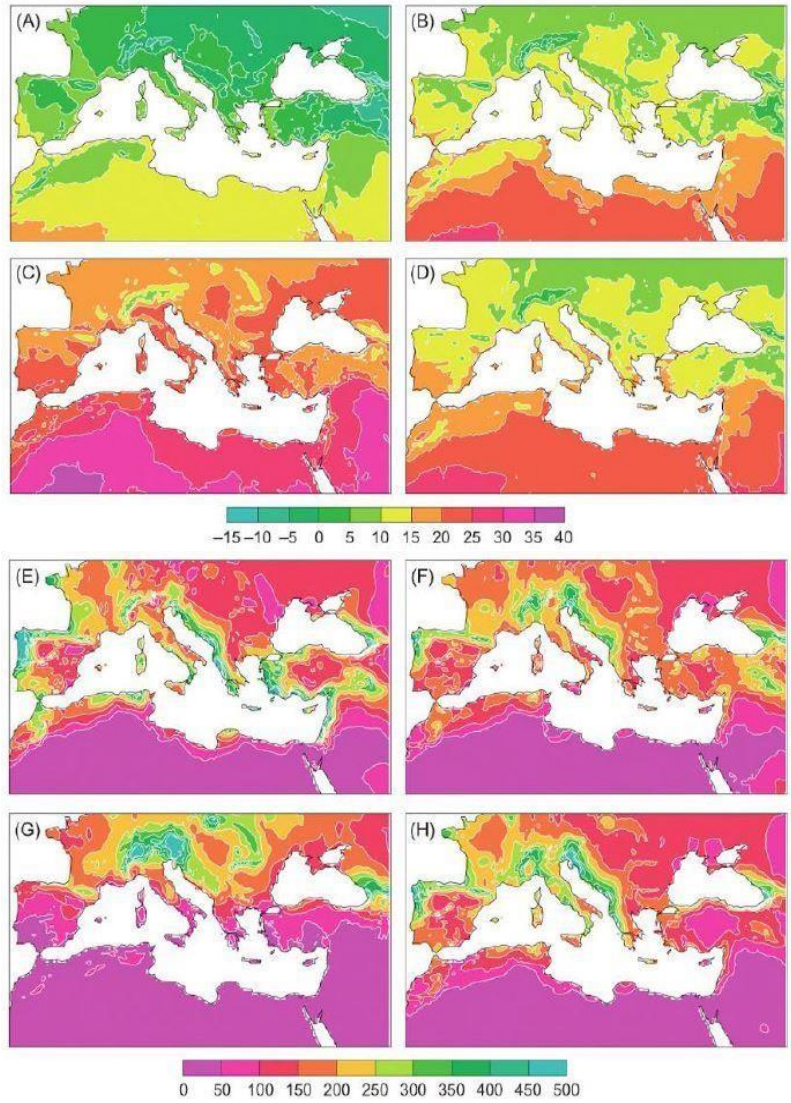


Figure 31 Seasonal (winter: December – January – February; sping: March – April – May; summer: June – July – August; autumn: September – Octomber – November) mean temperature (oC, panels A-D) and total precipitation (mm per season, panels E-H) maps for the period 1961 -1990 based on CRU data

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

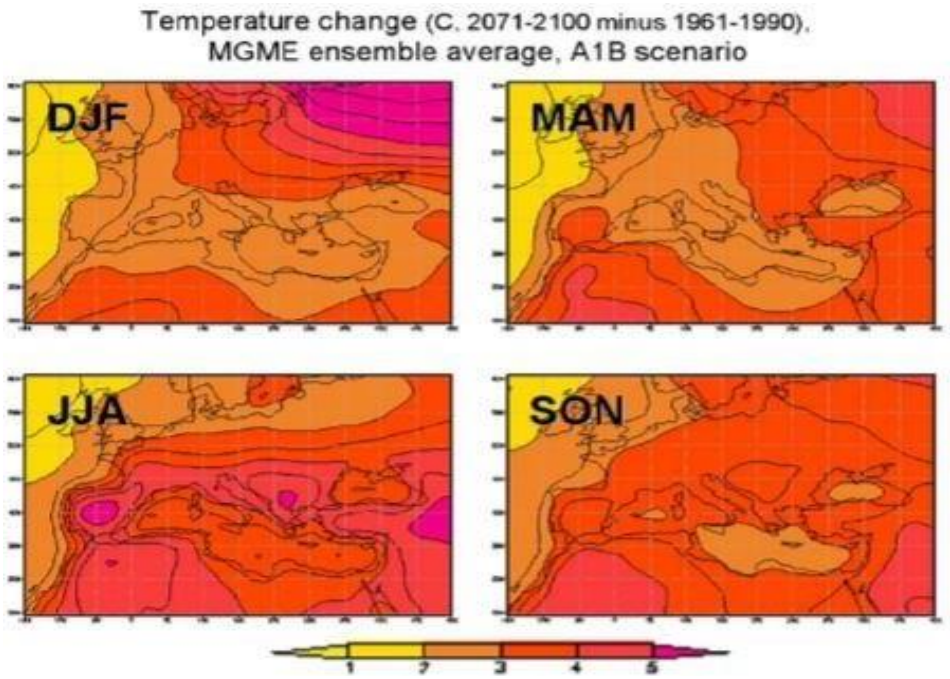


Figure 32 Multi Global Model Ensemble (MGME) average change in surface air temperature for the four seasons, 2071–2100 minus 1961–1990. Units are °C. DJF is December–January–February, MAM is March–April–May, JJA is June–July–August, SON is September–October–November

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

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

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

basin), as well as the high-demographic growth and socially vulnerable areas (Southern and Eastern rim, densely populated cities and suburbs).

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

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

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

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

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

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

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

Through the crucial issue of scarcity of water resources, their impacts are fraught with consequences in the 21st century for human activities, in particular agriculture, fishery, tourism, infrastructures, urbanized coastal areas and hydropower production. In order to minimize as much

as possible, the economic losses and damages, several adaptation options must be thought out and implemented.

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

4.2 Climate data for Lebanon

Current situation

Lebanon's climate is characterized by long, hot summers, and short cool winters. Temperature records extrapolated from Askaniia-Nova show a linear increase of 0.7°C from 1951-2000. However, seasonal variability is high.

Table 65 Climate data for Beirut, Lebanon.

Month	Average Max temperature (°C)	Mean total rainfall (mm)
January	16	125
February	16	99
March	18	59
April	21	42
May	26	9
June	28	0
July	30	0
August	31	0
September	30	0
October	28	51
November	22	42
December	18	123

As far as the wind is concerned, the average daily wind speed in January has been around 11 km/h, that's the equivalent to about 7 mph, or 6 knots. In recent years the maximum sustained wind speed has reached 69 km/h, that's the equivalent of around 43 mph, or 37 knots.

Table 66 Beirut – Lebanon region - Average wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Wind speed (Km/h)	66	56	78	63	93	74	74	37	39	48	78	74

4.3 Expected Climate Changes for Lebanon

According to the third communication report for FCCU the projected climatic changes in the Arab region and their impacts on natural resources were assessed through the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources in the Arab Region (RICCAR) which was led by the United Nations Economic and Social commission for Western Asia (ESCWA).

In Lebanon, the results of an ensemble of projections show an increase of 1.2°C and 1.7°C by mid-century (2046-2065) and up to 3.2°C by 2100. A decrease in precipitation of 4 to 11% is projected, with drier conditions by the end of the century (up to 5.8 mm decrease in average monthly precipitation).

Temperature and precipitation extremes will also intensify by the end of the century, causing the seasonal prolongation and geographical expansion of drought periods. RICCAR results show increasing trends of warming, reaching up to 43 additional days with maximum daily temperature higher than 35°C. The projections also trend towards drier conditions with an increase in number of consecutive dry days (maximum annual number of consecutive dry days when precipitation < 1.0 mm) by the end of the century. This indicated that the dry summer season will extend in length, projected by an additional maximum number of 6 consecutive drought days. This combination of significantly less wet and substantially warmer conditions will result in hotter and drier climate.

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.

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%.
- "D", corresponds to completion level of 0-25%.

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

Table 67 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	C
	Human, technical and financial resources identified	C
	Adaptation team (officer) appointed within the municipal administration and clear responsibilities assigned	B
	Horizontal (e.g. across departments) coordination mechanisms inplace	D
	Vertical (e.g. across governance levels) coordination mechanisms in place	D
	Consultative and participatory mechanisms set up, fostering the multi-stakeholder engagement in the adaptation process	A
	Continuous communication process in place	C
Step 2: Assessing risks and vulnerabilities to climate change	Mapping of the possible methods and data sources for carrying out a Risk &Vulnerability Assessment conducted	C
	Assessment of climate risks and vulnerabilities undertaken	B
	Possible sectors of actions identified and prioritized	A
	Available knowledge periodically reviewed and new finding integrated	A
Steps 3 and 4 – Identifying, assessing and selecting adaptation options	Full portfolio of adaptation actions compiled, documented and assessed	C
	Possibilities of mainstreaming adaptation in existing policies and plans assessed, possible synergies and conflicts identified	C
	Adaptation actions developed and adopted	D
Step 5: Implementing	Implementation framework set with clear milestones	B
	Adaptation actions implemented and mainstreamed as defined inthe SECAP document	B
	Coordinated action between adaptation and mitigation set	C
Step 6: Monitoring and evaluation	Monitoring framework in place for adaptation actions	D
	Appropriate monitoring and evaluation indicators identified	D
	Regular monitoring of the progress and reporting to the relevantdecision makers	D
	Adaptation strategy and/or Action Plan updated, revised andreadjusted according to the findings of the monitoring and evaluation procedure	D

4.5 Risk Assessment and Vulnerability Analysis

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

Table 68 Climate Hazard Types

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

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

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

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

Semqanieh Municipality has filled in the table below, in order to conduct the vulnerability analysis, based on sources such as the Future Cities Adaptation Compass Tool and UNFCCC.

Table 69 Vulnerability analysis (based on the Future Cities Adaptation Compass tool)

Receptors		Extreme weatherevent	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	• Energy supply and demand patterns' shift • Higher maintenance costs • Cooling problems	Conventional and renewable energy facilities (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 Precepetation	• 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

Table 70 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	Medium

			• Water quality issues	
		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
Biodiversity	Coastal zone ecosystems	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 haza

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

Table 71 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

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 Al-Semqnieh. Key measures to be applied under this program include:

1. Building the needed capacities to conduct health vulnerability assessments.
2. Educating and informing the public of the needed measures to protect health from the adverse impacts of climate change.
3. Developing climate-informed disease control programs and surveillance systems using meteorological services to target vector control in time and space.
4. Introducing new indicators that are useful for protecting health, such as Air Quality Index, UV index, in cooperation with the relevant institutions.
5. 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.

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.

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 considering 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 Al-Semqanieh municipality.

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

Campaigns should include information and advices for citizens on how they can protect themselves in case of extreme heats, floods, landslides, vector borne diseases etc. so as to prevent impacts and infections. The aim is to communicate the risks disseminating public messages through media, informational material and social media. Special efforts should be made to reach vulnerable population such as elderly people, children, citizens with chronic diseases and employees working outdoors. The estimated cost for this action is 60,000 Euro.

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 72 Suggested adaptation actions for infrastructure

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

Water management plan

The expected reduced precipitation, the temperature increase and the evaporation will result in less recharge and less replenishment of surface water and groundwater reserves. In addition, the water demand is increased and contributes in reducing per capita shares. An important action is to develop a plan so as to manage the water supply systems in order for instance to detect leakages, organize regular maintenance and notify the Municipality when such incidents take place.

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

A certain part of electricity consumption in Semqanieh, but also in all Lebanon, will depend 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.

Mapping of sites with landslides and flood risks

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

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

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

Support rainwater harvesting systems

The municipality will work on supporting store of rainwater for reuse on-site, rather than allowing it to run off. Rainwater can be collected from roads or roofs, and in many places, the water collected is redirected to a deep pit (well, shaft, or borehole), aquifer, a reservoir with percolation, or collected from dew or fog with nets or other tools. Its uses include water for gardens, livestock, irrigation, domestic use with proper treatment, indoor heating for houses, etc. The harvested water can also be used as drinking water, longer-term storage, and for other purposes such as groundwater recharge.

4.6.3 Built Environment

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

Table 73 Suggested adaptation actions for built environment

Actions' characteristic	Adaptation Actions
Strategic	Enforcement of building codes for more energy efficient and heat tolerant structures
	Integrated land use planning with zoning system depending on the different areas
Educational	Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises
Technical	Greening infrastructure such as buildings' roofs and walls
	Increasing the amount of shade and green areas in the city by planting trees and using green pavements to reduce the heat island effect
	Insolated bricks on roofs (insulators)
	Rainwater collection and use
	Adoption of methods to reduce water demand
	Using water resistant construction materials

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

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

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

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

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

Semqanieh 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 Semqanieh Municipality is going to implement a series of awareness activities in the mitigation and adaptation thematic fields, it is the Municipality's intention to group where possible these activities for better coordination.

Greening infrastructure such as buildings' roofs and walls

A green roof is covered with vegetation and between other purposes it serves to provide insulation and help to lower air temperatures. It also contributes in mitigating the heat island effect and in cleaning the air in parallel with decreasing stress of the inhabitants.

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

In order to adapt to the high temperatures, the Municipality could create shade and green areas in places where a lot of people gather or pass through their day. Trees and parks can contribute in reducing the heat island effect and provide outdoor thermal comfort as well as a shaded and breezy place for the people passing to rest. In addition, the chosen material for the construction of sidewalks should be heat absorbing so as to prevent the extra heating from the ground to be reflected. In that way, citizens will feel euphoria and will be partially protected by a heat stroke. This project is similar to the mitigation action section above.

Insolated bricks on roofs (insulators)

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

Rainwater collection and use

Collecting rainwater is an excellent way to conserve the fresh water. Using rain barrels, rainwater collection systems with big tanks underground (to avoid evaporations) can lead to significant water savings. This water could be used for domestic purposes like gardening, washing vehicles and equipment, flushing toilets etc. This action envisages rainwater collection in selected municipal buildings at first, as a pilot study.

Adoption of methods to reduce water demand

Since water scarcity is a major problem for Lebanon in general, and Semqanieh 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.

Using Water Resistance Constriction Material

The municipality will support using water resistance material in the construction phase. The support will be through awareness campaign to present the importance of using water resistance material in the building.

4.6.4 Economy

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

Table 74 Suggested adaptation actions for economy

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

Elaboration of water and ground water management plan

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

Adoption of integrated land use planning for the tertiary sector

Integrated land use planning is a strategy to prevent climate impacts such as flooding, drought, water scarcity and heat stress, as well as to avoid exposure of valuable elements to risks. The planning for the tertiary sector proposes that construction in flood areas should be avoided if possible, urban development should be planned in low hazard areas, development of buildings, housing, economical values etc. in flood risk areas should be restricted and storm water services should be planned.

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 75 Suggested adaptation actions for biodiversity

Actions' characteristic	Adaptation Actions
Strategic	Establishment of a fire management plan
Educational	Educating the citizens
Technical	Trees planting

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.

Educating the citizens

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

Trees planting

An important action towards the protection of biodiversity is the tree planting and the expansion of green areas with friendly drought-tolerant plants. Trees not only contribute to the preservation of the natural habitat of fauna but they can also prevent floods and soil erosion. Moreover, they are significant actors in air cleaning which means that more trees and plants will reduce more the greenhouse gasses. This action illustrated as an action in mitigation section.