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SEACAP template - Work in progress

Union of Donnieh municipalities – Cluster 3 Lebanon

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Executive Summary

Donnieh is a region of 150000 registered inhabitants in the north of Lebanon, extending from the Mediterranean Sea to the highest mountains in the Middle East on a 365 km2 area. Donnieh falls within the boundaries of the Minieh-Donnieh Caza in the district of north Lebanon. Minieh-Donnieh is surrounded by Akkar in the north, Hermel in the east, Becharreh and Zgharta in the south and Tripoli in the south west. The Western part of the Caza borders the Mediterranean Sea.

The region is a land of great natural resources where Its geography stretches from the highest mountain peaks to the deepest valleys arriving to the shores of the Mediterranean thus hosting a huge variety of environments, biodiversity and resources from all kind. It has the largest forests in Lebanon including the rare junipers (Lezzab) forest and the cedar forest as well as a rich has water potential with a big quantity of aquifer and the largest number of springs in the country. Its climate is Mediterranean and mild suitable for a very diverse biological environment.

Cluster three falls on the western end of the Donnieh region and is the closest to the Minieh-Donnieh coast. Indeed, the cluster's altitude never exceeds 500 meters above sea level. This cluster constitutes the main corridor of the region to the coast, via Markebta and Aazqai reaching Minieh and via the main road that goes through Kfar Habou and Kfar Chellane towards Tripoli and Zgharta villages. The cluster is shaped like a bottle neck that opens up in Donnieh making it the point of access to most of its regions as well as the link of Donnieh's villages to Tripoli, the capital of the Mohafaza of North Lebanon, and the principal service center for Donnieh residents. The cluster is spreading over an area of 28 sq. Km (8.5% of the total area of Donnieh).

The Donnieh cluster three comprises 5 municipalities but only three of them are committed to develop SEACAP (Kfarhabou, kfarchlane, Aazki) under the union of municipalities' authority, with a total registered population of 14697 and total permanent 14697 residents of in the baseline year of 2018. Cluster three is characterized by a social fabric that combines original residents and Arab nomadic tribes which were granted the Lebanese nationality in 1960 and purchased land in Donnieh.

The agriculture is still the major component of the region's economy. It is the only source of income to 40% of residents and a partial source to 30% of residents. Cluster three is poor in natural resources, knowing that the most common land use is agriculture and grazing. Moreover, the main farm products include grains and durum wheat, vegetables, plums, apricots, green plums, citrus fruits, and bitter orange flowers, in addition to non-irrigated crops like olives, almonds, and cactus. Non-irrigated crops are especially common in Kfar Chellane, whereas Kfar Habou specializes in olives and the production of olive oil, grows fruits, grains, durum wheat, and vegetables (with widespread use of plastic tents), and Aazqai is known for growing citrus and bitter orange flowers. The agriculture sector suffers from the absence of agriculture guidance, small land properties, poor management of irrigation water, and lack of academic and professional experts, the dominance of semi-traditional work methods, the commercial monopoly and the increasing cost of agriculture.

Regarding the industrial sector, it is witnessing a relative growth and diversified activities; for example, There is a charcoal factory in Kfarhabou. In addition, Donnieh cluster three contains artisanal establishments, most of them are small-size establishments. The most common types of investments in this sector are individual and family establishments with no big industries. The small factories are all based on animal production such as cream, yogurt, ice cream, natural honey and sweets.
The tourism sector in Donnieh cluster three has no great importance, however the sector is present with establishments such as hotels, restaurants and coffee shop are present in this cluster. In addition, cluster three

can be a destination for ecotourism. With the Syrian crisis the number of tourists and visitors drastically declined due to the high influx of Syrian displaced in the region, summer residence in Donnieh (1600 dwellings) witnessed a sharp decrease because the Syrian displaced occupied all kind of residences even the empty stores. The most important touristic sites in Donnieh cluster three are: caves with ancient drawings in Aazki (Silsilia cave, Berkit al hamra), Well-constructed by Australian army in Kfarchlane, Bridge of Arches, church (Crusader), Ain Al Qabou, and cemeteries (Phoenician and Roman) in Kfarhabou.

Besides, the vast majority of trade establishments are concentrated in the commercial centre or all along the main roads of large towns where Most of the remaining isolated and rural villages lack any trade activity. The decline in the number of permanent residents has given markets a seasonal aspect, which partially explains the creation of commercial projects and establishments outside the region of Donnieh.

The challenges that the union of municipalities needs to face for its long-term vision towards sustainability include the phenomenon of sustainable growth and population increase.

It is apparent that Donnieh is facing enormous challenges regarding the sustainable development of economical and infrastructure sectors, such as the sewage collection and treatment, the solid waste management, the urban planning and the development of the agriculture and tourism sectors.

The major threats to Donnieh's environment include: Loss of biodiversity, effect of littering and illegal garbage dumping on human health, dangerous effect of damping waste water into valleys.

The municipality's vision is to create a highly efficient municipal system that achieves the desired sustainable development and enhances the quality of life in Donnieh District. It has set as mission to providing the highest standards of municipal and social services, with the maximum participation of local community and partners.

Expanded municipal functions include public services, general planning, design, construction and maintenance of roads, street lighting and reforestation. The new municipality of Donnieh has set, since its creation, a set of basic goals, the most important of which is the implementation of projects aimed at creating infrastructure, consolidating comprehensive development projects and supporting the Green March, in addition to supporting and participating in large-scale urban regeneration and expansion.

This document comprises the Sustainable Energy Access and Climate Action Plan (SEACAP) of Donnieh city. It is a strategic planning document as well as practical municipal operational tool. It defines the city's climate action framework, with quantifiable objectives to be reached by 2030, based on a Baseline Emissions Inventory (BEI) and an assessment of climate adaptation and mitigation and sustainable energy needs.

The SEACAP was developed in the framework of the European Union's Clima-Med project (Acting for Climate in South Mediterranean Cities). It complements and is in line with Lebanese national climate strategies and goals and with the Donnieh local development plans. The SEACAP was prepared with the full participation of the municipality's leadership, its technical team and in collaboration with the National Coordination Group (NCG) led by the Ministry of environment, the Clima-Med National Focal Point.

By preparing the SEACAP and by joining the COM-MED, Donnieh municipality took an advanced step, proving its willingness and dedication to face climate change and reduce its GHG emissions, towards building a model sustainable village with clear objective, vision, targets, and concrete actions.

This SEACAP document includes the following eight sections, which are analysed in more detail in the next paragraphs:

- Chapter 1: Municipality's description and Vision
- Chapter 2: Baseline Emission Inventory

- Chapter 3: Risk and Vulnerability Assessment
- Chapter 4: Capacity Building and Local Governance
- Chapter 5: Mitigation Actions
- Chapter 6: Adaptation Actions
- Chapter 7: Action Fiches
- Chapter 8: Communication

Chapter 1: Municipality's description and Vision

The vision for the municipality of Donnieh has been set, utilising in the most appropriate way its potential resources. The challenges that the municipality needs to face for its long-term vision towards sustainability include the phenomenon of sustainable growth and population increase.

The municipality's main goal is to reduce air pollution, implement mitigation actions and measures to reduce CO_2 emissions, as well as cope with the impacts of climate change affecting the area.

The municipality of Donnieh aims at making those strategic decisions in terms of the future development of the region, that would create local jobs for residents, the development of sustainable tourism, investing on producing RES/ energy efficiency equipment and materials, the new modern water harvesting systems, the village greening, and the sustainable solid waste management strategy.

Chapter 2: Baseline Emission Inventory

The Baseline Emission Inventory (BEI) quantifies the amount of CO_2 emitted due to energy consumption and other non-energy use in the territory of Donnieh in the baseline year. Thus, it allowed the identification of the principal sources of CO_2 emissions and prioritization of the respective mitigation measures.

The BEI energy consumption sectors include buildings and facilities under municipal management, including public street lighting, residential and tertiary buildings, transportation, solid waste, agriculture, forestry and land-use change (AFOLU) and tourism.

Thus, based on the BEI assessment, adequate mitigation actions (aiming to cut emissions) were selected. Next to this, adaptation actions (aiming at adapting to the irreversible effects of climate change) were identified. Both were further developed into SEACAP projects (sections 5 and 6). Among those actions, the municipality has chosen and further developed into project fiches five priority actions or pilot projects that are considered most significant for the municipality.

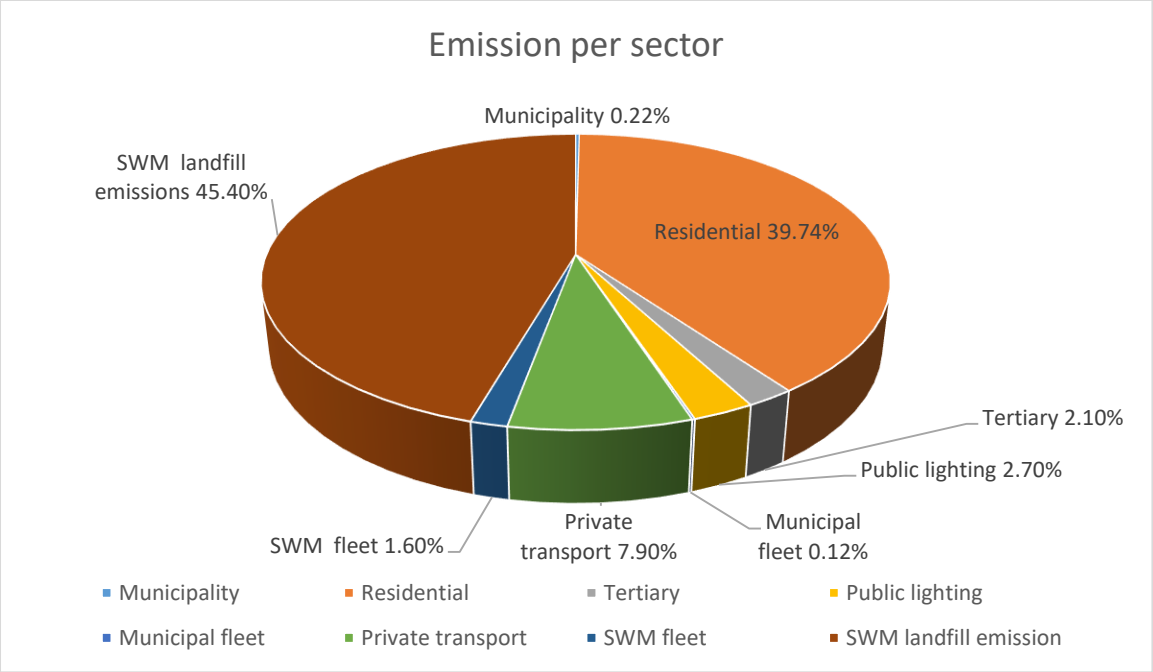


Figure 1 Emission per sector

Chapter 3: Risk and Vulnerability Assessment

The risk and vulnerability assessment sets the basis of the identification of climate risks and challenges that the municipality is facing. This assessment will help to identify the most impacted sectors from the climate hazards taking place in the region, so as to further allocate and develop adequate actions regarding the adaptation to climate change.

Chapter 4: Capacity Building and Local Governance

In order to improve the efficiency, the productivity and the knowledge of the employees, it is important to build capacity among them. Developing capacity for local governance will be achieved through the following step approach:

- Identifying local governance capacity needs for implementing climate change adaption in the city,
- Develop local policies to support Sustainable Energy Access and Climate Action Plans,
- Training municipal staff on green, sustainable or energy-efficient public procurement,
- Work on developing appropriate information measures and public awareness campaigns.

Chapter 5: Mitigation Actions

5.1 Buildings, Equipment/Facilities

- 5.1.1 Municipal existing buildings: Consumption saving measures
- 5.1.2 New Municipal buildings: Implementing and promoting the Green Building Code
- 5.1.3 Existing buildings at residential sector: Awareness raising activities for modification of the residents' consumption behaviour.
- 5.1.4 New buildings at residential sector: Implementing and promoting Green Building Code
- 5.1.5 Tertiary existing buildings: Awareness raising activities for modification of the Occupants' consumption behavior
- 5.1.6 New Tertiary buildings: Implementing and promoting the Green Building Code

5.2 Municipal Public Lighting: Modern street lighting system

5.3 Transportation sector

- 5.3.1 Road asset planning and management with smart mobility measures
- 5.3.2 Municipal transportation sector - Solid Waste sector

5.4 Solid waste management

5.5 Local Energy Production

- 5.5.1 Use of Renewable energy in the city

The below table includes the action results related to abatement of GHG emissions, estimated cost for implementation, annual saving cost (for saved fuels and energy) and climate results for short- and long-term plan.

The calculated results for mitigation are around 30.35% with annual saving of 697160.30 Euro, shared between local authority, citizens and investors, the abatement of emission could be increased through city greening and planting trees.

The plan indicates the abatement of GHG emission by 6,331.51 tCO_2-eq on yearly basis, with one-time investment cost of 3736807 Euro.

If the plan could not be implemented, the city will continue producing CO_2 emission and it could reach 20,859.25 tCO_2-eq by 2030.

Sector	Actions	Mitigation MWh/a	Mitigation tCO_2/a	Cost of implementation Euro	Annual saving cost in Euro	BAU emissions tCO2-eq at 2030	climate result 2030
Municipal Building	5.1.1 Municipal existing buildings: Consumption saving measures	14.11	10.04	0	1,742	48.1	0
	5.1.2 New municipal buildings: Implementing and promoting the green building code	6.08	4.34	0	752.41		0
Residential Sector	5.1.3 Existing buildings at residential sector: Awareness raising activities for modification of the residents' consumption behaviour	1,269.16	937.31	200,000	159,754.31	8,386.61	26.67
	5.1.4 New buildings at residential sector: Implementing and promoting Green Building Code	1,859.19	756.55	200,000	145,111.88		33.04
Tertiary Sector	5.1.5 Existing buildings at tertiary sector: Awareness raising activities for modification of the Occupants' consumption behaviour	200	95.84	200,000	18,186	462.37	260.86

	5.1.6 New buildings at tertiary sector: Implementing and promoting the Green Building Code	86.62	41.71	200,000	7,904.07		599.43
Public Street Lighting	5.2 Municipal Public Lighting: Modern street lighting system	433.90	338.90	185806.50	57,274.80	573.4	68.53
Transportation sector	5.3.1 Road asset planning and management with smart mobility measures	469.23	118.85	1,000,000	30,377.83	1,697.87	1051.74
	5.3.2 Municipal transportation sector - Solid Waste sector	117.44	31.47	500,000	5,637.06	104.9	1986
Solid waste management	5.4 Solid waste management		2,396.5	To be estimated	To be estimated at the time of implementation	9,586	
Renewable Energy Production	5.5 Renewable energy production from photovoltaic panel	2048	1600	1251000	270419.89		97.73
Total contribution to emissions reduction 6,331.51/20,859.25= 30.35%		**6,503.7**	**6,331.51**	**3736807**	**697,160.3**	**20,859.25**	**4,124**

Chapter 6: Adaptation Actions

After assessing the risks and the vulnerability to climate change in the municipality of Donnieh, procedures and actions for adapting to future changes were developed, aiming at reducing and enabling efficient management of risks from climate change.

The municipality and the local council approved the following key adaptation actions.

The following key adaptation actions.

6.1 Adaption actions for population and public health

- Establishment of an early warning system;
- Adopt healthy buildings, through formulation of
- building guidelines which include instructions for advanced sanitary installation that separate grey water from black water;
- Sustaining and improving sanitary conditions
- Health action plan for the extreme events, included access to air-condition public building during heat waves or extreme events. Updating building code and improve building ability to provide protection against extreme heat events and floods and public awareness in addition to other actions listed in details in the chapter 6.

6.2 Adaption actions for infrastructure.

- Water Resources was tackled in this action as the main climate hazards that the water sector faces in Palestine are temperature increases, precipitation decreases, increased incidents of drought and increased evaporation, reduced groundwater recharge, groundwater quality deterioration, stream flow reduction and increased water demand. The suggested actions include but not limited to Rainwater

harvesting, Wastewater treatment, Increasing Efficiency of irrigation technologies, Grey water Reuse, Public awareness and Collecting water from floods.

6.3 Adaption actions for built environment.

- The importance of adaptation actions in built environment is to improve the resilience of the built environment in the face of climate change and also will aims to protect the wellbeing of communities through targeted policy initiatives and better urban and building design, ensure appropriate institutional arrangements to facilitate adaptation, realise economic benefits from early adaptation through effective strategic planning and risk minimization, advance sustainability through better resource and risk management strategies, and increase community education and awareness about climate change risks and adaptation.

  The action includes:

  - Introduce climate responsive building techniques and elements to reduce the effect of heat and reduce demand on energy for cooling;
  - Promote the use of energy saving devices, and raise awareness on the long-term benefits of energy efficiency and saving devices;
  - Amendments to sector policies and regulations, such as building codes, to reflect climate change risks and direct people towards insulating buildings to reduce energy demand;
  - Construct proper storm water network to discharge storm water from built environment;
  - Zoning and development changes to reflect increased vulnerability of specific locations and/or resources.

6.4 Adaptation action for agriculture

6.5 Adaptation actions for biodiversity

6.6 Livestock development strategy

6.7 Home farming project

6.8 Agricultural production training

6.9 Sustainable environment improvement plan

1. Chapter 1: Municipality's Description and Vision

1.1. Municipal and NDC Targets

The Donnieh union of municipalities done the commitment of its local governance council, has adhered to the Covenant of Mayors Mediterranean (CoM-Med) and is committed to reduce its emissions by 15% by 2030 in line with the unconditional target of Lebanon Intended Nationally Determined Contribution INDC, against the baseline emissions in year 2018.
The overall target being set by the Local Government Unit of Donnieh union of municipalities places emphasis on working closely with all community actors. It will take all necessary measures on its facilities, establishing a good paradigm for the community, while it will place a lot of emphasis on collaborating with the public and achieving significant reductions from the residential, tertiary and transport sectors, with solid waste, water and agriculture.

1.2. Overview of Municipal Characteristics

1.2.1 Geographical location

Donnieh is a region in north Lebanon, extending from the Mediterranean Sea to the highest mountains in the Middle East on a 365 km^2 area, 150,000 registered inhabitants, not counting the Syrian refugees, estimated at 75,000 grouped in 80 towns and villages.

Donnieh falls within the boundaries of the Minieh-Donnieh Caza in the district of north Lebanon. Donnieh region has an average altitude of 1000 m and an average distance from the capital Beirut of 118 Km and at 12 km from Lebanon's second largest city, Tripoli.

Cluster three falls on the western end of the Donnieh region and is the closest to the Minieh-Donnieh coast. Indeed, the cluster's altitude never exceeds 500 meters above sea level. This cluster constitutes the main corridor of the region to the coast, via Markebta and Aazqai reaching Minieh and via the main road that goes through Kfar Habou and Kfar Chellane towards Tripoli and Zgharta villages. The cluster is shaped like a bottle neck that opens up in Donnieh making it the point of access to most of its regions as well as the link of Donnieh's villages to Tripoli, the capital of the Mohafaza of North Lebanon, and the principal service center for Donnieh residents. The cluster is spreading over an area of 28 sq. Km (8.5% of the total area of Donnieh).

In Donnieh cluster three the climate is Mediterranean, with mild and rainy winters and hot and sunny summers. Cluster three average altitude is 300m. In fact winters are cold, while summers are humid and hot. In winter cluster three experience a heavy rainfalls. The rains follow the Mediterranean pattern, in fact they only occur between October and April, and more abundant in winter. From June to September, it almost never rains, and the sun shines everywhere.

1.2.2 Population and Employment

The Donnieh cluster three comprises 5 municipalities but only three of them are committed to develop SEACAP (Kfarhabou, kfarchlane, Aazki) under the union of municipalities' authority, with a total registered population of 14697 and total permanent 14697 residents of in the baseline year of 2018. The cluster is witnessing a high population growth rates accompanied by a high fertility rate. Cluster three is characterized by a social fabric that combines original residents and Arab nomadic tribes which were granted the Lebanese nationality in 1960 and purchased land in Donnieh.

The average household size in Donnieh region is of 5.9 members, with a density rate of 215 inhabitants per square kilometre. Donnieh is a young region whereby age categories below 18 years old constitute around 42.5

% of total population and those below 40 years make up about 70 % of total population, 28 % are between 18 and 39 years old, 21 % between 40 and 64 years old, and 8% are 65 years old and above.

The region suffers from deprivation and the unemployment rate reaches 70 %. The percentage of workers in the agriculture sector is estimated at 70 %, industry at 10 %, and trade at 20 %.

1.2.3 Economic Sectors

The agriculture is still the major component of the region's economy. It is the only source of income to 40% of residents and a partial source to 30% of residents. Cluster three is poor in natural resources, knowing that the most common land use is agriculture and grazing. Moreover, the main farm products include grains and durum wheat, vegetables, plums, apricots, green plums, citrus fruits, and bitter orange flowers, in addition to non-irrigated crops like olives, almonds, and cactus. Non-irrigated crops are especially common in Kfar Chellane, whereas Kfar Habou specializes in olives and the production of olive oil, grows fruits, grains, durum wheat, and vegetables (with widespread use of plastic tents), and Aazqai is known for growing citrus and bitter orange flowers. The agriculture sector suffers from the absence of agriculture guidance, small land properties, poor management of irrigation water, and lack of academic and professional experts, the dominance of semi-traditional work methods, the commercial monopoly and the increasing cost of agriculture.

The Syrian crisis increased the challenges and hampered agricultural growth in some way where it hampers the transit of goods through Syria. The export of agricultural products to Gulf countries decreased significantly due to the insecure transit via Syria, the abundance of the cheap Syrian labour that accept to work with lower wages is also a cause of the high rate of unemployment.

Moreover, livestock grazing is still an important activity in the region. Donnieh cluster three is poor in pastures. However, there are some domestic animal farming of goats, sheep and beehives with beekeepers.

Regarding the industrial sector, it is witnessing a relative growth and diversified activities, for example, there is a charcoal factory in Kfarhabou. In addition, Donnieh cluster three contains artisanal establishments, most of them are small-size establishments. The most common types of investments in this sector are individual and family establishments with no big industries in the region. The small factories are all based on animal production such as cream, yogurt, ice cream, natural honey and sweets.

Besides, the vast majority of trade establishments are concentrated in the commercial centre or all along the main roads of large towns where most of the remaining isolated and rural villages lack any trade activity. The decline in the number of permanent residents has given markets a seasonal aspect, which partially explains the creation of commercial projects and establishments outside the region of Donnieh.

The tourism sector in Donnieh cluster three has no great importance.However, tourism establishments such as hotels, restaurants and coffee shops are present in this cluster. In addition, cluster three can be a destination for ecotourism. With the Syrian crisis the number of tourists and visitors drastically declined due to the high influx of Syrian displaced in the region, summer residence in Donnieh (1600 dwellings) witnessed a sharp decrease because the Syrian displaced occupied all kind of residences even the empty stores. The most important touristic sites in Donnieh cluster three are: caves with ancient drawings in Aazki (Silsilia cave, Berkit al hamra), Well-constructed by Australian army in Kfarchlane, Bridge of Arches, church (Crusader), Ain Al Qabou, and cemeteries (Phoenician and Roman) in Kfarhabou.

1.2.4 Infrastructure and Key Services

Despite the problems faced by all regions in Lebanon when it comes to electricity, Donnieh's situation in this regard is worse than that of other regions. This has negatively impacted spending summer vacations as well as

the living conditions on many levels. Donnieh cluster three towns and villages are supplied with electricity from EDL (Electricite Du Liban) for 10 to 12 hrs per day, and from back up private diesel generators for the remaining time.

As regards access to drinking water, as well as water for irrigation purposes, it is believed that Donnieh compasses the largest ground water reservoir in the Middle East. Nevertheless, a large number of villages and houses in cluster three suffer and are not linked to drinking water networks. Public potable water networks are available only in some villages and towns of the cluster, while unfinished networks are available in many other villages. Public water networks are facing several problems. Serviced villages are linked to networks in poor condition (according to the assessment of local authorities). It is to be noted that the networks are in a poor condition in most villages of the cluster. Concerning the irrigation in Donnieh cluster three, the problem resides in the absence of water in a number of villages, poor water distribution and the resulting conflicts, poor irrigation methods (flood irrigation), poor condition of irrigation networks (often in the soil), lack of water storage, incomplete vital projects, and groundwater pollution.

Another significant issue for the municipality is the management of solid waste, as well as waste-water treatment. The waste collecting is a municipal issue, each municipality is responsible for its own waste collection, the union distributed trucks to collect waste from its municipalities, and they collect their mixed garbage following the same traditional way without any processing and dispose it to ADWI, the only landfill in the region. The municipalities are disposing their waste without any processing. The percentage of the waste composition is taken from the landfill: Organic: 65%, paper: 20%, plastic: 5%, metal: 5% others: 5%. In general, the waste production in Donnieh cluster three is about 12 tons per day.

Furthermore, Donnieh cluster three is deficient in sewage networks, which are only available in few of the villages. In general, the cluster lacks the infrastructure that befits its strategic position, while its residents face a number of environmental issues, including sanitation problems in the upper villages (the absence of a wastewater treatment plant), and the presence of a garbage dumpsite in Aadoua. The most important problems affecting sewage networks consist of their age, the wearing out of certain parts and the lack of maintenance or rehabilitation especially that parts of the networks are now aboveground. The core problem resides in the absence of sewage water recycling plants. The drainage of sewage water in valleys, rivers, the outskirts of villages and irrigation canals constitute a substantial damage to the environment affecting the soil and the underground as well as damageing agricultural products.

Finally, as regards the rest of the available infrastructure in the Donnieh union, a quarter of the roads are in good condition while remaining of the road network is in poor condition. In general, the road network of cluster three suffers from several problems among which: lack of pavement, absence of maintenance, narrowness of roads, and absence of roads safety equipment. However one of the most important impediments to development in some parts of Donnieh resides in the lack of connection between regions and their linkage to the road network. Besides, the telephone services in the cluster three towns and villages are provided by the national and international companies and cover most of the dwellings in the cluster.

1.3. Strategy:

1.3.1 Vision for the future

The vision for the union of municipalities of Donnieh has been set, utilising in the most appropriate way its potential resources. The vision focuses on Donnieh maintaining its identity as traditional villages, and a sustainable touristic villages as well.

The challenges that the union of municipalities needs to face for its long-term vision towards sustainability include the phenomenon of sustainable growth and population increase.

The union of municipalities' main goal is to reduce air pollution, implement mitigation actions and measures to reduce CO2 emissions, as well as cope with the impacts of climate change affecting the area.

The union of municipalities of Donnieh aims at making those strategic decisions in terms of the future development of the region, that would create local jobs for residents through the reactivation of the agricultural sector as it was in the past, development of sustainable tourism, investing on producing RES/ energy efficiency equipment and materials, the new modern water harvesting systems, the villages greening, the sustainable strategy for livestock sector development, and the sustainable solid waste management strategy.

1.3.2 Complementarity with municipal and national plans and other related actions/ Coordination with national and local authorities

The SEACAP has been developed in line with Lebanon National Climate Change Policy. The policy set advanced concrete strategic objectives, measures and instruments, to adapt the country to climate change impacts in each involved sector (water, coastal areas, agriculture/food security, health, tourism, biodiversity, and socioeconomic situation/poverty).

Also, SEACAP is in line with the National Strategy and action plan for sustainable consumption and production for Lebanon NEEAP and NREAP, for mainstreaming sustainable consumption and production into Agriculture/Food Production, Transport, and Waste Management Sectors.

In addition to the above, SEACAP will play an essential role extremely important in helping the implementation of Lebanon Intended Nationally Determined Contribution (INDC) submitted to the UNFCCC, which determines to reduce the GHG emissions by 15 % by 2030 unconditionally. However Lebanon conditionally and subject to the availability of international financial aid and support to means of implementation, commits to reduce its GHG emissions by additional at least 15 % by 2030.

1.3.3 Adaptation of administrative structures and Involvement of local stakeholders

The plan will be mainstreamed though the current existing structure which is already set to implement similar initiatives. The union of municipalities already has an active technical services department and an environmental committee and the necessary channels to communicate with the local community and various significant local stakeholders.

To assure long term sustainability, the relevant municipalities' staff, including members from the union municipal council, as well as volunteers from the local community, will be engaged in the plan preparation and implementation beyond the current council mandate.

The union of municipalities has appointed a local coordinator, who is responsible to coordinate the varying aspects of work between the different union departments, the president of the union and the union municipal council as the opposite decision making bodies, as well as the local stakeholders engaged in the process. This role is especially challenging, since many of the challenges that local authorities usually have to cope with, are the different roles and responsibilities across the different municipal departments. Considering that the SEACAP implementation usually sets a series of cross-sectoral targets, coordination between them is of high importance.

1.3.4 Overall budget allocated for implementation and financing sources

The union municipal budget largely originates from the budget received by the national government, as well as municipal taxes for the services offered to the citizens (e.g. solid waste and waste-water management, provision of fresh water and irrigation services etc.). This municipal budget allows the union of municipalities to be able to realise small scale investments, heavily depending on attracting grants or loans with favourable conditions, in order to be able to implement the planned activities.

1.3.5 Implementation and monitoring process

The implementation of the Action Plan requires the participation of all union municipal departments, which in turn requires that these departments work in harmony and avoid conflicts in the implementation course. This requires a special department that works independently on the development of the working frameworks and coordinates with each other for good implementation, monitoring and evaluating the results, and re-evaluating the most successful work plan. The existence of a special unit that performs these functions is called the SEACAP Unit and should be able to tackle this work under the management of the SEACAP coordinator.

As regards the monitoring process, specific monitoring indicators have been allocated across all municipal activities, in order to allow their close follow up, progress assessment and receipt of corrective actions where needed. These indicators are in line with the guidelines, and analysed in detail under the appropriate sections in Chapters 4 and 5.

2. Chapter 2: Baseline Emission Inventory (BEI)

2.1. BEI Methodology

The Baseline Emission Inventory (BEI) quantifies the amount of CO_2, or CO_2 equivalent emissions, produced mainly due to the energy consumption in the territory of the local Authority in the selected baseline year. The BEI allows to identify the principal anthropogenic sources of CO_2 emissions and to prioritize the reduction measures accordingly.

The emission inventory includes the CO_2 direct emissions due to fuel combustion in the territory of the local authority, indirect emissions related to consumption of grid-supplied energy (electricity, heat/cold), as well as relevant non-energy related emissions that occur in the local authority.

Considering that the municipality has opted for the use of IPCC emission factors in terms of CO_2-equivalent, based on the IPCC 2006 Guidelines (IPCC, 2006), the emissions of CH_4 and N_2O from the energy generating activities are already included in this methodological approach. For non-energy related activities like waste-water treatment, solid waste management, AFOLU and others, the CH_4 and N_2O where applicable will be calculated separately and transformed into CO_2-eq. These emissions will be included in the BEI, since the municipality is planning to include mitigation measures along these sectors.

It should be also noted that in line with the guidelines for the South Mediterranean, CO_2 emissions from the sustainable use of biomass/biofuels, as well as emissions of certified green electricity, are considered zero.

The method adopted in the BEI calculation utilizes the 'standard' emission factors' approach, in line with the Intergovernmental Panel on Climate Change (IPCC) principles and complies with the United Nations Framework Convention on Climate Change (UNFCCC) reporting system.

2.1.1. Baseline Year

A primary component of the inventory process is choosing the baseline year. Determination of the baseline year takes into consideration the availability of accurate historical data. Baseline year is the year against which the achievements of the emission reductions in 2030 shall be compared. The municipality, taking into consideration the data availability, has selected 2018 as the baseline year.

2.1.2. Sectors to be included in BEI

The local authority will report the CO_2 emissions for the below sectors:
- Municipal buildings/ Equipment and facilities
- Public Lighting
- Tertiary buildings/ Equipment and facilities
- Residential buildings
- Transportation; municipal fleet, private transport, public transport
- Local energy production from renewable energy sources, as well as other local power generation.
- Other non-energy related, solid waste management, agriculture, and water sector

2.1.3. Emission factors and Conversion rates

The emission factors expressed in (tCO_2-eq/MWh) are coefficients which quantify the emissions per activity data. The emission factors used by the local authority are the last updated emission factors provided by JRC and attributed for the electricity consumption. The JRC-COM-NEEFE dataset includes the 1990-2015 time series of the National Emission Factors for Electricity Consumption (NEFE). Considering the lack of availability for more recent data, and following consultation with JRC, the Emission Factor for 2018 (IPCC approach) has been considered for the calculations of this report. The EF is 0.781 $tCO_{2\text{-eq}}$ /MWh

Besides electricity, the Fuel Emission Factors used by the local authority, expressed in tCO_2-eq/MWh and presented in the below table, are the default factors of IPCC (2006).

Table 1 CO_2 Emissions Factor tCO2-eq/MWh

Fuel	CO_2 Emissions Factor tCO_2-eq/MWh
Diesel	0.268
Gasoline	0.250
Kerosene	0.259
LPG	0.227

The conversion factors between litres or Kg and KWh expressed in (KWh/L) for fuel combustion, used by the local authority, are the factors provided by IPCC (2006).

Table 2 Conversion Factor for Energy fuel resources to KWh

Fuel	Conversion Factor	Unit
Gasoline	9.2	KWh/L
Diesel	10	KWh/L
Kerosene	9.7	KWh/L
LPG	13.7	KWh/Kg

2.2. Energy Consumption

2.2.1.Municipal Buildings, Equipment & Facilities

Cluster three in Donnieh comprises 3 municipalities managing and operating buildings. Their total consumption is of 41.4 MWh per year, for lighting, space heating, cooling and other activities. The EDL "Electricite de Liban" supplies the electricity to cluster three towns and villages, for 12 hours only per day, with a shortage of 12 hours daily. Private backup diesel generators supplies electricity to cover the shortage period of EDL.
The table below presents the Municipal Buildings, Equipment & Facilities Annual Electrical Consumption and CO2 emissions:

Table 3 Municipal Buildings, Equipment & Facilities Annual Electrical Consumption and CO_2 emissions

Municipal Buildings, Equipment & Facilities Annual Electrical Consumption and CO_2 emissions		
Site Category	Annual consumptions in MWh	Annual Emissions in tCO_2-eq
Municipal Building & facilities(EDL)	20.7	16.1667
Municipal Building & facilities(DG)	20.7	16.1667
TOTAL	41.4	32.3334

The municipalities of Donnieh cluster 3 consumes fuel for the space heating. The table below presents the fuel consumption and the CO_2 emissions for Municipal buildings and facilities space heating.

Table 4 the fuel consumption and the CO_2 emissions for Municipal buildings and facilities space heating

Municipal Buildings Annual Fuel Consumption and CO_2 emissions				
Fuel Type	Fuel consumptions in Liters	LPG (KG)	Fuel Consumptions in MWh	Annual Emissions in tCO2-eq

LPG (Space Heating)	0	420	5.754	1.3

2.2.2.Residential Buildings

According to the municipality, in its area there are approximately 1860 households. In line with the data gathered by the utility company, the annual electricity consumption is 4629.6 MWh, as presented in the table below. Considering a total number of residents of 14697 people, the annual electricity consumption per capita is considered to be 290.4 KWh. The annual electricity consumption for residential and tertiary buildings values are obtained from the utility company.

The table below presents the annual electricity consumption and CO_2 emissions in residential buildings:

Table 5 the annual electricity consumption and CO_2 emissions in residential buildings

Residential an Buildings Annual Electrical Consumption and CO_2 emissions		
Site Category	Annual consumptions in MWh	Annual Emissions in tCO_2-eq
Residential buildings (EDL)	2134.80	1,667.27
Residential buildings (DG)	2134.80	1,667.27
TOTAL	4269.60	3,334.54

**Emission Factor for Electricity Consumption is 0.781 tCO_2-eq/MWh (CoM-JRC)*

The households in Donnieh cluster three consume LPG for cooking and Diesel for space heating. The data provided by the municipality showed that each household consume about 15 Kg of LPG per month for cooking. The households use LPG for cooking and Diesel for space heating during winter cold time.

The table below presents the annual fuel consumption and CO_2 emission for cooking and space heating:

Table 6 the annual fuel consumption and CO_2 emission for cooking and space heating

Residential Buildings Annual Fuel Consumption and CO_2 emissions				
Fuel Type	Fuel consumptions in liters	Fuel consumptions in Kg	Fuel Consumptions in MWh	Annual Emissions in tCO2-eq
Diesel(space heating)	555,600	0	5,556	1489.01
LPG (space heating)	0	334800	4,586.76	1041.19
TOTAL			10,142.76	2530.20

2.3. Tertiary Buildings, Equipment & Facilities

The tertiary sector includes the commercial buildings, offices of private companies, banks, commercial and retail activities, private & governmental schools, hospitals and other activities, offering services beyond the control of the municipality. The annual electricity consumption for this sector is presented in the table as received from the utility company “EDL/Qadisha” and from the owners of backup diesel generators.

Table 7 the annual fuel consumption and CO_2 emission for cooking and space heating

Tertiary Buildings Annual Electrical Consumption and CO_2 emissions		
Site Category	Annual consumptions in MWh	Annual Emissions in tCO_2-eq
Tertiary Buildings (EDL)	149.43	107.29
Tertiary Buildings (DG)	149.43	40.04
TOTAL	298.87	147.33

The annual fuel consumption for space heating and the relative CO_2 emissions in Tertiary Buildings are shown in the table below:

Table 8 Tertiary Buildings Space Heating Annual Fuel Consumption and CO_2 emissions

Tertiary Buildings Space Heating Annual Fuel Consumption and CO_2 emissions				
Fuel Type	Fuel consumptions in liters	Fuel consumptions in Kg	Fuel Consumptions in MWh	Annual Emissions in tCO_2-eq
Diesel	13000	0	130	34.84
LPG	0	17712	242.6	55
TOTAL			372.6	89.84

**Emission factor for diesel is 0.268 in (tCO_2-eq/MWh)*
**Emission factor for LPG is 0.227 (tCO_2-eq/MWh)*

Local electricity production: Diesel generators

In Donnieh cluster three municipalities, there are no solar PV plants for electricity generation. In the baseline year, 3 backup private diesel generators were supplying electricity to cover the 12 hours daily shortage of EDL. The diesel generators are operated at ¾ of its total output for better efficiency and diesel consumption.

The electricity production for back up diesel generators is presented in the table below.

Table 9 Local electricity production, diesel generators emissions

Annual Local Electricity Production and CO_2 Emissions in the baseline year of 2018										
Site Category	DG No	Load in KVA	load in KW	Total Load in KW	Consumption in L/h at (3/4load)	Total produced in MWh	MWh consumed tCO_2-eq	Diesel consumption in (L/a)	Diesel consumption tCO_2-eq	LEP tCO_2-eq
DG1	2	550	440	880	88.68	2904	778.272	780384	2091.42912	1313.16
DG2	3	200	160	480	33.91	1584	424.512	447612	1199.60016	775.09
DG3	1	150	120	120	25.8	396	106.128	113520	304.2336	198.11
TOTAL						4884	1308.912	**1341516**	**3595.26**	2286.35

The formula used for the calculation of produced electricity from diesel generators is:

- MWh/a= T.KW*0.75*4400/1000 (Generator operated at ¾ load for better efficiency and diesel consumption / data collected form municipality and from generator owners / daily operation hrs is 12 h

2.3.1.Buildings' & facilities' Synopsis

The Buildings sector consume a lot of electricity for lighting, heating, cooling and other electrical devices operation. The table below summarizes the annual electricity consumption and the CO_2 emissions in the buildings sector.

The table below Buildings & Facilities Summary of Annual Electricity Consumption and Emissions

Table 10 Buildings & Facilities Summary of Annual Energy Consumption and Emissions

Sector	FINAL ENERGY CONSUMPTION [MWh]					
	Electricity	Fossil Fuels			Total (MWh)	Emission tCO_2-eq
		Diesel	Gasoline	LPG		
BUILDINGS, EQUIPMENT/FACILITIES & PUBLIC STREET LIGHTING						
Municipal Buildings	41			5.75	46.75	23
Residential Buildings	4269.60	5556		4586.76	14412.36	4679.60
Tertiary Buildings	298.87	130		242.65	671.52	89.92
Subtotal	4609.47	5686		4835.16	15130.63	4792.52

2.4. Municipal public lighting

The street lighting in Donnieh cluster 3 Municipality is partly relying on LED efficient lights but still heavily relying on inefficient lamps (HPS, MH) causing high emissions of CO_2. The annual electricity consumption and CO_2 emissions for the base line year of 2018 are shown in the table below.

Table 11 Public Lighting Annual Electricity consumption (MWh), and CO_2 emissions (tCO_2-eq)

Public Lighting Annual Electricity consumption (MWh),and CO_2 emissions (tCO_2-eq)				
Type of street lamps	Quantities	Watt per lamp	Annual consumptions in MWh	Annual Emissions in tCO_2-eq
HPS	95	250	104.5	81.61
HPS	263	150	173.58	135.56
HPS	400	100	176	137.45
LED	30	90	11.88	9.27
LED	180	60	47.52	37.11
TOTAL			513.48	401.02

**Emission Factor for Electricity Consumption is 0.781 tCO_2-eq/MWh (CoM-JRC)*

2.5. Transport

The transport sector covers a number of subcategories, such as the municipal fleet, the private and commercial transport and the public transport services in the city. According to the union, the municipal fleet in the villages of Donnieh cluster three comprises of different vehicles including passenger vehicles, light trucks, medium to large trucks, construction machineries, and other vehicles. The fuels used for the municipal fleet are gasoline and diesel, with their consumptions and calculated respective emissions presented under the following table.

As regards the private cars, the final values of the fuel consumption are calculated by the municipality based on the total numbers of cars in the region, the average travelled distance and the average consumption per kilometre for each type of vehicle. Same approach is used for the commercial vehicles and public transportation.

Table 12 Municipal, Private & Public Transport Annual Fuel Consumption and CO_2 Emission

Municipal, Public & Private transport Annual fuel consumption and CO_2 emissions						
Fuel Type	Municipal Fleet	Private Transport	Public Transport	Fuel consumptions in Liters	Fuel Consumptions in MWh	Annual Emissions in tCO_2-eq
Diesel (L)	0	85590	0	85590	855.9	229.38
Gasoline (L)	7850	408644.7	0	416494.7	3831.75	957.94
TOTAL					4,687.65	1,187.32

**Emission factor for diesel 0.268 in (tCO_2-eq/MWh)*
**Emission factor for Gasoline 0.25 in (tCO_2-eq/MWh)*
**Conversion factor for diesel 0.010 in (MWh/L)*
**Conversion factor for Gasoline 0.0092 in (MWh/L)*

Transport phase in Solid waste management (SWM)

The Union of Donnieh cluster three municipalities collects and transfer its solid waste using different types of garbage vehicles that consumes a significant amount of Diesel. The Donnieh Cluster three has a total population of 14697 people the annual solid waste quantity produced is about 4380 tons, 12 tons on daily basis, and is steadily increasing due to the continuously increasing population. The solid waste produced composition is Organic: 65%, paper: 20%, plastic: 5%, metal: 5% others: 5%.

The table below shows the annual fuel consumption for the transportation of solid waste management

Table 13 Transportation emission related to solid waste management

Annual Solid Waste Garbage Vehicles Fuel Consumption and CO_2 Emissions			
Municipality	Diesel/a	Consumption in MWh	tCO_2-eq
Donnieh Cluster three	90382	903.82	242.22

Table 14 The total emission on transportation in the city

Sector	Fuel Consumptions (MWh)	Emission tCO_2-eq
Municipal Fleet	72.22	18.05
SWM Fleet	903.82	242.22
Private cars/trucks	4615.43	1169.27
Total	5,591.47	1,429.54

2.6. SWM Landfill emissions

Donnieh Cluster three Municipalities collects its waste through trucks in each of the five towns that constitue it and then dump it in the only landfill in the region without any treatment or sorting and very oftenly dumped randomly in valleys.

Donnieh cluster three has a total population of 14,697 people producing around 20 tons of solid waste on a daily basis. The solid waste produced composition is 65% organic waste, 20% paper and cardboard, 5% plastic, 5% metal and 5% other mixed materials.

Converting organic waste to compost represent one of the solutions for 65% of waste in cluster three, where the composting is the process of controlled biological maturity under aerobic conditions, where the organic matter is decomposed to materials with shorter molecular chains more stable, hygienic, and finally beneficial for the agricultural crops and for recycling of soil organic matter.

The cluster three is productive in agriculture where the cultivated area is considerable, the main farm products include grains and durum wheat, vegetables, plums, apricots, green plums, citrus fruits, and bitter orange flowers, in addition to non-irrigated crops like olives, almonds, and cactus. Hence it is very crucial to support the farmers through producing organic fertilizers from organic waste to be used by farmers instead of synthetic fertilizers.

It is expected by year 2030 the waste produced will reach 10439 tons based on the business-as-usual scenario developed by JRC (Annual consumption (7300 x BAU coefficient (1.43)) so it is important to consider the waste as one of the priority projects in the city.

In the Solid waste disposal sites (SWDS) the degradable organic carbon in waste is decomposed by bacteria under anaerobic conditions into methane (CH4) and other compounds. The CH4 emissions from SWDS are important contributors of global anthropogenic CH4 emissions.

The IPCC default method is a simple mass balance calculation which estimates the amount of CH4 emitted from the SWDS assuming that all CH4 is released the same year the waste is disposed of, which is considered in this report.

The below equation will be used to calculate the emissions in the landfill and based on this calculation the suggested action will give us an estimation on emission reduction.

The method assumes that all the potential CH4 emissions are released during the same year the waste is disposed of. The method is simple and emission calculations require only input of a limited set of parameters, for which the IPCC Guidelines provide default values, where country-specific quantities and data are not available.

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

Where:

MSW_T: total MSW generated (Gg/yr)

MSW_F: fraction of MSW disposed to solid waste disposal sites (assumption 80%)

MCF: methane correction factor (fraction), 0.6 as general default value.

DOC: degradable organic carbon (fraction) (kg C/ kg SW)

$$DOC = (0.4 \bullet A) + (0.17 \bullet B) + (0.15 \bullet C) + (0.3 \bullet D)$$

Where:

A = Fraction of MSW that is paper and textiles

B = Fraction of MSW that is garden waste, park waste or other non-food organic putrescible

C = Fraction of MSW that is food waste

D = Fraction of MSW that is wood or straw

In Donnieh cluster three region, 65% of waste is composed of organic material and 20% paper, cardboard 5% plastic, 5% metal and 5% other mixed materials

$$DOC= (0.4 \bullet 0.2) + (0.17 \bullet 0) + (0.15 \bullet 0.65) + (0.3 \bullet 0)$$

$$DOC= 0.1775$$

DOC_F: fraction DOC dissimilated; The IPCC default value is 0.77.

F: fraction of CH_4 in landfill gas (IPCC default is 0.5)

16/12: conversion of C to CH_4

R: recovered CH_4 (Gg/yr) The default value for methane recovery is zero.

OX: oxidation factor (fraction – IPCC default is 0)

The results:

Methane emissions (Gg/yr) = (7.3Gg ● 0.8 ● 0.6 ● 0.1775● 0.77 ● 0.5 ● 16/12-0) ● (1-0))

Methane emissions (Gg/yr) = 0.39 Gg/yr

Emisssion of methane in Gg/yr	Emisssion of methane t CO_2 eq /yr	BAU year 2030 t CO_2 eq /yr
0.3192728	0.3192728*1000*21= 6,704.7	6,704.7 *1.43=9,587.7

2.7. Final emissions related to use of fossil fuel and non-related energy activities in the city

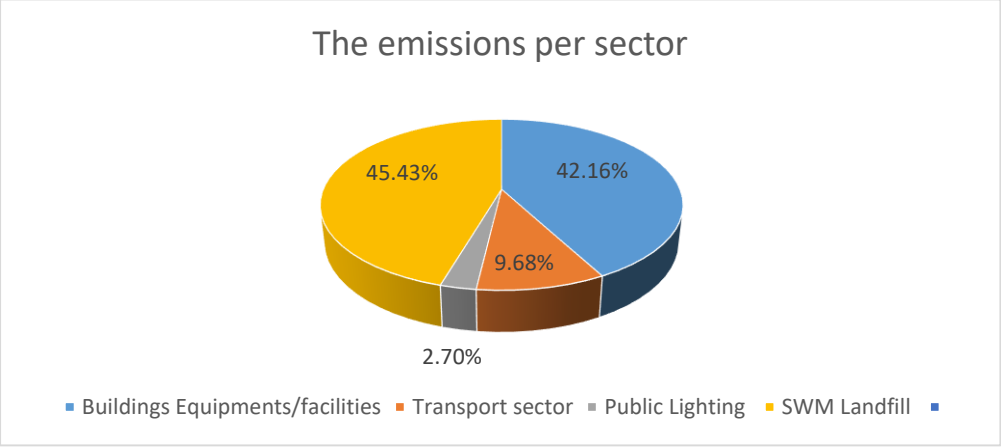
The final energy consumption in the local authority territory is the sum of the electricity and the fuel consumptions.

Table below presents the Final Energy Consumption in the Local Authority Territory

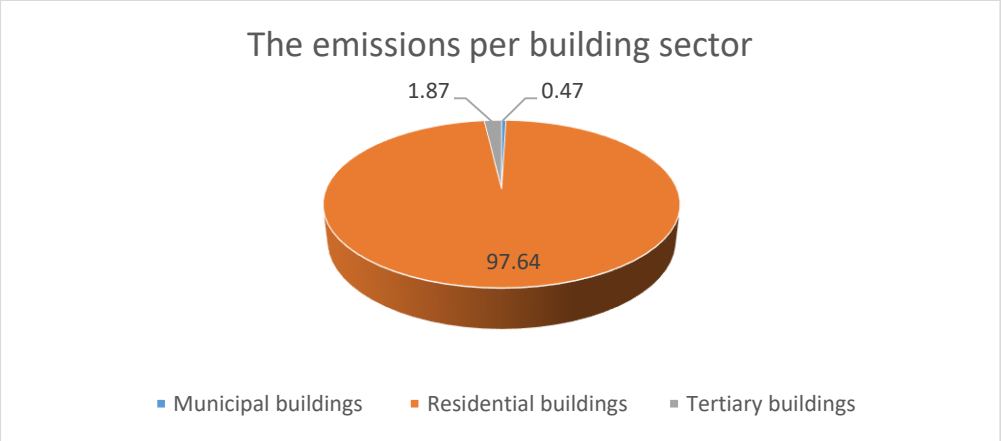
Table 15 Final emissions related to use of fossil fuel and non-related energy activities in the city as to base year 2018

Municipality final energy and non-energy activities		
Sector	**MWh**	**tCO_2-eq**
Buildings, equipment/facilities	**15,131.034**	**6,221.6**
Municipality	47.154	33.6
Residential	14,412.36	5,864.74
Tertiary	671.52	323.26
Transport sector	**5,591.47**	**1,429.54**
Municipal Fleet	72.22	18.05
Private cars and trucks	4615.43	1169.27
SWM Fleet	903.82	242.22
Public Lighting	**513.48**	**401.02**
SWM Land fill emissions		**6,704.7**
TOTAL	**21,235.984**	**14,756.86**

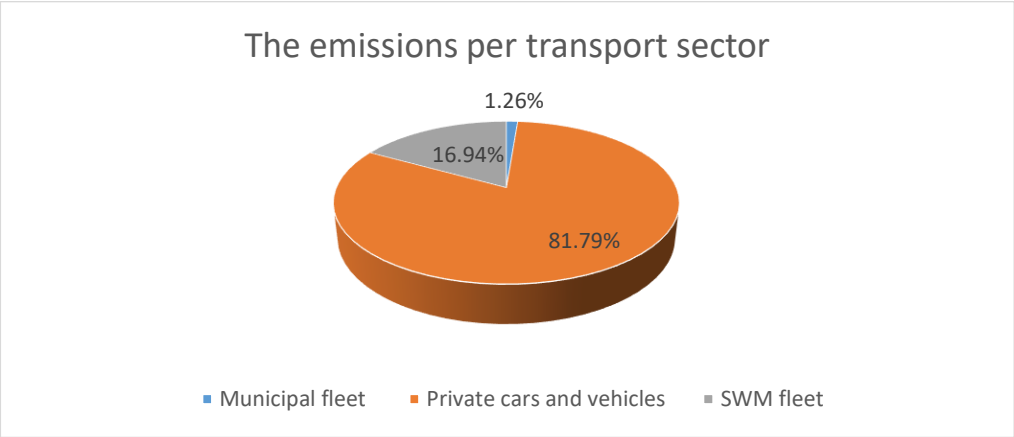
The emissions per sector



The emissions per building sector



The emissions per transport sector



2.7 Final emissions related to use of fossil fuels and non-related energy activities in the city

The final energy consumption in the local authority territory is the sum of the electricity consumption and the fuel consumption.

The table below presents the Final Energy Consumption in the Local Authority's Territory

Table 16 Final emissions related to use of fossil fuels and non-related energy activities in the city as to base year 2018

Municipality final energy and non-energy activities			BAU at 2030
Sector	MWh	tCO_2-eq	tCO_2-eq
Buildings, equipment/facilities	15,131.034	6,221.6	8,896.91

Municipality	47.154	33.6	48.05
Residential	14,412.36	5,864.74	8,386.6
Tertiary	671.52	323.26	462.26
Transport sector	**5,591.47**	**1,429.54**	**2,044.24**
Municipal Fleet	72.22	18.05	25.81
Private cars and trucks	4615.43	1169.27	1672.06
SWM Fleet	903.82	242.22	346.37
			0
Public Lighting	**513.48**	**401.02**	**573.45**
SWM Land fill emissions		**6,704.7**	**9,587.7**
TOTAL	**21,235.984**	**14,756.86**	**21,102.3**

**Annual Consumption x BAU Coefficient (1.43 in 2018 / JRC)*

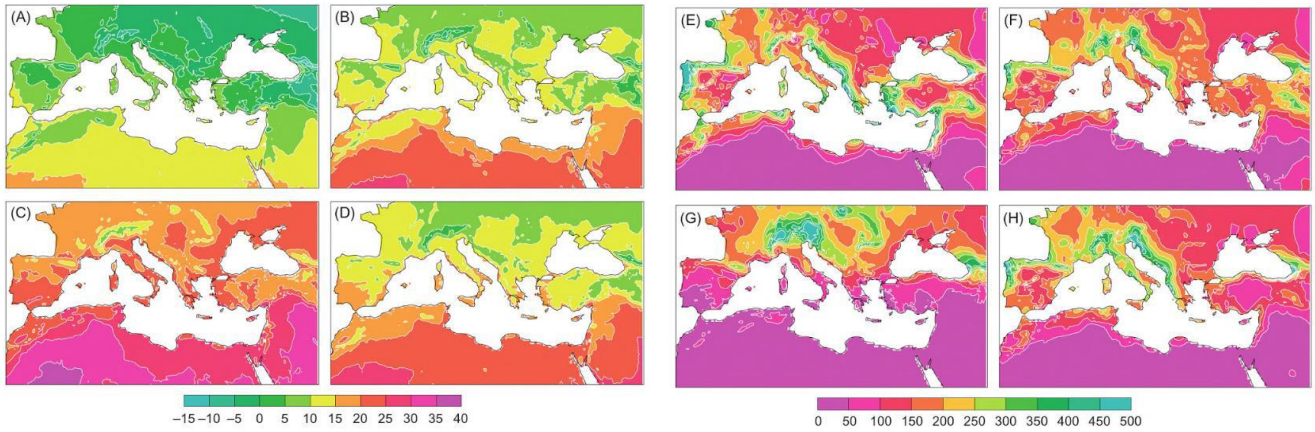
3. Chapter 3: Risk and Vulnerability Assessment

3.1. Introduction on climate change impact

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 mid latitude regimes produces large climate variability at multiple timescales and a strong seasonal variability of precipitation in many areas (Lionel 2012). The Mediterranean has been identified as one of the most prominent "Hot-Spots" in future climate change projections (Giorgi 2006). 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 (Lionel 2012).

The Mediterranean region has experienced drastic changes in its climate over the years and according to Luterbacher et al. (2006), 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 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.



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

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

In the Mediterranean region, 50% of the urban population lives in an altitude of less than 10 meters from the sea level, in areas which are vulnerable to sea level rise. In addition to the above, tourist destinations in these areas are vulnerable not only due to the sea level rise, but also due to the temperature increase encountered (Plan Bleu, 2009).

The impacts of climate change on the Mediterranean environment will relate particularly to (EIB, 2008):

- 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 northwards 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 (EIB, 2008).

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.).

3.2. National and Regional Strategy on Climate Change Adaptation

3.2.1.The commitments at national level

Lebanon ratified Kyoto protocol in 2006. The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gas emissions, based on the premise that Global Warming exists and human-made CO2 emissions have caused it.

The Kyoto Protocol implemented the objective of the UNFCCC to fight global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system". The Protocol is based on the principle of common but differentiated responsibilities: it puts the obligation to reduce current emissions on developed countries on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

Lebanon’s presents its INDC of development challenges, as an Adaptation priority for Lebanon as well as its commitment of mitigation actions of reduced greenhouse gases. Lebanon is already facing and will continue to

face significant obstacles regarding climate change, such as, scarce water resources, increased temperatures, increased risks of forest fires and high sea level. This agreement will come into effect in 2030, empowering all countries to act to prevent average global temperature and to reap the many opportunities that arise from a necessary global transformation to clean and sustainable development.

3.2.2.Lebanon's INDC Summary

Lebanon nationally determines to reduce it greenhouse gases emissions by 15% compared to the Business- As-Usual (BAU) scenario in 2030, 15% of the power and heat demand in 2030 is generated by renewable energy resources and a 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under the Business-As-Usual scenario. The unconditional mitigation scenario includes the impacts of mitigation actions which Lebanon is able to implement without additional international support.

However, Lebanon, conditionally and subject to availability of international financial aid and support to means of implementation, commits to reduce its GHGs emissions of 30% compared to the BAU scenario in 2030, where 20% of the power and heat demand in 2030 is generated by renewable energy sources and a 10% reduction in power demand through energy-efficiency in 2030 compared to the demand under BAU scenario.

3.2.3.The national strategy, its goals and commitments, sectors affected

Lebanon conducted several strategic programs in different sectors such as Biodiversity, Forestry and agriculture and water as a main adaptation policy to reduce adverse impacts on environment, economic and social systems.

The National Sustainable Development strategy, clearly highlight highlights the importance of adaptation actions in nearly all of its sectoral chapters, where Lebanon seeks climate change adaptation into electricity infrastructure, tourism and public health sectors.

3.2.4.Climate data and Climate projections

Donnieh is a region in north of Lebanon, having an average altitude of 1000m, where Donnieh municipalities extend from about 300m till the highest altitude of 3087m that represents the highest mountain in the country, Qurnat al Sawda. Climate change and their effects have been widely seen in the past years, where it has been clearly shown the gradual increase in temperature, where it has a direct effect on agriculture, by increasing pesticides, and damaging crops. This change has been widely shown especially in regarding snow accumulation, where in the past years, the precipitated snow started covering areas from about 600-700m and about for several days repeated several time per year, however nowadays, in the past couples of year, this precipitation of snow has decreased significantly affecting several sectors such as ground water, and agriculture. In addition to that, the decrease in snow precipitated stimulate the action of increased temperature, by which the white color of snow act on reflecting the sun rays, however by decreased snow precipitation or their absence, would alter this action, leading to the absorption of these sun rays by the ground, causing the gradual increase in temperature.

Besides that, Donnieh is suffering from the enormous amount of rain precipitation, that are the major leaders to flooding after the first rain, and between the end of winter and beginning of the spring, that are considered as a major issue in the destruction of houses, agricultural lands, and properties.

3.3. Adaptation Scoreboard

The adaptation scoreboard is part of the SEACAP template developed. Donnieh Cluster three municipalities have realized 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%. Finally,

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

East Baalbek Municipalities has put one of these four grades to each one of the adaptation cycle specific steps, as presented in the following table.

Table 17 East Baalbek Municipalities 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	C
	Horizontal (e.g. across departments) coordination mechanisms in place	C
	Vertical (e.g. across governance levels) coordination mechanisms in place	C
	Consultative and participatory mechanisms set up, fostering the multi stakeholder engagement in the adaptation process	C
	Continuous communication process in place	C
Step 2: Assessing risks and vulnerabilities to climate change	Mapping of the possible methods and data sources for carrying out a Risk &Vulnerability Assessment conducted	C
	Assessment of climate risks and vulnerabilities undertaken	D
	Possible sectors of actions identified and prioritized	D
	Available knowledge periodically reviewed and new finding integrated	C
Steps 3 and 4 – Identifying, assessing and selecting adaptation options	Full portfolio of adaptation actions compiled, documented and assessed	D
	Possibilities of mainstreaming adaptation in existing policies and plans assessed, possible synergies and conflicts identified	C
	Adaptation actions developed and adopted	C
Step 5: Implementing	Implementation framework set with clear milestones	C
	Adaptation actions implemented and mainstreamed as defined in the SECAP document	C
	Coordinated action between adaptation and mitigation set	C
Step 6: Monitoring and evaluation	Monitoring framework in place for adaptation actions	C
	Appropriate monitoring and evaluation indicators identified	D
	Regular monitoring of the progress and reporting to the relevant decision makers	C

	Adaptation strategy and/or Action Plan updated, revised and readjusted according to the findings of the monitoring and evaluation procedure	C

3.4. Section B: Climate Change Risk Assessment and Vulnerability Analysis

Table 18 Vulnerability Analysis

Vulnerability analysis				
Receptors		**Extreme weather event**	**Potential effects**	**Who/What is affected**
Population	Public Health	Extreme heat	Deaths due to cardiovascular diseases	Everyone, but especially elderly people, babies, children, workers in outdoor environments and sensitive groups of people
			Spread of vector born and infectious diseases	
			Altered allergic pattern	
			Heat stress	
		Droughts	Asthma and cardiovascular diseases	All people living or working in the area
			Accumulation of trace elements	
		Floods	Loss of lives	People living or working in the area
			Spread of waterborne diseases	
		Landslides	High risk of death to people living around due to damage of building	All people living or working in the area
		Forest Fires	Respiratory issues, coughing, wheezing and shortness of breaths	Farmers, fire fighters, all people living around the burned area.
			Cardiovascular disease	
			Decrease lung function	
			Heat related injuries such as burns	
Infrastructure	Transport	Extreme heat	Rail and road network damages	Roads, rail roads, public transport, people mobility
			Change in behaviour patterns	
			Air quality problems	
			Higher maintenance costs	
		Droughts	Difficult transport of bulk material	Waterways, water management
		Floods	Road network damage	

			Destruction of houses and properties	Roads and transport damage
		Landslides	Destruction of roads	Roads, rail roads, public transport, people mobility
	Energy	Extreme heat	Altered electricity peaks/demand	Conventional power plants, electricity providers and consumers
			Damages	
			Cooling problems	
			Reduction of efficiency yield from conventional power plants and distribution grid	
			Higher maintenance costs	
		Droughts	No/lower production from hydro power plants	Conventional and renewable energy facilities (hydro, PVs, etc)
			Energy supply and demand patterns' shift	
			Higher maintenance costs	
			Cooling problems	
			Effect energy production	
		Floods	Destruction to power plants	Conventional power plants, electricity providers and consumers
		Landslides	Damage to infrastructure that depend on energy supply	Conventional and renewable energy facilities (hydro, PVs, etc)
			Effect energy production	
	Water	Extreme heat	Higher water demand	Public health, water infrastructures
			Water quality issues	
			Higher maintenance costs	
		Droughts	Water scarcity	Public health, water infrastructures
			Water quality issues	
			Higher maintenance costs	
		Floods	Water quality issues	Public Health
			Water management issues	

			Distribution to clean water	
		Forest fires	Alter in water quality	Public health
		Landslides	Alter in ground water quality	Public health, water infrastructures
			Damage to water extensions	
		Decrease in Ice and snow precipitated	Decrease in melted water that could alter spring water and underground water.	Alter water capacity that could affect public health and other several sectors.
	Social	Extreme heat	Higher electricity demand to cover cooling needs	Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities
			Changes in behaviour patterns, e.g. living outdoors	
			Burdening of the health care facilities due to the increased number of patients in hospitals	
		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
		Landslides	Direct costs attributed to damages of landslides	Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities
Built Environment	Building stock and material	Extreme heat	Concrete's damages	All building infrastructure
			Increased cooling demands	
			Higher maintenance costs	
			Urban heat island effect	
		Droughts	Higher water demand	All building infrastructure
		Floods	Destruction of building and private property	All building infrastructure
			Damage to bot the structure and contents of building	
		Landslides	Damage to building	All building infrastructure
			Damages of lands	

Economy	Tourist	Extreme heat	Increased demand for cooling	Tourists, tourist infrastructure, tourist related economy
			Lower touristic flows during the impacted seasons	
			Higher water demand	
		Droughts	Increased pressure on water resources, escalating water scarcity issues	Tourists, tourist infrastructure
			Increased water supply costs	
		Floods	Damage of building and touristic sites	Tourist, tourist infrastructure
		Forest fires	Tourism unappealing	Tourist, tourist infrastructure
		Landslides	Reduction of visitors and tourist to town	Tourists, tourist infrastructure
			Destruction of tourist sites	
	Agriculture	Extreme heat	Changes in growth cycle	Farmers, food industry, consumers
			Damages / loss of harvest	
			Livestock loss and impacts on health	
			Lower crop yields	
		Droughts	Damages / loss of harvest	Farmers, food industry, consumers
			Lower crop yields	
			Livestock loss and impacts on health	
			Land degradation	
		Forest fires	Loss of crops	Farmers, food industry, consumers
			Soil quality degradation	
			Post-fire soil erosion	
			Loss of habitats, territories and shelter	
			Increase possibility of landslides	
			Loss of crops	
		Floods	Farm land degradation	

			Decrease in crops yield	Farmers, food industry, consumers
			Destruction of lands and farm properties	
			Loss of land value	
		Decrease in Ice and snow precipitated	Decrease in underground water that alters crops yield	Farmers, food industry, and consumers
			Trees and bushes that depend highly on snow in winter season will be affected	
			Increases temperature with decreasing snow precipitated, will result in increased pesticides and insects	
		Landslides	Damages of agricultural lands	Farmers, food industry, consumers
			Loss of crops	
Biodiversity	Green zones/ Forests	Extreme heat	Fires and destruction of the ecosystem, flora and fauna	Ecosystem, fish industry, consumers
		Floods	Destruction of forests and ecosystem	Ecosystem
		Forest fires	Destruction to green forests and lands	Ecosystem
			Loss of wide animal species	
			Soil erosion and degradation	
		Droughts	Fires and destruction of the ecosystem, flora and fauna	Ecosystem
		Landslides	Destruction to green forests and lands	Ecosystem

Table 19 Risk Assessment

Risk Assessment				
Receptors		**Weather Sensitivity**	**Future Risk**	**Impact**
Population	Public Health	Extreme heat	- Increased number of deaths	High
			- Reinforcement of heat stress	
			- Increased infectious diseases	
			- Altered allergic patterns	
		Droughts	- Increased allergic incidents	Medium
			- Decreased air quality	
			- More respiratory problems	
		Floods	-Increase number of deaths	High
			-wide spread of waterborne diseases	
		Landslides	-increase number of deaths	Medium
			-increases number of traumatic injuries	
		Forest fires	-increased number of respiratory diseases	High
			Increased cardiovascular diseases	
			-Decreased air quality	
Infrastructure	Transport	Extreme heat	- Damages on road and rail network	High
			- Modification of transport frequency and means	
			- Air quality problems	
			- Higher maintenance costs	
		Droughts	- Difficult transport of bulk material	Low
		Landslides	-increased damages to roads	High
		Floods	-Damages of road network	High
	Energy	Extreme heat	- Blackouts and inability to cover demand load	High
			- Damages, especially in the thermal power plants	

		Droughts	- Blackouts and inability to cover demand load	Medium
			- Higher maintenance costs	
			- Cooling problems in power plants	
		Floods	-Breakdown of electricity	Medium
		Landslides	-Destruction of energy plants	Low
	Water	Extreme heat	- Water scarcity	Medium
			- Water quality issues	
		Droughts	- Water scarcity	High
			- Water quality issues	
		Floods	-water management issues	High
			-water quality issues	
		Forest fires	-Alter in ground water quality	Medium
		Landslides	-Alter in water quality	Medium
		Decrease in Ice and snow precipitated	-Decrease in melted water that could alter spring water and underground water.	Medium
	Social	Extreme heat	- Increased needs for air conditioned public spaces	Medium
		Droughts	- Increased numbers of people presenting respiratory problems and burdening the health care facilities	Medium
			- Inability to cover the water demand	
			- Difficulties in the operation of certain facilities due to lack of water (e.g. swimming pools)	
Built Environment	Building stock and material	Extreme heat	- Concrete's damages	Low
			- Increased cooling demands	
			- Higher maintenance costs	
			- Urban heat island effect	
		Droughts	- Higher water demand	Medium
		Floods	-Building damage	High
		Landslides	-increased risk of building destruction	High

Economy	Tourist	Extreme heat	- Change of the tourism season – lower touristic flows	Medium
			- Reduction of the tourism related economy	
		Droughts	- Increased water supply costs	Low
			- Potential increase of indirect costs for the tourists (infrastructure related) and reduction of touristic flows	
		Floods	-Damages of touristic sites	High
		Forest fires	-Increase in air pollution, decreased air quality results in appealed tourism	High
		Landslides	-High risk of tourist sites destruction	Medium
			-Reduction of tourist visitors	
	Agriculture	Extreme heat	- Changes in growth cycle	High
			- Damages / loss of harvest	
			- Livestock loss and impacts on health	
			- Lower crop yields	
			- Increased fire risks	
		Droughts	- Damages / loss of harvest	High
			- Lower crop yields	
			- Livestock loss and impacts on health	
			- Land degradation	
			- Increased fire risks	
		Floods	-increased damage of farm lands and crops	High
		Forest fires	-increased damage to farm lands	High
			-increased probability of landslides, desertification and loss of species	
		Landslides	-loss of crops.	Medium
			-loss of green and agricultural lands.	
		Decrease in Ice and snow precipitated	-Decrease in underground water that alters crops yield	Medium
			-increase risks of pesticides	

Biodiversity	Green zones/ Forests	Extreme heat	- Fires and destruction of the ecosystem, flora and fauna	High
		Floods	-Increase damage of farm lands and crops	High
		Landslides	-loss of green forests	Medium
		Droughts	- Fires and destruction of the ecosystem, flora and fauna	High
		Forest fires	-loss of green space -Increased probability of soil erosion -loss of wide range of both animal and plant species	High

4. Chapter 4: Mitigation Actions

4.1 Developing capacity for local governance for implementing climate change adaption in the city.

Background

Municipalities are disproportionately affected by climate change, primarily due to its exposure to impacts, as well as various constraints in resources.

Local governance suffers from lack of technical know-how, financial and human resources, inflexible legislation and effective monitoring mechanisms, preventing effective climate change adaptation.

Developing capacity for local governance is essential not just for delivering development goals, but also to support the process of making the Local Authority more responsive, inclusive and accountable.

Individual and societal vulnerability to climate change is often determined by the availability of resources and influenced by institutional dynamics.

Action

Local governance is complex, situated at the base of the multi-level governance hierarchy, and beset by resource limitations. At the same time, local governance is deemed an essential entity in multi-level governance for implementing climate change adaptation measures.

The relationship between governance, policy, and implementation is complex, and the inconsistencies of local governance highlight the need for a versatile methodological approach to elucidate operational challenges at the local level.

The methodological approach of this action is based on the premise that governance actors come together to form policies to be implemented for generating effective results and attaining substantive objectives.

However, improved policy planning does not necessarily lead to improved implementation as it is difficult to predict outcomes that largely depend on the capacity of policy implementers, which is to an extent determined by governance effectiveness.

Based on above, the action will focus on Identifying local capacity needs as key for enabling multilevel governance to effectively respond to climate change through following method:

- Carrying out a local governance assessment based on evaluative criteria to identify local capacity needs for implementing climate change adaptation in city.
- Identifying and integrating local capacity needs into recommendations for policy measures to support municipal local adaptation plan process.

Processing these activities requires the intervention of consultants who can carry out specific activities, not only to assess the capacity of local governance systems to implement climate change adaptation and to identify capacity needs, but to address capacity needs in recommendations for climate-smart policy formulation.

The **recommended and indicative methodology** of work could be summaries as follow:

1. **Conduct Capital Approach Framework (CAF)** to assess the capacity of local governance for implementing climate adaptation.
2. **Participatory interactive workshops** to co-develop appropriate recommendations for policy formulation based on the results of the CAF.

   The participatory workshops can be organised on the following manner:

   - **Municipal Council participatory workshop with the participation of all municipal counsellors**, to have plenary discussion and deliberation on management objectives of municipal council

in relation to climate change adaptation.

The results of the CAF can be presented and validated. This can be done by asking participants to either agree or disagree with key findings.

- A National Government participatory interactive workshop with representatives from various Ministries, non-governmental organizations (NGOs), and external research institutions to
  - Discuss the management objectives of local governance in the context of climate change adaptation.
  - Validate the findings from the assessment,
  - Discuss and agree on the recommendations for policy formulation from the Municipal Council

4.2 Local policies to support Sustainable Energy Access and Climate Action Plans

Background

Strengthening the multilevel governance allows addressing more effectively the issues of climate change in cities.

For successful climate and energy policies, the local authority can boost a process of exploring possibilities and discussing different options with a wide range of stakeholders towards selecting, detailing, implementing and monitoring local action.

Climate and energy policies can be developed in two main different forms of collaboration horizontal and vertical, both of them are crucial to bridge the gaps of knowledge, skills and authority.

The local authorities can play a key role in facing climate change issues and have the capacity to support and mobilize action for local energy generation investments through several modes of urban climate governance.

In the following, four modes of urban energy and climate governance are a policy matrix that summarizes the scope of each mode along with the main tools, the barrier that requires being addressed and exemplary actions to support local energy sustainability is provided.

Actions

The modes of urban energy and climate governance can be mainly summarised as:

- MUNICIPAL SELF-GOVERNING
- MUNICIPAL ENABLING (GOVERNING THROUGH ENABLING)
- GOVERNING THROUGH PROVISION
- REGULATION AND PLANNING (GOVERNING BY AUTHORITY)

Methodology of work

Overall, the barriers that can be addressed with each main tool under these modes of governance are different. For this reason, it is often necessary to combine multiple modes of governance to reinforce and align incentives for particular objectives. This must be supported by an analysis of the legal, physical, social and economic barriers hindering local energy generation prior to considering corrective actions and measures.

Municipal self-governing

Local Authorities have the capacity to govern their own activities and undertake strategic investments in municipality-owned assets, which include investments in energy efficiency and local energy generation based on renewable energy sources.

Municipal enabling (governing through enabling)

As a facilitator, the local authority has an active role in enabling cooperation between community actors, including those that lead to the launch of public-private partnerships to promote local energy generation. Moreover, the involvement of a range of different partners increases the democracy of the processes.

Governing through provision

The Local Authority is a provider of urban services and as such, has control or influence over infrastructure development.

Regulation and planning (governing by authority)

In addition to capacities as implementer, enabler, and provider, local authorities govern by authority through setting regulations and putting forth urban planning principles.

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4.3 Green, Sustainable or Energy-efficient Public Procurement

Background

Public procurement plays a key role in rationalizing public expenditures and in strengthening accountability, enhancing transparency and consequently contributing to sustainable development. Public procurement refers to the process by which public authorities, such as local authorities, purchase work, goods or services from companies. Public procurement and the way procurement processes are shaped and priorities are set in the procurement decisions, offer a significant opportunity for local authorities to improve their overall energy efficiency.

Green public procurement is the process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. This means that public contracting authorities take environmental considerations into account when procuring goods, services or works.

Sustainable public procurement goes even further and means that the contracting authorities take into account the three pillars of sustainable development – the effects on environment, society and economy when procuring goods, services or works.

Energy efficient public procurement allows improving energy efficiency by setting it as relevant criteria in the tendering and decision-making processes related to goods, services or works. It applies to the design, construction and management of buildings, the procurement of energy consuming equipment, such as HVAC systems, vehicles and electrical equipment, and also to the direct purchase of energy, e.g. electricity, gas. It includes practices such as life-cycle costing, the setting of minimum energy-efficiency standards, the use of energy efficient criteria in the tendering process, and measures to promote energy efficiency across organisations.

Energy-efficient procurement offers public authorities, and their communities, social, economic and environmental benefits:

- By using less energy, public authorities will reduce unnecessary costs, and save money;
- Some energy-efficient goods, such as light bulbs, have a longer lifespan and are of higher quality than their cheaper alternatives. Purchasing them will reduce valuable time and effort involved in frequently replacing equipment;
- Reducing CO_2 emissions as a result of energy-efficient procurement will help public authorities to decrease their carbon footprint;
- Through leading by example, public authorities help to convince the general public and private businesses of the importance of energy efficiency and support the development of green economy.

The interest in developing Green Public Procurement regards not only its impact in terms of CO_2 emission reduction, but also in terms of its financial impact.

Action

The implementation of Green procurement in the villages and towns is not an easy task; it needs full understanding of green procurements with proper implementation and training for municipal staff.

The following are indicative steps of action for proper implementation.

- Raise awareness and developing local capacity to enhance green procurement in the city.
- Organise a session on Green Procurement with municipal staff with Ministry of Local Administration and concerned institution for administration development in Jordan to conduct SWOT analyses to elaborate the means and tools to ensure proper implementation of Green Procurement in the city.
- Upgrade the internal procedure and regulation of procurement to include the sustainability clause;
- Adapt the local regulations and polices to ensure proper implementation of Green procurement
- Training the Local administration departments and related representatives on the new rules;
- Assign a consultant to support the developing and implementing sustainability rules in the public procurement;
- Upgrade the internal procedure and regulation of procurement to include the sustainability clause;

4.4 Information measures and public awareness

Background

Public awareness and social engaging play a pivotal role for successful climate action. Measures to induce behaviour change and to provide education significantly contribute to the decrease of energy consumption through social and non-technological approaches that must be included in policies that support energy efficiency and energy savings.

In the CoM framework, local authorities are integrating policies aiming at increasing public awareness (such as information and benefit campaigns) towards a behavioural change in energy use in their territories.

This chapter aims at guiding local authorities in the preparation and successful implementation of this kind of measures that allow improving the impact of their information and training campaigns.

Type of measure

Measures targeting different groups and covering several sectors are frequently selected from local authorities in their Sustainable Energy and Climate Actions Plans.

The most common tools which the measures rely on include:

Web based platforms, whose popularity is growing;

Mass info campaigns: In general, the scope and messages to be communicated are extremely varied. There is a need to tailor-made targeted messages for specific audiences. However, they must target specific areas of society, and the message need to be repeated to be effective

Based on active communication on-line tools: to calculate CO_2 reduction or energy savings estimations.

Database containing examples of energy efficiency applications: illustrated examples of energy renovated houses, energy efficient expert list. These kinds of measures targeting users with previous knowledge on the topic may be very effective.

Energy days, dedicated moments and spots to specific topics enable to raise the attention of public on themes that may be daily neglected (helpdesk and info points).

"Training measures" may have a great impact on community since they target more enthusiastic or empathic audience (students, energy related workers). However, these measures are not very common, because they are more difficult to set and organize, requiring specific skills. Three most common training measures are:

General training to adults, targeting sectors or general ones

Education and awareness raising at schools

Eco driving, general (adults, students) or professional (drivers, energy related workers) ones.

Planning implementing and monitoring an information measure

Planning

Literature and experience show the relevance of an optimal planning of information measures to be implemented. A carefully designed strategic plan to develop measures improves effectiveness. The recommended planning steps are:

Setting the measure/program goals in line with policy goals;

analysis the determinants of desired behavioural change;

analysis market segmentation and choice of target groups;
choice of instruments;
planning the organization and management;
risk analysis and backup plan;
programmer testing and pilot campaigning;
planning the resources;
Planning the monitoring and evaluation.

One of the most important factors to be considered in the planning phase is the selection of the communication channel. This is based on:

cost-efficiency;
media brands;
media coverage and access;
cultural factors;
Long-term view and repetition.

In particular, the repetition is a frequently underestimated factor, which is on the contrary, a key to initiate the process for a change in the behaviour. Repetition or further development of the campaign is recommended in order to keep the message in the minds of the target group.

However, pure information doesn't necessarily result in behavioural changes: information materials must be accompanied by actions allowing people reproducing a new behaviour.

Finally, the suitability of the selected communication tools is another important element. Often it is much more effective to write a personal letter than to use anonymous direct mailing. Face-to-face contacts are more appropriate than telephone calls. Pictures and films are livelier than brochures and texts and leave a more lasting impression.

Implementing

The effectiveness of information campaign relies mostly on the effectiveness of delivered messages. They must be simple, adequate to the targeted group, easy to understand and inspiring. Three main aspects need to be considered:

Emotions and rational arguments: Emotions are a very appropriate way to raise awareness. Once the target group is aware of the problem (e.g. motorised transport) and also of their own role, it makes sense to provide also rational arguments that support a change of behaviour.

Tone: pessimistic and catastrophic messages are not translated in a positive behavioural change. Experience shows that the message needs to be funny and must engage the audience. It needs to be tailored, positive and based on principles of cooperation and self-responsibility. The main pillars of this type of communication are: information, consultation, cooperation and self-responsibility. Moreover, the message must clearly reach the audience, so it might have to be disseminated in local languages.

Feasibility: Maybe the most important aspect to be addressed to ensure the effectiveness of measures. Citizens need to be informed and motivated, but they absolutely need to be able to adopt the measures. The role of the authorities is to provide opportunities for feasible actions. It should also be considered that only reliable information can enable the implementation of effective solutions.

Monitoring and evaluation

The monitoring and evaluation phase of any kind of measure is crucial. It must be integrated in the planning phase, especially when trying to adapt or modify human behaviour. The evaluation of the effectiveness of the measure needs to:

- Choose an evaluation method. A current challenge is to find better ways to evaluate measures effectiveness, to develop new indicators for societal progress allowing to measure if higher awareness is translated into more energy efficient individual behaviours;
- Collect the data;
- Conduct the evaluation and report results and disseminate the results to improve the effectiveness of future programs.

Even if there is still not an harmonised world-wide method for comparing energy behavioural measures, literature gives several examples that can easily be adopted by local authorities: "comparison before the program and after"; the use of statistical analysis like the Difference in differences (DDI) "comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group" or the Randomized control trial (RCT) "the people being studied are randomly allocated one or other of the different treatments under study" Schulz K.F. et al. (2010). The table below shows strengths emerged from information measures implemented in the CoM framework.

Table 20 Strengths/ tips on information campaign Covenant signatories

Strengths:
unifying information in web pages (information hubs)
the development of active communication tools is growing
generation of datasets targeting audience with energy knowledge
easier and more engaging access to energy information through energy days and info-points

Overall recommendations

There is still a lack of knowledge among end-consumers of the existing economic and health potential associated with energy savings and solutions available. Furthermore, the low level of knowledge is not due to the inadequacy of available information. On the contrary, it depends on the way the information is provided. It might be deduced that previous approaches such as the price-based approach (save money) and the environmental approach (save the planet) were not completely successful. Based on the fact that human behaviour and decision making are the core of the Climate Change problem, and that solutions should come from that, the social approach could succeed where other approaches failed. The social approach may drive information and awareness measures for changing the energy behaviour towards sustainable practices. Improvements are still necessary: people need to be inspired, to be engaged, to have fun when receiving the message. This must be carefully selected and keep as simple as possible. The table below summarizes these considerations.

Table 21 Overall recommendations

City planners should consider
emphasize energy use/Climate Change as a real, actual local and personal risk

facilitate more affective and experiential engagement (personal stories)
leverage relevant social group norms
frame policy solutions on what can be gained from immediate action
appeal to intrinsically valued long-term goals and outcomes

5. Chapter 5: Mitigation Actions

5.1 Buildings, Equipment/Facilities

The building sector accounts for a big share of the overall CO_2 emissions in a city, thus, it is important to take specific measures to contribute in mitigation of these emissions. This section proposes a set of actions allocated for this purpose, to apply them in the three essential pillars of the building sector; Municipal, Residential and Tertiary sectors.

5.1.1 Municipal existing buildings: Consumption saving measures

Background

The Union of Donnieh cluster 3 Municipalities has its building under its direct control and management which consumes 41.40 MWh per year (2018) on electrification producing 32.33 tCO_2-eq of emission. Commitment of the municipal council in mitigating emissions through energy saving projects in the municipal buildings and facilities, that will be a role model at the local level. These set of measures will enable the municipal staff to acquire the needed expertise in implementation of energy efficiency actions and promoting the green economy at local level.

Mitigation	
MWh/a	t CO_2-eq /a
14.08	10.04
Contribution for	
30 %	
Cost of Implementation	
Cost should be part of municipality daily work so it is considered nil	
Involvement of Stake Holders	LA H
	External L
	Other L
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Energy bill	
Measurement Units	
MWh	
Area of intervention	
Energy efficiency	
Policy Instrument	
Awareness raising	
Origin of action	
Local authority	
Priority of action	

Below, the proposed actions for the municipality on energy efficiency measures.

Description of the action

Mapping the behaviour of energy consumption at municipal buildings along with energy audits will allow to identify the basic measures to implement that will lead to energy saving.

Behavioural change through optimal use of energy and consumption savings measures leads to achieve tangible amount of savings

Energy audits are useful tool, to provide the information needed to analyse the current consumptions and later implement energy efficiency measures, through a longer-term programme aiming to improve energy management.

Under this section, the proposed indicative measures will support the municipality in understanding the impact of these measures on energy consumption and quantify the round figures for the cost of implementation. However, the municipality as a first step, should assign an energy engineer who will be able to lead the development of measures, identify the steps of implementation and monitor the results

Measures that will be taken by the municipality are listed below:

- Assign an Energy Expert to lead the work in municipal buildings as an energy performance advisor. With him, the municipality will set its vision and target of energy saving.

- Conducting an energy audits in municipal buildings or facilities to identify the source of consumption then list the measures that will help reducing it and quantify the required budget to apply them.
- The municipality at this step should identify the source of funding, apply the measures and monitor the implementation with the support of the energy expert.

The indicative measures may vary between measures that help to reduce consumption and those that improve energy efficiency and can be divided into short term actions and long-term actions:

Short term actions:
Implementing consumption saving measures, such as turning off the lights after leaving the place; use of natural lighting whenever possible; efficient use of the office equipment (PCs, printers,…); adjusting air cooling and heating units according to the thermal calendar; and continuous maintenance of equipment and appliances.

Long term actions:
Using of high efficiency equipment through green procurement; Replace old office appliances with new highly efficient ones; Use of motion sensors in public places such as halls, bathrooms and stairs; Retrofitting existing lighting by a more efficient type such as the LED lighting. This could be applied upon the end of existing lamp life and finally Improving the insulation of the roof and walls of the building

General objectives

The aim of the actions undertaken by the municipality is to raise awareness and provide guidance by investing in energy efficiency measures in municipal buildings that can yield energy savings.

Financial analysis

In the below table, the calculations for the energy savings are presented based on assumptions for the contribution of actions in the overall saving amount. These assumptions can be verified and revised at the time of implementation. Concerning the share of electricity consumption per original source of consumption, the assumptions show that the lighting contributes to 25% of municipal consumption, 40% for heating ventilation and air-conditions (HVAC) and 35% for equipment's and appliances.

	Assumption's consumption estimation	Term of action	Proposed actions	Energy saving calculations assumptions	Energy saving per annual
Electricity consumption 41.40 MWh	Offices artificial Lighting contributes by 25% to the entire municipal building electrical consumption	Short term action	- Turning off the lights after leaving the place. - Focusing on the use of natural lighting whenever possible.	5%	25% * 5% * 41.40= 0.52 MWh
		Long term action	- Install motion sensors for controlling lights in public places	1%	25% * 1% * 41.40 = 0.10 MWh
			- Replace the existing bulbs by a more efficient type as the LED lighting	50%	25% * 50% * 41.40= 5.18 MWh
	Equipment contributes by 35% of entire municipal building electrical consumption	Short term action	- Efficient use of the office equipment (PCs, printers,…)	1%	35% * 1% * 41.40= 0.14 MWh
		Long term action	- Using of high efficiency equipment in green procurement.	10%	35% * 10% * 41.40 = 1.45 MWh
	HVAC contributes by 40% of entire municipal building electrical consumption	Short term action	- Adjusting air cooling and heating units according to the thermal calendar, - Maintaining the equipment and appliances.	30%	40% * 30% * 41.4 = 5 MWh
Fuel Consumption for space heating (LPG) 5.74 MWh	Space Heating & cooking	Long term action	Improve the insulation of the roof and walls of the building. Promote the use of responsible cooking methods	30%	5.74*30%= 1.72
				TOTAL	**14.11 MWh/a**

**Energy saving (MWh)= Electricity consumption (MWh) x consumption per original source of consumption (%) x Energy saving based on assumptions (%)*

The calculated energy saving can contribute in the reduction of energy bills which will be calculated according to the energy costs at the time of preparation of this report.

Foreseen funding resources:

The total electrification in the municipal buildings and facilities costs annually around 5464.80 Euro (41.40 MWh x (132 Euro/MWh)

Most of the actions in municipal buildings can be achieved at affordable cost to the municipality, where the foreseen funding resources come from the municipal fund.

	Source of energy	Consumption as in MWh	Annual Energy saving in MWh	Annual saving cost in (Euro)	Mitigation emission in tCO_2-eq
	Electrification	41.4	12.36	132*12.36 = 1,631.52	12.36*0.781= 9.65
	Fuel (LPG)	5.74	1.72	1.72* 0.88 * 1000 / 13.7 = 110.48	1.72*0.227= 0.39
	TOTAL	47.14	14.08	1742	10.04

**Annual Saving cost= Annual Energy saving (MWh) x cost of electricity (132 EURO /MWh)*

Budget: The calculated cost for this action will be null, through promoting behavioural change, applying green procurement and following the manufacturer recommendation on operation and maintenance of equipment. does not require huge amounts of funding and thus can be covered by the municipality's own funds. The municipality is in any cases paying for its daily expenses and these changes or slight increases in

routine spending should be put on the account of green procurement and green measures that will show its results in the near future and on the long term.

Climate results: The project is expected to generate an abatement of 10.04 tCO_2-eq /a and will count for 80.35 tCO_2-eq until year 2030. If these measures are implemented by 2022,
The climate result is equal to the implementation cost divided by the abatement of 80.35 tCO_2-eq until year 2030 according to Paris agreement.

Energy savings will reduce the annual bill by 1,742 Euro.

5.1.2 New municipal buildings: Implementing and promoting the green building code

Background

Mitigation	
MWh/a	t CO_2/a
6.08	4.34
Contribution for	
30 %	
Cost of Implementation	
This action under new buildings	
Involvement of Stake Holders	LA H External L Other L
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Energy bill	
Measurement Units	
MWh	
Area of intervention	
Energy efficiency	
Policy Instrument	
Green building code	
Origin of action	
Local authority	
Priority of action	

The building sector, the leading contributor to energy consumption, represents the main pillar that should be addressed in the SEACAP.

Green building practice goes beyond enacting legislations; it requires effective work to avoid any failure in taking actions and implementations that hinder its achievement, mainly after the introduction of the municipalities' new buildings system in Lebanon. This system provides incentives for the environmentally friendly green buildings characterized by their ability to conserve energy and rationalize its consumption.

The energy consumption in the municipal buildings sector has reached 47.14 MWh in year 2018, which is expected to increase by year 2030 to 67.41 MWh (*BAU coefficient 1.43 according to JRC at base year 2018*).

The suggested measures vary between applying green building code on new buildings; using renewable energy; using electricity and water- saving appliances and abiding by the insulating buildings, that in turn could save energy; Greening the areas surrounding the buildings and growing plants that don't need much water.

All the processes that are involved in the energy efficiency of buildings, from the design and the construction, to the renovation and operation.

MUNICIPAL BUILDINGS, EQUIPMENT & FACILITIES ANNUAL ELECTRICAL CONSUMPTION						
SITE CATEGORY	Consumption in (MWh) at base year 2018	CO_2 emissions (tCO_2-eq) at base year 2018	BAU consumption (MWh) at 2030	BAU emissions tCO_2-eq at 2030	Estimated for new building consumption (MWh)	Estimated for new building emissions tCO_2-eq
MUNICIPALITY BUILDINGS, ANNUAL ELECTRICITY	41.40	32.33	59.20	46.24	17.80	**13.90**
ANNUAL FUEL CONSUMPTIONS (LPG)	5.74	1.30	8.21	1.86	2.47	**0.56**
TOTAL	**47.14**	**33.03**	**67.41**	**48.10**	**20.27**	**14.46**

Description of the action

Energy efficiency of buildings

In this framework, ten steps are suggested to improve the energy efficiency of buildings, which implies also adopting measures on both thermal and electric energy (e.g. through reducing the wall transmittance in the former and using efficient appliances in the latter). This approach leaves ample freedom to designers while supporting them in adopting solutions that also take into consideration local specificities of climate, culture, locally available materials: Define explicitly the building objectives, with particular focus on the thermal comfort; Assess the microclimatic factors and intervene on the site layout and features which can affect the comfort indoor; Control the heat gains at the external surface of the building envelope; Control and modulate heat transfer through the building envelope; Control the internal gains from appliances and lighting; Allow for local and individual adaptation; Use passive means and strategies to deliver and remove

thermal energy to/from the building; Use HVAC systems assisted by natural (and renewable) energy sources; Use high efficiency active conventional heating and cooling plants, if still necessary; Train building managers and occupants on how to use, monitor the performance of and adequately operate and maintain the building.

Indicative suggestions for Improvement of the envelope and other aspects

One of the most common strategies for energy retrofit of buildings usually consists in reducing both thermal losses through the envelope and cooling loads and in controlling the solar heat gains.

The losses of energy through the envelope may be reduced through the implementation of several measures that affects glazing, frames, and the walls and roofs characteristics.

- Gains and losses of energy through windows are four to five times higher than the rest of the surfaces. Both daylight provision and gaining or protecting from solar radiation penetration must be taken into account in the choice of appropriate glazing. New technologies with decreased values of transmittance for glazing are available.
- Either internal or external thermal insulation of walls reduces their transmittance values according to specific needs and location of the buildings. Commonly-used types of insulation in building construction include: Fiberglass, Polyurethane foam, Polystyrene foam, Cellulose insulation and Rock wool. These materials also contribute to reduce the effect of thermal bridge and to improve sound insulation and thermal inertia.
- The abatement of cooling loads is achieved by reducing solar radiation penetration through the use of shading devices. These comprise: movable devices which can be controlled either manually or automatically; internal and external blinds which help control lighting level and uniformity, and allow stopping solar radiation before penetrating into the room when arranged externally.
- An increased energy performance of buildings is achievable by operating on the heating system. The overall efficiency of the space heating/cooling system includes the efficiency of the generator and the losses of distribution, emission and inaccurate control systems.

General objectives

The aim of the actions undertaken by the municipality is to promote green code on building, raise awareness and provide guidance by investing in energy efficiency measures in municipal buildings that can yield energy savings.

Financial analysis

In the table below the calculation for the energy saving based on assumption for the contribution of actions in overall saving amount, which can be verified and revised at time of implementation.

Energy saving calculation based on assumptions which can be verified at time of implementation						
SITE CATEGORY	Estimated for new building consumption (MWh)	Estimated for new building emissions tCO_2-eq	Estimated reduction on energy consumption based on green building code	Calculated saving in energy consumption in MWh/a	Calculated saving emissions tCO_2-eq	Cost of action
MUNICIPALITY BUILDINGS, ANNUAL ELECTRICITY	17.80	13.90	30%	5.34	4.17	This should be considered part of municipal fund and can be considered nil
ANNUAL FUEL CONSUMPTION (LPG)	2.47	0.56	30%	0.74	0.17	
TOTAL	**20.27**	**14.46**	**30%**	**6.08**	**4.34**	

The calculated energy saving can contribute on the reduction of energy bills which will be calculated according to current the energy costs at the time of preparation of this report.

Foreseen funding resources:

The total electrification in the new municipal buildings and facilities will cost annually around 2349.60 Euro (17.80 MWh x (132 EURO/MWh) if no parameters of green building code applied.
Most of the actions in the new municipal buildings can be achieved at affordable cost to the municipality, where the foreseen funding resource are the municipal funds used to finance the construction of the new infrastructure.

	Source of energy	Consumption as in MWh	Annual energy saving in MWh	Annual saving cost in (Euro)	Mitigation emission in tCO_2-eq
	Electrification	17.8	5.34	132*5.34= 704.88	5.34 *0.781= 4.17
	Fuel (LPG)	2.47	0.74	0.74* 0.88 * 1000 / 13.7 = 47.53	0.74*0.227= 0.17
	TOTAL	20.27	6.08	752.41	4.34

Budget: The calculated cost for this action will be null, applying green building code on new buildings, promoting behavioural change, applying green procurement and following the manufacturer recommendation on operation and maintenance of equipment does not cost any additional huge cost. The cost of construction following the green building code will be normally considered in the budgeting of any new infrastructure construction.

Climate results: The project is expected to generate an abatement of 4.34 tCO_2-eq per year and will count for 34.71 tCO_2-eq until year 2030 if these measures implemented by 2022.
The climate result is equal to the implementation cost divided by the abatement of 34.71 tCO_2-eq until year 2030 according to Paris agreement.

Energy bill will be reduced the bill annually by 752.41 Euro.

5.1.3 Existing buildings at residential sector: Awareness raising activities for modification of the residents' consumption behaviour

Background

Citizens' engagement is of utmost importance since almost the 67.86% of the total energy consumption is due to the residential sector which comprises 1860 households from which 5% have installed solar water heaters. The municipality's role should be supportive to its citizens in reducing their energy consumption bills, increase their living standards and preserving local natural resources. Awareness campaigns can influence the customer consumption patterns and can modify the purchasing behaviour towards more energy efficient products. Municipality can use licensed ads and publish them at different times and has the initiative and ability to raise awareness in collaboration with various governmental parties, community sectors and residents.

Mitigation	
MWh/a	t CO_2/a
1269.16	937.31
Contribution for	
8.81 %	
Cost of Implementation	
200000 euro	
Involvement of Stake Holders	LA H
	External L
	Other H
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Energy bill	
Measurement Units	
MWh	
Area of intervention	
Energy efficiency	
Policy Instrument	
Awareness raising	
Origin of action	
Local authority	
Priority of action	

RESIDENTIAL BUILDINGS, ANNUAL ENERGY CONSUMPTION		
SITE CATEGORY	consumption (MWh) at base year 2018	Emissions (tCO_2-eq) at base year 2018
Residential buildings	4269.60	3334.56
Fuel used of cooking and space heating (LPG)	4586.76	1041.19
Fuel used for space heating (DIESEL)	5556.00	1489.01
TOTAL	**14412.36**	**5864.76**

The Residential sector is responsible for 39.74 % of city's emissions, therefore it is important to encourage citizen to consider energy saving, as the most important step to be taken at the household level.

Description of the action

The awareness raising campaigns for the residents of the Union of Donnieh Cluster 3 municipalities should be organized frequently within the 2030 horizon by municipality. An example which can be used in such campaigns follows.

- Organization of "Energy Days". In these energy days the importance of energy saving and protecting the environment will be stressed, through simple actions such as modification of the energy behaviour, changing incandescent lamps with fluorescent or LED lamps, importance of purchasing high energy class appliances and installation of solar panels for water heating in existing buildings etc.
- Delivering, 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.

Issuing and distributing a booklet to households, explaining the procedures that can be used in this framework, and indicating the mechanisms that help in saving water and energy, energy use rationalization and environmental awareness-raising.

Holding awareness campaigns through the audio-visual communication means, social media, lectures in schools and worship places to motivate citizens to pursue sustainability and highlight its positive effects on economy and society as follows:

- **Water:** The importance of rationalizing water consumption; Demonstrating methods to reduce water consumption; Holding campaigns to encourage residents obtain a permit allowing them to build water harvesting tanks to store water within the existing residential retreats that conform with modern buildings principles.
- **Electricity:** Encourage residents to install solar water heaters, use energy-efficient lighting such as LED and setting the air-conditioners at moderate temperature in summer or winter.
- **Insulating Buildings:** The importance of buildings' insulating and the benefits.
- **Agriculture:** Greening the areas around private buildings, and growing plants that do not need much water.
- **Solid Waste**: promote sorting from source, using degradable trash bags and using reusable grocery bags
- **Cooking:** Promote the use of responsible cooking methods, rationalization of food waste and the use of kitchen utensils, achieving savings in the consumption of oils and fuels such as LPG through the use of pressure cooker.

In the below table is presented the calculation for the energy saving based on assumptions for the contribution of each actions, in the overall energy saving. The data can be verified and revised at time of implementation.

	The assumption for consumption per original source of consumption	Term of action	Proposed actions	Energy saving calculations are based on the following assumptions	Energy saving	Indicative Cost of action in Euro
Electrification consumption 4,269.60 MWh	Electrical water heaters contribute by 20 % of entire residential electrical consumption considering 5% of houses have SWH	Long term action	Replacement of electric water heater by solar water heaters (SWH).	70%	70% * 20% * 95% * 4,269.60= 567.86 MWh	the action based on awareness activities led by municipality, made on annual base to promote people to change behaviour and replace old appliances with efficient one. the cost estimated to be 20,000 euro per year for 10 years plan which count for 200,000 euro
	The dwellings artificial Lights contributes by 21 % of entire residential electrical consumption	Short term action	Focusing on the use of natural lighting whenever possible and turning off the lights after leaving the place.	5%	21% * 5% * 4269.60 = 44.86 MWh	
		Long term action	Replace existing non efficient lights by efficient type as the LED lighting. Assumption based on 50% of houses have efficient led lights	50%	21% * 50% * 50% * 4269.60 =224.15 MWh	
	Home Appliances: Refrigeration contributes by 12 %. Washing machines contributes by 8%. TV, computers mobile chargers … contributes by 4% of entire residential electrical consumption.	Long term action	Replacement of existing refrigerators and freezers by new energy efficient A+++ rated ones. Assumption based on 50% of houses have already energy efficient refrigerators	50%	12% * 50% * 50% * 4269.60 = 128.09 MWh	
		Long term action	Replacement of existing washing machines, by new energy efficient A+++ rated ones. Assumption based on 20% of houses afford changing the washing machine	10 %	8% * 10% * 20% * 4269.60 = 6.83 MWh	
		Short term action	Efficient use for the TV, computers and other small electrical equipment.	1%	4% * 1% * 4269.60= 1.71 MWh	
	Air conditioning contributes by 35% of entire residential electrical consumption	Short term action	Adjusting air cooling and heating units according to the thermal calendar. Maintaining the equipment and appliances. Assumption will be based on 30% of houses will apply this action	30%	35%*30%*30%* 4269.60= 134.49 MWh	
		Long term action	Replacing the old air condition with efficient one. Assumption based on 20% of houses will be able to do that	20%	35% * 20% * 20% * 4269.60= 59.77 MWh	
Space heating and cooking consumption. Fuel type (LPG and DIESEL) 10142.76 MWh	Space Heating & cooking	Long term action	Improve the insulation of the roof and walls of the building. Promote the use of responsible cooking methods and use of pressure cookers. Assumption based on 10% of households are able to afford investing in this action.	10%	10% * 10% * 10142.76 = 101.43 MWh	
				Calculated energy saving	**1,269.16 MWh**	

**Assumptions for electrical consumption and savings are based on Ruble & Karaki Energy policy 52(2013)608-617 https://www.sciencedirect.com/science/article/pii/S0301421512008749*

The following table indicates the mitigated amount of emission on annual base along with the energy bill saving cost.

	Source of energy	Consumption as in MWh	Annual Energy saving in MWh	Annual saving cost in (Euro)	Mitigation emission in tCO_2-eq
	Electrification	4,269.6	1167.74	132 * 1167.74 = 154,141.68	1,167.74 * 0.781 = 912
	Fuel (LPG)	4,586.76	45.86	45.86* 0.88 * 1000 / 13.7 = 2,945.75	45.86*0.227= 10.41
	Fuel (Diesel)	5,556	55.56	55.56*0.48*1000/10 = 2,666.88	55.56*0.268 = 14.89
	total	14,412.36	1,269.16	**159,754.31**	**937.31**

Average Consumer Prices in Lebanon for LPG year 2018 equal to 0.88 EURO/Kg

Kerosene price 0.72 EURO/L
Emissions Factor tCO_2-eq/MWh LPG 0.227 Fuel: Conversion Factor for LPG 13.7 KWh/Kg(the default factors of IPCC (2006) Fuel).

The return of investment is estimated at 159,754.31 Euro per year

Foreseen funding resources:

- The total energy saving in the residential sector is around 1,269.16 MWh and it counts for 159,754.31 euro.
- Budget: estimated 200,000 euro for 10 years with an investment of 20,000 euro per year.
- Climate results: The project is expected to generate an abatement of 937.31 tCO_2-eq per year and will count for 7,498.44 tCO_2-eq until year 2030 if these measures implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 7,498.44 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 159,754.31 Euro each year if the actions are implemented.
- Source of finance: the house owner should pay for all cost for greening the building, however the municipality have a role in promoting greening of the existing buildings, either from municipal fund or can look for outsourcing the fund through innovation way, for example the municipality can amend the contracts signed with advertising companies, to allocate days for unpaid advertisements, to promote use of energy efficient products in houses. and encourage companies that sell household appliances to promote energy savings products through its annual advertisement programme.

5.1.4 New buildings at residential sector: Implementing and promoting Green Building Code

Background

Energy consumption in the residential buildings of the cities of Donnieh Cluster 3 Union of municipalities reached 14412.36 MWh in 2018 and is expected to reach 20609.67 MWh by 2030, based on a business-as-usual scenario and without a plan to reduce the energy demand. Where the Joint Research Centre of European Union indicated that energy demand will rise to 1.43 times in 2030 the consumption recorded in 2018.

Therefore, it is important to work on reducing energy consumption and conserving resources through sustainable development and the adoption of the green building model in modern buildings, as it is estimated that a green building will use 25% - 35% less energy than traditional buildings and uses approximately 40% of the Water. This means lower electricity and water bills for those who will live in such buildings, as well as less reliance on imported energy.

It is therefore important to rely a lot on initiatives and encourage the local community to follow green build standards. Here comes the role of the municipality in guiding citizens to adhere to green building standards when submitting an application for a building permit.

Mitigation	
MWh/a	t CO2/a**
1859.19	756.55
Contribution for	
30 %	
Cost of Implementation	
200000 Euro	
Involvement of Stake Holders	LA H
	External H
	Other H
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Start implementation	
Measurement Units	
Number of new green licenses	
Area of intervention	
Integrated action	
Policy Instrument	
Building standard	
Origin of action	
LA	
Priority of action	

Average Consumer Prices in Lebanon for LPG (local currency) year 2018 equal to 0.88 /Kg
Kerosene price 0.72 EURO/L
the default factors of IPCC (2006) Fuel: Emissions Factor tCO_2-eq/MWh LPG 0.227 Fuel: Conversion Factor for LPG 13.7 KWh/Kg

RESIDENTIAL SECTOR ANNUAL ELECTRICAL CONSUMPTION						
SITE CATEGORY	Consumption (MWh) at base year 2018	Emissions (tCO_2-eq) at base year 2018	BAU Consumption (MWh)* at 2030	BAU Emissions tCO_2-eq at 2030	Estimated building Consumption on new buildings (MWh)*	Estimated for new building Emissions tCO_2-eq
RESIDENTIAL BUILDINGS, ANNUAL ELECTRICITY	4,269.60	3334.56	6105.53	4768.42	1835.93	1433.86
SPACE HEATING AND COOKING FUEL CONSUMPTION (LPG)	4,586.76	1041.19	6,559.07	1488.91	1972.31	447.71
SPACE HEATING USING (DIESEL)	5,556	1489.01	7945.08	2129.28	2389.08	640.27
TOTAL	**14,412.36**	**5,864.76**	**20,609.67**	**8,386.61**	**6,197.31**	2,521.85

The suggested measures vary between promoting green building and other measures include:

- The need for using water storage tanks in modern buildings during winter, also in seasons when water becomes scarce
- Installation of solar water heaters to reduce electricity consumption;
- Use of thermal insulation to reduce energy consumption in buildings by preventing heat loss;
- Greening the areas surrounding the buildings and growing plants that don't need much water;
- Commitment to provide car parking for buildings;
- Commitment to use surface rebound and construction ratios;
- Using heat insulated windows.

Description of the action

The following indicative measure which can be reviewed and updated by municipal council and stakeholders.

- Work with national authorities and stakeholders to prepare guide booklet for green building recommendation which can be used with new building licences.
- Awareness raising campaigns addressing citizens on the importance of green buildings, aiming not only at protecting the environment but also at reducing the costs and encouraging citizens to impose pressure on real estate developers. This would be achieved through audio-visual communication means, social media, lectures held in schools and worship places to encourage them to use environment friendly renewable energy sources and recognize their positive effects on the economic and social levels.

General objectives

The objectives of the actions do not only aim at reducing consumption and pollution caused by burning fuel to generate electricity, but also saving consumption costs on citizens and reducing the governmental subsidies to support the energy sector, thus easing the burden on its citizens.

Financial analysis

In the table below is presented the calculation for the energy saving based on assumptions for the contribution of each action in the overall saving amount, which can be verified and revised at time of implementation.

Energy saving calculation based on assumptions which can be verified at time of implementation						
SITE CATEGORY	Estimated for new building consumption (MWh)	Estimated for new building emissions tCO_2-eq	Estimated reduction on energy consumption based on green building code	Calculated saving in energy consumption MWh/a	Calculated saving emissions tCO_2-eq	Annual saving in (Euro)
RESIDENTIAL BUILDINGS, ANNUAL ELECTRICITY	1,835.93	1433.86	30%	550.78	430.16	132 * 550.78 = 72,702.96
SPACE HEATING AND COOKING FUEL CONSUMPTION (LPG)	1972.31	447.71	30%	591.69	134.31	0.88 * 591.69 * 1000 / 13.7 = 38,006.36
SPACE HEATING USING (DIESEL)	2389.08	640.27	30%	716.72	192.08	0.48*716.72*1000/10 = 34,402.56
TOTAL	**6,197.31**	**2,521.85**	**30%**	**1,859.19**	**756.55**	**145,111.88**

Average Consumer Prices in Lebanon for LPG year 2018 equal to 0.88 EURO /Kg
Kerosene price 0.72Euro/L
Emissions Factor tCO_2-eq/MWh LPG 0.227 Fuel: Conversion Factor for LPG 13.7 KWh/Kg(the default factors of IPCC (2006) Fuel).

The calculated energy saving can contribute in the reduction of energy bills which will be calculated according to current energy costs at the time of preparation of this report.

Foreseen funding resources:

- The total energy saving in residential sector around 1859.19 MWh and it counts for 145,111.88 euro
- Budget: estimated 200,000 euro for 10 years with investment of 20,000 euro per year.
- Climate results: The project is expected to generate an abatement of 756.55 tCO_2-eq per year and will count for 6,052.43 tCO_2-eq until year 2030 if these measures implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 6,052.43 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 145,111.88 Euro each year if the actions are implemented.
- Source of finance: the house owner should pay for all cost for greening the building, however the municipality have a role in promoting the greening of the new buildings, either from municipal fund or can look for outsourcing the fund through innovation way, for example the municipality can amend the contracts signed with advertising companies, to allocate days for unpaid advertisements, to promote use of energy efficient products at houses. and encourage companies that sell household appliances to promote energy savings products through its annual advertisement programme

5.1.5 Tertiary existing buildings: Awareness raising activities for modification of the Occupants' consumption behaviour

Mitigation			
MWh/a		t CO_2/a	
199.96		95.84	
Contribution for			
29.78 %			
Cost of Implementation			
Euro			
Involvement of Stake Holders	LA		H
	External		H
	Other		H
Staff Capacity	L	M	H
Years of Implementation			
Key performance Indicator			
Start implementation			
Measurement Units			
Number of new green licenses			
Area of intervention			
Integrated action			
Policy Instrument			
Building standard			
Origin of action			
LA			
Priority of action			

Background

The tertiary sector represents the (non-municipal and non-residential) buildings, equipment/facilities, for example shops, offices, banks, commercial and retail activities, schools, hospitals...etc. which consume around 4.45% of the energy consumed in building sector.

The municipality's role along with the stakeholders should be supportive to the tertiary sector in reducing its energy consumption bill by highlighting the most important measures that this sector can present, encouraging and motivating them to change their consumption behaviour and to take measures and actions toward energy efficiency and renewable energy use.

TERTIARY BUILDINGS, ANNUAL ELECTRICAL CONSUMPTION AND EMISSIONS		
SITE CATEGORY	Consumption (MWh) at base year 2018	Emissions (tCO_2-eq) at base year 2018
TERCIARY BUILDINGS, ANNUAL ELECTRICITY	298.87	233.42
ANNUAL FUEL CONSUMPTION (LPG)	242.65	55.08
ANNUAL FUEL CONSUMPTION (DIESEL)	130	34.84
TOTAL	**671.52**	**323.34**

Description of the action

During the implementation phase, the selected measures should be adapted according to the city's existing situation and needs. Below, the indicative main measures that can support the attainment of the set objectives are presented.

The awareness raising campaigns for the tertiary sector of Donnieh Cluster 3 Union of municipalities should be organized frequently within the 2030 horizon by municipality.

Common actions for all types of tertiary buildings

a. **Replacement of old inefficient lamps**: Indoor illumination of tertiary-sector buildings uses the largest proportion of electrical energy. the most common strategy is the replacement of old inefficient lamps, with new performing ones. Where, in a typical lighting system, only 30% of the lumens emitted by the lamp contribute to the lit environment. There is a huge amount of losses due to the luminaire, the light absorption on surrounding surfaces and the light redirection to avoidable areas, additional factors that influence the energy consumption due to lighting: 1) the choice of the type of lamp; 2) the displacement of lamps; 3) the relation between lamp and luminaires. 4) the lumen per watt. In addition, use of natural light during daylight hours limit the use of artificial light: hence reducing electrical consumption and thermal load, and improve comfort.
b. Smart use and adoption of **thermometer calendars** in air conditioning with programmable timer will help in reducing energy consumption, every degree matters! Setting your thermostat at a comfortable

temperature that won't make your unit work too hard, but will still make you feel like you're sitting pretty comfortable.

c. Use of **Inverter type air condition** could be a solution to reduce energy consumption and energy bill.
d. Promotion of **regulating water use** and use of tap adaptor to reduce water consumption. This could be applied in public areas and can be heavily implemented in the Mosques and will rationalising the water consumption.
e. Replace electrical water heater with **solar water heaters** in restaurants, clinics, Mosques….etc.
f. **Efficient office appliances**: Energy savings in appliances are possible through the selection of energy-efficient products.

More specific actions for large and more complex buildings such as hospitals, shopping malls…etc. include:

a. **Behaviour and building management:** adequate behaviour of building occupants may also generate significant savings.
b. **The management of technical installations in buildings**, may lead to energy savings: make sure heating is turned off during week-ends and holidays, make sure lighting is off after work, fine tuning of the heating/cooling operation, adequate set points for heating and cooling. For simple buildings, a technician or an energy manager could be appointed for such tasks. For complex buildings, the help of a specialised company may be necessary. Therefore, it may be necessary to renew or set up a new contract with a competent maintenance company with adequate requirements in terms of energy performance; **Promoting energy performance contract**, the way the contract is drafted could highly influence the motivation of such a company to effectively find out ways of reducing energy consumption; Monitoring: implement a daily/weekly/monthly monitoring system of energy consumption in main buildings/facilities, allowing the identification of irregularities and taking immediate corrective action.
c. **Improving the performance of buildings through retro-commissioning:** is a process to improve the efficiency of an existing building's equipment and systems. involves a systemic evaluation of opportunities to improve energy-using systems. It can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life as equipment has aged, or as building usage has changed (bring equipment to its proper operational state, improve indoor air quality, increase equipment lifespan, improve maintenance operations and others). The kinds of problems that retro-commissioning will identify and fix include: 1) Equipment or lighting that is on when it may not need to be; 2) Systems that simultaneously heat and cool; 3) Belts and valves that are not functioning properly; 4) Thermostats and sensors that are out of calibration; 5) Air balancing systems that are less than optimal; 6) Economizers that are not working as designed; 7) Controls sequences that are functioning incorrectly; 8) Variable-frequency drives that operate at unnecessarily high speeds or that operate at a constant speed even though the load being served is variable.
d. **Improvement of the building thermal envelope** through walls and roofs efficient insulation, white reflective paints on roofs, and integration of double-glazing windows. Promoting efficient pressure cookers in the restaurants, hospitals, hotels…etc.

There is not an official study available at the time of preparation of this report regarding the energy consumption in tertiary sector and the estimation of the contribution of lighting, office equipment's and

etc to energy consumption. For that we have considered the link below as a base for the calculation where the assumptions could be reviewed at the time of implementation.
https://www.eceee.org/static/media/uploads/site-2/library/conference_proceedings/eceee_Summer_Studies/2007/Panel_6/6.178/paper.pdf
In the table below is presented the calculation for the energy saving based on assumption for the contribution of actions in the overall energy saving, which can be verified and revised at the time of implementation.

	Assumption consumption estimation	Term of action	Proposed actions	Energy saving calculations	Energy saving	Indicative Cost of action in Euro
Electricity consumption 298.87 MWh	The artificial Lights contributes based on assumption that lighting represents **25** % of entire building electrical consumption	Short term action	- Turning off the lights after leaving the place. - Focusing on the use of natural lighting whenever possible.	5%	25 % * 5% * 298.87 = 3.74 MWh	The estimated investment cost is 200000 euro in 10 years
		Long term action	- Install motion sensors for controlling lights in public places	1%	25 % * 1% * 298.87 = 0.75 MWh	
			- Replace the existing lighting by a more efficient type	50%	25 % * 50% *298.87 = 37.36 MWh	
	Electrical equipment contributes based on assumption that equipment represents **35 %** of entire building consumption	Long term action	- Use of efficient office appliances - Replace electrical water heater with Solar one	10%	35 % * 10% * 298.87 = 10.46 MWh	
	Air conditioning contributes based on assumption that AC represents **40 %** of entire building electrical consumption	Short term action	- Adopting thermometer calendars in air conditioning with programmable timer - Regular maintaining the equipment and appliances.	30%	40 % * 30% * 298.87 = 35.86 MWh	
		Long term action	- Use of Inverter type AC			
Fuel for space heating and cooking (DIESEL) 372.65 MWh	Space Heating & cooking	Long term action	Improve the insulation of the roof and walls of the building. Promote the use of responsible cooking methods and use of pressure cookers. Assumption based on 10% of households are able to afford investing in this action.	30%	372.65*30%= 111.80 MWh	
				Calculated energy saving	**199.96 MWh**	

Financial analysis

Source of energy	Consumption as in MWh	Annual Energy saving in MWh	Annual saving cost in (Euro)	Mitigation emission in tCO_2-eq
Electrification	298.87	88.17	132 * 88.17 = 11,638.44	88.17* 0.781 = 68.86
Fuel (LPG)	242.65	72.79	0.88 * 72.79 * 1000 / 13.7 = 4,675.56	72.79*0.227= 16.52

Fuel (DIESEL)	130	39	39*0.48*1000/10 = 1,872	39*0.268 = 10.45
Total	671.52	199.96	18,186	95.84

The return of investment is estimated a 18,186 Euro per year

Foreseen funding resources:

- The total energy saving in the tertiary sector is around 199.96 MWh and it counts for 18186 euro
- Budget: estimated 200,000 euro for 10 years with an investment of 20,000 euro per year.
- Climate results: The project is expected to generate an abatement of 95.84 tCO_2-eq per year and will count for 766.68 tCO_2-eq until year 2030 if these measures are implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 766.68 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 18186 Euro each year if the actions are implemented.
- Source of finance: the tertiary sector owners should pay for all the costs for greening the building, however the municipality have a role in promoting the greening of the new buildings, either from municipal funds or can look for outsourcing the fund through innovation way, for example the municipality can amend the contracts signed with advertising companies, to allocate days for unpaid advertisements, to promote use of energy efficient products.

5.1.6 New Tertiary buildings: Implementing and promoting the Green Building Code

Background

In 2018, the energy consumption of the tertiary sector in the cities of Donnieh Cluster 3 Union of municipalities was 671.52 MWh, and it is expected to reach 960.27 MWh by 2030, based on the study presented by JRC, where the demand for energy will increase to 1.43 times the current rate of consumption.

Therefore, it is important to work on reducing energy consumption and conserving resources through sustainable development and the adoption of the green building model in modern buildings, as it is estimated that a green building will use 25% - 35% less energy than traditional buildings and uses approximately 40% less of Water. This means lower electricity and water bills for those who will live in such buildings, as well as less reliance on imported energy.

Mitigation	
MWh/a	t CO2/a
86.62	41.71
Contribution for	
30%	
Cost of Implementation	
200000 Euro	
Involvement of Stake Holders	LA H
	External H
	Other H
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Start implementation	
Measurement Units	
Number of new green licenses	
Area of intervention	
Integrated action	
Policy Instrument	
Building standard	
Origin of action	
LA	
Priority of action	

TERTIARY BUILDINGS, ANNUAL ENERGY CONSUMPTION AND EMISSIONS						
SITE CATEGORY	Consumption (MWh) at base year 2018	Emissions (tCO_2-eq) at base year 2018	Based on BAU the demand for energy (MWh) at 2030	Based on BAU emissions tCO_2-eq at 2030	Estimated demand for energy in new building (MWh)	Estimated emissions for new building tCO_2-eq
TERTIARY BUILDINGS, ANNUAL ELECTRICITY	298.87	233.42	427.38	333.79	128.51	100.37
SPACE HEATING USING (LPG)	242.65	55.08	346.99	78.77	104.34	23.69
SPACE HEATING USING (DIEEL)	130.00	34.84	185.90	49.82	55.90	14.98
TOTAL	**671.52**	**323.34**	**960.27**	**462.37**	**288.75**	**139.04**

Description of the action

The core activities in raising awareness about green building code plays important roles in, promoting green building standard benefitting both the city which can encourage practices that lower the city's environmental footprint, developers and owners who can invest in green buildings that offer lower utility bills and can attract corporates wanting to demonstrate their commitment to sustainability.

The municipality with the support of stakeholders can play a vital role in reducing the demand of energy in tertiary sector.

The following indicative approach for green building are obtained from world green council.

Taking an intelligent approach to energy

- Minimising energy use in all stages of a building's life-cycle, making new and renovated buildings more comfortable and less expensive to run, and helping building users learn to be efficient too.
- Integrating renewable and low-carbon technologies to supply buildings' energy needs, once their design has maximised inbuilt and natural efficiencies.

Safeguarding water resources

- Exploring ways to improve drinking and waste water efficiency and management, harvesting water for safe indoor use in innovative ways, and generally minimising water use in buildings.

- Considering the impact of buildings and their surroundings on storm water and drainage infrastructure, ensuring these are not put under undue stress or prevented from doing their job.

Minimising waste and maximising reuse

- Using fewer, more durable materials and generating less waste, as well as accounting for a building's end of life stage by designing for demolition waste recovery and reuse.
- Engaging building users in reuse and recycling.

Promoting health and wellbeing

- Bringing fresh air inside, delivering good indoor air quality through ventilation, and avoiding materials and chemicals that create harmful or toxic emissions.
- Incorporating natural light and views to ensure building users' comfort and enjoyment of their surroundings, and reducing lighting energy needs in the process.
- Designing for ears as well as eyes. Acoustics and proper sound insulation play important roles in helping concentration, recuperation, and peaceful enjoyment of a building in educational, health and residential buildings.
- Ensuring people are comfortable in their everyday environments, creating the right indoor temperature through passive design or building management and monitoring systems.

Keeping our environment green

- Recognising that our urban environment should preserve nature, and ensuring diverse wildlife and land quality are protected or enhanced, by, for example, remediating and building on polluted land or creating new green spaces.
- Looking for ways we can make our urban areas more productive, bringing agriculture into our cities.

Creating resilient and flexible structures

- Adapting to our changing climate, ensuring resilience to events such as flooding, earthquakes or fires so that our buildings stand the test of time and keep people and their belongings safe.
- Designing flexible and dynamic spaces, anticipating changes in their use over time, and avoiding the need to demolish, rebuild or significantly renovate buildings to prevent them becoming obsolete.

Connecting communities and people

- Creating diverse environments that connect and enhance communities, asking what a building will add to its context in terms of positive economic and social effects, and engaging local communities in planning.
- Ensuring transport and distance to amenities are considered in design, reducing the impact of personal transport on the environment, and encouraging environmentally friendly options such as walking or cycling.
- Exploring the potential of both 'smart' and information communications technologies to communicate better with the world around us, for example through smart electricity grids that understand how to transport energy where and when it is needed.

Considering all stages of a building's life-cycle

- Seeking to lower environmental impacts and maximise social and economic value over a building's whole life-cycle (from design, construction, operation and maintenance, through to renovation and eventual demolition).
- Ensuring that embodied resources, such as the energy or water used to produce and transport the materials in the building are minimised so that buildings are truly low impact.

Financial analysis

In the table below the calculation for the energy saving based on assumption for the contribution of actions in overall saving amount, which can be verified and revised at time of implementation.

Energy saving calculation based on assumptions which can be verified at time of implementation						
SITE CATEGORY	Estimated for new building consumption (MWh)	Estimated for new building emissions tCO_2-eq	Estimated reduction on energy consumption based on green building code	Calculated saving in energy consumption MWh/a	Calculated saving emissions tCO_2-eq	Annual saving cost in (Euro)
TERTIARY BUILDINGS, ANNUAL ELECTRICITY	128.51	100.37	30%	**38.55**	**30.11**	132 * 38.55 = 5,088.60
ANNUAL FUEL CONSUMPTION (LPG)	104.34	23.69	30%	**31.30**	**7.11**	0.88 * 31.30 * 1000 / 13.7 = 2,010.51
ANNUAL FUEL CONSUMPTION (DIESEL)	55.90	14.98	30%	**16.77**	**4.49**	16.77*0.48*1000/10 = 804.96
TOTAL	**288.75**	**139.04**	**30%**	**86.62**	**41.71**	**7,904.07**

Average Consumer Prices in Lebanon for Diesel 0.48 Euro/L
Emissions Factor tCO_2-eq/MWh Diesel 0.268 Fuel: Conversion Factor for LPG 10 KWh/Kg(the default factors of IPCC (2006) Fuel).

The calculated energy saving can contribute in the reduction of energy bills which will be calculated according to current energy costs at the time of preparation of this report.

Foreseen funding resources:

- The total energy saving in the residential sector is around 86.62 MWh and it counts for 7904.07 euro
- Budget: estimated 200,000 euro for 10 years with an investment of 20,000 euro per year.
- Climate results: The project is expected to generate an abatement of 41.71 tCO_2-eq per year and will count for 333.65 tCO_2-eq until year 2030 if these measures are implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 333.65 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 7904.07 Euro each year if the actions are implemented.
- Source of finance: the tertiary owner should pay for all the costs for greening the building, however the municipality have a role in promoting the greening of the new buildings, either from municipal funds or can look for outsourcing the fund through innovation way, for example the municipality can amend the contracts signed with advertising companies, to allocate days for unpaid advertisements, to promote use of energy efficient products in buildings

5.2 Municipal Public Lighting: Energy efficient street lighting

Background

Mitigation	
MWh/a	t CO2/a**
433.9	338.9
Contribution for	
59.1 %	
Cost of Implementation	
185806.5 Euro	
Involvement of Stake Holders	LA H
	External L
	Other L
Staff Capacity	L M H
Years of Implementation	
Key performance Indicator	
Start implementation	
Measurement Units	
Number of replaced lights	
Area of intervention	
Energy efficiency	
Policy Instrument	
Energy management / Public procurement	
Origin of action	
LA	
Priority of action	

With outdated, inefficient street lighting systems, a significant amount of municipal energy bills goes on street lighting.

Modern LED lighting solutions are advancing rapidly and can deliver significant energy saving potentials. Increasing efficacy, optimized luminaire design and flexible lighting control enable enhanced performance at lower cost for different lighting and traffic conditions.

Advanced technology nowadays can offer 30-70% of electrical energy savings from the public lighting sector. The street lighting improvement project can include using of LED technology, smart LED drivers and use of astronomical timers. Where, intelligent control systems can create additional savings as the lighting level can be adjusted depending on the time of day and other requirements, contrary to traditional systems that only enable lights to be either on or off.

Description of the action

The municipalities should take the appropriate measures to reduce energy consumption and improve energy efficiency through replacing old street lighting with a modern type that saves energy and gives better quality lighting, reduces light pollution and lowers the cost of maintenance.

The following indicative actions are based upon

- Developing master plan for the city identified the streets and paths with recommended type and model of street light luminaires to be used,
- Modernize the protection components of street lights system, this include installation of
    - Surge protection on feeders and pole sides,
    - Ensure proper grounding system,
    - Overload and short-circuits protection,
    - Astronomical timers,
    - Switching components,
    - Energy consumption metering,
    - Differential relays,
    - Permanent over voltage protection.
- Procuring, installing, maintaining the new lights along with necessary protections devices and control system,

  The procurer shall specify the streets and paths for which the street lighting system will be designed or lighting system components shall be procured.

  The system shall be specified based on the standard EN13201 and the related national standards. Among others the procurer shall specify:
    - Illuminance levels,
    - Uniformity levels,

- Lighting system maintenance factors.

- **Obtaining the measurement for light distribution** before and after the work completion,
- Setup the **Operational and Maintenance Plan** for the Public lighting.
- **Conduct training on operation and maintenance** for the technical staff to ensure quality of services and to extend the operation life time of components.

General Objectives

Modern public lighting systems will positively impact social aspects of the city, from traffic safety, decreased criminal acts, increase productivity in legitimate activities due to security at night as well as cost oriented aspects such as reduction in cost due to energy efficiency and finally environmental related parameters such as reduction of toxic gases, CO2 emission.

Existing type of public street lights year 2018					BAU
	Type of street lamps	Quantities	Watt per lamp	Annual consumptions in MWh	*Annual consumption
	HPS	95	250	104.5	149.435
	HPS	263	150	173.58	248.2194
	HPS	400	100	176	251.68
	LED	30	90	11.88	16.9884
	LED	180	60	47.52	67.9536
Total				513.4	734.2

**Emission Factor for Electricity Consumption: 0.781 tCO2-eq/MWh

*Annual consumption x BAU coefficient 1.43 for the base year of 2018

Planned replacement for public street lights					
	Type of street lamps	Quantities	Watt per lamp in watt	Annual consumptions in MWh	Energy saving in MWh
	LED	95	100	41.8	62.7
	LED	263	70	81.004	92.576
	LED	400	40	70.4	105.6
	LED	30	90	11.88	0
	LED	180	60	47.52	0
Total				252.6	260.8

The expected results of the action implemented on the street lighting system are shown in the below table:

Sectoral & Field of action Number	Key Actions and Measures	BAU Scenario		Mitigation in Energy		Mitigation in %	Cost in Euro
		MWh/a	tCO2/a	MWh/a	tCO2/a		
Public Street Lighting		734.2	573.4	433.9	338.9	59.1	185806.5
	Developing master plan	734.2	573.4				5000
	Modernize the protection components of street lights system			60.9	47.5		18456.5
	Procuring, installing, maintaining the new lights			373	291.3		156350

	Obtaining the measurement for light distribution						2000
	Setup the Operational and Maintenance Plan						2000
	Conduct training on operation and maintenance						2000

5.3 Transportation sector

Transportation is important to the economy of Lebanon society's and critical to its quality of life with an average of 1 car for 3 citizens.

The transport sector in the city includes only road transport and comprises of a number of subcategories, such as the municipal fleet and the private transport, while there are no public transport services in the city. According to the municipality, the municipal fleet comprises of different vehicles including passenger vehicles, light trucks, medium to large trucks, construction machineries, and other vehicles. The fuels used for the municipal fleet are gasoline and diesel. As regards the private cars, the final values of the fuel consumption are calculated by the municipality based on the total numbers of cars in the region, the average travelled distance and the average consumption per kilometre for each type of vehicle. Same approach is used for the commercial vehicles and private/public transportation. The below table presents the estimated data for annual diesel and gasoline consumptions. [1]

By 2030, based on the study presented by JRC, the demand for energy will increase by 1.43 the current rate of consumption year 2018.

Municipal, Private transport Annual fuel consumption and CO_2 emissions						
Transportation sector	Diesel (L)	Gasoline (L)	Fuel Consumptions MWh	Emissions tCO_2-eq	Based on BAU the demand for energy (MWh) at 2030	Based on BAU emissions tCO_2-eq at 2030
Municipal fleet	0.00	7850	72.22	18.06	103.27	25.82
Private sector	85,590	408644.7	4615.43	1169.26	6600.07	1672.05
TOTAL	85,590	416494.7	4687.65	1187.32	6703.34	1697.87

**Emission factor for diesel 0.268 in (tCO_2-eq/MWh) *Emission factor for Gasoline 0.25 in (tCO_2-eq/MWh) *Conversion factor for diesel 0.010 in (MWh/L) *Conversion factor for Gasoline 0.0092 in (MWh/L)*

5.3.1 Road asset planning and management with smart mobility measures

Background

In Donnieh Cluster 3 area there are private vehicles moving on daily basis emitting a considerable quantity of CO_2. The peak hours of congestion are in the morning around 8:00 am and in the afternoon between 2:00 pm and 4:00 pm, where residents are moving to their jobs and students to their schools and returning back to their homes. Hence, implementing measures and actions to improve and enhance the citizen's transport is crucial in order to establish a transport system that is sustainable and environmentally friendly.

In below table the transportation sector contributes for 9.65% of the city emissions.

TRANSPORT SECTOR, ANNUAL FUEL CONSUMPTION				
SITE CATEGORY	Consumption (MWh) at base year 2018	Emissions (tCO_2-eq) at base year 2018	Based on BAU the demand for energy (MWh) at 2030	Based on BAU emissions tCO_2-eq at 2030
TRANSPORT SECTOR	4687.65	1187.32	6703.34	1697.87

Mitigation	
MWh/a	t CO_2/a
469.23	118.85
Contribution for	
7 %	
Cost of Implementation	
To be calculated	
Involvement of Stake Holders	LA: H; External: L; Other: L
Staff Capacity	L / M / H
Years of Implementation	
Key performance Indicator	
Start of planning and progress in work	
Measurement Units	
Number of users	
Area of intervention	
integrate urban and public transport services	
Policy Instrument	
Land use planning regulation	
Origin of action	
LA	
Priority of action	

Description of the Action

1. **Long-term vision** for sector-level road asset management:
   A long-term vision for road asset management at the township level, securing road connectivity to form a continuum of arterial field path and reliable access to social, economic and administrative services.[2]
2. **Improve road network planning:** To plan the development of rural areas based on the best utilisation of the road connectivity for urbanisation, agriculture and industry and livelihoods promotion, passenger transportation, access to socio- economic services and the achievement of the SDGs generally, etc. Strengthen the local community and governance institutions to play a proactive role in planning, maintenance, public transportation services, and road safety.[3]
3. **Road asset management**: is the strategic and systemic process of operating, maintaining, upgrading, and expanding physical road assets throughout their life cycle and improve network efficiency. This may require consideration of the hierarchy of roads within a" transportation" framework, integration with other transport modes, and incorporation of imperatives of economic growth and strategic requirements. It focuses on better decision making based on quality information, well defined objectives, and improved business and engineering procedures. The key principle is recognizing the economic value of assets, optimization of expenditure over the asset's life, Road asset management strategies are well aligned with the poverty-reduction and other positive socio-economic outcomes for rural roads.[4]

4. **Smart Mobility** has been investigated in many programs in the European Union, here are some suggestions for possible Smart Mobility programs to be tested within the borders of city and governorate.
    a. **RING A LINK:** a community-based provider of local transport services[5] work as transport coordination unit, directly operate and/or contract with minibuses to provide primarily general use base for rural transportation with pre- booked services and some fixed route services.
    This type of service will address:
        - Solutions usable by all the population and especially the disadvantaged;
        - New business concepts and solutions for improving the accessibility of rural areas;
        - Local initiatives involving the community to identify transport solutions.

    And it will cover the main mobility needs of the target rural area in (i) daily access to work and education from villages and rural areas; and (ii) access to essential services for vulnerable and isolated people.
    The importance of this measure is that it will address the major gaps represented in the lack of a comprehensive public transportation network and/or an alternative framework for commuting throughout the city and province.
    b. **PRONTOBUS**: is an on-demand bus service which aims to integrate urban and extra-urban public transport services with the neighbouring villages and rural areas of Donnieh cluster 3. The Prontobus include a software system with real-time information to the user via a web portal or smartphone app, and allows the booking of the service.
    in addition, it allows the call centre to manage the reservation with a dedicated web interface, to collect information about each single reservation (origin and destination stop, hour, duration and length of single trips, etc) and to communicate with the bus drivers via tablet. Moreover, Prontobus offers a flexible transport solution usable by all population including mobility-impaired people (the service is carried out with small buses equipped for the get-on/get-off of disabled passengers).[6]

General Objectives

Key objectives
1. Combat social exclusion by providing opportunity to travel for all people in the rural areas;
2. Improve access between villages and the main urban centres;
3. Optimisation of resources by efficient route and ride-matching and dispatching;
4. Increased emphasis on the integration of rural transport services with existing transport provision.[7]

Financial analysis

In the tables below the calculation for the fuel saving based on assumption for the contribution of actions, which can be verified and reviewed at time of implementation.

Energy saving calculation based on assumptions which can be verified at time of implementation					
SITE CATEGORY	BAU the demand for energy (MWh) at 2030	BAU emissions tCO_2-eq at 2030	Estimated saving assumption in percentage	Calculated energy saving MWh/a	Calculated saving emissions tCO_2-eq
TRANSPORT SECTOR	6703.34	1697.87			

5 https://ruralsharedmobility.eu/wp-content/uploads/2019/08/SMARTA-GP-Ring-a-Link.pdf

6 https://ruralsharedmobility.eu/wp-content/uploads/2019/08/SMARTA-GP-Modena.pdf

7 https://ruralsharedmobility.eu/wp-content/uploads/2019/08/SMARTA-GP-Ring-a-Link.pdf

Improve road network planning			2 %	134.07	33.96
Road asset management			3 %	201.10	50.94
Smart Mobility			2 %	134.07	33.96
Total			**7%**	469.23	118.85

Average Consumer Prices in Lebanon for fuel (Gasoline) year 2018 equal to 0.80 (local currency).

**Emission factor for diesel 0.268 in (tCO_2-eq/MWh) *Emission factor for Gasoline 0.25 in (tCO_2-eq/MWh) *Conversion factor for diesel 0.010 in (MWh/L) *Conversion factor for Gasoline 0.0092 in (MWh/L)*

Source of energy	Consumption litre	BAU 2030	Annual saving cost in (Euro)
Fuel (Diesel)	85,590	85590 *1.43 = 122,393.70	7% * 122393.70 * 0.48 = 4,112.4
Fuel (Gasoline)	416,494.7	416494.70*1.43 = 595,587.42	7% * 595578.42 * 0.63 = 26,265.40
Total	502,084.7	**717,981.12**	**30,377.83**

Foreseen funding resources:

- The total energy saving in transportation sector around 469.23 MWh and it counts for 30377.83 Euro
- Budget: estimated 1000000 euro for 10 years with investment of 100,000 euro per year.
- Climate results: The project is expected to generate an abatement of 118.85 tCO_2-eq per year and will count for 950.80 tCO_2-eq until year 2030 if these measures implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 950.80 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 30377.83 Euro each year if the actions are implemented.
- Source of finance: the municipality have a main role in implementation the action, either from municipal fund or outsourcing the fund through national fund or grants. The smart mobility can be implemented through participation of private sector or investors. The municipality must secure the necessary legislation for the work of the private sector, facilitate its work and support it.

5.3.2 Municipal transportation sector - Solid Waste sector

Background

Mitigation			
MWh/a		tCO2/a	
117.44		31.47	
Contribution %			
30 %			
Cost of implementation			
500000 euros			
Involvement of stake holders		LA	■
		External	■
		Other	■
Staff Capacity	L	M	H
	■		
Years of Implementation			
■ ■ ■ ■ ■ ■ ■ ■ ■ ■			
Key performance indicator			
Start of planning			
Measurement units			
Fuel saving /Percentage of sorting			
Area of intervention			
Manging resources			
Policy Instrument			
Waste management			
Origin of action			
LA			
Priority of action			
■ ■ ■ ■ ■ ■ ■ ■ ■ ■			

In 2018, Lebanon generated 2.10 million tons of solid waste, 16% of paper and cardboard, 52.5% organic, 11.5% plastic, 5.5% metal and 3.5% glass. As with all environmental problems, the yearly increase in solid waste production of 1.65% that goes hand in hand with growing population and rising consumption has become a focus of great concern. Along with these rising levels, the investment, management and maintenance of solid waste collection and transport vehicles is seeing a continual increase in financial outlay.

Solid Waste Management: The Union Donnieh Cluster 3 municipalities collects and transfers its solid waste using different types of garbage vehicles that consumes a significant amount of diesel. The table below shows the annual fuel consumption for the garbage vehicles. The Union collects its solid waste and transports these wastes to a non-populated area specific site, and often these wastes are disposed of through direct burning.

The Donnieh Cluster villages has a total population of 14,697 people with an annual solid waste quantity produced of 7,300 tons, 20 tons on daily basis, and is steadily increasing due to the continuously increasing population.

The table below presents the annual fuel consumption and CO_2 emissions for solid waste collection and transport process:

Annual Solid Waste Garbage Vehicles Fuel Consumption and CO_2 Emissions			
Municipality	Diesel/a	Consumption in MWh	tCO_2-eq
Donnieh Cluster 3	27375	273.75	73.36

*Annual consumption x BAU coefficient (1.43 given by JRC)

Description of the Action

1. Optimization of fuel consumption for municipal solid waste collection through routing design and Control.

   The procedure will be based on the development of a GIS-based model to calculate the fuel consumption of vehicles collecting municipal solid waste. The model will then be used to explore optimal conditions for waste collection in the city and to improve the efficiency of the waste management system, thus reducing the cost of waste collection which could eventually lead to environmental benefits.

   In the beginning, the municiplaity must collect detailed data on the tracks used in waste collection, the cost of operation and maintenance, the amount of waste collected, the number of garbage bins and their locations, in addition to details related to the issue of solid waste collection and transportation management, for example, what is incinerated and damp in landfilled or recycled. This information will

be used is to assess the progress of work in the next stages when implementing measures related to better waste management.

Second: The municipality should apply GPS to Garbege vehicles and GIS-based model to explore and test different collection scenarios and ensure effective solid waste management. The GPS based Vehicle Tracking and Monitoring System (VTMS) will confirm online real-time monitoring of the movement of garbage vehicles and will provide live lane compliance for garbage vehicles using data feeds.

Third: IP cameras should be installed at entry and exit from the landfill site, and an Integrated Weighbridge Vehicle Monitoring System (IWVMS) should be provided at entry and exit points.

Fourth: The VTMS system must be integrated with the central command and control center in the municipal administration building and stakeholders should be trained on managing the entire ecosystem of the VTMS system.

Fifth: A GIS-based model should be developed to explore different scenarios to reach the optimal way to collect waste. This will include supporting the calculation of fuel consumption and greenhouse gas emissions under current conditions and for scenarios explored without changing waste bin numbers or locations, investigation of the adequacy of the number and positions of existing collection bins, conducting route improvement for the location of the proposed bins, implementing the new municipal solid waste collection plan, reviewing the results and making an update necessary when needed.

2. Optimization of fuel consumption for municipal solid waste collection through applying sorting from source

   Working on sorting from the source requires understanding the nature of people, preparing a long-term plan, creating the appropriate conditions, securing containers, awareness campaigns, community participation, training courses, motivating work, support from national authorities as well as past experiences in the same context with other municipalities.

General Objectives

To provide a basis for the management of urban waste throughout the years.
Solving the daily challenges of planning, managing and operating municipal solid waste program and facilities; To handle city's waste in an environmentally acceptable way; Raise public awareness of waste-related problems in the city; To incorporate good practices in the waste management systems**;** To reduce emissions resulting from lower fuel oil consumption; To reduce the annual cost of the municipality for waste management; To create new job opportunities for local community.

Fuel Saving Calculation

It was reported that some municipalities have saved about 10% of fuel by adjusting the work of the lanes, and this percentage increases when sorting from the source is adopted to reach 30%, as the daily waste collection is reduced to 3 times a week, not to mention saving on maintenance of machinery and financial returns from selling recyclable materials, as well as creating new job opportunities in the community, conserving local resources and protecting the environment.
In this report, these percentages were taken, and they must be verified upon implementation.

Financial analysis

In the tables below the calculation for the fuel saving based on assumption for the contribution of actions, which can be verified and reviewed at time of implementation.

Energy saving calculation based on assumptions which can be verified at time of implementation					
SITE CATEGORY	BAU the demand for energy (MWh) at 2030	BAU emissions tCO2-eq at 2030	Estimated saving assumption in percentage	Calculated energy saving MWh/a	Calculated saving emissions tCO_2-eq
TRANSPORT SECTOR	391.46	104.90			
routing design and Control.			10 %	39.15	10.49
applying sorting from source			20 %	78.29	20.98
Total			**30%**	**117.44**	**31.47**

Average Consumer Prices in Lebanon for fuel (Diesel) year 2018 equal to 0.48 euro per Litre.

**Emission factor for diesel 0.268 in (tCO_2-eq/MWh) *Emission factor for Gasoline 0.25 in (tCO_2-eq/MWh) *Conversion factor for diesel 0.010 in (MWh/L) *Conversion factor for Gasoline 0.0092 in (MWh/L)*

Source of energy	Consumption liter	BAU 2030	Annual saving cost in (Euro)
Fuel (Diesel)	27375	27375 *1.43 = 39146.25	30% * 39146.25 * 0.48= 5,637.06

Foreseen funding resources:

- The total energy saving in transportation sector around 117.44 MWh and it counts for 5637.06 Euro
- Budget: estimated 500,000 euro.
- Climate results: The project is expected to generate an abatement of 31.47 tCO_2-eq per year and will count for 251.77 tCO_2-eq until year 2030 if these measures implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 251.77 tCO_2-eq until year 2030 according to Paris agreement.
- Energy bill will be reduced by 5,637.06 Euro each year if the actions are implemented.
- Source of finance: the municipality have a main role in implementation the action, either from municipal fund or outsourcing the fund through national fund or grants. There are many EU and international programmes support the sorting from source, the municipality should source such programme and apply to them.

5.4 Solid Waste Management: Landfill emissions

Background

Mitigation			
tCO_2/a			
2,396.5			
Contribution %			
25 %			
Cost of implementation			
To be estimated			
Involvement of stake holders		LA	
		External	
		Other	
Staff Capacity	L	M	H
Years of Implementation			
Key performance indicator			
Start of planning			
Measurement units			
Quantity of treated waste in tons			
Area of intervention			
Managing resources			
Policy Instrument			
Waste management			
Origin of action			
LA			
Priority of action			

The solid waste generated in Lebanon was 2.10 Million tons or nearly 5753 tons/ day in 2019. Where the average production per capita is about 1.2 kg/day. Municipal waste is collected by a service provider company in the grater Beirut which is not the case here in Donnieh union of municipality, where the federation of the union has set to the municipalities a fleet of trucks to collect waste. Disposal methods for solid waste in Lebanon ad specially in Donnieh cluster three are mainly landfilling and dumping (random or controlled).

Donnieh Cluster three Municipalities collects its waste through trucks in each of the five towns that constitue it and then dump it in the only landfill in the region without any treatment or sorting and very oftenly dumped randomly in valleys.

Donnieh cluster three has a total population of 14697 people producing around 20 tons of solid waste on a daily basis. The solid waste produced composition is 65% organic waste, 20% paper and cardboard, 5% plastic, 5% metal and 5% other mixed materials.

Converting organic waste to compost represent one of the solutions for 65% of waste in cluster three, where the composting is the process of controlled biological maturity under aerobic conditions, where the organic matter is decomposed to materials with shorter molecular chains more stable, hygienic, and finally beneficial for the agricultural crops and for recycling of soil organic matter.

The cluster three is productive in agriculture where the cultivated area is considerable, the main farm products include grains and durum wheat, vegetables, plums, apricots, green plums, citrus fruits, and bitter orange flowers, in addition to non-irrigated crops like olives, almonds, and cactus. Hence it is very crucial to support the farmers through producing organic fertilizers from organic waste to be used by farmers instead of synthetic fertilizers.

In the Solid waste disposal sites (SWDS) the degradable organic carbon in waste is decomposed by bacteria under anaerobic conditions into methane (CH_4) and other compounds. The CH_4 emissions from SWDS are important contributors of global anthropogenic CH_4 emissions.

The IPCC default method is a simple mass balance calculation which estimates the amount of CH_4 emitted from the SWDS assuming that all CH_4 is released the same year the waste is disposed of, which is considered in this report.

The below equation will be used to calculate the emissions in the landfill and based on this calculation the suggested action will give us an estimation on emission reduction.

The method assumes that all the potential CH_4 emissions are released during the same year the waste is disposed of. The method is simple and emission calculations require only input of a limited set of parameters, for which the IPCC Guidelines provide default values, where country-specific quantities and data are not available.

Methane emissions (Gg/yr) = (MSW_T ● MSW_F ● MCF ● DOC ● DOC_F ● F ● 16/12-R) ● (1-OX)

Where:

MSW_T: total MSW generated (Gg/yr)

MSW_F: fraction of MSW disposed to solid waste disposal sites (assumption 80%)

MCF: methane correction factor (fraction), 0.6 as general default value.

DOC: degradable organic carbon (fraction) (kg C/ kg SW)

$$DOC = (0.4 \bullet A) + (0.17 \bullet B) + (0.15 \bullet C) + (0.3 \bullet D)$$

Where:

A = Fraction of MSW that is paper and textiles

B = Fraction of MSW that is garden waste, park waste or other non-food organic putrescible

C = Fraction of MSW that is food waste

D = Fraction of MSW that is wood or straw

In Donnieh cluster three region, 65% of waste is composed of organic material and 20% paper, cardboard 5% plastic, 5% metal and 5% other mixed materials

$$DOC= (0.4 \bullet 0.2) + (0.17 \bullet 0) + (0.15 \bullet 0.65) + (0.3 \bullet 0)$$

$$DOC= 0.1775$$

DOC_F: fraction DOC dissimilated; The IPCC default value is 0.77.

F: fraction of CH_4 in landfill gas (IPCC default is 0.5)

16/12: conversion of C to CH_4

R: recovered CH_4 (Gg/yr) The default value for methane recovery is zero.

OX: oxidation factor (fraction – IPCC default is 0)

The results:

Methane emissions (Gg/yr) = (7.3Gg ● 0.8 ● 0.6 ● 0.1775● 0.77 ● 0.5 ● 16/12-0) ● (1-0))

Methane emissions (Gg/yr) = 0.3192728 Gg/yr

Emisssion of methane in Gg/yr	Emisssion of methane t CO_2 eq /yr	BAU year 2030 t CO_2 eq /yr
0.3192728	0.3192728*1000*21= 6,704	6,704 *1.43=9,586

Description of the Action

Waste-management practices can provide effective mitigation of GHG emissions from this sector: a wide range of mature, environmentally-effective technologies are available to mitigate emissions and provide public health, environmental protection, and sustainable development co-benefits. These technologies can directly reduce GHG emissions, through landfill gas recovery, improved landfill practices, avoid significant GHG generation, through controlled composting of organic waste and state-of-the-art incineration. In addition, waste minimization, recycling and re-use represent an important and increasing potential for indirect reduction of GHG emissions through the conservation of raw materials, improved energy and resource efficiency and fossil fuel avoidance.

Municipal solid waste management (MSW) presents potential options for GHG redcution and has links to other sectors (e.g., energy, industrial processes, forestry, and transportation) with further GHG reduction opportunities. Solid waste management deals with the way resources are used as well as with end of life deposition of materials in waste stream, ofen complex decisions are made regarding ways to collect, recycle, transport, and dispose of municipal solid waste that affect cost and environmental releases.

At the outset, municipality should reinforce the idea that solid waste is one of the important local resources that must be preserved and invested in, and not disposed of in landfills. Involving the local community in the responsibility and giving it the role for better waste management will pave the way towards a successful implementation of waste management and create a new concept which is the preservation and investment of local resources. This action includes raising awareness of the importance of “sorting at source” and engaging the community, especially youth, who must be trained and given tools for implementation. The continuation of this awareness periodically will establish the commitment of the largest number of the population to start sorting from the source.

The municipality can study its options and develop a local strategic plan to manage the waste , taking into account the national plans and integration with neighboring towns. One or a set of measures can be considered for example: recycling, composting, converting waste to energy, landfilling with gas collection and recovery energy, and reducing greenhouse gas emissions.

In all steps the municipality need to prepare the ground for efficient management for solid waste and identify the methodology of work based on following but not limited to below indicative measures:

1. Waste reduction, re-use and recycling, through; Solid Waste Sorting Plant; Solid Waste Sorting from Source.

   Recycling reduces GHG emissions through lower energy demand for production (avoided fossil fuel) and by substitution of recycled feedstocks for virgin materials. This is especially true for products resulting from energy-intensive production processes such as metals, glass, plastic and paper. The magnitude of avoided GHG-emissions benefits from recycling is highly dependent on the specific

materials involved, the recovery rates for those materials, the local options for managing materials, and (for energy offsets) the specific fossil fuel avoided.

2. **Biological treatment including composting, anaerobic digestion, and MBT (Mechanical Biological Treatment.**
   Composting decomposes waste aerobically into CO_2, water and a humic fraction; some carbon storage also occurs in the residual compost. However, CH_4 and N_2O can both be formed during composting by poor management and the initiation of semiaerobic (N_2O) or anaerobic (CH_4) conditions. For that it is important to plan well the composting process to avoid increasing the emissions.
   Depending on compost quality, there are many potential applications for compost in agriculture, horticulture, soil stabilization and soil improvement (increased organic matter, higher water-holding capacity).
3. **Waste to energy combustion.** "Incineration and other thermal processes for waste-to-energy"
   These processes include incineration with and without energy recovery, production of refuse-derived fuel (RDF), and industrial co-combustion. Incineration reduces the mass of waste and can **offset fossil-fuel use**; in addition, GHG emissions are avoided, except for the small contribution from fossil carbon.
4. **Landfills with gas collection and energy recovery**. Commercial recovery of landfill CH_4 as a source of renewable energy has been practised at full scale in many countries, because of landfill gas recovery and complementary measures (increased recycling,decreased landfilling, use of alternative waste-management technologies).

General Objectives

The main objective of solid waste management, is to set the basis for a well defined waste routing system, by the aid of solid waste plan sorting from source; a sorting plant; and a composting plant. These could aid in minimizing solid waste methane emissions or avoiding any contamination with ground water, decrease number of trucks and routing system thus decreasing fuel consumption, reduce annual cost of municipality,increase income of municipality, and benefit from compost as an organic fertilizer that enhances soil and crops quality.

Financial analysis

Integrated strategies involving recycling, composting, waste-to- energy combustion, and landfills with gas collection and energy recovery play a significant role in reducing GHG emissions by recovering materials and energy from the MSW stream.

In the tables below the calculation for the GHG emission reduction based on assumption for the contribution of actions, which can be verified and reviewed at time of implementation.

Reduction of GHG emissions which can be verified at time of implementation			
SITE CATEGORY	BAU emissions tCO_2-eq at 2030	Estimated mitigation assumption in percentage	Calculated mitigation emissions tCO_2-eq
Solid waste management	9,586	25%	2,396.5

Above estimated reduction in emission will be based on SWM measures which will be applied and the actual cost will be known accordingly, it is important to verify the measures cost and its feasibility based on climate cost.

Foreseen funding resources:

Source of finance: the municipality has a main role in implementing the action, either from municipal fund or outsourcing the fund through national fund or grants. The SWM can be implemented through participation of private sector or investors. The municipality must secure the necessary legislation for the work of the private sector, facilitate its work and support it, starting with feasibility study should identify the way of finance and lead to better understanding the potential opportunity for sustainable management of waste.

5.5 Local Energy Production

5.5.1 USE of Renewable energy in the city

Background

Green Energy			
MWh/a		tCO2/a	
2048		1600	
Cost of implementation			
1251000 euros			
Involvement of stake holders		LA	
		External	
		Other	
Staff Capacity	L	M	H
Years of Implementation			
2022			
Key performance indicator			
Installed Re in MWp			
Measurement units			
Produce green energy in MWh			
Area of intervention			
Renewable Energy			
Policy Instrument			
RE			
Origin of action			
Local level			
Priority of action			

Electricity consumption in Donnieh cluster three union is about 5.1 GWh (in base year 2018) as the demand for electricity will increase and may reach more than three times the current consumption by 2030 according to the business-as-usual scenario. Meanwhile, the city, like other Lebanese cities, suffers from a shortage of electricity due to the Electricitee du Liban (EDL) company, the "main provider of the network" with only 12 hours of alimentation per day leaving the rest of the time for private generators to operate and cover the shortage.

On the other hand, the city is located in an area rich in energy derived from the sun, with an annual sunshine of 3000 hours and an average global horizontal radiation of 5.3 kWh/m2/day. The typical average production factor for PV systems is between 1520 and 2148 kWh/kWp per year.

Here emerges the important role of the municipality in promoting the trend towards sustainable energy and generalizing the use of renewable energy in public or private buildings and working together with investors to invest in this field.

Description of the action

The experiences in the use of renewable energy in Lebanon are many and varied, and this represents a factor that helps in popularizing the use of renewable energy. Moreover, the investment in renewable energy requires high capital investment, experience and knowledge of the latest technologies. where the municipality does not have the technical expertise and financial resources the municipality can work with the private sector and enter into partnerships with investors who have successful experiences in implementing renewable energy projects and possess sufficient financial assets that guarantee the implementation of long-term projects.

It is important here to pay attention to the need for there to be a third party to ensure the design, implementation and operation of these projects. Hence, the importance of securing contracts that guarantee this work is not only for its implementation but also to ensure sustainable operation and the efficiency of the desired results from this project. Thus, the investor guarantees the economic return on his investment and the municipality guarantees the sustainable operation of the project.

Below is the suggested list of projects which the municipality could implement on a short and long term of period.

- Municipal buildings: online grid connected PV system could vary from 5 to 9 KWp based on average daily consumption of municipal buildings, Such Projects in municipal buildings are important even if they are small in size, as they develop confidence in the use of renewable energy and give practical experience to individuals working in the municipality and make them talk about the success of the project with others and help in understanding the new technologies. The payback period for the investment in grid-connected photovoltaic systems ranges from 4 to 7 years and is considered a good investment.

- Use of PV systems with water pumping stations for drinking water and irrigation water is important to ensure the stability in supplying the water and reduce the energy bill and reduce the dependence of fossil fuel. The municipality can work with EU and international programs to implement such projects in the city, also the municipality can partner with the private sector to implement similar projects through energy performance contracts to guarantee such projects. The payback period for the investment in grid-connected photovoltaic systems ranges from 4 to 7 years and is considered a good investment.
- A PV solar farm in the city is important as it can secure the stability of electricity in the city and reduce the energy dependence on fossil fuel.
  The PV farm project should be coordinated with national authorities and IEC to secure the stability of grid during the day time and to guarantee the return of investment, the long-term EPC should be applied along with third party role to monitor the performance and guarantee the long term of operation and protect interest of both parties the municipality and the investors.

The calculated green energy program

SOLAR PV FARM ANNUAL ELECTRICITY PRODUCTION (MWh)				
Site Category	System type	Annual Production (MWh)	CO_2 emissions saving in tCO2-eq	Project cost In Euro
PV system on municipal building	9 KWp	9KWp x 5.3 Average operation hours per day x 365 days / 1000 to convert to MW =17.41 MW	17.40 * 0.781 = 13.60	10000
PV systems with water pumping stations	50 KWP	50 x 5.3 x 365 / 1000= 96.73 MWh	96.7 * 0.781 = 75.54	50000
Solar PV Farm	1MWh	1 MWp x 5.3 Average operation hours per day x 365 days =1934.50 MW	1934 * 0.781 = 1510.84	1200000
		2048.64 MWh	**2357 * 0.781 = 1599.98**	**1251000**

Financial analysis

Source of energy	Production of green energy MWh per annul	Annual green energy produced in (Euro)
RE	2048.64	132* 2048 = 270419.89

The return of investment is estimated a 270,419.89 Euro per year

Foreseen funding resources:

- The total energy saving is around 2048 MWh and it counts for 270,419.89 euro
- Budget: estimated 1251000 euro.
- Climate results: The project is expected to generate an abatement of 1599.98 tCO_2-eq per year and will account for 12799.87 tCO_2-eq until 2030 if these measures are implemented by 2022.
- The climate result is equal to the implementation cost divided by the abatement of 12799.87 tCO_2-eq until 2030 according to the Paris agreement.
- Energy bill will be reduced by 270419.89 Euro each year if the actions are implemented.
- Source of finance: the municipality can build long term partnerships with the private sector.

6. Chapter 6: Adaptation Actions

6.1 Adaptation actions for population and public health

Extreme heat events can be dangerous to health – even fatal. These events result in increased hospital admissions for heat- related illness, as well as cardiovascular and respiratory disorders.

- Extreme heat events can trigger a variety of heat stress conditions, such as heat stroke. Heat stroke is the most serious heat-related disorder. It occurs when the body becomes unable to control its temperature. Body temperature rises rapidly, the sweating mechanism fails, and the body cannot cool down. This condition can cause death or permanent disability if emergency treatment is not given. Small children, the elderly, and certain other groups including people with chronic diseases, low-income populations, and outdoor workers have higher risk for heat-related illness;
- Higher temperatures and respiratory problems are also linked. One reason is because higher temperatures contribute to the build-up of harmful air pollutants;
- One of the most important effects of climate change in Lebanon is shortage of water. One of the adaptation measures to cope with water shortage includes reuse of grey or treated wastewater in irrigation of trees or vegetables; this could increase the opportunity for transmission risk of several pathogens through crop contamination with pathogens that could cause outbreaks like Typhoid fever or Hepatitis A if the water is not well treated;[8]
- In addition, rising temperature due to climate change will increase microorganisms' growth; leading to increases in water and food-borne diseases, in contrast flooding which is a result of extreme rainfall through concentrating the annual rainfall in a small interval lead to disruption of water purification and contamination with sewage disposal systems, leading to increase the probability of epidemics due to vector borne "VBDs," water and food-borne diseases;[1]
- Climate change may also influence the seasonal pattern for respiratory diseases, cardiovascular diseases and mortality. The most visible effect of climate change on respiratory diseases is on chronic respiratory diseases including bronchial asthma and chronic obstructive pulmonary diseases "COPD"; acute infectious respiratory diseases seems that are not going to be directly affected;
- The sensitivity of the health sector in Lebanon is directly or indirectly affected by climate change. The influence scale ranged from insignificant (malnutrition) to catastrophic emerging epidemics (haemorrhagic fevers). Young children and elderly are the most sensitive group mainly to foodborne and waterborne diseases where the admission rate will be increased followed by respiratory diseases where the admission rate and mortality rate will be increased.
- The increased temperature resulted from climate change will increase the frequency of days with unhealthy levels of ground-level ozone, which is a harmful air pollutant and a component in smog that results in damaging lung tissue, reduce lungs functioning and results in premature deaths.

Main adaptation measures suggested on national level:

- Establishment of an early warning system;

[8] National report MOE & UNDP TNC

- Adopt healthy buildings, through formulation building guidelines which include instructions for advanced sanitary installation that separate grey water from black water;
- Sustaining and improving sanitary conditions

The following table explains the adaptation actions for population and public health:

Actions' characteristic	Adaptation Actions	Estimated cost in
Strategic	Health action plan for the extreme events that the municipality is facing e.g. heat etc. (heat health action plan)	
	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.)	
	Updating building codes and landscaping laws to increase energy efficiency and improves the ability of buildings to provide protection against extreme heat events, for example green roofs and strategically located shade trees.	
	Reorganize the working hours and to reschedule the working time to avoid the mid-day work	
	Collaboration with the regional medical services to increase preparedness level	
Alert / Communication	Developing an early warning system to alert citizens in the case of extreme weather events or natural disasters such as heat waves, floods.	
Educational	Educational and awareness raising campaigns about health-related effects of heat waves, floods, vector borne diseases etc., and educate residents on the ways to protect their health and prevent infection or impact.	
	Provide instruction for public like staying hydrated and avoiding strenuous outdoor exercise during heat alerts	
	Provide easy access to public drinking fountains, swimming pools, and spray pads, take preventive action like opening cooling centres where the public can gather for relief from the heat	
Technical	Regular cleaning and maintenance of the sewage and drainage system	
	Identification of potential hot spots for the development of vector borne diseases	
	Urban forests, including street and wooded areas	
	Frequent monitoring of water and air quality	
Years of Implementation		

6.2 Adaptation actions for infrastructure

Climate change has the potential to impact the safety of existing structures, to increase the frequency of weather-related disasters, to regionally increase premature weathering and to significantly change design criteria and engineering of structures. Because infrastructure built in current times is intended to survive for decades to come, it is critically important that adaptation options to climate change be developed today, incorporated into design and implemented as soon as possible. Prioritization of required adaptation actions will need to account for existing and future vulnerabilities, the variable lifecycles of structures and replacement and maintenance cycles. "No regrets" types of adaptation actions that are available today need to be applied as soon as possible. These include measures to reduce uncertainties in climatic design values, regularly updated climatic design values, enforcement of codes and standards, maintenance of climate data records and networks, consistent forensic analyses of infrastructure failures, regular maintenance scheduling and community disaster management planning. However, given the potential changes expected, it is also likely that many impacts on communities and infrastructure will lie outside of the coping ranges of infrastructure. When this occurs, engineering and planning practices will need account for these growing uncertainties while new adaptation options are developed over time.

Water Resources:

The main climate hazards that the water sector faces in Lebanon are temperature increases, precipitation decreases, increased incidents of drought and increased evaporation. Climate sensitivity indicators in the water sector were determined as reduced groundwater recharge, groundwater quality deterioration, stream flow reduction and increased water demand.

Adaptation strategies and measures suggested for the water sector on national level are:

- Rainwater harvesting
- Wastewater treatment
- Increasing Efficiency of irrigation technologies
- Grey water Reuse
- Public awareness

Actions' characteristic	Adaptation Actions	Estimated cost in
Strategic	Water and waste water management plan	
	Modelling predicted supply changes in the electricity from the locally available resources that serve the community, as a result of the climate change	
	Frequent monitoring of the infrastructure in order to spot and quickly repair any damages	
	Reduce uncertainties in climatic design values, regularly updated climatic design values, enforcement of codes and standards, maintenance of climate data records and networks, consistent forensic	

	analyses of infrastructure failures, regular maintenance scheduling and community disaster management planning.	
Alert / Communication	Issuing alerts in case a part of the infrastructure has been severely damaged and citizens should avoid it	
Educational	Developing guides and awareness raising campaigns for citizens on how to save water and energy, especially during crisis	
Technical	Integration of sustainable drainage systems	
	Establishment of underground water reservoirs	
	Green roofs on top of impermeable surfaces to deal with rainwater storage and heat.	
	Increase the use of renewable energy to decrease pressure on the public grid and would contribute to prevent failure of power plants	
	Rain water harvesting	
	Development of controlled flood management zones near afflicted zones	
	Using advance tap water such as the aerator tap that regulates water flow	
	Improve the efficiency of water storage systems to reduce evaporation	
	Rain water collection through building roofs for household usage	

Years of Implementation								

6.3 Adaptation actions for built environment

The importance of adaptation actions in built environment is to improve the resilience of the built environment in the face of climate change and also will aims to protect the wellbeing of communities through targeted policy initiatives and better urban and building design, ensure appropriate institutional arrangements to facilitate adaptation, realise economic benefits from early adaptation through effective strategic planning and risk minimization, advance sustainability through better resource and risk management strategies, and increase community education and awareness about climate change risks and adaptation.

Urban Sector:

The Representative Concentration Pathways (RCP) is the latest generation of scenarios that provide input to climate models. Scenarios have long been used by planners and decision makers to analyse situations in which outcomes are uncertain. In climate research, emissions scenarios are used to explore how much humans could contribute to future climate change given uncertainties in factors such as population growth, economic development, and development of new technologies. Projections and scenarios of future social and environmental conditions are also used to explore how much impact lesser or greater amounts of climate change would have on different possible states of the world, for example futures with greater or lesser amounts of poverty. The purpose of using scenarios is not to predict the future, but to explore both the scientific and real-world implications of different plausible futures.

Adaptation measures suggested for the urban sector

- Introduce climate responsive building techniques and elements to reduce the effect of heat and reduce demand on energy for cooling;
- Promote the use of energy saving devices, and raise awareness on the long-term benefits of energy efficiency and saving devices;
- Amendments to sector policies and regulations, such as building codes, to reflect climate change risks and direct people towards insulating buildings to reduce energy demand;
- Construct proper storm water network to discharge storm water from built environment;
- Zoning and development changes to reflect increased vulnerability of specific locations and/or resources.

The following table explain the adaptation action related to urban sector:

Actions' characteristic	Adaptation Actions	Estimated cost
Strategic	Modification of building codes to allow more energy efficient and heat tolerant structures	
	Modification of building codes against seismic activity	
	Provision of reductions on the municipal taxes for those proceeding in adoption of adaptation measures in their houses	

	Integrated land use planning with zoning system depending on the different areas (e.g. red for areas to be heavily afflicted by floods or sea level rise)	
	Prevent any cement covering areas between homes and roads, and replace it with printed concrete.	
Alert / Communication	Not applicable	
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 to reduce the heat island effect	
	Building exemplary districts with adapted urban forms and buildings	
	White roofs (cool colours), shading and bioclimatic design	
	Rainwater collection and use Adoption of methods to reduce water demand	
	Using water resistant construction materials	
	Update sewage system by separating grey and black water, to benefit from recycling the grey water in several household applications.	
	Integrate a real-time warning system for landslides	
Years of Implementation		

6.4 Adaptation actions for agriculture

Agriculture Sector:

Donnieh municipality is known for irrigated crops and is characterized by the production of distinctive qualities of vegetables such as summer crops and olives, and fruits such as Njas. Agriculture in Donnieh is a source of income for about 40% of residents. Agriculture in Donnieh suffers from the absence of agriculture guidance, small land properties, poor management of irrigation water, and the lack of academic and professional experts, the dominance of semi-traditional work methods, the commercial monopoly, and the increasing cost of agriculture

The major climate exposure risks associated with agriculture Donnieh-Lebanon were identified as:

1. Temperature increase;
2. Rainfall decrease;
3. Shift in rainy season.
4. Water scarcity

The major sectors of high climate sensitivities were

1. Cropping systems;
2. Livestock production and
3. Livelihood and food security.

The key adaptation measure to climate change is setting and implementing a sustainable agriculture policy.

Adaptation measures vary horizontally according to the agricultural subsectors and their vulnerability to climate change. These measures vary vertically according to the different actors involved in the development and implementation of this policy.

The Adaptation strategies to a changing climate include:

- Agronomic and crop strategies that are intended to offset either partially or completely the loss of productivity caused by climate change through the application of defence tools with different temporal scales, e.g. short term adjustments and long term adaptations, and spatial scales, e.g. farm, regional or national level adaptation; and
- Socio-economic strategies intended to meet the agricultural costs of climate change.

Generally, the most important adaptation measures in Agriculture are:

- Modification of cropping pattern;
- Modification of crop calendar including planting and harvesting dates;
- Implementation of supplemental irrigation and water harvesting techniques;
- Improve water use efficiency;
- Use of different crops varieties and
- Modification of policies and implementation of action plans.

Most of the interventions to upgrade rain fed agriculture can be cost-effective in farming systems, especially where irrigated agriculture is not feasible. For example, supplemental irrigation (the watering of rain fed

crops with small amounts when rainfall fails to provide sufficient moisture) has proven to be a drought-proof strategy in most areas.

Increase of water available for supplementary irrigation can be achieved through **on-farm rainwater harvesting and management system,** i.e. small farm ponds for micro irrigation using drip or sprinkler irrigation systems. Larger rainwater storage structures can also be constructed to provide supplementary irrigation water to a number of small farms or fields by using the micro-dams.

Conservation agriculture, on the other hand is very efficient, leading to increased crop yield. In this adaptation measure, several techniques are used to enhance soil water storage. Water conservation is usually enhanced through mulching and crop residue retention through zero or minimum tillage, stubble mulch tillage, strip tillage and crop rotation. Conservation agriculture, however, requires extension programs such as training and provision of equipment.

Socio-economic Analysis:

The study used the income assessment as a main critical indicator to the sensitivity of local community to the climate change. The importance of these indicators are linked to the impacts of climate change on the yield agricultural productivity at the study site especially that 54.47% of the community income based on agriculture which was considered the most sensitive sector to climate change.

Further measures are required to explore the linkages between socio-economic studies and climate change impacts to enhance the adaptive capacity in communities

Such measures include:

- Increase women's skill-development and capacity building opportunities through training in community and political participation skills and link them to general literacy and education initiatives;
- Take measures to increase the labour productivity of rural women through improved access to training, extension services and technology;
- National governments must prioritize inclusive economic growth that, rather than excluding the rural poor, improves their well-being and reduces rural poverty;
- Mainstream the role of media in climate change and support NGOs and community based organizations (CBOs) are well placed to spearhead awareness raising efforts in different community segments, and in their climate change media-targeting activities;
- A pilot study on vulnerability to food security due to climate change using a multilevel approach, including analytical and relatively comprehensive chain of logical events regarding the impacts of climate change for farm households is needed.

The adaptation actions to agriculture

Actions' characteristic	Adaptation Actions	Estimated Cost in
Strategic	Elaboration of drought, water and ground water management plan	
	Agriculture land assessment for soil quality	
	Adoption of integrated land use planning for the touristic activities	
Alert / Communication	Prepare protective system for any fire hazard	
Educational	Educating farmers and tourist personnel on ways to conserve natural resources, especially during extreme weather events	
Technical	Adopt awareness sessions on the importance of agriculture and its sustainability, and encourage participation of young youth and farmers and their integration with the old farmers to benefit from their experiences.	
	Adoption of agroforestry systems	
	Utilization of drip irrigation practices	
	Adoption of energy efficient and water conservation programs at resorts	
	Reducing cooling needs in resorts by installing automations and setting thermostats at given temperature	
	Promotion of RES (SWH, PVs) in resorts	
	Adopt Fertigation technique; drip technique of both chemical or organic fertilizers and water.	
	Conserve to organic agriculture that combine zero or low tillage and permanent soil cover.	
	Protection of forests and prevent overgrazing	

Years of Implementation								

6.5 Adaptation actions for biodiversity

Biodiversity and Ecosystems:

The expected **impacts** from climate change on ecosystems in Lebanon according to climate exposure and sensitivity of ecosystems are droughts, forest dieback, and community composition change, expansion of drier biomes into marginal lands, habitat degradation and Species loss.

For water vegetation, the analysis study expects reduced growth and reduced growth range due to lower soil moisture. For evergreen Oak forests and Pine forests it is expected to have lower regeneration rate, change in community composition and shrinkage in geographic range.

For Mediterranean non-forest vegetation, it is expected to have reduced growth in lower elevations and shift toward higher elevation with time.

Highest adaptive capacity was noticed to be in desert vegetation, tropical vegetation and to lower extent in marginal vegetation types such as steppe vegetation.

The adaptation for the biodiversity

Actions' characteristic	Adaptation Actions	Estimated cost in
Strategic	Establishment of a fire management plan	
Alert / Communication	Early warning system for flooding or fire hazards	
Educational	Educating the citizens	
	Awareness session in forest important role in environment and ecosystem	
Technical	Fragmenting the forest into section to allow better fire management	
	Planning, construction and maintenance of forest roads	
	Trees planting	

Years of Implementation								

6.6 Livestock sector Improvement

Background

Livestock grazing is still an important activity in the region. Donnieh is known for its pastures especially in the highlands which attract shepherd from outside the area. However, there are increasing complaints regarding the practices of shepherds in forests which are damaging the environment whereby the goat livestock can harm trees and buds. There are around 19, 0 0 0 goats and sheep in Donnieh and comprises 33,500 beehives and 750 beekeepers, domestic animal farming is almost disappearing, poultry farms are distributed among five villages containing a total of 100 thousand birds.

Development of livestock is a complementary activity for the agricultural production, so a greater attention must be given to this sector especially following the recent years crisis that hindered the development of livestock wealth.

Hence, the sustainable development of the livestock sector is very crucial to support the sustainable development of the local community.

Description of the Action

Promote livestock breeding, and develop the agro-food industry through the following measures and actions:

- Organize awareness campaigns on the importance of domestic livestock breeding
- Lobby for the subsidization of animal feed and veterinary drugs
- Encourage the creation of livestock farms (cattle and poultry)
- Provide support to beekeepers (drugs, awareness on fighting bee diseases, reducing tariffs on the import of queens and other products)
- Establish a new slaughterhouse that complies with the health and environmental standards.
- Establishing manufacturing cooperation's
- Establish dairy factories
- Establish honey production and packaging factories
- Establish modern olive presses

General Objectives

Support the main income of the permanent residents, create a sustainable livestock sector to ensure the economic growth of the local community, keep the citizens in their rural areas, improve and ensure the food security in the region, and improve the agro-food production.

A sustainable livestock sector is of ultimate importance in a region like Donnieh, rich in pastures in a very large mountainous area at different altitude ranging from 1800 m to 3088 m above sea level, which give the possibility to diversify livestock wealth and provide a secure and safe food system, improving the healthy life of the citizens.

6.7 Home Farming Project

Background

Donnieh embraces a great diversity of terrain, climate, and high rainfall in winter. This diversity contributes to giving Donnieh an agricultural advantage, as it has the appropriate conditions such as water availability and soil fertility.

However, the residents of Donnieh suffer from the problems of poverty and unemployment, which have intensified with the influx of large numbers of displaced Syrians and the increase in the number of people living below the poverty line.

In response to these challenges, the idea of a home farming project came to help the villagers and rural areas who are vulnerable to difficult living conditions that are beyond their control.

The role of the project is embodied in granting a group of families the capabilities and resources they need to cultivate home gardens that will result in meeting two of the basic needs, namely food and a source of income.

Description of the actions

The project is targeting 50 of the less fortunate families who suffer the most poverty levels in Donnieh cluster three by helping to grow any kind of crop including all kinds of vegetables. The project also includes educational sessions and follow-up throughout the duration of implementation. This will result in establishing a perfect home garden helping the family to produce local crops to ensure its food security and increase its income.

The project will be implemented in 5 phases:

Phase 1: it starts by choosing the families that are in need for this project. Choosing families is based on clear criteria including the level of income, the level of education, the number of family members, the capacity and the will of the family to establish a house farm, the social status and other factors.

Phase 2: Establishing of 25 house farms for 25 families close to each other to facilitate the execution the first working plan and working measures.

Phase 3: Establishing of 25 house farms for other 25 families close to each other to facilitate the execution the first working plan and working measures.

Phase 4: 4 interacting workshops for the families, for 4 continuous weeks aiming at training the families' members for the principles of planting vegetables, follow-up the growing, and irrigation techniques.

Phase 5: it is the last phase, and includes routine visits for the beneficiaries by the municipal working team, reporting the current situation for each family work and highlighting the difficulties and the challenges that are facing.

General Objectives

To raise the level of income for the poorest families in Donnieh cluster three villages and towns. Enhance and assure the food security for these families.

6.8 Agricultural Production Training

Background

Donnieh is facing high levels of unemployment and increasing poverty levels. The loss of jobs and of the productive and commercial fabric resulting from the recent crisis led to decrease in resources and an increase in social vulnerability.

The devaluation of the Lebanese currency led also to very high prices of alimentary and vegetables products.

Due to the high cost of living and due to the loss of jobs and the fact that agriculture is a sector with great potential for growth and creation of new jobs, an overall trend emerged at the citizens level to ensure their proper foodstuff and accordingly focus on the development of agricultural activities to face the economic and financial crisis.

In this context, it became a need to take advantage of small properties and realize an agricultural training and orientation project in order to improve the level of agriculture in Donnieh region, encourage people to embark on agricultural professionalism through producing and marketing homemade secondary products and also guide people to raise domestic animals in order to ensure self-food security.

Description of the actions

This project aims to train citizens interested to start agricultural activities in their lands on basic agricultural practices and to rehabilitate a group of local farmers training them on modern farming methods, introducing them to alternative crops and enable them to diagnose diseases and agricultural problems and work to solve them in appropriate ways.

In parallel other sources of food provision will be enhanced by providing knowledge to raise and increase quality and productivity regarding raising of chicken and eggs and bees and honey.

Urban agriculture in small urban plots or terrace will also be promoted by providing information of the specifities of this type of agriculture and their added value as instrument of social cohesion. To this end, experts from Barcelona, a city with a long track record of promoter of urban agriculture as instrument of social inclusion, will transfer experience and knowhow either in face to face training or in virtual one accompanied by materials.

Lastly the action will seek to raise capacity to promote the potential for commercialization, exchange, distribution at local scale of those food products.

General Objectives

- To improve public understanding of the principles and needs for urban agriculture.
- Supporting the union of municipalities of Donnieh as promoter of opportunities to increase food security in the area.
- Providing the local community with tools to address the most pressing issues affecting agricultural practices in the territory.
- Instrumental zing urban and peri-urban agriculture as a vector of social cohesion.
- To create awareness and support for municipalities' vision to move toward sustainable agriculture.

6.9 Sustainable Environment

Background

Environmental sustainability is concerned with whether environmental resources will be protected and maintained for future generations.

Donnieh region is very rich in natural resources, rare forests of cedars and Lazzab, and a variety of old trees and plants, natural water resources, natural reserves, fertile soil, valleys and mountains, and ecological diversity.

Preserving the environment of Donnieh is very crucial to avoid depletion and degradation of natural resources, as well as to ensure healthy environment for the local community to improve the citizen's living conditions and economic growth.

Description of the Action

Monitor the implementation of projects that preserve the environment, conduct environmental awareness and design new environmental projects through the implementation of the following actions and measures:

- Organize awareness campaigns on the importance of the environment and its sustainability.
- Organize public cleanliness campaigns in the regions
- Monitor the implementation of the sanitation network and waste water treatment projects
- Monitor the " Jurd Mrebbin environmental center" project
- Organize reforestation campaigns
- Produce a forests management plan and identify the means of benefiting from forests and ways to sustain their biological diversification.

General Objectives

Regulating environment resources to meet the needs of society and industry while preserving the forest's health, conducting responsible interaction with the environment to avoid depletion or degradation of natural resources and allow for long-term environmental quality, practicing of environmental sustainability to ensure that the needs of today's Donnieh population are met without jeopardizing the ability of future generations to meet their needs.

Human actions can deplete natural resources, and without the application of environmental sustainability actions and plans, long-term viability can be compromised.

7. Chapter 7: Project Fiches
8. Chapter 8: Communication
9. References