MINARET

NETWORKING FOR THE FUTURE

RENEWABLE ENERGY ASSESSMENT – LEBANON

Sweden Sverige

FUTURE PIONEERS Empowering Communities

IUCN

NERC National Energy Research Center

Royal Scientific Society

1 Table of Contents

1 Table of Contents 2
1 Executive Summery 3
2 Introduction 4
2.1 Background 4
2.2 Objectives and scope 4
3 Methodology 5
3.1 Methods: Data collection and analysis methodologies 5
3.2 Data validation 5
4 General Overview 6
4.1 Current situation 6
5 Analysis and Findings 7
5.1 Photovoltaics system 7
5.1.1 Municipality main building 7
5.1.2 The Upper Water Pumping Station 11
5.1.3 Solid waste separation plant 14
5.1.4 Waste water treatment station 16
5.2 Biogas 18
5.2.1 Background 18
5.2.2 Biogas Assessment 19
6 Recommendations 20
7 Conclusion 22

1 Executive Summery

In this report, site assessments for different buildings located in Jdaideh Al-Shouf - Lebanon, were conducted in order to observe the potential of installing photovoltaics system on the rooftops and the installation of a biogas plant.

The site assessment was undertaken through site visits, determining obstacles on site, gathering information on Lebanon's situation, sharing information, objective and results of the site assessment, in addition to meetings with stakeholders and collecting information on the country's regulations. The team found out that the electricity power is sporadic in general and the public is getting power supply from different sources such as diesel generators.

The following points summarize the conducted assessment in Jdaideh Al-Shouf:

- The Municipality's main building has a potential of 15 kWp. The system could be installed as a hybrid on-grid one with a storage that supplies the municipality building during the day and lights up the main street during the night.
- The waste sorting plant has a potential of 70 kWp as a hybrid off-grid system.
- The upper water pumping station has a potential of 20 kWp as a hybrid on-grid system with storage.
- The waste water treatment station has a potential of 6 kWp as a hybrid on-grid system with storage.
- A potential of 200 KWp of biogas plant that could be installed using the biomass from the two aforementioned locations; solid waste separation plant and wastewater treatment plant utilized.

The report also includes a simple payback period for each location and concludes with the recommendations of the site assessment.

2 Introduction

2.1 Background

The MENA Region Initiative as a Model of NEXUS Approach and Renewable Energy Technologies (MINARET), is developed to address the unique sustainability challenges and opportunities of the MENA region by increasing local and regional sustainability capacities using the synergies between renewable energy technology and efficiency, water management and food security.

The project will also work at the regional level to create a platform for regional dialogue and sharing information among gathered experts in renewable energy, sustainable development and water in addition to discussions on policies, optimal and appropriate localized techniques that are carried out within and beyond the scope of the Project.

2.2 Objectives and scope

- Build the municipality's resilience to climate change by adopting renewable energy resources (RER) and energy efficiency (EE) applications, water management techniques and food security approaches.
- Strengthen institutional capacities of the relevant government authorities involved in the project, by promoting policy dialogue and implementing different capacity-building programs.
- Promote inter-municipal regional cooperation to enhance good governance and equitable dealing and handling of human needs and rights especially for refugee's surviving in and around municipalities.
- Reinforce the role of women, youth and marginalized groups in developing and implementing NEXUS approach.
- Develop a MENA dialogue platform focusing on knowledge sharing, education and lesson learnt on national and regional policy levels.

3 Methodology

3.1 Methods: Data collection and analysis methodologies

Water, energy and food security on a global level can be achieved through a NEXUS approach. A NEXUS approach integrates management and governance across sectors and levels.

This report covers the renewable energy part. The methodology was conducted through site visits, meetings with stakeholders and gathering governmental data and studies relevant to the project.

Different tools and software were also used to analyze the acquired data. Each location was modeled in 3D via a simulation tool, in which real data such as the sun path and shading analysis were used to calculate the anticipated energy production for that specific location. A simple payback period for the PV systems was also calculated.

A study of exploiting biomass produced from the two locations: the Solid Waste Separation Plant and Wastewater Treatment Plant was conducted. The objective of the study is to produce biogas (to generate electricity) and sterile fertilizer.

3.2 Data validation

This data is valid for five years as the loads may change or the building itself may get upgraded in addition to the new technologies that may appear meanwhile.

4 General Overview

4.1 Current situation

There is no usage of renewable energy in Jdaideh Al-Shouf or in buildings affiliated with the municipality due to the high cost of installing PV systems, in general. Moreover, many residential buildings that use renewable energy as a source of power (especially PV systems) are doing so without connecting the system to the grid since the utility is sporadic and unavailable most of the day.

Figure 1*: Municipality building in Jdaideh Al-Shouf*

5 Analysis and Findings

There are several locations affiliated with the municipality of Jdaideh Al-Shouf that have the potential of installing photovoltaics systems.

a. Municipality main building
b. Solid waste separation plant
c. Upper water pumping station
d. Waste water treatment station

PV systems can be categorized by various aspects, such as: grid-connected vs. stand-alone systems and building-integrated vs. rack-mounted systems. According to the preliminary study, the systems in Jdaideh Al-Shouf are either hybrid systems that are grid-connected or hybrid systems that are off-grid depending on the status of each location. A civil study of all considered buildings is a prerequisite prior to installing any system, in order to determine a building's tolerance levels that are resultant from the additional weight when installing PV panels.

Installing a biogas plant was studied for different types of biomass to utilize the biogas in electicity generation, sewage sludge and organic municipal waste in an anaerobic co-digestion processes.

5.1 Photovoltaics system

5.1.1 Municipality main building

The available area to install a PV system could cover the electricity demand. The system could be connected to the grid using PV-up inverters with battery storage to ensure the availability of power supply to the building and streets lighting at the night when the utility grid is disconnected.

***Figure 2**: 3D model of the municipality main building downtown.*

The team learnt that one transformer supplies both the main building and the street lighting. Therefore, coupling these two loads in one system hosted by the municipality building is deemed as the simplest solution.

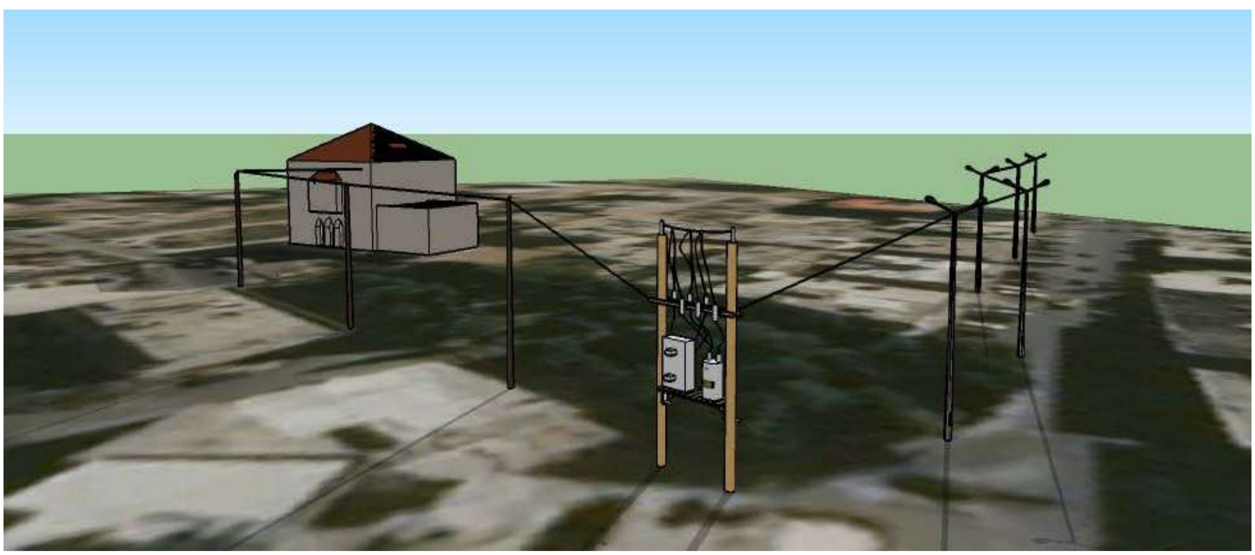


***Figure 3:** One transformer supplies both loads.*

A PV system with a capacity up to 15 kWp could be installed on the rooftop of the municipality building in addition to a battery bank as shown in Figures 4 and Figure 5 below. The system generates/saves approximately 23,400 kWh/year.

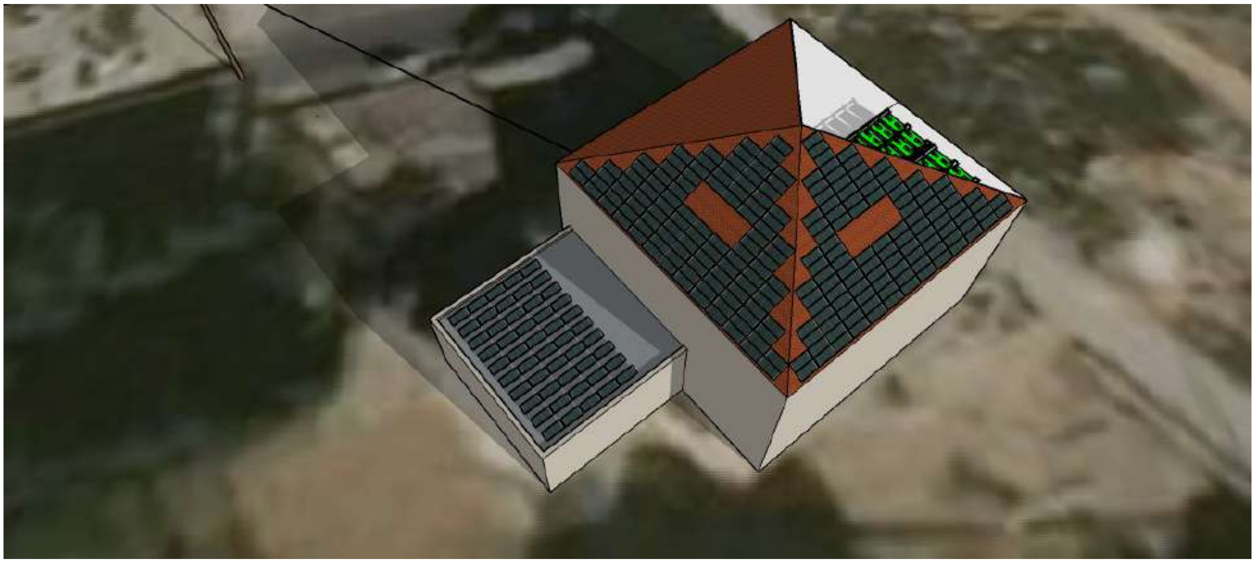


Figure 4: *PV modules on the roof-top including shading analysis for the lower area during sun peak hours in wintery mornings*

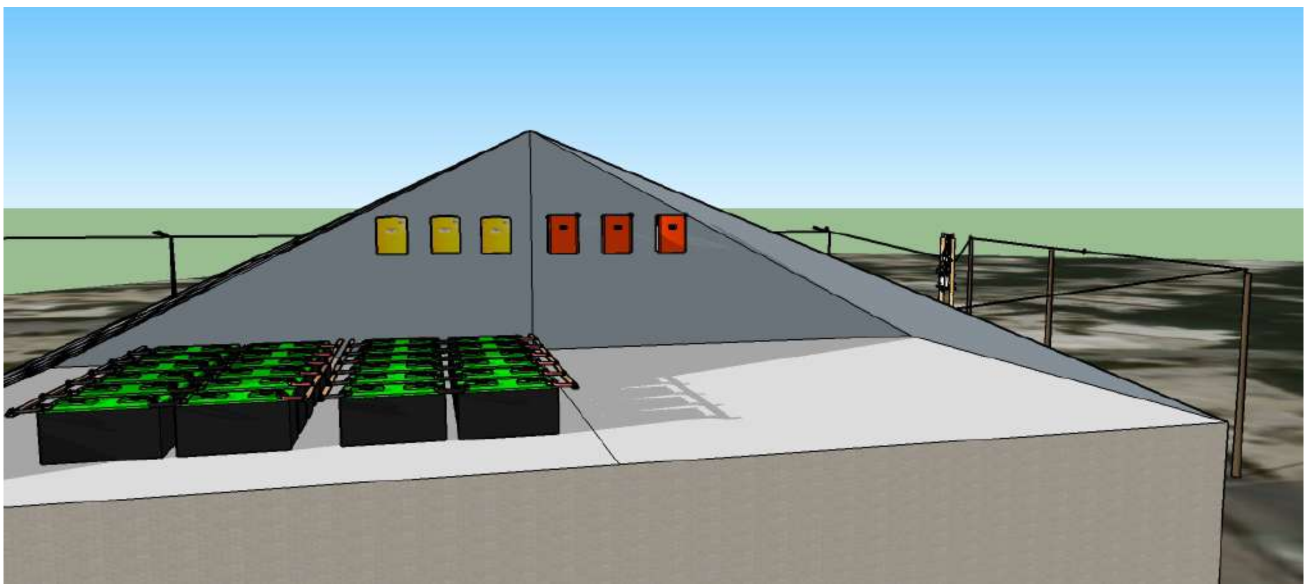


Figure 5*: Layout of the battery bank and electrical room*

The system could be connected either to the grid or to the diesel generator as shown in Figure 6.

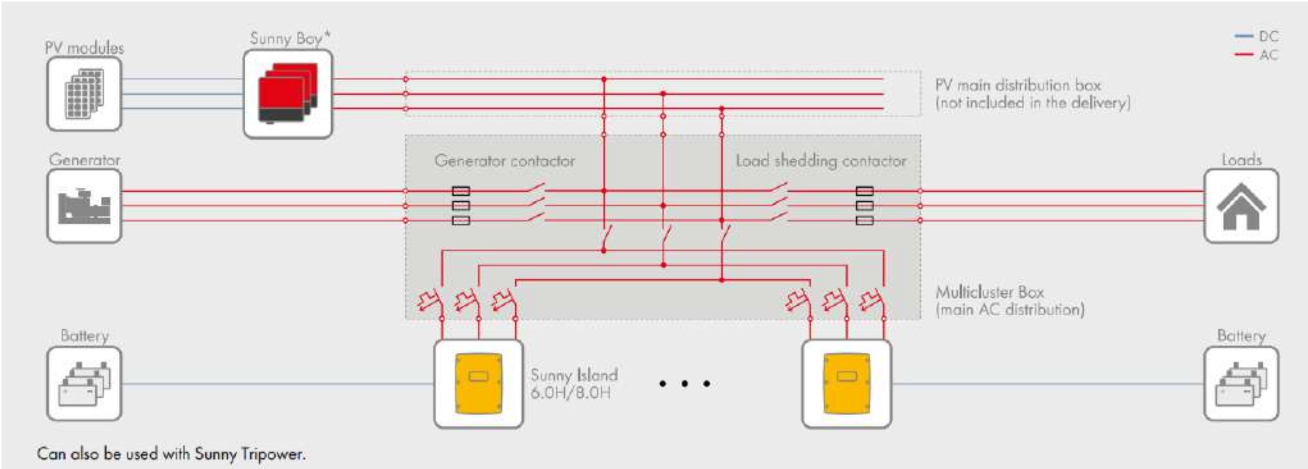


Figure 6: *System Electrical Design*

The total investment for this system is 67,889,000 LBP with a payback period of 11 years.

5.1.2 The Upper Water Pumping Station

A hybrid on-grid system with battery banks could be installed at the upper water pumping station. The free area on the roofs of both storage tanks fit a capacity of 20-kWp PV system. The system generates/saves 31,200 kWh/year approximately.

This connection helps in enhancing the power quality in the station and reduces power loss through the transmission lines.

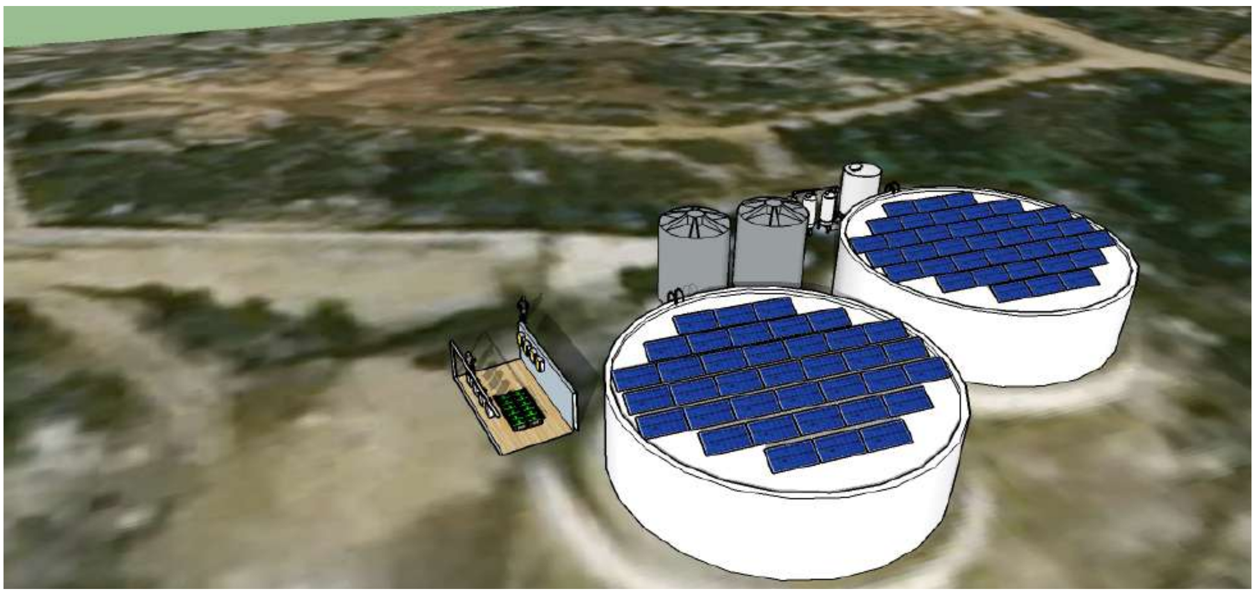


Figure 7: *3D model of the upper pumping station*

The loads at the Upper Water Pumping Station consist of a filtration station in addition to three 7.5 kW pumps for water distribution.

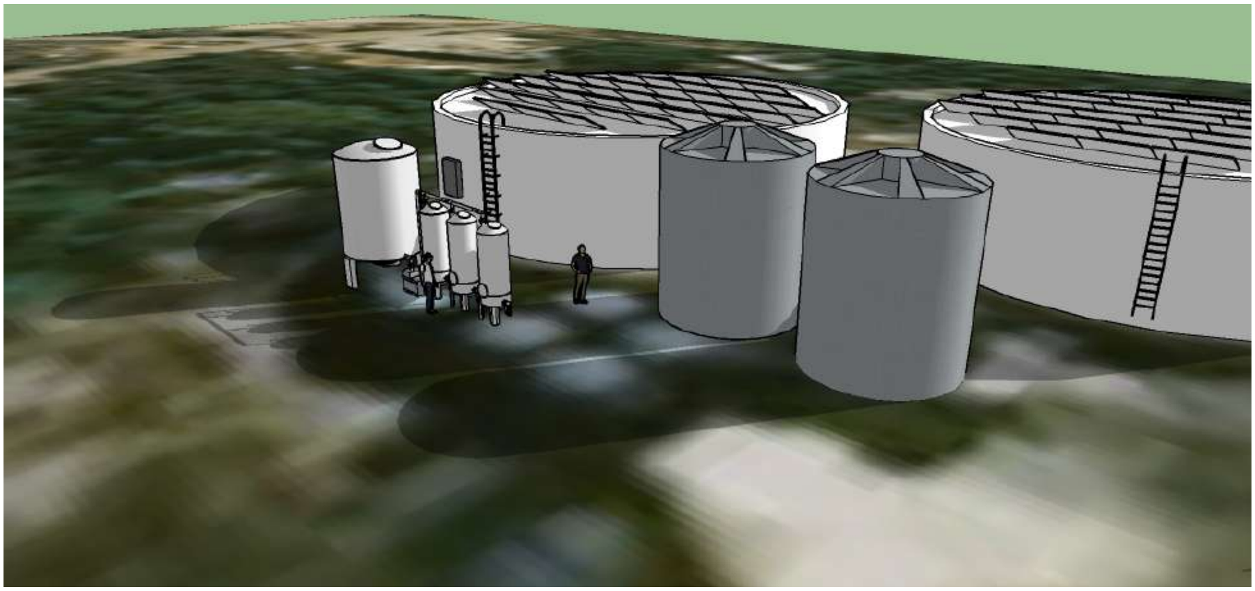


Figure 8: *The filtration station*

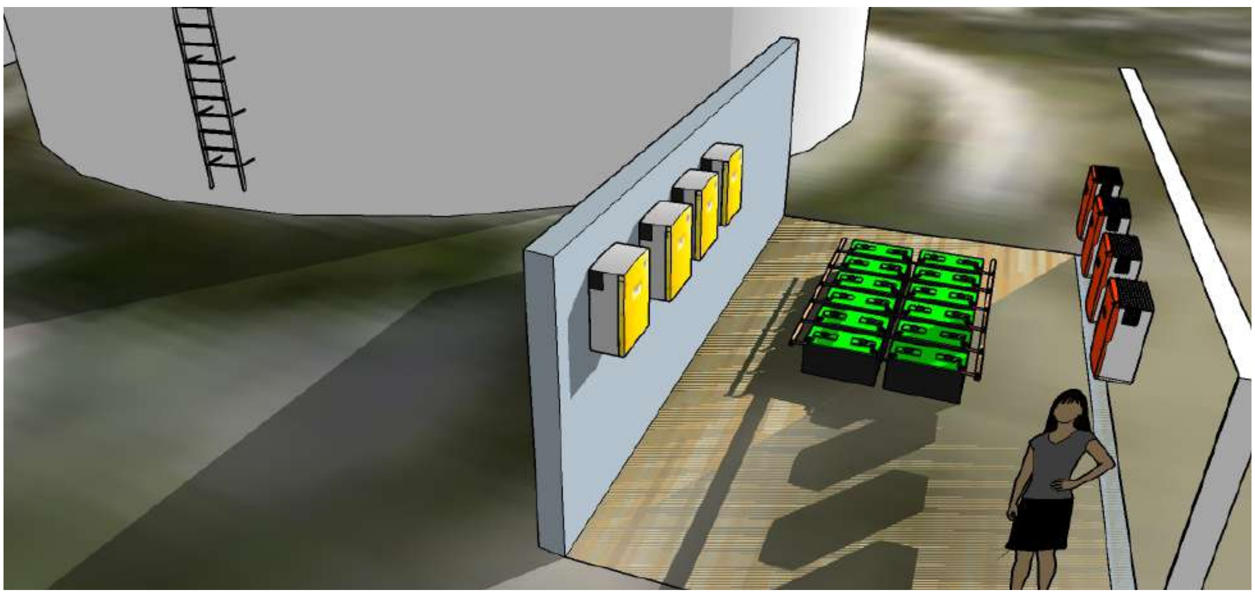


Figure 9: *Electrical room layout*

The system could be connected either to the grid or to the diesel generator as shown in Figure 14.

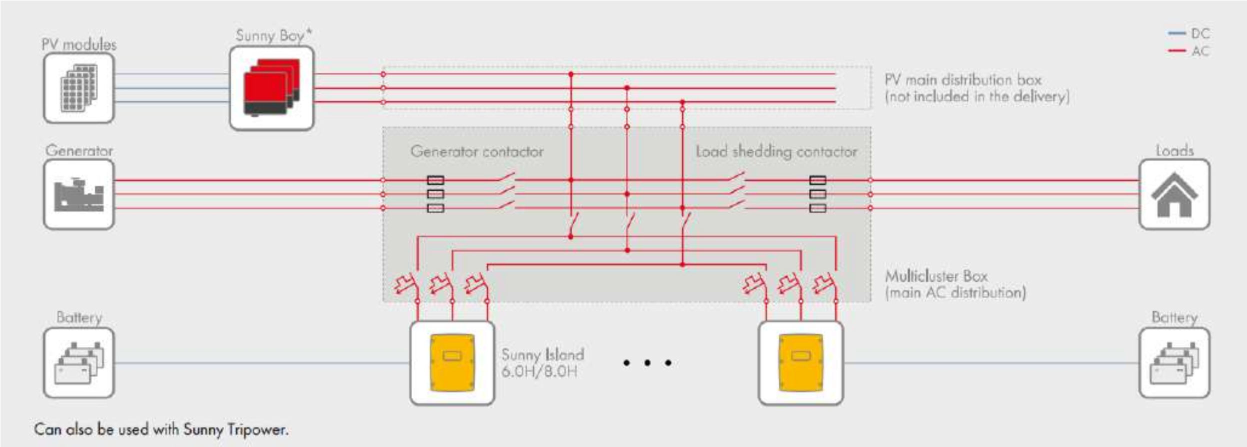


Figure 10: *System Electrical Design*

This system costs 90,519,000 LBP with a payback of 9.7 years.

5.1.3 Solid waste separation plant

The solid waste separation plant operates using its own diesel generation plant, a capacity of 250KVA. The system that could be installed on site is a hybrid off-grid system due to the unavailability of the utility grid. The rooftop fits approximately a 70-kWp PV system. The PV system will reduce the fuel consumed by the generator to meet the plant demand. The system generates/saves approximately 109,200 kWh/year.

Figure 11: *The waste sorting plant*

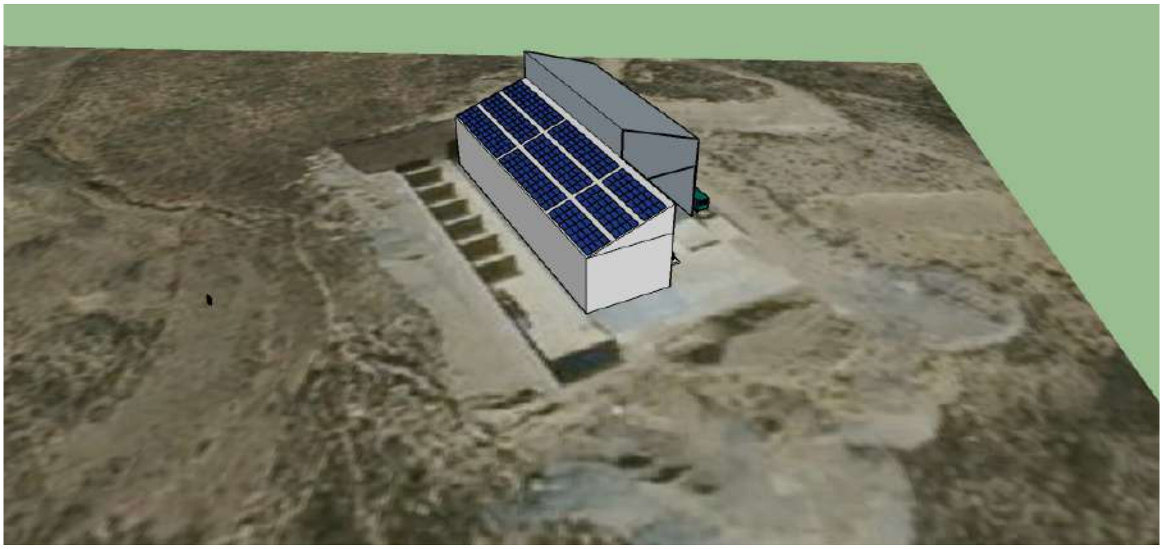


Figure 12: *3D model of the PV system on the rooftop*

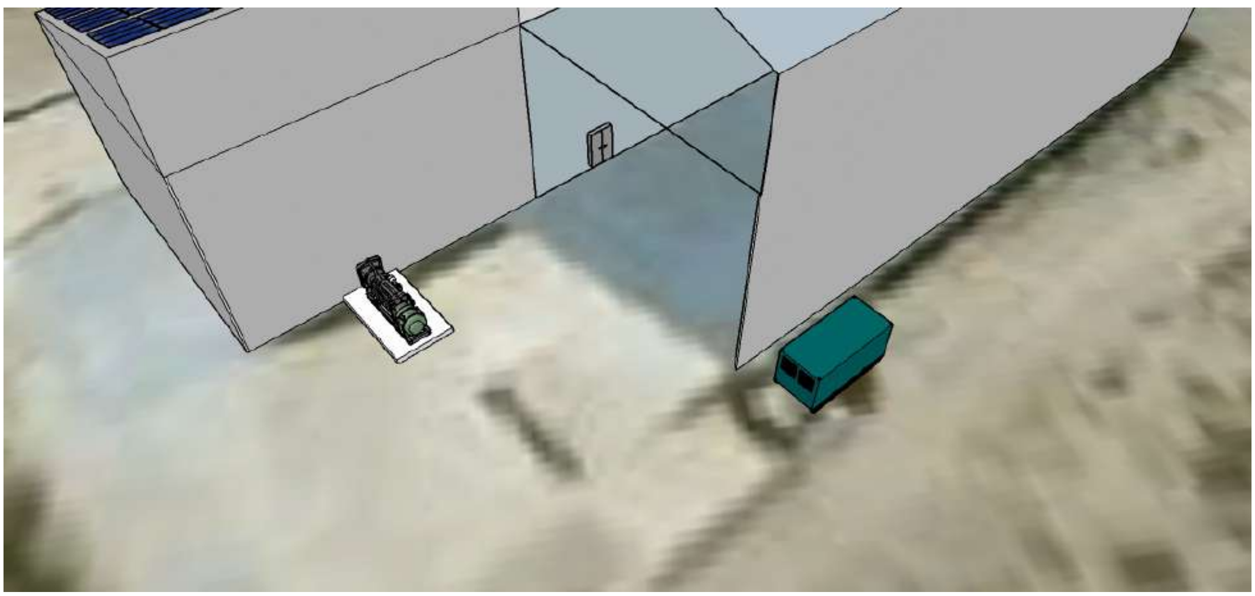


Figure 13: *Diesel generators location on site*

The proposed system is called an off-grid PV system that aims to reduce the fuel consumption during the day. The PV plant serves as a secondary power source.

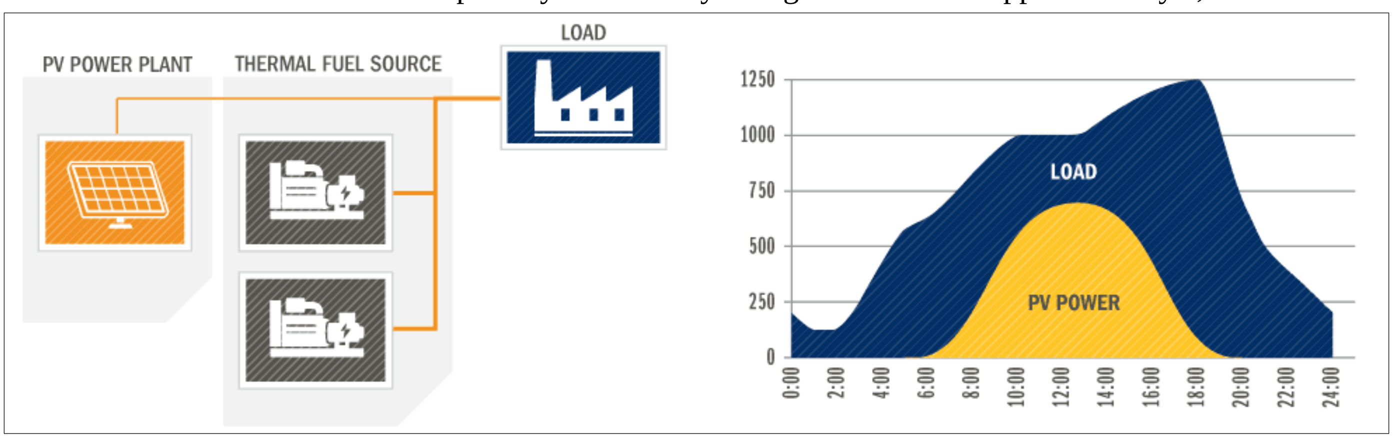
Figure 14: Off-grid fuel saving system chart

The Hybrid system could be connected to the AC bus directly in order to reduce the fuel requirements of the existing generators. Using this methodology, the fuel consumption will be reduced which leads to saving money without affecting the reliability of the source of power. Figure 10 demonstrates how the PV systems works as a source of energy during the day.

This system costs 316,815,000 LBP and a payback of 3 years.

5.1.4 Waste water treatment station

The hybrid on-grid system with storage could be installed at the waste water treatment station. The free area at the site could fit a 6-kWp PV system. The system generates/saves approximately 9,360



kWh/year.

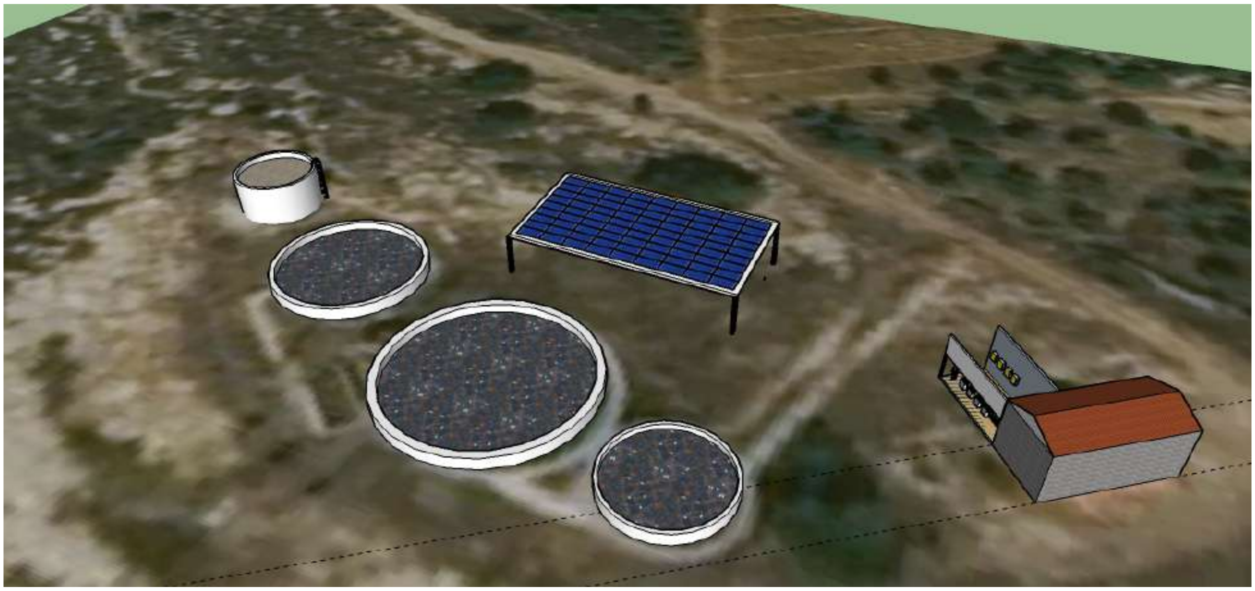


Figure 15: *The waste water treatment station as a 3D model*

The Photovoltaic system can be installed as a canopy, as shown in Figure 13

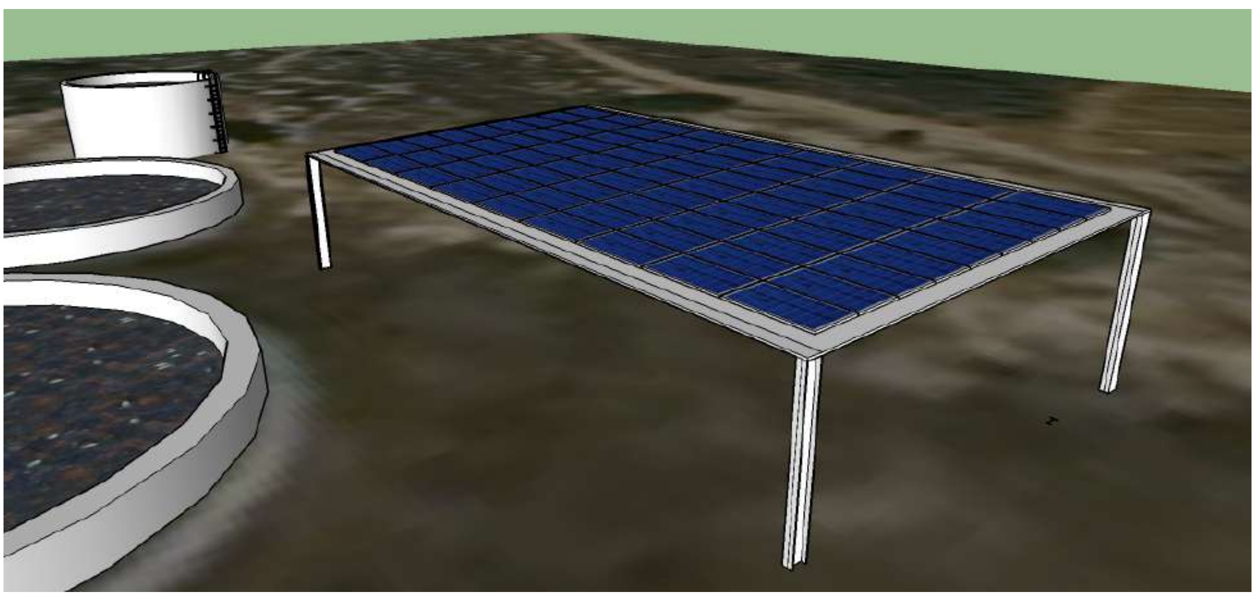


Figure 16: *The 3D model for the canopy*

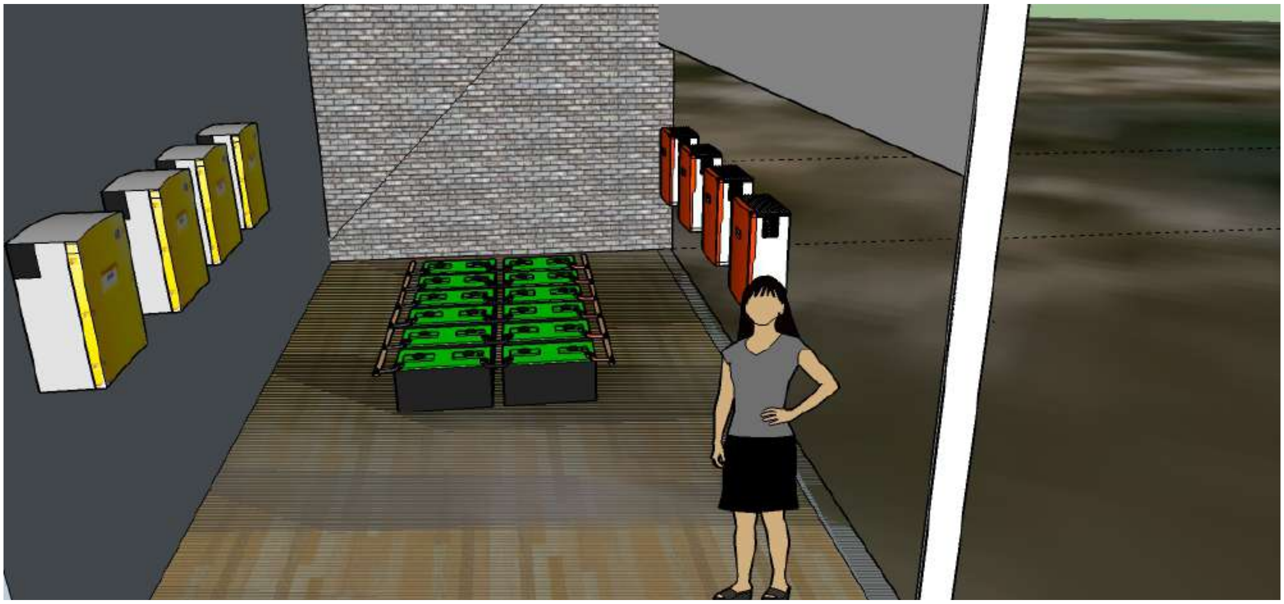


Figure 17: *Electrical room layout*

The system could be connected either to the grid or to the diesel generator as shown in Figure 18.

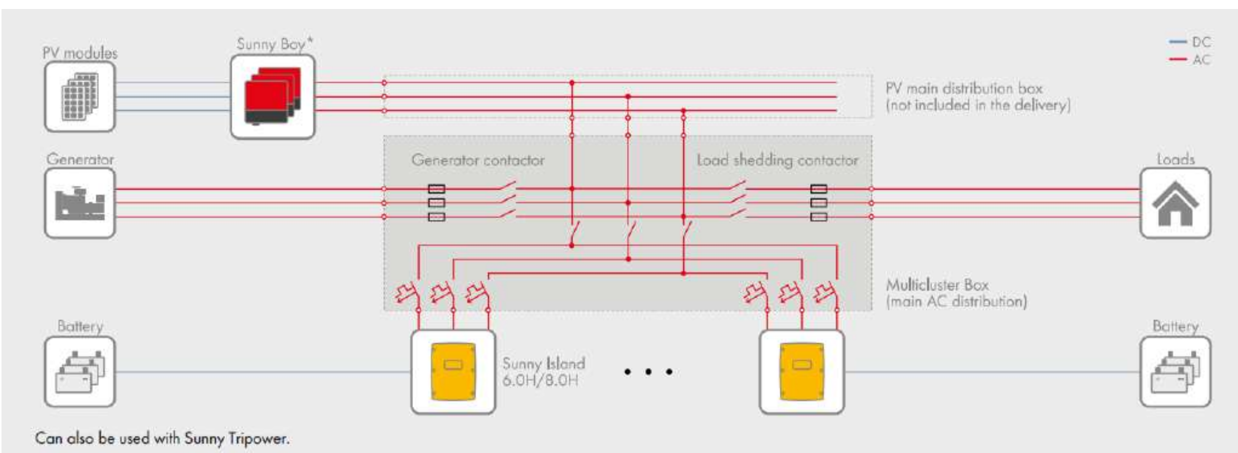


Figure 18: *System Electrical Design*

This system costs 27,156,000 LBP with a payback 7.5 years.

5.2 Biogas

5.2.1 Background

The biogas is a mixture of gases that consist mainly of methane (CH_4) and carbon dioxide (Co_2), generated from fermenting the biomass.

The fermentation is a biological process that generates biogas from the biomass in specific conditions such as PH, temperature and total solid (TS) to emit biogas with high methane content. On the other hand, the fermentation produces sterile fertilizer which can be used for improving the agriculture. The initial assessment for Jdaideh Al-Shouf Municipality showed existing potential of exploiting biomass, which is produced from a commercialized production process.

The proposed biogas unit should be designed, implemented and operated through a specific method in order to get a high percentage of biogas which will be used in generating the electricity or used in (to create) thermal processes.

5.2.2 Biogas Assessment

The initial assessment of the expected amount of produced biomass showed that around 5.9 tons/day of organic waste from the municipal solid waste and around 198 Kg of sewage sludge are produced daily.

The expected amount of biogas and energy that will be produced if the total amount of biomass was exploited to generate biogas is illustrated in the Tables hereunder:

A- Digestion unit size:

***Table 1**: Digester unit size*

Item	Description
Total expected amount of biomass (tons/year)	2226
Hydraulic retention time (day)	22
Required working digester volume (m3)	225
Required area for landing spreading (m2)	2000

B- Gas Production:

***Table 2:** Biogas production in the biogas plant.*

Item	**Description**
Expected amount of biogas (m3/year)	258,000
Methane content (%)	60.0%
Amount of Methane (m3/year)	154,800

Capacity of biogas plant	200 Kwp

C- Energy generation:

Table 3: *Energy generation in biogas plant.*

Item	**Description**
Methane Energy content (Kwh)	1,548,000
Electricity generation efficiency (%)	0.35
Electricity product (Kwh/year):	67,725

D- Fertilizer product:

The expected amount of bio-fertilizer that will be produced from the biogas station is **365,880 tons per annum.**

6 Recommendations

Although most of these locations have a potential of installing PV systems, the civil study is fundamental and must be conducted prior to the installation in order to determine the building's tolerance level coming from the additional weight of installing PV panels. The civil study results will determine the possibility of installing solar systems.

Furthermore, all buildings should have an access to the rooftops during and after the project implementation. Therefore, the team should include installing ladders to access all rooftops in the tender.

Finally, an approval from the local authority should be obtained in case of installing solar systems on the ground.

7 Conclusion

The report provided renewable energy analysis, evaluation and assessment of Jdaideh Al-Shouf, Municipality, in Lebanon. Following is a summary of the results:

- The Municipality main building has a potential of 15 kWp as a hybrid on-grid system with storage to power the municipality building during the day and to light the main street during the night.
- Waste sorting plant has a potential of 70 kWp as a hybrid off-grid system to minimize the fuel consumption during the day.
- The upper water pumping station has a potential of 20 kWp as hybrid on-grid system with storage.
- The waste water treatment station has a potential of 6 kWp as hybrid on-grid system with storage.
- Installing a biogas plant with capacity 200 KWp is needed.

All buildings were modeled using a 3D simulation tool as well as using real data such as the sun path and shading analysis. Furthermore, the civil study of all buildings is deemed as a prerequisite before installing systems. The results of the civil study will determine required prospects to proceed with the installation.

Table 4 below summarizes the capacity, generated/energy saved by the system, the investment cost and the payback period required for each location:

Table 4: *Site assessment summary*

Location Name	Capacity (kWp)	Generated/Saved Energy (kWh/year)	Total investment (LBP)	Payback Period
Municipality main building	15	23,400	67,889,000	11

Solid Waste Separation Plant	70	109,200	316,815,000	3
Waste Water Treatment Plant	6	9,360	27,156,000	7.5
The Upper Water Pumping Station	20	31,200	90,519,000	9.7

www.minaretproject.com minaret.mena

National Energy Research Center / Royal Scientific Society (NERC/RSS) P.O.Box: 1945 Jubeiha, Amman 11941 Jordan Tel: +962 6 5338014/42 Fax: +962 6 5338043