MINARET

NETWORKING FOR THE FUTURE

RENEWABLE ENERGY ASSESSMENT – TUNISIA

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1 Table of Contents

1 Executive Summery

In this report, site assessments for different buildings located in Al-Monastir - Tunisia were conducted in order to observe the potential of installing photovoltaics system on rooftops.

The site assessment was undertaken through site visits; determination of obstacles on site; gathering information about the status quo in Tunisia; sharing information, objectives and results of site assessment; meeting with stakeholders and collecting information on the country's regulations.

During the assessment, the team learnt that several buildings have a potential for installing photovoltaics systems. However, some buildings require approvals from local authorities based on public work criteria. The site assessment was conducted at these locations:

1. Municipality Main building.
2. Mustapha Ben Janet Monastir Stadium (football court, swimming pool & basketball arena)
3. Salle Olympic Mohammad Mzali Monastir
4. Warehouse building
5. Central market
6. Al-Basatin School
7. Onas Frina (wastewater treatment plant)
8. Monastir Municipality Pumping Station
9. Dabeebi Hospital
10. Monastir Hotel Centre
11. Higher Institute of Biotechnology De Monastir

The report concluded with recommendations, simple payback period and a table of total power that could be generated per system.

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 regional level to create a platform for regional dialogue gathers experts in renewable energy, sustainable a development and water to share experiences and discuss policies and techniques appropriate to the area and applied, 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, through promoting policy dialogues and implementing different capacity-building programs.
- Promote inter-municipal regional cooperation to enhance good governance, and equitably dealing with the needs and human 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 share, education and lesson learned at national, regional policy levels.

3 Methodology

3.1 Data collection and analysis methods

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

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

Different tools and software were also used to analyse the acquired data. Each location was modelled 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 was calculated as well, assuming that the tariff per kWh is 0.084 USD and the building consumes all the generated power by the PV system. The cost of the PV system is assumed to be 1100 USD.

3.2 Data validation

This data is valid for five years. However, the consumption may be altered upon following the installation of any additional loads or due to incorporating new and emerging technologies.

3.3 Limitations, risks and mitigation measures

During the sites assessment in Tunisia, the team faced challenges in accessing the rooftops of buildings and gathering essential data such as electricity bills. Prior to the installation of the solar system on any rooftop, a civil study has to be conducted in order to estimate the building's level of tolerance following the additional weight that accompanies the installation of the PV panels. Moreover, some locations lacked availability of space for installing the PV systems.

4 General Overview

4.1 Current situation

Electricity production depends by 99% on natural gas: this reliance may pose serious security implications on electrical generation, knowing that domestic production of natural gas is going through a period of stagnation, it has even been declining in recent years.

The country enjoys a very good solar radiation potential, which ranges from 1800 kWh/m² per year in the North to 2600kWh/m² per year in the South.

4.2 Future perspective and trends

Tunisia's Ministry of Energy, Mines and Renewable Energies has launched a tender for the deployment of 210 MW of renewable energy power. Bids for PV projects must be submitted by Nov. 15, 2017. Through the tender, the Ministry aims to allocate 70 MW of solar capacity and 140 MW of wind. The government targets to increase this share to 11% by 2016, and 25% by 2030, approximately 4.7 GW of renewable energy capacity by 2030.

5 Analysis and Findings

There are several buildings that are affiliated with the municipality that possess good potentials for installing a photovoltaics system, in addition to three other locations inside Al-Monastir City:

a. Municipality Main Building
b. Central Market
c. Warehouse
d. Mustapha Ben Janet Monastir Stadium (football court, swimming pool & basketball arena)
e. Salle Olympic Mohammad Mzali Monastir
f. Al-Basatin School
g. Onas Frina (wastewater treatment plant)
h. Monastir Municipality Pumping Station
i. Dabeebi Hospital
j. Monastir Hotel Centre
k. Higher Institute of Biotechnology De Monastir

PV systems can be categorized as per various aspects, such as: grid-connected vs. stand-alone systems, building-integrated vs. rack-mounted systems. According to the preliminary study, all systems in Tunisia are grid-connected due to the availability of the grid. Furthermore, all systems could be installed on rooftops of those buildings.

The biggest advantage of solar energy is generating immediate electricity bill savings. However, due to the unavailability of electricity bills, the amount of savings compared to the consumption per location was calculated. The average tariff in Tunisia is 0.084 USD per kWh and the cost of 1100 USD per kWp for the PV system, therefore the payback period is approximately **7 years** supposing that the building consumes all power generated by the PV system.

5.1 Municipality Main Building

- Location: https://goo.gl/maps/9VDJgkSXTg62

The available spaces on the rooftop can fit approximately 90-kWp on-grid system and approximately 25 kWp could be installed as canopies in the parking lot in front of the main gate. The total capacity that could be installed is 115 kWp. The system could cover a distinct percentage of the electricity demand. The system generates/saves approximately 207,000 kWh/year with an investment of approximately 126,500 USD.

***Figure 1**: The Municipality main building.*

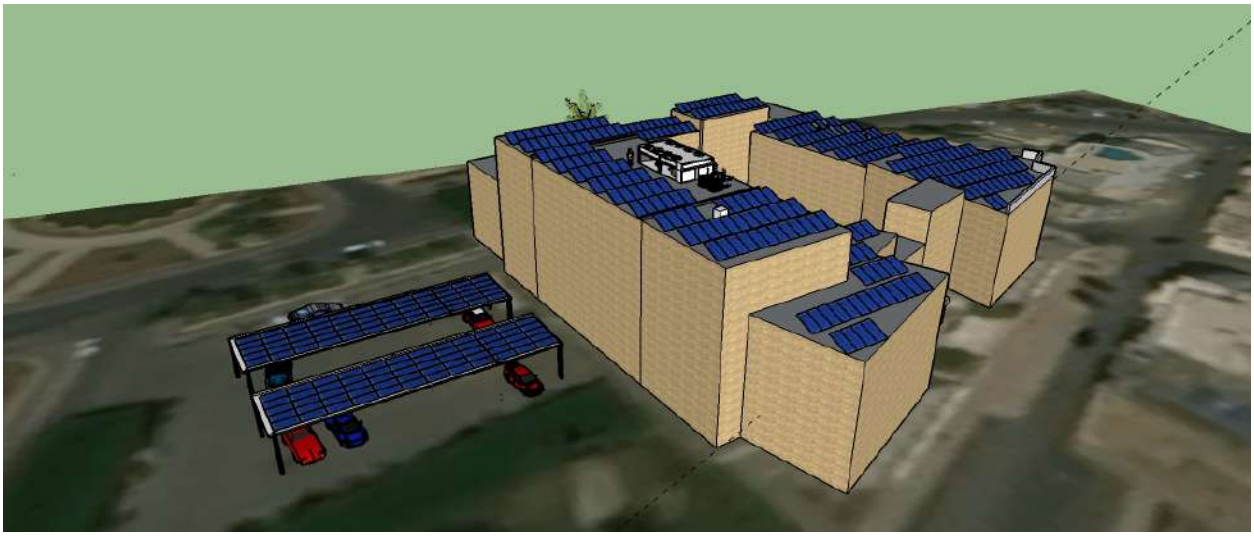


***Figure 2:** The Municipality main building as a 3D model*

5.2 Central market

- Location: https://goo.gl/maps/uVhBXhEBka42

The available spaces on the rooftop can fit approximately 40-kWp on-grid system. The system generates/saves approximately 72,000 kWh/year with an investment of approximately 44,000 USD.

However, the preliminary study showed the age of the building is very old. Therefore, a civil study prior the installation of the PV system is a must to determine if the building can tolerate the weight of the system.

Figure 3: *Central market rooftop*

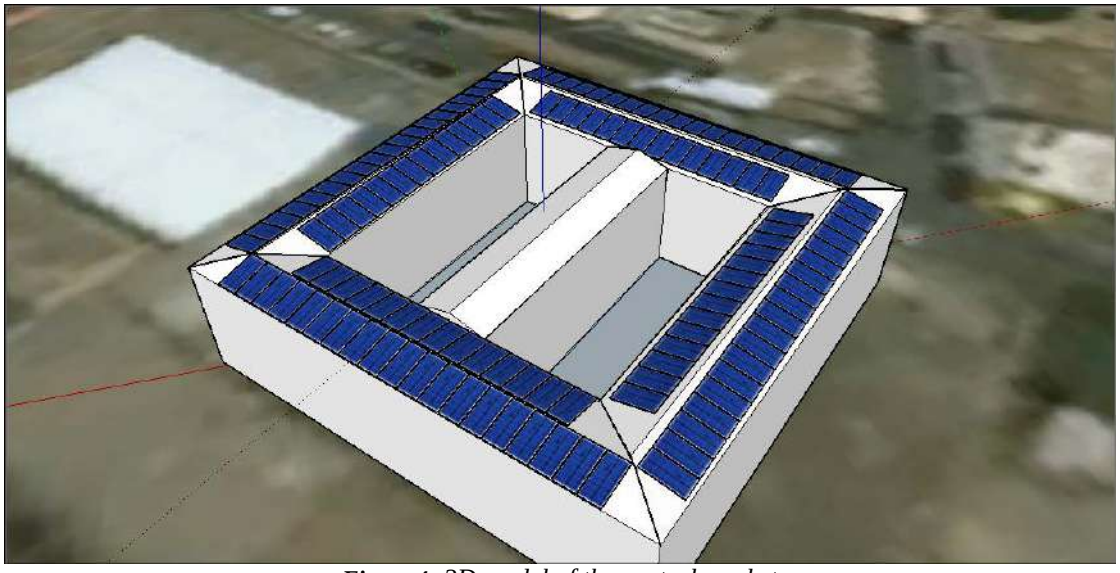


Figure 4: *3D model of the central market*

5.3 Warehouse

- Location: https://goo.gl/maps/zX1w2fWb7N42

The warehouse contains one building and many hangars. The prilimianry studies showed that the hangars were very old; it would be very risky to install PV modules on them. On the other hand,

the available space on top of the building can fit approxmielty 12 kWp. The system generates/saves approximately 21,600 kWh/year with an investment of approximately 13,200 USD.

Figure 5: *Warehouse*

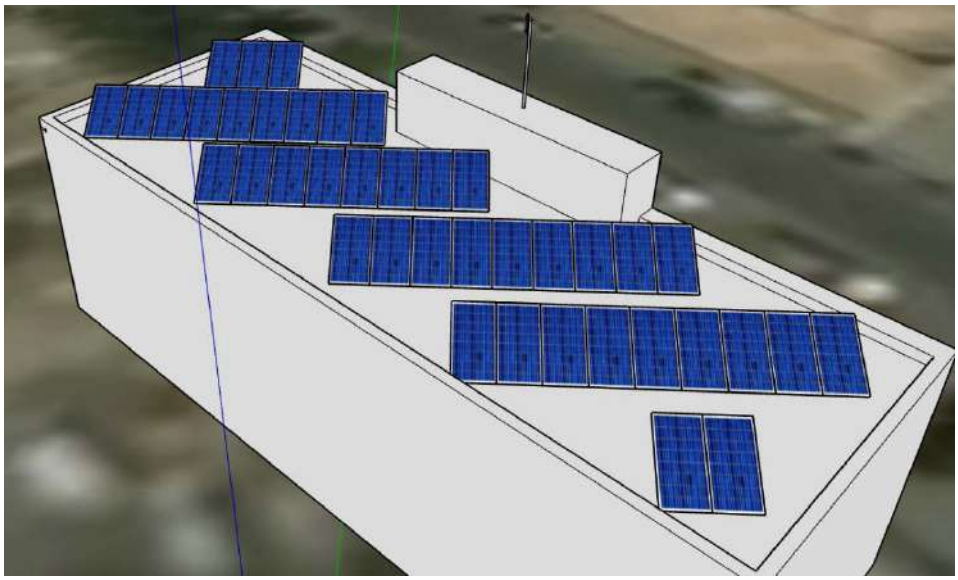


Figure 6: *3D model of the warehouse*

5.4 Mustapha Ben Janet Monastir Stadium - Swimming pool building

- Location: https://goo.gl/maps/qCmjmUK5sb92

The Stadium consists of the football court, swimming pool and basketball arena. The team learnt that there is not enough space to install the PV system in the stadium expect for the building next to the swimming pool.

The available space on the building next to the swimming pool can fit approxmielty 20 kWp. The system generates/saves approximately 36,000 kWh/year with an investment of approximately 22,000 USD. There are no other available space in the staduim to implement other systems.

Figure 7: *The building next to the swimming pool*

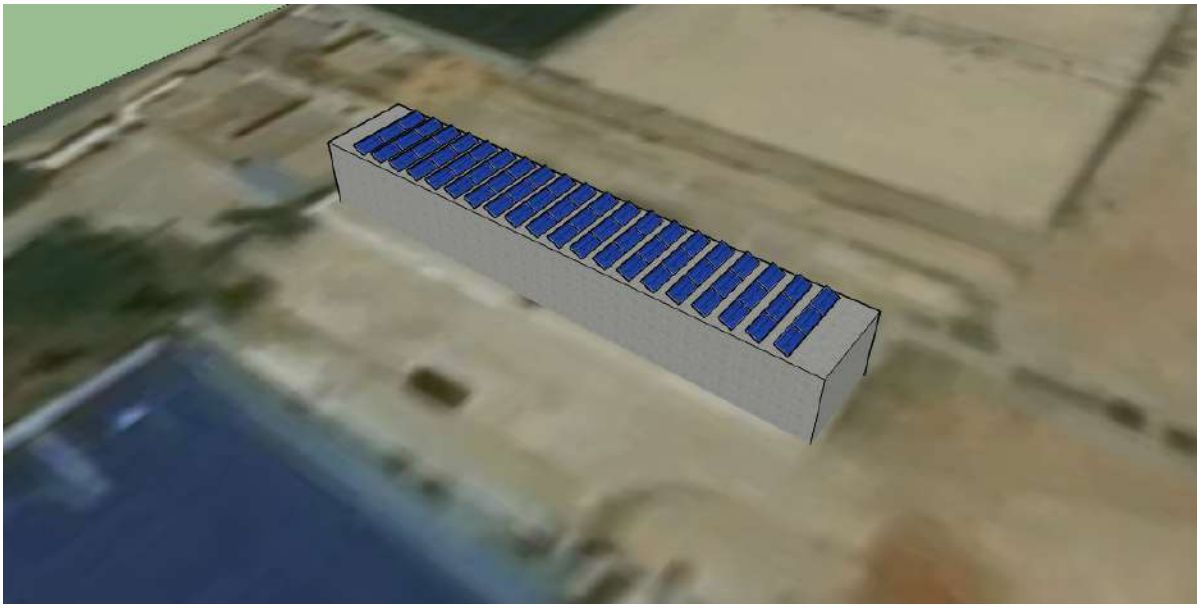


Figure 8: *3D model of the building*

5.5 Salle Olympic Mohammad Mzali Monastir

- Location: https://goo.gl/maps/mEJrwpfU44x

There was no available space on the top of the stadium or surrounding area.

Figure 9: *Salli Olympic Mohammad Mzali Monastir*

5.6 Al-Basatin School

- Location: https://goo.gl/maps/Y26UXvhwH8r

There is a high potenial at Al-Basatin school where the available area can fit approxmielty 50 kWp. The system generates/saves approximately 90,000 kWh/year with an investment of approximately 55,000 USD. However, there is shading due to sourrounding trees around school rooftops; furthermore, there is no access to the rooftops.

Figure 10: *The school rooftops are shaded by surrounding trees*

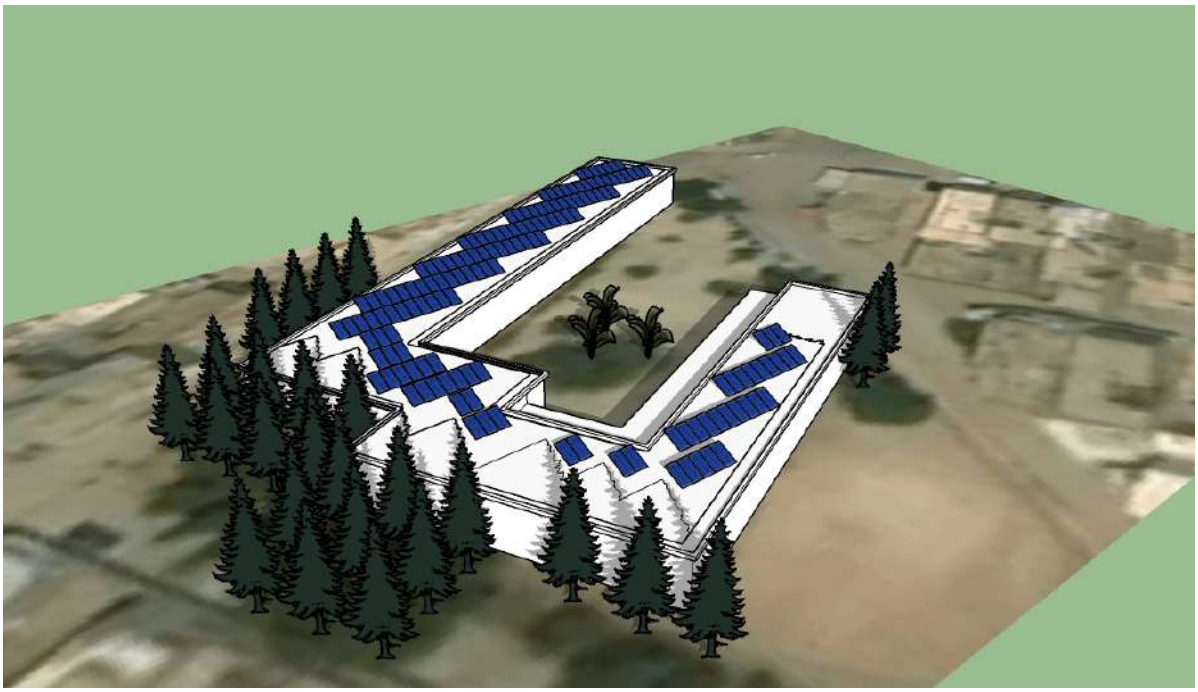


Figure 11: *3D model of the school*

5.7 Monastir Municipality Pumping station

- Location: https://goo.gl/maps/Kom4cfvCUUv

This location consists of five small buildings, two tanks and a free ground space. The team considered all these areas for the installation of PV systems, but there were some hurdles facing the implementation, as listed below:

- Approvals are required in case of installation on ground.
- Approvals are required for the installation on top of the tanks.
- A civil study is required for all buildings.
- Some shading due to trees for building No. 4.
- No access to all rooftops.

Table 1: *PV potential capacity for each building for the pumping station*

Building number	PV System potential capacity (kWp)
Main building	8
1	8.4
2	10.8
3	11
4	7
total	45.2

The system generates/saves approximately 81,000 kWh/year with an investment of approximately 50,000 USD. The following figures shows 3D modules for each building:

1) Main building

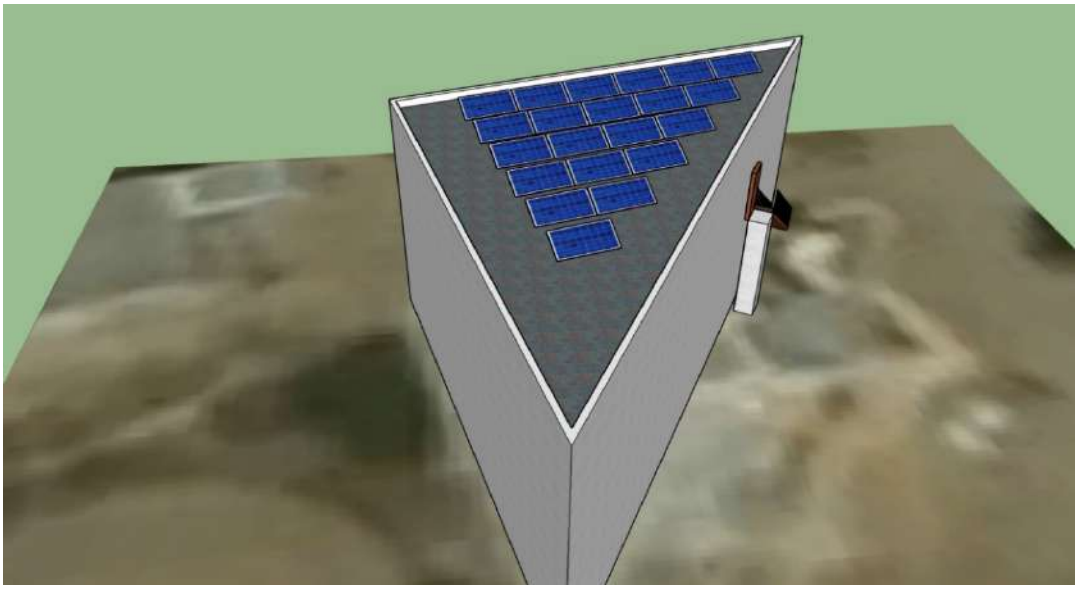


Figure 12: *3D model of main building*

2) Building number 1

Figure 13: *Building number 1*

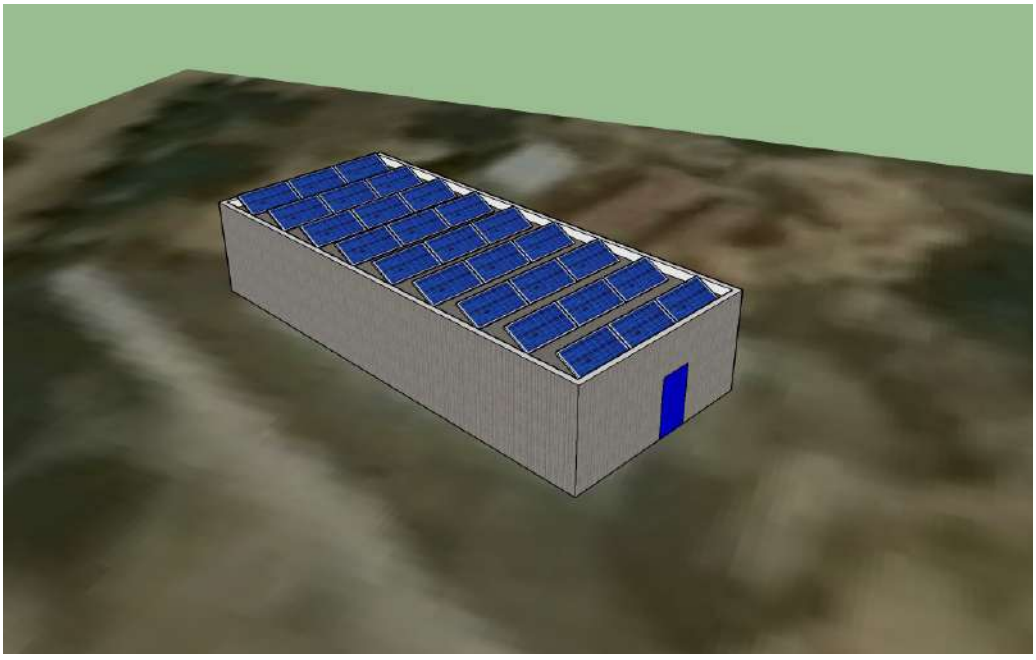


Figure 14: *3D model of building number 1*

3) Building number 2

Figure 15: *Building number 2*

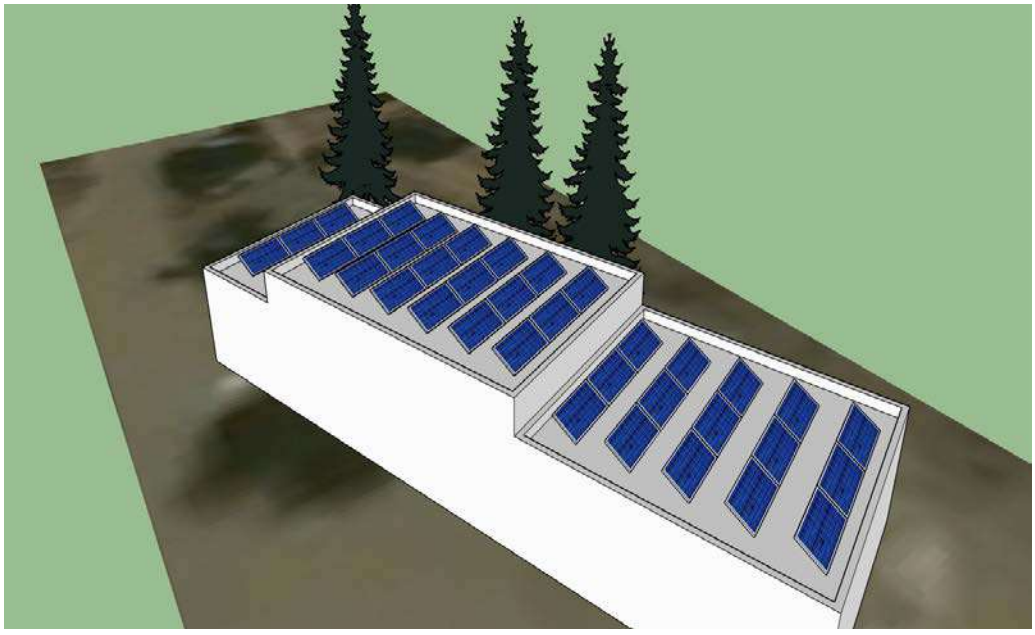


Figure 16: *3D model of building number 2*

4) Building number 3

Figure 17: *Building number 3*

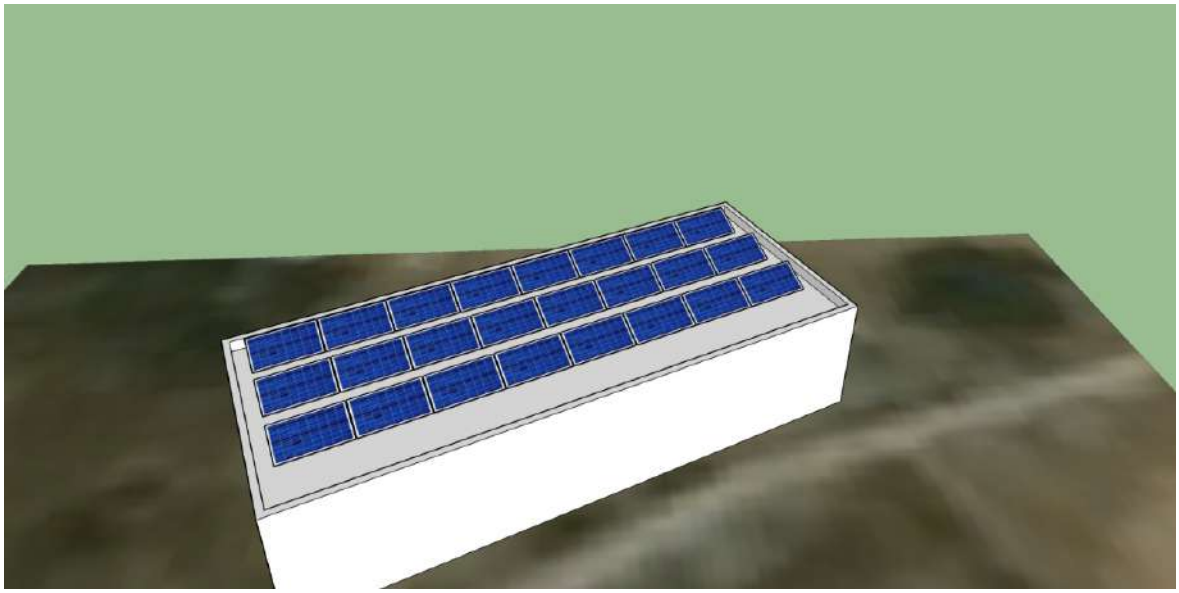


Figure 18: *3D model of building number 3*

5) Building number 4

Figure 19: *Building number 4*

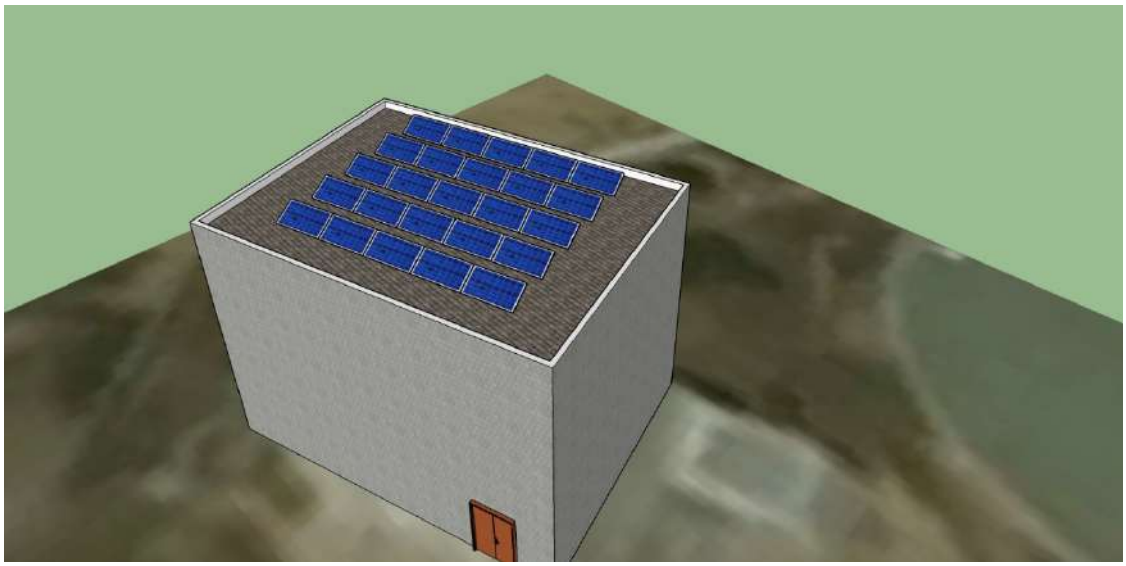


Figure 20: *3D model of building number 4*

5.8 Onas Frina (wastewater treatment plant)

- Location: https://goo.gl/maps/NSXRxfAyFto

The technical team of Onas Frina informed the NERC team that a free area of 3 Hectares (30 Donum) can be exploited for the installation of the PV system and could cover the station's consumption. The free land could fit approximately 2.5 MWp and the installation will be ground-mounted. Some environmental hurdles shall be considered such as cutting trees.

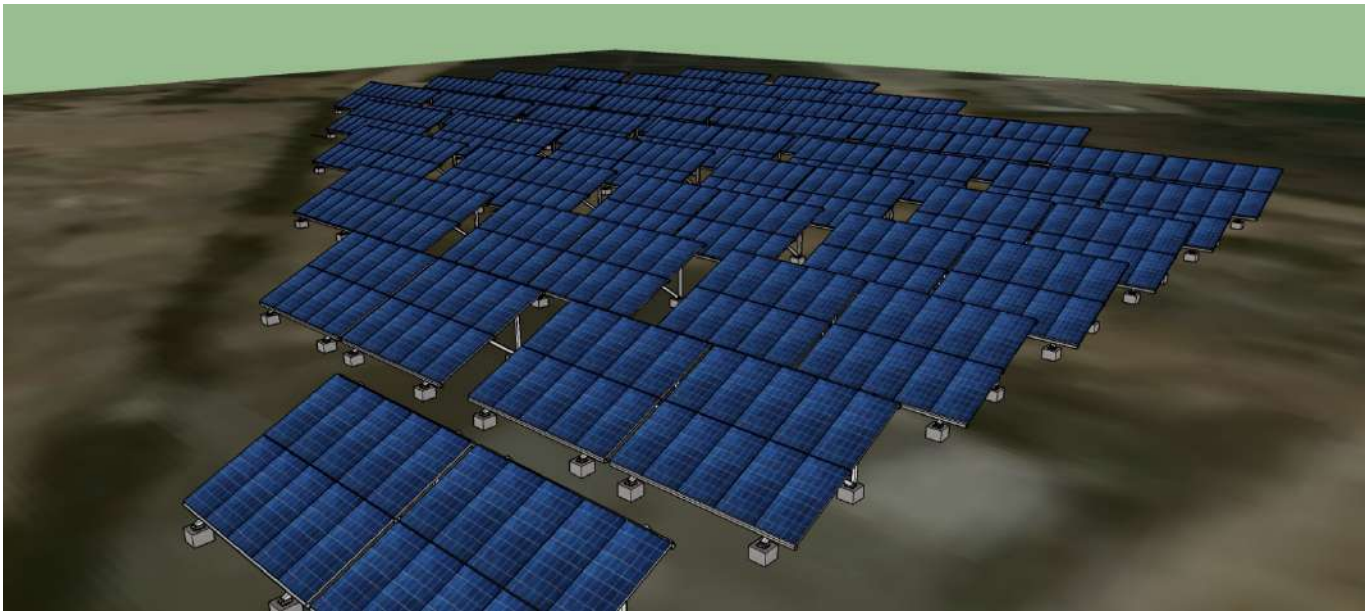


***Figure 21**: 3D model of the free area at Onas Frina*

5.9 Higher Institute of Biotechnology De Monastir

- Location: https://goo.gl/maps/jgyznMGkKtK2

The Institute consists of several buildings with high potential to install PV systems. There was no access to all rooftops but the team assumed that all of them are available for implementation. The proposed PV system capacity is 90 kWp. The system generates/saves approximately 162,000 kWh/year with an investment of approximately 99,000 USD. However, more study is required for the available space in addition to civil study.

Figure 22: *Rooftops for Higher Institute of Biotechnology De Monastir*

Figure 23: *3D model of the rooftops for the Institute*

5.10 Dabeebi Hospital & Monastir Hotel Centre

The team also visited Dabeebi Hospital and Monastir Hotel Center, but unfortunately, there was no space available on the rooftops in both locations.

6 Recommendations

Although most of these locations have a high potential of installing PV systems, the civil study is fundamental to conduct prior the installation in order to determine the building's tolerance level due to the additional weight of installing PV panels. The civil study results will determine the possibility to install the 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 assessment report showed a high potential for the following buildings:

1) Municipality Main building: 115 kWp

2) Mustapha Ben Janet Monastir Stadium - Swimming Pool Building: 20 kWp
3) Warehouse building: 12 kWp
4) Central Market: 40 kWp
5) Al-Basatin School: 50 kWp
6) Onas Frina
7) Monastir Municipality Pumping station: 45.2 kWp
8) Higher Institute of Biotechnology De Monastir: 90 kWp

All buildings were modelled using a 3D simulation tool as well as using real data such as the sun path and shading analysis.

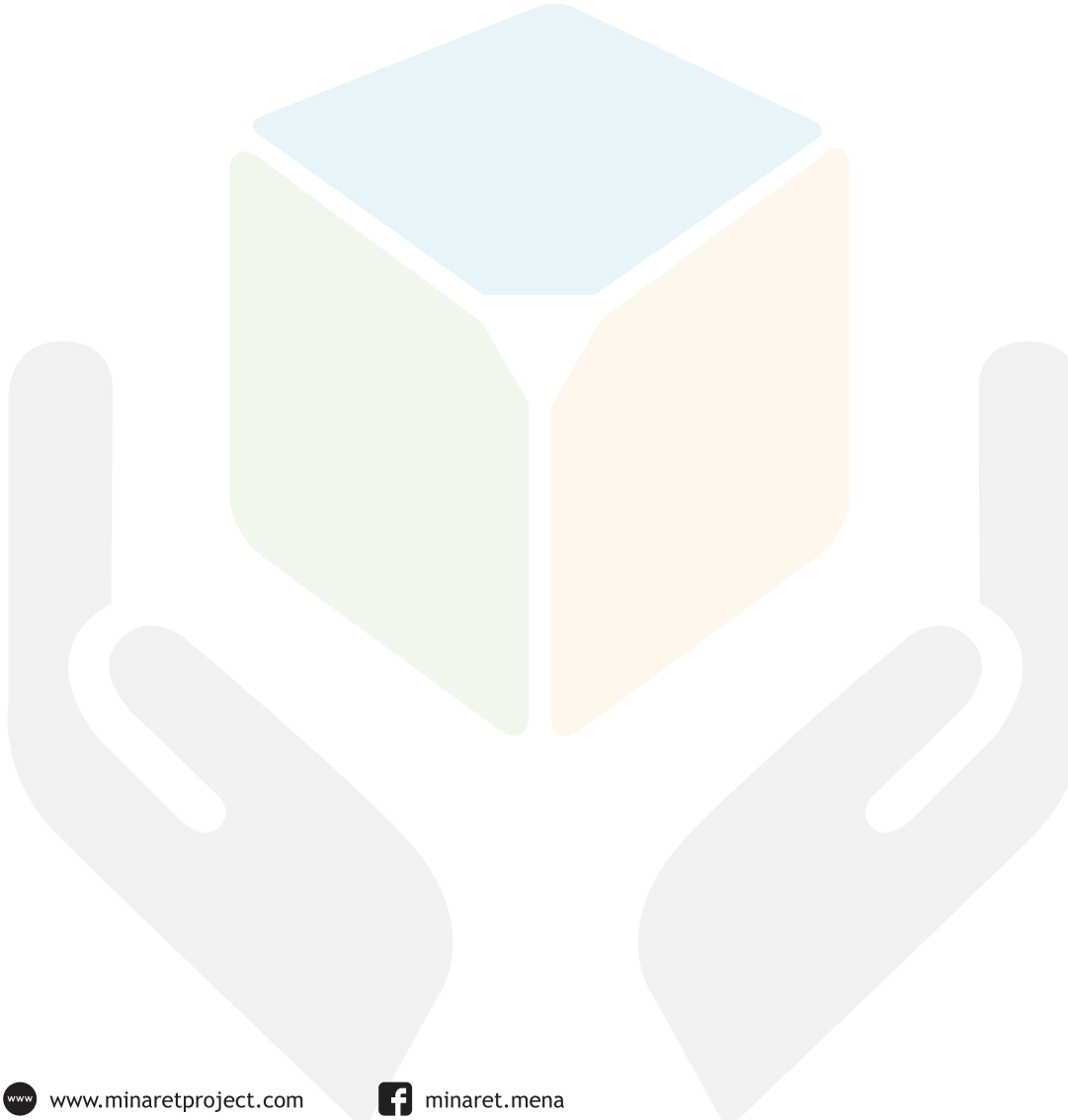
Furthermore, the civil study for all buildings is deemed as a prerequisite before the installation of the systems. The results for the civil study will determine the prospect to proceed with the installation.

The payback period for the PV system is **7 years**, assuming that all the energy generated will be consumed in the same building and a tariff of 0.084 USD, and assuming that the cost of the system per kWp is 1100 USD as well.

Table 2 below summarizes the capacity, generated/energy saved by the system and the investment required for each location:

Table 2: Site assessment summary

Location Name	Capacity (kWp)	Generated/Saved Energy (kWh/year)	Total investment (USD)
Municipality main building	115.00	207000.00	$126,500.00
Central Market	40	72000.00	`$44,000.00
Warehouse	12	21600.00	$13,200.00
Mustapha Ben Janet Monastir Stadium - Swimming Pool Building	20	36000.00	$22,000.00
Al-Basatin School	50	90000.00	$55,000.00
Monastir Municipality Pumping station	45.2	81360.00	$49,720.00
Onas Frina	Free land of 30 Donum that fits 2.5 MWp.		
Higher Institute of Biotechnology De Monastir	90	162000.00	$99,000.00



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