The University of Jordan

Transition toward a sustainable campus

Academic Year 2022-2023

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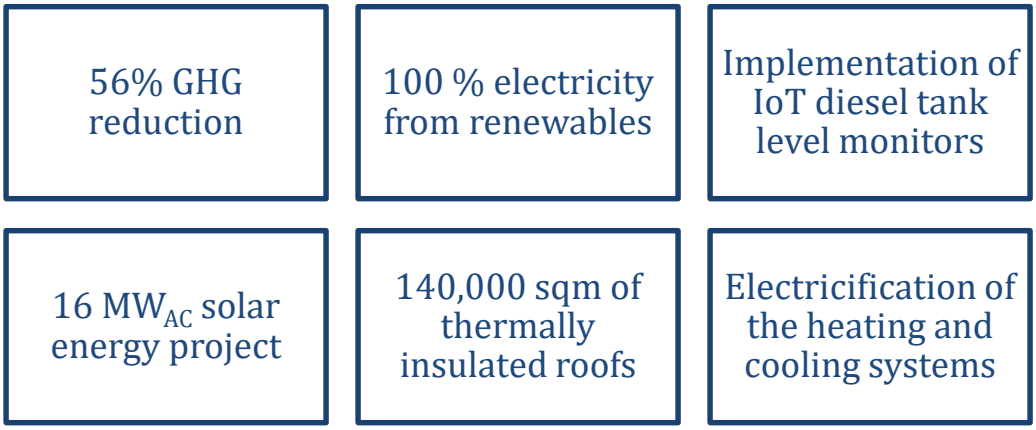
Executive summary

A major green renovation of the University of Jordan campuses is ongoing in its transition toward a sustainable campus. This renovation adopted the three-tier approach to sustainable heating, cooling, and lighting of the buildings (i.e., energy conservation, energy efficiency, and renewable energy). Since 2019, The University of Jordan continues to make a huge improvement:

- The GHG in 2023 was reduced by 56% compared to 2019.
- Currently, 100 % of electricity demand is covered using solar energy. The largest on-grid (Net-metering) solar energy project in Jordan with a capacity of 16 MWac is installed on the rooftops and car parks of the university.
- 140,000 sqm of rooftops have been thermally insulated to adhere to the new thermal insulation codes in Jordan, and to conserve energy required for heating and cooling in buildings. Thousands of old fluorescent lamps have been replaced by energy savings units (LED).
- The University has prepared a techno-economic evaluation and tender documents for the electrification of the heating and cooling systems for four main buildings of the campus.

While the GHG emissions dropped by 56% during the period 2019-2023, the carbon reduction target of the university by 2050 is to reach net zero emissions through a set of planned measures. This document presents a short overview of the key efforts done by the University of Jordan in its transition toward a sustainable campus both in its main branch, the Aqaba branch, and the Marine Science Station.



1. Green House Gases (GHG)

The University of Jordan (UJ) was founded in 1962 and has grown to become Jordan's largest university. In fact, it is the first university in Jordan, established in the capital city of Amman by a Royal Decree in 1962. Figure 1 presents an aerial view of the university campus.

Figure 1 Location of the University of Jordan in Northern Amman, Capital of Jordan

This section presents the items involved in the calculations of the Green House Gases (GHG), both the Direct GHG emissions and the indirect GHG emissions. Where Direct GHG emissions are emissions from sources that are owned or controlled by the university, while Indirect GHG emissions are emissions that are a consequence of the activities of the university but occur at sources owned or controlled by another company.

UJ calculates carbon emissions in line with the GHG Protocol Corporate Reporting Standard and calculated International Energy Agency (IEA) conversion factors electricity generation. Presently we report our scope one and two emissions.

Scope 1

Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment.

Basically, these sources fall into two categories:

1. Diesel used for space heating of buildings. (About 110 buildings).
2. Diesel and gasoline used for university fleet. This mainly includes:
    a. 30-seat buses (Coaster).
    b. 50-seat buses (MAN).
    c. Saloon cars.
    d. Other vehicles (water tankers, trucks, etc.)

The annual mtCO2e during the year 2019 within scope 1 was 3,877 while in 2023 it was 5,396.

Scope 2

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the University. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the university. Scope 2 emissions physically occur at the facility where electricity is generated. Basically, the main item considered in this scope is the Purchased electricity.

The annual mtCO2e during the year 2019 within scope 2 was 8,381 while in 2023 the solar energy project covered 100% of the university electricity demand, and thus the mtCO2e in 2023 was dropped to zero.

Considering both scope 1 and scope 2 for the years 2019 and 2023, the mtCO2 emitted during 2019 was 12,258, while in 2023 due to the great reduction in scope 2 emissions, the total emissions dropped by 56% to 5,396 mtCO2e.

Diesel used for heating plants data was obtained from the supplies department for the years 2019 till now. While the gasoline and diesel quantities used for fleet and consumed during 2019 till now are measured values obtained from the department of transport at the university.

Table 1 Campus emissions inventory 2019-2023

reporting year		2019	2020	2021	2022	2023	Till 4th April 2024
Calculated emissions (mtCO2e)							
Emissions for Scope 1: Direct Emissions							
	Diesel for Heating Plants (Liters of Diesel)	1,318,691	1,719,430	1,401,830	2,111,291	1,826,036	79,3450
	Calculated emissions (mtCO2e)	3,569	4,653	3,794	5,714	4,942	2,147
	Gasoline for Fleet Transportation (liters of gasoline)	47,669	31,802	42,956	44,000	46,808	12136
	Calculated emissions (mtCO2e)	111	74	100	102	109	28
	Diesel for Fleet Transportation (Liters of Diesel)	73,180	61,891	69,759	125,000	128,204	31,428.0
	Calculated emissions (mtCO2e)	197	167	337	337	346	85
	scope 1 subtotal	**3,877**	**4,894**	**4,230**	**6,153**	**5,396**	**2,260**
Emissions for Scope 2: Purchased Utilities							
	Electricity for Campus (GWh)	14.5	9.9	0.0	0.0	0.0	0.0
	Calculated emissions (mtCO2e)	8,381	5,722	-	-	-	-
	scope 2 subtotal	8,381	5,722	-	-	-	-
	scope 1 + scope 2	**12,258**	**10,616**	**4,230**	**6,153**	**5,396**	**2,260**

2. Emissions reduction strategies

The three tiers approach toward sustainability and emissions reduction (presented in Figure 2.) has been adopted at the University of Jordan. Where the first step focuses on energy conservation measures, while the second step relies on using energy-efficient equipment, and the final step is using Renewable Energy (RE) to cover the remaining loads of the university.

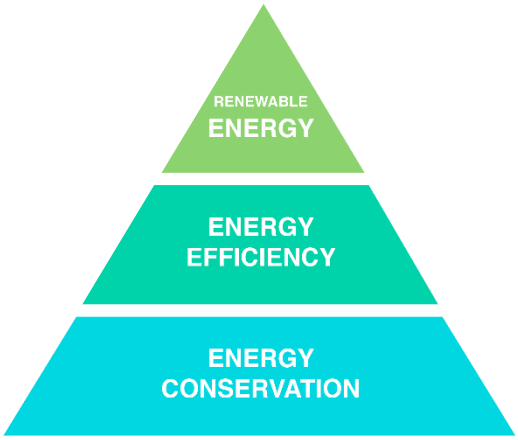


Figure 2 Energy pyramid.

While the GHG emissions were dropped by 56% during the period 2019-2023, the carbon reduction target of the university by 2050 is to reach net zero emissions, this would be achieved by a set of measures related to the electrification of the heating and cooling systems, waste, and recycling, as well as e-mobility. In the following sections, a summary of the key efforts in each of these steps.

1. Energy conservation

1.1 Energy Benchmarking

The first step pursued in energy conservation is the zero-level energy audit (i.e. the energy benchmark) of the campus buildings in order to understand the status of energy consumption and the energy saving potential in the different university buildings. Since there was no available benchmark data for educational buildings in Jordan to compare with, researchers from UJ have taken this responsibility and published the first energy benchmark and Energy Use Intensity (EUI) for educational buildings in Jordan (Ayadi et al., 2023), and since the campus buildings are diverse from the use perspectives, the university buildings have been classified based on their function and usage type. The buildings have been initially divided into five main categories: Hospital, Administrative, Schools, Dorms, and activities buildings. Furthermore, due to the unique requirements of each school type at the University, such as laboratory requirements and student schedules, schools have been further divided into three categories: humanities, scientific, and

health schools. So, the final classification consisted of seven categories. The following categorizations were utilized:

a) University Hospital
b) Administrative buildings
c) Art and humanities schools
d) Scientific schools
e) Health schools
f) Dormitories
g) Buildings for students' activities

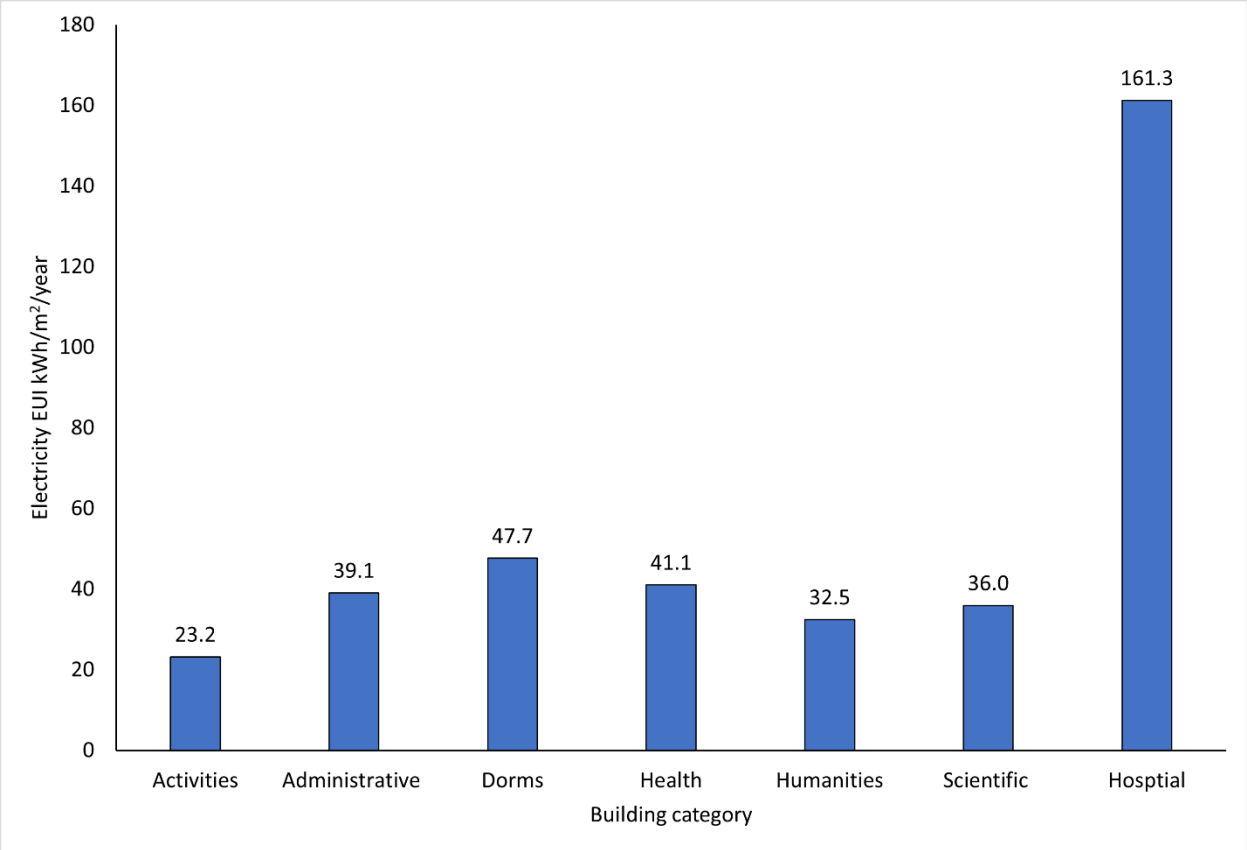


Figure 3 Electricity EUI for different building categories based on the built floor area.

The analysis of the EUI for different building categories revealed significant variability in EUI values across different building categories at the campus. This highlights the importance of targeted energy conservation efforts that consider each category's specific needs and usage

patterns. The hospital has an extremely high EUI value (161 kWh/m^2/year) compared to the other categories, (e.g., the EUI for humanities schools is 32.5 kWh//m^2/year). Whereas, considering the EUI in terms of the number of students, scientific schools have the highest EUI in terms of energy per student, which is 295 kWh/student/year compared to 145 and 133 kWh/student/year for Health and Humanities schools respectively. Overall, this highlights the importance of targeted energy conservation efforts that consider the specific needs and usage patterns of each building.

While most of the energy consumption in university is used for heating and cooling of buildings, tier 1 suggests insulating buildings to reduce the heating and cooling loads of the buildings, and thus reducing the energy required for the HVAC equipment to reach the thermal comfort in the spaces.

1.2 Thermal insulation

During the period 2019-2021, the University of Jordan has thermally insulated 140,000 sqm (about 1.5 million sqft) of its buildings' rooftops to abide by the Jordanian thermal insulation code requirement for roofs, achieving U-value less than 0.55W/m2.K

Figure 4 presents the thermal insulation layers implemented in this project. While Figure 5 presents the process of the implementation of these layers on some buildings of the university.

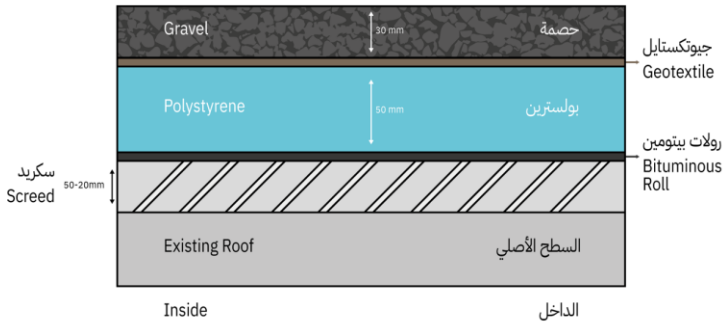


Figure 4 Thermal insulation layers implemented on the rooftops.

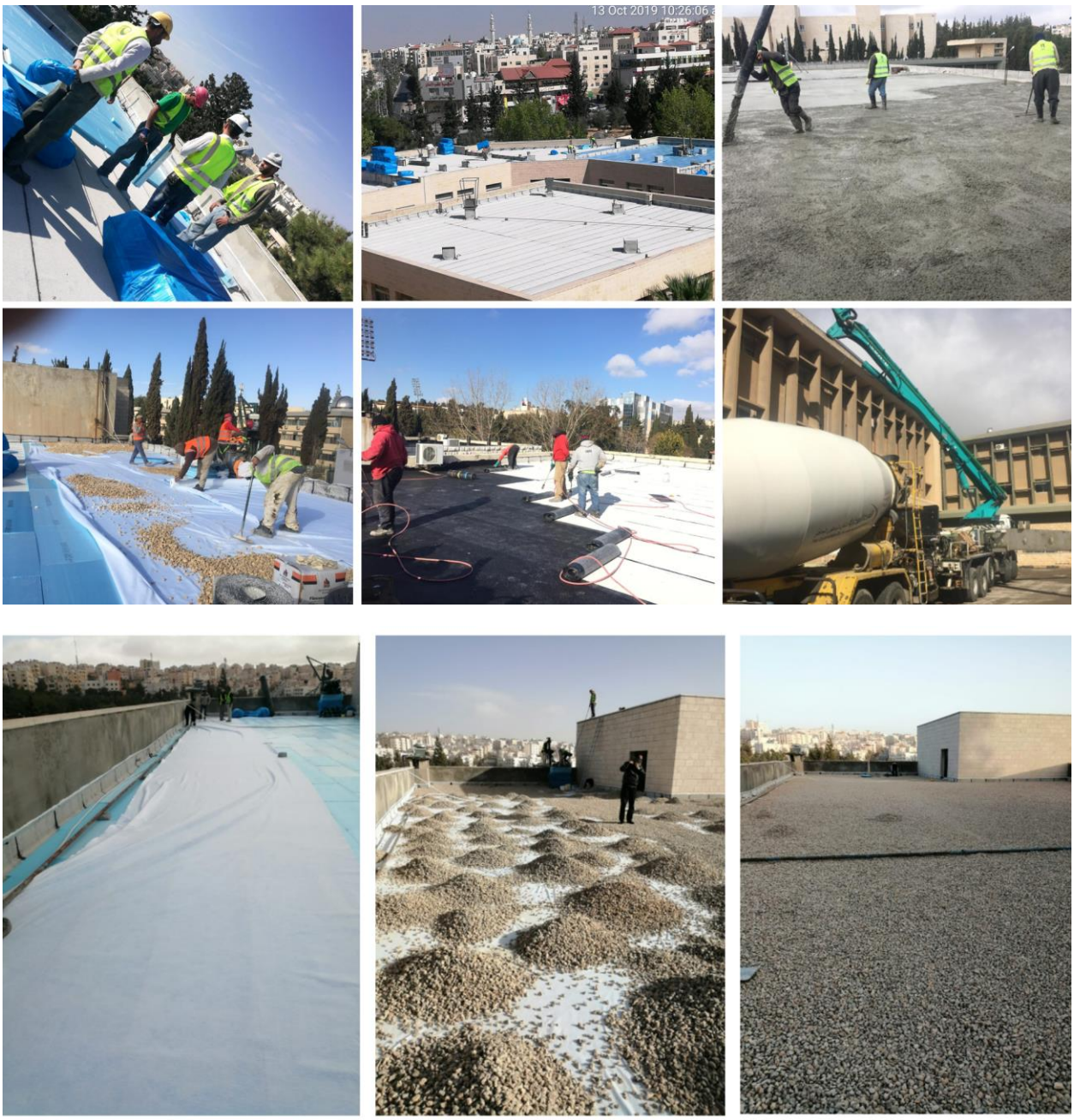


Figure 5 The implementation of thermal insulation on the rooftops of the buildings.

1.3 Diesel Level Sensor:

In its ongoing commitment to environmental sustainability, the University of Jordan has implemented a diesel tank level sensor in our heating systems. This strategic move is part of our concerted efforts to monitor and optimize the use of diesel, thereby reducing our carbon footprint. The sensor provides real-time data on fuel levels, enabling us to manage our resources efficiently and prevent wastage. By ensuring optimal fuel consumption, we are contributing to the reduction of CO2 emissions, a significant step towards our sustainability goals. Furthermore, the sensor aids in the early detection of any potential leaks or discrepancies, thereby ensuring the safety and longevity of our systems. Through this initiative, the University of Jordan reaffirms its commitment to resource conservation and environmental protection.

This device is a smart level meter device that measures the height of the liquid inside a tank by measuring the pressure of the liquid height using a submersible pressure sensor at the bottom of the tank. To send the data collected from the in-tank sensor, it would be connected to an outside sensor box which has a led bar to indicate the height percentage. Also, it is connected to the internet through WIFI connection to transmit the level reading which can be seen by the user through a mobile app from any place in the world. This device will be helpful for controlling the consumption of the diesel remotely, and if there is any leak and any suddenly drop in the level of the diesel it will appear in the application immediately.

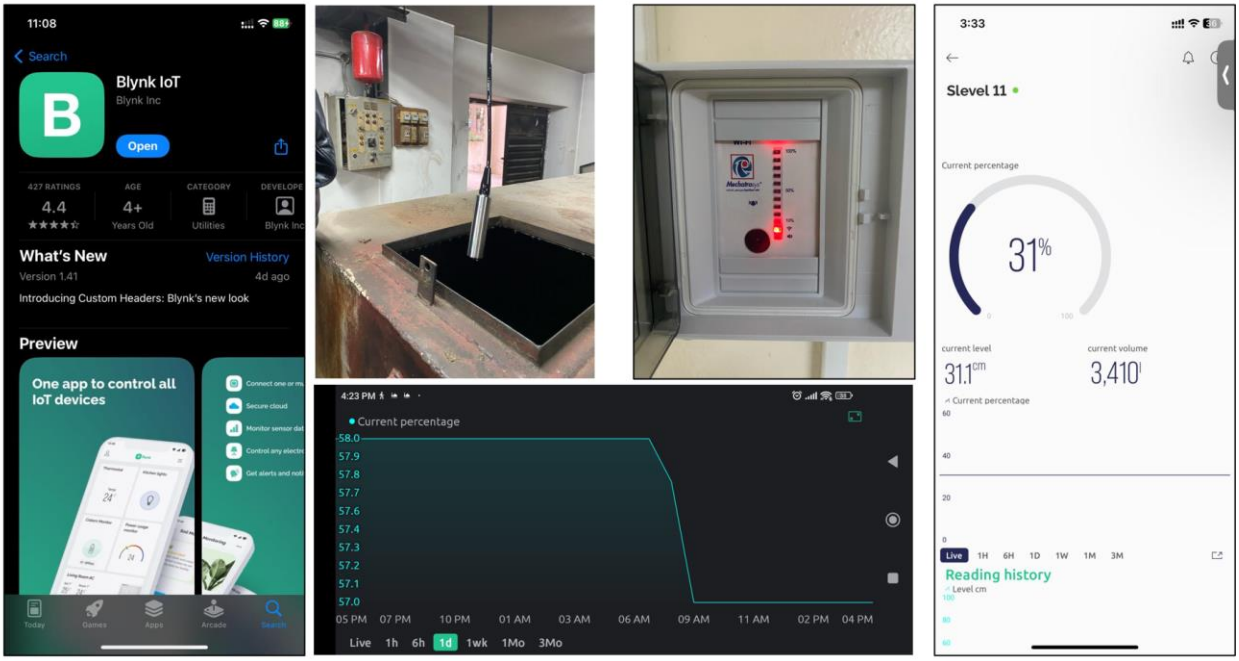


Figure 6 The diesel tank level sensor and its mobile application.

2. Energy efficiency

In this regard, the university is working in three tracks:

1. The operation and maintenance department has planned a campaign to replace all of the internal and external lighting fixture with more energy efficient LED lights, most of which are equipped with motion detectors.
2. The engineering department updated the specifications and requirements for new lighting and air-conditioning devices to be energy efficient ones.
3. A special committee was formed to conduct a comprehensive techno-economic evaluation for the electrification of the heating and cooling systems in four main buildings on campus. This initiative involves the preparation of detailed tender documents, outlining the technical specifications, economic considerations, and expected environmental impact. The move towards electrification is anticipated to enhance the energy efficiency of our campus buildings, reduce our reliance on fossil fuels, and contribute to a substantial reduction in CO2 emissions.

3. Renewable energy

The University's annual electricity consumption has been increasing steadily due to the growing number of buildings, students, and services. At a high electricity tariff of 0.376 US $/kWh, the resulting electricity bill amounts to roughly 10 million US dollars annually, placing considerable financial pressure on the University's annual budget. In response, the University has identified Renewable Energy and Energy Efficiency (RE & EE) as strategic objectives for the next decade. Specifically, the University has set an ambitious goal of achieving 100% electrical energy independence, primarily through renewable solar energy via photovoltaic (PV) panels (Ayadi et al., 2018). Moreover, a detailed comparison between solar thermal and solar electric options for builds have been carried out by (Ayadi & Al-Dahidi, 2019).

a. Solar energy project at the main campus

In 2017, a tender was prepared for the Design, Engineering, Supply, Delivery, Installation, Testing, Commissioning, Cleaning, and Maintenance of Grid-Connected 16 MW AC Photovoltaic Systems at the University of Jordan to meet the annual electricity needs of the University. Of the total capacity, 12 MW will be installed on building rooftops, while the remaining 4 MW to be erected in parking lots[1]. The commercial operation of the solar PV project began in 2021. [2] Figure 7 presents images of the solar energy project implemented on the rooftops and carparks of the university.

[1] https://www.pv-magazine.com/2017/05/26/university-of-jordan-announces-16-mw-net-metering-pv-tender/
[2] https://www.jordantimes.com/news/local/jordan-university-jepco-start-operating-solar-energy-systems-campus

Figure 7 The solar energy project, installed on the rooftops and car parks of the campus.

b. Solar energy project at the Aqaba Branch

In 2020 a 500 kWp grid-connected PV system was installed at the University of Jordan – Aqaba branch. This system consists of a 170 kWp car park and 330 kWp ground-mounted installations. The campus is about 6 km away from the red sea. During the first year of operation, the ground-mounted system and the car park system produced 1920 kWh/kWp-year and 1695 kWh/kWp-year respectively. Compared to PV plants worldwide, the analyzed plant has an excellent overall performance. System images are presented in Figures 8 and 9.

Figure 8 Ground-mounted PV system at Aqaba branch.

Figure 9 Solar Car park system installed at Aqaba branch.

In addition to the aforementioned system, one of the first building-integrated PV BIPV systems in Jordan was installed in the University, as shown in Figure 10.

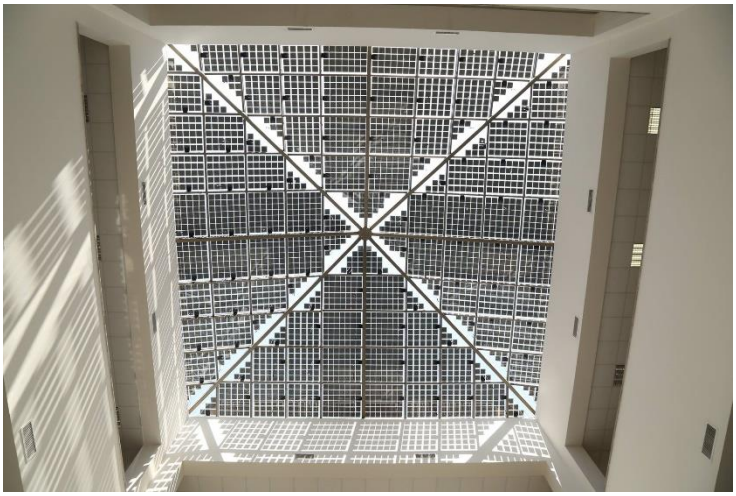


Figure 10 Solar BIPV installed in Aqaba branch.

c. Solar energy project at the Marine Science Station

A 180 kW solar PV system was installed in 2021 at the marine science station at the cost of the red sea in Aqaba.

Figure 11 Ground-mounted solar PV system installed at the Marine Science Station.

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