The University of Jordan

Transition toward a sustainable campus

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Executive summary

A major green renovation of the University of Jordan campus 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 made a huge improvement:

- The GHG in 2022 was reduced by 50% 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 carparks of the university.
- 140,000 sqm of rooftops have been thermally insulated to adhere with 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- Thousands of old fluorescent lamps have been replaced by energy savings units (LED).

While the GHG emissions dropped by 50% during the period 2019-2022, 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.

50% GHG reduction	100 % electricity from renewables
16 MW_{AC} solar energy project	140,000 sqm of thermally insulated roofs

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 2022 it was 6,153.

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 2022 the solar energy project covered 100% of the university electricity demand, and thus the mtCO2e in 2022 was dropped to zero.

Considering both scope 1 and scope 2 for the years 2019 and 2022, the mtCO2 emitted during 2019 was 12,258, while in 2022 due to the great reduction in scope 2 emissions, the total emissions dropped by 50% to 6,153 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 2019-2022

reporting year		2019	2020	2021	2022	till 30-6-2023
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	1,017,182
	Calculated emissions (mtCO2e)	3,569	4,653	3,794	5,714	2,753
	Gasoline for Fleet Transportation (liters of gasoline)	47,669	31,802	42,956	44,000	23,000
	Calculated emissions (mtCO2e)	111	74	100	102	53
	Diesel for Fleet Transportation (Liters of Diesel)	73,180	61,891	69,759	125,000	60,000
	Calculated emissions (mtCO2e)	197	167	337	337	162
	scope 1 subtotal	**3,877**	**4,894**	**4,230**	**6,153**	**2,968**
Emissions for Scope 2: Purchased Utilities						
	Electricity for Campus (GWh)	14.5	9.9	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**	**2,968**

2. Emissions reduction strategies

The three tiers approach toward sustainability and emissions reduction (presented in Figure 2.) have 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.

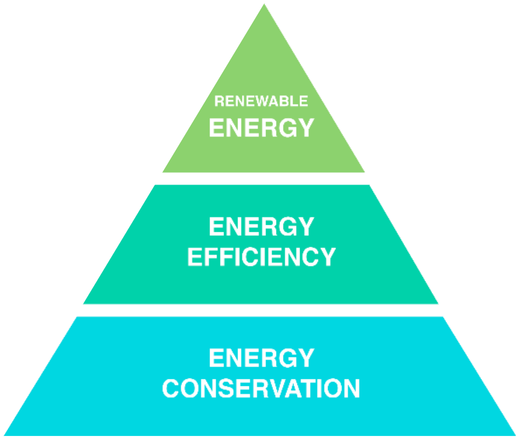

Figure 2 Energy pyramid.

While the GHG emissions was dropped by 50% during the period 2019-2022, 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

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

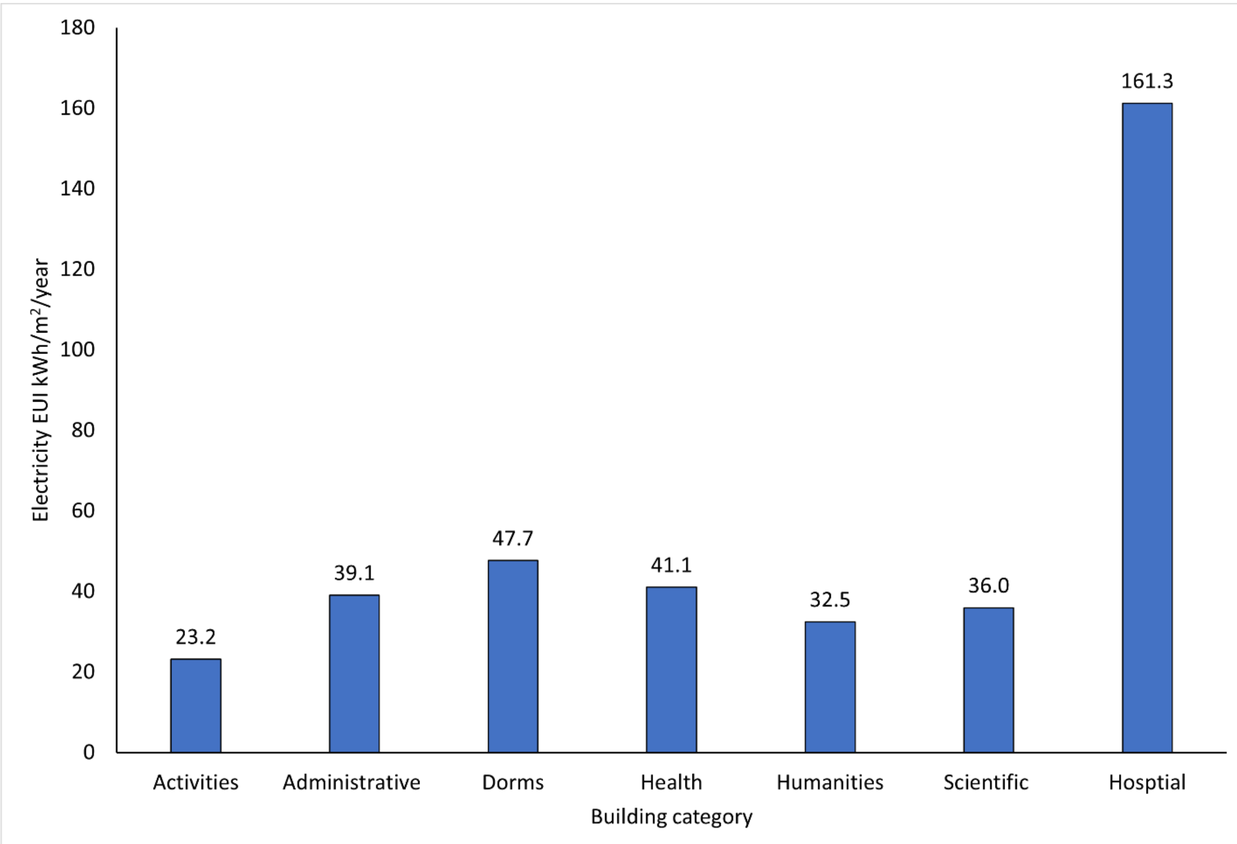

Figure 3 Electricity EUI for different building categories based on the built floor area.

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.

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 roof, 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.

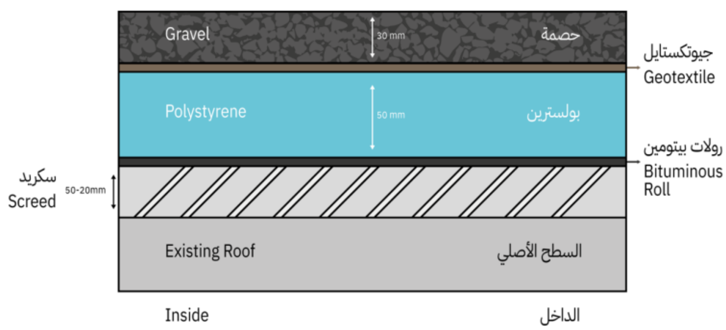

Figure 4 Thermal insulation layers implemented on the rooftops.

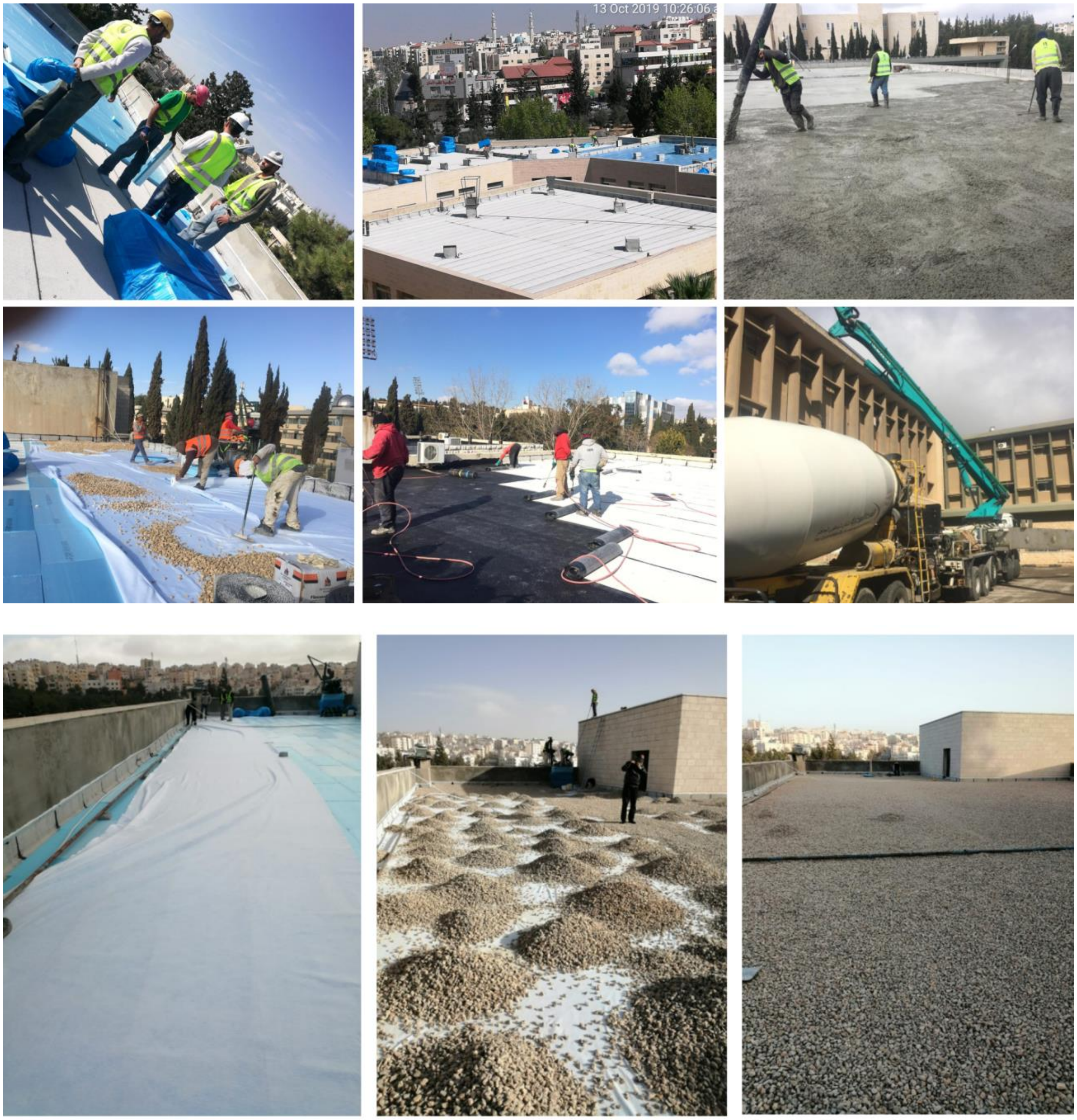

Figure 5 The implementation of thermal insulation on the rooftops of the buildings.

2. Energy efficiency

In this regard, the university is working in two 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. 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).

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

[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

6 presents images of the solar energy project implemented on the rooftops and carparks of the university.

Figure 6 The solar energy project, installed on the rooftops and carparks of the campus.

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