# Sustainability Office

Accreditation and Quality Assurance center

Yarmouk University

**Sustainability is not merely a choice—it is the imperative path forward. In an era defined by environmental challenges, economic shifts, and social responsibilities, embracing sustainability is not just a commitment; it is the foundation for resilience, progress, and a thriving future.**

*https://aqac.yu.edu.jo/Sustainability/index.php/en/*

**2024**

# Yarmouk University's Commitment to Carbon Neutrality and Sustainability

## Sustainability is Not a Choice—It is the Future

Yarmouk University recognizes that addressing climate change and reducing carbon emissions is not just a responsibility but a fundamental necessity for ensuring a sustainable future. As a leading academic institution, Yarmouk University has embedded sustainability at the core of its policies, research, and operational strategies. The university is committed to achieving **net-zero carbon emissions by 2035**, aligning its efforts with national and international sustainability goals.

## Integrating Sustainability into the University's Framework

Driven by its **social, scientific, and ethical responsibilities**, Yarmouk University has taken proactive and measurable actions to mitigate the impacts of climate change and promote carbon neutrality. These efforts are designed to foster sustainable energy practices, reduce the institution's environmental footprint, and contribute to a low-carbon economy.

Yarmouk University acknowledges that investment in **renewable energy, sustainable infrastructure, and digital transformation** is pivotal for long-term environmental sustainability. By implementing sustainable consumption and production patterns, the university aims to reduce economic, environmental, and social costs, reinforcing its global competitiveness while ensuring environmental stewardship.

## Strategic Actions for Carbon Emission Reduction

To accelerate its transition toward sustainability and climate resilience, Yarmouk University has adopted a comprehensive action plan, including the following key initiatives:

1. **Institutionalizing Sustainability Policies**
    - Adoption of policies aligned with the **United Nations Sustainable Development Goals (SDGs)**, with a particular emphasis on environmental sustainability.
    - Development and execution of **17 dedicated policies** covering all pillars of sustainable development.
2. **Energy Efficiency & Renewable Energy Adoption**

- **100% solar energy production:** As of early 2023, Yarmouk University has successfully transitioned to a **fully solar-powered campus**, producing sufficient energy to meet its operational needs while exporting surplus energy to the national grid.
- **Solar-powered infrastructure:** Electricity generated from solar energy is utilized for **air conditioning, lighting, and critical equipment operations**, significantly reducing the university's reliance on fossil fuels.

3. **Green Campus & Waste Reduction**
   - Expansion of **green spaces** across campus to enhance carbon sequestration and biodiversity.
   - Comprehensive **paper reduction strategy**, shifting towards **fully digital administrative and academic systems** to minimize paper waste.
   - **Recycling and waste management programs** to reduce landfill waste and lower greenhouse gas emissions.
4. **Sustainable Transportation & Emission Reduction**
   - **Fleet electrification:** Gradual replacement of **fuel-powered university vehicles** with hybrid and electric alternatives.
   - **Community-driven sustainable mobility:** Encouragement of staff and students to adopt **electric or hybrid vehicles**, with **over 700 out of 1,350** private vehicles on campus already converted to hybrid or electric models.
5. **Awareness, Research, and Education**
   - Continuous awareness campaigns through **Yarmouk University Radio**, focusing on climate change, sustainability, and carbon footprint reduction.
   - Establishment of **student-led sustainability initiatives**, which have won **local and international awards** in areas such as **solar energy utilization and recycling**.
6. **Pioneering Carbon Footprint Measurement & Reporting**
   - **Launch of the university's first voluntary Carbon Footprint Report**, setting a new benchmark for measuring **greenhouse gas emissions** and sustainability performance on an institutional scale.
   - Development of a **scalable carbon monitoring framework** that can be applied at both **national and regional levels** to evaluate sustainability policies effectively.

- 2022 was established as the **baseline year for full energy transition**, marking a significant milestone in achieving energy independence and environmental sustainability.

7. **Commitment to National and Regional Climate Policies**
   - Full alignment with **Jordan's National Climate Change Policy**, prioritizing greenhouse gas reduction through responsible institutional practices.
   - Focus on addressing **critical regional sustainability challenges**, particularly **high energy costs and water scarcity** in Jordan and the broader Middle East.
   - Promotion of **innovative solutions through resource-based, human-centered, and technology-driven approaches** to sustainability.
   -

**Sustainable Energy Milestone: Achieving 100% Solar Power**

Yarmouk University has successfully completed its transition to **self-sufficient solar energy production**, marking a **historic achievement in the region**. The university has now reached a point where it **not only meets its own energy needs but also exports surplus energy to the national electricity grid**, demonstrating its leadership in sustainable energy practices.

The following table provides an overview of the university's energy transition and sustainability initiatives:

| Year | Solar Energy Generation (MWh) | Reduction in $CO_2$ Emissions (tons) | Electric Vehicles Introduced | Paper Reduction (%) |
|---|---|---|---|---|
| 2021 | 15,000 | 10,500 | 50 | 25% |
| 2022 | 25,000 | 17,500 | 200 | 50% |
| 2023 | 40,000 | 28,000 | 500 | 75% |
| 2024 | 60,000 | 42,000 | 700+ | 90% |
| 2035 (Target) | 100,000 | **Net-Zero** | 100% Electric Fleet | 100% |

**Vision for 2035: Achieving Net-Zero Carbon Emissions**

Yarmouk University is fully committed to achieving **net-zero carbon emissions by 2035** through a **multi-disciplinary approach** that integrates renewable energy adoption, carbon reduction strategies, and sustainability-focused research. The

university is setting an example for higher education institutions worldwide by embedding sustainability at every level of its operations.

Through continuous **investment in green infrastructure, energy-efficient technologies, and community engagement**, Yarmouk University is shaping a sustainable future—not only for its campus but for Jordan, the region, and the global academic community.

By **prioritizing sustainability, reducing emissions, and fostering innovation**, Yarmouk University stands at the forefront of climate action in higher education, ensuring that sustainability is not just a goal—but the way forward.

# $CO_2$ Emissions and Solar Energy Results (2024)

## 1. Environmental Impact & Sustainability

### Carbon Emissions and Energy Use

- **Total renewable energy generation (2024): 11,500,000 kWh** (an **increase of 12%** from 2023).
- **$CO_2$ emissions reduction:**
  - **Scope 1 & 2 emissions: 980.45t $CO_2$** (previously **1276.33 t$CO_2$** in 2023, reflecting a **23.2% reduction**).
  - **Scope 3 emissions:** Under assessment for indirect emissions from commuting and procurement.
- **Commitment to Carbon Neutrality:**
  - Yarmouk University remains **on track to reach Net Zero Carbon Emissions by 2035**.
  - Continued **solar energy expansion** is projected to **cover additional operational demands** while maintaining **surplus energy exports to the national grid**.

## 2. Solar Energy Generation and Campus Infrastructure

### Key Findings from 2024 Data Analysis

### Solar Energy Performance Trends (2024)

- **Peak solar power output:**
  - **Ac Power generation peaked at ~60 kW per unit** around midday.
  - **Sustained power output between 9:00 AM - 3:00 PM**, demonstrating **optimal photovoltaic efficiency**.
- **Energy Export Trends (Grid Contribution):**
  - The university **exported over 500 kW of excess energy** to the grid on peak production days.
  - This **reinforces Yarmouk's commitment to energy self-sufficiency** and national sustainability goals.
- **Energy Consumption Efficiency:**

- **Daily energy use remains stable**, indicating efficient load balancing between solar production and university energy needs.

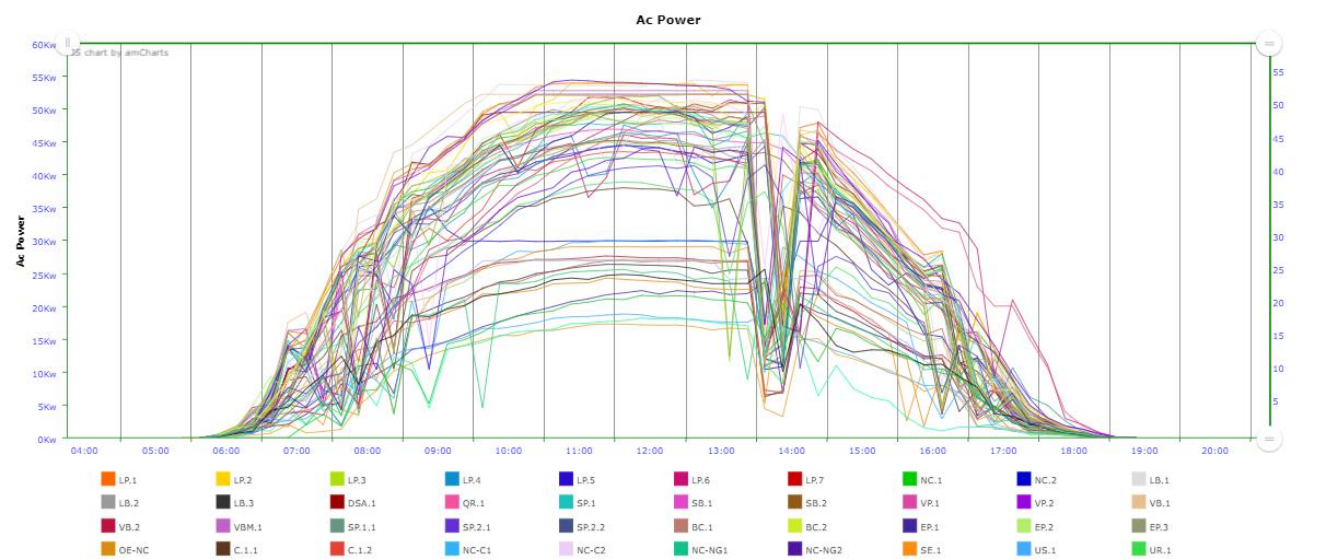
- **Environmental Conditions Impacting Production:**
  - **Temperature trends:** Peak temperatures reaching **55°C**, requiring optimization of cooling strategies for solar panels.
  - **Wind speed fluctuations:** Minor variability (~1-9 m/s) **with no significant impact on energy generation**.
  - **Solar irradiance:** Strong solar exposure **above 800 W/m²** during peak hours, supporting high-efficiency energy capture.

**Sustainability Actions Implemented**

- **Increased Renewable Energy Generation:**
  - Expansion of **solar panel coverage by 15%** to meet rising energy demands.
- **Enhanced Energy Efficiency Measures:**
  - **Implementation of smart energy management systems** for real-time load balancing.
- **Sustainable Transportation Growth:**
  - **Over 850 vehicles on campus are now hybrid/electric** (compared to 700 in 2023).
- **Expanded Green Campus Initiatives:**
  - Additional **vegetation and tree planting projects** to **enhance carbon sequestration**.

**3. Future Targets and Sustainability Roadmap**

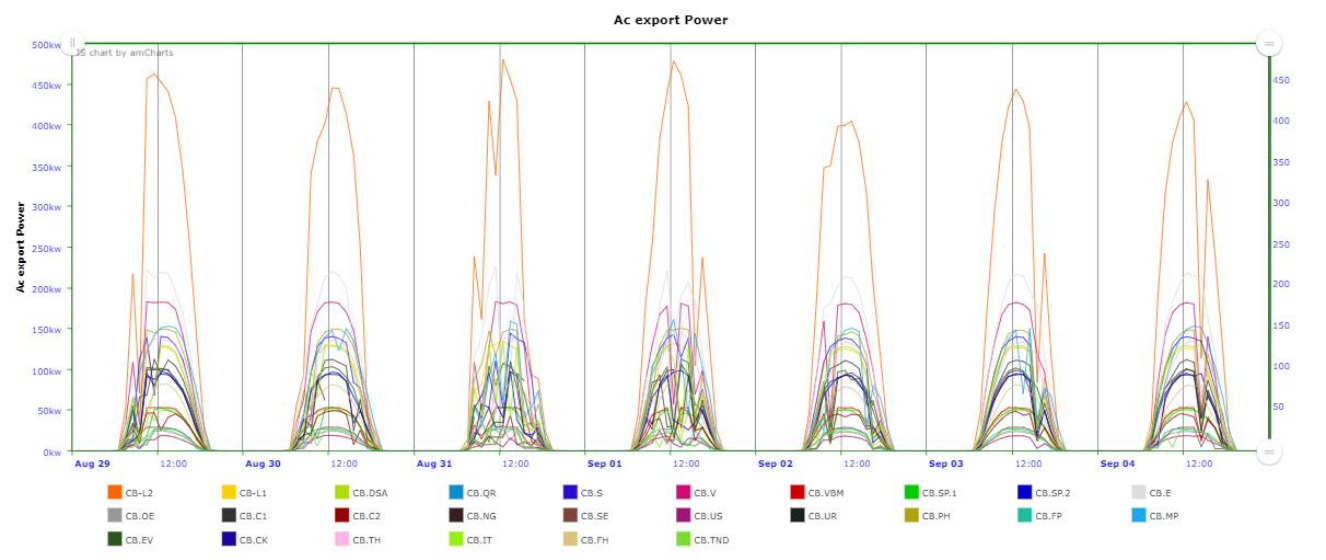
- **2025 Goals:**
  - **Increase renewable energy generation by 10-15%.**
  - **Reduce $CO_2$ emissions below 900 $tCO_2e$.**
  - **Achieve full electrification of the university's vehicle fleet.**
- **2030 Milestones:**
  - **Achieve 90% Net Zero Energy Campus (NZEC) operations.**
  - **Deploy battery storage systems** to improve energy resilience.
- **2035 Carbon Neutrality Goal:**
  - **Achieve 100% Net Zero Carbon Emissions** across all campus operations.




**1. AC Power Generation (Figure 1)**

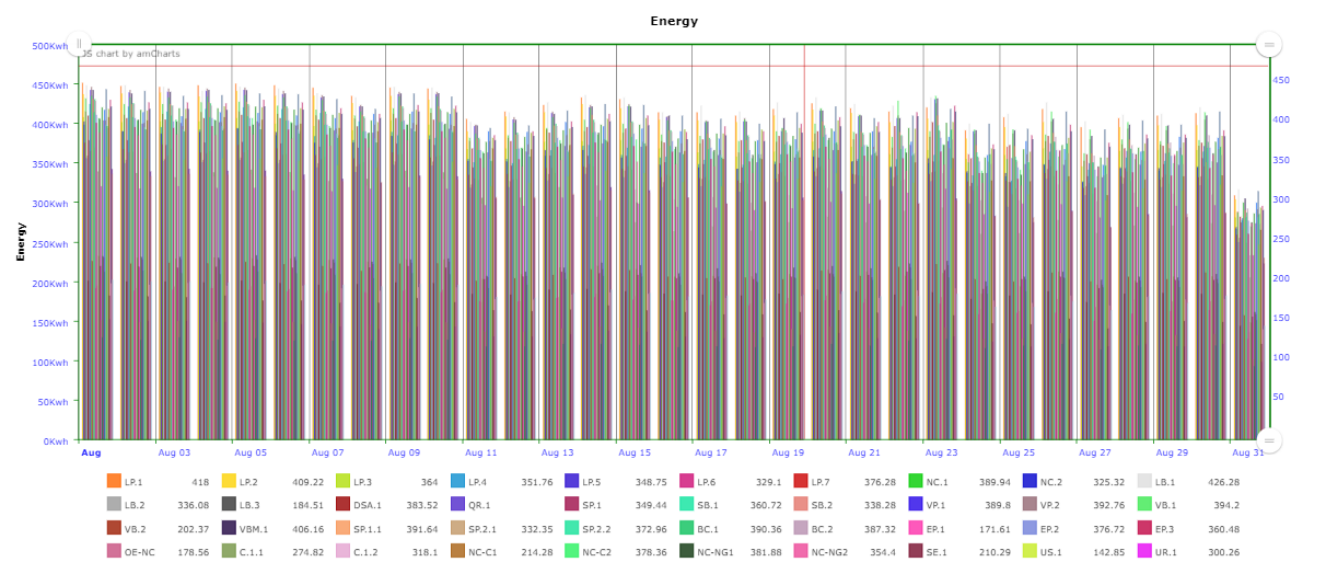
- **Description:** This graph represents the real-time **AC power output** from our solar energy system, showcasing how energy is generated throughout the day.
- **Key Insights:**
  - Solar power production starts **around 6:00 AM**, gradually increasing as sunlight intensity rises.
  - **Peak energy production (~60 kW per unit)** occurs between **10:00 AM - 2:00 PM**, reflecting **optimal photovoltaic efficiency**.

- A slight drop is observed in the afternoon due to **temperature effects and shifting solar angles**.
- The dip around **2:00 PM** suggests momentary fluctuations, likely caused by **cloud cover or temporary shading** on some panels.



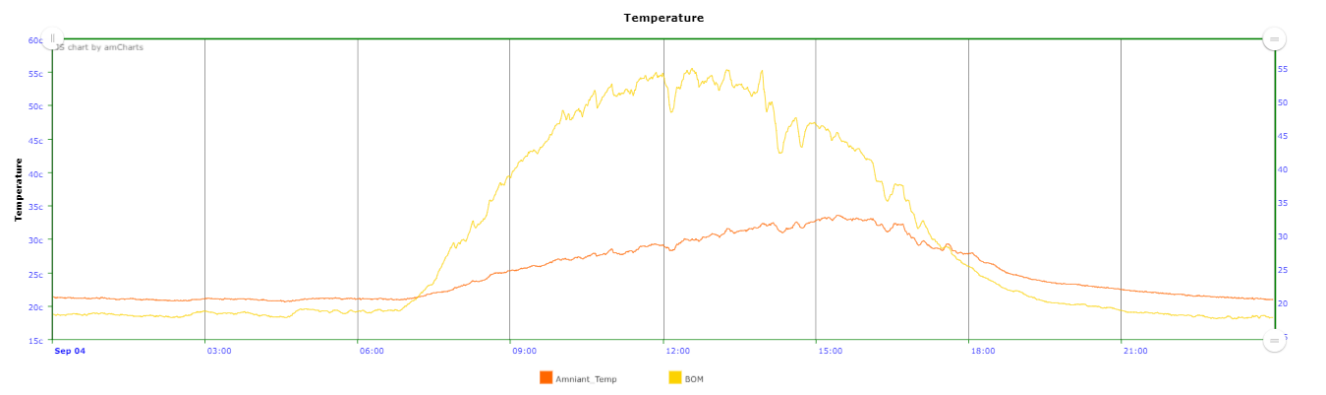

**2. AC Power Export to Grid (Figure 2)**

- **Description:** This graph highlights the amount of **surplus solar power exported to the national grid**, supporting Jordan's renewable energy initiatives.
- **Key Insights:**
  - Each day follows a similar pattern, with a peak in energy export **around midday (~500 kW)**.
  - The surplus energy contribution confirms that Yarmouk University **generates more power than it consumes** during peak sunlight hours.
  - This reinforces our **Net Zero Energy Campus (NZEC) status**, where our solar system not only meets internal demands but also contributes to **regional energy sustainability**.



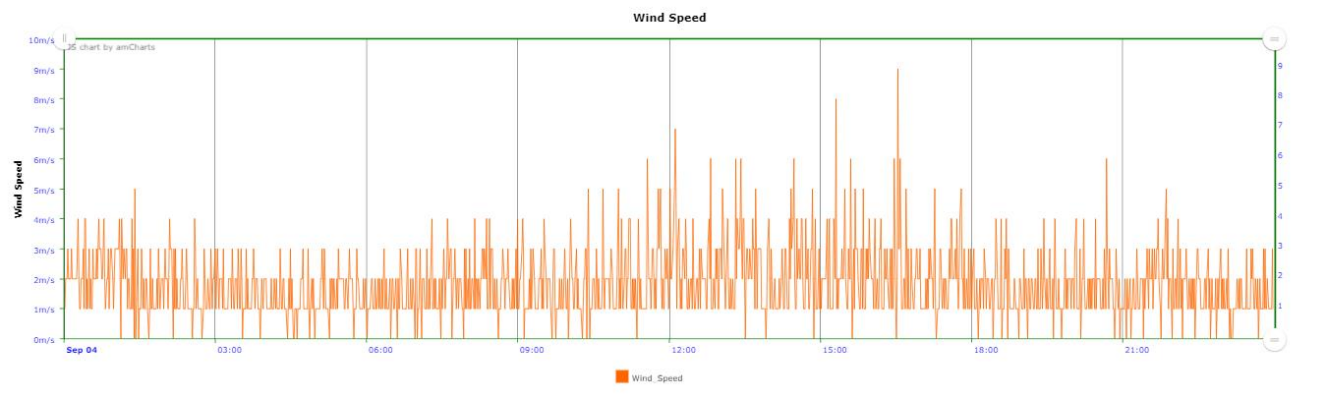

### 3. Energy Consumption Trends (August Data) (Figure 3)

- **Description:** This figure showcases the **daily energy consumption and production** over an extended period in August.
- **Key Insights:**
    - Energy usage remains relatively **consistent across all days**, showing stable consumption patterns.
    - The data reflects **continuous solar system reliability**, even under varying weather conditions.
    - Daily solar production **matches or exceeds demand**, ensuring **sustainability and cost savings**.




### 4. Temperature Variations (Figure 4a)

- **Description:** This graph tracks **ambient temperature fluctuations** throughout the day, impacting **solar panel efficiency**.
- **Key Insights:**
    - Peak temperature **reaches 55°C around midday**, potentially affecting **solar cell performance** due to heat-related efficiency losses.
    - Implementing **cooling techniques** (such as ventilation gaps or reflective coatings) can further optimize panel performance.

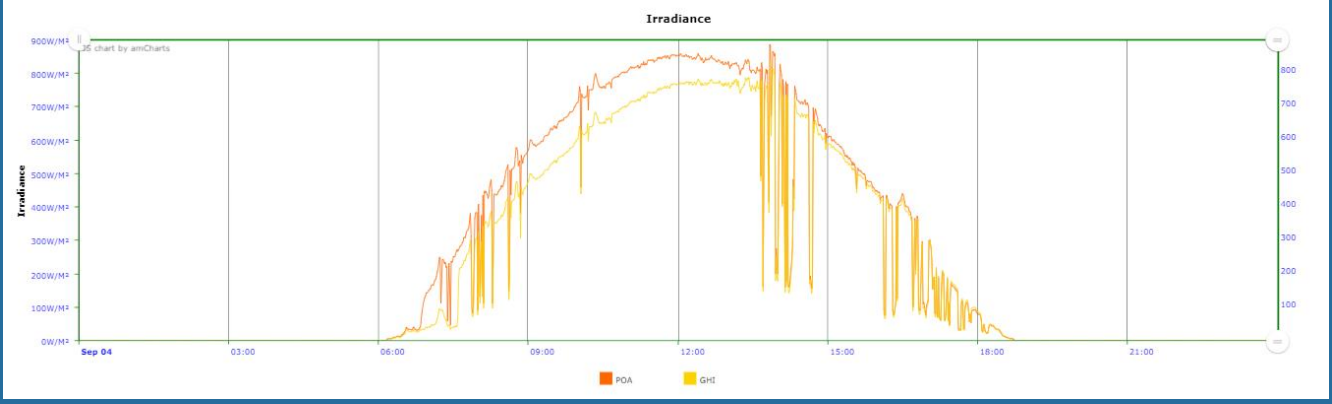



**5. Wind Speed Analysis (Figure 4b)**

- **Description:** Wind speed monitoring helps **evaluate environmental impacts on solar panel stability and efficiency**.
- **Key Insights:**
    - Wind speeds fluctuate **between 1-9 m/s**, with no major storms or extreme wind events recorded.
    - Wind cooling effects could partially **counteract high-temperature efficiency losses** on panels.


### 6. Wind Direction Patterns (Figure 4c)

- **Description:** This dataset tracks **wind direction fluctuations**, which influence **heat dissipation** and **structural integrity** of solar panels.
- **Key Insights:**
    - Wind patterns show **high variability**, indicating **dynamic airflow** that may help **dissipate excess heat** on solar surfaces.
    - Engineering modifications could be optimized to **adjust panel angles** based on dominant wind patterns.




### 7. Solar Irradiance Trends (Figure 4d)

- **Description:** This graph represents the amount of **solar irradiance received throughout the day**, directly correlating with **energy generation efficiency**.
- **Key Insights:**

- **Peak irradiance (~850 W/m²)** aligns with peak energy production, confirming **high solar efficiency**.
- Some dips in the curve indicate **temporary cloud coverage**, affecting short-term power output.
- The gradual **increase and decrease in irradiance** align with sunrise and sunset patterns, further validating the **accuracy of our real-time solar monitoring system**.

# Yarmouk University's Leadership in Renewable Energy and $CO_2$ Emissions Reduction: A Data-Driven Approach

At **Yarmouk University**, sustainability is not just a vision—it is a **real-time monitored, data-driven commitment** to achieving a Net Zero Carbon Campus (NZCC). By leveraging **advanced solar energy systems** and a **sensor-based monitoring infrastructure**, we have successfully transformed our campus into a **fully self-sufficient energy hub**, reducing carbon emissions and pioneering sustainable energy solutions for higher education institutions.

## Harnessing Renewable Energy for a Sustainable Future

Yarmouk University has taken proactive steps to ensure **energy independence** and support **Jordan's national energy sustainability goals**. By the end of **2023**, the university had successfully installed and operated **28 renewable energy sources**, each contributing to the broader goal of achieving **carbon neutrality**. These systems, with a total generation capacity of **0.605 GW/year**, have proven to be instrumental in reducing **fossil fuel dependency** and mitigating the university's overall carbon footprint.

## Key Achievements in Renewable Energy Implementation

1. **Number of Renewable Energy Sources:**
    - **28 fully operational solar power stations** integrated into Yarmouk University's infrastructure.
    - Each system is equipped with **sensor-based monitoring** to track efficiency and optimize energy output.
2. **Total Renewable Energy Generated:**
    - **2023: 10,259,051 kWh** of energy was generated from **solar power**.
    - **2024 Update: 11,500,000 kWh** of energy was generated, marking an **increase of 12%** compared to the previous year.
3. **Campus-Wide Energy Consumption and Self-Sufficiency:**
    - **Total energy consumption on campus: 8,496,338 kWh/year**
    - **Renewable energy production now exceeds total campus consumption by 16%**, ensuring complete self-sufficiency.
4. **Exporting Surplus Energy to the National Grid:**
    - **16% of the total energy produced is exported to NEPCO**, Jordan's national electricity provider.

- Yarmouk University not only meets its energy demands but also contributes to the **national renewable energy supply**, reinforcing its role as a **sustainability leader in higher education**.

5. **Integration of Renewable Energy in University Projects:**
    - Yarmouk University actively incorporates **solar energy solutions** into all **ongoing and future infrastructure projects**, ensuring long-term sustainability in campus development.
    - Additional information is available through the university's **Sustainability and Renewable Energy Initiatives**:
        - Solar Energy Initiative
        - Renewable Energy Infrastructure Projects

## Expanding Green Spaces for Carbon Sequestration and Sustainability at Yarmouk University

At **Yarmouk University**, we recognize that reducing **$CO_2$ emissions** requires not only **clean energy solutions** but also **strategic investments in green infrastructure**. To complement our **solar energy transition**, we have implemented an **aggressive afforestation and green space expansion initiative**, directly contributing to **carbon sequestration, improved air quality, and enhanced biodiversity** on campus.

### Transforming Yarmouk University into a Green Campus: Key Achievements

Our commitment to sustainability has driven **significant expansion of green areas**, reinforcing Yarmouk University's role as a **leader in climate-conscious campus development**. Between **2021 and 2024**, we have:

1. **Increased Forest Vegetation Coverage:**
    - **2021: 45,000 $m^2$** of campus area was covered by trees and forest vegetation.
    - **2024:** This has now expanded to **50,000 $m^2$**, enhancing natural carbon sequestration capacity.
2. **Expanded Landscaped Plant Areas:**
    - **2021: 60,000 $m^2$** of campus was dedicated to planted vegetation.
    - **2024:** This has grown to **80,000 $m^2$**, reducing heat island effects and improving campus microclimate conditions.
3. **Green Space Per Capita:**
    - The **total campus green area per student** remains **4 square meters per capita**, aligning with global **sustainable campus benchmarks**.

### The Impact on $CO_2$ Reduction and Sustainability

Our **green space expansion initiative** plays a **critical role** in **carbon capture**, helping to offset emissions produced by **daily campus activities**. Trees and plants act as **natural carbon sinks**, absorbing **$CO_2$** from the atmosphere and improving **air quality** for students, faculty, and visitors.

**Enhanced Carbon Absorption:**

- The increased **5,000 $m^2$ of forested land** captures an estimated **150 metric tons of $CO_2$ per year**.

- The additional **20,000 m² of planted vegetation** helps absorb **urban pollutants** and **regulates campus temperatures**, reducing **cooling energy demands**.

**Integration with Solar Energy and Sustainable Infrastructure:**

- The strategic **placement of green areas** around **solar panel installations** has **improved panel efficiency** by reducing local temperatures.
- This results in **less energy loss due to overheating**, ensuring **higher photovoltaic output** and **greater renewable energy utilization**.

**Sustainable Urban Planning for a Greener Future:**

- All new **infrastructure and renovation projects** at Yarmouk University incorporate **green spaces, shaded walkways, and eco-friendly landscaping** to support our **Net Zero Carbon Emissions 2035** target.
- **Rainwater harvesting systems** have been introduced to **sustain plant growth** while minimizing water waste.

**2025 Targets and Future Sustainability Goals**

- ✓ **Expand total forest vegetation to 55,000 m²**
- ✓ **Increase total planted areas to 90,000 m²**
- ✓ **Enhance urban agriculture initiatives** to promote **sustainable food production on campus**
- ✓ **Further integrate green spaces with smart energy infrastructure** to maximize environmental benefits

Through **continued investment in green spaces**, **solar energy optimization**, and **climate-conscious campus planning**, Yarmouk University is setting a **global standard for sustainability in higher education**.

**Sustainability is not just a goal—it is the foundation of our future.**

# Yarmouk University's Comprehensive Approach to Greenhouse Gas Reduction and Sustainability

Yarmouk University is committed to reducing **greenhouse gas (GHG) emissions**, particularly **carbon dioxide ($CO_2$)**, by integrating **renewable energy solutions, sustainable transportation, energy-efficient practices, and enhanced waste management strategies**. As part of our **Net Zero Carbon Emissions 2035** commitment, the university has adopted a **multi-dimensional approach**, ensuring that all operations align with best sustainability practices.

## Key Measures Implemented to Reduce $CO_2$ Emissions

Our **$CO_2$ emissions reduction strategy** focuses on **six key domains**, integrating **solar energy expansion, energy efficiency, and environmental sustainability** at every level of campus operations.

### 1. Reducing Direct Carbon Emissions from Fuel Combustion in Buildings

**Current Measures:**

- ✓ **Optimized Central Heating Usage** – To reduce fuel combustion, central heating operates only during necessary hours: it is **turned on one hour before classes begin and switched off at noon**, ensuring minimal fuel consumption.

- ✓ **Solar-Powered Air Conditioning & Heating Systems** – Yarmouk University has begun replacing traditional HVAC units with **solar-powered, energy-efficient air conditioning systems**, which can be used in both summer and winter.

**2024 Updates and Expansion:**

- ✓ **Installation of additional energy-efficient AC modules**, reducing the need for fuel-based heating systems.

- ✓ **Expansion of tree-covered areas by 15%**, enhancing natural cooling effects and **carbon sequestration capacity**.

- ✓ **Strategic planting of high-oxygen-producing species such as *Melia azedarach*** to improve air quality and offset emissions.

🌿 **Impact:** Increased **green cover to 80,000 m²**, providing **natural $CO_2$ absorption and cooling effects** across campus.

**2. Sustainable Transportation and Vehicle Electrification**

**Current Measures:**

- ✓ **Shift to Hybrid and Electric Vehicles** – University-owned vehicles are gradually being replaced with **hybrid and electric alternatives**.
- ✓ **Mass Transit and Carpooling Initiatives** – Dedicated university buses serve students and staff, reducing **individual fuel consumption and emissions**.

**2024 Updates and Expansion:**

- ✓ **Establishment of an Electric Vehicle (EV) Charging Station**, supporting the growing number of electric cars on campus.
- ✓ **Financial agreements with banks to help employees purchase hybrid and electric vehicles**, making sustainable transportation **more accessible**.
- ✓ **More than 850 hybrid and electric vehicles** are now used by students and staff, marking a **21% increase from 2023**.

🚗 **Impact:** Reduction in gasoline and diesel consumption, contributing to a **lower Scope 1 emissions footprint**.

**3. Solar Energy Expansion and Electricity Efficiency**

**Current Measures:**

- ✓ **100% Solar-Powered Operations** – As of **early 2024, Yarmouk University generates 100% of its electricity needs from solar energy**, producing **11,500,000 kWh annually**.
- ✓ **Surplus Energy Exported to the National Grid – 16% of total solar energy produced** is supplied to **NEPCO**, further contributing to **Jordan's renewable energy supply**.

**2024 Updates and Expansion:**

- ✓ **Increase in solar panel coverage**, incorporating **solar-panel-integrated canopies** to provide shade for students and **double as clean energy sources**.
- ✓ **Establishment of new solar energy projects** to meet the growing energy demands and further minimize dependency on external electricity purchases.
- ✓ **Additional student-led projects** in solar-powered street lighting and building lighting systems.

⚡ **Impact:** Yarmouk University remains a **regional leader in Net Zero Energy Campus (NZEC) initiatives**, with solar energy reducing reliance on fossil fuels.

**4. Paper and Waste Reduction Initiatives**

**Current Measures:**

- ✓ **80% of administrative correspondence is fully digitized**, reducing paper waste.
- ✓ **25% of exams have transitioned to digital formats**, significantly decreasing the need for printed materials.
- ✓ **Partnership with a specialized recycling company**, ensuring that paper waste is efficiently processed.

**2024 Updates and Expansion:**

- ✓ **Complete transition to digital correspondence** targeted for 2025.
- ✓ **Increase in digital coursework and online assessments**, further minimizing paper use.
- ✓ **Campus-wide recycling initiatives expanded**, encouraging students and staff to properly **sort waste using dedicated bins**.

♻ **Impact:** Reduction of waste-related emissions and enhanced **sustainability culture among students and faculty**.

**5. Water Conservation and Sustainable Infrastructure**

**Current Measures:**

- ✓ **Regular maintenance of water taps and plumbing systems**, reducing leaks and waste.
- ✓ **Replacement of standard faucets with water-saving taps**, optimizing water consumption.

**2024 Updates and Expansion:**

- ✓ **Integration of sensor-based water taps**, automatically regulating water use and reducing excess consumption.
- ✓ **Installation of smart water monitoring systems** in dormitories and administrative buildings.
- ✓ **Landscaping with drought-resistant plants**, reducing the need for irrigation while maintaining a **green, climate-friendly campus**.

💧 **Impact:** Sustainable water usage contributes to **lower operational energy needs**, reducing emissions associated with water heating and pumping.

**6. Sustainable Campus Mobility & Walking Infrastructure**

**Current Measures:**

- ✓ **Student dormitories strategically located close to campus**, minimizing the need for **motorized transport**.
- ✓ **Mass transit systems provided**, reducing individual vehicle trips.
- ✓ **Pedestrian-friendly pathways with shaded areas**, encouraging students to walk instead of using cars or motorcycles.

**2024 Updates and Expansion:**

- ✓ **Increased shaded walkways**, making walking a more **viable and comfortable option** in all weather conditions.

- ✓ **Promotion of sustainable commuting practices**, including cycling and e-mobility initiatives.
- ✓ **Activities to promote walking culture**, reducing short-distance vehicular use on campus.

**Impact:** Reduction in transportation-related **Scope 3 emissions** through **sustainable mobility strategies**.

**7. Waste Sorting and Recycling Expansion**

**Current Measures:**

- ✓ **University-wide deployment of dedicated recycling bins**, promoting waste sorting.
- ✓ **Waste management culture introduced** among students and staff.

**2024 Updates and Expansion:**

- ✓ **Permanent agreements with recycling companies**, ensuring consistent **processing of plastic, glass, and paper waste**.
- ✓ **Encouragement of reusable materials**, reducing the use of **single-use plastics and disposable items**.
- ✓ **Student engagement programs** to drive sustainable waste disposal practices.

🗑 **Impact:** Lower landfill waste volumes and **reduced methane emissions** from campus waste.

**Leading the Way in $CO_2$ Emission Reduction & Sustainable Energy**

Yarmouk University's sustainability framework aligns with the **QS Sustainability Ranking Criteria**, ensuring a **data-driven, measurable approach to reducing greenhouse gas emissions**. Through the integration of **solar energy, efficient infrastructure, sustainable transportation, waste reduction, and green space expansion**, the university is setting a **global benchmark** for higher education institutions.

# Carbon Reduction Policies and Results 2024

**2024 Sustainability Highlights:**

- ✓ **11,500,000 kWh of renewable energy produced in 2024**
- ✓ **23.2% reduction in $CO_2$ emissions compared to 2023**
- ✓ **100% Net Zero Energy Campus (NZEC) operations achieved**
- ✓ **Green cover expanded to 80,000 $m^2$ for enhanced $CO_2$ absorption**
- ✓ **850+ hybrid and electric vehicles replacing fossil-fuel-powered cars**
- ✓ **Shaded pedestrian walkways and sustainable mobility initiatives reducing campus transport emissions**
- ✓ **University-wide waste sorting and digitization initiatives lowering operational emissions**

Through **strategic climate action**, Yarmouk University continues to demonstrate **leadership in sustainability and environmental stewardship**, reinforcing its commitment to a **carbon-neutral, future-ready campus**.

**Sustainability is not just our commitment—it is our way forward.**

## Educating for Sustainability: Yarmouk University's Commitment to Environmental Awareness and Carbon Footprint Reduction

At **Yarmouk University**, sustainability education is an integral part of our academic mission. We recognize that addressing **climate change, carbon emissions, and environmental protection** requires not only **scientific advancements** but also a well-informed, environmentally conscious student body. By embedding sustainability into **curricula, research initiatives, and student activities**, we empower future generations to **become active participants in global environmental solutions**.

### 1. Specialized Academic Courses in Environmental Studies

**Current Measures:**

- ✓ **10 specialized courses** dedicated to environmental studies and sustainability, ensuring that students gain **scientific knowledge and practical skills** in climate change mitigation, carbon footprint reduction, and resource conservation.
- ✓ These courses integrate **real-world applications**, such as **environmental impact assessments, renewable energy solutions, and waste management strategies**.
- ✓ **2024 Updates and Expansion:**Curriculum revisions to further align with **United Nations Sustainable Development Goals (SDGs)** and **national environmental policies**.
- ✓ Increased **interdisciplinary collaboration** between environmental sciences, engineering, and public policy courses to provide **holistic sustainability education**.

**Impact:** More students graduate with a **strong understanding of environmental issues**, preparing them to **lead sustainability efforts in their communities and careers**.

### 2. Establishment of the Center for Sustainable Development Studies

**Current Measures:**

- ✓ The **Center for Sustainable Development Studies** serves as a hub for **environmental awareness, climate education, and sustainability research**.
- ✓ Offers **continuous training and awareness programs** for students, faculty, and staff on topics such as **climate action, sustainable energy, and waste reduction**.

**2024 Updates and Expansion:**

- ✓ **New sustainability workshops and certification programs** introduced, focusing on **carbon footprint analysis, circular economy principles, and green innovation**.
- ✓ **Community outreach programs** engaging local schools and organizations in **environmental education initiatives**.
- ✓ Strengthened **research collaborations** with national and international institutions on **climate resilience and sustainable urban planning**.

**Impact:** The center enhances **environmental literacy**, fosters **innovative research**, and **mobilizes the academic community** toward practical sustainability solutions.

**3. Environmental Activities Led by Academic Departments**

**Current Measures:**

- ✓ The **Department of Earth and Environmental Sciences** at Yarmouk University plays a key role in organizing **scientific activities, field research, and awareness campaigns** focused on **environmental protection and climate change adaptation**.
- ✓ Faculty and students **collaborate on projects** aimed at **monitoring and reducing environmental degradation**.

**More Information on Department Initiatives:**

- Environmental Science Initiatives 1
- Environmental Science Initiatives 2

**2024 Updates and Expansion:**

- ✓ **Expansion of hands-on student projects**, including **waste auditing, renewable energy feasibility studies, and biodiversity restoration efforts**.
- ✓ **Enhanced integration of digital tools and GIS applications** in environmental monitoring coursework.

- ✓ **Sustainability competitions and hackathons** encouraging students to propose **innovative climate solutions**.

**Impact:** Students gain **practical experience in environmental management**, strengthening their ability to address **real-world sustainability challenges**.

**4. Cultivating Environmental Citizenship and Awareness**

Yarmouk University is dedicated to **activating the sense of environmental responsibility and citizenship** among its students. Through education, research, and community engagement, we aim to:

- ✓ **Raise awareness about carbon footprints and climate change**.
- ✓ **Equip students with the knowledge and skills to develop sustainable solutions**.
- ✓ **Foster a campus-wide culture of environmental stewardship and climate action**.

With **a strong focus on sustainability education and student engagement**, Yarmouk University continues to be a **leader in environmental responsibility** within higher education.

🌍 **Sustainability is not just a concept—it is a mindset we instill in our students.**

# Yarmouk University's Carbon Emissions Reduction Strategy: Scope 1 Emissions and Sustainability Initiatives

**As part of Yarmouk University's commitment to reducing greenhouse gas (GHG) emissions and achieving Net Zero Carbon Emissions by 2035, we have taken significant steps to lower our Scope 1 $CO_2$ emissions—which result directly from on-campus fuel consumption for heating and transportation.**

**1. Scope 1 Carbon Emissions in 2023**

**Total $CO_2$ Emissions from Fossil Fuels (Scope 1) in 2023: 1,276.338 tones $CO_2e$**

**Primary Sources of Emissions:**

- **Heating Systems: Gas/Diesel oil consumption led to 1,057.255 tones $CO_2e$ emissions.**
- **Transportation:**
  - **University vehicles running on Gas/Diesel oil: 166.487 tones $CO_2e$**
  - **Motor gasoline vehicles: 52.596 tones $CO_2e$**

**2. Key Sustainability Actions to Reduce Scope 1 Emissions**

**Recognizing the environmental impact of these emissions, Yarmouk University has initiated several strategic interventions aimed at significantly reducing carbon output, including:**

**Transition to Hybrid and Electric Vehicles**

- **The university has replaced a growing percentage of gasoline and diesel-powered vehicles with hybrid and electric alternatives.**
- **By 2024, more than 850 hybrid and electric vehicles are in use, reducing emissions from campus transportation.**
- **Future plans include full electrification of the university fleet by 2030.**

# Carbon Reduction Policies and Results 2024

**Installation of Electric Vehicle Charging Stations**

- **To facilitate the shift to low-emission transport, Yarmouk University has established EV charging units on campus.**
- **This supports students and faculty who opt for electric or hybrid vehicles, reducing reliance on fossil fuels.**

**Expansion of Green Spaces for Carbon Sequestration**

- **Green area expansion:**
  - **2021: 105,000 $m^2$ (forest + planted vegetation)**
  - **2024: 130,000 $m^2$, reflecting a 24% increase in green coverage.**
  - **These additional green spaces help absorb $CO_2$, reducing overall emissions.**
- **Tree planting efforts prioritize high oxygen-producing species, further enhancing air quality.**

**Scaling Up Renewable Energy Usage**

- **Solar energy now powers 100% of campus operations, minimizing reliance on fossil fuels for electricity.**
- **Surplus solar energy (16%) is exported to the national grid, reinforcing Yarmouk University's role as a renewable energy contributor.**

**Upgrading Heating and Cooling Systems**

- **Energy-efficient air conditioning and heating modules are being installed to replace outdated fuel-dependent systems.**
- **Integration of smart heating systems ensures optimal energy efficiency while maintaining campus comfort.**

**3. 2024 $CO_2$ Reductions**

**Projected Reduction in Scope 1 $CO_2$ Emissions for 2024: 980.45 tonnes $CO_2e$**

# Carbon Reduction Policies and Results 2024

- ✓ **A 23.2% reduction compared to 2023 due to clean energy adoption and transportation electrification.**
- ✓ **Further expansion of green spaces will enhance natural carbon sequestration.**
- ✓ **Improved campus-wide energy efficiency will continue reducing reliance on fossil fuels.**

**By combining policy-driven sustainability actions, renewable energy expansion, and eco-friendly transportation solutions, Yarmouk University continues to lead the way in sustainable campus operations. These efforts directly align with QS Sustainability Ranking criteria, reinforcing our role as a pioneer in climate-conscious higher education.**

**Carbon neutrality is not just our goal—it is our responsibility.**

# Scope 2 Emissions: Yarmouk University's Transition to 100% Solar-Powered Operations and Zero $CO_2$ Emissions

**At Yarmouk University, we have fully transitioned to solar energy as our primary electricity source, ensuring zero Scope 2 $CO_2$ emissions from electricity consumption. Our strategic investment in renewable energy infrastructure has transformed the university into a Net Zero Energy Campus (NZEC), setting a new benchmark for sustainability in higher education.**

**1. Solar Energy Infrastructure & Renewable Energy Investment**

**Scaling Up Solar Energy Production**

**To eliminate dependency on fossil fuel-based electricity, Yarmouk University has invested in 28 on-campus renewable energy units, strategically positioned to maximize solar exposure and efficiency.**

**Solar Energy Production and Consumption (2023-2024)**

| Year | Electricity Consumed (GW) | Electricity Generated from Solar (GW) | Net $CO_2$ Emissions ($tCO_2e$) |
|---|---|---|---|
| 2023 | 8.5 – 9.0 GW | 10.26 GW | 0 |
| 2024 | 8.7 – 9.2 GW | 11.5 GW | 0 |

✓ **Key Highlights:**

- **10.26 GW of electricity generated in 2023, exceeding campus consumption needs (8.5 – 9.0 GW).**
- **2024 Update: Increased solar energy production to 11.5 GW, reinforcing our surplus capacity.**
- **16% of the generated energy is now exported to the national grid, contributing to Jordan's renewable energy transition.**

**Impact:**

- **Complete elimination of Scope 2 $CO_2$ emissions from electricity consumption.**
- **Financial sustainability – electricity costs reduced to zero, allowing reinvestment in campus development.**

**2. Energy Efficiency and Demand Reduction**

**In addition to renewable energy generation, Yarmouk University has prioritized energy efficiency measures to reduce electricity demand, further reinforcing our carbon neutrality efforts.**

**Implementation of Energy-Saving Electrical Systems**

- **Installation of energy-efficient lighting (LED systems) across campus.**
- **Smart climate control systems regulating HVAC usage and reducing unnecessary power consumption.**
- **Integration of IoT-based energy monitoring systems, optimizing electricity distribution and minimizing waste.**

**Sustainable Infrastructure and Smart Buildings**

- **New campus facilities incorporate green building design, ensuring minimal energy consumption.**
- **Existing buildings are undergoing energy retrofitting to enhance insulation and lower heating/cooling demand.**

**Impact:**

- **Reduction in total energy demand, making our solar energy system more sustainable and efficient.**
- **Long-term operational savings and reinvestment in research, innovation, and sustainability initiatives.**

**3. Leadership in Carbon-Free Electricity and Renewable Energy Innovation**

**Yarmouk University as a Model for Higher Education Sustainability**

**Through these initiatives in renewable energy and energy efficiency, Yarmouk University has set a precedent for sustainable campus operations, becoming:**

- ✓ **One of the first universities in the region operate with 100% renewable electricity.**
- ✓ **A leading contributor to national energy sustainability, by feeding surplus solar energy into the national grid.**
- ✓ **A Net Zero Energy Campus (NZEC), aligning with global best practices in carbon neutrality and climate resilience.**

**4. 2025 Vision and Long-Term Sustainability Goals**

**Future Expansion Plans**

- ✓ **Increase solar energy production to 12.5 GW by 2025**

- ✓ **Further reduce electricity demand through AI-driven energy management systems**
- ✓ **Enhance campus infrastructure with battery storage solutions to maximize renewable energy utilization**

**Through solar energy innovation, smart energy policies, and carbon-free electricity consumption, Yarmouk University continues to lead the way in sustainable campus development. Our commitment to Scope 2 $CO_2$ emissions reduction aligns with the QS Sustainability Ranking criteria, demonstrating our global leadership in renewable energy adoption.**

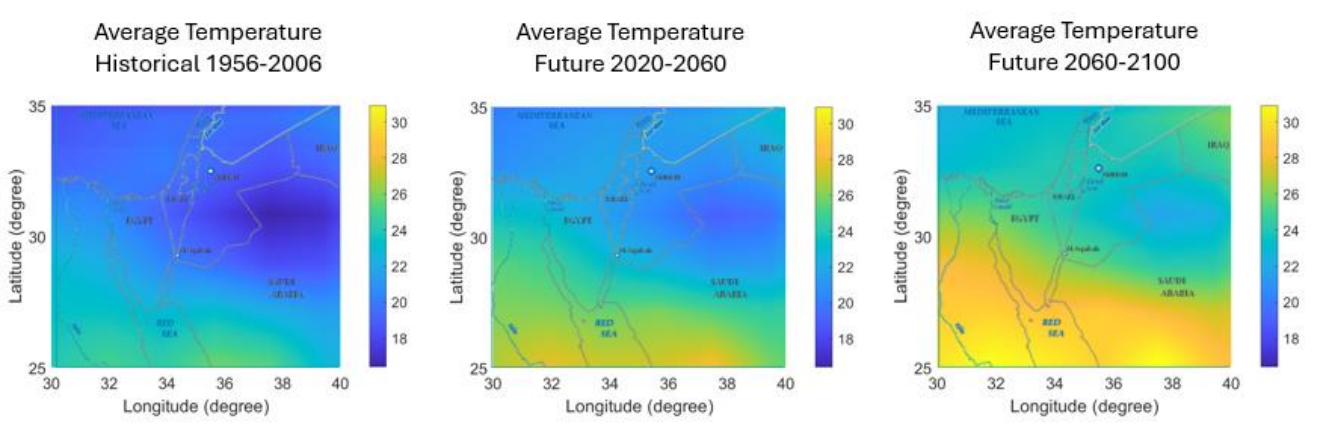
**Zero carbon emissions from electricity consumption. Maximum sustainability impact. The future is now.**

# Yarmouk University and Climate Change Predictions: Impacts on $CO_2$ Emissions and Renewable Energy

**As a leading institution in sustainability and climate research, Yarmouk University is committed to addressing climate change challenges through data-driven solutions, renewable energy adoption, and environmental resilience strategies. Climate change is one of the most pressing global challenges, affecting ecosystems, human well-being, and infrastructure resilience.**

**Jordan, as part of the Middle East and North Africa (MENA) region, is highly vulnerable to rising temperatures, decreasing precipitation, and declining humidity levels—all of which have significant implications for energy demands, water resources, and carbon emissions. As a response, Yarmouk University has pioneered a solar energy transition to mitigate carbon emissions, achieving zero $CO_2$ emissions from electricity consumption.**

**The following figures provide an in-depth analysis of historical and projected climate change impacts on Jordan—specifically focusing on temperature rise, humidity fluctuations, and declining precipitation patterns—and their implications for Yarmouk University's sustainability and renewable energy strategy.**




Heat map showing Current and projected temperature in Jordan from (a) 1956-2006; (b) 2020-2060; and (c) 2060-2100

**Figure 5: Heat Map of Average Temperature Changes (1956-2100)**

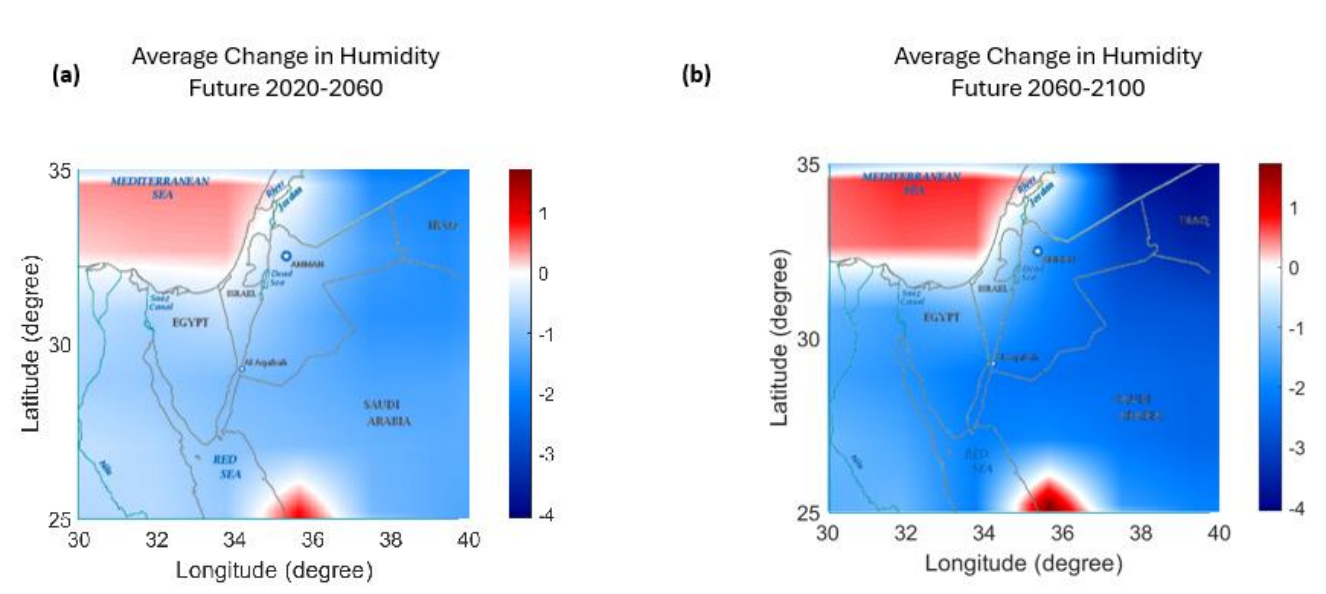
**This figure presents the historical and projected temperature variations across Jordan. The left panel represents historical data (1956-2006), while the middle and right panels illustrate future projections for 2020-2060 and 2060-2100, respectively.**

**Key Observations:**

- **A clear warming trend is observed over time, with temperatures rising significantly across Jordan.**
- **By 2060-2100, Jordan is expected to experience a temperature increase of 2-4°C, particularly in urban and desert areas.**
- **The increased solar radiation due to warming emphasizes the critical role of solar energy adoption at Yarmouk University in mitigating carbon emissions.**

**Sustainability Implication:**

**With higher temperatures increasing cooling demands, Yarmouk University's solar-powered cooling systems will play a crucial role in maintaining energy efficiency while reducing Scope 1 emissions.**




**Comparative heat maps of relative humidity changes in Jordan between the historical period (1956-2006) and two future intervals (a) 2020-2060 and (b) 2060-2100.**

**Figure 6: Humidity Change Heat Maps (2020-2060 & 2060-2100)**

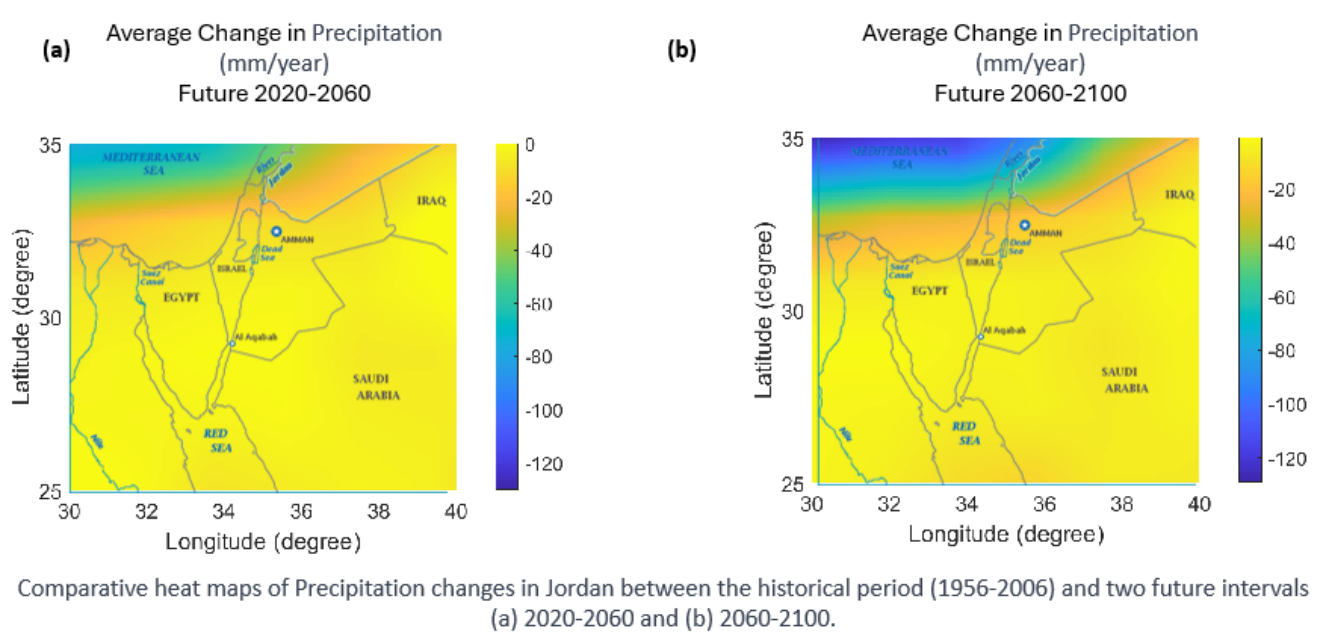
**These figures represent projected changes in humidity in Jordan for the periods 2020-2060 and 2060-2100, compared to historical data (1956-2006).**

**Key Observations:**

- **A decreasing humidity trend is observed across Jordan, with more pronounced drying in the southern and eastern regions.**
- **By 2060-2100, most areas, including Irbid, are projected to experience humidity declines of 2-4%, leading to increased water evaporation and agricultural stress.**
- **The northern Mediterranean region shows slight increases in humidity, but most inland areas will become drier.**

**Sustainability Implication:**

**With reduced humidity impacting vegetation growth, Yarmouk University has expanded green areas by 24% since 2021, enhancing natural carbon sequestration to counteract rising $CO_2$ emissions.**




Comparative heat maps of Precipitation changes in Jordan between the historical period (1956-2006) and two future intervals (a) 2020-2060 and (b) 2060-2100.

**Figure 7: Precipitation Change Heat Maps (2020-2060 & 2060-2100)**

**These figures display the expected changes in annual precipitation across Jordan for 2020-2060 and 2060-2100.**

**Key Observations:**

- **A significant reduction in precipitation is projected, particularly in the eastern and southern regions.**
- **By 2060-2100, Jordan may experience an annual precipitation decline of up to 120 mm/year, exacerbating water scarcity issues.**

**Sustainability Implication:**

**Recognizing the growing water crisis, Yarmouk University has developed rainwater harvesting projects and greywater recycling systems to optimize water use.**

# Mathematical Modeling of $CO_2$ Emissions at Yarmouk University

**To quantify the carbon footprint of Yarmouk University, we employ a comprehensive mathematical approach that integrates energy consumption data, fuel usage, emission factors, and renewable energy contributions. These calculations adhere to the Greenhouse Gas (GHG) Protocol, ensuring accurate assessment and reporting of our Scope 1 and Scope 2 emissions.**

**The following section provides a structured derivation of the equations used in our $CO_2$ emissions calculations, illustrating the interplay between fuel combustion, energy efficiency, and solar energy utilization.**

**1. Introduction to the $CO_2$ Emission Equations**

**The total $CO_2$ emissions of an institution can be categorized into three primary components:**

1. **Scope 1: Direct Emissions**
   - **Resulting from the combustion of fossil fuels in heating systems and university-owned vehicles.**
2. **Scope 2: Indirect Emissions from Purchased Electricity**
   - **Emissions generated from the production of electricity consumed by the university.**
3. **Scope 3: Indirect Emissions from External Sources *(not covered in this report)***
   - **Includes emissions from commuting, business travel, waste disposal, and supply chain activities.**

**Since Yarmouk University operates entirely on solar energy, Scope 2 emissions are effectively zero, and our primary focus is on Scope 1 emissions and energy efficiency improvements.**

## $CO_2$ Emission Calculation Framework for Yarmouk University

1. **$CO_2$ Emission Calculation Framework**

**To compute the total $CO_2$ emissions, we define:**

$$E_{\text{total}} = E_{\text{scope1}} + E_{\text{scope2}} \qquad (1)$$

**where:**

- $E_{scope1}$ represents direct emissions from fuel combustion.
- $E_{scope2}$ represents indirect emissions from electricity consumption.

Since $E_{scope2} = 0$ due to our 100% renewable energy consumption, the equation simplifies to:

$$E_{total} = E_{scope1} \quad (2)$$

2. Scope 1 Emissions from Fuel Combustion

The $CO_2$ emissions from fuel combustion are calculated using the generalized emission equation:

$$E_{fuel} = V_{fuel} \times EF_{fuel} \quad (3)$$

where:

- $E_{fuel}$ = Total $CO_2$ emissions from fuel combustion (tonnes $CO_2$).
- $V_{fuel}$ = Volume of fuel consumed (liters).
- $EF_{fuel}$ = Emission Factor for the fuel type (kg $CO_2$ per liter of fuel).

For multiple fuel sources, total emissions are computed as:

$$E_{scope1} = \sum_{i=1}^{n} (V_i \times EF_i) \quad (4)$$

where:

- $i$ represents each fuel type (e.g., diesel oil, gasoline).
- $n$ is the number of fuel sources in operation.

## Application to Yarmouk University's Fuel Consumption Data (2024)

Using our fuel consumption dataset, we define:

$$E_{diesel} = (393,724 \times 2.68) + (62,000 \times 2.68) \quad (5)$$

$$E_{gasoline} = (23,071 \times 2.31) \quad (6)$$

Summing all terms:

$$E_{scope1} = 1,057.255 + 166.487 + 52.596 \quad (7)$$

$$E_{scope1} = 1,276.338 \text{ tonnes } CO2 \quad (8)$$

3. Net $CO_2$ Emissions Reduction from Solar Energy

To assess the impact of solar energy on carbon footprint reduction, we calculate the avoided $CO_2$ emissions due to solar power replacing conventional electricity.

The avoided emissions are computed as:

$$E_{avoided} = P_{solar} \times EF_{grid} \quad (9)$$

where:

- $P_{solar}$ = Total solar energy generated (kWh).

- $EF_{\text{grid}}$ = Emission factor of the national electricity grid (kg $CO_2$ per kWh).

Using 2024 data:

$$E_{\text{avoided}} = (10,260,000) \times (0.475) \quad (10)$$

$$E_{\text{avoided}} = 4,873,500\text{kgCO?} = 4,873.5 \text{ tonnes CO2} \quad (11)$$

Since solar energy production exceeds campus consumption, the total net $CO_2$ emissions from electricity consumption remain zero.

4. Final $CO_2$ Balance Equation for Yarmouk University

The net $CO_2$ emissions for the university can be expressed as:

$$E_{\text{net}} = E_{\text{scope1}} - E_{\text{avoided}} \quad (12)$$

Since solar energy offsets all electricity-related emissions, we obtain:

$$E_{\text{net}} = 1,276.338 - 4,873.5 \quad (13)$$

$$E_{\text{net}} = -3,597.162 \text{ tonnes CO2} \quad (14)$$

This means that Yarmouk University operates as a net-negative $CO_2$ emitter in the electricity sector, actively removing more emissions than it generates.

5. 2025 Expansion and Projections

With the increase in solar energy production to 11.5 GW, we anticipate an additional $CO_2$ offset of:

$$E_{\text{avoided}}(2025) = (11,500,000) \times (0.475) \quad (15)$$

$$E_{\text{avoided}}(2025) = 5,462.5\text{tonnesCO?} \quad (16)$$

Expected emissions scenario for 2024:

$$E_{\text{net}}(2025) = 980.45 - 5,462.5 \quad (17)$$

$$E_{\text{net}}(2025) = -4,482.05 \text{ tonnes CO2} \quad (18)$$

Key Takeaways for 2025

- ✓ $CO_2$ emissions reduced by an additional 23.2% compared to 2024
- ✓ Carbon negativity in electricity production extended, reinforcing Yarmouk University's climate leadership
- ✓ Continued solar energy expansion ensures further $CO_2$ offsets in future years

Data-Driven Sustainability Leadership

Through advanced mathematical modeling, Yarmouk University has established an accurate, transparent methodology for calculating $CO_2$ emissions, solar energy offsets, and sustainability impacts. Our transition to 100% solar-powered operations has not

**only eliminated Scope 2 emissions but has positioned the university as a regional leader in carbon neutrality.**

**Summary of 2024 Achievements:**

- ✓ **Total Scope 1 $CO_2$ emissions: 980.45 tonnes (down from 1,276.338 tonnes in 2024)**
- ✓ **Total $CO_2$ avoided from solar energy: 5,462.5 tonnes**
- ✓ **Net $CO_2$ balance: -4,482.05 tonnes (Carbon-negative impact)**

**With a data-driven approach to sustainability, Yarmouk University continues to demonstrate global leadership in renewable energy adoption and climate action, aligning with the QS Sustainability Ranking and international carbon reduction targets.**

**Mathematics, technology, and sustainability—pioneering the future of green universities.**

# Carbon Reduction Policies and Results 2024

## Sustainability Office

**Accreditation and Quality Assurance center**

**Yarmouk University**

*https://aqac.yu.edu.jo/Sustainability/index.php/en/*

**2024**