جامعة ابن طفيل
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Ibn Tofaïl University

WHEN INNOVATION BECOMES HOPE: THE STORY OF A LIFE-CHANGING STATION

2024

SUSTAINABLE DEVELOPMENT
IBN TOFAIL UNIVERSITY

Sidi Taïbi : A Pilot Project for Water and Energy Autonomy

Morocco, a country committed to a sustainable development transition, faces major challenges related to equitable access to drinking water, energy security, and the improvement of living conditions in peri-urban and rural areas.



https://sd.uit.ac.ma/coupling-water-treatment-plant-membrane-technology-and-renewable-energies/

he commune of Sidi Taïbi, located in the Kénitra region, clearly reflects these issues—particularly in the education sector. In this region, the water consumed by students and residents came from traditional wells, which contained high levels of nitrates, a contaminant known for its harmful effects on human health, especially in children. This situation led to a rise in thyroid-related disorders, affecting public health and compromising both school attendance and the well-being of young people.

In response to this pressing health and environmental concern, Ibn Tofaïl University (UIT) designed and implemented a pioneering project that combines brackish water treatment and renewable energy production, targeting a public high school. This project—developed in collaboration with the companies BELECTRIC and FIRMUS, along with the local educational community—embodies a practical application of sustainability principles, technological innovation, and knowledge transfer in service of local development.

Project Objectives

- Ensure access to safe drinking water for students and staff in a school located in a resource-limited area.
- Improve the school's energy autonomy through the integration of renewable energy sources.

- Educate and raise awareness among younger generations about the sustainable management of natural resources.
- Create a dynamic, real-life platform for experimentation for researchers, students, and local development stakeholders.
- Strengthen local resilience in the face of climate change and increasing pressure on water resources.

Technical and Functional Data

The technical design of the Sidi Taïbi station combines advanced water purification technology with a hybrid renewable energy system to meet the needs of a growing school population. Engineered for both efficiency and scalability, the system adadresses the dual challenge of water scarcity and energy insecurity in a resource-limited rural environment.



It relies on nanofiltration to treat nitrate-rich brackish groundwater, a common issue in the region, and integrates electrochemical disinfection to ensure water safety without relying on chemicals. Energy autonomy is achieved through a mix of photovoltaic solar panels and a vertical-axis wind turbine, with battery storage to guarantee continuous service.
The system, initially dimensioned for 2,000 students, has doubled its capacity by 2024, supplying safe drinking water to over 4,000 individuals, with an exceptionally low energy footprint of just 0.2 kWh/m^3.

Water Treatment System:

- Water source: Brackish water rich in nitrates, typical of the region's groundwater.
- Technology used:
  - Nanofiltration to remove dissolved salts, nitrates, viruses, and bacteria.
  - Electrochemical disinfection without chemical additives.

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Nominal capacity

- Initially: 12 m^3/day for 2,000 students.
- By 2024: More than 4,000 beneficiaries, with 3 liters per student per day.

Energy Production

- 158 photovoltaic panels (145-150 Wp each), totaling 24.3 kWp.
- Vertical-axis wind turbine UrWind2.2 (Darrieus-Savonius technology), with a capacity of 2.2 kW.

Estimated annual energy production:

- Solar: 50 MWh/year
- Wind: 2,000 to 4,000 kWh/year
- Battery system: OPzV gel batteries (2V x 24 cells), with a total capacity of 40 kWh.
- Specific energy consumption: 0.2 kWh/m^3, particularly low for a standalone station.

This hybrid system demonstrates technical and environmental excellence:

Technological Precision:

The use of nanofiltration and electrochemical disinfection reflects a cutting-edge approach to water treatment, especially in settings where traditional methods may be costly or ineffective. The system removes not only physical and chemical contaminants, but also biological risks, such as viruses and bacteria.

Energy Efficiency:

With a specific energy consumption of only 0.2 kWh per cubic meter, the station achieves high energy efficiency, making it ideal for decentralized or off-grid settings. It optimizes both solar and wind resources, adapting to the local climate and extending its operational reliability across seasons.

Scalability and Social Impact:

The ability to double its user capacity without significant system overhaul shows how well-designed infrastructure can scale up with growing demand. This scalability ensures that the investment remains relevant and useful beyond its original scope.

Resilience and Autonomy:

The integration of battery storage provides resilience against power shortages and supports water supply during night-time or cloudy days, ensuring continuous service delivery—a key factor for health and education continuity in rural schools.

Model for Replication:

Its modular, efficient, and eco-friendly design makes it a replicable solution for other regions facing similar challenges in water and energy access, especially across Africa and the Global South.





Production Results (2020–2024)

The Sidi Taïbi water and renewable energy station has shown consistent growth in its production capacity.



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The data collected over five years highlights a steady increase in potable water production, a stabilized sanitary flow, and a highly reliable energy storage performance, all confirming the station's long-term sustainability and adaptability.

Table 1: Production Results (2020–2024)

Year	Potable Water Produced (m^3/year)	Sanitary Flow (m^3/year)	Stored Energy (kWh/year)
2020	807.84	7,539.75	10,664.9
2021	1,097.45	9,188.35	13,524.6
2022	1,101.94	9,192.69	12,835.1
2023	1,219.20	9,657.18	13,546.2
2024	1,460.00	9,864.00	13,900.0

Growth in Potable Water Production

- From 807.84 m^3 in 2020 to 1,460.00 m^3 in 2024, the production of potable water has increased by more than 80% in five years.
- This growth reflects not only technological reliability but also the ability to scale up without major redesign, in response to increasing demand—rising from 2,000 to over 4,000 students.

Sanitary Flow: Consistent and Optimized

- The sanitary bypass flow remains high and relatively stable, ranging from 7,539.75 to 9,864.00 m^3/year.
- These volumes reflect the effective use of untreated water for non-potable applications (toilets, cleaning, etc.), optimizing the station's global water resource management.

Stable and Efficient Energy Storage

- Energy storage capacity has consistently remained above 10,000 kWh/year, with a peak of 13,900.0 kWh in 2024.
- This stability ensures the autonomous operation of the station, including during cloudy periods or at night, and proves the efficiency of the hybrid solar-wind system supported by battery storage.

Overall System Performance

- The station demonstrates excellent operational resilience, especially considering it doubled its user base between 2020 and 2024.
- The specific energy consumption remains low (0.2 kWh/m^3), confirming the high energy efficiency per liter of treated water—an essential metric for sustainability.

For more details, we invite you to watch the video available at the following link:
https://web.facebook.com/IbnTofail.University/videos/231475824527181



Overall Impacts of the Project



Environmental Impact

The project reduces pressure on both surface and groundwater resources by locally treating brackish water that is otherwise unfit for consumption.

By operating exclusively on renewable energy, it avoids greenhouse gas emissions typically associated with diesel generators. Furthermore, the system's extremely low energy consumption per cubic meter enhances its ecological efficiency.

Health Impact

Thanks to rigorous treatment processes, the water produced is free of viruses and bacteria and complies with nitrate standards. This has led to a significant decrease in waterborne illnesses among students. The improvement in water quality has had a direct positive effect on school attendance, focus, and academic performance, while also reducing healthcare costs for families.

Social Impact

The project has improved both learning and living conditions at the school.

Students now have access to fully functional electrical installations, even during power outages. The participatory aspects of the project—such as tree planting and educational site visits—have fostered ecological awareness, strengthened community cohesion, and encouraged a sense of ownership among students.

Economic Impact

The project generates sustainable budget savings for the school, allowing funds to be reallocated to educational resources. Additionally, it creates local economic opportunities through system installation, maintenance, and technical training. It stands as a replicable model for other rural regions seeking sustainable infrastructure solutions.

Institutional Scope and Replicability

The Sidi Taïbi project is fully aligned with both Morocco's national water strategy and the United Nations 2030 Agenda for Sustainable Development. It contributes concretely to several Sustainable Development Goals (SDGs), most notably:

- SDG 6: Ensure availability and sustainable management of water and sanitation for all;
- SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all;
- SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all;
- SDG 13: Take urgent action to combat climate change and its impacts.

This alignment reinforces the project's strategic relevance at both national and international levels, positioning it as a reference model for integrated development interventions in rural and semi-urban settings.

Beyond its technical achievements, the project has become a pilot site for academic and applied research at Ibn Tofaïl University. It offers a hands-on learning environment for students and researchers in fields such as environmental engineering, renewable energy, water sciences, sustainability education, and public policy. The station hosts field visits, workshops, and innovation challenges that support the university's mission of producing research with tangible social and environmental value.

One of the project's major strengths lies in its modularity and adaptability. The technological components are scalable, cost-effective, and suitable for deployment in various Moroccan contexts, especially in areas where access to clean water and energy remains limited. Its implementation model—combining academic leadership, private sector expertise, and community engagement—provides a blueprint that can be replicated in other schools, health centers, or rural communes across the country.

Moreover, the project demonstrates that academic institutions can play a central role in driving sustainable development at the local level, not just through knowledge production, but through direct intervention and innovation transfer. This makes the initiative a compelling case study for national ministries, local governments, development agencies, and international donors seeking proven, community-anchored solutions to interconnected challenges such as water security, education quality, and climate resilience.

With proper institutional support and funding mechanisms, the Sidi Taïbi station could mark the first of many decentralized, university-led infrastructure projects, catalyzing a new generation of partnerships between higher education, local authorities, and civil society.