Ministry of Water & Irrigation
وزارة المياه والري

THE WATER SECTOR’S ENERGY POLICY

2023 – 2040

Jordan

This document is an integral part of the National Water Strategy 2023–2040 and related policies:

1. Groundwater Sustainability Policy
2. Surface Water Utilization Policy
3. Wastewater Management and Reuse Policy
4. Water Demand Management Policy
5. Water Reallocation Policy
6. Energy Efficiency and Renewable Energy Policy
7. Climate Change for a Resilient Water Sector Policy
8. Sector Policy for Drought Management
9. Water Sector Gender Policy

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List of Abbreviations and Definitions

AAWDCP	**Aqaba-Amman Water Desalination and Conveyance Project**
ASL	Above Sea Level
AWC	Aqaba Water Company
Billed Water	Volume of water that is delivered to users and billed, excluding losses and NRW
BOT	Build-Operate-Transfer
CHP	Combined Heat and Power
CSP	Concentrated Solar Power
Distributed	Total volume of water distributed (Water Produced + Water imported)
EE	Energy Efficiency
EMRC	Energy and Mineral Resources Company
EnDMS	Energy Data Management System
EnMS	Energy Management System
EnPI	Energy Performance Indicator
Exported	Total volume of water exported to other water utilities from the supply area
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoJ	Government of Jordan
GWh	Giga Watt Hour
HPP	Hydro Power Plant
Imported Water	Total volume of water imported from other water utilities including water imported from private operators (Private operators entails private wells and BOT
JVA	Jordan Valley Authority
KFW	Kreditanstalt für Wiederaufbau
kWh	Kilo Watt Hour
M&V	Measurement and Verification
MCM	Million Cubic Meter
MEMR	Ministry of Energy and Mineral Resources
MoA	Ministry of Agriculture
MoEnv	Ministry of Environment
MWh	Mega Watt Hour
MWI	Ministry of Water and Irrigation
NEPCO	National Electric Power Company
NRW	Non-Revenue Water
O&M	Operation and Maintenance
PPP	Public-Private Partnerships
Produced Water	Total volume of water treated for input to water transmission lines or directly to the distribution system, coming from water utilities' own resources
PV	Photovoltaic
RE	Renewable Energy
SCADA	Supervisory Control and Data Acquisition
SEC	Specific Energy Consumption
SPD	Specific Power Demand
Supplied Water	Net volume of treated water distributed through the distribution network or tankers (Water Produced + Water imported – Water Exported)
TWG	Technical Working Group
WAJ	Water Authority of Jordan

WEFE	Water-Energy-Food-Environment
WU	Water Utility
WWTP	Wastewater Treatment Plant
YWC	Yarmouk Water Company

Foreword

Jordan is a nation burdened with extreme water scarcity, that has always been one of the biggest barriers to our economic growth and development. The impact of climate change on Jordan's water supplies has exacerbated the existing crisis, a situation further complicated by the effects of the COVID-19 pandemic.

The scarcity of water and the increase in the water demand has forced the water sector to make use of all water sources available and to search for innovative solutions. As a result, the energy consumption and the operational costs have been adversely influenced, affecting the Water Utilities (WUs) sustainability as well .

In response to these challenges and to achieve our goal of efficient water resources management, the MWI, WAJ and WUs are collaboratively working to identify possible solutions and approaches to address the increase in operational costs caused by the raise in energy demand and cost. I appreciate the dedicated efforts that have resulted in updating the water sector's energy policy, with clear objectives and well-defined action plans to manage the scarce water resources efficiently, sustainably and cost effectively .

I am confident that the Water sector will adopt this energy policy and support its implementation at all levels by following dynamic management, and that the benefits will be positively reflected on the sector in the near future.

Eng. Raed Abu Al-Saud

Minister of Water and Irrigation

Executive Summary

Energy use to produce and supply water to consumers in Jordan is a heavy burden, as energy demand for producing water is high compared to other countries. This is mainly due to the scarcity of water resources and the complex hydrogeology and topography of the country. As the population grows and reliance on energy and water resources increases, this burden intensifies.

This update of the 2021 "Energy Efficiency and Renewable Energy Policy for the Water Sector" aims to provide a solid basis for promoting the desired change of achieving measurable improvement in energy efficiency and in increasing the use of renewable energy in the water sector.

The overall country-wide specific energy consumption (SEC) of total supplied water in 2021, eliminating the factor of NRW, is approximately 3.44 kWh/m^3, and 7.25 kWh/m^3 if accounting for NRW. These values are considerably higher than international benchmarks and are predicted to rise further if current practices persist. This is mainly due the following reasons:

- Declining water quality
- Diminishing water quantities and low efficiency in ground water extraction
- Deep aquifers and water desalination as future water resources, with high SEC.

Therefore, there is a sector-wide emphasis on fostering sustainable, and long-term adjustments in energy utilization in the water sector. Public and private entities collaboratively strive to achieve this priority, recognizing water as the most crucial development sector.

To attain the envisioned enhancements, this policy outlines four goals, seven objectives and eight corresponding indicators. The goals provide the overarching direction of the policy, while the objectives delineate specific measurable and time-bound objectives. Meanwhile, the indicators serve to measure the progress towards the targets over time.

Goals 1 and 2 are the core goals of this policy. Whereas goals 3 and 4 serve as supportive goals, fostering practical improvements in the water sector to facilitate the achievement of goals 1 and 2.

The following section outlines the goals, objectives, and indictors:

Goal 1. Improve energy efficiency throughout water sector operations by implementing advanced energy management practices to enhance the overall financial performance of the sector.

- Objective 1.1: Improve energy efficiency in water production, transmission, and supply (WAJ/JVA) by implementing optimized operation practices (2022- 2027).
    - Indicator 1.1.1: Cumulative energy savings.
- Objective 1.2: Improve energy efficiency of water supply, treatment, and distribution by implementing optimized network operations (2028 – 2040).
    - Indicator 1.2.1: Cumulative energy savings.
- Objective 1.3: Improve energy efficiency in wastewater treatment and in the transmission of treated effluent (2028 - 2040).
    - Indicator 1.3.1: Cumulative energy savings.

Goal 2. Increase the integration of renewable energy sources within the water sector and enhance WEFE Nexus in Jordan.

- Objective 2.1: Enhance the Water-Energy Nexus cooperation to allow the integration of more renewable energy into the water sector operations, reduce electricity Tariff and develop water-energy projects.
  - Indicator 2.1.1: WEFE nexus structures approve 10 measures aimed at improving the financial performance of the sectors.
- Objective 2.2: Develop large (> 1 MW) and small-scale (< 1 MW) renewable energy projects.
  - Indicator 2.2.1: Proportion of electric energy supplied to water sector operations from renewable energy sources reaches 40% by 2040, considering the consumption in 2021 as a baseline.
- Objective 2.3: Development of a framework for the integrated governance of the Water, Energy, Food and Environment (WEFE) Nexus
  - Indicator 2.3.1: WEFE Nexus framework is developed and operationalized.

Goal 3: Implement Energy Management Systems (EnMS) to progressively cover the water sector.

- Objective 3.1: Implement energy management systems (**EnMS**) to progressively cover all large and medium water facilities.
  - Indicator 3.1.1: Percentage of water facilities with full implementation of EnMS relative to the total number of previously identified large and medium facilities.

Goal 4: Establish and Implement Energy Data Management Systems (EnDMS)

- Objective 4.1: Develop and implement an Energy Data Management System (EnDMS) for the water sector.
  - Indicator 4.1.1: EnDMS to cover all water facilities connected to SCADA.

A monitoring and evaluation table has been developed, providing an overview of baseline values for each indicator alongside planned targets. This table includes blank cells intended to be filled for the annual monitoring and evaluation reporting, facilitating a comparative analysis of actual progress against baseline and target values for each indicator during the specific planning period.

Energy and Water Sectors’ Existing Situation in Jordan

Jordan has been facing chronic stresses in the water and energy sectors, primarily due to natural resources scarcity. The demand for both water and energy has been consistently rising due to population growth and urbanization, and increased reliance on these resources.

The Water supply in Jordan depends heavily on Energy, with approximately half of the water sector’s operational budget allocated to energy consumption. This is mainly attributed to the complex hydrological and topographical characteristics of the country. The considerable energy requirements are associated to the need to pump groundwater from substantial depth and pump against varying elevations, ranging from -420 m below sea level at the dead sea to 1850m Above Sea Level (ASL) at Wadi rum mountains.

Notably, as Jordan transitions towards seawater desalination in Aqaba, energy consumption in the water sector is expected to escalate further. Therefore, it is crucial to prioritize energy efficiency at every operational stage to address this impending challenge. The Ministry of Water and irrigation has launched several strategies and policies, including the National Water Strategy (2023-2040) and the Energy Efficiency and Renewable Energy Policy (2016- 2021), to promote energy efficiency and renewable energy use in the water sector. These policies have played a key role in emphasizing the importance of improving energy efficiency and reducing energy costs in the water sector, particularly in utilizing concepts of energy management systems and establishing energy units at Water Utilities (WUs). However, there are several tools and approaches that could further improve energy management in the water sector, hence this effort to update the energy policy.

In 2021, Jordan’s energy mix, as outlined in the Jordan Energy Strategy[1], comprised of 11% renewable energy. Oil and gas combined accounted for 87%, but only 8% of the total energy consumption came from domestically produced oil and natural gas. The upcoming 10-years plan involves a gradual transition with natural gas increasing from 21% to 25%, renewable energy rising from 11% to 14%, and a decrease in oil consumption from 58% to 51%. Although Jordan Energy strategy aimed for 31% contribution from renewable energy to electricity generation by 2030, current efforts are underway to increase this rate to 50%. In 2022, renewable energy already comprised around 29% of the total electricity generated in the Jordanian system[2].

The water sector, a key strategic sector, faces high energy demand. Given the projected increase of energy due to the predicted increase in water desalination and longer pumping distances, it is imperative to transition towards a substantial use of renewable energy sources. This shift towards renewable energy deployment is vital for sustaining reasonable water costs.

The main direct source of water in Jordan is rainfall, recharging both surface and groundwater resources. However, the country’s arid to semi-arid climate, characterized by low rainfall and high evaporation rates, results in approximately 92% of the territory receives less than 200 mm of rainfall annually (see Figure 1). Moreover, the impacts of climate change are evident in the declining rainfall and alterations in distribution patterns across the country. These changes intensify the stress associated with water scarcity in Jordan.

[1] Jordan Energy Strategy 2020-2030. (2020). Amman.
[2] National Electric Power Company Annual Report 2022. (2022) Amman.

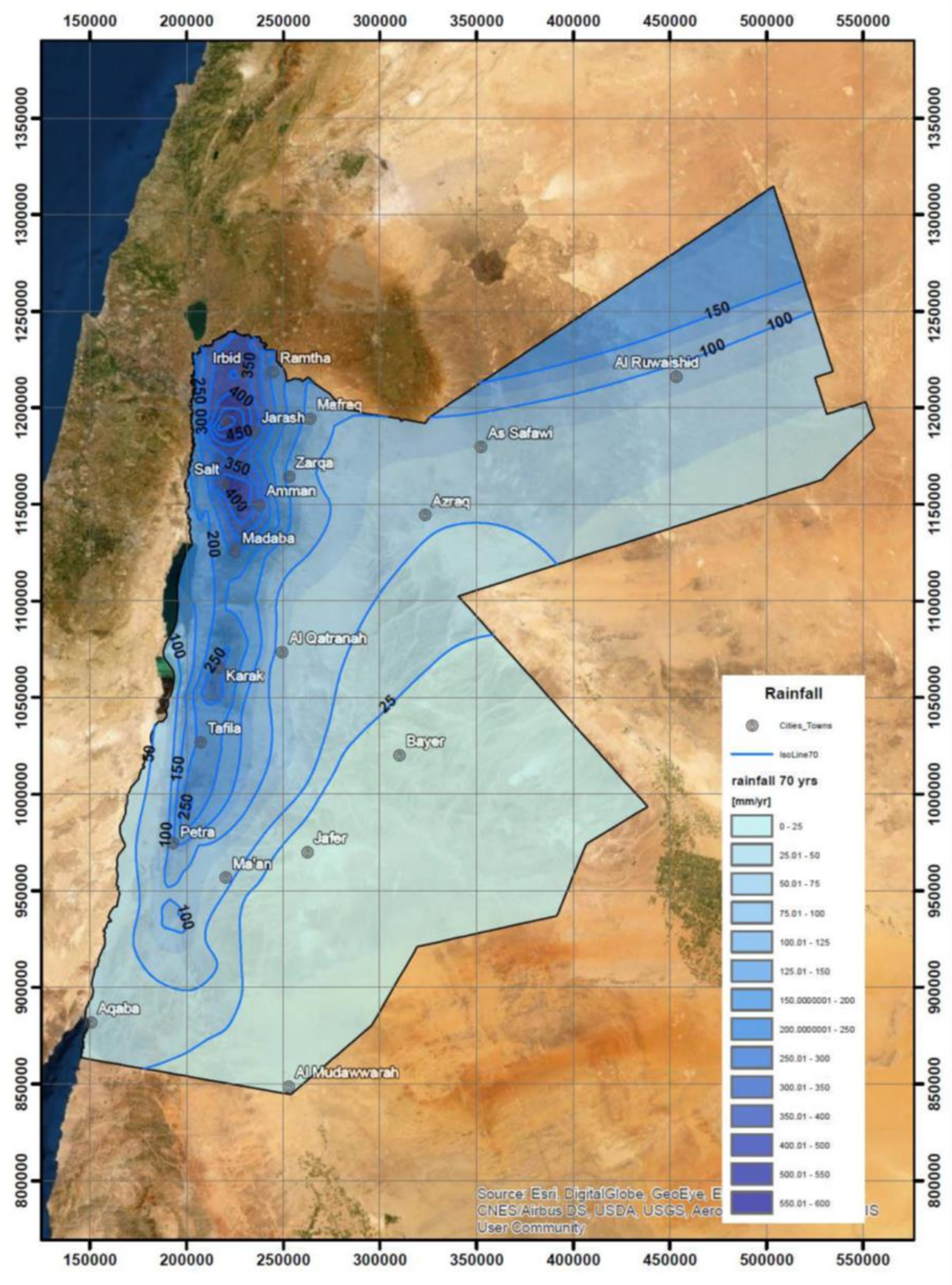

Figure 1 Rainfall distribution map for 70-years average of water years 1943/44 – 2012/13 (MWI, 2014[3])

The challenge has intensified as Jordan's population has more than doubled in the last two decades. Over the last 20 years, the country's population has grown at an average rate of approximately 4.2%, which is double the growth rate in 2021 (see Figure 2).

[3] MWI. (2014). The Ministry of Water and Irrigation Open Files.

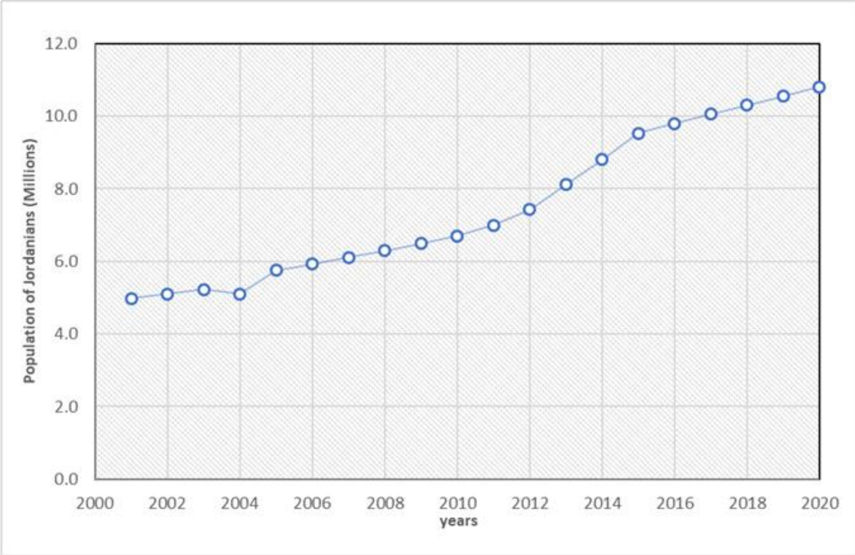

Figure 2 Population in Jordan over the last 20 years (Source DOS, 2021[4])

Alongside population growth, recurring political crises have led to the influx of many displaced people seeking refuge in Jordan. This has caused sudden increases in demand for water supply and wastewater treatment, as well as for energy. Consequently, it has disrupted the existing water management plans and the expansion plans of the water sector. Due to the limited water resources and the rapid population growth, the available water per capita in Jordan has significantly declined. in 1962, renewable internal freshwater resources per capita peaked at 674.81 m^3/capita, but it steadily declined to 77 m^3/capita in 2014, and to 61 m^3/capita in 2021 (see Figure 3). Compared to the MENA Region average, the situation in Jordan is alarmingly dire, as can be seen in

Figure 3. To put matters further into perspective, the global average renewable internal freshwater resources per capita is orders of magnitude higher than that of the MENA Region.

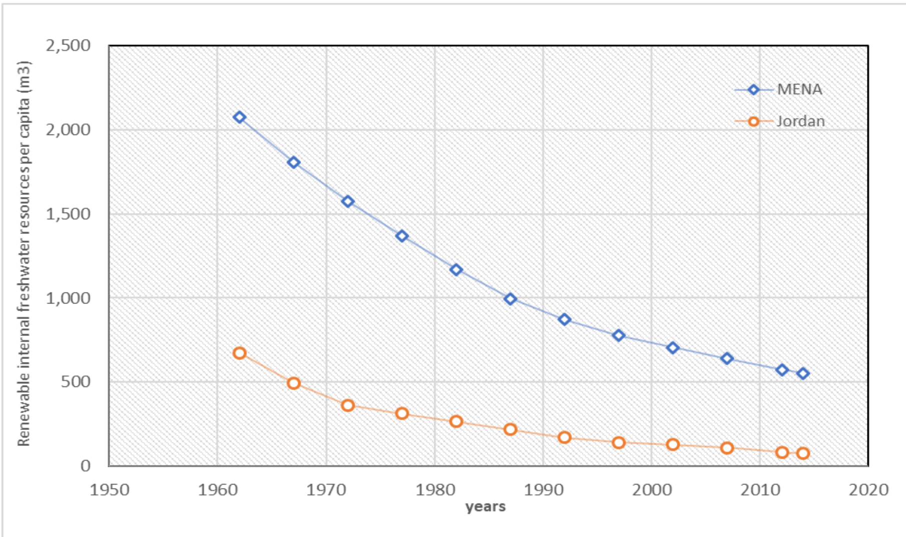

Figure 3 Renewable internal freshwater resources per capita for Jordan and MENA (Food and Agriculture Organization (AQUASTAT), 2021[5])

[4] DOS. (2021). Jordan in Figures 2020. Department of Statistics.

[5] Food and Agriculture Organization (AQUASTAT). (2021). Renewable internal freshwater resources per capita (cubic meters) - Jordan. World Bank Open Data.

Water Sector's Energy Demand

The Ministry of Energy and Mineral Resources (MEMR) annually discloses the energy and electricity consumed across all sectors in Jordan. The reported electricity use in all sectors is summarized in Figure 4 below, where the electricity consumption for water pumping encompasses public water pumping, private water pumping and agricultural activities. The water sector can be considered as Jordan's largest single electricity consumer with "public water pumping" accounting to approximately 10% of Jordan's total electricity consumption in 2021. Notably, the primary consumer of electricity within the water sector is the process of water pumping surpassing other electricity-consuming processes.

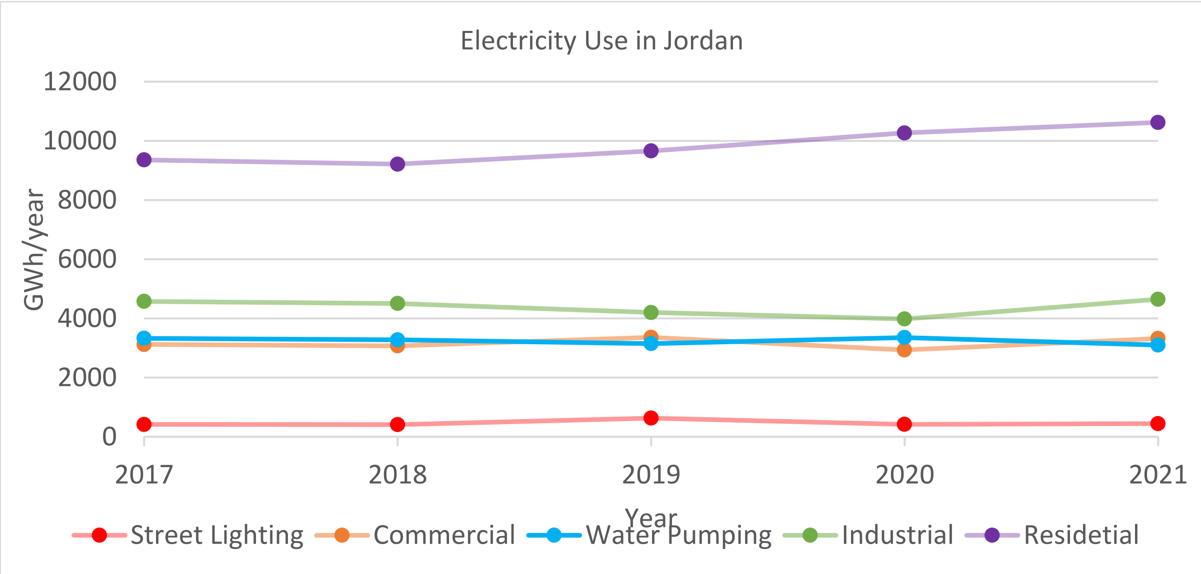

Figure 4 Electricity use in Jordan across economic sectors during the years 2016 to 2021 (Source: MEMR, 2022[6]).

Table 1 delineates the breakdown of electricity consumption among the service providers (water utilities and WAJ), JVA and private operators (BOTs) as well as total electricity utilized from RE sources within the water sector.

As of 2021, Jordan Water Company - Miyahuna was responsible for the provision of water and wastewater services to the middle governorates including Amman, Zarqa, and Madaba. Yarmouk Water Company (YWC) was responsible for the provision of water and wastewater services to the northern governorates including Irbid, Mafraq, Jerash, and Ajloun. Additionally, Aqaba Water Company (AW) was responsible for the provision of water and wastewater services to the governorate of Aqaba. Until the end of 2021, WAJ used to hold the responsibility for delivering water and wastewater services for the remaining governorates i.e., Balqa, Karak, Ma'an and Tafileh. However, in 2022, a shift occurred in management: Miyahuna held the responsibility for Balqa, while Aqaba Water Company held the responsibility for Karak, Ma'an, and Tafileh.

Disi Project is an infrastructure water supply project implemented under a Build-Operate-Transfer (BOT) structure with a 25-year concession agreement whereby MWI and WAJ pay a water tariff for the delivery of the bulk water by the Project.

[6] Annual Report 2021. (2022). Ministry of Energy and Mineral Resources, Amman.

Al Samra Wastewater Treatment Plant (WWTP) is the country's largest wastewater treatment plant implemented under a BOT scheme where the government of Jordan remunerates the project's Special Purpose Company (SPC) for the provision of treated water.

Jordan Valley Authority (JVA) is responsible for the development, protection, and management of the water resources of the Jordan Valley. Its mandate includes utilizing these resources for irrigated farming, domestic and municipal uses, industrial uses, generating hydroelectric power and other beneficial uses.

Table 1 Electricity consumption of WUs, JVA, and WAJ for years 2017-2021 in GWh (Source MWI, 2021)

Year	WAJ	Miyahuna	YWC	AWC	Disi Project	Al Samra WWTP	JVA	Total Electricity utilized from RE*	Total
2021	211.37	808.35	345.63	41.34	299.57	19.59	47.45	70.87	1844.17
2020	208.37	853.84	335.33	40.92	286.67	19.13	55.45		1799.71
2019	174.88	799.95	336.39	37.32	289.58	16.23	50.61		1704.96
2018	199.50	804.70	325.70	38.50	283.00	17.70	44.90		1714
2017	208.40	801.40	318.50	32.90	306.60	17.60	37.10		1722.5

* This value doesn't include electricity generated by Hydropower at King Talal as the scheme for this plant is PPA with NEPCO i.e., the power generated by the plant is sold to NEPCO at an agreed-upon price.

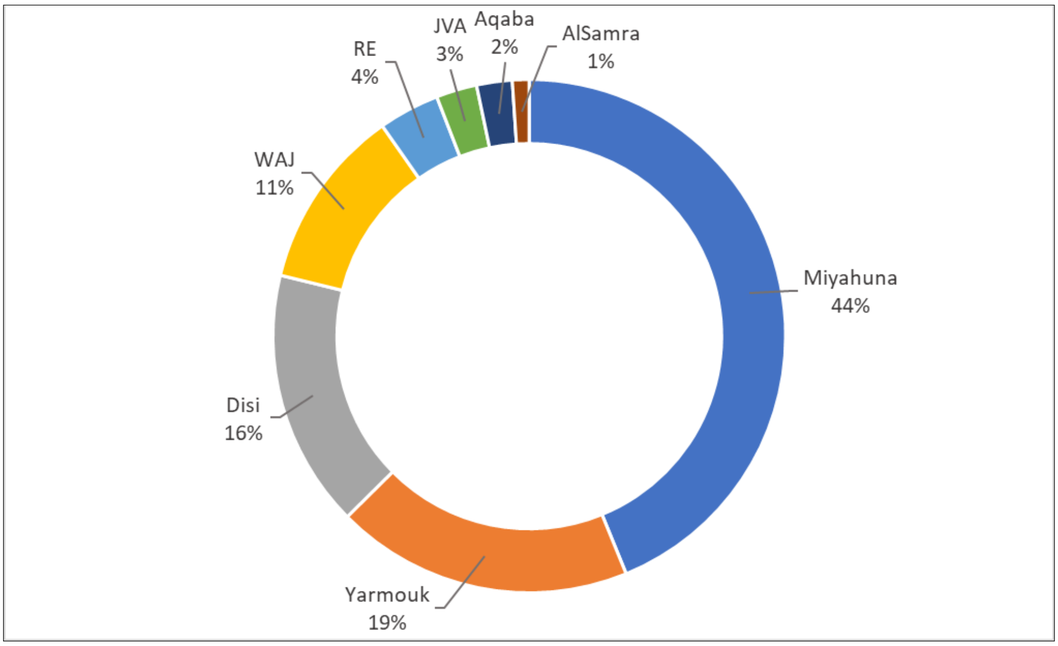

Figure 5 Distribution of the water sector's electrical consumption in 2021

The total electrical consumption of the water sector throughout the years 2015 to 2021, is presented in Figure 6.

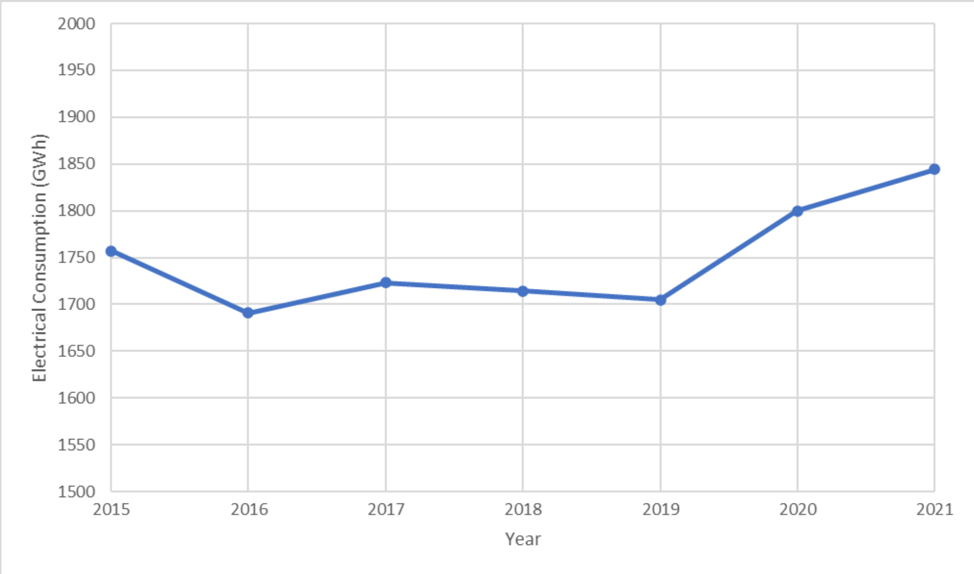

Figure 6 Total electrical consumption of the water sector throughout the past 7 years

Municipal water supply stands out as the most energy consuming activity in the water sector in Jordan and worldwide. In 2021, an estimate 522 million m^3 of water was extracted, treated, imported and supplied to consumers as municipal water in Jordan, with approximately 52.5 % lost as Non-Revenue Water (NRW). Consequently, around 248 million m^3 of water was billed to costumers, requiring a total energy input of around 1,797 GWh. In the baseline year 2021, The specific energy consumption for billed water was 7.25 kWh and the specific energy consumption for supplied water was 3.44 kWh/m^3. The Specific Energy Consumption for the WUs are given in **Table 2**.

Table 2 Supplied and billed water values for each WU in 2021 (Source MWI, 2021)

Entity	Supplied Water** [m^3]	Billed Water [m^3]	Total Consumed Electricity [GWh/yr]	Specific Energy Consumption for supplied water [kWh/m^3]	Specific Energy Consumption for billed water [kWh/m^3]
WAJ	94,899,682	26,892,464	211.37	2.23	7.86
Miyahuna*	285,797,202	145,388,949	808.35	2.83	5.56
Yarmouk (YWC)	112,197,884	56,338,765	345.63	3.08	6.13
Aqaba (AWC)	28,990,809	19,331,453	41.34	1.43	2.14
Disi	0	N/A	299.57	N/A	N/A
Al Samra WWTP	N/A	N/A	19.59	N/A	N/A
Total Electricity consumed from RE	N/A	N/A	70.87	N/A	N/A
Total	**521,885,577**	**247,951,631**	**1,796.72**	**3.44**	**7.25**

* The electricity consumed by Miyahuna does not include Disi electricity while the water distributed by Miyahuna does include 100% of Disi water. Miyahuna exports a portion of this quantity to YWC.

** On the national level, supplied water quantities are assumed to be equal to produced water and to distributed water quantities, as water is not being imported from nor exported to other countries.

To understand the magnitude of the specific energy consumption of municipal water in Jordan, a comparison is drawn with average values in the United States and Germany (See Table 3). The amount of specific energy consumption of water depends heavily on the type of water source used. For example, surface water sources are the least energy intense and require about 0.42 kWh/m^3, while ground water sources require marginally more energy with 0.55 kWh/m^3, and desalination; the most energy intense of water sources, requires about 3.17 kWh/m^3. By comparing the previous values to that of Jordan (3.44 kWh/m^3), it is noticed that the energy demand in the water sector in Jordan is significantly higher than that of other countries. For this reason, this policy is essential to adopt and implement in order to control and limit this high level of specific energy consumption, predicted to increase in the near future, over the coming 20 years.

Table 3 specific energy consumption of water in Jordan compared to Germany and USA

Parameter	Jordan (combined water sources not considering NRW)	Surface water supply (USA & Germany)	Ground water supply (USA & Germany)	Desalination water supply (USA & Germany)
Specific energy consumption of supplied water [kWh/m^3]	3.44	0.42	0.55	3.17

Challenges Facing Future Energy Demands in the Water Sector

The energy demand of the water sector in Jordan is considerably high and is predicted to further increase in the future due to the following main challenges:

Deterioration of the Quality and Quantity of Available Water Resources

The degradation of water quality in Jordan necessitates increased water treatment efforts and exploration of additional source locations, resulting in higher energy consumption. Ongoing incidents of water quality deterioration, stemming from over-pumping and wastewater release, indicate a persistent challenge. To address this, the water sector must implement advanced treatment schemes and develop new water resources, both requiring additional energy. Effects of water quality deterioration[7], include changing groundwater gradients, increasing salinities, and declining water availability. Additionally, impacts on irrigation return flows and contamination levels, including heavy metals and microbiological contaminants, underscore the urgent need for proactive measures in the water sector.

Water Desalination as a Future Water Resource

Jordan's existing water resources are under tremendous stress, necessitating new unconventional sources to ensure freshwater availability within the next five years. With groundwater aquifers and surface water resources nearly depleted, seawater desalination emerges as crucial option left to meet the country's water demand. Accordingly, the Ministry of Water and Irrigation (MWI) announced the launch of the Aqaba-Amman Water Desalination and Conveyance Project (AAWDCP) shortly called The National Conveyor, describing it as "the largest water generation scheme to be implemented in the history of the Kingdom."

The AAWDCP involves the development of infrastructure, starting from the Southern Red Sea coast in Aqaba and ending in the capital city of Amman. Water is to be desalinated in Aqaba, with the treated water to be pumped to Amman and other governorates in a similar manner to the Disi Water Conveyance project. The desalinated water shall be pumped up to approximately 1000 m elevation difference through a conveyance pipeline spanning a distance of around 420 km. Given the unprecedented scale, the project demands careful planning for large-scale renewable energy sources to meet its substantial energy requirements and ensure cost-effectiveness.

This project assumes paramount importance in addressing the widening gap between water demand and supply. The anticipated water demand-supply gap is projected to reach around 261 MCM by 2025 and expand to 364 MCM in 2040[8] (Figure 7**Error! Reference source not found.**). In accordance with the latest plans, the AAWDC project is being developed to produce 300 MCM/year of drinking water for its full capacity, following a BOT scheme and targeting operational status by 2030.

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[7] Margane, A. and Dwairi, M. (2020). Rapid Assessment of the consequences of declining resources availability and exploitability for the existing water supply infrastructure.

[8] National Water Strategy 2023-2040 (2023). Ministry of Water and Irrigation, Amman

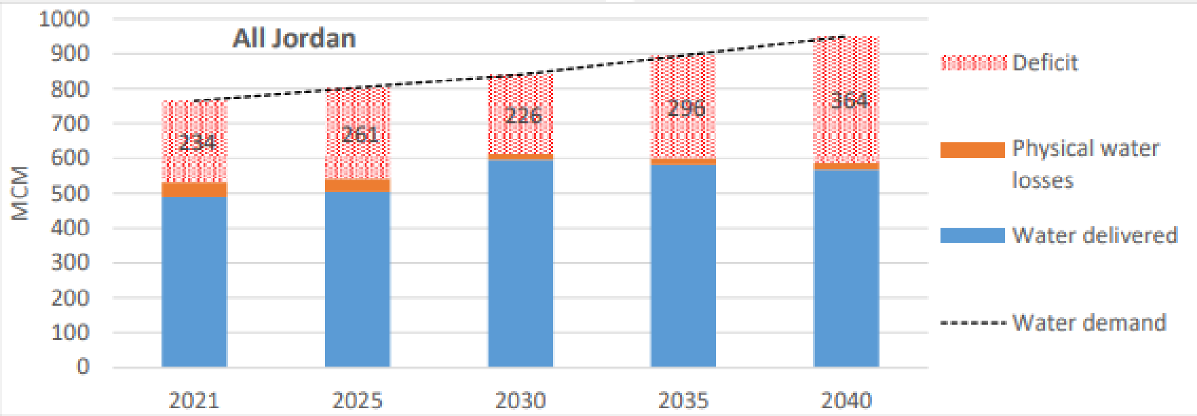

Figure 7 National Water Demand-Supply Deficit Curve (MWI, 2023)

Goal 1. Improve energy efficiency across water sector operations by implementing advanced energy management practices to enhance the overall financial performance of the sector.

The objective of improving energy efficiency in the water sector is divided into two distinct timeframes in this policy. Objective 1.1 addresses the period from 2022 to 2027, while Objectives 1.2 and 1.3. addresses the subsequent period from 2028 to 2040. For Objective 1.1, the indicator and target are established based on cumulative energy savings projected from budgeted projects. This approach aims to drive immediate improvements while awaiting more detailed and reliable data for defining optimized objectives through a model-based energy performance and objective monitoring system.

By 2027, It is expected that sufficient data will be available when SCADA covers all water facilities in Jordan enabling automatic handling of related data accurately. Moreover, by 2027 an Energy Data Management System (EnDMS) will be established and utilized effectively for energy management the planning, monitoring and Measurement and Verification (M&V). A standardized model will be employed to precisely represent the relationship between related variables and energy consumption, considering ongoing plans, projects and achievements through the energy management system at that time. While it is true that single metric such as simple ratio could be used for indicative comparison on higher level (such as benchmarking) and on operational level for operational KPI (O&M indicators), it can be misleading in measuring energy performance, therefore energy modelling approach should be utilized for this purpose starting from 2028 considering the various aspects.

Table 4. Goal 1 Objectives and Indicators

Goal 1: Improve energy efficiency throughout water sector operations by implementing advanced energy management practices to enhance the overall financial performance of the sector				
Objectives	Indicators	Baseline (2021)	Target	Timeline
Objective 1.1: Improve energy efficiency in water production, transmission, and supply (WAJ/JVA) by implementing optimized operation practices*	Indicator 1.1.1: Cumulative energy savings**	0	500 GWh	2022-2027
Objective 1.2: Improve energy efficiency of water supply, treatment, and distribution by implementing optimized network operations	Indicator 1.2.1: Cumulative energy savings	NA	TBD	2028 - 2040
Objective 1.3: Improve energy efficiency in wastewater treatment and in the transmission of treated effluent	Indicator 1.3.1: Cumulative energy savings	NA	TBD	2028 - 2040

* Optimized operations practices could be achieved through technical improvements such as implementing energy efficiency projects, or operational improvements such as applying operational control procedures.

** Cumulative energy savings is the summation of total annual achieved energy savings from all EE projects based on M&V over the specified period, considering the degradation effects of each project (refer to M&V).

Goal 2. Increase the integration of renewable energy sources within the water sector and enhance WEFE Nexus in Jordan.

Table 5 Goal 2 objectives and indicators

Goal 2: Increase the integration of renewable energy sources within the water sector and enhance WEFE Nexus in Jordan				
Objectives	Indicators	Baseline (2021)	Target	Timeline
Objective 2.1: Enhance the Water Energy Nexus cooperation to allow the integration of more renewable energy into the water sector operations, reduce electricity tariff and develop water-energy projects	Indicator 2.1.1: WEFE nexus structures approve 10 measures aimed at improving the financial performance of the sectors	2	10	2040
Objective 2.2: Develop large (> 1 MW) and small-scale (< 1 MW) renewable energy projects	Indicator 2.2.1: Proportion of electric energy supplied to water sector operations from renewable energy sources reaches 40% by 2040, considering the consumption in 2021 as a baseline	89.63 GWh	738 GWh	2040
Objective 2.3: Development of a framework for the integrated governance of the Water, Energy, Food, and Environment (WEFE) Nexus	Indicator 2.3.1: WEFE Nexus framework is developed and operationalized	NA	Yes	2025

Objective 2.1: Enhance the Water Energy Nexus cooperation to allow the integration of more renewable energy into the water sector operations, reduce electricity Tariff and develop water-energy projects.

Globally and particularly in Jordan, the Water-Energy Nexus has gained increasing attention. Given the significant challenges faced by both the energy and water sectors in Jordan, a comprehensive and synergistic approach is crucial. Balancing the needs of these sectors is essential, as they are interdependent. The water sector relies on energy for various processes, while the energy sector requires water for cooling, power generation, and hydro-electric pumped energy storage. This policy aims to address these challenges and promote holistic development in both sectors.

The Water Sector’s ability to achieve its energy efficiency and renewable energy targets relies on the active engagement and support from the energy sector. To promote the use of renewable energy in the water sector, adjustments to energy policy and regulatory measures are essential, requiring strong collaboration to align policies affecting both sectors. Ideally, establishing a joint master plan for both sectors, should foster collaboration, with the goal of aligning the water sector’s energy plan with that of the energy sector. This collaboration is vital for projects like the National Conveyance Project, where green energy plays an important role.

The basis for setting the electricity tariff for the water sector is unclear and has been inconsistent over time. In late 2020, it was determined that the electricity tariff for the Water Sector should be reduced by ten (10) Fills per kWh to take effect from the beginning of the year 2021 under the condition of canceling some planned solar power projects; an unsustainable way to manage the situation. Through Nexus platform, the tariff should be carefully analysed to support the severely stressed water sector and try to lower its energy-related cost as much as possible. The tariff adjustment discussion should include management aspects that could support reducing the tariff, such as use of pumped storage, load management application, and time of use tariff structuring.

Furthermore, other energy-related initiatives that can be developed through the Nexus framework, include:

- Further development of the pumped storage project as a win-win solution for the water and energy sector.
- Development of electric load management model, assessment of the techno-economic feasibility, and studying institutional requirements.
- Studying the possibility of utilizing amounts of surplus RE energy in the energy sector for existing and future loads in the water sector.

Objective 2.2: Develop large (> 1 MW) and small scale (< 1 MW) renewable energy projects.

The water utilities and WAJ aim to develop a mixture of large (> 1 MW) and small (< 1 MW) renewable energy projects to generate 40% of the electricity needs in the water sector, considering a baseline consumption from 2021.

The most applicable and economical renewable energy technologies in Jordan are Photovoltaic (PV) systems, Biogas cogeneration/Combined Heat and Power (CHP), Hydro Power Plant (HPP), and wind farms. Net-metering and wheeling mechanisms could be applied according to RE law and regulations.

According to the current RE constraints in Jordan, the Water Sector can develop RE projects capped at 1 MWp capacity as per Cabinet Resolution no (2714) dated 9/1/2019. Accordingly, the water sector could utilize such potential opportunity subjective to the Jordanian Electrical System requirements. The nexus framework should allow the water sector to expand the use of renewable energy, and to even get exceptions to develop large-scale renewable energy projects exceeding 1 MW.

A very important future water resource in Jordan and the world is water desalination. This type of technology is energy demanding as it relies on high-pressure pumping. For its high energy demand, it is preferable to develop desalination technology using innovative energy solutions such as renewable energy and demand side management. Without renewable energy in the mix, water desalination projects could significantly increase the price of water borne by costumers due to the high cost of grid-supplied electricity. The main water desalination project in Jordan is the Aqaba Amman Water Desalination and Conveyance Project. In addition to smaller projects for wells with brackish water, which are expected to be developed in the coming 5 years.

Objective 2.3: Development of Framework for the Governance of the Water, Energy, Food and Environment (WEFE) Nexus.

This policy prioritizes the Water-Energy Nexus due to its focus on energy but aims to establish an effective governance framework for the Water-Energy-Food-Environment (WEFE) Nexus. The Nexus governance framework is anticipated to create effective cross-sectoral coordination and planning structures and processes. This should result in improved integrated planning and policy consistency.

Effective management of the interconnections between water, energy, food, and environment (WEFE) sectors will help promote collaboration, optimize resources, maintain consistent policies and regulations, and integrate planning activities across the WEFE sectors.

A well-established WEFE framework, characterized by a robust mission and authority, is expected to operate efficiently across the WEFE sectors. Additionally, it is expected to collaborate effectively with both the Ministry of Finance and the Ministry of Planning and International Cooperation. It will be beneficial to integrate WEFE into the planning and management of the water sector and promote innovative projects that integrate all WEFE considerations.

Key benefits of integrated governance of the Water, Energy, Food and Environment (WEFE) Nexus:

- Enhanced planning and policy coherence
- Integrated and effective resource management
- Enhanced sustainability and resilience
- Improved environmental protection.
- Enhanced equity and inclusiveness
- Greater responsiveness to the needs and priorities of different stakeholder
- Enhanced social and political stability.

Goal 3: Implement Energy Management Systems (EnMS) to progressively cover the water sector.

Table 6 Goal 3 objectives and indicators

Goal 3: Implement Energy Management Systems (EnMS) to progressively cover the water sector				
Objectives	Indicators	Baseline (2021)	Target	Timeline
Objective 3.1: Implement energy management systems (EnMS) to progressively cover all large and medium water facilities. *	Indicator 3.1.1: Percentage of water facilities with full implementation of EnMS relative to the total number of previously identified large and medium facilities	38%	60%	2021-2025
			100%	2026-2030

* The list of large and medium water facilities for Energy Management System (EnMS) Implementation is attached to this policy.

Objective 3.1: Implement an Energy Management System

The policy of the MWI shall be to develop and implement an EnMS according to ISO 50001 to progressively cover the water sector within the timeframe of this policy. The EnMS shall provide a systematic, data-driven, and fact-based process focused on continually improving energy performance in order to ensure effective and measurable results over time. Energy performance is related to energy efficiency, energy use, and energy consumption.

The EnMS is based on the Plan-Do-Check-Act (PDCA) continual improvement framework and shall incorporate energy management into existing MWI practices according to the following general steps:

Plan*:* which is the phase of studying the full context, establishing an energy policy and an energy management team, considering actions to address risks and opportunities, conducting energy reviews, identifying significant energy uses and establishing energy performance indicators, energy baseline(s), objectives and energy objectives, and action plans necessary to deliver results that will improve energy performance in accordance with this policy.

Do*:* which is to implement the action plans, operational and maintenance controls, and communication, ensure competence, and consider energy performance in design and procurement.

Check*:* which is to monitor, measure, analyze, evaluate, audit, and conduct management review(s) of energy performance and the EnMS.

Act*:* which is to take actions to address nonconformities and continually improve energy performance and the EnMS.

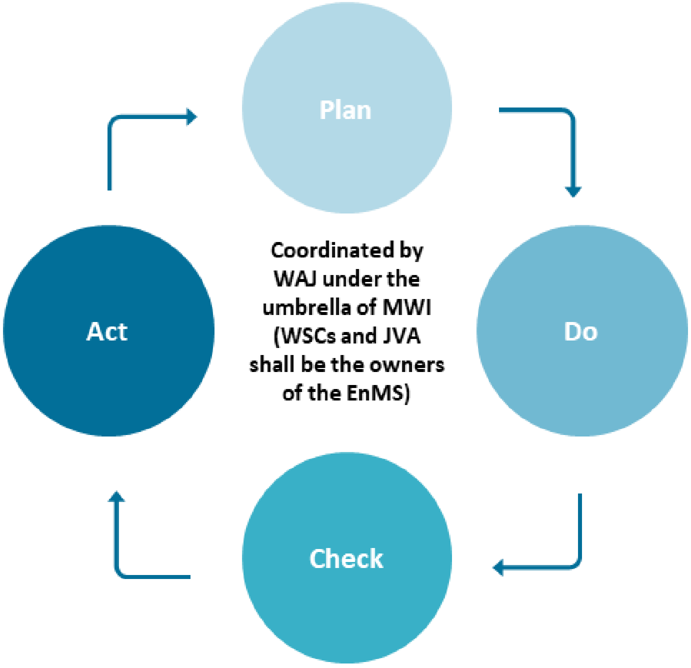

Figure 8 EnMS Plan-Do-Check-Act Cycle

The EnMS was developed in two phases; a pilot scale phase followed by an up-scaling implementation phase. The pilot scale is concluded and included specific water facilities within Miyahuna, YWC, AWC, WAJ operated areas (Balqa, Karak, Maan, and Tafileh) in addition to JVA. An EnMS expansion road map was developed to up-scale the implementation gradually to cover all large and medium water facilities by 2030.

Goal 4: Establish and implement Energy Data Management Systems (EnDMS)

Table 7 Goal 4 objectives and indicators

Goal 4: Establish and implement Energy Data Management Systems (EnDMS)				
Objectives	Indicators	Baseline (2021)	Target	Timeline
Objective 4.1: Develop and implement an Energy Data Management System (EnDMS) for the water sector.	Indicator 4.1.1: EnDMS to cover all water facilities connected to SCADA	0%	60%*	2021-2025
			100%*	2026-2030

* The percentage indicates the proportion of facilities covered by EnDMs relative to the total facilities connected to SCADA

Objective 4.1 – Energy Data Management System (EnDMS)

The policy of MWI shall be to develop and implement an EnDMS to cover the water sector within the time frame specified in this policy, as data management has become a critical function for water utilities. EnDMS shall attempt to provide a strategic solution to support, gather, maintain, and analyze data within an integrative data management environment. In addition, the system aims to transform data into useful information for monitoring energy consumption and other performance indicators. This will optimize operation and decision making to improve energy performance and the use and supply of water resources. The proposed EnDMS will ensure accomplishing the following key functions.

Technical Functions Related to Data Collection, Storage, Interconnections, and Interoperability

- Water utility facilities assets data modeling and data granularity management – considering the connection to existing data sources from various companies, Miyahuna, AWC, YWC, …etc.
- Connecting existing and future IT-systems (wherever possible by technology) with existing/already implemented systems, such as SCADA, ERP, and Energy Systems)

Analytical Functions Related to Data Categorization, Processing, and Evaluation to Generate Useful Information

- Provide the level of data- / information aggregation and user interaction required by the different hierarchies of interest groups.
- Apply the necessary insights and analysis based on business needs and complying ISO 50001 requirements for Energy Performance Indicators (EnPIs) monitoring and operational control monitoring (Operational EnPIs such as SEC, Specific Power Demand (SPD) and Efficiency) and visualize the results through dashboards and widgets within the platform.
- Provide required components that could perfectly disseminate and transfer data to information that could lead to improved strategic planning and decision making, i.e., the approach would help move from numbers read by various indicators to objectives and action plans.

Monitoring and Evaluation

Goal 1: Improve energy efficiency throughout water sector operations by implementing advanced energy management practices to enhance the overall financial performance of the sector																							
Objectives	**Indicators**	**Baseline (2021)**	**planned target (2027)**	**planned target (2040)**	**Progress**																		
					2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Objective 1.1: Improve energy efficiency in water production, transmission, and supply (WAJ/JVA) by implementing optimized operations practices	Indicator 1.1.1: Cumulative energy savings	0	500 GWh	NA																			
Objective 1.2: Improve energy efficiency of water supply, treatment, and distribution by implementing optimized network operations	Indicator 1.2.1: Cumulative energy savings	NA	NA	TBD																			
Objective 1.3: Improve energy efficiency in wastewater treatment and in the transmission of treated effluent	Indicator 1.3.1: Cumulative energy savings	NA	NA	TBD																			

Goal 2: Increase the integration of renewable energy sources within the water sector and enhance WEFE Nexus in Jordan																						
Objectives	**Indicators**	**Baseline (2021)**	**planned target (2040)**	**Progress**																		
				2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Objective 2.1: Enhance the Water-Energy Nexus cooperation to allow the integration of more renewable energy into the water sector operations, reduce electricity tariff and develop water-energy projects	Indicator 2.1.1: WEFE nexus structures approve 10 measures aimed at improving the financial performance of the sectors	2	10																			
Objective 2.2: Develop large (> 1 MW) and small-scale (< 1 MW) renewable energy projects	Indicator 2.2.1: Proportion of electric energy supplied to water sector operations from renewable energy sources reaches 40% by 2040, considering the consumption in 2021 as a baseline	89.63 GWh	738 GWh																			
Objective 2.3: Development of a framework for the integrated governance of the Water, Energy, Food and Environment (WEFE) Nexus	Indicator 2.3.1: WEFE Nexus framework is developed and operationalized	NA	NA																			

Goal 3: Implement Energy Management Systems (EnMS) to progressively cover the water sector																							
Objectives	**Indicators**	**Baseline (2021)**	**planned target (2025)**	**planned target (2030)**	**Progress**																		
					2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Objective 3.1: Implement energy management systems (EnMS) to progressively cover all large and medium water facilities.	Indicator 3.1.1: Percentage of water facilities with full implementation of EnMS relative to the total number of previously identified large and medium facilities	38%	60%	100%																			

Goal 4: Establish and implement Energy Data Management Systems (EnDMS)																							
Objectives	**Indicators**	**Baseline (2021)**	**planned target (2025)**	**planned target (2030)**	**Progress**																		
					2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Objective 4.1: Develop and implement an Energy Data Management System (EnDMS) for the water sector.	Indicator 4.1.1: EnDMS to cover all water facilities connected to SCADA	0%	60%	100%																			

Enclosure: The list of large and medium water facilities for Energy Management System (EnMS) Implementation.