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MINISTRY OF ENERGY AND WATER

WATER-ENERGY NEXUS OF WATER AND WASTEWATER SERVICES IN LEBANON

Volume I:

EXECUTIVE SUMMARY

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WATER • TECHNOLOGY • PEOPLE

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WATER-ENERGY NEXUS OF WATER AND WASTEWATER SERVICES IN LEBANON

This research report was produced through the combined efforts of the IFI team (Nadim Farajalla, Rana El Hajj, Marc Ayoub, Lea Zgheib, Abed Hajj Chehadeh, Francis Hanna and Nay Karam) and the Oxfam team.

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The Joint Humanitarian Development Framework (JHDF) identified WaSH as a key priority sector for Lebanon. H2ALL, a WaSH consortium that consists of the Norwegian Refugee Council (NRC), Oxfam, World Vision International (WVI), and Gruppo di Volontario Civile (GVC) have come together to implement the project "Improving access to safe and affordable water to vulnerable communities", under the EU Madad Trust Fund program "Water, Sanitation and Hygiene (WaSH) programme for Syrian refugees and Lebanese host communities". Within this framework, Oxfam in Lebanon commissioned the Issam Fares Institute for Public Policy and International Affairs at the American University of Beirut to undertake the "Water Energy Nexus of Water and Wastewater Services in Lebanon" study.

The project aims to contribute to effective, sustainable, and multi-level water governance in crisis-affected Lebanon, through empowering local and regional authorities, and demonstrating cost-effective systems for water-service provision.

Though well established and understood by practitioners, policy-makers ignore the interrelation between energy and water when developing energy and water policies, known as the water-energy nexus This has led to the rise of complex challenges, especially in Lebanon, due to the fact that policies and strategies in both sectors have often been developed in isolation of each other. This resulted in policy fragmentation that has negatively affected the sustainable development of both sectors.

The interdependencies and tradeoffs between water and energy require an integrative approach to policy planning and resource management. This is not possible without a supportive knowledge base, and an understanding of these interlinkages and systems. Lebanon, to date, lacks a comprehensive assessment of energy consumption and efficiency in water and wastewater service provision. Additionally, the policy frameworks and coordination mechanisms in place do not facilitate the development of an integrated and efficient water-energy scheme, to alleviate pressures on both sectors. Accordingly, there is a need to develop a comprehensive understanding of the links between water and energy within the current Lebanese legal and operational framework, to assess barriers and opportunities for better-integrated policies, management strategies, and solutions.

The study presented herein aims to address the issues raised above by examining the role of energy, particularly electricity, in Lebanon's water and wastewater service provision. This includes an investigation and analysis of associated legal, social, environmental, and economic aspects along with existing legal, policy, and institutional frameworks pertaining to the water, wastewater, and energy sectors. The potential of and obstacles to mainstreaming energy efficiency, particularly renewable energy, in the water and wastewater sectors are also addressed along with a quantification of social, environmental, and economic impacts of energy-use and efficiency of both the individual (homeowner) and water establishment. Finally, a national roadmap for improved energy efficiency in the water and wastewater sector is proposed and evidence is provided on the potential deployment of renewable energy in water services.

Energy Analysis

A two-step energy analysis involving a walk-through survey followed by an in-depth energy audit and assessment were conducted for 62 water and wastewater facilities, mostly operated by the four water establishments. The intended aim was to develop a clear picture of the extent that energy impacts the provision of water and wastewater services, as well as the potential for energy efficiency opportunities within the audit, and similar facilities. The analysis was performed throughout the country for 39 water-pumping stations and 23 wastewater treatment plants (WWTP). Available electricity bills of those stations, for the past three years (2016-2018), were obtained and analyzed using energy-performance assessment tools and key performance indicators. These were then benchmarked against best practices and trends in several countries in the region, and around the world.

Water Facilities

Analysis of the electricity bills of the regional water establishments (RWEs) revealed the extent of the high cost of energy incurred in providing potable water. For example, around 20% of the annual budgets of both North Lebanon (NLWE) and Beirut and Mount Lebanon Water Establishments (BMLWE) go for energy consumption for water service provision. For the BMLWE, this represents 33.6% of its operation and maintenance (O&M) cost. The Bekaa Water Establishment's (BWE) estimated energy costs are higher, nearing 36% of the 2019 total budget equivalent to 47% of the overall O&M budget[1].

The energy audit results and analysis did not depict a direct correlation between the stations that registered high electricity bills and their respective pumps' performance, leading to the conclusion that the high-energy cost is not always caused by an inadequate pump performance. This was reached through an analysis of the pumps of the audited pumping stations, with respect to their performance, and the required power to operate efficiently—the latter, mainly, to ascertain whether the selected pumps were properly sized. This analysis showed that around 70% of the pumps in facilities run by BMLWE are operated in an acceptable or good manner, compared to 40% in SLWE facilities, 30% of NLWE's facilities, and 28% in BWE facilities[2]. The results lead towards two possible reasons behind the energy-intensive operation at the identified stations: the use of expensive energy sources (i.e. fuel-sourcing, such as a diesel generator and heavy fuel oil for the utilities), or an inadequate operation and maintenance (philosophy and program) within stations across all establishments.

Such results highlight operation and maintenance as "low-hanging fruit", with a potential for high positive impact on energy cost and efficiency. As such, it was determined that a set of universal O&M guidelines that can be followed by RWEs be developed at all levels, from management to operators. This was accomplished in close collaboration with Dar Al-Handasah Consultants (Shair & Partners), where a complete manual for operations and maintenance guidelines in water pumping facilities (available in Volume III Appendix D) was developed. The guidelines suggest O&M measures for a variety of pumps, along with ancillary fittings and fixtures such as valve and strainer maintenance that can shift the RWEs from the current emergency response maintenance schemes to preventive, and even predictive, maintenance operations.

[1] *Energy costs often make up 25 to 30 percent of a utility's total operation and maintenance (O&M) costs. They also represent the largest controllable cost of providing water and wastewater services according to US Environmental Protection Agency (EPA): https://www.epa.gov/sustainable-water-infrastructure/energy-efficiency-water-utilities#:~:text=Energy%20costs%20often%20make%20up,providing%20water%20and%20wastewater%20services*

[2] *Full details of the results and analysis can be found in Volume III of this report.*

In addition to the O&M guidelines, a set of technological, design, policy, and planning recommendations were proposed, these are summarized below:

- Technological: The use of high-efficiency electrical motors and very high-efficiency pumps (in planning new plants, or while replacing or rehabilitating existing ones), the use of turbines that generate electricity from water pressure, the installation of Variable Frequency Drives (VFDs), and the implementation of Solar pumping stations wherever possible.
- Design Criteria: Set design criteria that ensure efficiency in energy consumption, such as duty point and pump selection, and water networks to ensure their proper sizing thereby optimizing energy requirements when pumping.
- Operations and Maintenance: In addition to the guidelines described above, it is important to develop an operational philosophy for water-pumping stations when it comes to water sources' management and energy efficiency measures; continuous data acquisition/collection; proper instrumentation and proper monitoring; improve water systems management, etc.; revise all O&M contracts to ensure energy efficiency, amongst others; and produce a new set of standardized measures.
- Planning: Define a set of energy efficiency standards in the terms of references of future projects, homogenize those among all concerned public stakeholders (RWEs, Council of Development and Reconstruction [CDR], consultants, contractors, etc.), and establish a centralized monitoring system for standards' compliance (for example, under LIBNOR, or IRI); consider asset management and ensure that water and energy requirements are met in any design.
- Policy: Develop an appropriate pricing strategy based on water meters to account for the RWEs' energy costs; issue publications related to energy efficiency standards and specifications for water utilities; push towards power-wheeling and corporate PPA schemes; and enforce the role of Ministry of Energy and Water (MoEW), in terms of supervision and monitoring.

Wastewater Facilities

Similar to water service provision, wastewater collection and treatment services are affected by high-energy costs. Even though most energy bills for wastewater services are currently being covered by the CDR, the high-energy cost associated with operating and maintaining the plants is creating resistance by RWEs to take over the responsibility of operating the facilities, due to the establishments' limited financial resources.

The energy audit clearly showed that plants using Conventional Activated Sludge and Extended Aeration wastewater treatment processes have the lowest energy consumption, confirming what is presented in the literature. On the other hand, Activated Sludge with Trickling Filters system plants are characterized by the highest energy consumption, almost two times higher than the two other processes.

Results indicate that design aspects of the plants lie behind energy inefficiency, which have led to high-energy costs. It was observed that out of 16 audited secondary treatment facilities, 14 operate below capacity, reflecting a tendency for over-sized plant design, with treatment capacity greater than what is needed (accounting for future increased loads, due to population load, should not be used as an excuse for such oversizing). Although slight oversizing is necessary to account for fluctuating loads, excessive oversizing may result in greater energy consumption, as experienced by most facilities. It was also observed that smaller plants are more energy intensive than larger ones. The analysis of the energy performance of wastewater treatment plants shows that as the population served increases, energy consumption decreases, with high-energy consumption being attributed to plants serving the lowest number of people. This finding highlights the importance of cost sustainability in O&M, in terms of energy, in the proper design and sizing of future and planned WWTPs.

As for the existing WWTPs, the potential for energy efficiency improvement is mostly present in improving the O&M aspects, knowing the significant impact it can have on the overall energy bill. This shall also be a key consideration in the planning of future plants as well. A co-benefit from looking at energy efficiency through the O&M lens is that it would greatly aid in the move, by the operators, away from unplanned emergency maintenance procedures to predictive and preventive maintenance. With this in mind, a set of O&M guidelines inside (equipment, technology, operations) and outside (networks) of existing plants, as well as future plants (those under tender/in preparation/in design) are summarized below[3].

[3] *Detailed recommendations can be accessed through Volume III of this report.*

- Improving energy efficiency through the O&M of existing plants:
    - Equipment/Technology: Install adjustable speed drives on pumps and blowers, introduce Dissolved Oxygen (DO) sensors to monitor and control aeration tanks, electric load monitoring devices, flow and pressure monitoring equipment, and VFDs for pumps, motors, and blower.
    - Operations: Reduce odor control ventilation operations; control heating and cooling in unoccupied areas; conduct periodic pump tests and repair inefficient ones; reduce aeration requirements by using chemical injection of salts in primary sedimentation; replace old and worn out equipment; address leaks and equipment malfunctions; alternate the operation of installed equipment and monitor logging of data, centralizing it in one unit, where archiving and tracking can be carried out.
    - Policy: Develop an agreement with the Litani River Authority (LRA) on tariffs for the discharge of treated wastewater into the Litani River; set appropriate tariffs for wastewater collection and treatment; enforce the implementation of the desired operation and maintenance protocols in tenders and contracts to be signed for future plants; hold contractors accountable for O&M/diesel costs/volume, and hours of water treated, etc.; and always conduct a full inventory for all available assets.
    - Networks: Separate sewage networks from stormwater drainage networks; treat industrial and medical waste separately, in-situ, or in dedicated facilities before being discharged into domestic wastewater systems.
    - Equipment: Install VFDs for all pumps, motors, and blowers; use energy efficient equipment during any repair or maintenance procedure; full monitoring and control systems to optimize energy consumption (SCADA), along with sensors and controllers.
- Improving energy efficiency through activities outside of existing plants through:
    - Networks: Separate the two systems of stormwater drainage networks and sewage networks; introduce equalization tanks into the facility to regulate inflows and operation patterns devised to attain the 80-85% DU range; ensure the design inflow into the WWTP is met, and reduce extraneous inflows.
- Improving energy efficiency through the proper design and planning of future plants (those under tender/in preparation/in design)
    - Design/Planning: Put energy efficiency at the top of WWTPs' site selection, designer, new treatment plants in trains; ensure that actual wastewater characterization studies are conducted to determine its sources; move towards the medium to large-scale facilities; incorporate equalization tanks in the design of future treatment plants; ensure that actual incoming flow is maintained at approximately 80-85% of the design capacity; incorporate energy production from sludge treatment using such methods as anaerobic digestion; and attempt to implement the more energy efficient treatment processes whenever possible.

Renewable Energy Market Assessment

In parallel to the energy audit, the possibility of integrating Renewable Energy (RE), mainly solar photovoltaic (PV), was assessed in water/wastewater service provision. Current legislation and local market dynamics were reviewed, and a mapping of the surrounding areas of audited water and wastewater facilities (rooftops, reservoirs, unused lands, etc.) was conducted. Integrating RE in service provision has the potential to extensively reduce energy bills and reliance on expensive and polluting private diesel generators.

A market for RE in Lebanon's water and wastewater services already exists, and is at an appropriate level of readiness. However, the potential of this market is constrained by some real challenges: the absence of enabling a legal framework; the lack of financial incentive and performance-driven assessments; and the perpetual cycle of operating in "crisis mode" at the centralized and utility levels, which impedes the uptake of energy and cost-saving interventions. Despite Lebanon being a small market for RE, technology know-how and a capable private sector exist, and await for an enabling environment to grow in different sectors, including water and wastewater. Although a few existing pipeline projects do include RE systems, the analysis shows the true potential of RE in water and wastewater networks, and facilities remains largely untapped.

Specifically, solar PV systems carry significant potential due to their scalability, current level of market readiness, and increasingly low costs. It was shown that despite some varying potential among water and waste establishments, the sector could achieve substantial savings by adopting solar PV interventions. The suitability of these interventions should be determined on a case-by-case basis, and on the principle of economic efficiency, i.e. based on a realistic financial viability model that takes into account consumption levels, load profile, cost of service, and available space and features (shading levels, orientation, land vs. rooftop, etc.).

A techno-economic modeling of solar PV systems feasibility in 19 water and wastewater facilities conducted suggests that solar PV systems can indeed be deployed to meet at least part of the facilities' energy demand, and provide cost savings. Some of the facilities, such as Yanouh, Chamsine, and Jdita can even generate a surplus, and be able to export to the grid or other areas, through a power-wheeling arrangement in the future. In cases where utilities can generate power beyond their needs, energy storage solutions would be a major boost for the RE market in the water and wastewater sectors. However, and despite the impressive decline in the costs of energy storage in recent years, the conducted modeling did not support the inclusion of storage solution at this stage.

Some water facilities can achieve up to 10% savings on their actual annual energy costs when installing solar PV. Wastewater treatment plants can realize significant savings too. For example, both Iaat and Tripoli can achieve around 8% annual savings on every US dollar spent per cubic meter of wastewater treated, and 16% on EDL and diesel bills on average. More importantly, the annual monetary savings, under current conditions, are over USD 25,000 per station in some water facilities (Fouar, Taybeh, Chamsine, and Dayshounieh Baabda WTP), and over USD 10,000 per plant in some WWTPs (Iaat and Tripoli). As a result, installing RE can reduce the financial burden on water establishments, while promoting energy security. However, the key to unlocking the RE market potential is to enhance the water-energy nexus in a legal framework. This is best achieved through power-wheeling agreements and mainstreaming RE in these services through policy, targeting design requirements, and financing, as summarized below:

Level	Theme 1: Improving Energy-Resilience of Water Establishments	Action Timeline
Policy	Develop a policy for RE integration in all water and wastewater facilities at the national level[4], as part of a Water Sector Strategy. All water and wastewater facilities with significant potential from available lands and rooftops should undertake a techno-economic analysis to assess the installation of solar PV to cover at least part of their energy consumption. This should consider future ramp-up of capacity and its impact on land requirements.	Medium-long term
Finance	Enhance RE affordability further by exempting RE components from import and other taxes to reduce the initial cost of financing.	Medium-long term
Finance	Assess the possibility to revise the reallocation of international loans and funds to give priority to water and wastewater projects that incorporate RE and integrate energy efficiency measures.	Medium-long term
Design	Mainstream the deployment of solar PV in the design of water and wastewater facilities, whenever applicable. This should be a priority for the following water stations: Chamsine, Taybeh, Dayshounieh Baabda, and Fouar WTP; and the following WWTPs: Iaat and Tripoli.	Immediate
Design	Assess the techno-economic feasibility of hydro-storage solutions in facilities with elevated heads to generate electricity from hydropower and/or extend the sizing of solar PV generation.	Medium-long term
Utility	Regularly monitor energy consumption and efficiency through scheduled energy and financial audits. Following such best-practice measures would allow establishments to explore RE alternatives and savings opportunities.	Immediate
Utility	Within the current economic situation, and knowing that a legal framework is already in place but is not yet applied (PPP Law 48/2017), seek Public Private Partnerships (PPPs) for solar PV installation and maintenance by ensuring the legal and policy environment enables investments to support such projects. This would also require coordination between the utility, the water establishment, the municipality, and the private sector.	Medium-long term

[4] *Refer to Jordvan's "Energy Efficiency and Renewable Energy Policy for the Water Sector" (2016) for lessons-learned from a neighboring country.*

Level	Theme 2: Improving the Integration of EDL and Water Establishments	Action Timeline
Policy	Advocate for power-wheeling agreements to avoid wasting potential energy excess generated by solar PV. The draft distributed renewable energy law, which sets the legal foundation for peer-to-peer distributed RE, ought to be passed. Distributed RE would be supported further with the unbundling of the electricity sector, as per Law 462 (2002), which is yet to be implemented.	Immediate
Policy	Prioritize adequate implementation of multi-site net metering by addressing technical challenges such as the grid's instability.	Immediate
Policy	Increase synchronization between EDL and the facilities acting as decentralized producers, generating solar PV surplus: Apply a smart rationing scheme whereby EDL provides electricity when utilities generate excess, to incentivize the installation of RE in those with large potential.	Medium-long term
Policy	Work towards eliminating EDL subsidies and increasing the electricity tariff, which would promote solar PV as a competitive, less expensive substitute. Concurrently, this would reduce the water establishments' electricity bills and their reliance on diesel powered generators.	Medium-long term
Finance	Rethink the relationship between EDL and the water establishments by proposing variable day/night tariffs to be reflective of cost recovery, at the level of connecting utilities to the grid, in such a way that incentivizes WEs to reduce costs or choose to operate during the least-cost available option.	Medium–long term
Utility	In the case of water pumping facilities, rescheduling the load to eight hours per day, covered by solar PV, would reduce heavy reliance on EDL.	Medium-long term
Utility	Seek agreements with nearby municipalities for land utilization for power-wheeling.	Medium-long term

Level	Theme 3: Involving water establishments in climate action	Action Timeline
Policy	Monitor and report yearly GHG emissions to set mitigation action plans. Given the demonstrated reductions in GHG emissions from water and wastewater treatment plants, solar PV should be considered as a main mitigation action in this area.	Immediate

Social Impact Assessment

With the hypothesis that interlinkages between water and energy, and in the absence of an integrated policy of the ramifications trickling down to the citizens, a social impact assessment in a selected case study was conducted. Based on the energy audit results, geographic areas of interest (serviced by high cost and energy intensive utilities) were prioritized to select a case study area and analyzed in Volume V: Socio-Economic Impact Assessment of the W-E Nexus. A multiple screening process was conducted, taking into consideration several criteria that depended on data, such as water-establishment bills covering collection rates, number of subscribers, current balances, and electricity bills per district and per station for the period 2017-18. The energy audit revealed that the Loussi station in the Bekaa is a high-energy intensive station, one that suffers from intermittent and low-quality electricity supplies (12-hour outages), and lacks backup diesel generators. These compounded, energy-related challenges affect water service provision to the 18 villages that Loussi station serves. Thus, based on this, and on the screening process, the area serviced by the Loussi station was identified as a hotspot.

Further inspection of the area served by Loussi station, using social indicators, Al Rafid village was selected as a case study area for conducting social impact assessment of the W-E nexus. Al Rafid is characterized by a complex water supply system composed of two "sub-systems", dividing the village into two zones: one where the municipality provides water from a well, owned by BWE but operated and managed by the municipality (Zone A), and another where water is provided by BWE from the Loussi station (Zone B).

A survey was conducted of households in Al Rafid to gauge their perception regarding the linkages between water supply and energy, and how this reflects on them. Survey results showed that in both zones in the village, a link between electricity cuts and water availability was identified. More than 65% of respondents in Zone B (serviced by Loussi station) complained of water shortages all year round. As for respondents in Zone A, serviced by the municipality well, 19.7 % complained of water shortages during that same time period. Reasons for water shortages varied, as perceived by the respondents, with technical issues dominating, including energy/electricity. The technical issues in Zone B were at the Loussi station level, and eventually reached the community; while in Zone A, the issues came from technical problems with the pump, at the municipal well. Water shortages, resulting from a combination of factors, including electricity cuts, resulted in heavy reliance on water-trucks in the village.

Water-trucks, along with other forms of compensation for water shortages and poor water quality, led to a higher water bill for households in Al Rafid. Considering the income level of households, and the expensive water bills, Al-Rafid scored poorly in water affordability. The study clearly showcased the additional cost citizens pay for alternative water sources, which is up to two, and in some cases, three times the water bill charged by the establishment. In both zones, residents expressed willingness to pay a higher water bill in return for continuous, good quality water supply. This is a clear argument in favor of rethinking the water tariff to enable the establishments to cover their expenses/costs in order to provide better service. A major component in improving water service provision is electricity; water affordability can be significantly improved, as this cases study shows, if continuous and good quality electricity is provided to the station or well.

It is noteworthy to mention that the link between power cuts and water shortages was only directly perceived by the respondents that are serviced by the municipality operated well, while those serviced by Loussi station were not able to perceive such a link. This is a clear indication of the "unawareness" of citizens of the challenges that water establishments (WEs) face at a higher operational level.

This study repeatedly highlights the need for better cooperation and communication between the municipalities and the WEs; and for the need to rebuild trust between citizens and the WEs to break the vicious cycle of low-bill collection-rates, and no cost-recovery by the establishments. The team conducted a generalized simulation: comparing the cost of fully solarizing Loussi station to the cost of diesel provision, and the long-term financial impact this could have on the BWE, as well as the social repercussions at the village level. The results showed that investing in renewable energy at Loussi station would fix the water supply problem for Al-Rafid, and other villages facing the same difficulties. Costs on the community will be reduced significantly, and the water affordability score would increase from poor to good.

Social Network Analysis

The linkages between water and energy are intricate, and are present at different scales in the value chain. Such a reality necessitates strong and continuous cooperation and coordination between all stakeholders involved in order to create an integrated environment. The creation of such a network of stakeholders, with strong communication ties, first requires an understating of the network. Based on that, a social network analysis was conducted of the stakeholders identified as key that interface water and energy in Lebanon. A social network analysis (SNA) is a process that identifies and studies the interlinkages and connections between various stakeholders in a specific network. The SNA methodology comprises two steps: a stakeholder analysis to identify key stakeholders in both water and energy sectors, and the social network mapping.

Key stakeholders were identified based on feedback from experts, as well as a review of their mandates and the roles in the water and energy sectors. The key stakeholders were then asked to respond to a questionnaire covering three main communication themes: (a) communication regarding financial exchange; (b) sharing data, expertise, and technical assistance; and (c) communication regarding drafting and enforcing policies, strategies, and plans. The questionnaire results were analyzed, weighed, and converted to quantitative data using SNA tools. The analysis resulted in 14 maps showing the connections between stakeholders at all three levels, which can be accessed in Volume II of this report.

The highlights of the observations in the network maps show:

- In terms of financial linkages, the BWE is the stakeholder with the most diverse connections to funders; the EU was identified as the funding agency that has the highest number of connections with national organizations in Lebanon, and the CDR was identified as the stakeholder with the highest intermediary (middle-man) score, funneling funds from donors, such as the EU to numerous national organizations. In terms of data, expertise and technical assistance sharing, SLWE and the LCEC were shown as those sharing data on a regular basis with multiple national organizations, while CDR and LARI are observed as institutions that act as "hubs" for sharing information between the various stakeholders. In terms of enforcing and drafting policies, the MoEW appeared to be fulfilling its mandate with the highest connection/communication with other stakeholders on policy enforcement and drafting. Interestingly, CDR appears to play an intermediary role in communication regarding implementation and drafting of policies.

- Beyond observations of the network map: several stakeholders, such as the BWE, MoEW, CDR, EU, SLWE, and LCEC have strong connections to each other (throughout all three main themes) but limited connections with other organizations. Such strong ties/connections can be limiting in some cases, therefore there is a need to slacken these strong connections and focus further on developing weak ties amongst the stakeholders. This allows more interaction amongst all stakeholders, rather than promote the dominance of a few stakeholders. Stakeholders holding a high betweenness score are at the center of strong ties that block the flow of information between all stakeholders, concentrating it amongst themselves. To be able to develop weak ties, these central stakeholders need to reach out to different organizations and expand their networks, instead of focusing on the stakeholders they normally interact with.
- Not all stakeholders, especially nationally, function within the extent of their mandate, while others such as MoE and MoA could and should be playing a bigger role in strengthening communication on the water and energy interface. CDR being a perfect example, in that it has overstepped its mandate—namely, guaranteeing funding projects presented, and supervising their execution—and moved into developing policies and strategies.

All of the communication gaps highlighted in Volume II: Social Network Analysis, combined with the social impact assessment results, show that there is a need to decentralize the web of stakeholder networks by breaking down the centrality of some of the stakeholders dominating the network, by encouraging them to reach out to other stakeholders they normally would not engage with, to expand their network.

Key Takeaways

The interlinkage between energy and water was clearly highlighted and defined in this study. Challenges were identified at several levels, starting with governance and reaching all the way to operations of facilities. Measures to overcome these challenges were presented at all levels.

At the governance level, integrating the energy and water sectors would require cooperation and coherence in policy development, and operationally as well. The social network analysis conducted (Volume II) to assess the communication between organizations, in both sectors, showed numerous communication problems between governmental institutions, especially between municipalities, water establishments, and the MoEW. It also showed that there are stakeholders, which dominate communication within the network, creating unnecessary bottlenecks. Additionally, it was shown that some stakeholders are not operating according to their mandates, with some shirking policymaking responsibilities, while others intrude into this practice. Therefore to improve the flow of communication—knowledge, expertise, funding, etc.—it is imperative that the strong ties that hinder this flow be weakened to develop a network of weak ties between all stakeholders, to allow for information and data sharing, breaching new technological ideas and opportunities, and to facilitate drafting policies and their enforcement.

The conducted Energy Audit (Volume III) revealed the challenges faced by water establishments in covering energy costs and day-to-day maintenance operations of water pumping stations and WWTPs. It is important to include energy efficiency at the core of design for new water and wastewater facilities, and the rehabilitation of existing facilities. A key finding was that medium-to-large-scale WWTPs are more energy efficient than small-scale plants, and this should be well integrated in the selection of treatment facilities. Furthermore, it is important to evaluate projects in terms of energy consumption, operational expenditure, and potential energy efficiency measures, including a reduction in energy costs borne by the water establishments.

Integrating water and energy can also be found at the tendering phase. Tenders issued by authorities must include clear guidelines for equipment purchase and commissioning that take energy efficiency into consideration, as well as the operation and maintenance procedures to be followed. They must also incorporate clear Key Performance Indicators that operators must always abide by, especially when it comes to energy. Consequently, contracts for operation and maintenance must be performance-based with a focus on ensuring energy efficiency, without neglecting data collection and data monitoring procedures, which should be centralized in data centers at each water establishment.

Cost savings and energy efficiency may be realized in existing or planned water and wastewater facilities if renewable energy sources, mainly solar PV, are utilized. In addition, such an undertaking would aid in securing uninterrupted power supplies to facilities, which in turn would improve the water service for customers, and reduce the economic impact of water and power outages. The relatively high cost of investment needed in installing RE systems, would be recovered through cost savings realized over the project's lifetime.

The energy audit and social impact assessment highlight the fact that the interrupted power supply, and the resulting water shortages, has negative social and economic consequences for the ordinary citizens, who are burdened with extra costs in their attempt to secure water from an alternative source. It was shown that residents of a town facing such onerous costs are willing to pay higher tariffs, as long as water supply is consistent in quality and quantity. The study also highlighted the lack of trust between the water establishments and the citizens, and the need to rebuild it by enforcing the existing laws, reflecting efficient operations and maintenance procedures, while ensuring transparency and accountability.

Special Note:

This study was conducted over a period of nearly two years, a period during which the country experienced the upheaval of October 17, 2019, the COVID-19 pandemic, the associated economic collapse, and the Beirut Harbor explosion of August 4, 2020. Throughout all these events, the AUB-IFI research team soldiered on with remarkable focus and determination, which was equally matched by the Oxfam management team, who showed outstanding patience, flexibility, and responsiveness. All this makes this study remarkable for the true and total team effort (AUB-IFI, Oxfam, H2ALL consortium, and the EU team). We, the AUB-IFI team, believe that the output is unique and most practical. Contribution to the success of the study was also made possible with the support of the Ministry of Energy and Water through Suzy Hoayek; the Directors General of the regional water establishments: Wassim Daher,.Jean Gebran,. Khaled Obeid, and Rizk Rizk. Equally important was the technical support provided by Dar Al Handasah (Shair and Partners), especially Naji Edde and his electromechanical team, and the team at WASCOP, led by Ahmad Harake.

Oxfam has been working in Lebanon since 1993. We provide humanitarian assistance to vulnerable people affected by conflict, and we promote economic development, promotion of good governance at a local and national level, and women's rights through our work with our partners. Oxfam also works with local partners to contribute to the protection and empowerment of marginalized women and men.

THE ISSAM FARES INSTITUTE FOR PUBLIC POLICY AND INTERNATIONAL AFFAIRS

Inaugurated in 2006, the Issam Fares Institute for Public Policy and International Affairs (IFI) at the American University of Beirut (AUB) is an independent, research-based, policy-oriented institute. It aims to initiate and develop policy-relevant research in and about the Arab world. The Institute aims at bridging the gap between academia and policymaking by conducting high quality research on the complex issues and challenges faced by Lebanese and Arab societies within shifting international and global contexts, by generating evidence-based policy recommendations and solutions for Lebanon and the Arab world, and by creating an intellectual space for an interdisciplinary exchange of ideas among researchers, scholars, civil society actors, media, and policy makers.

CLIMATE CHANGE AND ENVIRONMENT PROGRAM

The Climate Change and Environment program was launched in 2008 as part of IFI's strategy of utilizing the AUB's significant research and analytical capabilities to inform and guide public policymaking of Lebanon and the Arab world. The program's strategic objective is to generate, and influence policy related to climate change and environmental issues.

WATER-ENERGY
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EXECUTIVE SUMMARY

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