Water-Energy nexus workshop:

Overcoming challenges for power supply of water and wastewater services:
Alternative energy supply solutions

Workshop report

March 2nd and 3rd, 2022

Introduction

This two-sessions workshop, organized in collaboration between LEWAP, IFI and Oxfam, aims at addressing the Water-Energy nexus by building capacities of sector's stakeholders to implement alternative solutions to fuel-powered water systems.

In 2021, power supply for water and wastewater services was interrupted regularly due to the diminution of state electricity supply and rise of fuel prices that the Regional Water Establishments could not cover financially. In response to this, local and international stakeholders started considering and implementing alternative power sources projects such as solarization projects at the level of pumping and treatment stations. This increased interest in alternative solutions came only a few months after The Issam Fares Institute for Public Policy and International Affairs (IFI) at the American University of Beirut (AUB), in collaboration with Oxfam, published a series of reports under the "Water-Energy Nexus of Water and Wastewater Service in Lebanon" project funded by the European Union.

Both the Water-Energy nexus study, and the recent solarization projects for water infrastructure, provide guidelines and recommendations to alleviate the challenges of energy supply for water and wastewater services. The objective of this workshop was to build upon these experiences to develop the capacities of actors to design and implement projects that aim at increasing energetic autonomy of water and wastewater services.

During the first session of the workshop, participants were introduced to the water-energy nexus and received recommendations from studies, presented by Dr Nadim Farajalla from AUB-Issam Fares Institute; and from Oxfam's experience of pumping station solarization by Jihad Abdul Ghani. The second session focused on collectively identifying needs and potentials for interventions; participants were divided in regional groups based on the four regional water establishments (North and Akkar, Beirut and Mount Lebanon, Bekaa and Hermel, and South and Nabatiye) and established a list of suggested actions based on their experience and knowledge of the field.

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1. ALTERNATIVE ENERGY SUPPLY SOLUTIONS FOR WATER AND WASTEWATER: RECOMMENDATIONS AND LESSONS LEARNED FROM STUDIES AND EXPERIENCE

During the first session, 46 participants from different organizations received information on solutions to increase energy supply for water and wastewater services in Lebanon. The session started with the presentation of a field experience, the solarization of two pumping stations in the Bekaa, implemented by Oxfam Lebanon in 2021. Then it was followed by a general overview of the water-energy nexus study of IFI-AUB addressing the different aspects of water-energy interlinkages and existing solutions. Recommendations were formulated from both sides, and every presentation was followed by a Q&A session.

1.1 Solar water pumping system: feedback and recommendations from two completed projects – Jihad Abdul Ghani, WASH Advisor at Oxfam Lebanon

M. Jihad Abdul Ghani, WASH Advisor at Oxfam Lebanon, started this session with two case studies of alternative power supply implemented in the Bekaa: solarization in Kfarzabad and Haour Taala pumping stations in 2021. The applied technologies were presented and it was followed by outcomes and recommendations.

1.1.1 Summary of the presentation

The full presentation is available on this link.

M. Abdul Ghani shared details on the existing system configurations and the tools used to select sites and adapted systems, being the technical assessment forms and list of selection criteria including vulnerability criteria, feasibility and ownership (*for details on each, refer to the presentation*).

Two examples of solarization were showcased: Kfarzabad borehole, connected to a 1000 m3 water tank, and Haour Taala station, with a 250 m3 water tank. In both cases, hybrid systems were installed (solar and Electricity), to allow a continuous functioning of the water pump during the fuel crisis and power shortages. In Kfarzabad, 10 hours of operation were supplied during the summer through the solar system, and 8 hours in Haour Taala, increasing water supply to the community by respectively 36.4% and 52%. Online control and monitoring systems were installed, and can be operated remotely by the Bekaa Water Establishment, to whom the infrastructures were handed over, increasing systems' reliability. As a result, financial burden decreased both for residents (as needs for water trucking significantly decreased) and for the Bekaa Water Establishment (BWE) in terms of fuel purchasing for generator.

At a governance level, it should be noted that coordination was ensured with BWE from the beginning of the project; capacity building was provided to the BWE as well as support for the control and monitoring of the water system. Municipalities also played a role in facilitating the construction; overall, this led to an increase in water supply hence improving the relationship between local citizens and the BWE.

M. Abdul Ghani also specified maintenance needs, especially preventive maintenance, with a proposed scheduled that can be referred to by stakeholders; Oxfam also shared a control checklist which can be consulted here. Several resources developed by Oxfam for solar-powered water systems implementation are available in the presentation.

For further information or clarification, contact Jihad Abdul Ghani: jabdulghani@oxfam.org.uk.

1.1.2 List of recommendations for the design and implementation of solarization projects based on the previous success stories from Oxfam:

- Testing of borehole (pump test) is required, in case of unavailability of borehole data and pump test report;
- Clear criteria have to be set for site selection, including: land availability; water supply improvement; cost reduction for Water Establishments; energy efficiency; and return on investment timeframe;
- WE's ownership of the land and system should be agreed upon;
- Role of municipality should be clear from the beginning of the project;
- Coordination with WE should be clear from the beginning of the project, during the execution and the handover process;
- WE teams' training should be conducted on operation, control and monitoring (can be repeated);
- Investment in quality solar water pumping systems has to be prioritized;
- Control and monitoring system (example: SCADA) should be installed for the borehole and solar pumping system;
- Fence should be installed to protect the site, including from theft;
- Additional spare parts supply (such as VFD and panels) can be considered.

1.1.3 Questions and answers on the presentation:

Technical questions regarding the system

- Does the system cost include pump replacement?
  Yes.
- If the pumps are not that old and are still functional, would it be better to replace them or is there a way to adapt the operation of the existing regular pumps to the solar system?
  It depends on the specifications of the pump – this is a case-by-case situation.
- What are the alternatives for power supply in winter when solar cannot provide the necessary powers?
  The system should be connected to another source of energy (EDL or generator) for the non-sunny days.
- What is the specific cost of the PV USD/KWp excluding pump for both sites?
  Around 1000 to 1200 $/KWp – however this depends on the land where the PV will be installed (in some cases there is work to be done on the land before installation).

- What is the Wp of the PV panels used?
  The panels installed in Saghbine are 405 Wp each, in Kfarzabad 340 Wp each and in Haour taala 335 Wp each.
- What is the depth of the pump in the two wells presented?
  Kfarzabad: 270m.
  Haour Taala: 276m.

Operation & Maintenance

- Is there an estimation for annual maintenance cost for such a system (especially, preventive maintenance)?
  Solar pumping systems have low maintenance and operation.
  Maintenance should be done as per maintenance schedule, and WEs should clean the panels regularly. In the last year, maintenance for the solar system was not required and no issues recorded.

Governance

- What is the municipality role since this project will be handed over to the BWE?
  The municipality is involved in the project; provided land, provided support and access to local contractor; and helped in solving issues during implementation.
  The municipality is aware that the handover should be done to the BWE after project is done.

1.2 The water energy nexus: study results and recommendations for project implementation – Dr. Nadim Farajalla, Director of the Climate change and environment program, AUB-Issam Fares Institute

Dr. Nadim Farajalla, director of the Climate Change and Environment program at AUB-Issam Fares Institute, completed the session by moving from specific examples towards general water-energy interlinkages in Lebanon and existing solutions for alternative energy supply. He presented the results from the 2021 water-energy nexus study and from a study on wastewater power production potential (to be published soon).

1.2.1 Summary of the presentation

The full presentation is available on this link.

Dr. Farajalla presented outcomes from the water-energy nexus study funded by the European Union and conducted by IFI in partnership with Oxfam. This study was based on an energy audit of 39 water stations and 23 wastewater stations, where electricity bills from 2016 to 2018 were looked at. Results showed that for water stations, there isn't an automatic correlation between electricity bills and pumps' performances: changing a pump will not necessarily reduce electricity bills or solve distribution issue. Instead, we should look at the systems' design, network, and water losses. Results were similar for wastewater facilities, where the design was also identified as a major reason behind energy inefficiency and high energy costs. Indeed, the cost of energy varies depending on the type of processes and those with higher energy costs are currently operating under capacity. Overall, the

study underlines the need to look at how energy is used in the process of water and wastewater services, to understand the correlation between service delivery and electricity costs and to conduct a proper design that considers Operation & Maintenance aspects to identify hidden costs.

Besides the audit of stations, the study also assessed renewable energy market and the legal framework for water and wastewater services, concluding to a series of recommendations listed in the next section below.

Key takeaway from this study is the need for an integrated approach to policy planning and resource management, considering water and energy together. This requires a comprehensive assessment of energy consumption and efficiency in water and wastewater service provision, as well as a better coordination at the policy level to facilitate the development of an integrated and efficient water-energy scheme.

To highlight examples of energy production for water and wastewater facilities outside of photovoltaics, Dr. Farajalla presented the outcomes from a second study that looked at wastewater facilities as a source of energy themselves through sludge co-digestion and micro-energy production. The study assessed how existing and planned wastewater treatment plants could increase their functional capacity by taking in sludge from smaller Wastewater Treatment Plant (WWTP) and from surrounding farms to increase their energy recovery from sludge co-digestion. Regarding micro-hydro power, the study identified 13 WWTP where secondary and tertiary treatment is available and where micro-electricity could be generated from water reuse. These results that will be published in March, point out potential sources of energy for the wastewater facilities themselves, if not other facilities in case of excess.

For further information or clarification, contact Nadim Farajalla: nf06@aub.edu.lb.

1.2.2 List of recommendations to increase efficiency and reduce costs of energy based on the studies presented by IFI-AUB:

- Focus should be put on the design of the system as it is often behind high energy costs and energy inefficiency for both water and wastewater stations;
- Proper design should include Operation & Maintenance hidden costs;
- A comprehensive assessment and monitoring of energy consumption and efficiency for water and wastewater should be conducted;
- Better coordination at the policy level and integrated water-energy scheme are necessary.

1.2.3 List of recommendations to increase renewable energies for water and wastewater

	Medium-long term	Immediate
Policy	Develop a policy for RE integration in all water and wastewater facilities at the national level as part of a National Water Sector Strategy	Advocate for power wheeling agreements

	Synchronize power generation by EDL and facilities – *see how facilities can act as decentralized producers of power*	Prioritize adequate implementation of multi-site net-metering by addressing technical challenges such as grid's instability – make sure that grid can handle added sources of power
	Eliminate EDL subsidies and increase electricity tariffs	Monitor and report yearly Green House Gas emissions to set mitigation action plans
Finance	Enhance RE affordability further by exempting RE components from import tax and other taxes to reduce the initial cost of financing	
	Assess the possibility of revising the reallocation of international loans and funds – currently taken into consideration by EU, USAID, AFD, World Bank	
	Rethink the relationship between EDL and the water establishments – synchronization rather than being a problem	
Design	Assess the techno-economic feasibility of hydro-storage solutions in facilities to generate power	Mainstream the deployment of solar PV in the design of water and wastewater facilities, whenever applicable – identification of such facilities in the study
Utilities	Seek Public Private Partnerships for solar PV installation and maintenance	Regularly monitor energy consumption and efficiency through scheduled energy and financial audits

1.2.4 Questions and answers

Water-energy nexus study

- For the sites that were assessed during the audit, were there any studies of what could be the RE coverage of the overall energy consumption (budget and land needed per station)?
  The study looked at available lands owned by WEs to assess where and how much solar panels could be installed to supply power to each site based on a rule of 25 m^2 per kilowatt. RE potential coverage of audited facilities was assessed, with and without storage (more details in the study).
- In which area RE is most suitable for water establishments (topography and land cost)?
  Only lands owned by WEs were looked at; there are possibilities in every water establishment, at least to cover a portion of needed energy to reduce the financial pressure on WEs.
  Jihad adds that one of the challenges in finding facilities was the ownership since some sites and lands were owned by municipalities and some didn't accept to handover the land to WEs – this may have changed now that energy is one of the major issue for operating.
- Was there one comprehensive plan on the national level, or has the study looked more at the level of each water establishment?
  The study aimed to look at the role of energy in water and wastewater service provision as a whole – it did not focus only on the facilities that were audited even though it was based on this. For RE potential, it looked more in details at several facilities, with no regional prioritization.
- Did you consider wind energy?
  Not in this study.

- Did you perform a social network analysis for the stakeholders involved, and maybe suggested or not a "decentralization" of roles and responsibilities?
  The report includes an important social network analysis as well as a social impact analysis. Regarding centralization/decentralization of facilities, it goes beyond roles and responsibilities which do not change much (rather related to the conceptualization of the size that is wanted, what is generated out of it, etc.
- Energy efficiency in design of water and wastewater facilities – are there example of project looking precisely into this?
  There were none that looked at energy as a component of the procurement process and operation – study emphasizes that the role of energy starts in the design and procurement phase which are critical for the whole facility.
  Hammena WWTP is more or less self-efficient – operated by the municipality.

Study on Wastewater potential for energy production

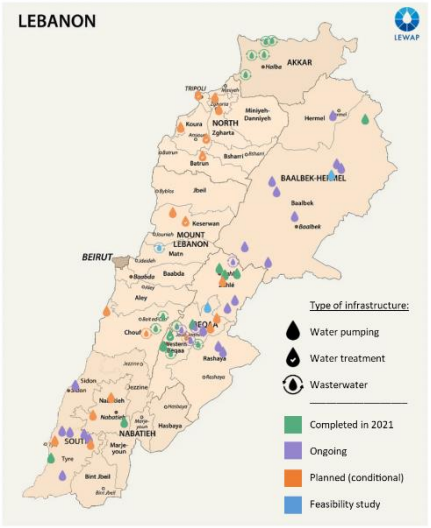
- When will the second study (WWTP potential for energy production) be published?
  It should be published in March and it will be shared online on IFI's website and circulated to actors through LEWAP.
- What is the situation of Tripoli WWTP in terms of energy generation from sludge?
  The sludge biodigestor is not operational.
  A positive example is the WWTP built in Tyre (not operational yet) which has integrated sludge biodigestion and sludge trucking from surrounding areas. It shows that this idea is growing and included more in new facilities.
- What is the situation of biodigestors in Saida?
  Not sure the biodigestors are working; the whole facility isn't working properly and seems to be working more as primary treatment only (as Ghadir WWTP).

In conclusion, Dr. Farajalla insisted on the importance of an integrated, complete and holistic solution including network, energy efficiency and capacity of the operator to manage now and further down the road.

2. COLLECTIVE SITUATION ANALYSIS OF ENERGY NEEDS AND SOLUTIONS FOR WATER AND WASTEWATER SERVICES AT REGIONAL AND NATIONAL LEVEL

This second session aimed at initiating discussions on the sector's needs and priorities to be considered regarding to the water-energy nexus – both to increase energy supply to water and wastewater services in the short term, and to develop an integrating approach to water and energy as pointed out during the first session. 25 participants from different organizations attended and were divided in four groups based on the four regional water establishments geographic coverage to zoom in on their needs and priorities in order to formulate recommendations in this context, and discuss these needs at the national level.

2.1 Situation analysis of the current interventions for the water-energy nexus



Juliette Samman from LEWAP introduced this session with an overview of interventions aiming at increasing energy supply – to support the upcoming discussions with data collected from partners (NGOs and donors) on existing interventions.

LEWAP developed a cartography of solarization projects for water and wastewater infrastructures – only solar was considered because it was the energy source developed by most intervening actors who shared their data. The cartography displays projects either conducted in 2021, ongoing, or planned (conditional to results of feasibility studies) – it is not exhaustive, but rather gives an overview of current coverage of needs and stakeholders with more than 60 projects identified.

The national and regional maps are available through this link. Partners whose projects not displayed on the maps, are invited to contact LEWAP to provide their information.

2.2 Discussions and recommendations by region

Based on the map of projects developed by LEWAP, the recommendations shared in the first day, and the attendees' expertise and field knowledge, participants discussed the needs and potential solutions region by region. Discussions covered infrastructure needs and other regional issues, potential interventions that would be adapted and key learning on how to ensure sustainability and to overcome challenges. Every group came up with a specific situation analysis and several recommendations for the region they were part of, as mentioned below.

2.2.1 North Lebanon

This group pointed out the **link between the water-energy nexus and water resource pollution**. Due to the surface water pollution in the north, regional actors are moving to groundwater pumping that require high power needs. Besides the high cost and lack of fuel to function fuel-based generators, oil leakages from these generators is prevalent in the canals and reaches groundwater - therefore there is a **regional need for more water-energy projects** to provide alternative solutions.

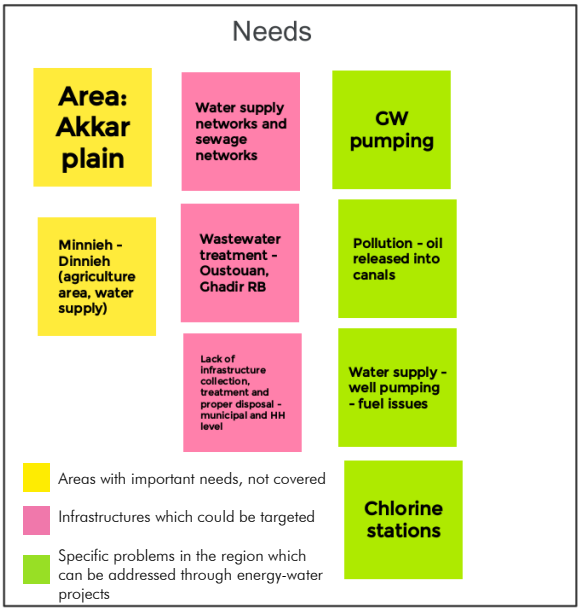
Moreover, the group underlined the increased pollution of water resources through the discharge of untreated wastewater into river basins due to the **lack of infrastructures for wastewater** collection, treatment and disposal. Wastewater treatment through **chlorine stations can be part of water-energy projects** by adopting solarization to function the stations - Tankamel Sawa are working on this with municipalities.

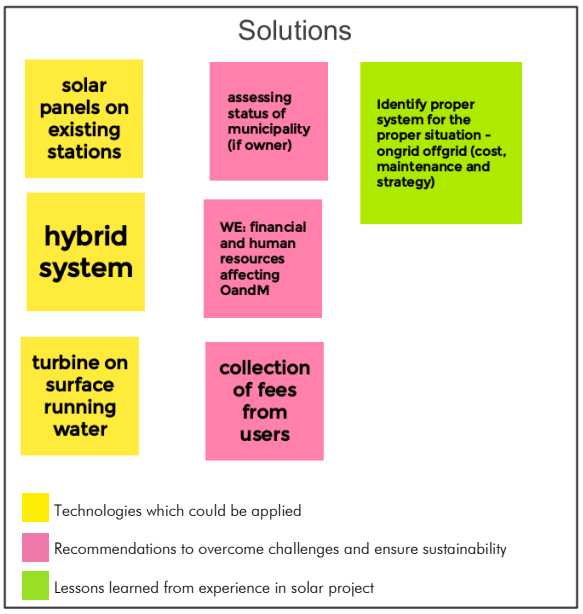
The North Lebanon group noted that **Akkar plains** should be further targeted by solarization projects as it offers large plains for big PV farms. **Minnieh and Dinnieh areas** also represent potential areas of interventions since they are agricultural areas with high needs in terms of water supply for irrigation.

Overall, solarization is one of the potential solution for existing stations in the North, with a preference for **hybrid systems** with EDL or generators. **Small-scale solar initiatives** for farmers can also be considered due to the profile of the region. One of the lessons learnt shared by participants in the group underlines the need to consider the whole power supply system (on/off grid, costs, O&M) when designing a solar system and implementing it.

Other alternative technologies mentioned were **turbine on surface water** to generate electricity and **wind power**. In regards to wind power, several projects mentioned are either in early phase or had been planned in the past but were canceled when the crisis started. Moreover, wind power systems face many challenges such as the feasibility of the system (only few areas, such as Qobayat, can benefit from wind energy), the social perception, and the will of local authorities to implement and maintain such systems. In line with the last challenge mentioned, participants pointed out that **communication and coordination with municipalities is easier than with the NLWE** for implementation and maintenance services. The current financial and human resources issues faced by the water establishment are a major challenge for sustainability of projects when ownership is at their level. One of the solution is to look at the **fees collection** and improve the relationship between end-users and the NLWE.

Below is a screenshot of the needs collected from participants and the solutions proposed:





2.2.2 South Lebanon

Several recommendations were formulated by the group, starting with the need to look at documents such as the **LCRP and assessments produced by the sector's stakeholders and core groups**, to identify needs of interventions for water and wastewater. Based on the map, it is clear that **many areas of the south have not been equipped through solarization projects** (especially Marjeyoun, Beit Jbeil and Jezzine), but this information is not enough to identify needs and should be completed by looking into the existing assessments.

The group pointed out the lack of a holistic approach when it comes to implementing interventions. This represents one of the main challenges as it leads to localized actions instead of **designing a whole system for water networks and sewage networks** that should be monitored properly.

Participants also shared information on the projects that are currently being assessed: biogas production from digestion of sludge and manure between IDS and farmers in the South (NRC); and upgrade of the wastewater network in Taameer area in Saida (DPNA).

Below is a screenshot of the needs collected from participants and the solutions proposed:

Needs	Solutions
o Are there some areas that are not currently covered and where needs are important? o Are there some infrastructures that you know of that you think should be targeted and why?	The needs are pervasive everywhere The regions of Jezzine, Marjeyoun and Bint Jbail appear to have no planned projects, so these shoul dbe targeted NRC: Bio-gas production from digestion of sludge and manure DPNA: Upgrade of WW network in the Ta3meer area Desludging DAI: Not a holistic plan for many ww projects e.g. Tripoli and Saida Donors and Gov. need to coordinate agendas and involve the right people

2.2.3 Bekaa

A first point discussed by this group was the **need for knowledge and assessments**, both to identify priorities and to design adapted systems. There is a need for an updated list of feasibility studies for boreholes at the level of the BWE to identify the most urgent needs. However, this information is not sufficient to determine the quality of boreholes and the results of pump tests are often unavailable. **Conducting pump tests and measure flow in the borehole is essential** for designing a system, especially that water tables in the Bekaa are dropping and some boreholes dried out or became seasonal. During the plenary session, this issue was highlighted mentioning the lack of detailed study on water table levels and recharge.

The group also discussed **governance and ownership**. The Bekaa water establishment does not manage all water sources and systems, and sector's actors are advocating for **complete ownership by the WE including solar systems for better management**. This raises up some tensed **relationships between BWE and municipalities**, for which solutions were proposed:

- Proving to municipalities the importance of solarization systems for water and wastewater services and its ownership to the BWE
- Improving the capacities of BWE to reassure municipalities on BWE ability to handle the system – **request to conduct trainings in Arabic at the end of the project, as well as every six months to one year**

Besides keeping a good system well maintained, these approaches could improve the relation with subscriber thus the collection rate, increasing sustainability of projects.

Other challenges were highlighted such as the financial capacity of WE to purchase items for O&M: it was suggested to **include spare parts in the tenders** during the planning of the project.

Below is a screenshot of the needs collected from participants and the solutions proposed:

Bekaa

Needs	Solutions
WE not managing all sources/ system	Update list regularly
list about borhole-feasibility with BWE	Use of spring/gravity to supply water
Capacity building of operator	Specific training to the Operator at the end of the project (Arabic), Training every 6 months
Capacity of water establishment to operate and maintain water system	Simple -not complicated system
Water supply System (including solar) should be managed by WE	Training during const. & handover and plan for training every year/6 months
Capacity to purchase items	Coordination and handover to BWE of all the water supply system
Information about borehole; Technical ass. for borehole before solarization (pump test),	Add spare parts in the tender
Improve relation between muicipality and BWE	Conduct pump test before design
Sustainability of the system	Explain project- Improve capacity of BWE to handle system
Issue of treatment of sludge	Opportunity for more subscriber
	Biogas from sludge-

2.2.4 Beirut-Mount Lebanon

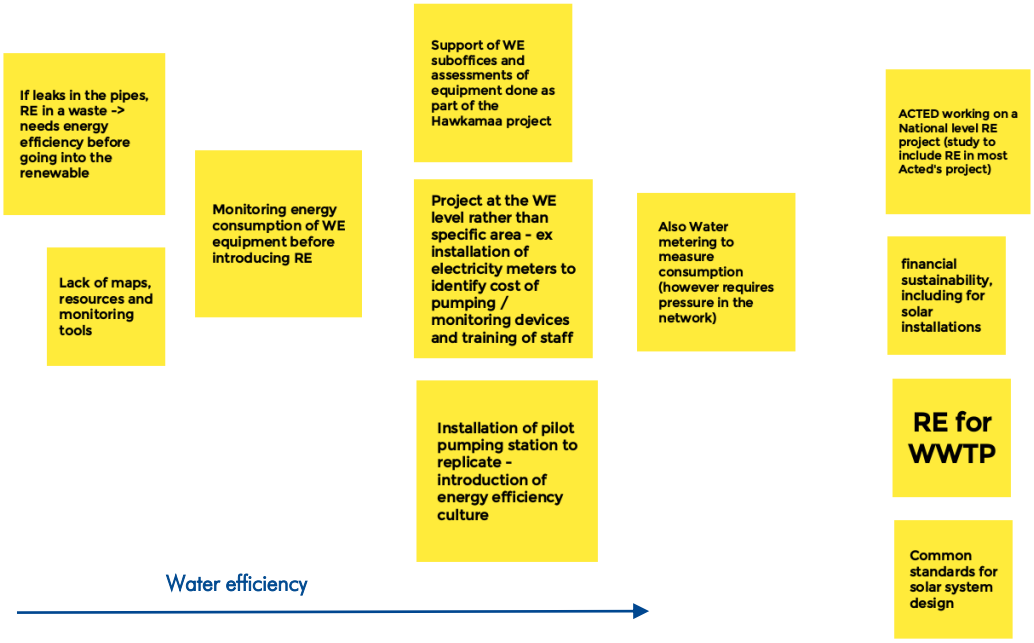
This group focused on **energy efficiency** and discussed the needs and challenges at the level of BMLWE rather than specific areas in the Beirut Mount Lebanon region. They considered particularly the need to **monitor the performance of water establishment utilities in terms of energy consumption** and management, due to the lack of knowledge on this matter, and due to pipes leakages and lack of energy efficiency. Therefore, it was proposed to **implement a pilot electricity-metering project in pumping stations** to introduce an energy efficiency approach at the level of the Beirut-Mount Lebanon water establishment.

The support to water establishment has been the ongoing focus of several organizations and donors in Lebanon; as part of the HawkaMaa-EU project, there is a big component on providing support to WE, ACTED is working with BMLWE on assessing their sub-offices and providing them with the needed tools.

Participants highlighted the needs and challenges to include renewable energy at the level of wastewater treatment plants: **need to reduce pollution discharge** and **challenges of the lack of financial sustainability and lack of national standards for solar panels**.

As part of the discussion, a project was mentioned which studies the possibility of implementing renewable energies for Chabrouh through three technologies: solarization; micro-hydropower (installing turbines in larger pipes from the reservoir to Faraya), and wind power. The aim of this project is to promote these solutions for most dams or hill-lakes to generate electricity.

Below is a screenshot of the needs collected from participants and the solutions proposed:



2.3 Discussions and recommendations at the national level

The discussions conducted at a regional level were brought in as recommendations at the national level, starting with the **need for energy auditing of existing boreholes, pumps, wastewater treatment plants,** to determine their efficiency, reduce costs of intervention and increase results of solarization project. Exchanges focused on how to measure and improve energy consumption at the level of all water establishments while ensuring power supply. Due to the current fuel crisis as well as the continuous pollution crisis, Dr. Farajalla recommended introducing renewable energy for water and wastewater services at the level of WE by focusing on an **integrating plan which take into consideration energy efficiency and monitoring, rather than ad-hoc interventions, so that all facilities become as autonomous as possible regarding energy**.

This converges with the need of a holistic approach from energy to water**. Actions and interventions should be coordinated among donors and decision-making authorities** for national implementation of alternative solutions for power supply for water and wastewater, rather than small-scale projects.

Finally, in the context of energy generation, excess energy produced by a facility cannot be converted to the national grid as prohibited by law 462; this law gives the monopoly on production, transmission and distribution of electricity to EDL. However, advocacy actions are ongoing on reforming this law and giving facilities, the right to sell their excess of energy produced.