Water-Energy Nexus in Lebanon

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Context

- Global estimates indicate that energy accounts for **30-40%** or more of total operating costs of water and wastewater utilities n developing countries

- Population growth and improved living standards, will create at least a **40%** rise in the demand for water and wastewater services by 2030

- **40%** of the world's population is expected to live in water scarce-regions by 2025

- Utilities can achieve up to **40%** of energy savings

Energy Input in the Water Sector

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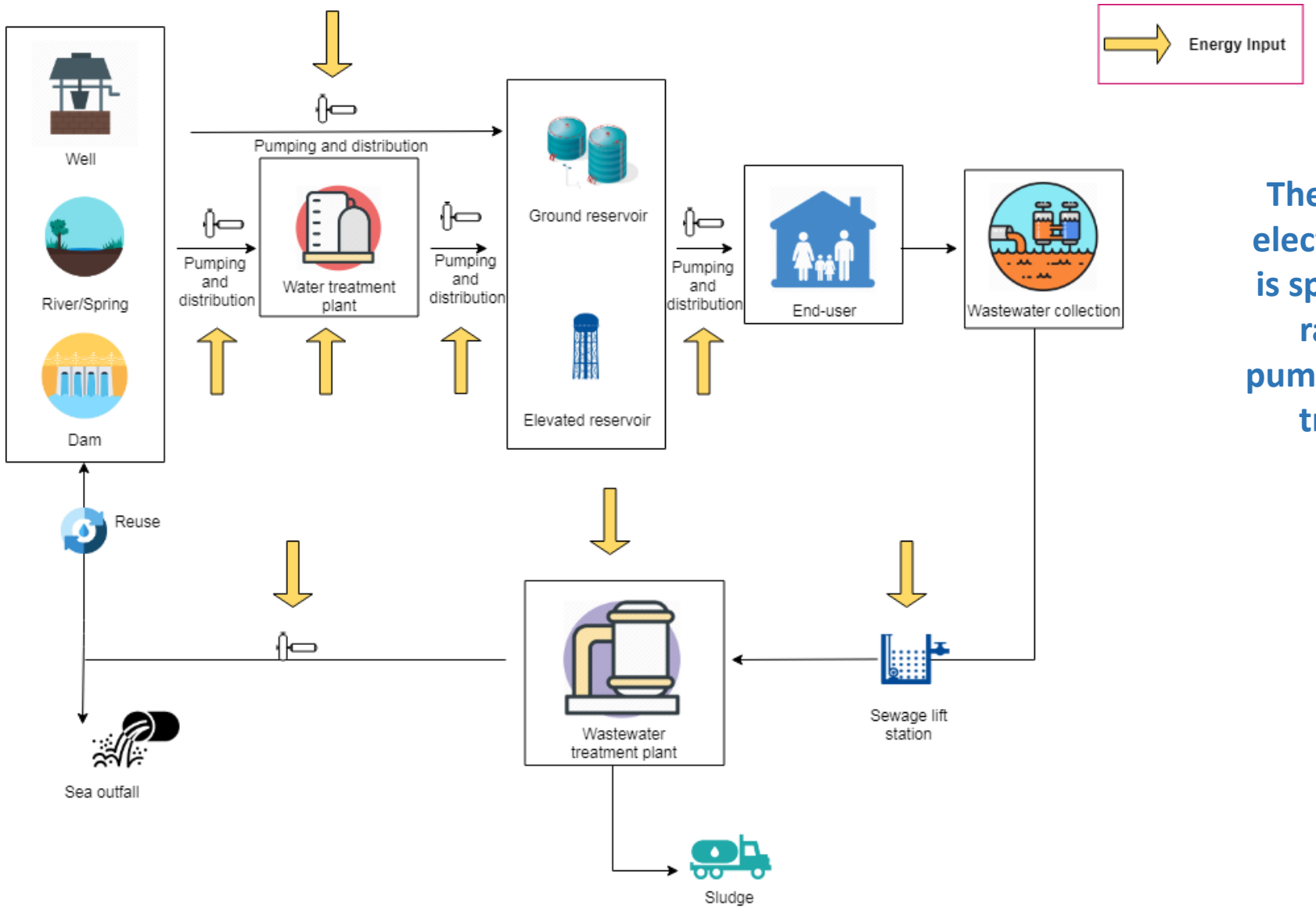
Pumping usually accounts for 70-80% or more of the overall electricity consumption.



The remaining electricity usage is split between raw water pumping and the treatment process.

The Lebanon Context

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- RWEs are reliant on EDL's electricity supply to provide water services, with average electricity cuts before October 2019 reaching **12-15 hours** per day, now cuts are near constant
- RWEs already suffer from high electricity bills,
- Most WWTPs are non-operational in major part due to high electricity bills
- Non-revenue water reaching 50% in some areas, requiring even more electricity

Water – Energy Assessment of RWE Facilities

Energy Audit in Water and Wastewater sectors

Energy audit's aim is to determine the following:

- Total electricity/fuel use cost per year;
- Breakdown of energy demand/consumption data across the whole supply chain;
- Benchmark against best practices and analysis of trends;
- Identify possible energy efficiency measures;
- Inform on performance challenges and differences.

Walk-through survey

In-depth energy audit and analysis

Energy Audit in Water and Wastewater sectors

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Establishment	Water station audited	Wastewater stations audited
Bekaa	5	7
Beirut and Mount Lebanon	14	9
North Lebanon Water	8	3
South Lebanon Water	12	4
Total	39	23

Electricity Bills Acquired

- ✓ *2017 only*
- ✓ *2016-2017-2018 billed invoices*
- ✓ *2016-2017-2018 unbilled invoices*
- ✓ *2018 only*

** Identification of potential lands/rooftops suitable for solar PV implementation*

Key Takeaways – Water Supply

- No direct correlation between the stations with high electricity bills and their respective pumps' performance.
- 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.

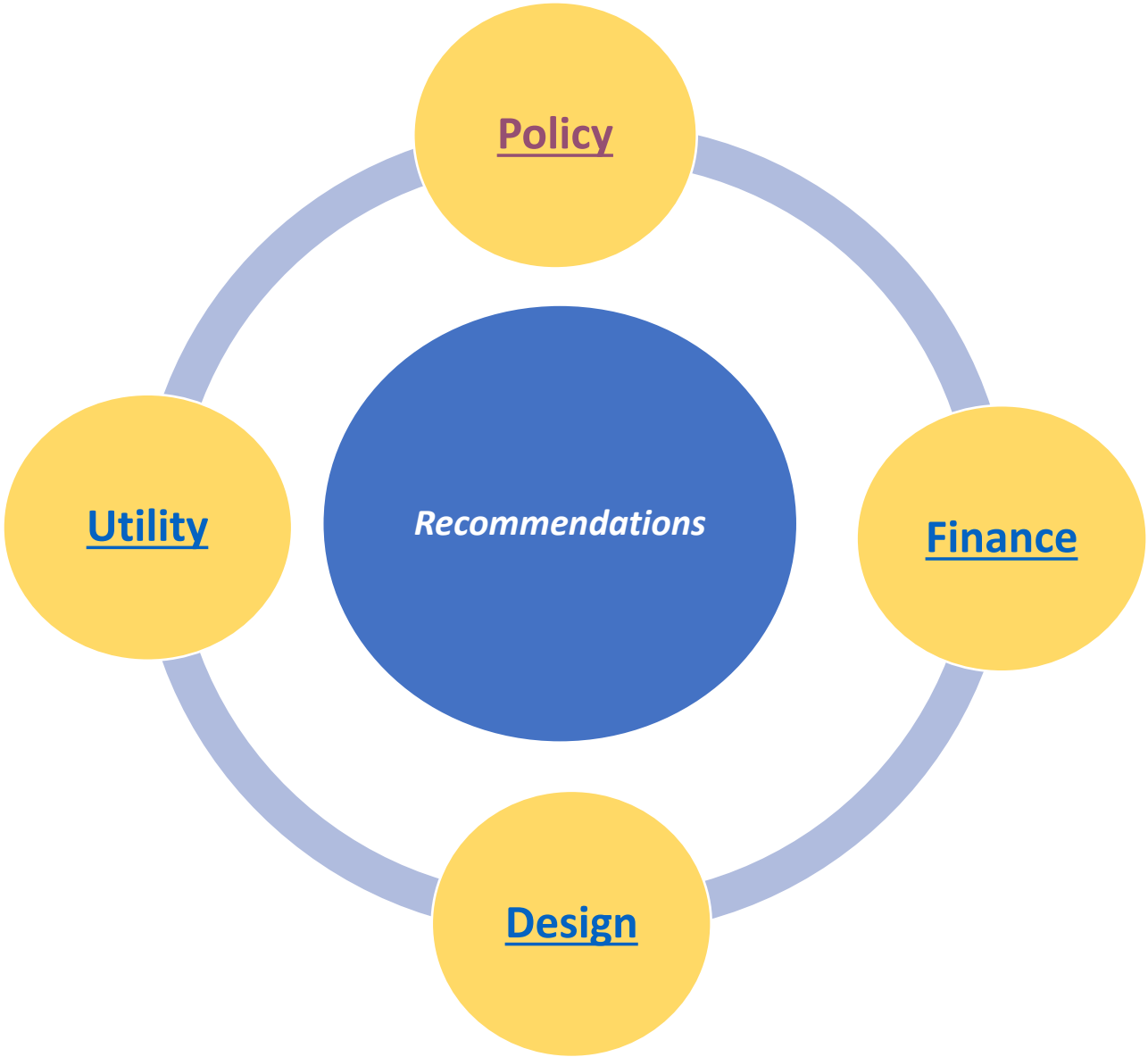
Key Takeaways – Wastewater Service

- Design aspects of the plants lie behind energy inefficiency which have led to high energy costs.
- Out of the 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).
- Smaller plants are more energy intensive than larger ones. 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.

RE Market Assessment

- Zoomed-in on the status of water/wastewater services in the RE legal framework
- Overview of existing and planned RE projects in water/wastewater services
- Market perspective: Interviews conducted with 3 solar PV contractors in Lebanon
- Assessed the RE potential in water and wastewater stations: case studies

Recommendations and The Way Forward



Renewable Energy Market Assessment

Policy

Medium - long term	Develop a policy for RE integration in all water and wastewater facilities at the national level as part of a Water Sector Strategy.
	Increase synchronization between EDL and the facilities acting as decentralized producers generating solar PV surplus.
	Eliminate EDL subsidies and increasing the electricity tariff.
Immediate	Advocate for power wheeling agreements
	Prioritize adequate implementation of multi-site net-metering by addressing technical challenges such as the grid's instability.
	Monitor and report yearly GHG emissions to set mitigation action plans.

Renewable Energy Market Assessment

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Finance

Medium - long term

- Enhance RE affordability further by exempting RE components from import and other taxes to reduce the initial cost of financing.
- Assess the possibility of revising the reallocation of international loans and funds.
- Rethink the relationship between EDL and the water establishments.

Renewable Energy Market Assessment

Design

Medium - long term

- Assess the techno-economic feasibility of hydro-storage solutions in facilities

Immediate

- Mainstream the deployment of solar PV in the design of water and wastewater facilities, whenever applicable

Renewable Energy Market Assessment

Utility

Medium - long term

seek Public Private Partnerships for solar PV installation and maintenance.

Immediate

Regularly monitor energy consumption and efficiency through scheduled energy and financial audits.

Project Key Takeaways

- The interdependencies and tradeoffs between water and energy require an integrative approach to policy planning and resource management.
- There is a need for a supportive knowledge-base and an understanding of these interlinkages and systems.
- Lebanon lacks a comprehensive assessment of energy consumption and efficiency in water and wastewater service provision.
- Lebanon's 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.

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Role of Wastewater Treatment Facilities as Sources of Renewable Energy

Project Dimensions

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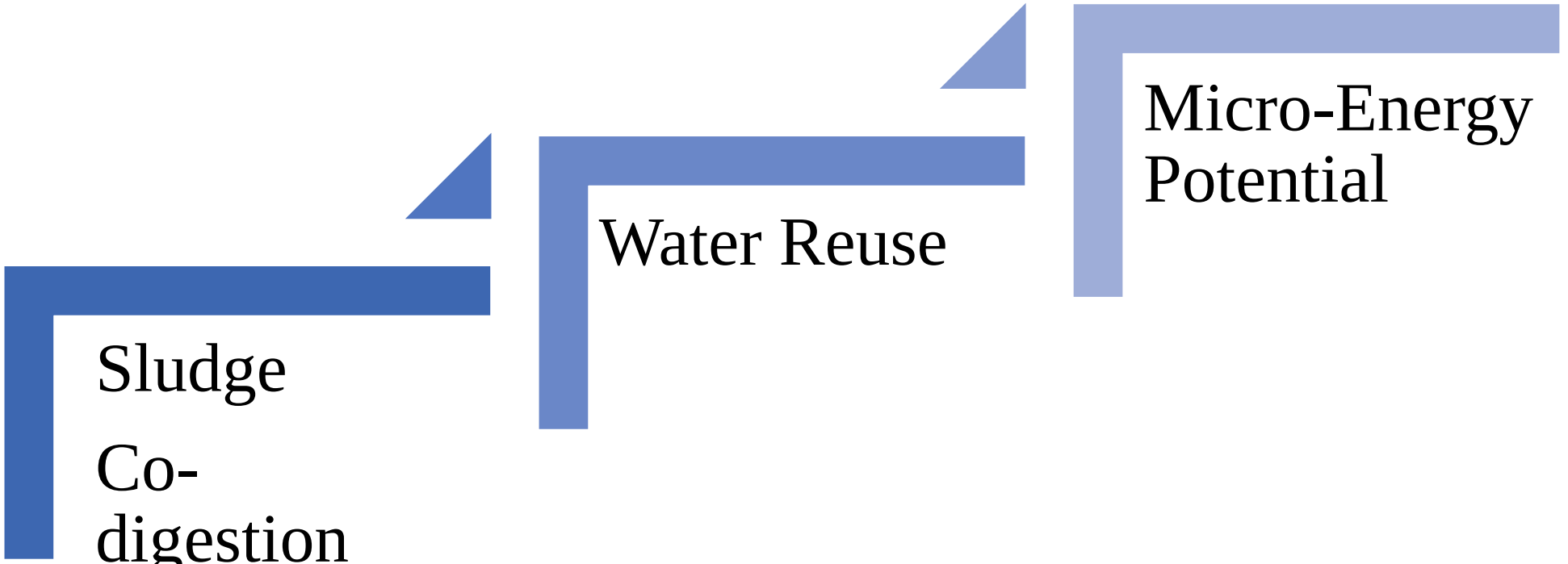
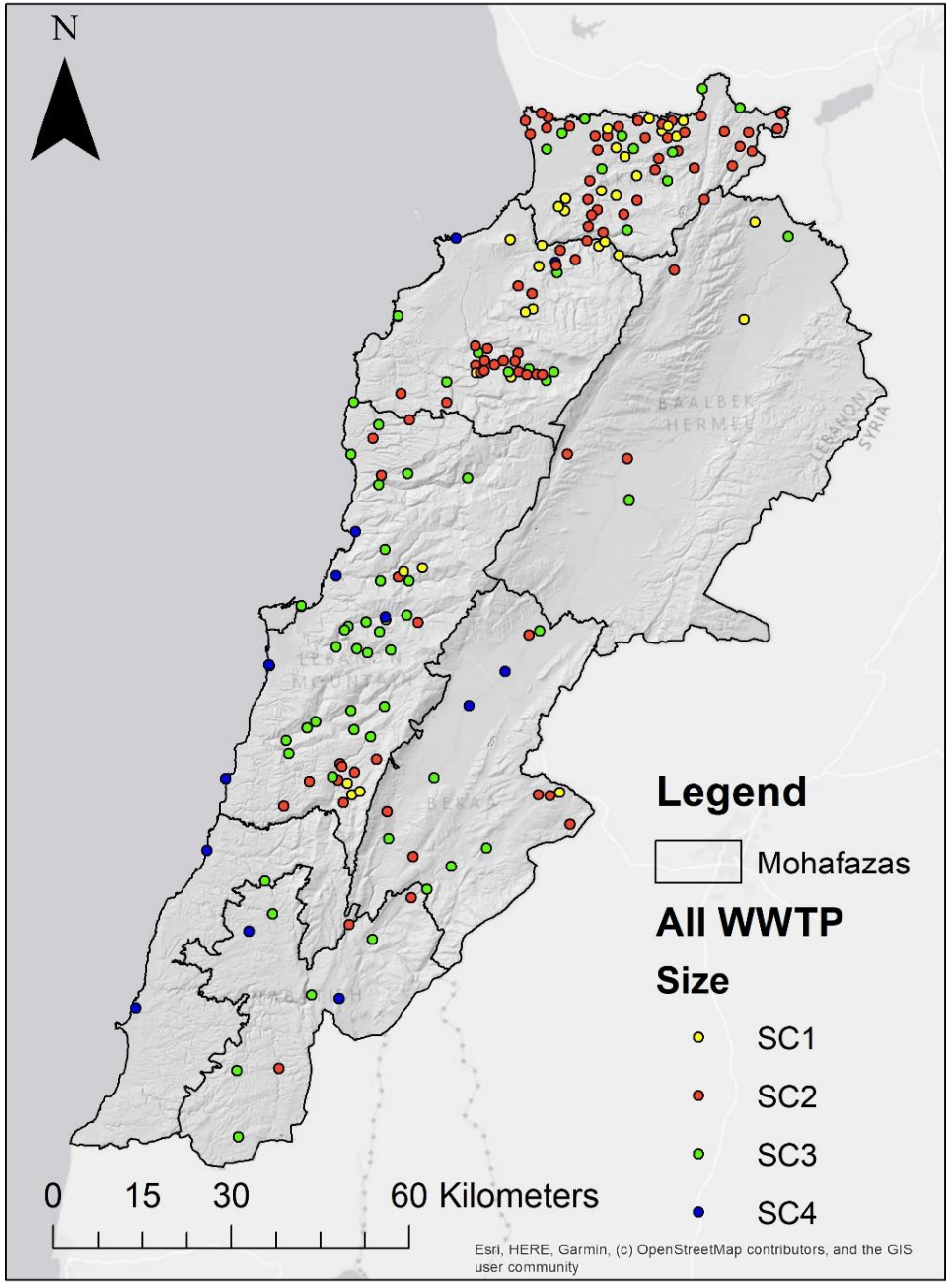


WWTP in Lebanon

Size class	PE range	Q(m3/day)
SC1	<2,000	<300
SC2	2,001-10,000	300-1500
SC3	10,001 - 100,000	1500-15000
SC4	>100,000	>15000

$$PE = Q(\,m^3/day)/\,Q(m^3/da\,y/p\,ers)$$

$$Q{=}0.15\,m^3/day/pers$$



WWTP Status

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271 WWTP

68 Existing

198 Proposed

5 Under Construction

33 Operating

4 SC1	Baadarane, Jebah, Kouakh, Mriste
9 SC2	Ammatour, Bater, El Fourzol, El Jdeide, El Khreibe, El Moukhtara, Maaser el Chouf, Qabaait, Saghbine
4 SC3	Ablah, El Barouk, Joub Janine, Machghara
6 SC4	Al Ghadir, Nabatiye, Ras Nabi Younes, Sainiq, Tripoli, Zahle
10 N/A	Aaychiye, Bteddine El-Lekche, Dahr Er Ramli, El Ghabbatiyeh, El Rihane, Haitoura, Kaitoule, Kfarkatra, Sniye

(Ministry of Energy and Water,2020)

Sludge Co-Digestion

- Depending on the size of the WWTP, three main cases can be identified:

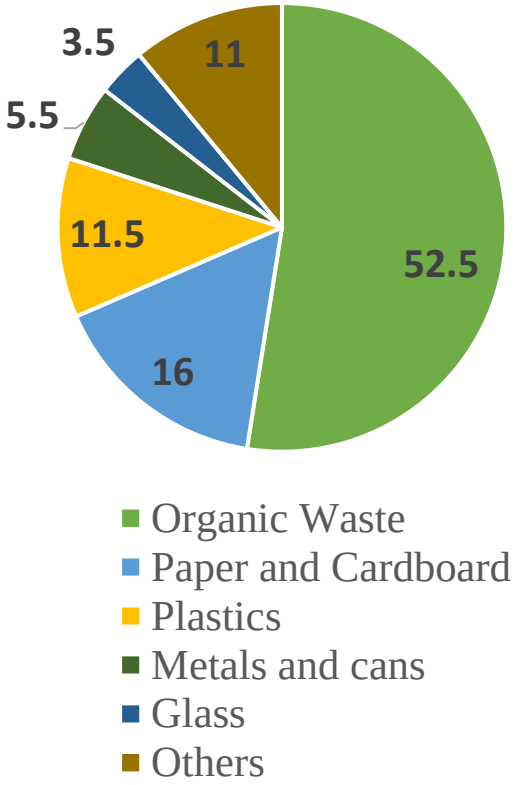
Case 1:Existing WWTP Large plant and external sludge (SC3,SC4)	Case 2:Proposed WWTP Medium plant and external sludge(SC2)	Case 3: New WWTP One co-digestion central unit
• Accept sludge from small plants (20km to 30km away) • Minor technical adjustment to existing WWTP.	• Entire WWTP must be designed to manage (proposed WWTP). • Form of centralization of sludge digestion	• Complete plant has to be largely designed with pre-treatment to accept sludge from small WWTP nearby

Characteristics of possible substrates

Substrate	Advantages	Disadvantages
Liquid Manure	- Stabilizes the process - Provides humidity for dilution - Contains necessary trace elements - Consistent supply	Low biogas production
Agro-food waste	High biogas production	- Seasonal - Some presence of unwanted components.
Organic waste from municipal collect	High biogas production	- Not recommended due to the need of very intense sorting.

(UNDP/ CEDRO, 2013)

Solid waste composition in Lebanon



(SWEEP NET, 2014)

Potential recovery from Co-digestion

Look into all WWTPs

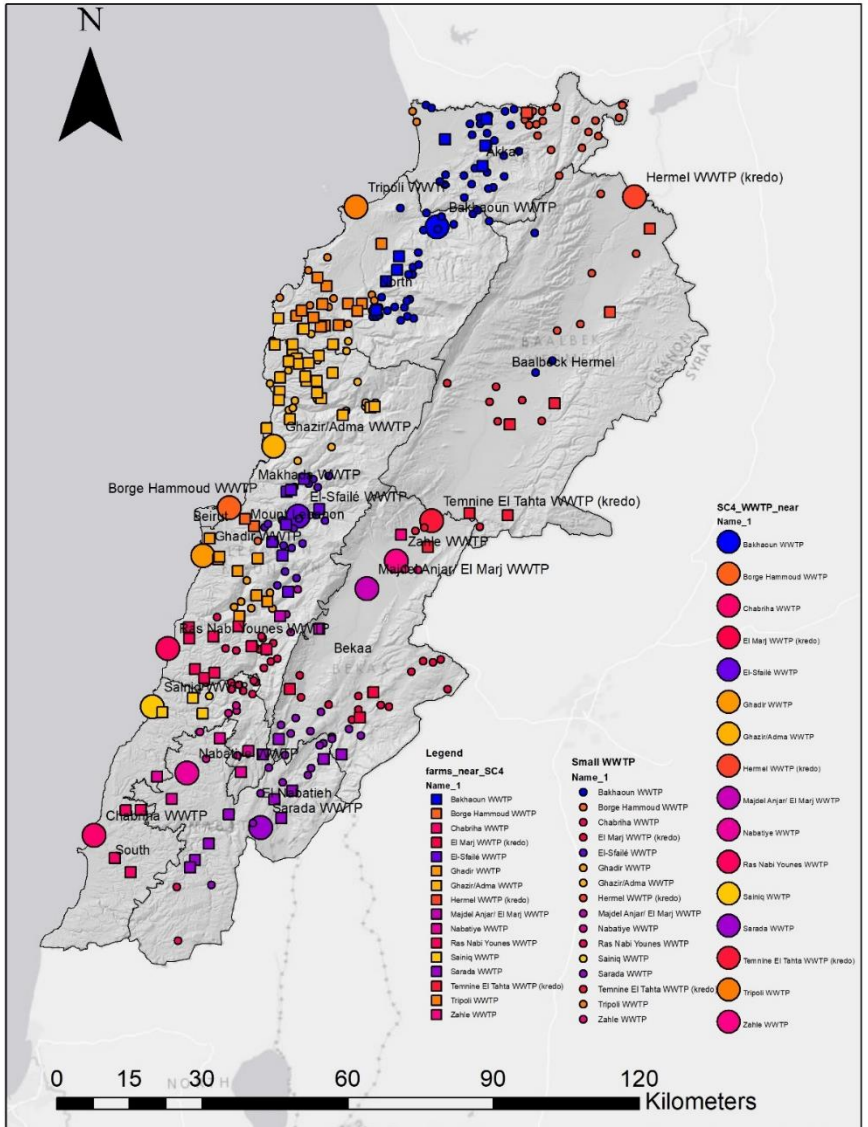
Select large WWTPs: SC3 & SC4

Existing farms nearby (30km radius)

or

Existing small WWTPs nearby (30km radius)

Potential energy recovery from sludge co-digestion



Potential Water Reuse

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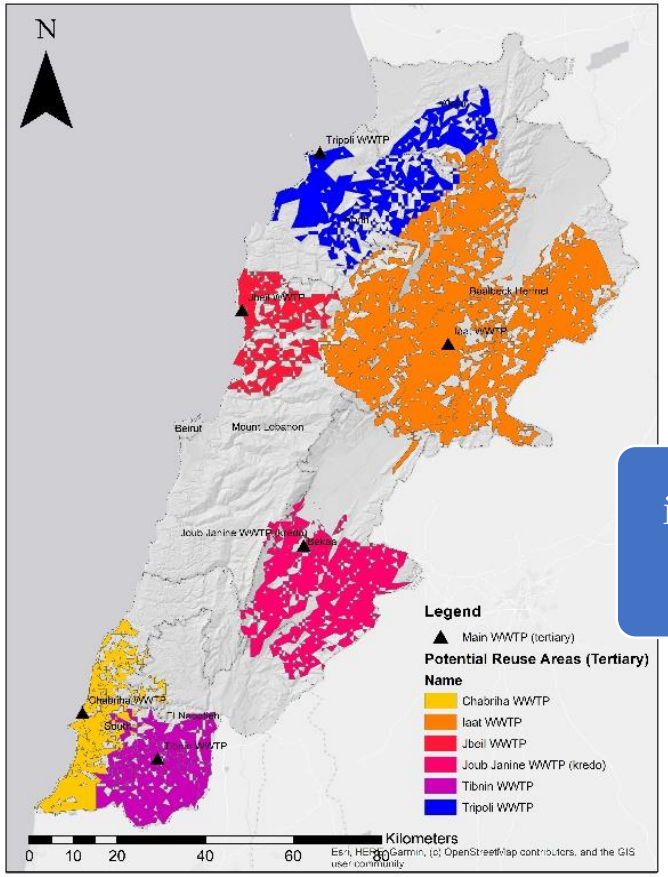


Look into all WWTPs

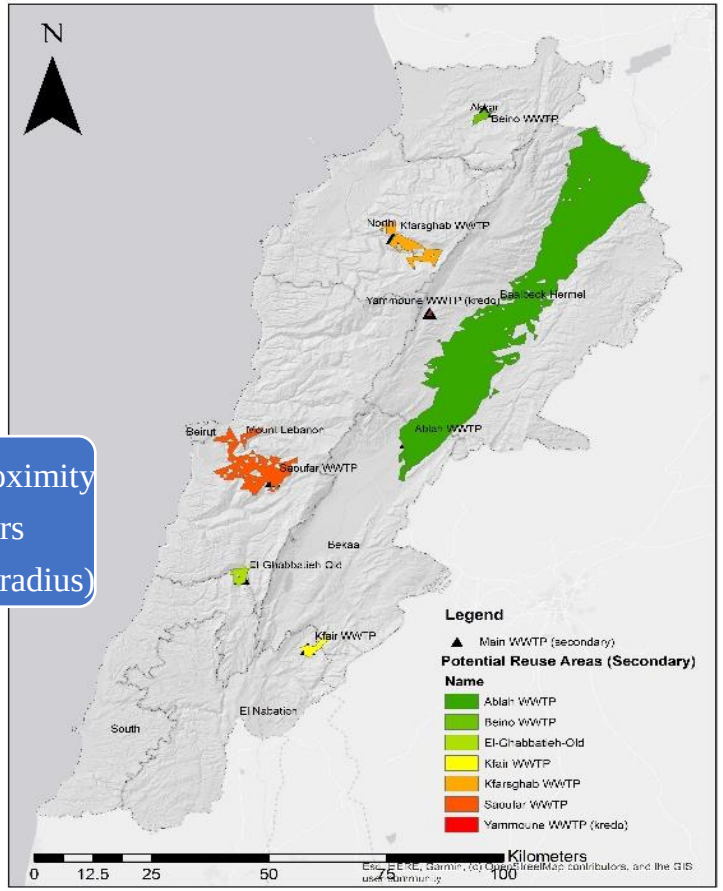
Select large WWTPs: SC3 & SC4

Located in industrial zones (or at a 30km radius)

Located in agricultural areas (or at a 30km radius)

Located in proximity of aquifers (or at a 30km radius)

Potential water reuse for agricultural/industrial purposes or groundwater recharge.



Micro-hydro Energy Potential

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Site Selection

Choose minimum power(P) to be economically viable

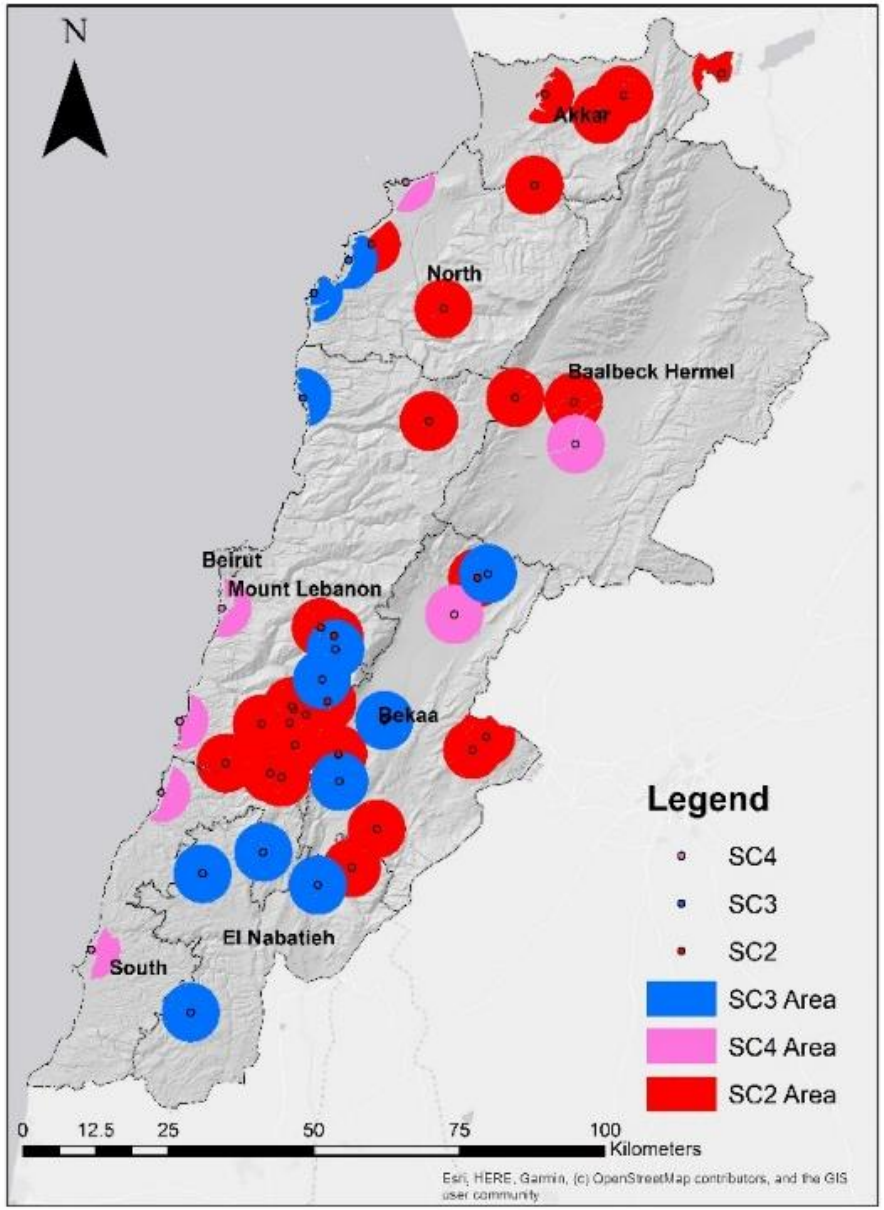
Calculate minimum required dynamic head (H) using:

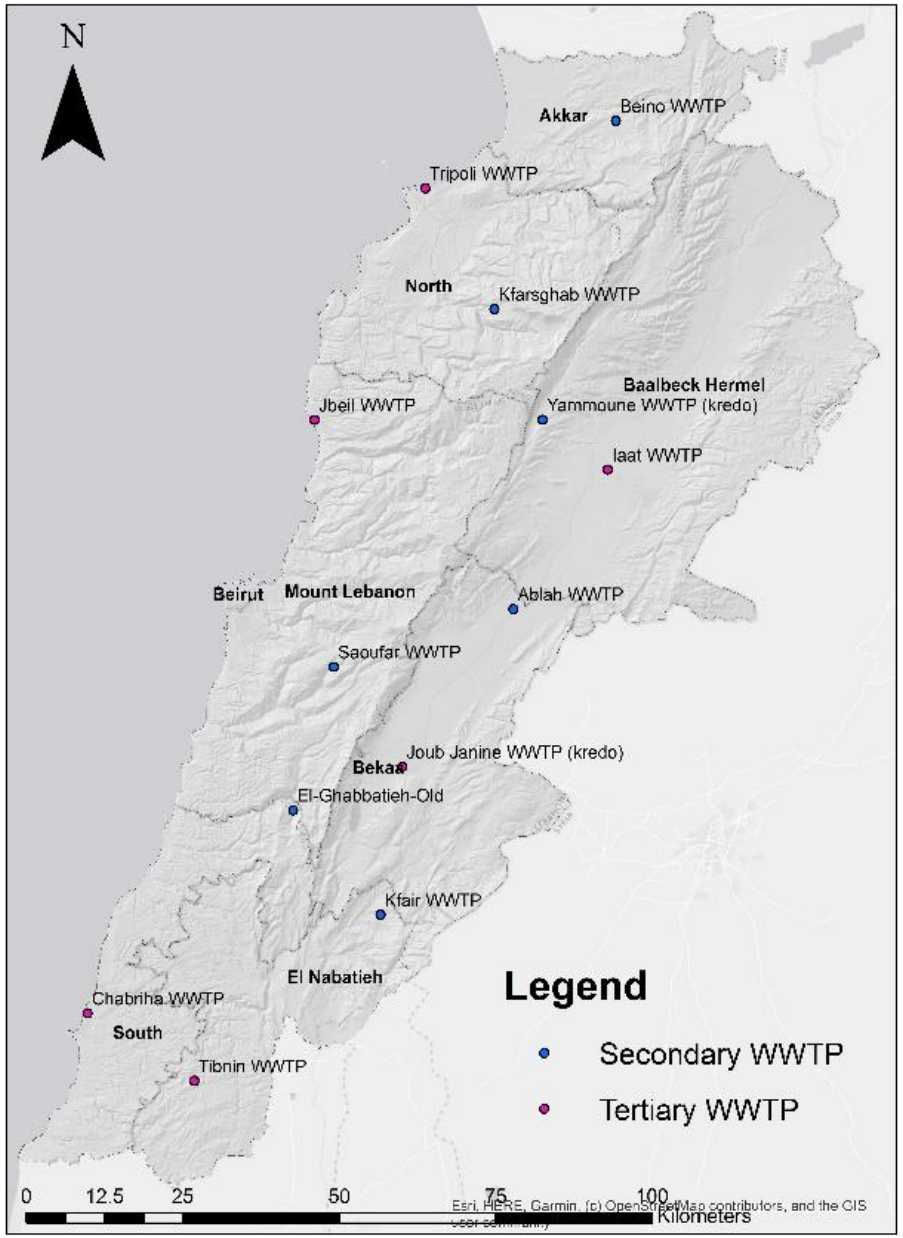
$$P = \eta \rho g Q H$$

Look for sites having a difference in height between the wastewater treatment works and the discharge point higher than H

Potential of micro-hydro energy

(García et al., 2021)





13 Selected WWTPs

Thank You

For further information please contact me at:

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Energy Audit in the Water Sector

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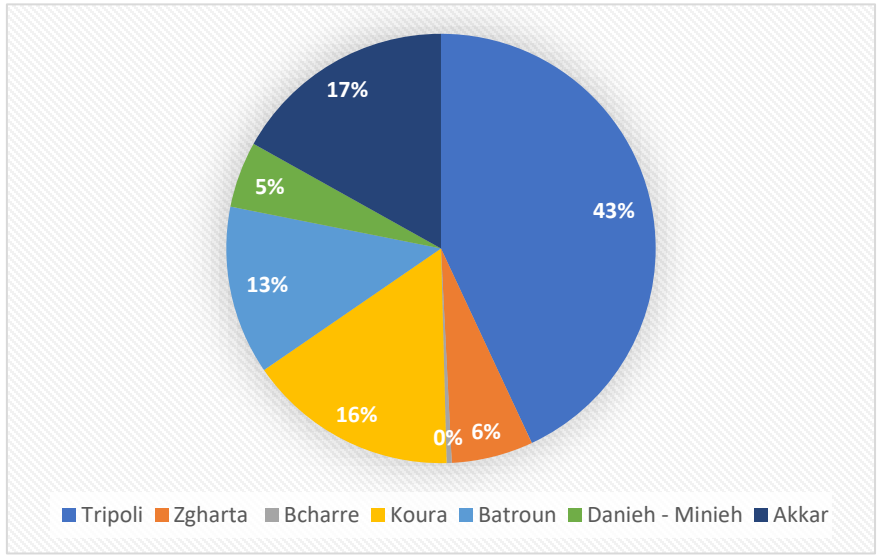
Electricity Bills Analysis (2016-2017-2018): NLWE

Unpaid bills

Caza	2016 (L.L)	2017 (L.L)	2018 (L.L)
TOTAL (L.L)	6,759,625,000	7,287,542,000	8,827,437,000
TOTAL (USD)	4,506,416.67	4,858,361.3	5,884,958

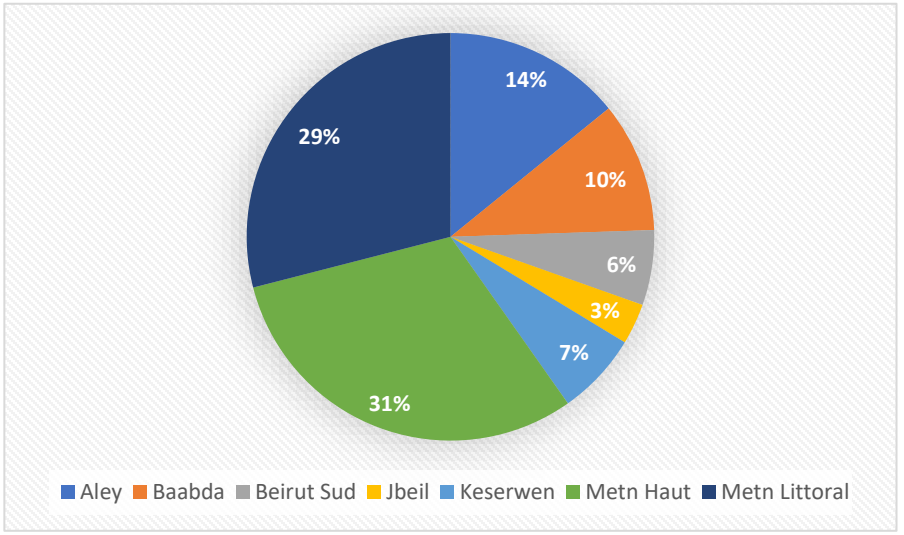


3 years Deficit on NLWE to EDL/Qadisha: 23 Billion LBP = 15.3 million USD

Electricity Bills Analysis (2016-2017-2018): BMLWE

Paid bills

Caza	2016 (L.L)	2017 (L.L)	2018 (L.L)
TOTAL (L.L)	18,076,888,016	19,145,353,017	22,225,088,018
TOTAL (USD)	12,051,258.67	12,763,568.67	14,816,725.34



3 years Total electricity cost on BMLWE to EDL: 59.3 Billion LBP = 39.5 million USD

LBP/USD exchange rate set at the old rate of $1 = LBP 1,500

Energy Audit in the Water Sector

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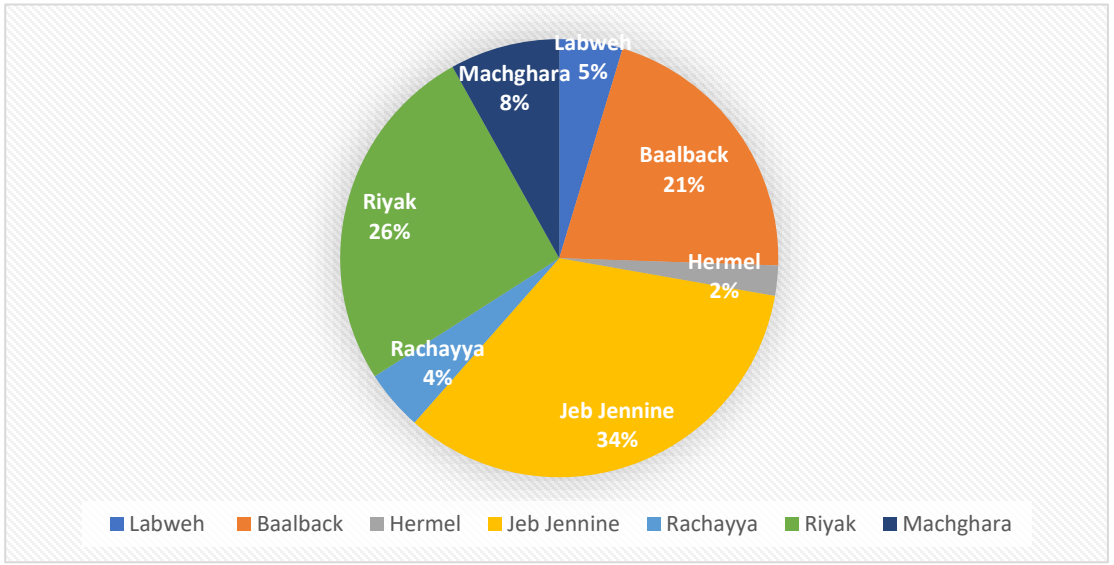
Electricity Bills Analysis: Bekaa Water Establishment

Unpaid bills

BWE

EDL/EDZ bills for 2017:

8,495,452,193 LL Or 5,663,635 USD



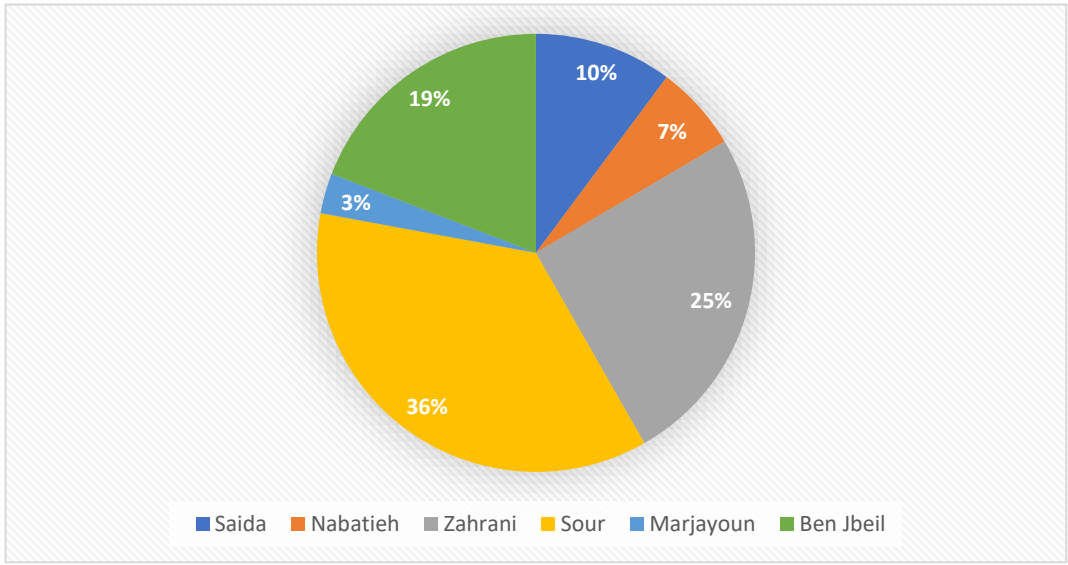
South Lebanon Water Establishment

Unpaid bills

SLWE

EDL bills for the audited station in 2018:

9,276,497,000 LL Or 6,184,331.33 USD



LBP/USD exchange rate set at the old rate of $1 = LBP 1,500

Water Analysis: In-Depth Energy Audit For Water Stations

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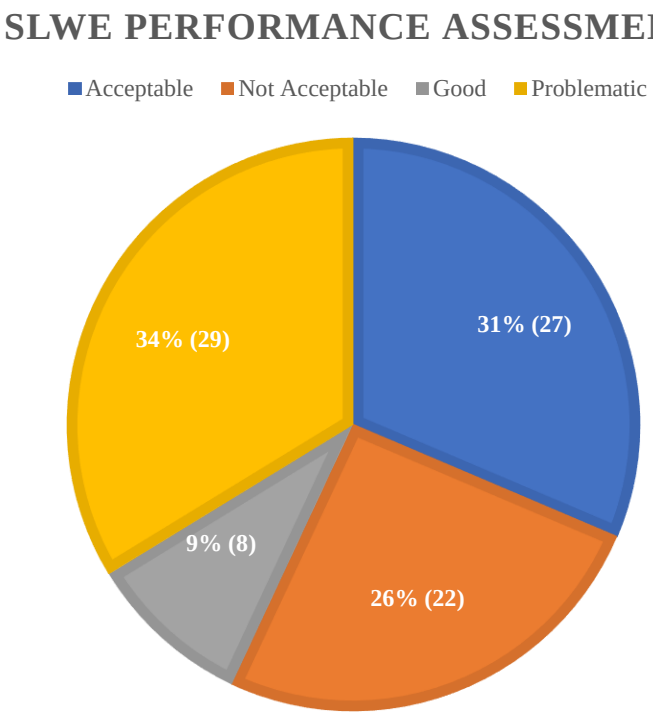
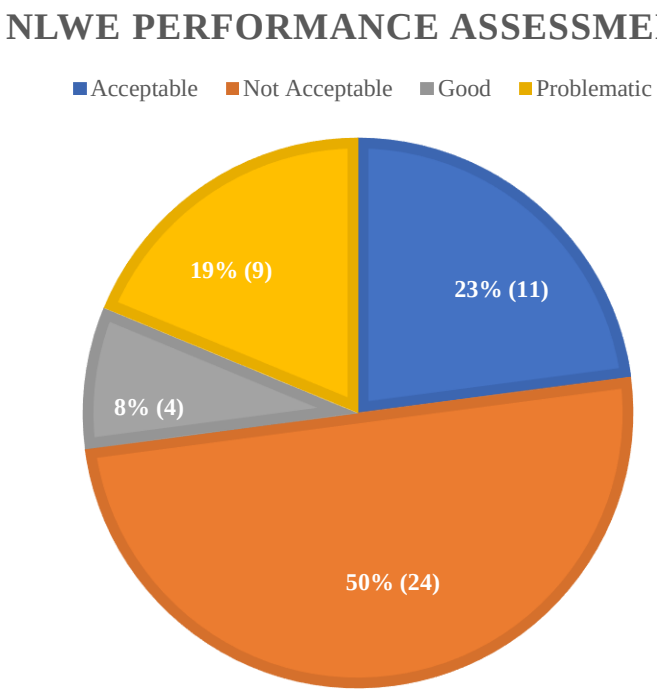
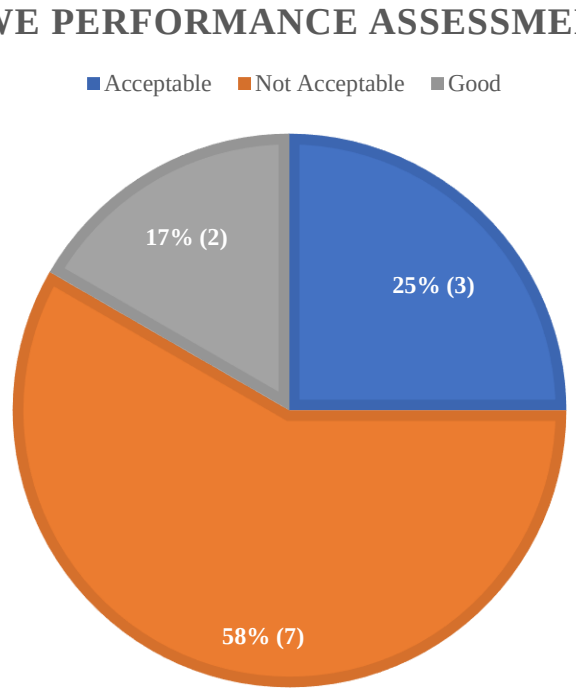


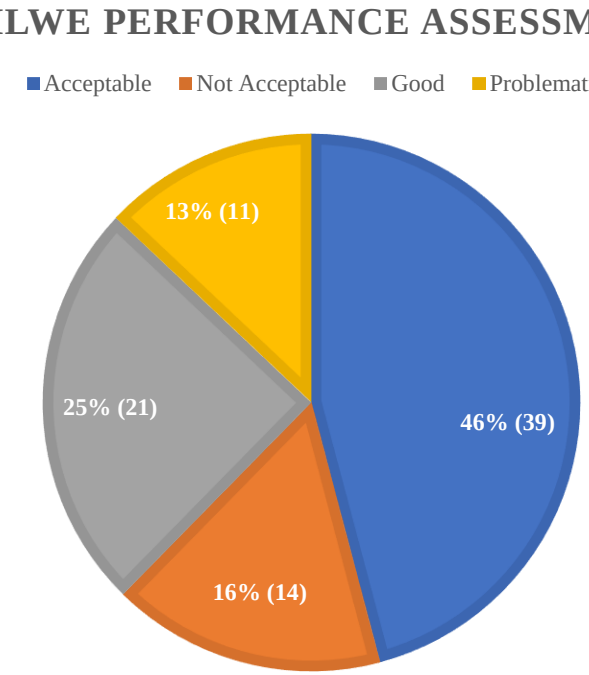


*SLWE data analysis has revealed that around 40% of the pumps fall in the good and/or acceptable ranges while the remaining **60%** are either not acceptable (26% or 22 pumps), i.e. performing below the 60% performance limit, or problematic (34% or 29 pumps), i.e. exceeding the 88% performance limit.*

*Around **70%** of NLWE's pumping systems are not performing well, where 50% (24 pumps) of the stations have a performance assessment below 60%, and 19% (9 pumps) are identified as problematic. Those are located in Bahsas, Qobbeh, Jradeh, Chekka and El Oyoun pumping stations.*

Water Analysis: In-Depth Energy Audit For Water Stations





*BWE reflects the highest percentage (**58%**) among all establishments for unacceptable pumping systems showing a performance assessment below 60% for a total of seven pumps, five located at the Loussi station and two pumps at the Chamsine station. The remaining two pumps in the latter show a problematic performance assessment.*

*BMLWE performance assessment shows that 46% of the available pumping systems (39 pumps) are within the acceptable 60-75% range, in addition to around 25% (21 pumps) which are in a good condition. Both clusters of pumps result in around 70% of the pumps which have acceptable performance assessment, leaving the remaining **30%** between unacceptable and problematic ranges.*