LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

Micro to Small Scale Hydro-Power Assessment for Public Utilities and Networks in Lebanon

ESCWA Workshop on Water Energy Nexus – 11th - 12th July 2017

Presented by Mr. Karim Osseiran – BEE
Advisor to H.E. the Minister of Energy & Water

Acknowledgements

CEDRO
Empowering Lebanon with Renewable Energy

entec

This project is funded
by the European Union

UNDP
Empowered lives,
Resilient nations.

Dr Hassan Harajli

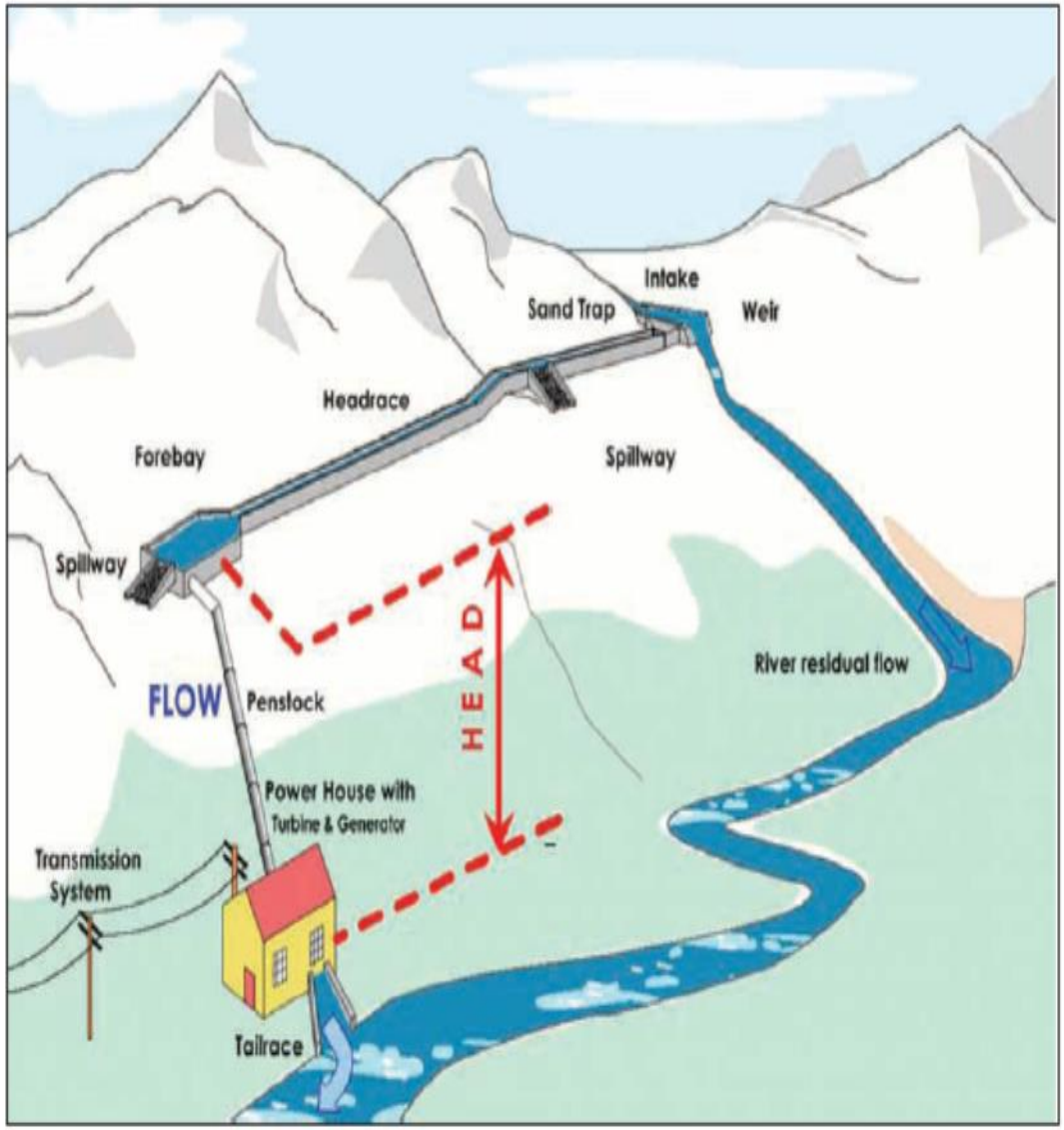
Mr Samer Sufer and Mr Gerhard Fischer

Table of contents

1. Study Background

- Lebanese government initiative in achieving 12% of its total energy needs from renewable energy sources by 2020
- The electricity demand in Lebanon exceeds the supply capacity of the existing plants
- The Lebanese government plans to use further potential sources for electricity generation, anywhere and everywhere they are technically and economically feasible, particularly focusing on renewable energy sources

2. Hydro Generation Principles



Typical example of a diversion type run-of-river hydropower plant

The **hydraulic potential** is defined as:

$P_{hy} = Rho * G * H * Q$

Where

P_{hy}= potential hydraulic power (W)

Rho = density of water =1000kg/m^3

G = acceleration due to gravity = 9.81m/s

H= head difference of water levels at inlet and outlet (m)

Q= water flow (m^3/s)

3. Water Energy Nexus Potential

- Irrigation Channels and Conveyers
- Waste Water Treatment Plants Inlet and Outfall Pipes
- Thermal Power Plants Outfall Pipes
- Drinking Water Distribution Networks

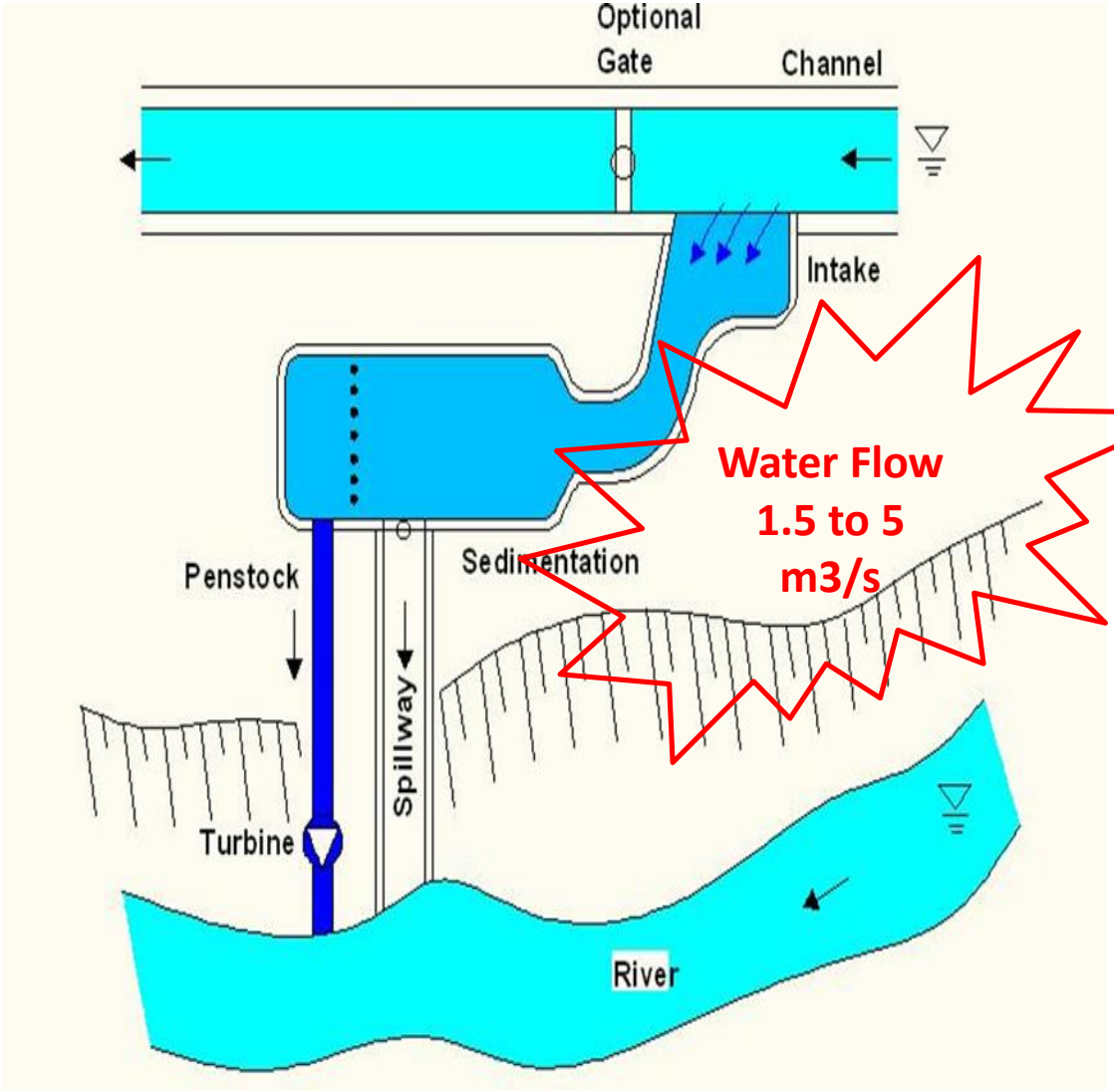
3. Water Energy Nexus Potential

Irrigation Channels and Conveyers

Quasmiyeh irrigation intake

3. Water Energy Nexus Potential

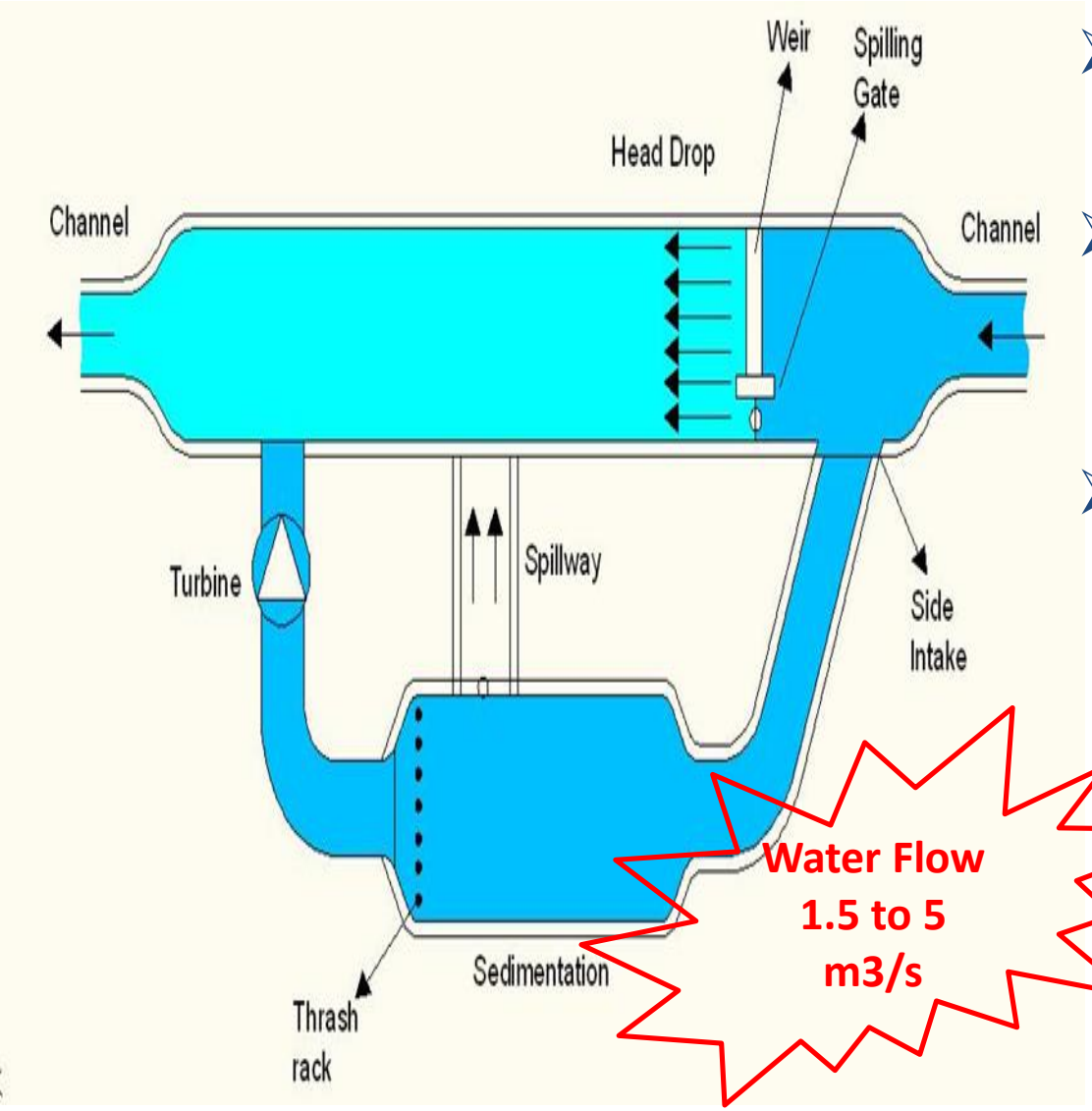
Irrigation Channels and Conveyers (A)



- Use a hydropower potential in a bypass leading from the channel back to the river
- Can only operate outside of the irrigation period
- High risk of conflict of interest between irrigation and power production

3. Water Energy Nexus Potential

Irrigation Channels and Conveyers (B)



- Use of a head drop in the channel itself
- The operating time is normally linked to the irrigation period
- Potential can be used without restrictions during the irrigation period or even outside the irrigation period if the channel can be used and the required flow is available

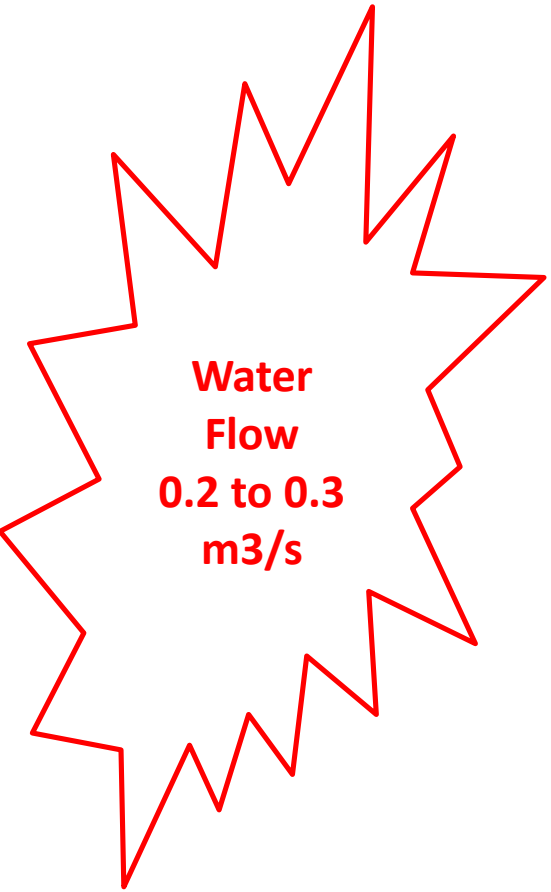
3. Water Energy Nexus Potential

Waste Water Treatment Plants Inlet / Outfall Pipes

Jieh Waste Water Treatment Plant

3. Water Energy Nexus Potential

Waste Water Treatment Plants Inlet / Outfall Pipes



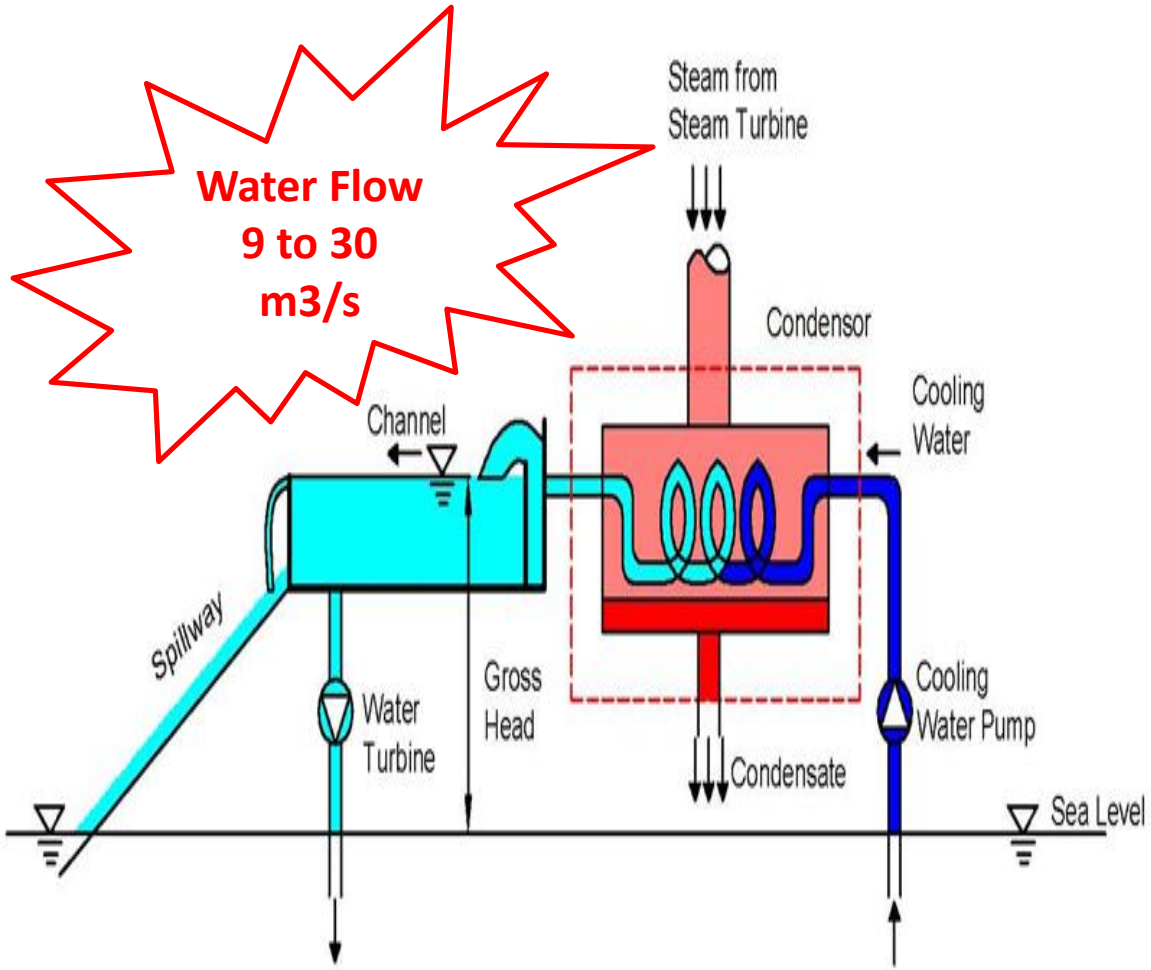
- All visited plants had been designed to reach their maximum capacity in around 20 years and they are not yet connected to the city networks
- The treated water would discharge at long distance into the sea
- Due to the small flow and head none of the visited wastewater treatment plants in Lebanon would offer a hydropower potential of more than 10 kW (pico hydro)
- Most of the WWTP are still under construction and review, and therefore potential hydropower applications may be considered at the design stage

3. Water Energy Nexus Potential
Thermal Power Plants Outfall Pipes

Deir Ammar Combined Cycle Power Plant Outfall Channel

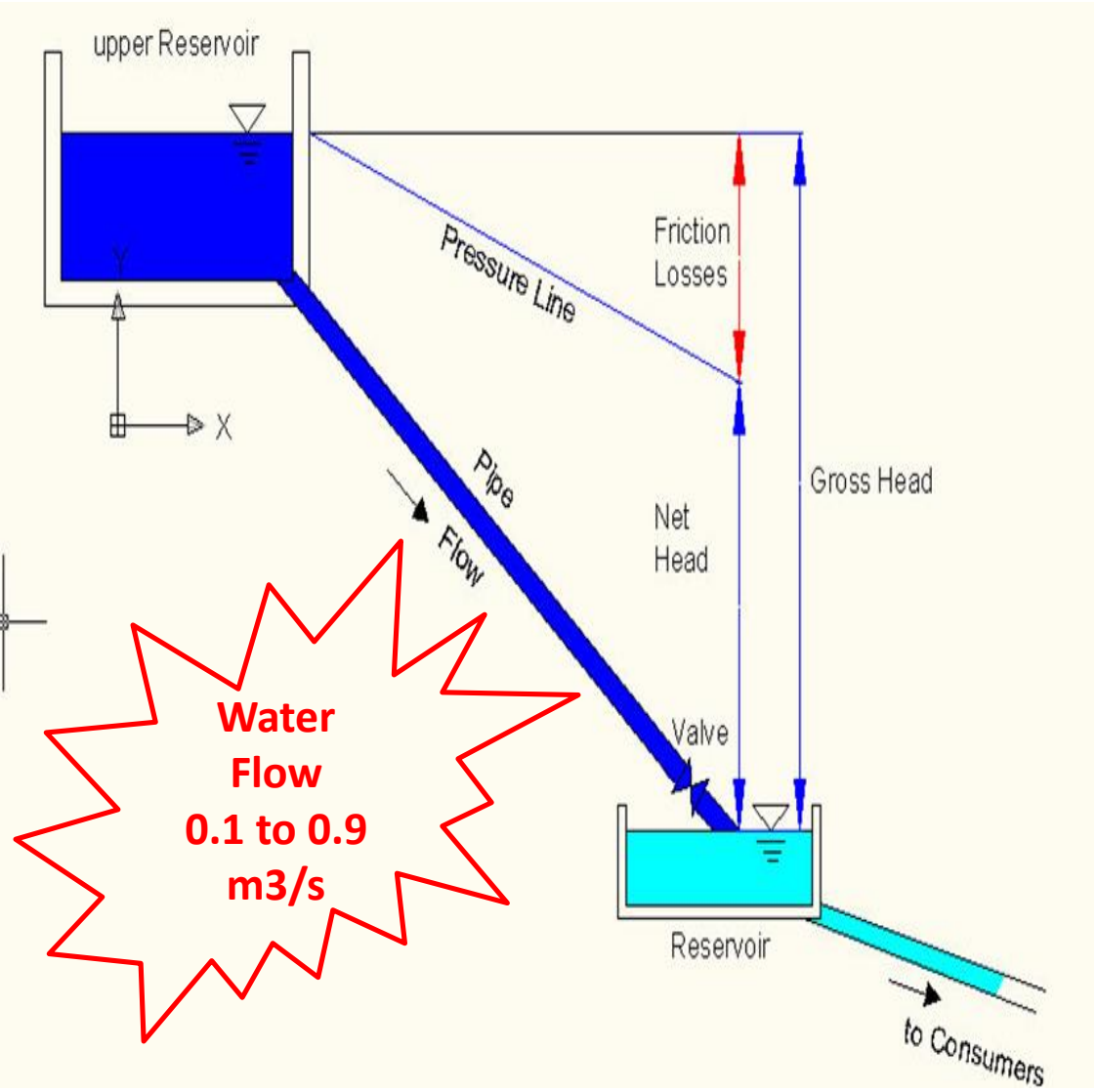
3. Water Energy Nexus Potential

Thermal Power Plants Outfall Pipes



- High production
- Hydropower system can be integrated in existing infrastructure
- Data available
- Easy access to the site
- Operation and maintenance can be done by the thermal power plant staff
- Produced power can be easily evacuated

3. Water Energy Nexus Potential
Drinking Water Distribution Networks



- The current distribution network in Lebanon use small pipes with high friction losses to reduce the pressure instead of pressure breakers
- Bigger pipe diameters would allow using the available head for energy production
- At lower consumption and thus lower flow (e.g. during night time) the available pressure is higher
- Depending on the turbine specifications a hydropower system would have to be shut down (in case of very low flow or very high head)

4. Assessment Methodology

Site Visits

- Main function of the existing infrastructure
- Location and existing layout documents
- Hydrological data: Water level (up and downstream); flow duration curve (if available); flow measuring system (available or not)
- Water quality
- Consumption data and the sources for the drinking water system
- Beneficiaries of a potential hydropower plant and location of a possible electrical grid interconnection point

4. Assessment Methodology
Potential Analysis

General: High benefit at low cost / High probability of sustainable operation

Technical: Power output, Annual production, existing Infrastructure, Head, expected complexity of civil/E&M works

Economical: Ratio of total investment costs to annual revenue. This value corresponds to the payback period*

Logistics and Organisation: Access to the site, location, reliability of available data, beneficiary conflict, social or environmental impacts, grid connectivity

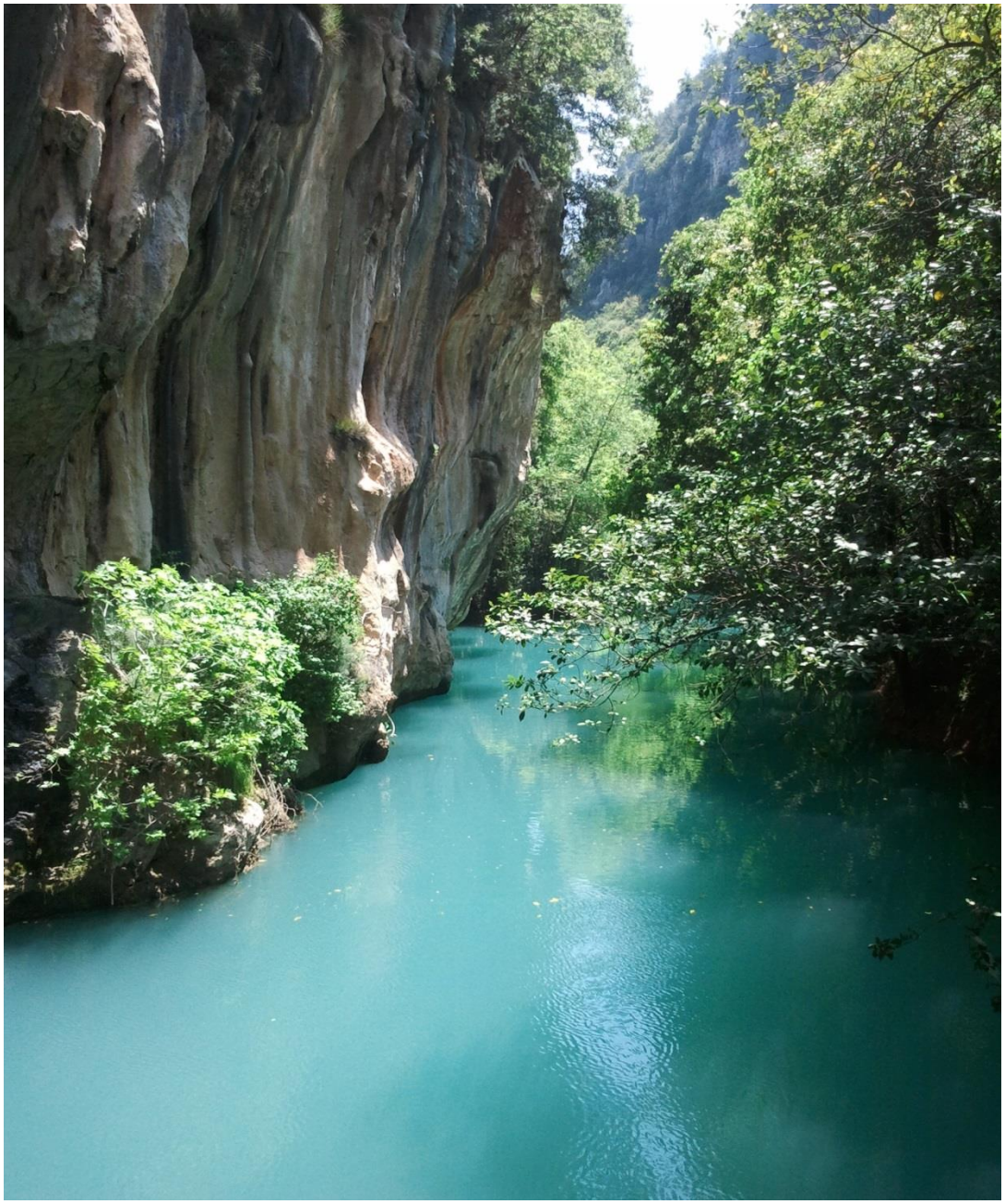
*The current tariff structure is based on an oil price of US$25/barrel and has not been adjusted to take into consideration the fluctuations of the oil prices in the recent years. The overall average selling tariff in Lebanon is US Cents 9.4/kWh. In reality the production costs are about US cent 14/kWh for an oil price of US$60/barrel.

5. Results

Micro Hydro Stream	Public Institution	No. of Studied Sites	MW
Irrigation Channels & Conveyors	Water Establishments, Ministry of Agriculture	**4**	**1.270**
Waste Water Treatment Plants Intakes & Outfalls	Water Establishments, CDR	**1**	**0.123**
Electric Power Plants Outfall Channels	EDL Electric Power Plants	**5**	**3.421**
Municipal Water Distribution Networks	Water Establishments, Municipalities	**4**	**0.144**

6. Conclusion & Recommendations

- Non river based hydro power plants have a limited potential in Lebanon
- A well-defined feed-in tariff for hydropower which exceeds the specific production costs (per kWh) would encourage also private investors → real production cost as minimum
- Investment in hydro power systems which can be integrated into thermal power plants in Lebanon is found to be economically attractive due to high load factor and high avoided costs
- Hydro power in irrigation systems in Lebanon can be interesting in case the operation period is longer than 5-6 months; if the water is flowing all year round via the irrigation channel (in wet and dry season), hydropower exploitation would become even more attractive
- Hydro power in Drinking Water distribution systems & Waste Water Treatment Plants has to be further investigated



Yahchouch Dam – Nahr Ibrahim

Thank You for your Attention ☺

Karim Osseiran , BEE

karim.m.osseiran@gmail.com