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THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

Hidden and Untapped Hydropower Opportunities in existing Infrastructures

Multipurpose projects : Overview and return on experience

Vincent Denis (Mhylab)

Annex XVI workshop – July 1st, 2021

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Multipurpose use of water

- Almost 30 years of Swiss support to the development of energy recovery in existing or planned infrastructures and more than one century return on experience.
- Water + Difference of level + flow = Potential hydropower
- Drinking water, wastewater, irrigation, ecological flow, fish pass system, navigation locks and dams, cooling systems = Hidden hydro
- Never forget that electricity generation is a secondary function (multipurpose scheme)
- Specific know how is needed as well for the design of the scheme, as for the design of fully adapted equipment.
- Unless specified, Mhylab direct return of experience.

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Environmental flow and attraction flow

Le Day (CH) – Environmental flow -126 kW – 2017
Variable speed operation due to variable head.
300 to 600 l/s – 17 m < Hn < 27 m
580'000 kWh/year
Production sold to the grid

Verbois (CH) – Environmental flow -348 kW – 2003
2000 l/s – 21 m
2'720'000 kWh/year
Production sold to the grid
Geos Ingénieurs conseils SA/JMC Engineering

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Drinking water turbining (High head)

La Zour (CH) – Savièse Community– 2004
1’800’000 kWh/year
Upstream of the reservoir
Porduction sold to the grid

3-nozzle Pelton turbine
Q = 300 l/s
Hn = 217 m
465 kW

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Drinking water turbining (Low head)

Poggio Cuculo (I)
Nuove Acque – 2010

Single regulated axial turbine

P = 45 kW
Q = 280 - 380 l/s
Hn = 12.5 to 27.0 m

Variable speed operation

360’000 kWh/year

Production used by the treatment plant

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Irrigation water

Armary (CH) – 68 kW – 2006
Pressure used for irrigation network during irrigation period

2-nozzle Pelton turbine
Hn = 105 m, Q = 90 l/s
580’000 kWh/year - Production sold to the grid

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Wastewater turbining – Before treatment

Profray (CH) – 380 kW
First installation 1993 -2007
New installation since 2008
Verbier ski ressort wastwater turbining

2-nozzle Pelton turbine
Hn = 430 m, Q = 100 l/s
800'000 kWh/year - Production sold to the grid
O&M around 40h per year

Wastewater turbining – After treatment

Terre-Sainte (CH) – 2016

Treatment plant outlet turbining

2-nozzle Pelton turbine – 110 kW
Hn = 430 m,
Q = 100 l/s
800’000 kWh/year

Production sold to the grid

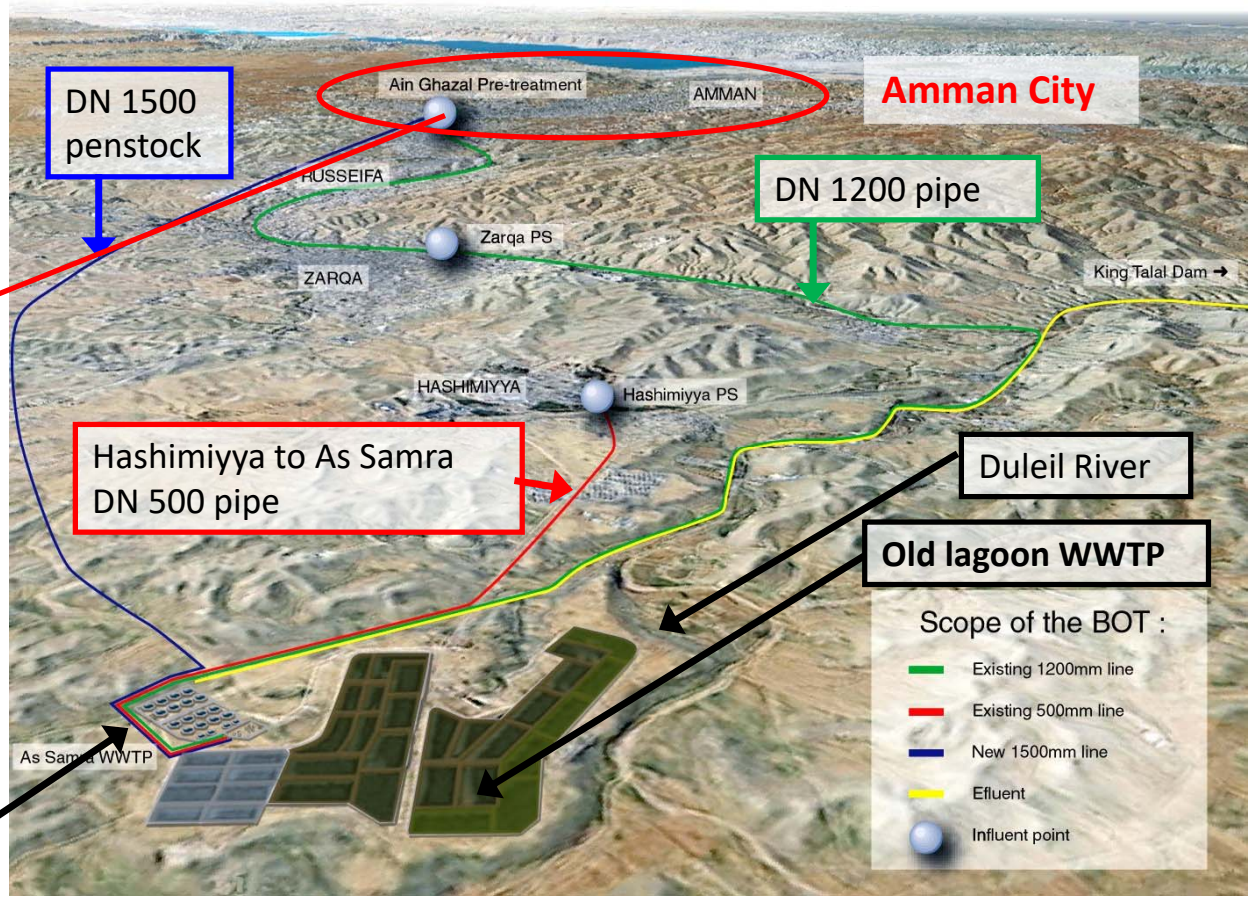
Regulated pressure reducer – Carnot type - Q = 0 to 170 l/s

Run off water

La Louve (CH) – 170 kW – 2006
Separation of run off water from wastewater and transport to the Lake.

2-nozzle Pelton turbine
Hn = 180 m, Q = 120 l/s
466'000 kWh/year - Production sold to the grid

Amman city area sewage system



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As Samra Inlet small HPP

2 five-nozzle Pelton — Pe = 2 x 830 kW

ΔZ = 104 m — E = 10.5 GWh/year

Q_n = 2 x 1.25 m^3/s — Commissioning : April 2007

H_n = 79.3 m @ Qn — Production used on site

Raw water turbines design challenges

- Trashes driven by the flow
- Strong head variation between part and nominal load
- Penstock's length (> 30 km)
- Strong H_2S concentration

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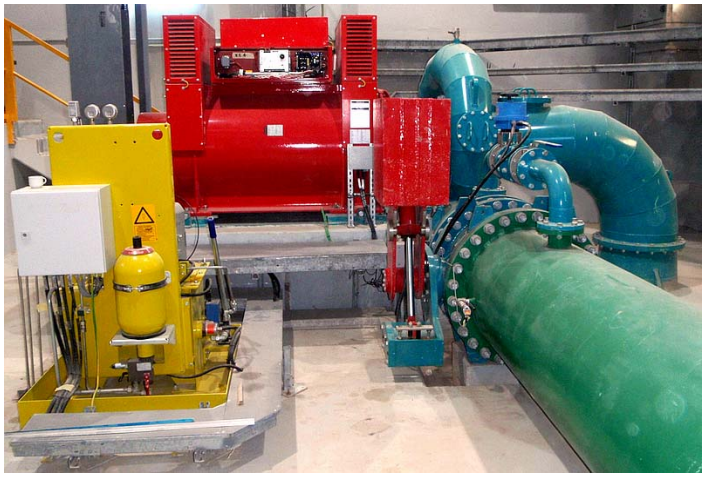
As Samra - Outlet small HPP

		Phase I	Phase II
ΔZ	m	42.1	42.1
Q_{max}	m^3/s	4.6	1.4
H_n	m	41.6	36.9
Nb of units	-	2	1
$Q_{N\ t}$	m^3/s	2.3	1.4
P_{el}	kW	2 x 750	490
Yearly production	GWh	8.5	

Treated water turbines design challenges

- Residual pollutant load
- Residual Cl_2 load due to water chlorination



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Conclusions

- Wide return on experience in Switzerland and abroad
- Technically and economically feasible
- Self consumption particularly interesting in wastewater treatment plants
- Low O&M costs when well designed
- Generally well accepted
- Simplified authorization procedures

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Thank you for your attention!

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