

# Experimental investigation of a pump-as-turbine (PAT) to recover the energy lost in drinking water networks

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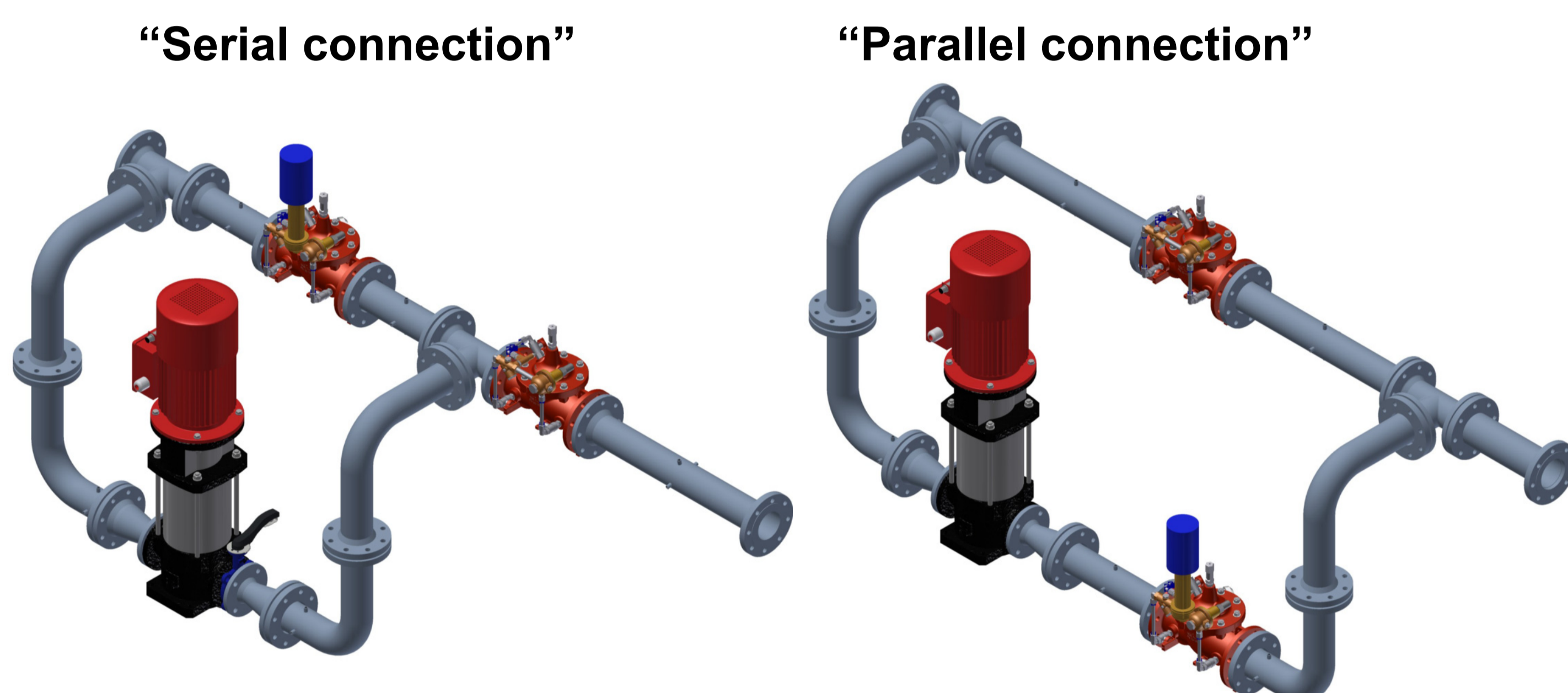
## Objective

The project focuses on the experimental investigation of a standard multi-stage pump used as turbine to recover the energy lost in a relief valve of a drinking water supply network.

Main project steps:

- ✓ Study of installation of a pump-as-turbine along with a regulation valve on the Savièse (Switzerland) pilot site;
- ✓ Design and manufacturing of two possible setting configurations (in series and in parallel), including a relief valve, a pump-as-turbine and a regulation valve;
- ✓ Experimental measurements campaign on the parallel version installed in the HES-SO Valais/Wallis universal hydraulic test rig.

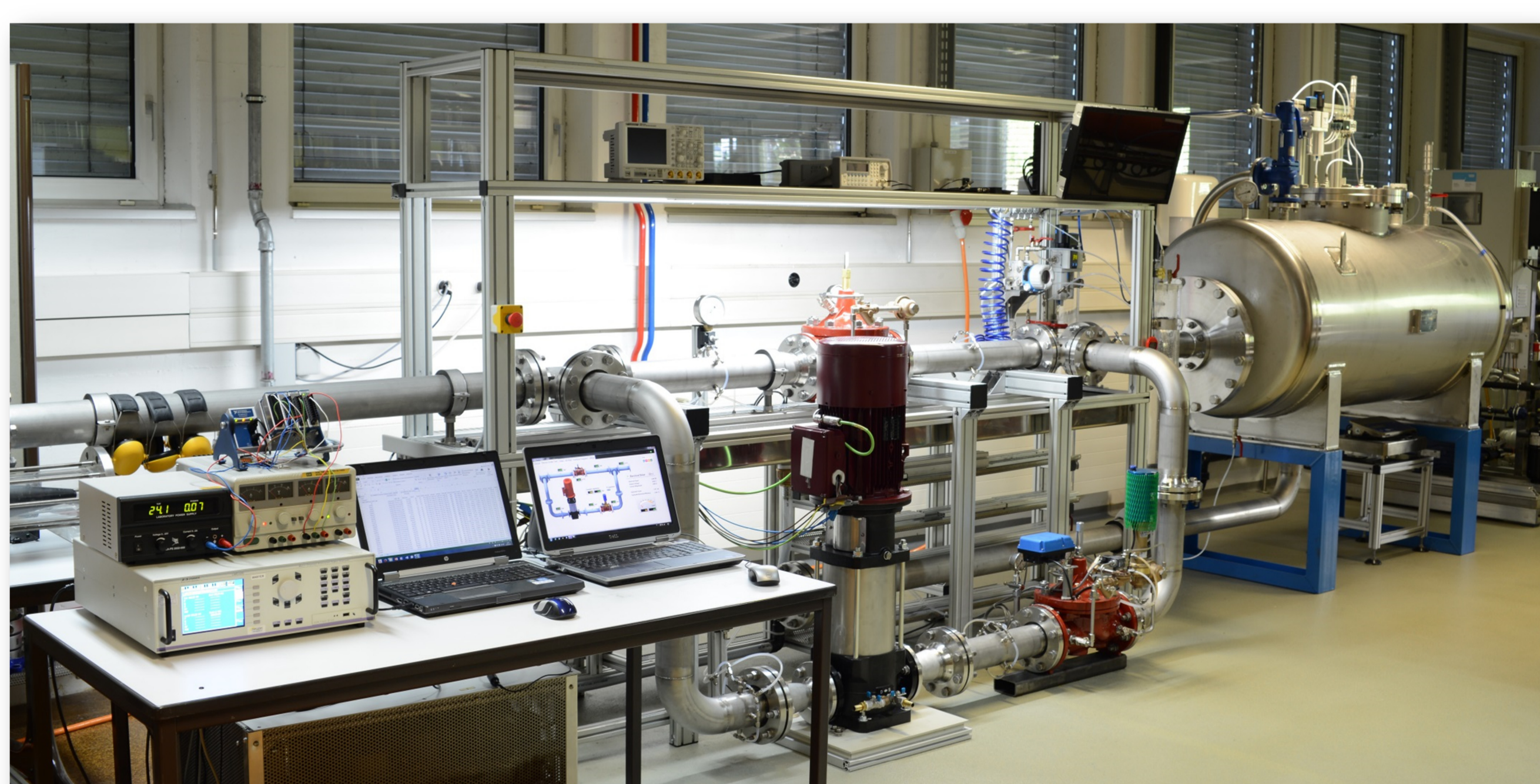
## Possible setting solutions



## Experimental setup and instrumentation

- ✓ Main components of the system:
  - Ebara EVMG32 5-0F5/11 pump as turbine – DN65, 5-stages
  - Leroy-Sommer LSRPM 132 M generator – 15.8 kW, 3000 rpm
  - ClaVal 90-G1E-01/KCOS relief valve - DN100
  - ClaVal PCM 49E-G1E-93/H1/KCOSX pressure reducing valve with actuated pilot – DN100
- ✓ Connection scheme: “parallel” - similar with the one of the pilot site
- ✓ Instrumentation:
  - Performed in accordance with the IEC 60193 standard
  - List of main employed instruments:

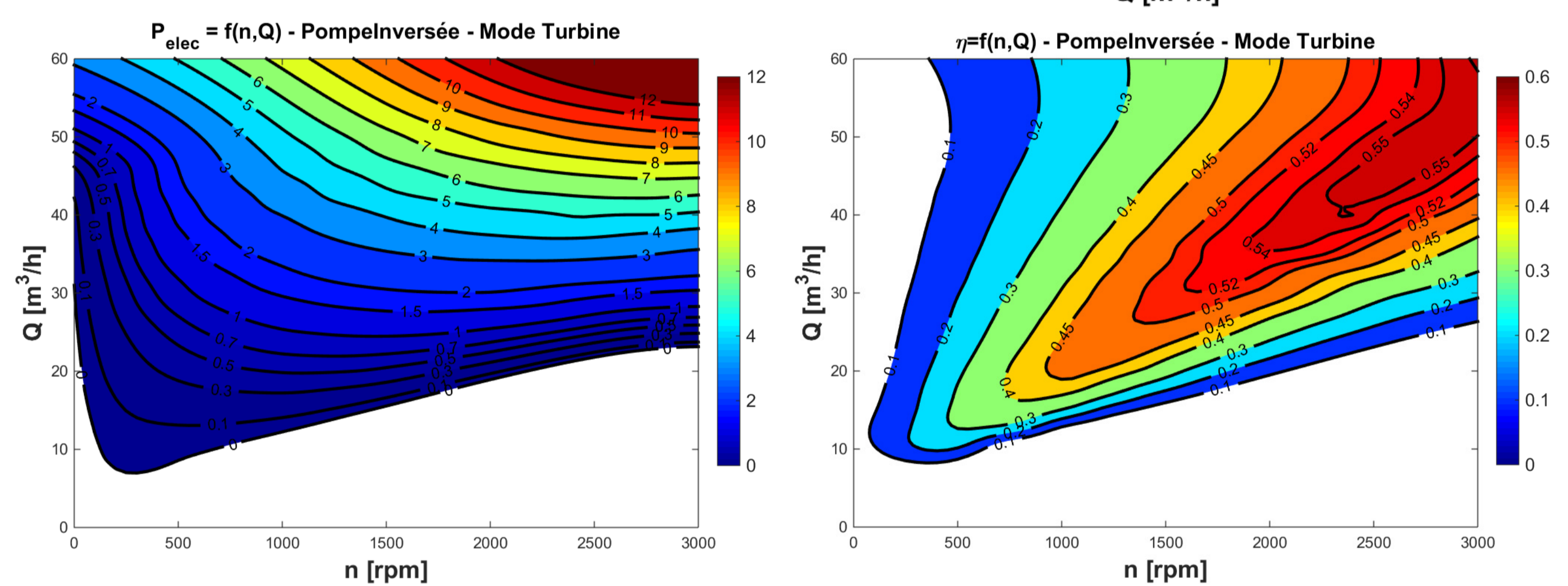
Measured quantity	Sensor type	Range	Precision
Discharge, Q	Electromagnetic flowmeter	0..±60 [m <sup>3</sup> /h]	± 0.5 [%]
Head, H	Differential pressure sensor	0..16 [bar]	± 0.1 [%]
Setting level, H <sub>s</sub>	Differential pressure sensor	0..5 [bar]	± 0.2 [%]
Absolute static pressure, M <sub>1,2,3</sub>	Capacitive pressure transducer	0..10/20 [bar]	± 0.05 [%]
Electrical power, P <sub>elec</sub>	Electrical multimeter	0..1000 [V <sub>trms</sub> ] 0..32 [A <sub>trms</sub> ]	± 0.03 [%]
Turbine rotational speed, n	UVW incremental encoder	0..6000 [rpm]	4096 [ppr]



## Measured characteristic curves (turbine mode)

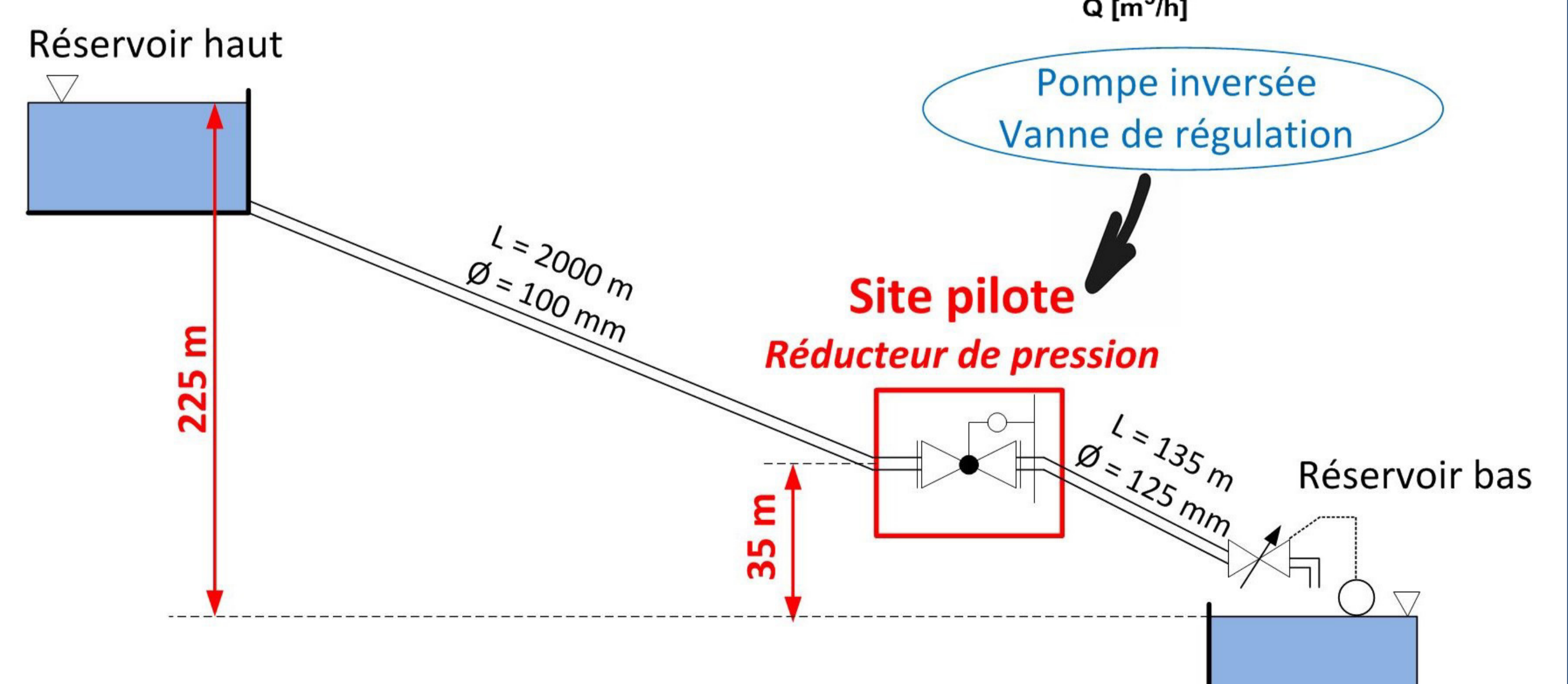
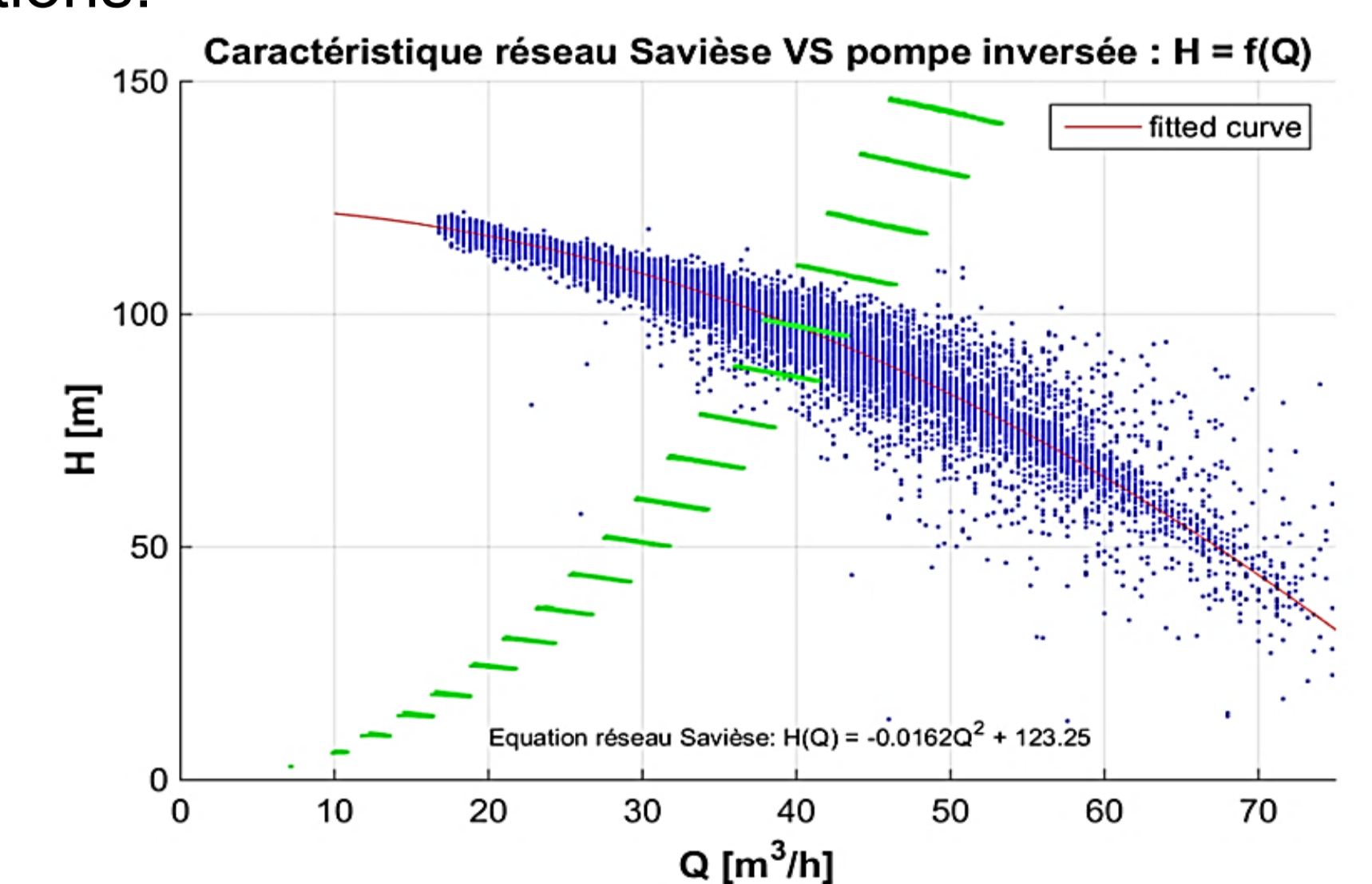
- ✓ Operating range:
  - Q = 10 ÷ 55 m<sup>3</sup>/h
  - H = 0 ÷ 146 m
- ✓ Best efficiency point:
  - n<sub>BEP</sub> = 2'650 rpm
  - Q<sub>BEP</sub> = 47.5 m<sup>3</sup>/h
  - H<sub>BEP</sub> = 115 m
  - P<sub>elec</sub> BEP = 8'500 W
  - η<sub>BEP</sub> = 56 %
- ✓ Maximum power point:
  - n<sub>Pelec max</sub> = 3'000 rpm
  - Q<sub>Pelec max</sub> = 52.6 m<sup>3</sup>/h
  - H<sub>Pelec max</sub> = 136 m
  - P<sub>elec max</sub> = 11'250 W
  - η<sub>Pelec max</sub> = 55.7 %

$$\eta = \frac{P_{elec}}{\rho \cdot Q \cdot (gH)} [-]$$



## Main characteristics of the Savièse pilot site

- ✓ Gross head: 192 m
- ✓ Net head at maximum discharge: H<sub>net</sub> = 37 m
- ✓ Maximum discharge: 97.2 m<sup>3</sup>/h
- ✓ Half-time available conditions:
  - Q<sub>50%</sub> = 35 m<sup>3</sup>/h
  - H<sub>50%</sub> = 105 m
  - P<sub>h50%</sub> = 10 kW



## Savièse project partners