



XFLEX HYDRO

Flexibility demonstrators

Grand Maison PSP

Focus Hydro

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- European policy towards energy transition
- Specific call for Hydro Flexibility improvement
 - Call for industrial scale demonstrators



- XFLEX HYDRO : 2019-2023
- Consortium 19 partners
- 6 demos TRL7
 - 2 at EDF Sites : Vogelgrun Hybrid; Grand Maison HSC



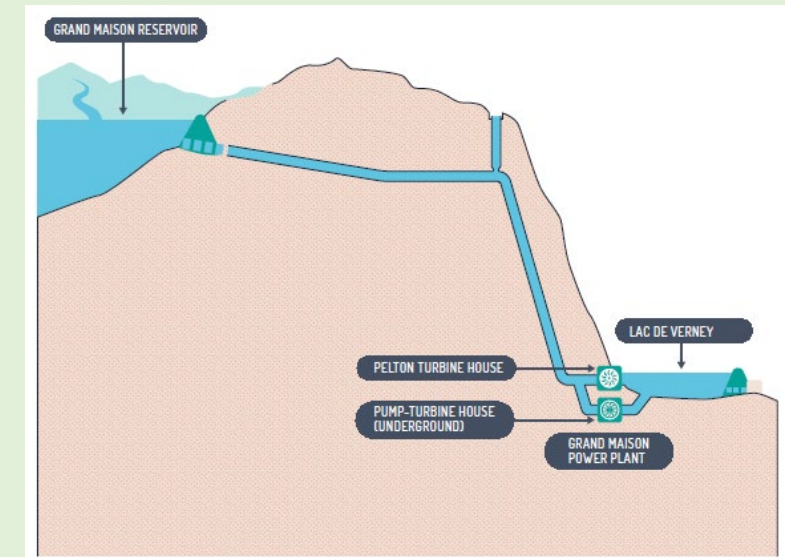
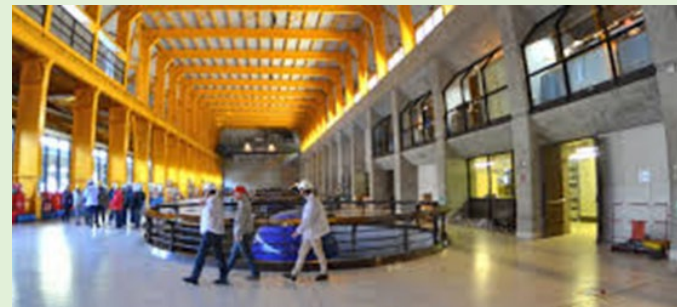
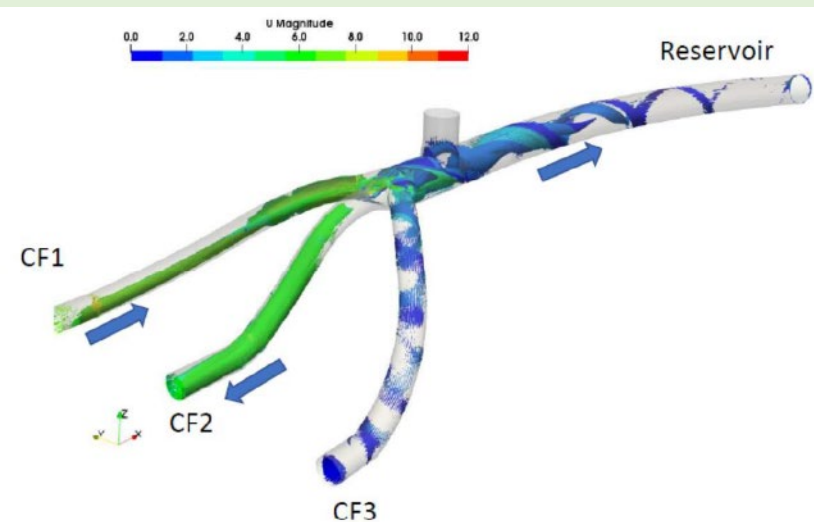
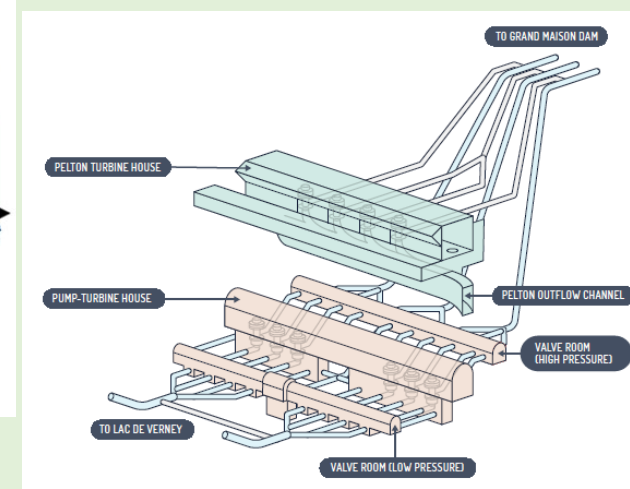
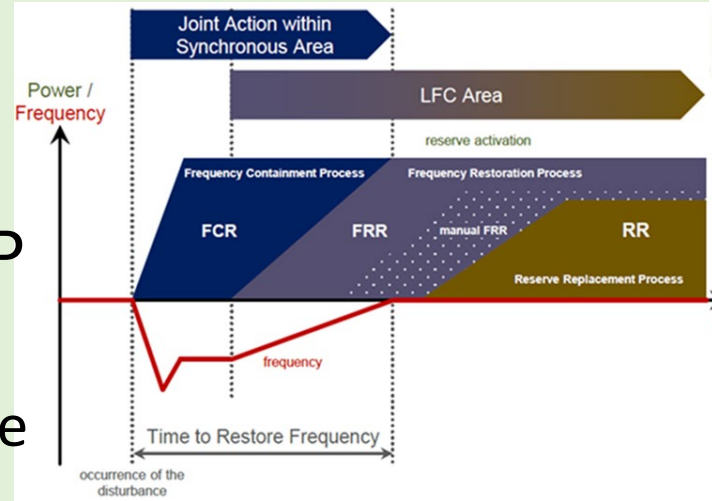
XFLEX - presentation slides 2023 - Focus Hydro Grenoble



Grand Maison : REVERSE - Objectifs



- PSP : 1800MW largest in Europe
 - 8 Pump Turbines + 4 Pelton
- Demonstrate flexibility of existing PSP
 - Contribute to grid frequency control
 - Provide regulating power in pump mode
 - Hydraulic Short Circuit
 - **In service since Sept 2021**



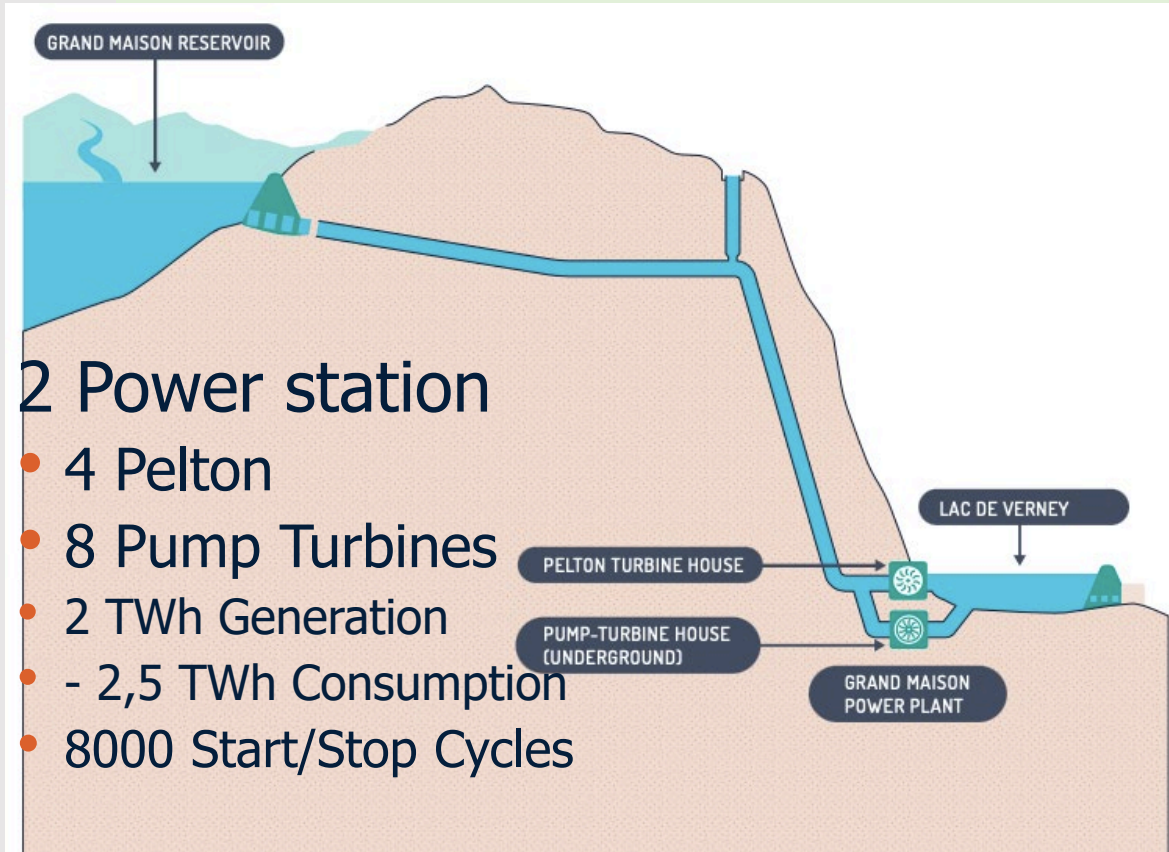
Schematic

- 2 Réservoirs

- 150Mm3
- 15Mm3
 - 30 hours pumping 1300MW
 - 20 hours turbining 1800MW

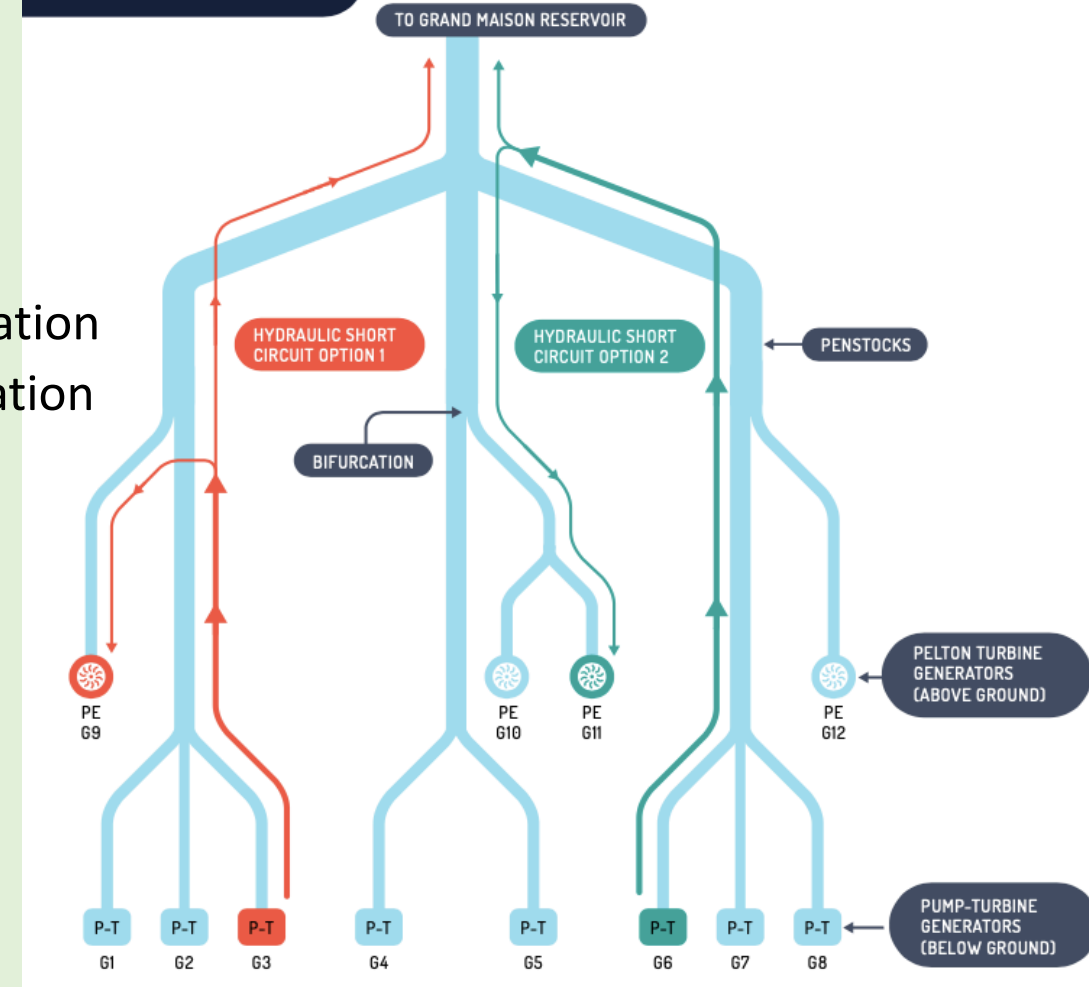
- 2 HSC possibilities

- Short branch at bifurcation
- Long branch at trifurcation



- 2 Power station

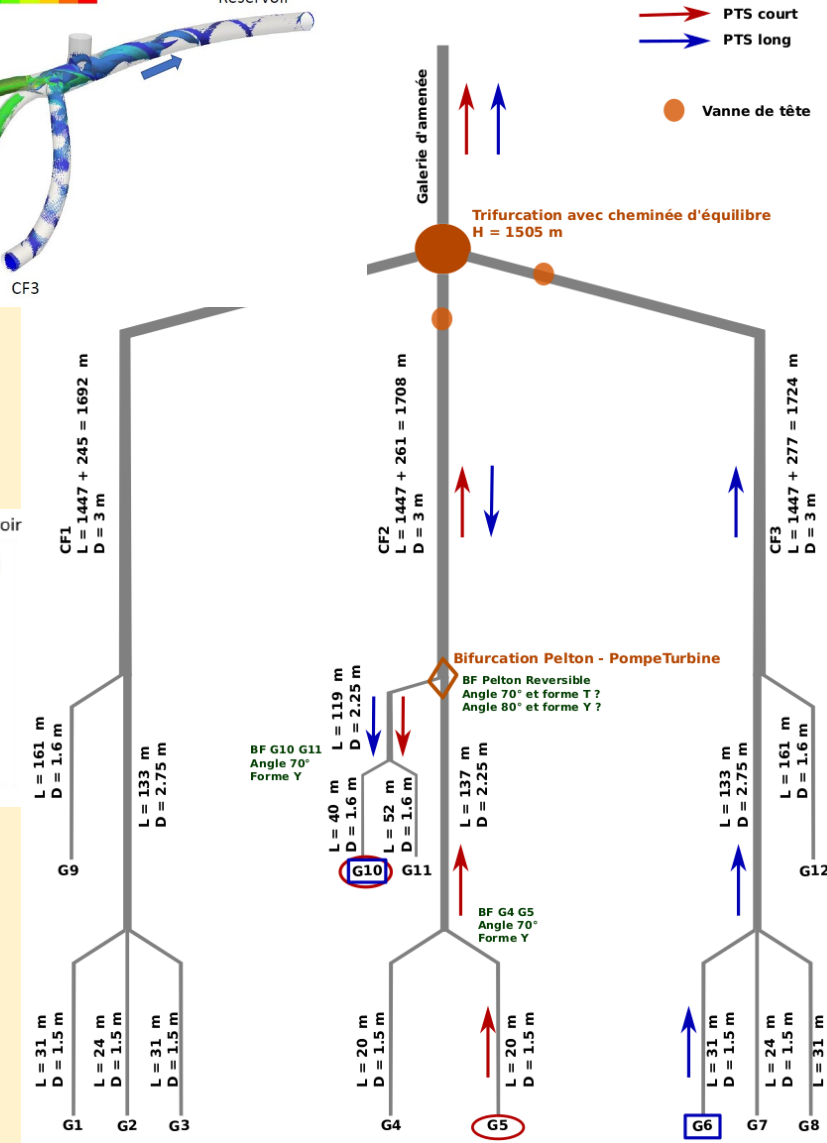
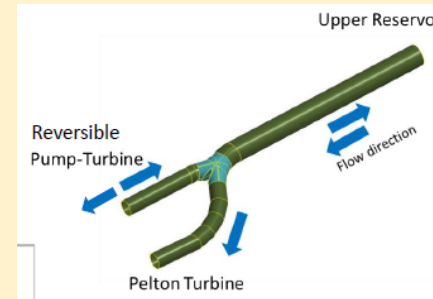
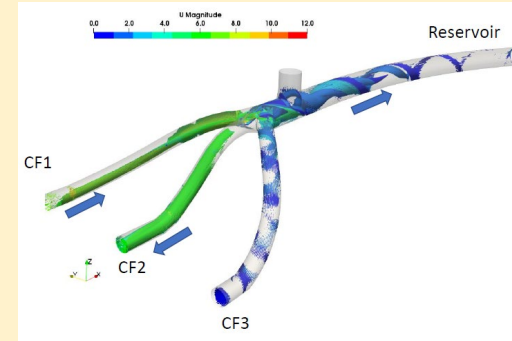
- 4 Pelton
- 8 Pump Turbines
- 2 TWh Generation
- - 2,5 TWh Consumption
- 8000 Start/Stop Cycles



- Demo put into operation Sept 2021
- 2200 hours of HSC operation so far
 - Represents 56% of pumping time

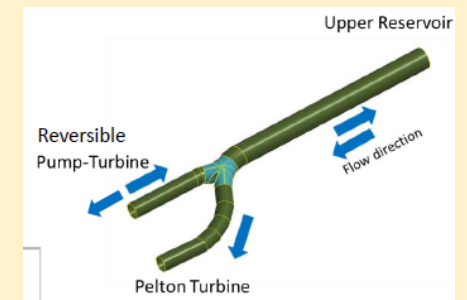
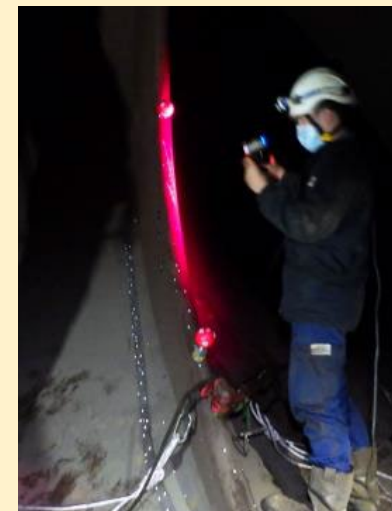
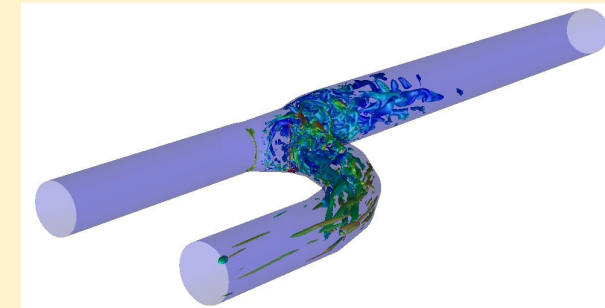
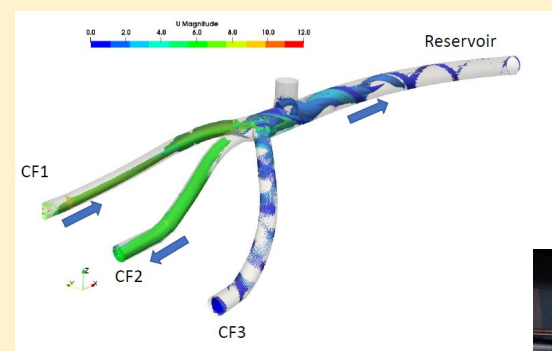
Hydraulic Short Circuit Technology

- Units not designed for HSC
- Operates Pumps and Pelton units together
 - Short route or long route
- Water By pass at penstock junction
 - Bifurcation or Trifurcation
- Extensive CFD and simulation
 - To detect any off design situation
 - Run Emergency Shut Down scenario
 - Check hydro transient behaviour
 - Water tunnel pressure
 - Surge shaft water level
- Identification of best efficiency combination
 - 17 000 + simulation performed



Site test

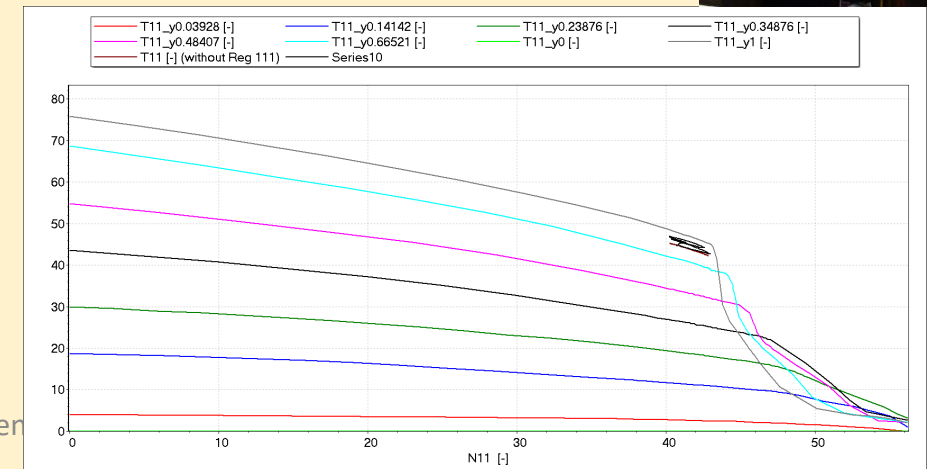
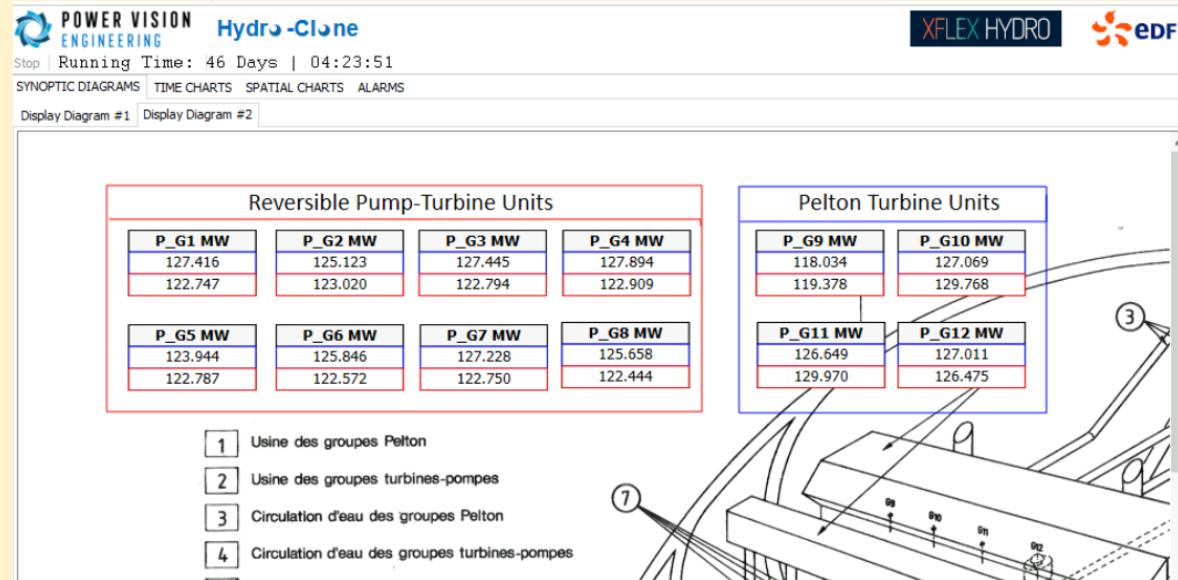
- Updated Scada and PSP control
 - Allowing simultaneous grid operation of pump and turbine
- Dynamic performance check to deliver regulating power
 - Compliance to grid code FCR and aFRR
- Vibration check of pumps and Pelton units
 - Reliability of operation
 - Vorticity of flow
- Noise check
- 3D Scan of bifurcation trifurcation
 - Before and after 2 years of operation
 - To check for any unexpected abrasion



Digital Twin : Hydro CLONE[®]



- Collects data from all 12 units + waterways
 - 130 parameters collected
- Runs locally
 - with cyber secure remote link
 - Remote access for maintenance
 - Remote access for data collection
- Improves plant and unit status assessment
 - Pelton efficiency loss



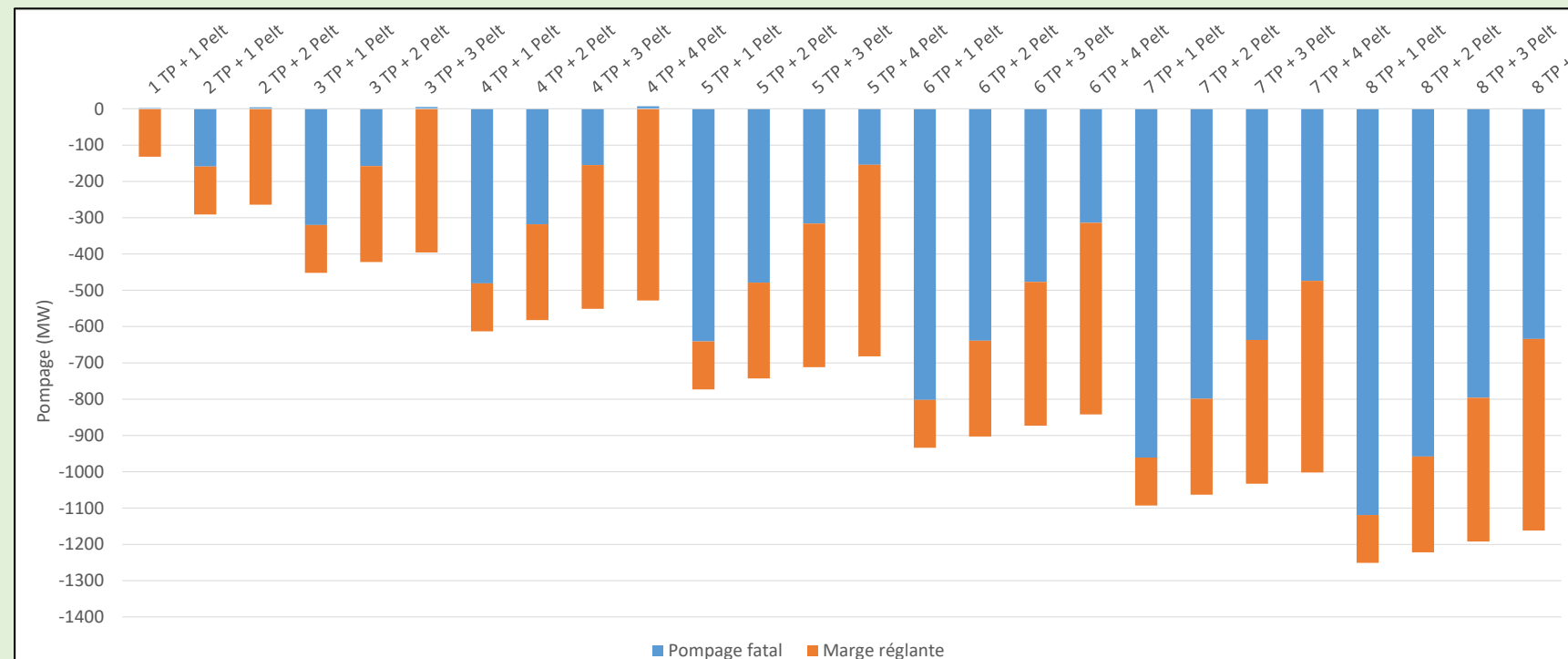
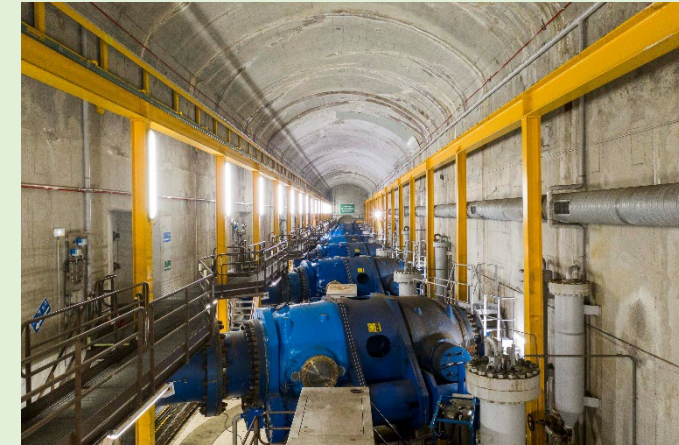
Scalability of HSC concept

- HSC concept applicable to the whole plant
 - All 4 Pelton
- Looking for more flexible operation
 - To include On the fly turbine operation
 - Pelton Direct Transfer from Launch to Turbine mode
 - Saves Start Stop cycles



Regulating Power in Pump mode

- Adjustable power in pump mode
- Offers frequency control from demand side
 - Up to 500MW as aFRR band available in 100s
- Economics based on aFRR revenues
- And overall generation fleet optimisation
 - Less fossil units operated for FCR/aFRR purpose during low demand periods
 - CO² emission reduction expected ~90 000 tons/year



Future Development

- Achievement of team work
- HSC proves easy to operate
- Regulating power during low demand periods is of interest for grid operators
- HSC operation at Grand Maison will continue and extended to all 4 Pelton units
- Target date summer 2023





Thank you

