Hydro Power Introduction

Hydro Introduction

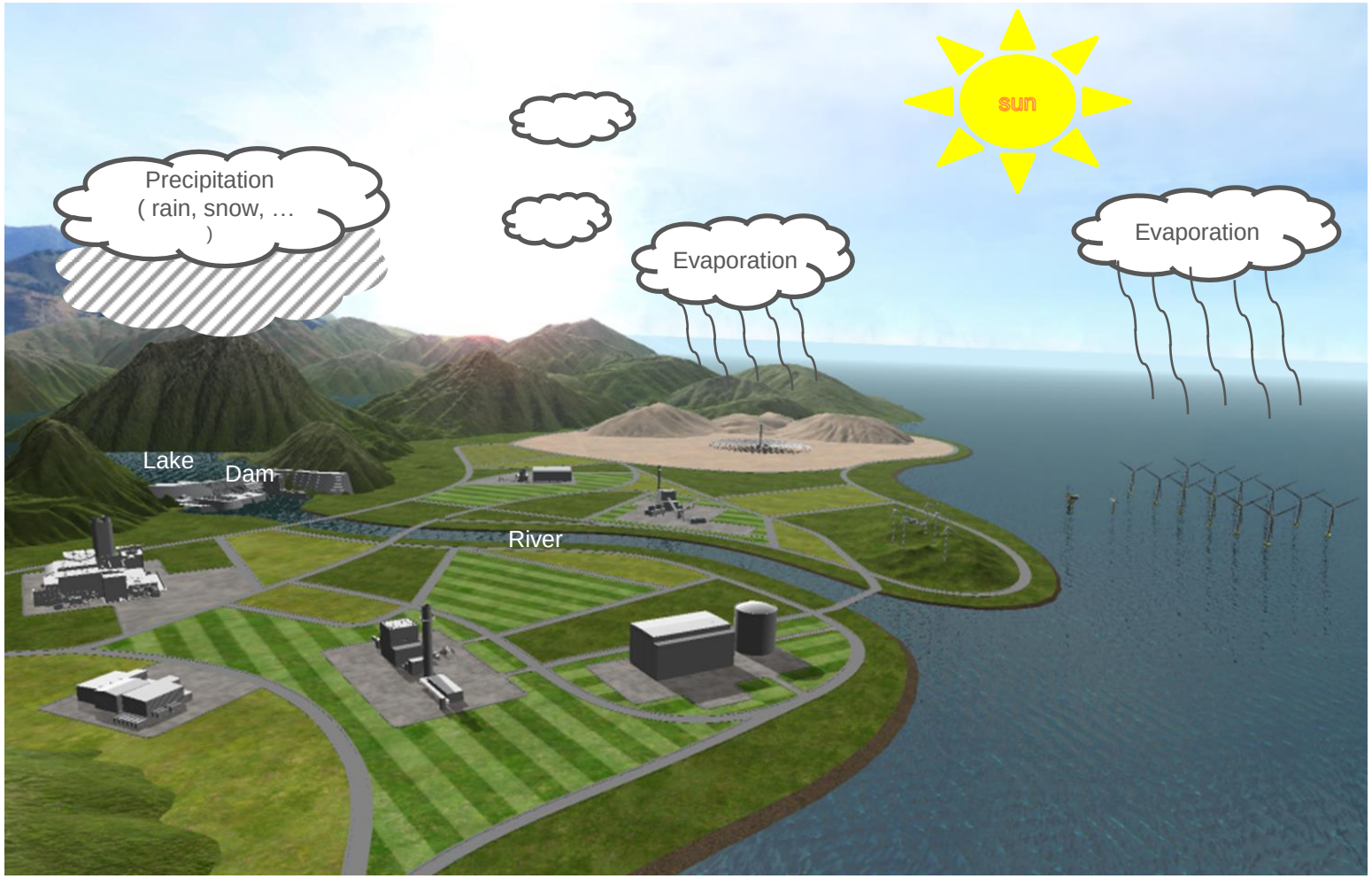
Agenda

- Hydraulic Energy
- Hydroelectric Installation: the Dams
- Hydroelectric Installation : plant configurations
- Hydro Powerhouses
- Hydro Products
- Hydro Project Cycle

Hydraulic Energy

Hydraulic Energy Principle

Water Cycle

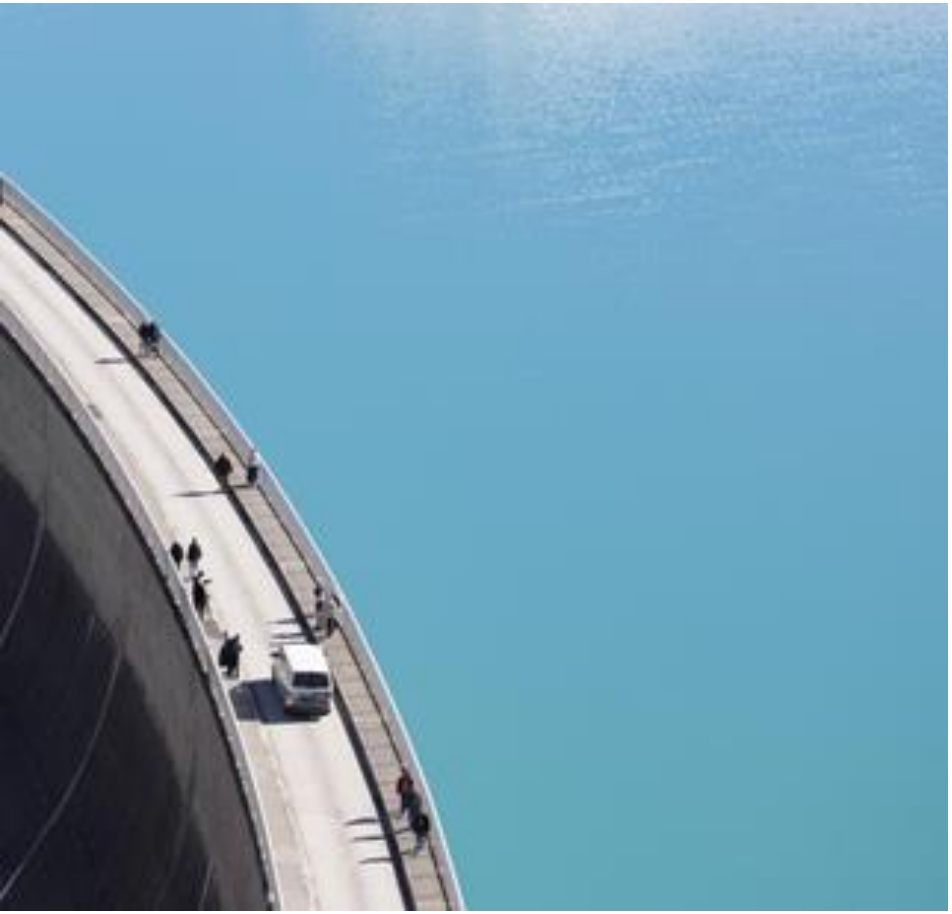


Hydraulic Energy

Main advantages of Hydraulic Energy

- World's biggest Renewable energy
- Clean Energy
- High Availability
- High Efficiency
- Long Plant Lifetime
- Energy storage
- Provides freshwater storage, irrigation, navigation

Hydraulic Energy

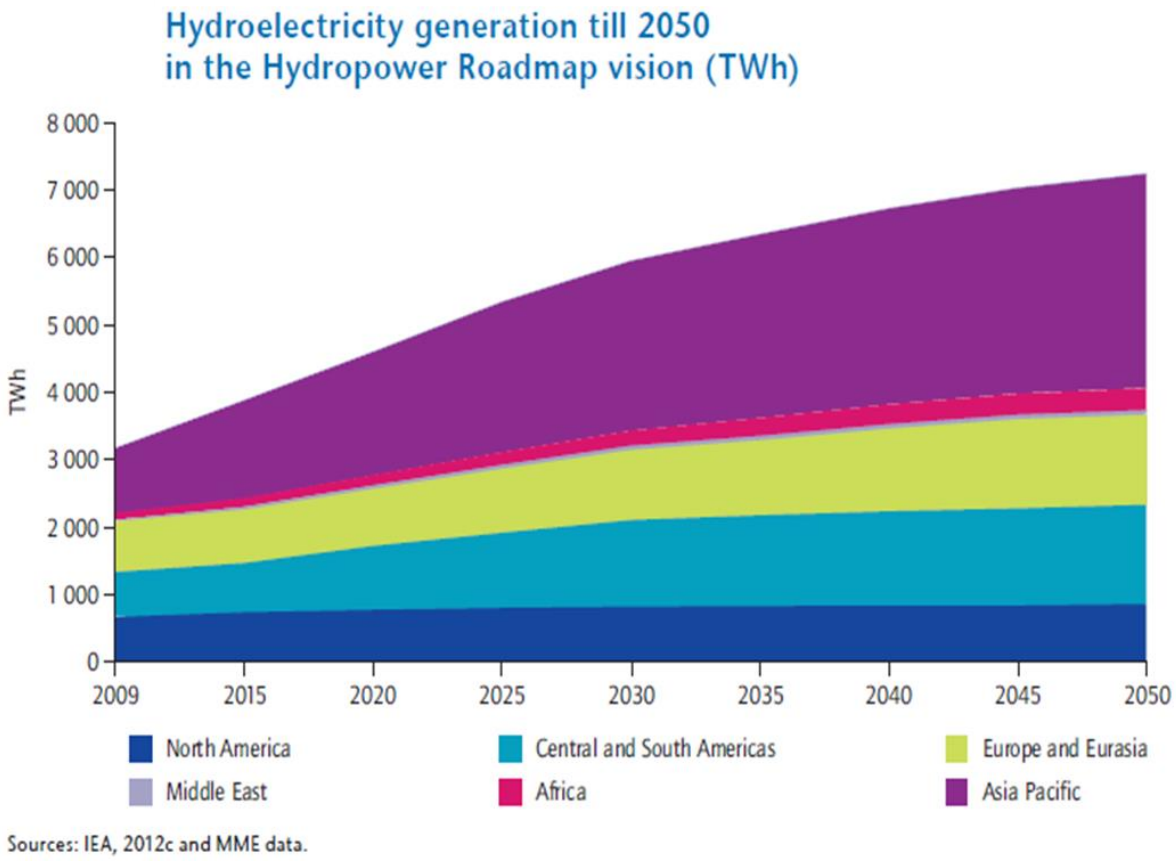


Main drawbacks of Hydraulic Energy

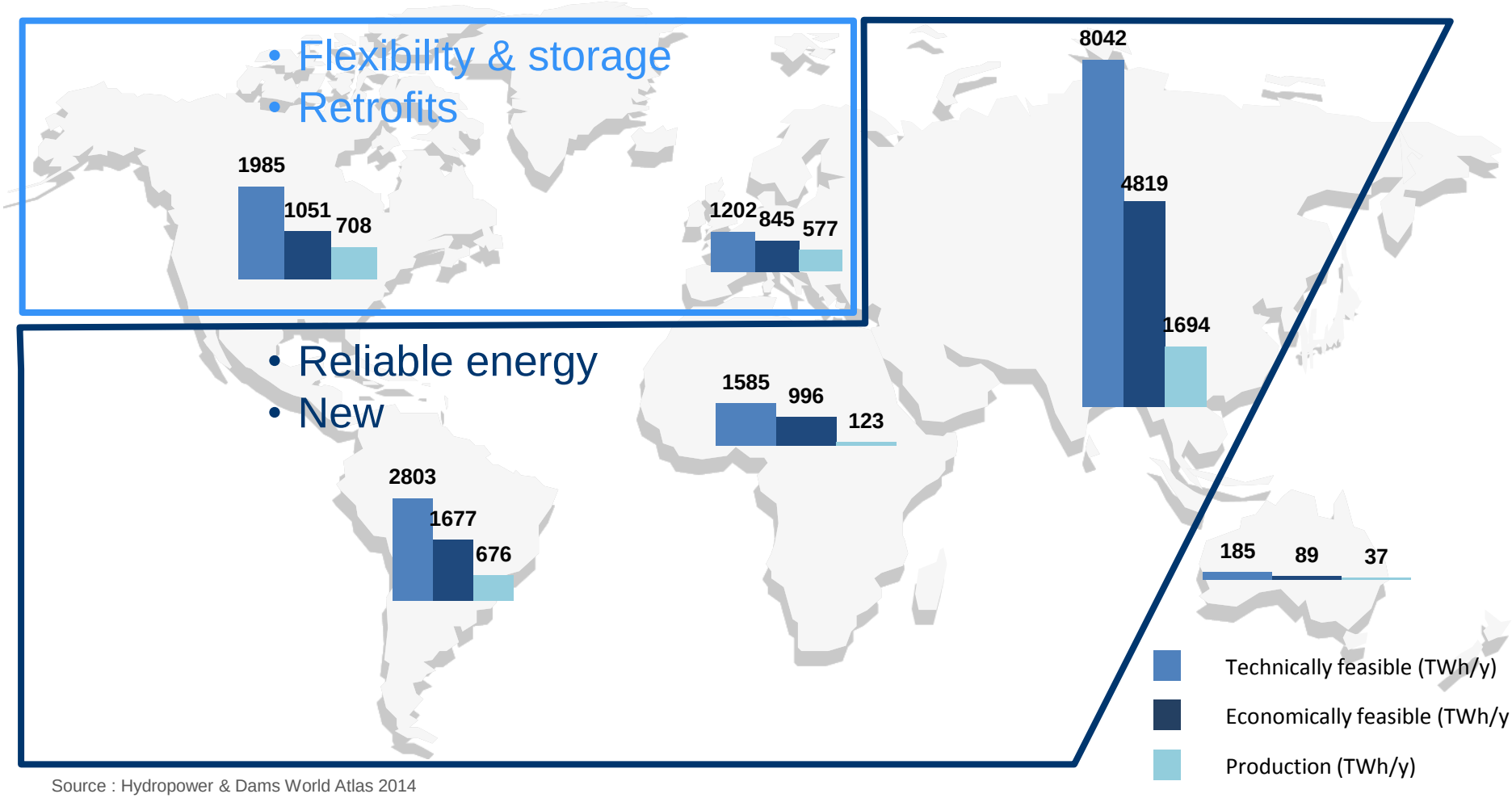
- Initial investment
- Rainfall depending
- Ecologic impact
- Population Displacement
- Geologic risks

Sustainable Market

Doubling of global capacity by 2050



Segmenting Customer Needs



Source : Hydropower & Dams World Atlas 2014

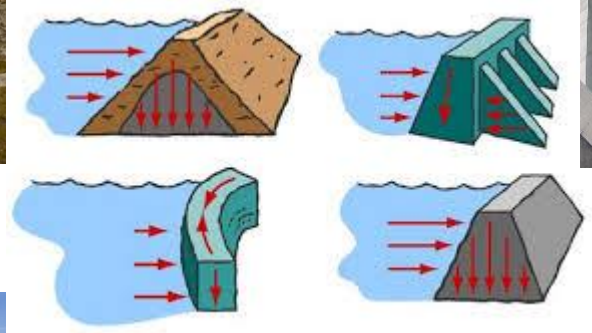
Hydroelectric Installation: the Dams

Hydroelectric Installation: The Dams

4 main types of Dams

Embankment dam

Buttresses dam



Arch dam

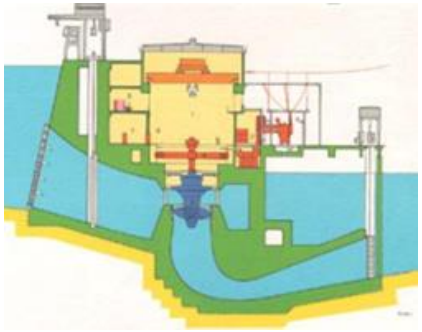
Gravity dam

Hydro Installation: Plant configurations

Hydro Installation configurations

Run of river Power Plants

- Characteristics:
  - Small head between upstream and downstream levels
- Operation:
  - Continuous operation, base load
  - Production depends on water flow available on the river
  - Energy production higher in summer than in winter



Ex: Beauharnois, Canada (28 Francis, 10 Propellers – head 24 m)

Hydro Installation configurations

Sluice operation power plants

Characteristics:

- The power house is located at the bottom of the dam

- Operation:
  - Discontinuous operation
  - Production depends on water level and capacity of the dam
  - Available energy can be predicted by dam level management and yearly water provided by the river

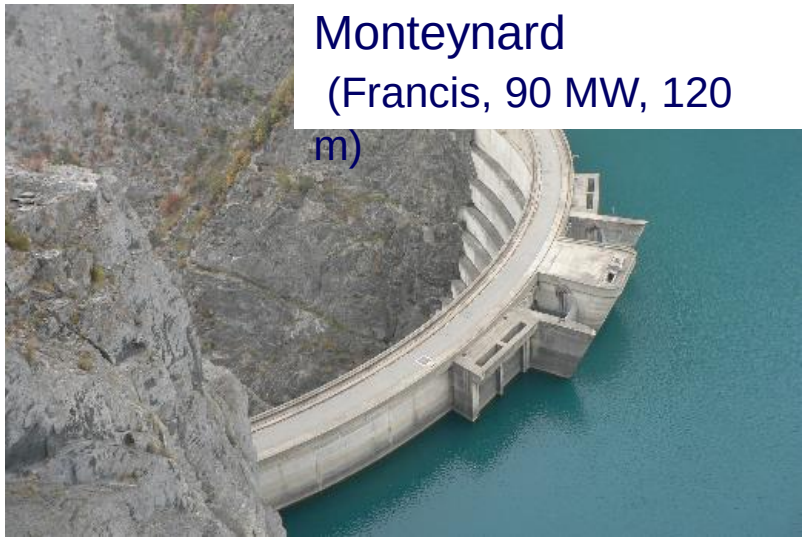
Itaipu (20 Vertical Francis
700 MW –118 m)

Hydro Installation configurations

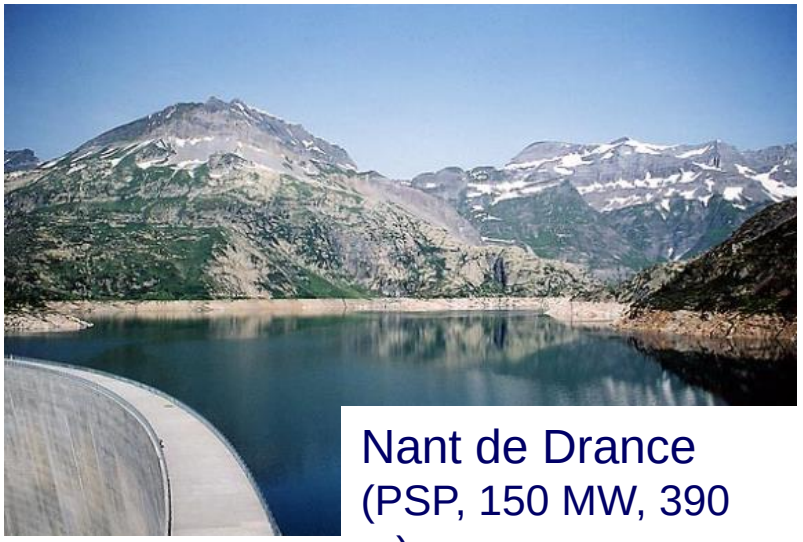
Reservoir Power Plants (PSP or some Francis)

- Characteristics:
  - High head
  - High pressure
  - Underground powerhouse

- Operation:
  - When power is needed (peak season demand)



Monteynard
(Francis, 90 MW, 120 m)



Nant de Drance
(PSP, 150 MW, 390 m)

Hydro powerhouses

Hydro Powerhouses

House type : External building

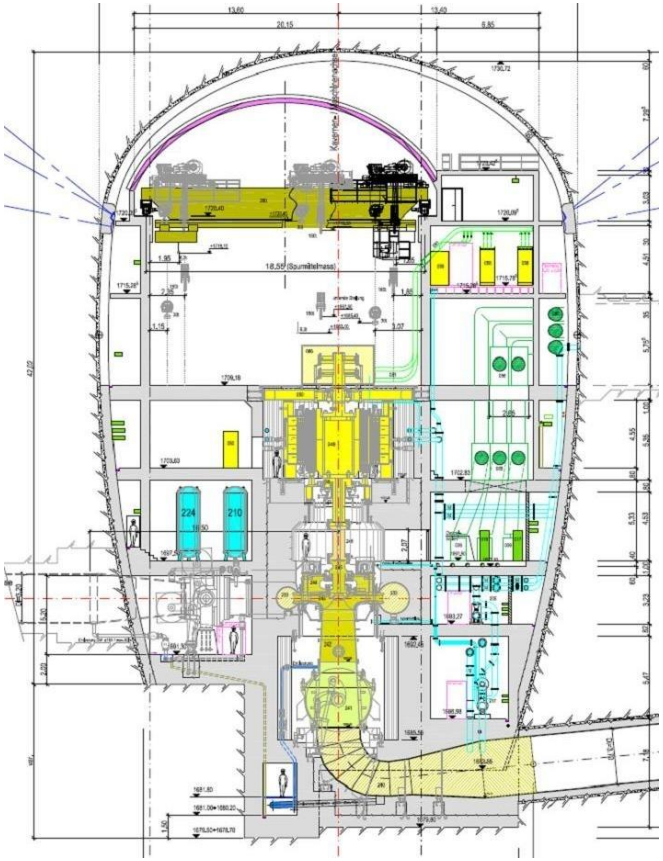
Run of river: Beauharnois, Canada – High head: Malgovert, France

Hydro Powerhouses

House type : Bottom of the dam (three gorges, China)

Turbine head = height of the dam

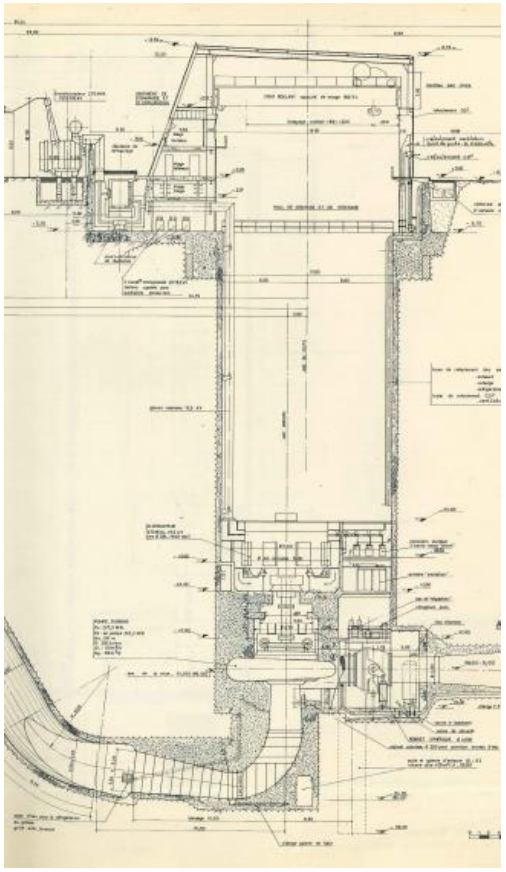
Hydro Powerhouses



House type: underground (Nant de Drance, Switzerland)

Well fitted for pump turbines (High submergence)

Hydro Powerhouses



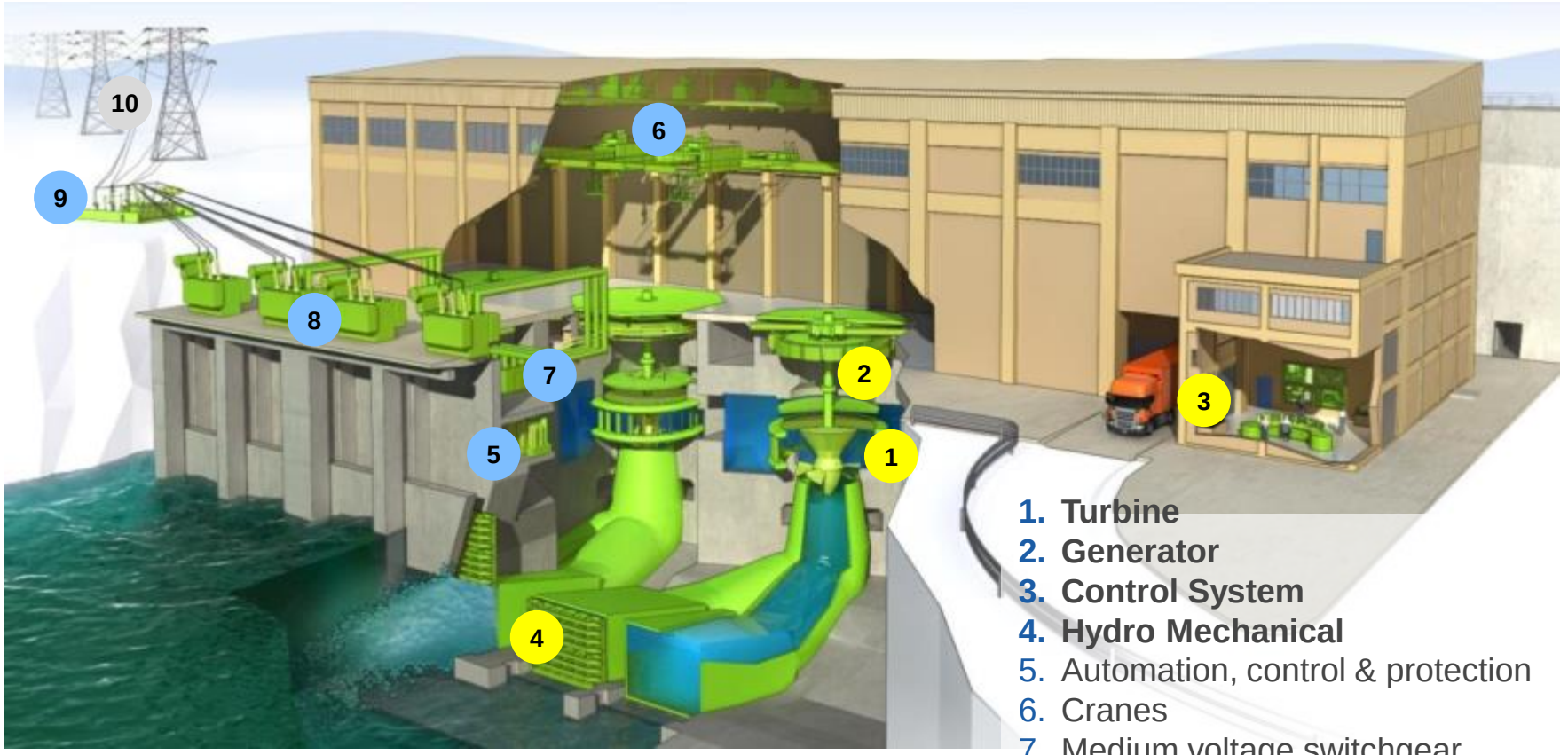
House type : pit (Le Cheylas, France)

Specific for pump turbines for same reasons as underground

Hydro Products

GE's product Scope

The complete range of Hydro Power Plant equipment



1. **Turbine**
2. **Generator**
3. **Control System**
4. **Hydro Mechanical**
5. Automation, control & protection
6. Cranes
7. Medium voltage switchgear
8. Power transformer
9. High voltage switchgear
10. Transmission line

- **GE Hydro solutions**
- **Products available from GE-EM**
- **Third parties**

Hydro Products

Turbines & Generators


Low Speed


Low Speed


Medium Speed


High Speed


Motor Generator


Bulb


Kaplan


Francis


Pelton


Pump Turbine

Hydro Products

Control, Protection & Automation Systems

- Applicable to all types of hydropower plants, provide cost reduction and operating benefits
- Governing and excitation system for maximum performance of turbines and generators

Hydro Products

Hydro Mechanical Equipment

- Hydropower plants and dams
  - Valves, tailor-designed gates and penstocks, lifting equipment
- Irrigation dams and canals
  - Flow and level control equipment, large diameter and long pipes, pumps, valves, gates
- Water supply and sewerage
  - Water treatment, level & flow & pressure control equipment, pumps, pipes
- Industrial applications
  - Pumps & outfitting

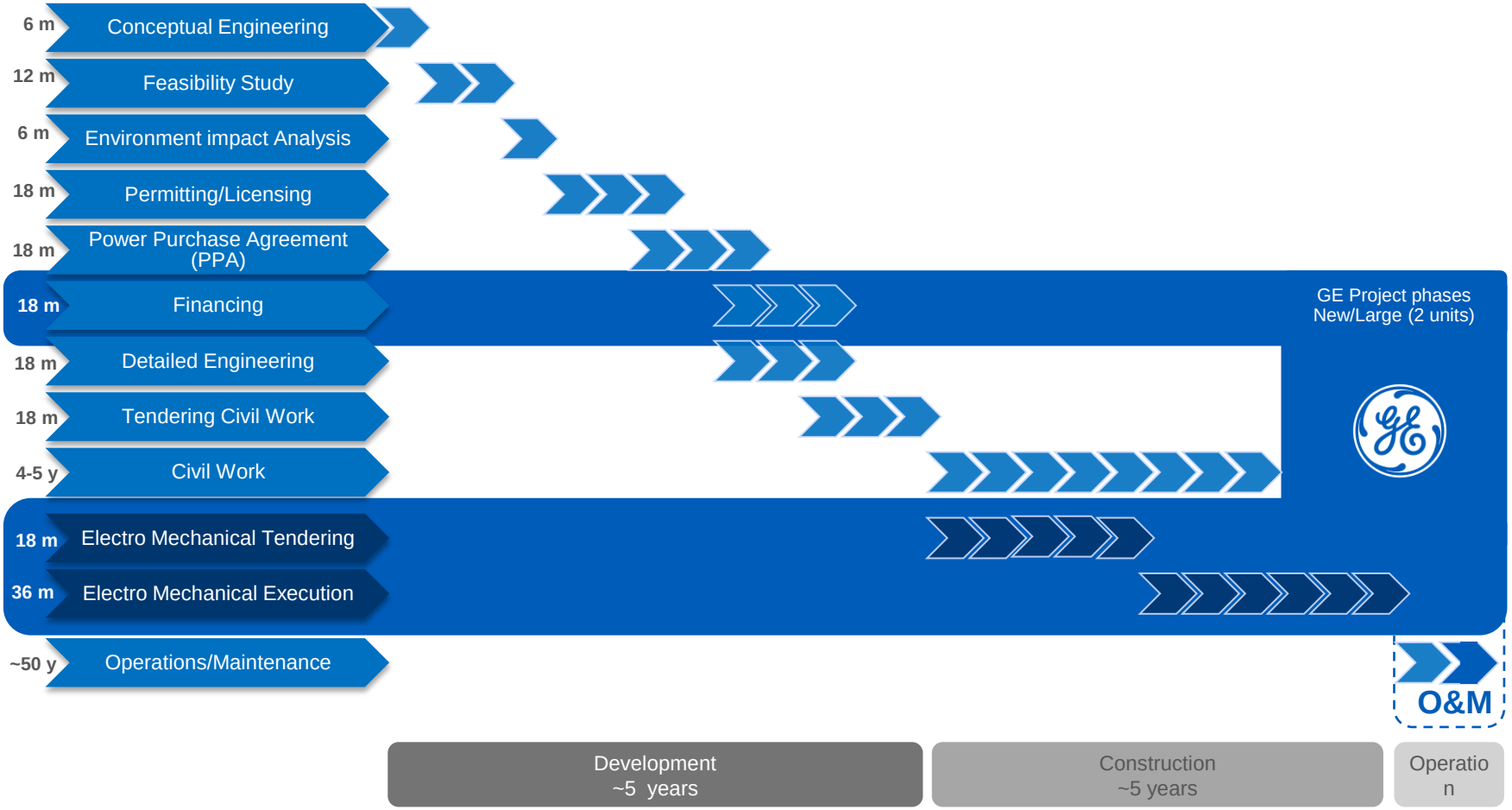
Hydro Products

Balance of Plant (BOP)

- Engineering and supply of all electrical and mechanical subsystems required for efficient operation of the Plant.
- Our expertise in BOP covers:
  - Electrical engineering / systems
  - Mechanical engineering / systems
  - Miscellaneous systems

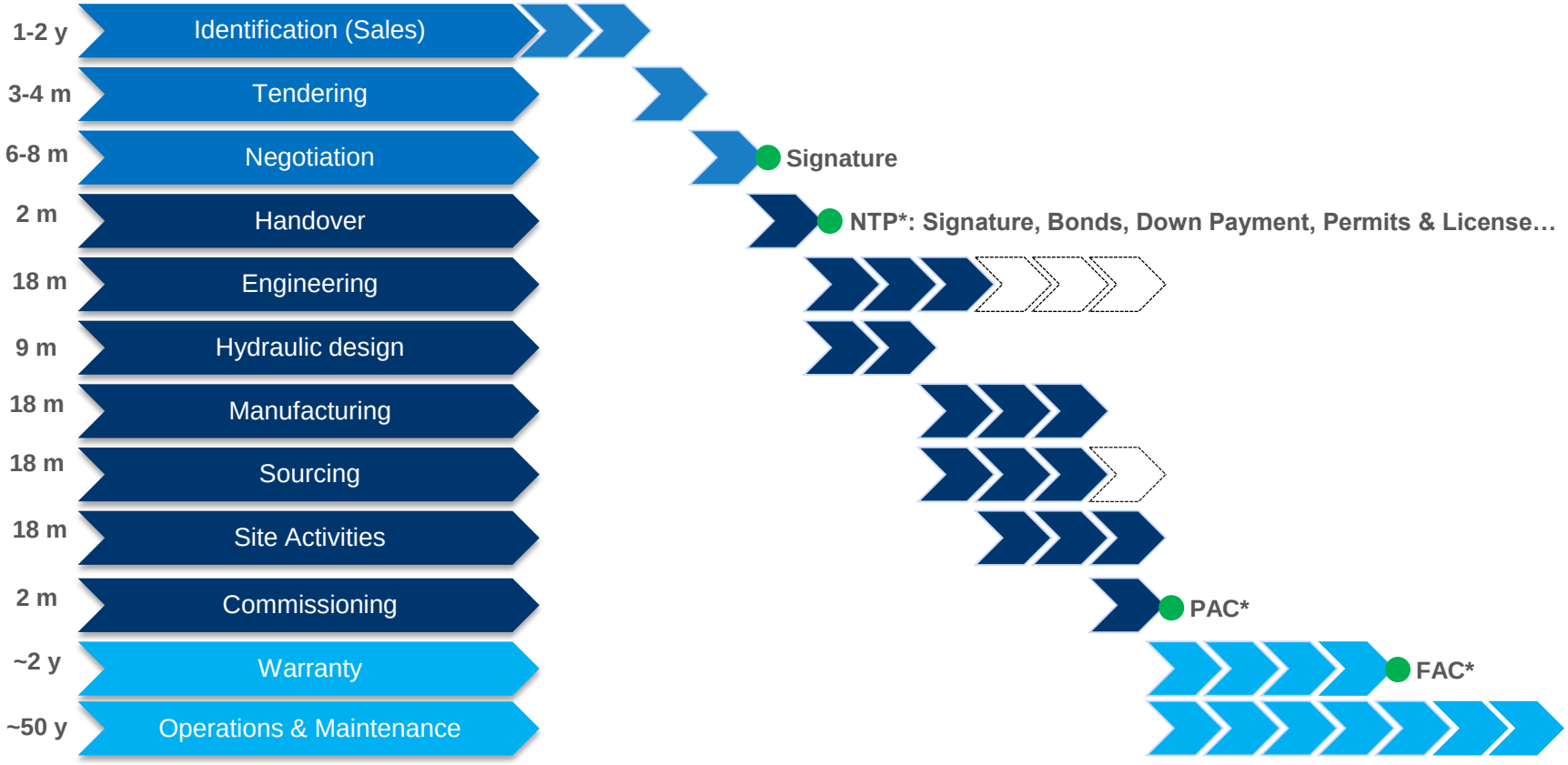
Hydro Project Cycle

Hydro Project Development (Typical) New/Large



PPA*: Power Purchase Agreement

GE Project phases New/Large (2 units)



NTP*: Notice to proceed
PAC*: Provisional Acceptance Certificate
FAC*: Final Acceptance Certificate

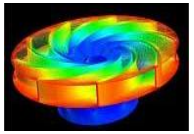
Inquiry to Order ~12 months | **Order to Remittance ~3 years** | **Services & O&M**

GE Hydraulic Design Process

Design until customer acceptance

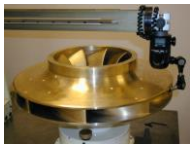
Step 1
- Establish a preliminary geometrical design (Theoretical)

Step 2
- Establish & optimise the turbine design using hydraulic calculations (CFD) and mechanical calculations (FEM)



Step 3
- Manufacture a scale model

Step 4
- Carryout research & development testing on the scale model



Step 5
- Carryout customer preliminary and contractual scale model testing

Step 6
- Proceed to life-size turbine manufacture

Step 7
- Collect feedback from the site for future development