



Hydro Power Introduction

Imagination at work

GE Proprietary Information—Class III (Confidential)
Export Controlled—U.S. Government approval is required
prior to export from the U.S., re-export from a third
country, or release to a foreign national wherever located.

Hydro Introduction

Agenda

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

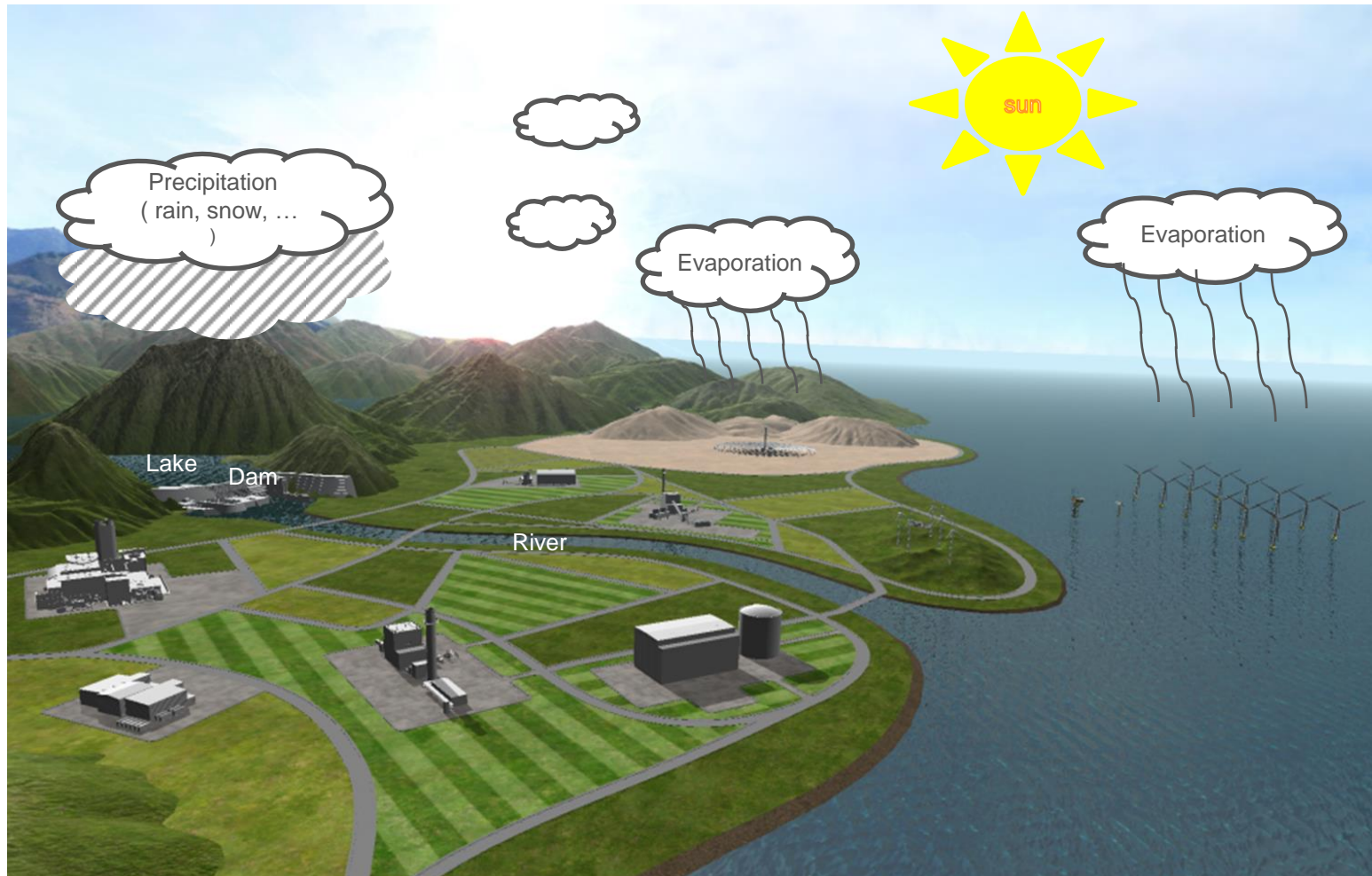


Hydraulic Energy



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



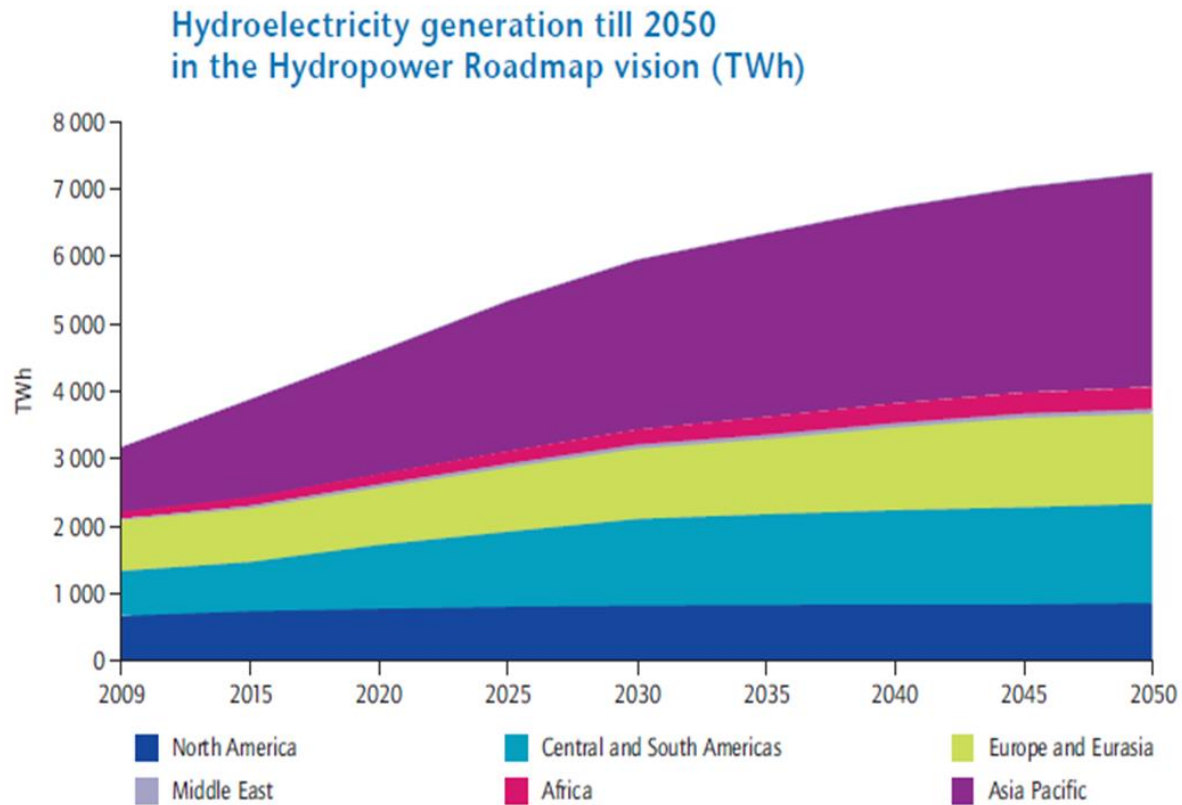
Main drawbacks of Hydraulic Energy

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



Sustainable Market

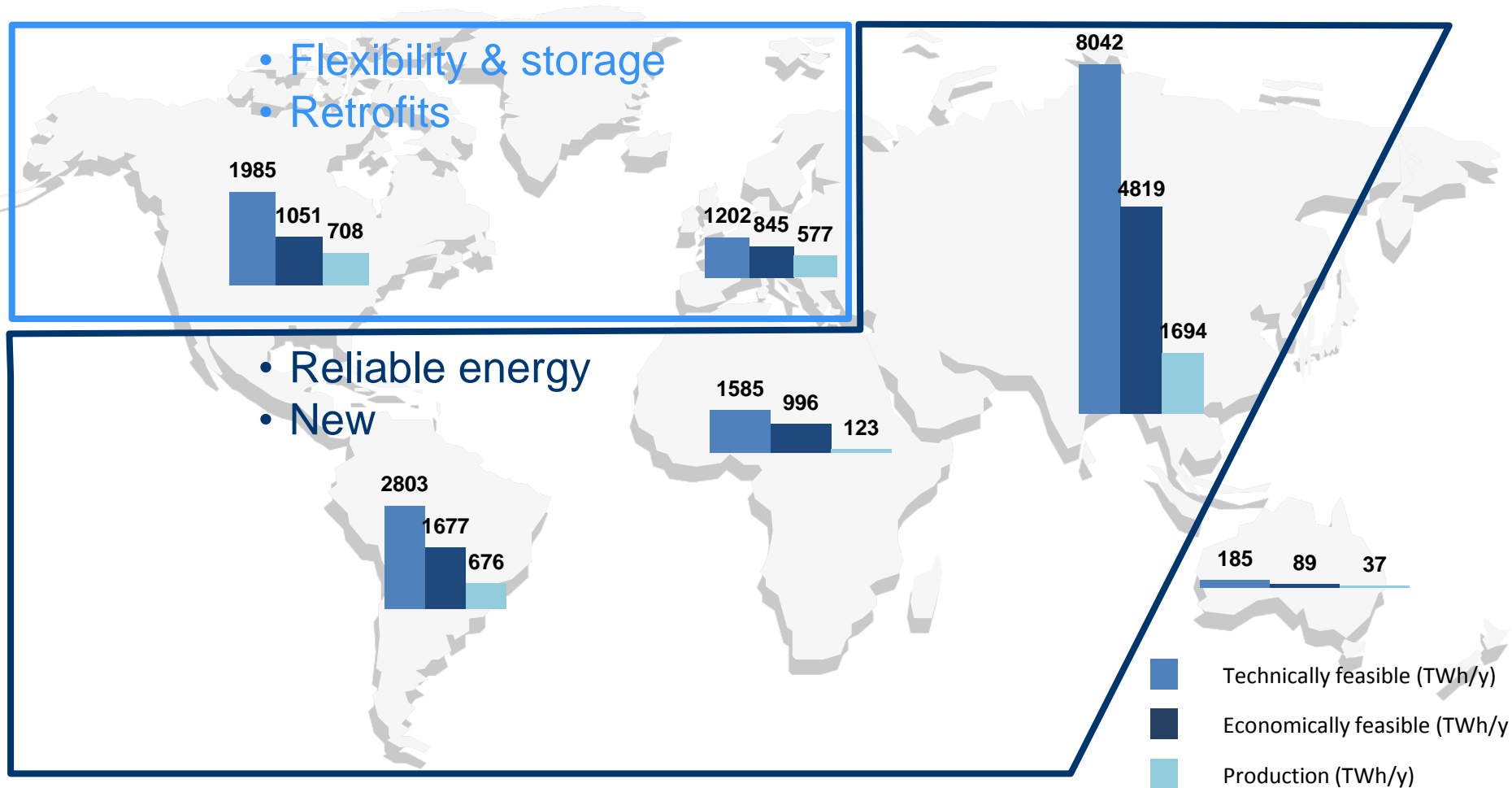
Doubling of global capacity by 2050



Sources: IEA, 2012c and MME data.



Segmenting Customer Needs



Source : Hydropower & Dams World Atlas 2014



Hydroelectric Installation: the Dams



Hydroelectric Installation: The Dams

4 main types of Dams

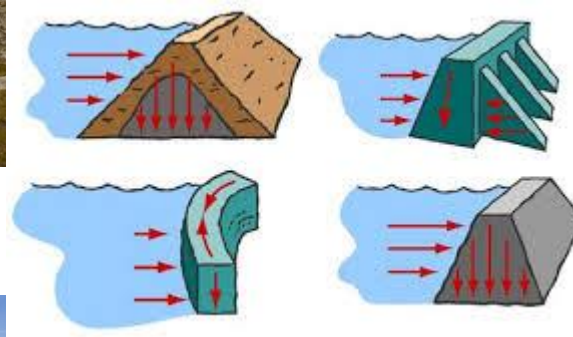
Embankment dam



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



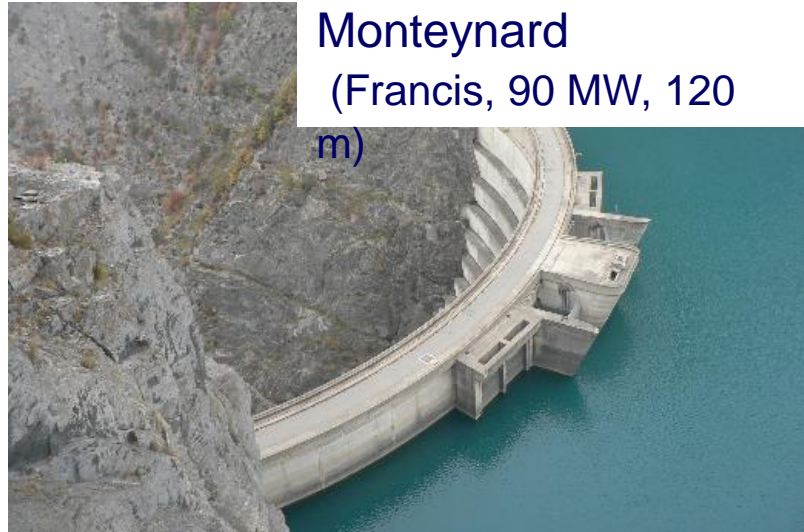
**Itaipu (20 Vertical Francis
700 MW –118 m)**



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

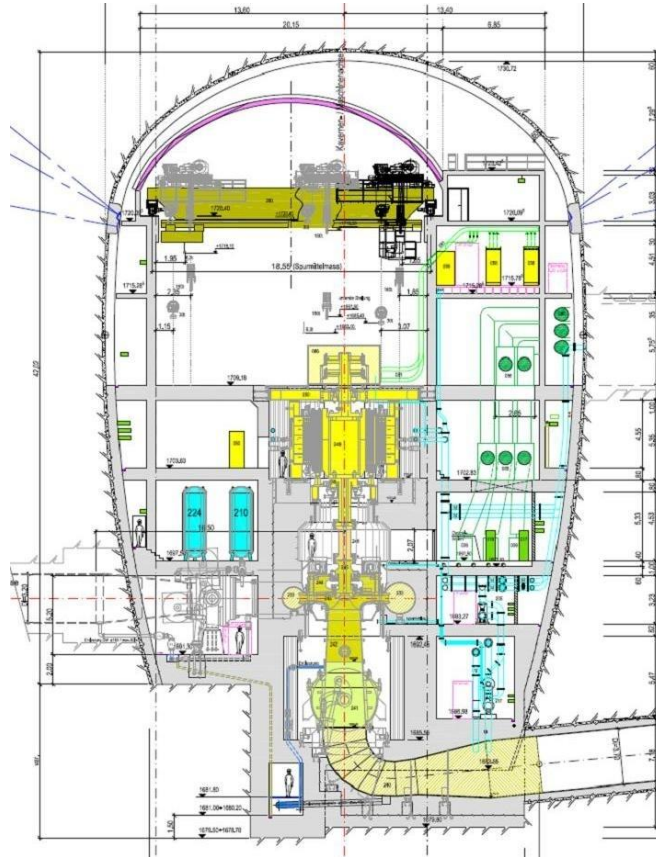


House type : Bottom of the dam (three gorges, China)

Turbine head = height of the dam



Hydro Powerhouses

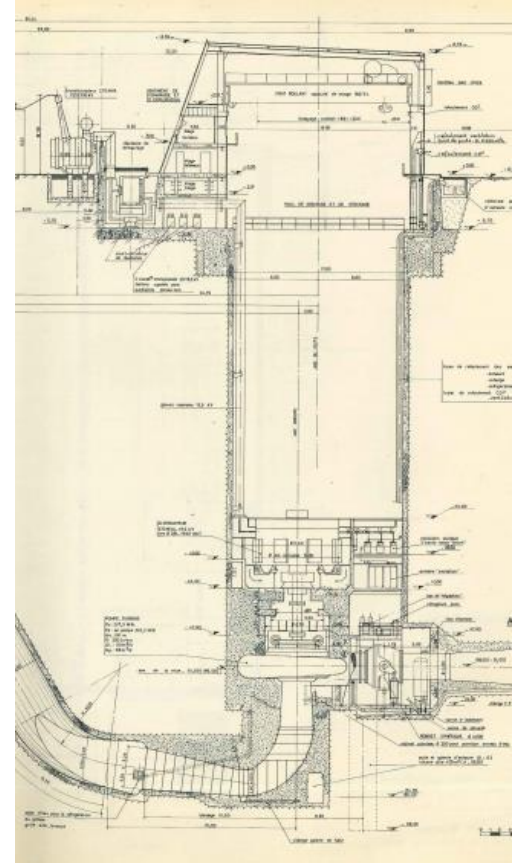
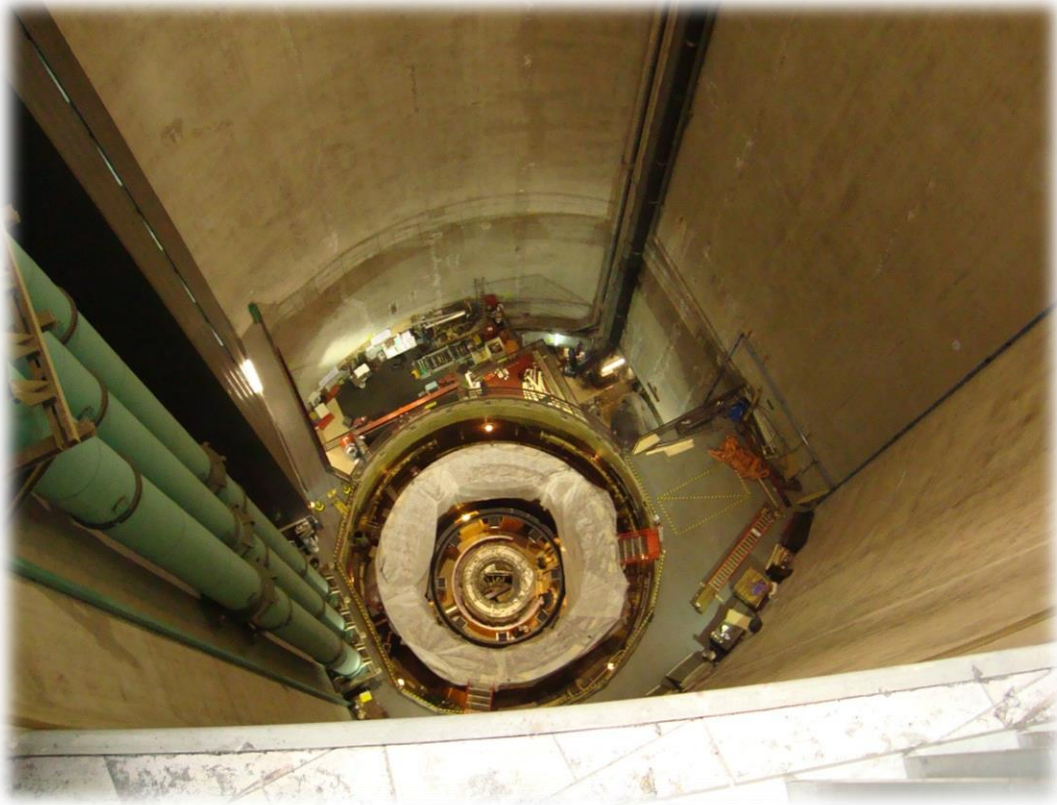


House type: underground (Nant de Drance, Switzerland)

Well fitted for pump turbines (High submergence)



Hydro Powerhouses



House type : pit (Le Cheylas, France)

Specific for pump turbines for same reasons as underground

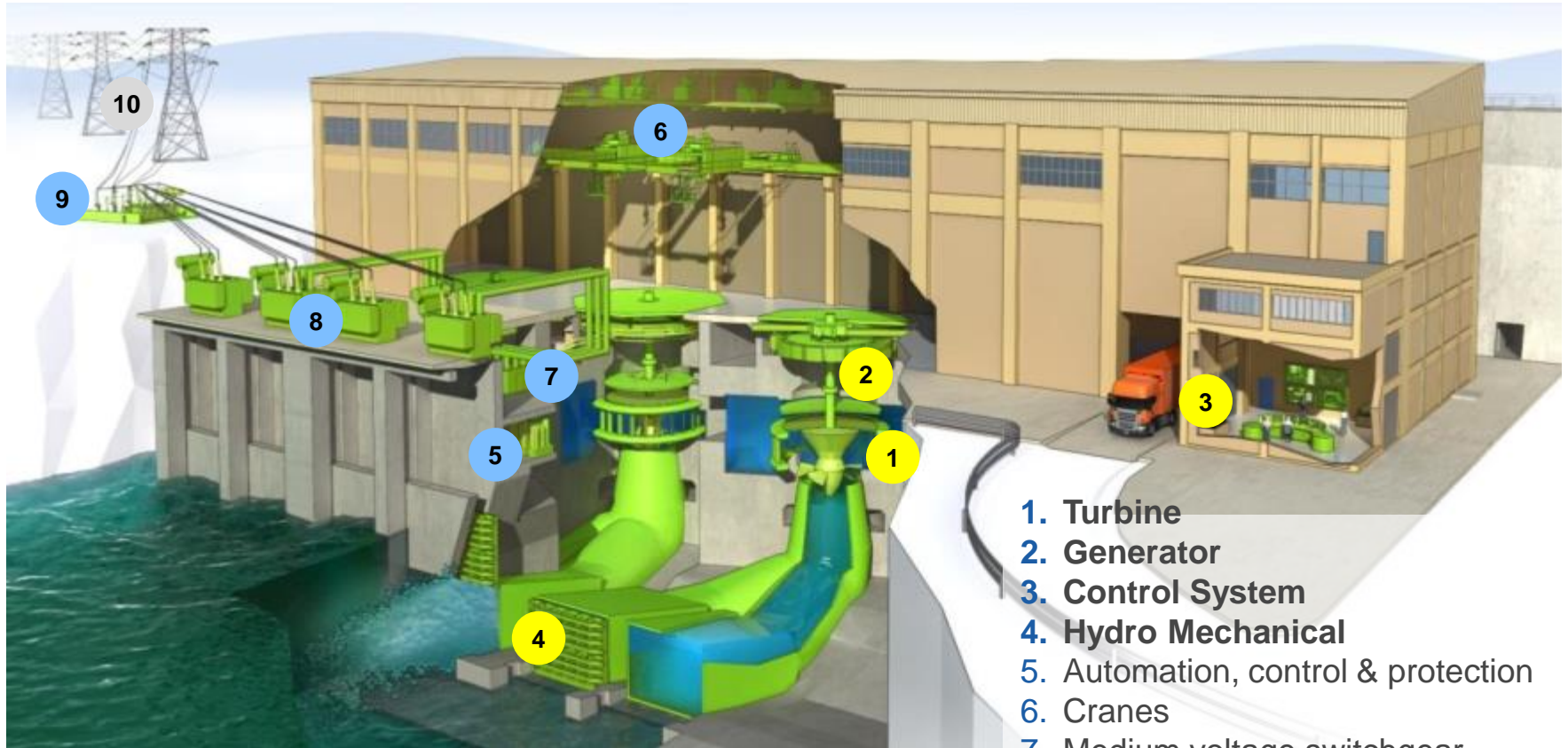


Hydro Products



GE's product Scope

The complete range of Hydro Power Plant equipment



- GE Hydro solutions
- Products available from GE-
- EM

Third parties

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



Hydro Products

Turbines & Generators



Low Speed



Low Speed



Medium Speed



High Speed



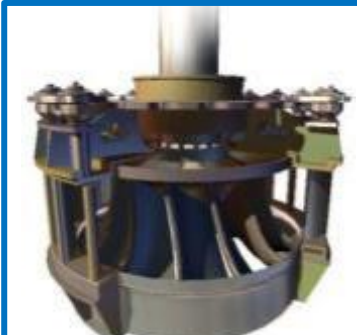
Motor Generator



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)



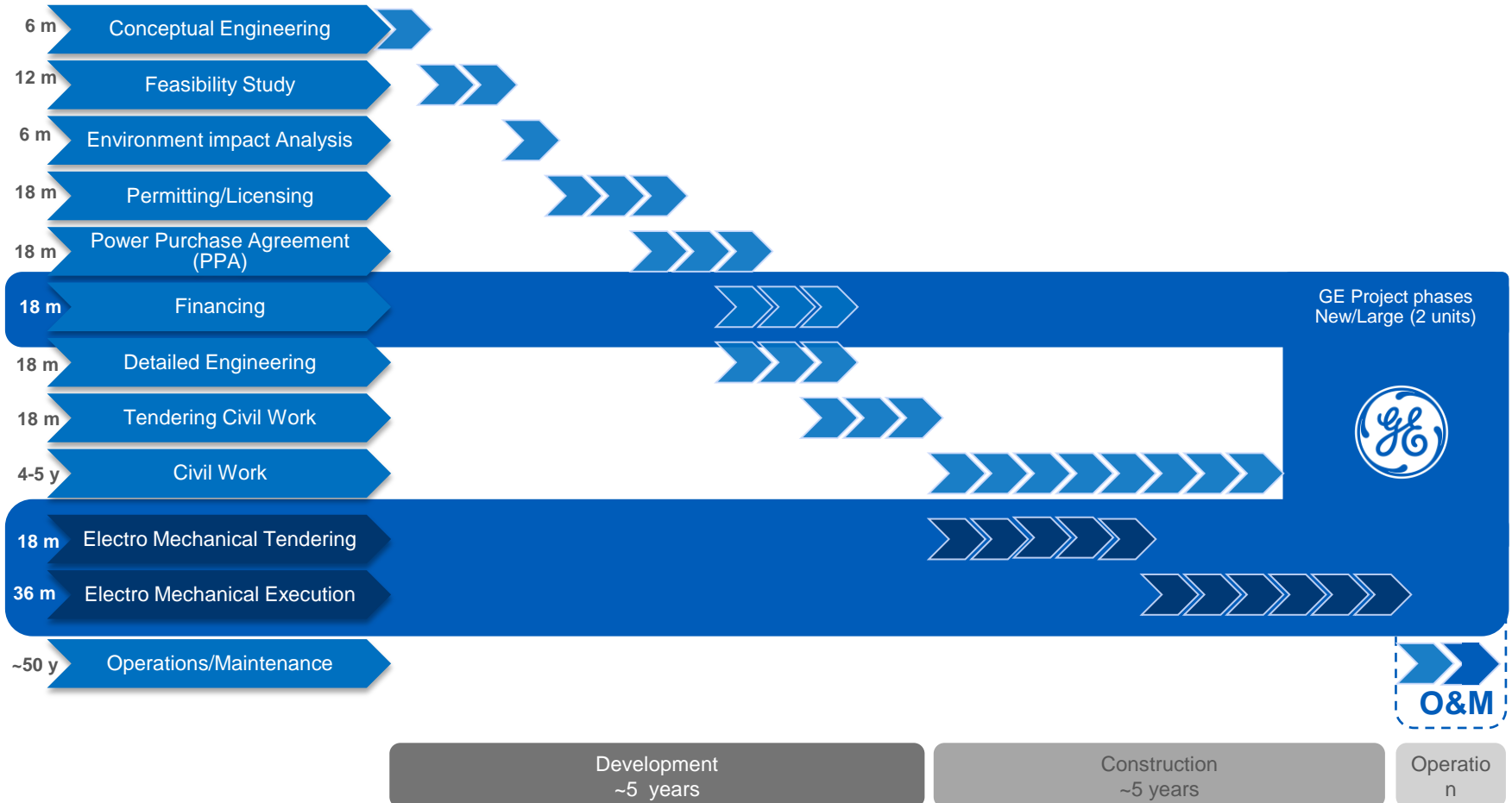
- Engineering and supply of all electrical and mechanical subsystems required for efficient operation of the Plant.
- Our expertise in BOP covers:
 - Electrical engineering / systems
 - Mechanical engineering / systems
 - Miscellaneous systems



Hydro Project Cycle



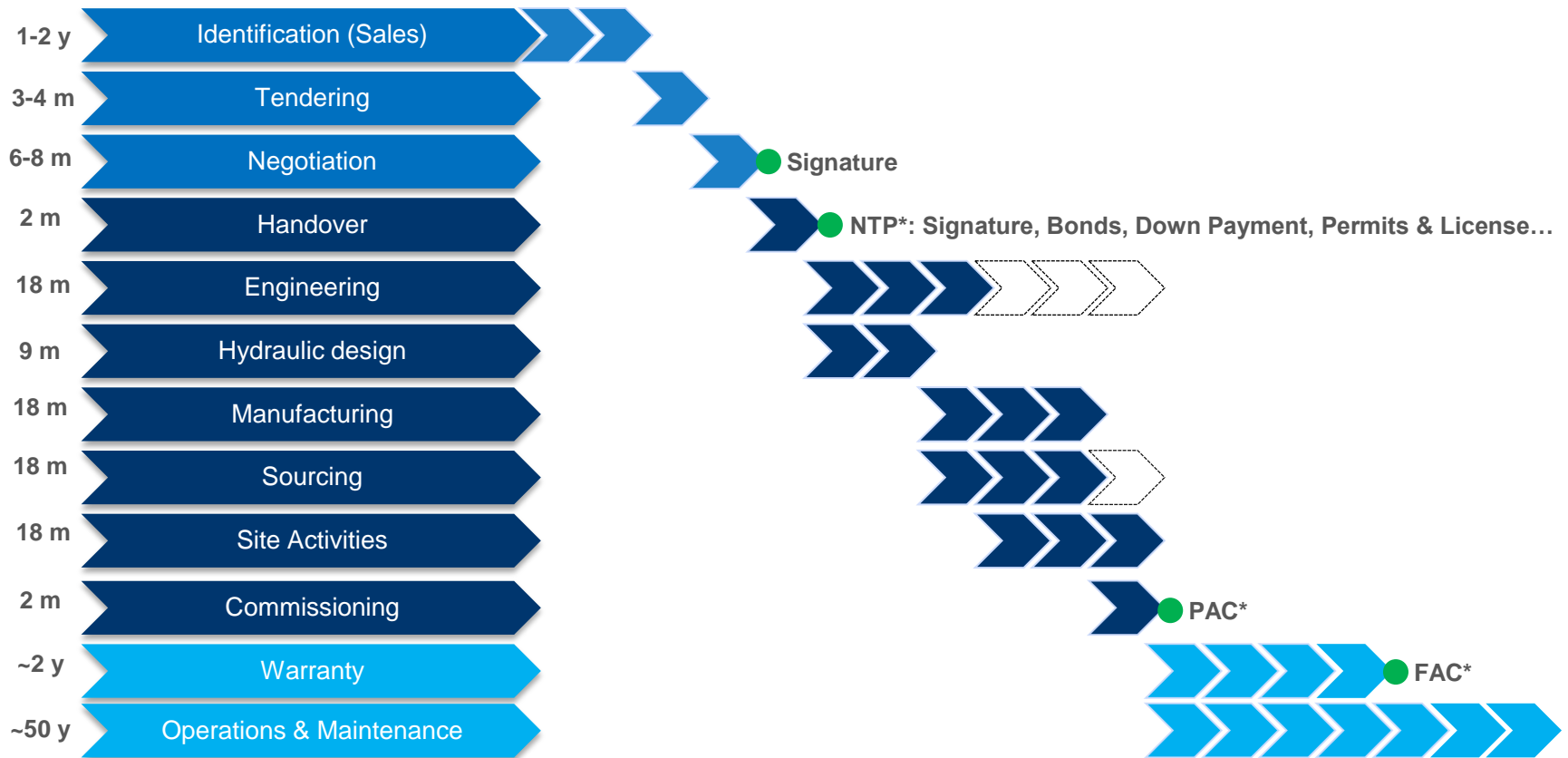
Hydro Project Development (Typical) New/Large



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

