



New Civil Engineer
nce ITA
AITES
**INTERNATIONAL
TUNNELLING &
UNDERGROUND SPACE**
AWARDS 2014
WINNER



Nant de Drance 900 MW pumped-storage power plant

Welcome to the SUEID 2018 participants !

Jean-Marie Rouiller
August 22th, 2018

Localisation: West of Switzerland Ridge of the Alps !



Barberine Dam
CFF-SFR ,1920-1926

Vieux-Emosson Dam
CFF-SFR, 1952-1955

Emosson Dam
ATEL-EDF, 1967-1975

Nant de Drance
ALPIQ-SFR-IWB-FMV
2008-2020



Nant-de-Drance

a gigantic underground project !



Nant-de-Drance *in short* !



The pumped-storage scheme of Nant-de-Drance is located between the two artificial lakes created by the Emosson (1'930 m a.s.l.) and Vieux-Emosson (2'225 m a.s.l.) dams.

After its completion in 2020, the 6 pump-turbines totalizing an installed power of 900 MW will produce 2'500 GWh of peak energy per year.

Two galleries, 1.7 km long and two vertical shafts, 424 m high will drive 360 m³/s.

***The volume of the Vieux-Emosson reservoir has been doubled with the heightening of the dam by 20 m.
The total investment will be 2.0 billion Swiss francs.***

Owners, budget and planning

• 39%

ALPIQ

• 36%



SBB CFF FFS

• 15%

iwb

• 10%

FMV



*Budget 2.0 billion CHF
Construction 2008-2020*

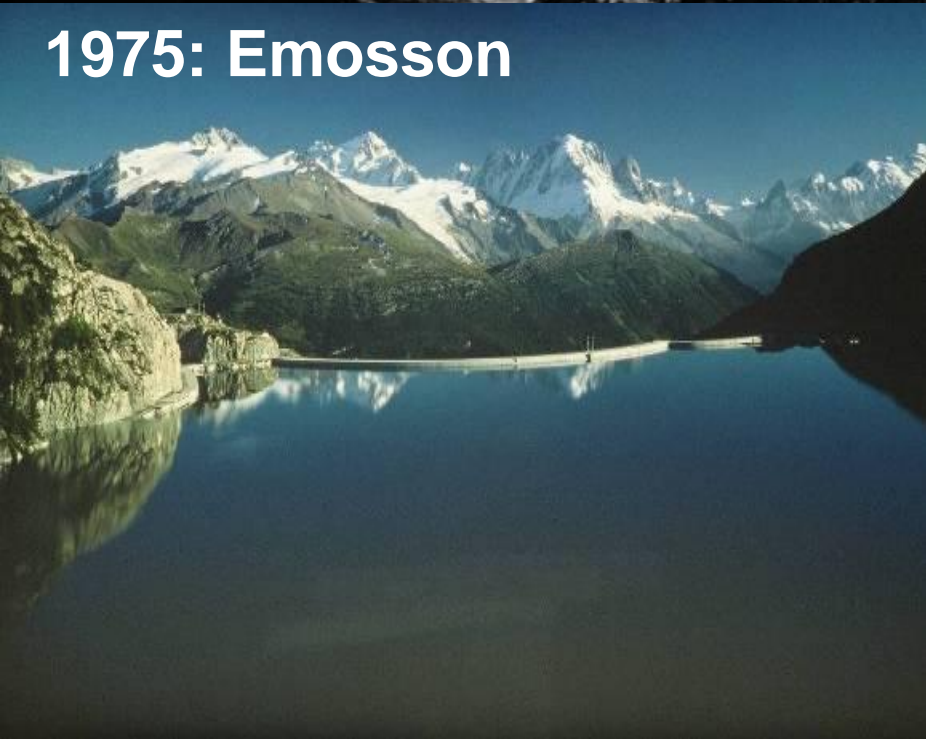
1925: Barberine



1955: Vieux-Emosson



1975: Emosson



2018: Nant de Drance

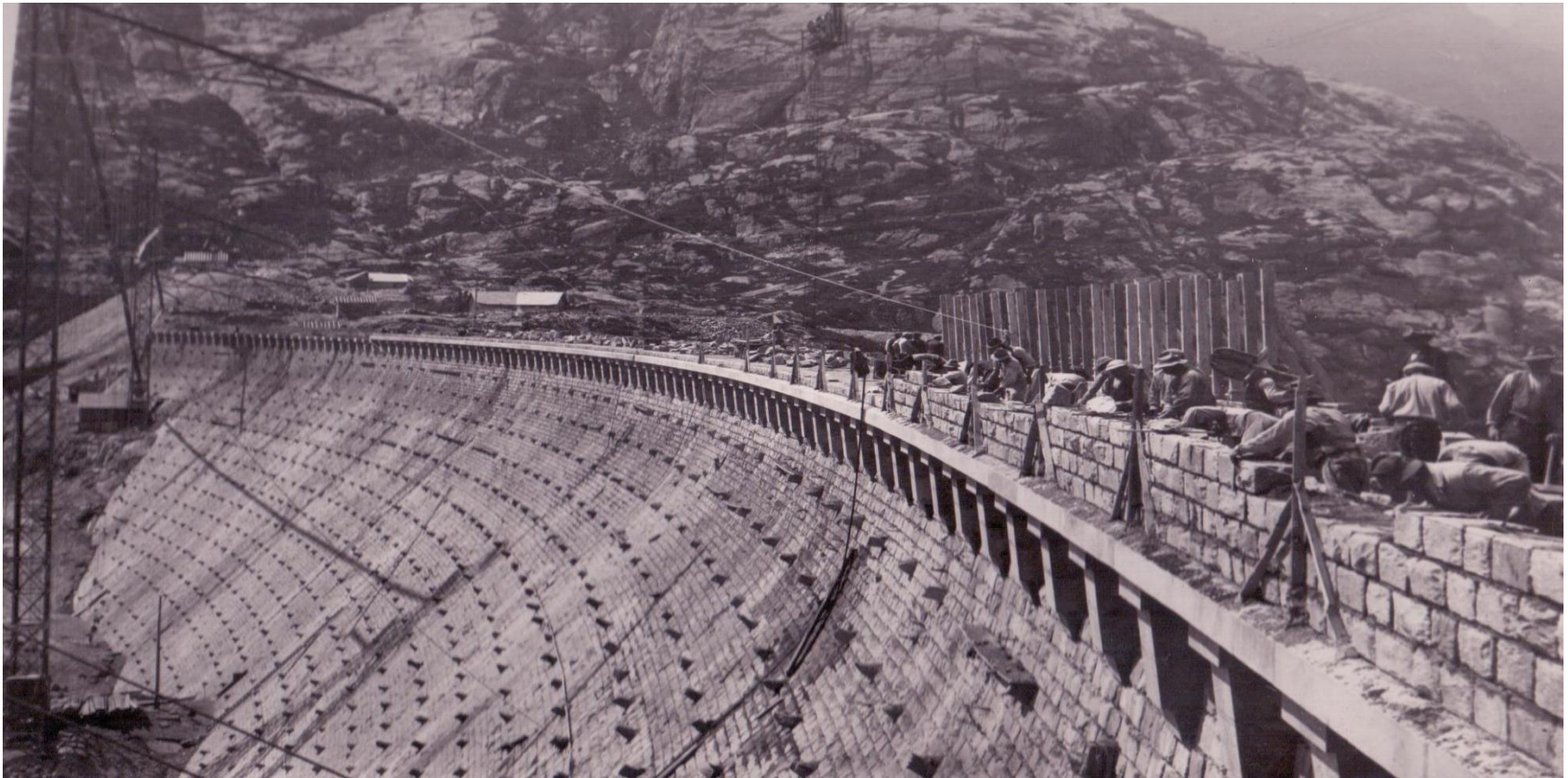


Barberine dam



*40 millions m³
Height 78 m
Spillway
1888.80 m a.s.l.*

Construction of the Barberine dam 1920-1925



Barberine dam at his max. level 1926



Barberine dam today: 40 m under Emosson max. lake level



Existing dams and hydroelectric facilities

Upper reservoir

VIEUX-EMOSSON

Construction:
1955 / 2015

Capacity:
12 / 24 Mio m³

High: 45 / 65 m

**Mix design Arch
dam - gravity dam**

Elevation:
2205 / 2225 m a. s. l.



Existing Dams and hydroelectric facilities

Lower reservoir

EMOSSON
Arch dam

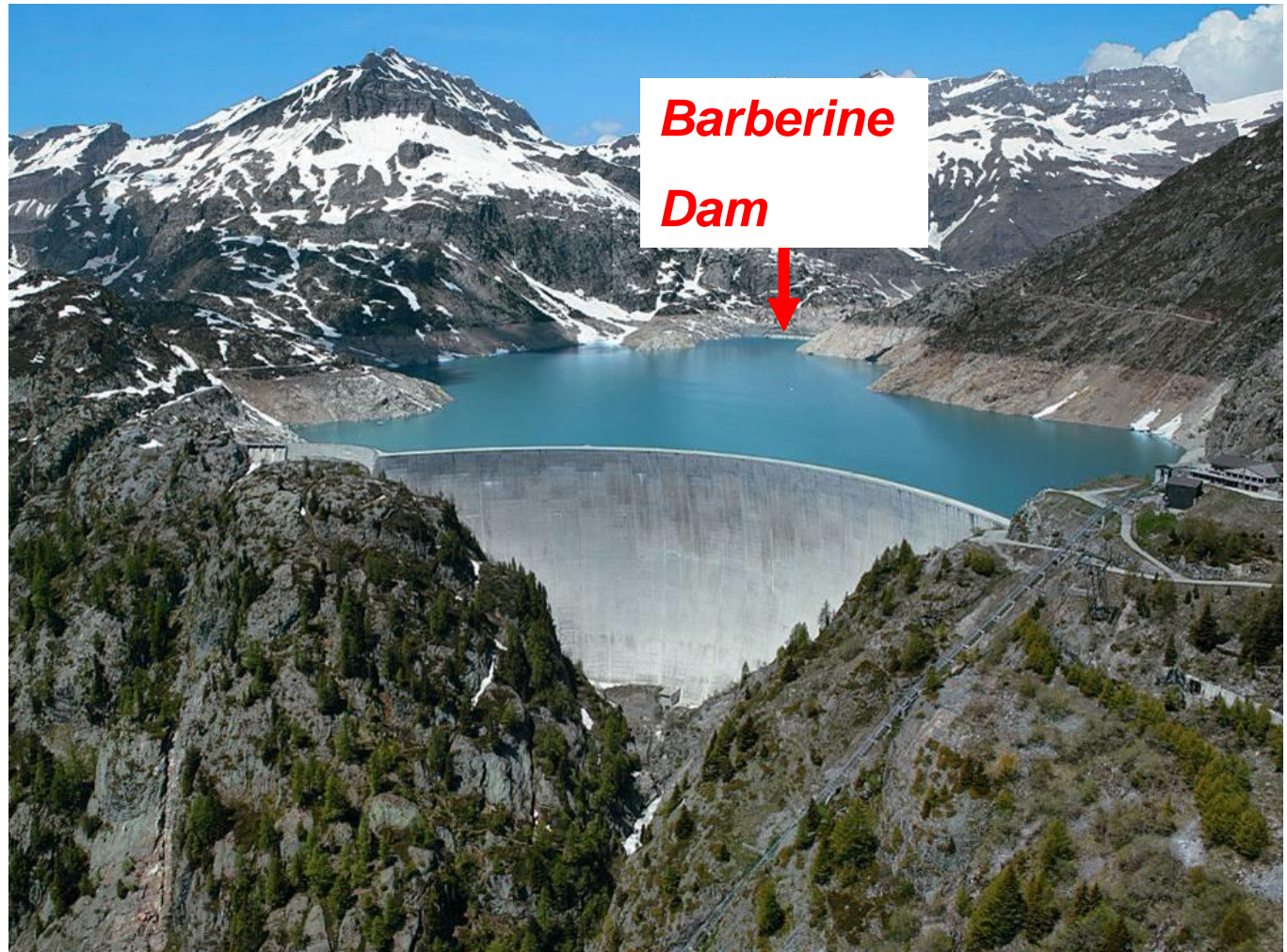
Construction:
1967 / 1975

Capacity:
225 Mio m³

High: 180 m

Elevation:
1930 m a. s. l.

Power:
CFF: 220 MW
ESA: 418 MW
Production:
CFF 430 GWh
ESA 870 GWh



Emosson

the most beautiful landscape to the world from a dam !



The Mont-Blanc chain



Sketch cross-section of the hydraulic system



3 access galleries inclined 12 % :

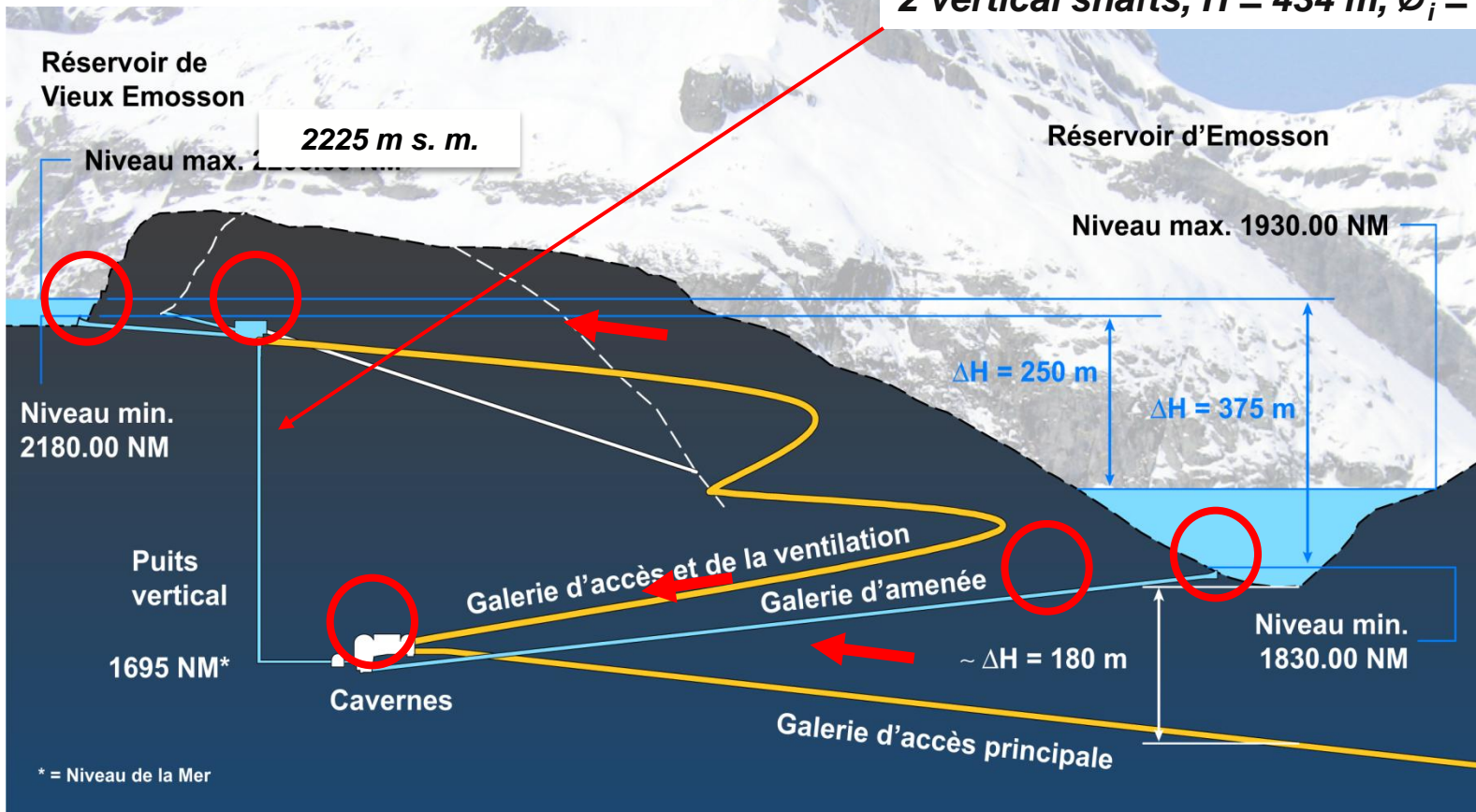
Main access gallery : 5.5 km

Adductions : dist. from Emosson : 1.7 and 2.1 km length

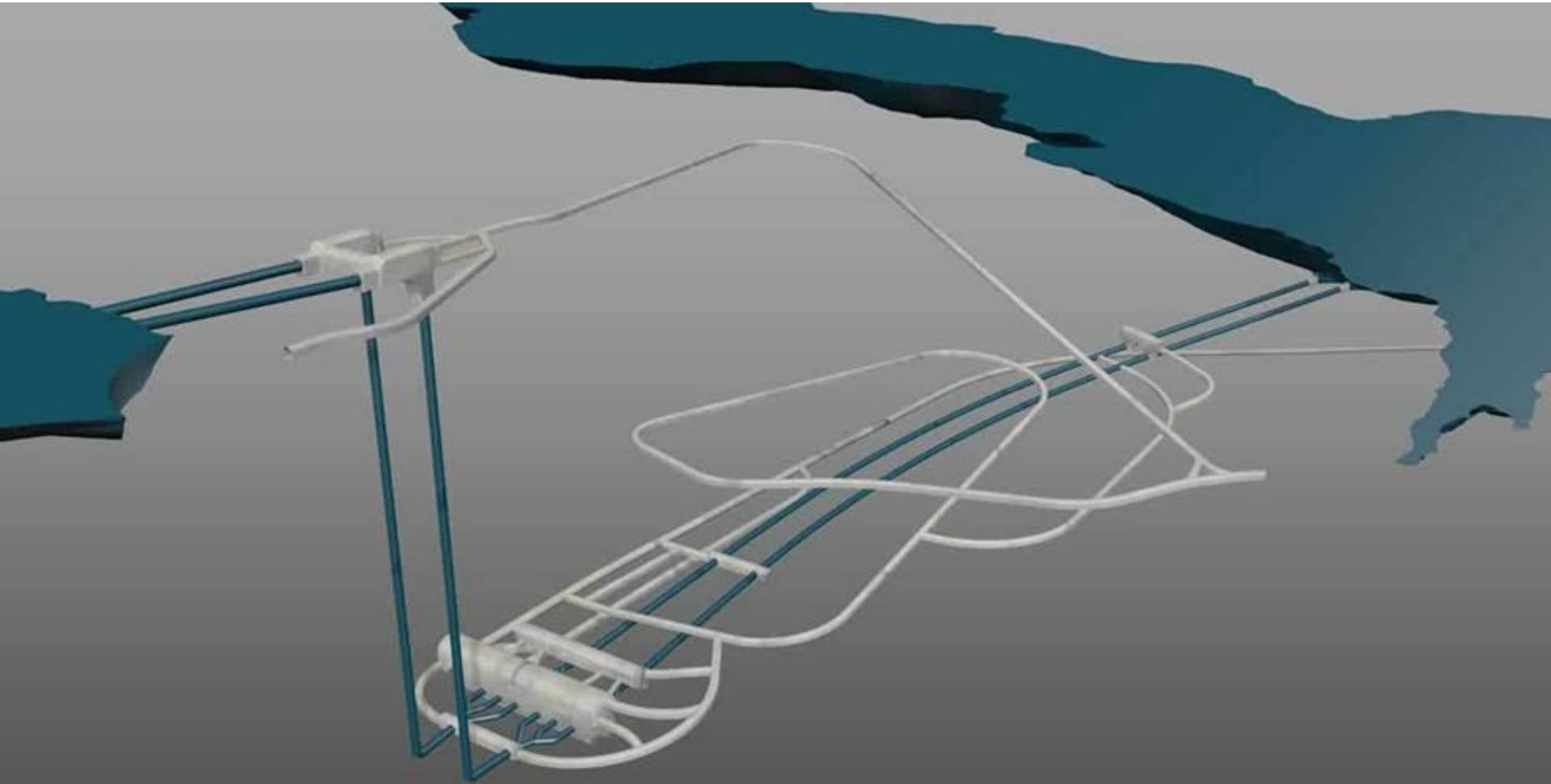
2 parallel hydraulic systems :
2x3 pump-turbines Francis 150 MW

2x2 safety spherical ball valves
2x2 water intakes

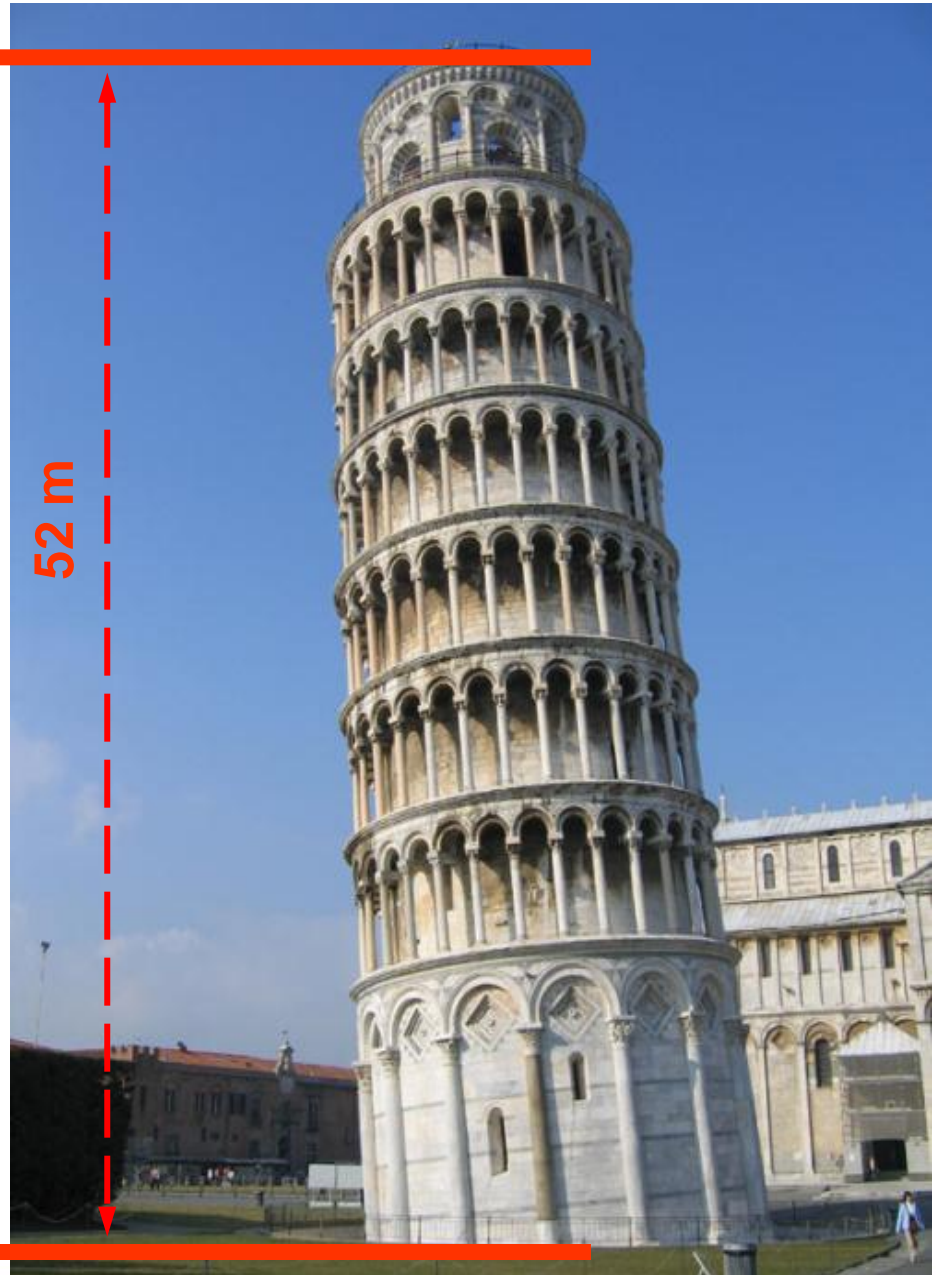
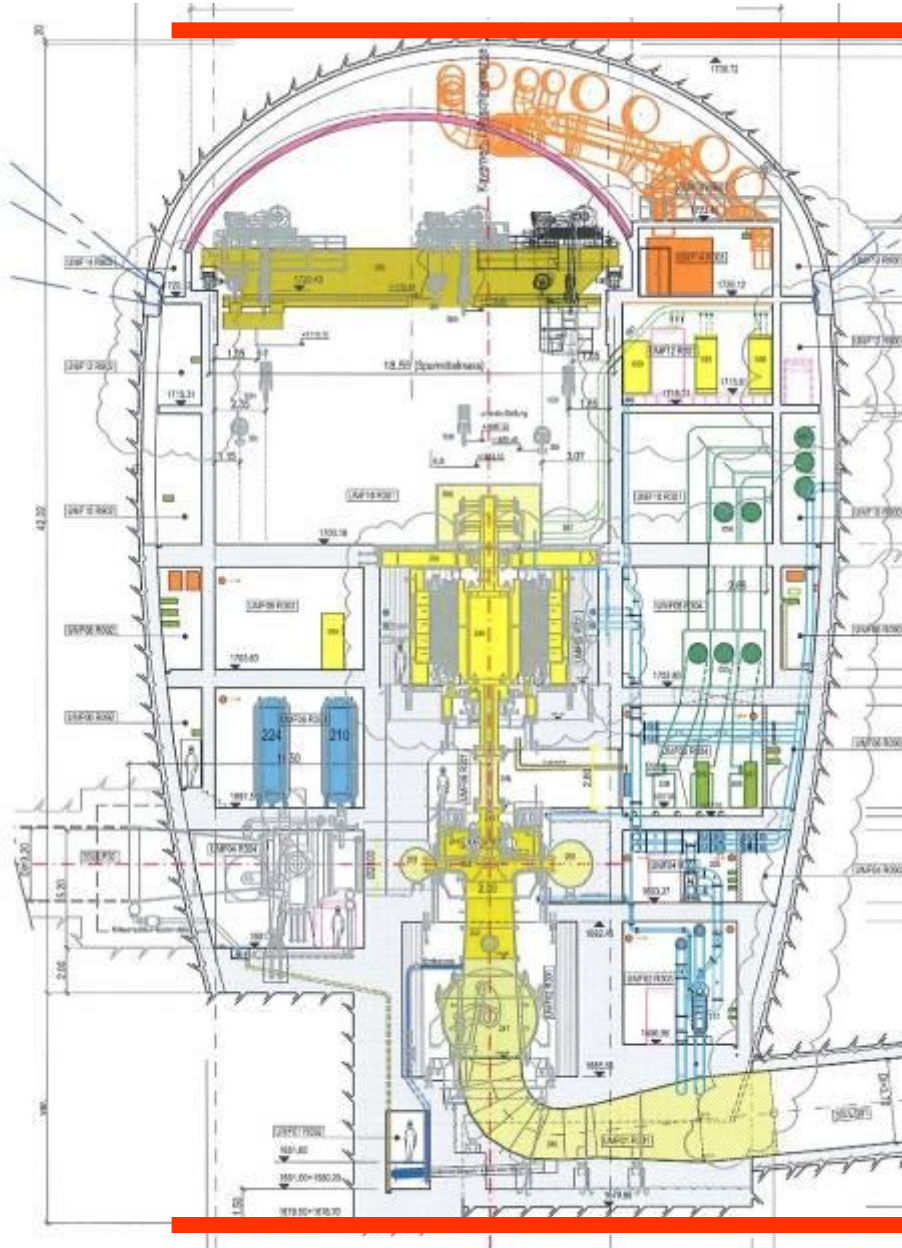
2 vertical shafts, $H = 434$ m, $\varnothing_i = 7.00$ m



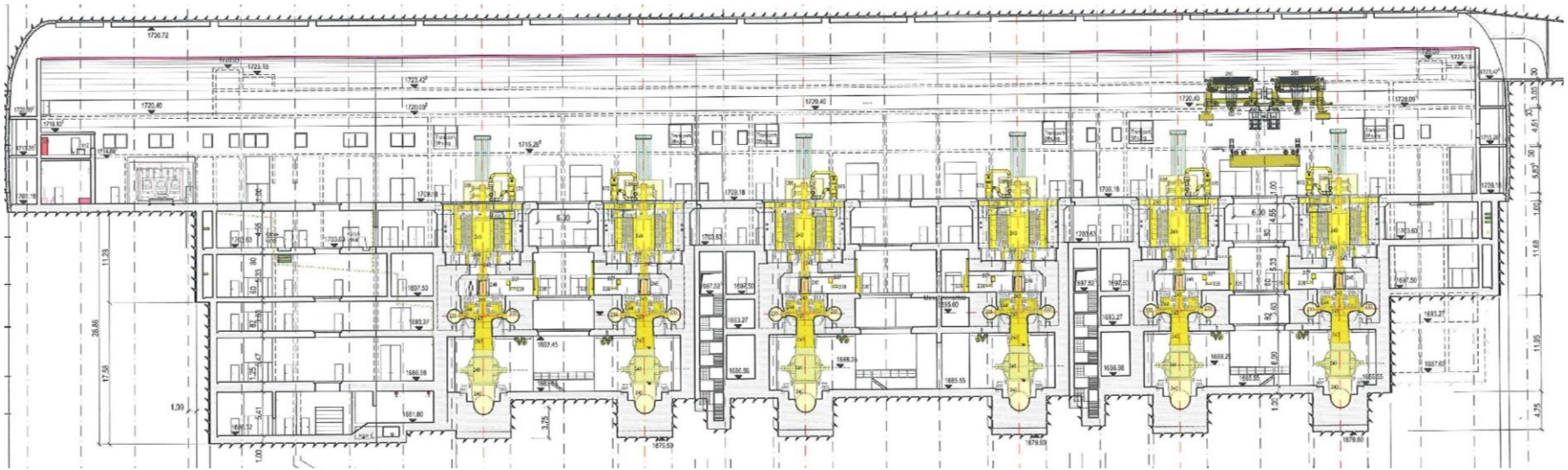
3D-modell of the hydraulic system



Width 32 m

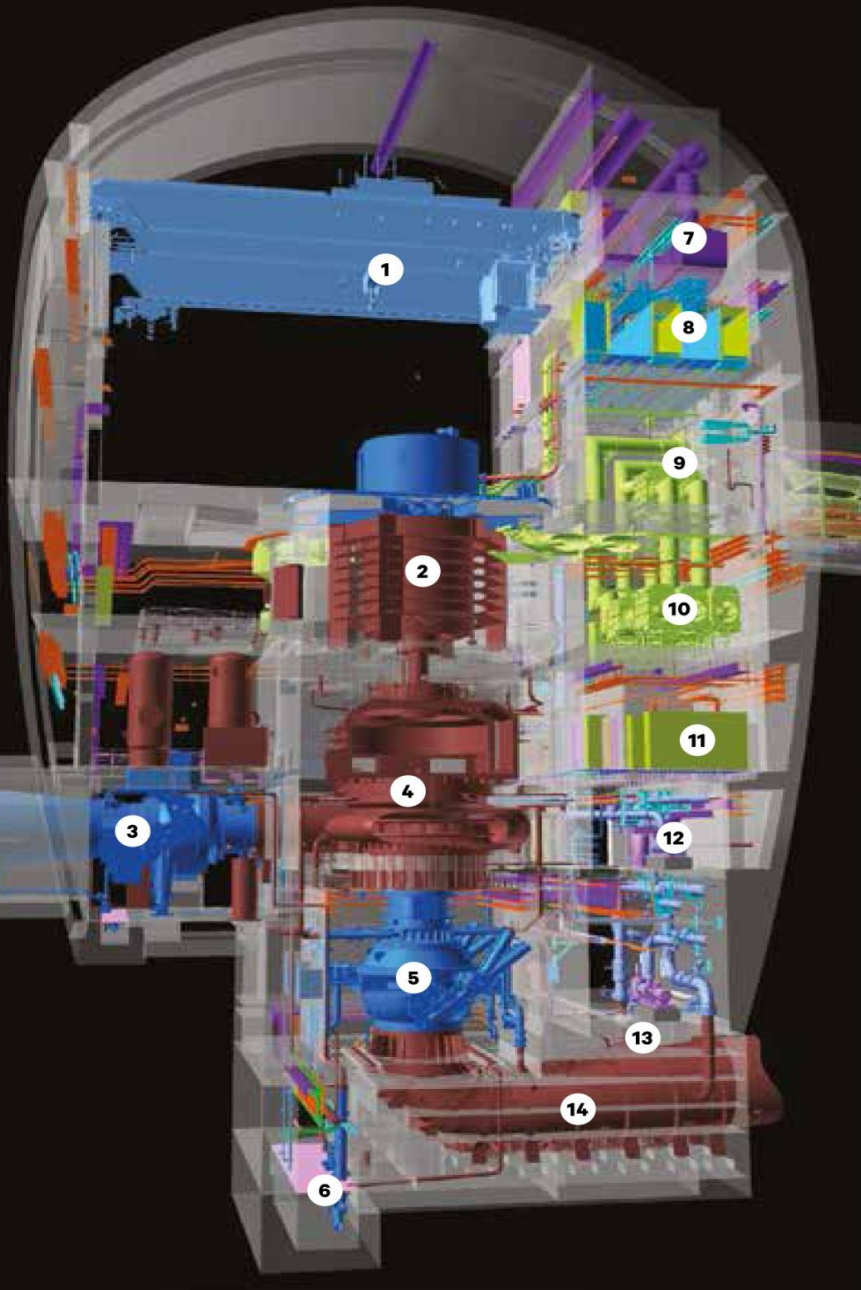


Vertical cross-section of machine cavern



Length 194 m

Machines cavern

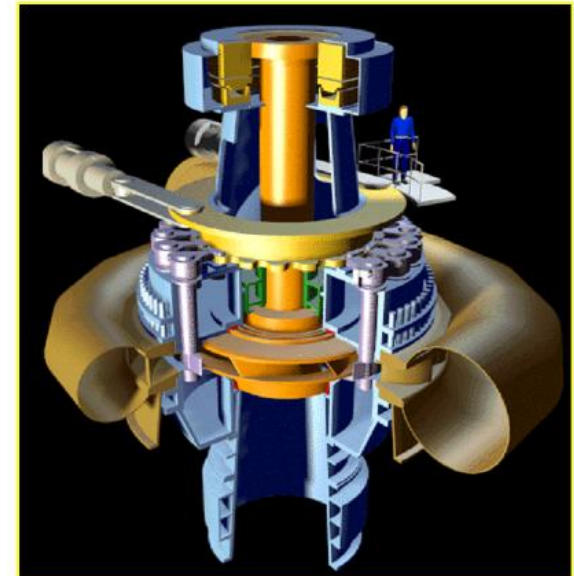
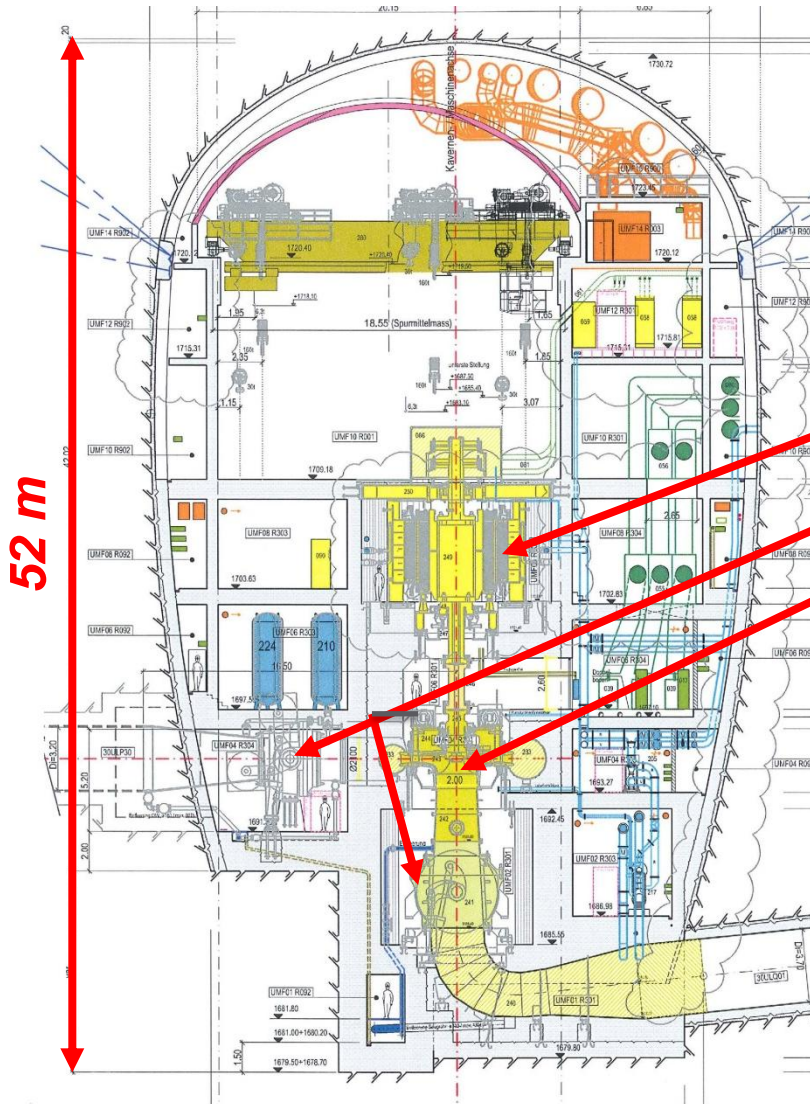


- 1. Rolling gantry cranes (2*160 t)**
- 2. Motor-generator**
- 3. Spherical ball-valves in**
- 4. Pump-turbine**
- 5. Spherical ball-valves out**
- 6. Draining system**
- 7. Ventilation aggregate**
- 8. Frequency converter**
- 9. Phase inverter switches**
- 10. Generator circuit breaker**
- 11. Control-command**
- 12. Secondary cooling system**
- 13. Primary cooling system**
- 14. Suction pipe**

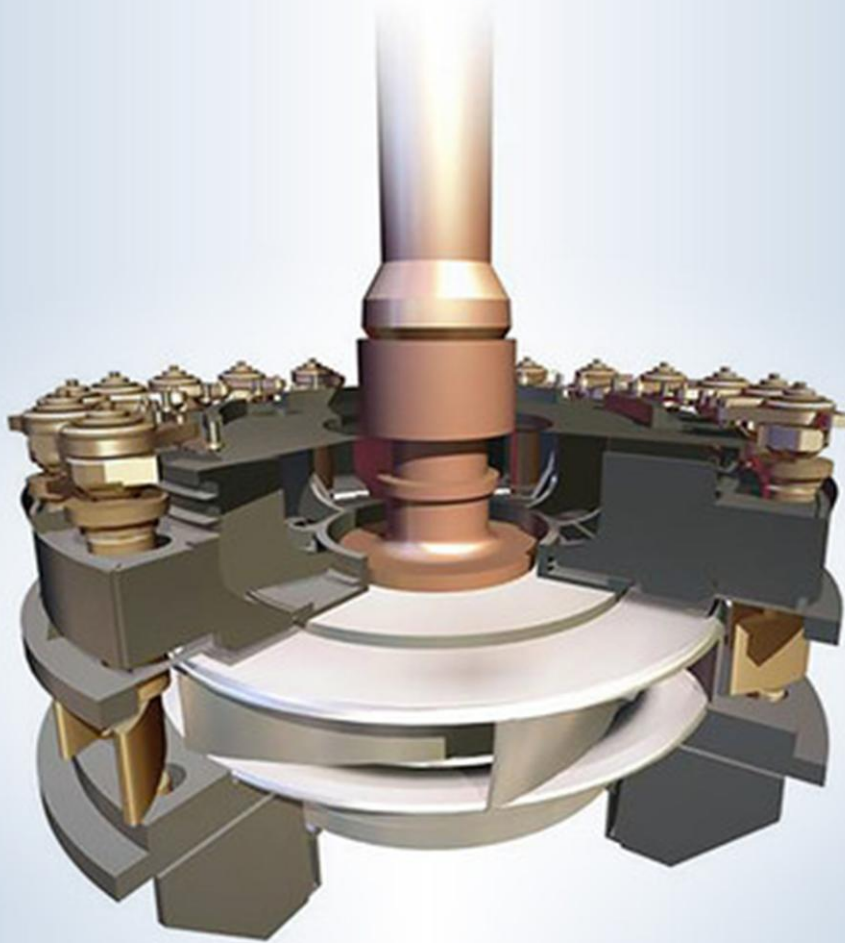
Machines cavern

The system is designed to be started and operated in 3 minutes !

Asynchronous Generator 175 MVA
Spherical ball-valves
Francis pump-turbine
 $Q = 60 \text{ m}^3/\text{s}$



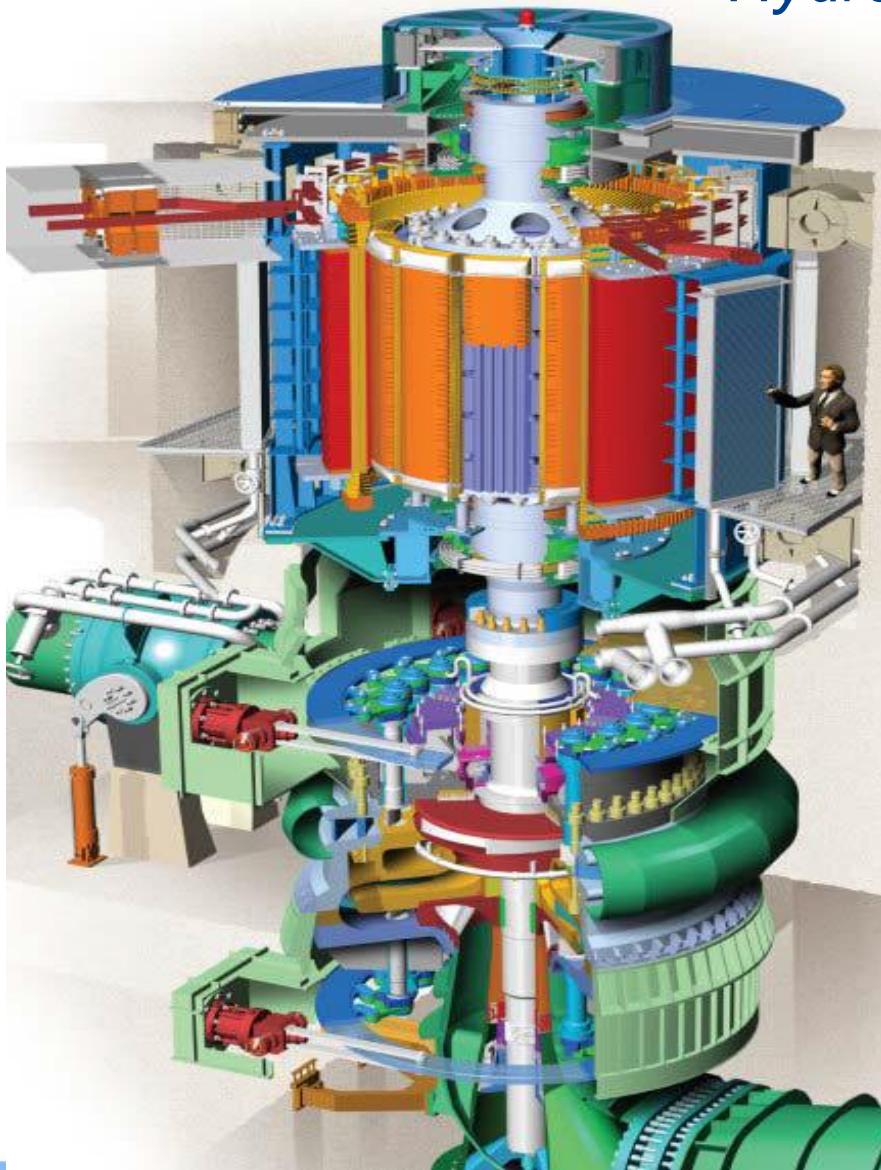
Reversible Francis turbine-pump



•Pompe Turbine

- Type Francis
- Pression maximale amont : 65 bars
- Pression maximale aval: 35 bars
- Survitesse maximale: 650 tr/mn
- Entrée bêche : 2100mm
- Diamètre entrée roue: 3500 mm
- Diamètre sortie roue 1900 mm
- Hauteur du distributeur : 345 mm
- Démarrage en pompe avec bêche dénoyée

Masse de la roue: 19 t



• Donnée générales

- Puissance nominale: 6 x 175 MVA
 - Puissance maximale: 6 x 155 MW
 - Chute brute: 250 à 395 m
 - Débit maximale: 6 x 60 m³/s
 - Vitesse de rotation:
 - 428tr/mn -10%/+7%
 - Rendement de cycle: 80%
 - Production: 2500GWh/an
 - Consommation: 3200GWh/an
- Nota :
- La vitesse variable permet d'élargir la plage
 - de fonctionnement de la turbine ce qui permet
 - une bonne adaptation à la forte variation de
 - chute et une variation de la puissance en
 - pompe.

Mass of rotor : 210 t

Mass of stator: 320 t

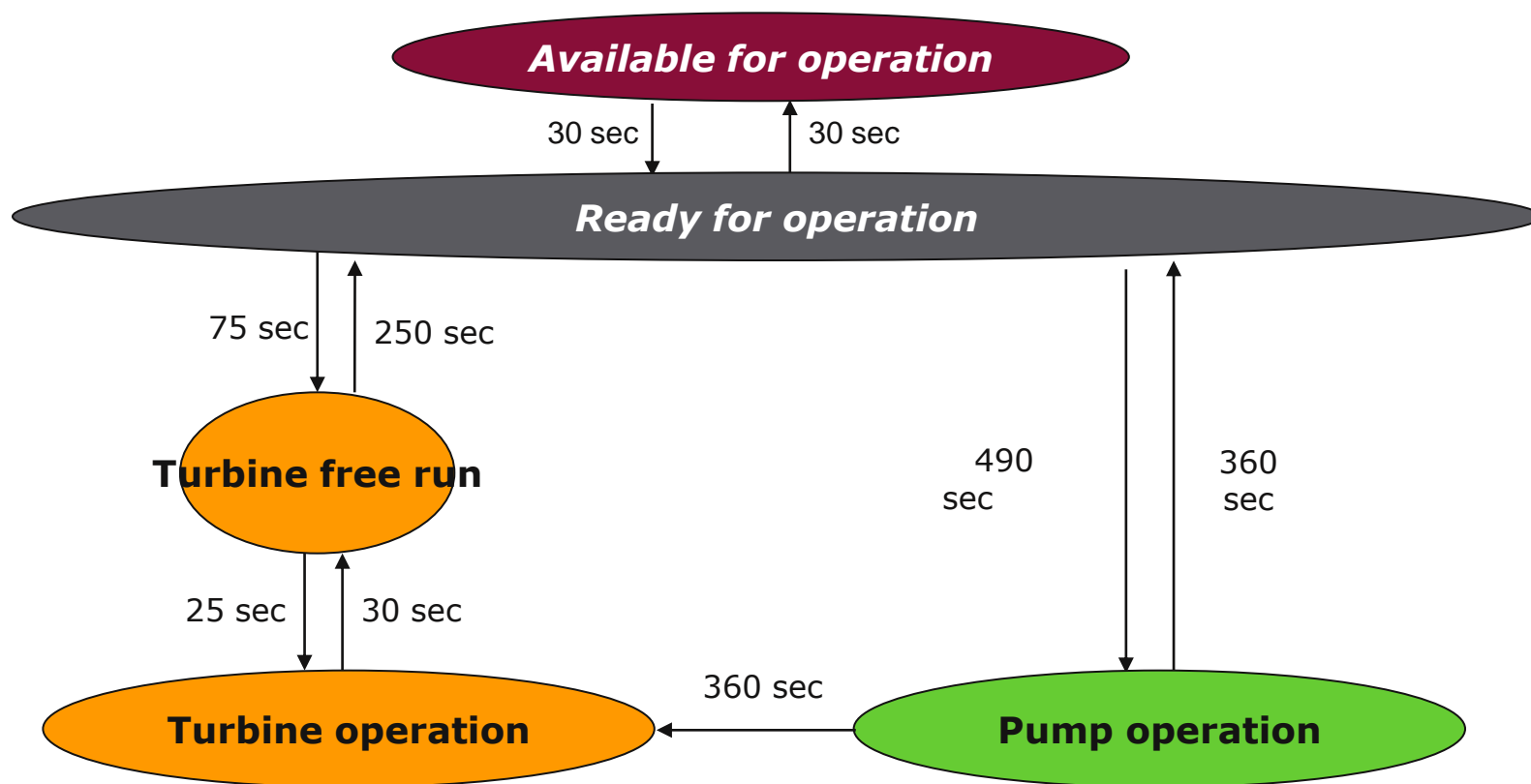
Transformer and switch yard cavern

900 MW connection to grid

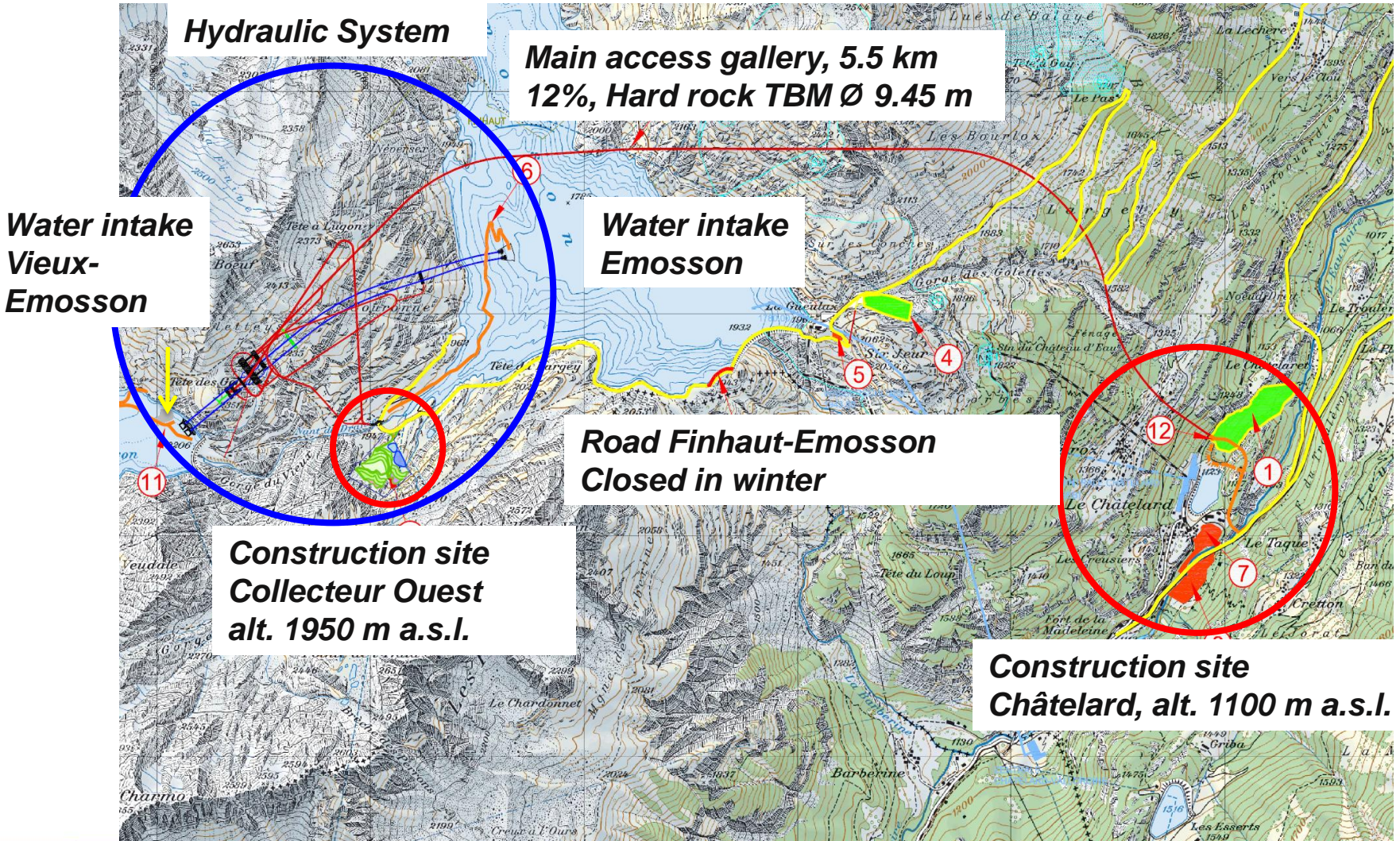


High flexibility

900 MW of power after < 3 minutes !



Project overview



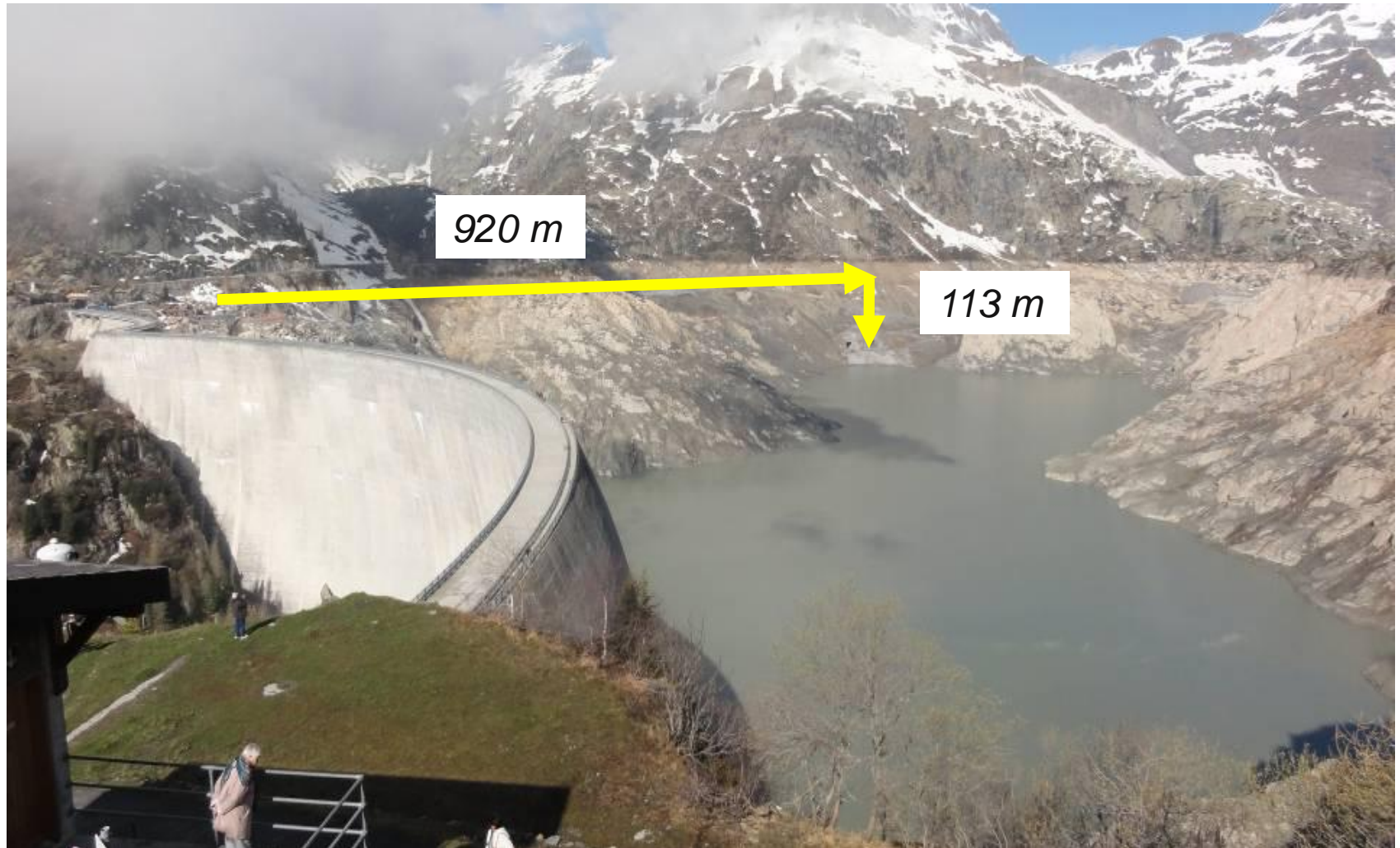
Emosson: building of a water intake

Mass: 1700 t
Height: 12 m
Width: 22 m



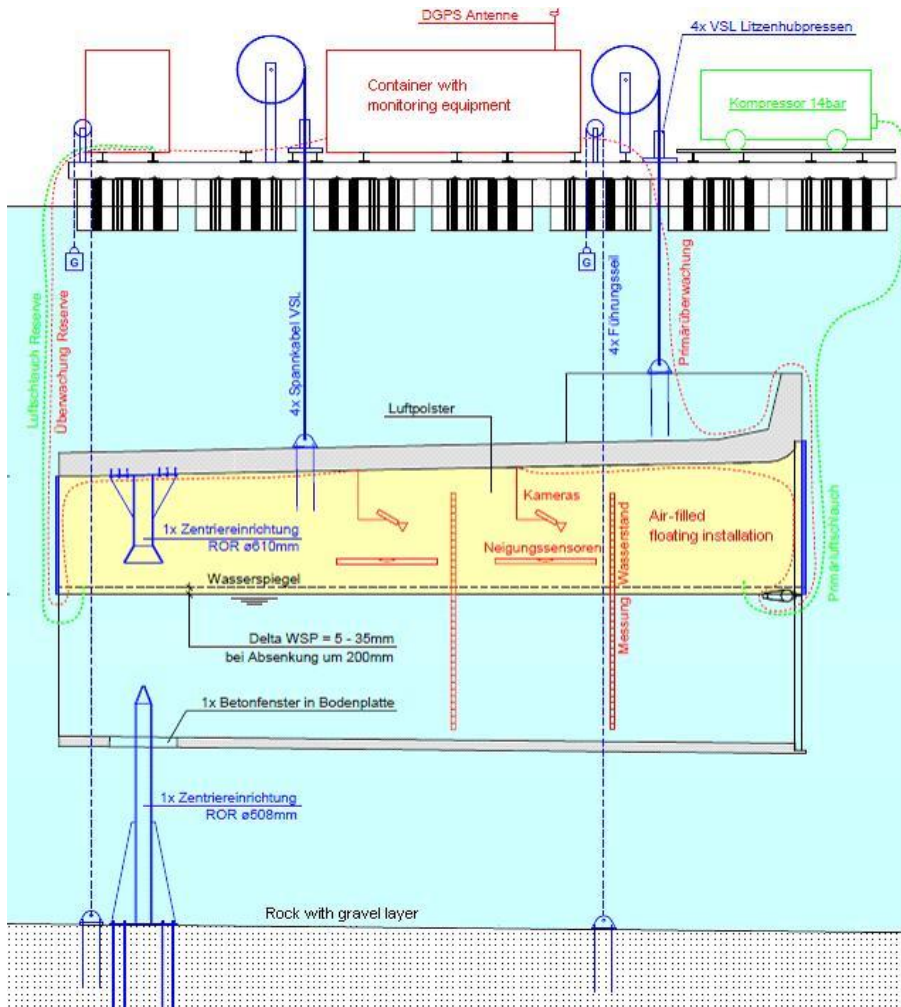
Emosson water intakes

Immersion of the structures



Emosson water intake

Floating of the first structure

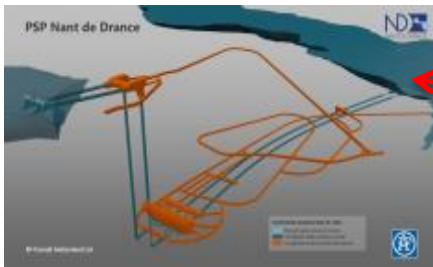


80 % of the weight is supported by the air in the building

Injection of compressed air to have always the same free volume

Emosson water intakes

Each one intrance surface 250 m², 180 m³/s





Machines cavern

The end of the excavations

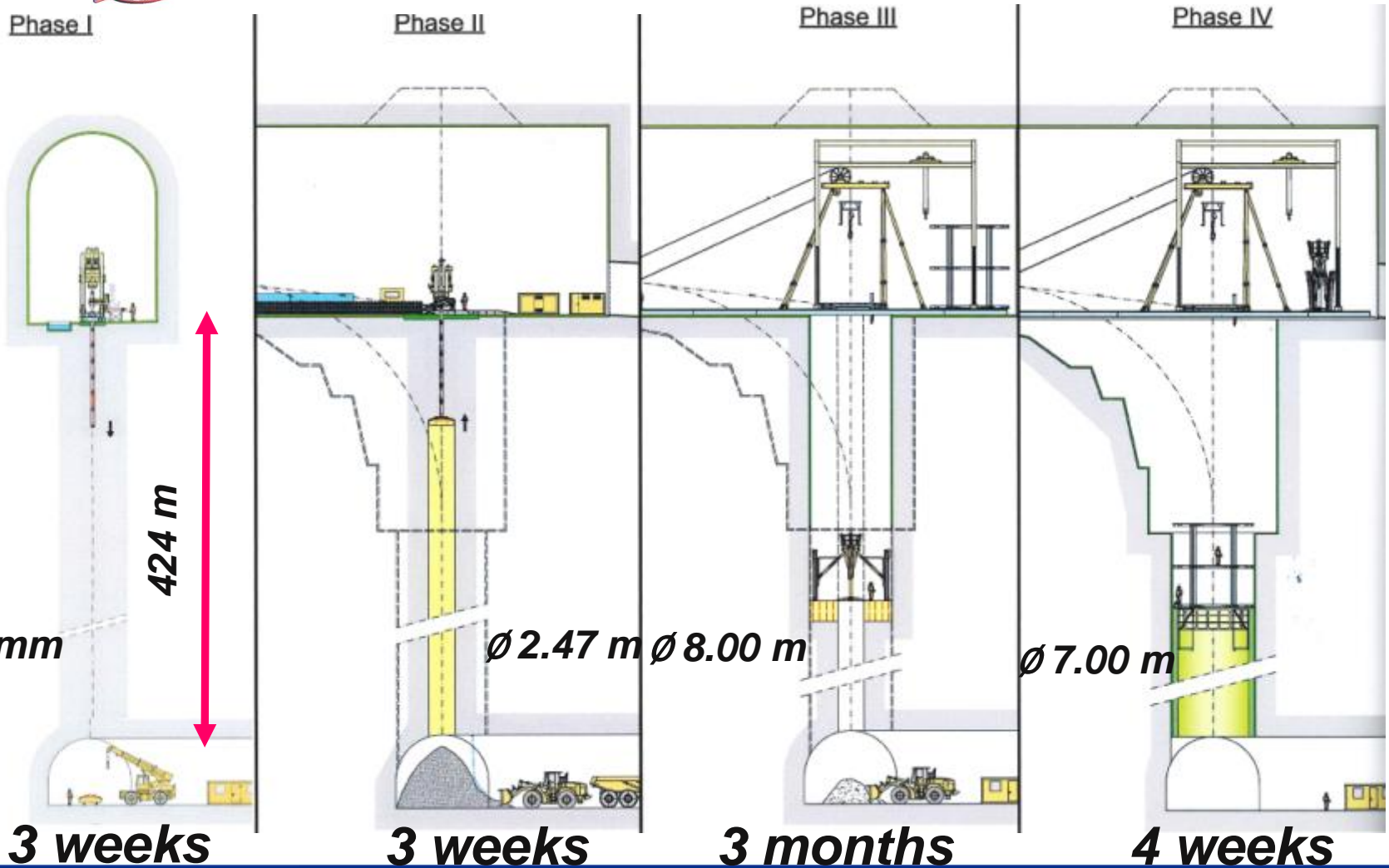
22.04.2014



*Mrs Doris Leuthard
Swiss minister of the energy...*

Vertical shafts

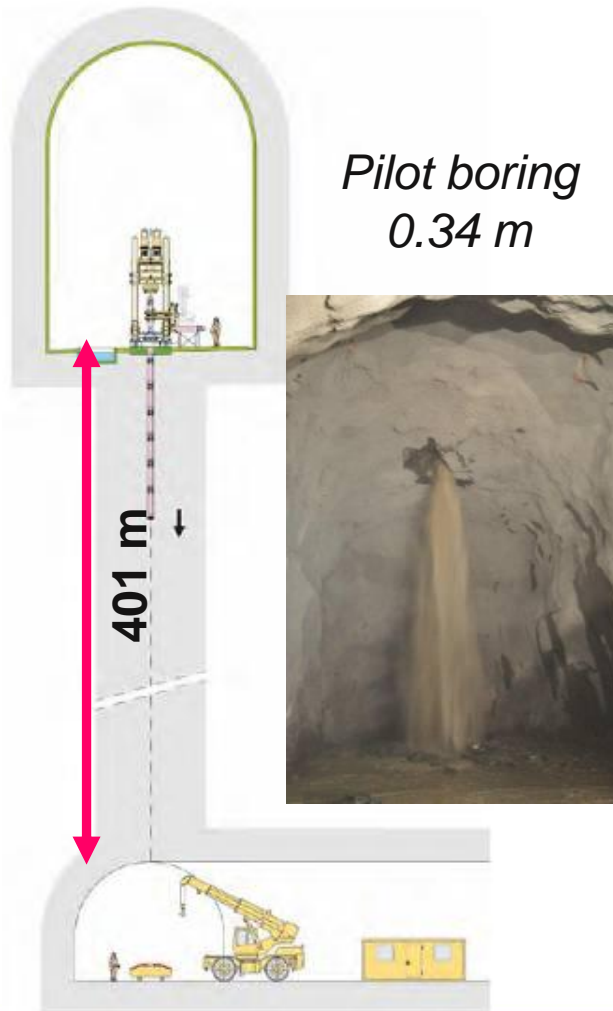
7/24 working hours



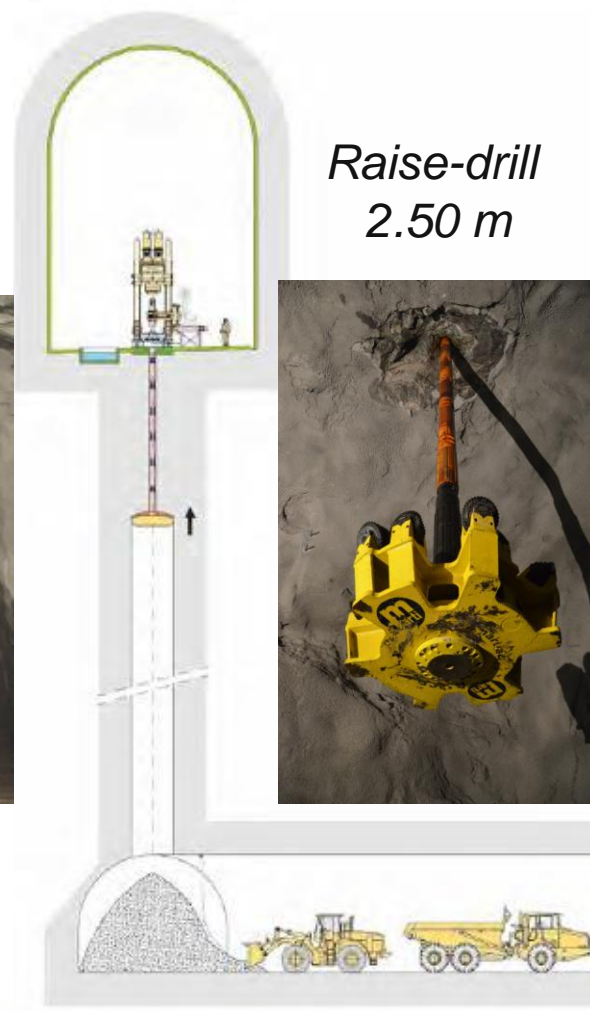
Vertical shafts



A) Forage pilot

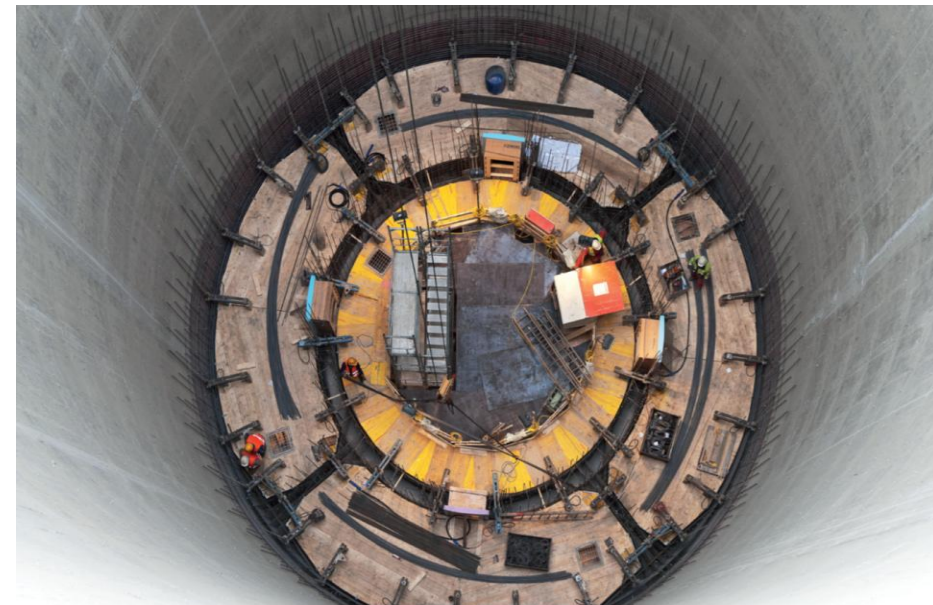


B) Forage d'alésage





Enlargement (8.0 m) by drilling and blasting



Final diameter 7 m

The vertical shaft butterfly valve





***Butterfly valve
Int. diameter
6 m, 130 t***

Vertical shafts, the elbow

Bottom cavern before concreting



Hydraulic connections to 3 turbines



The 3 turbines are hydraulically connected

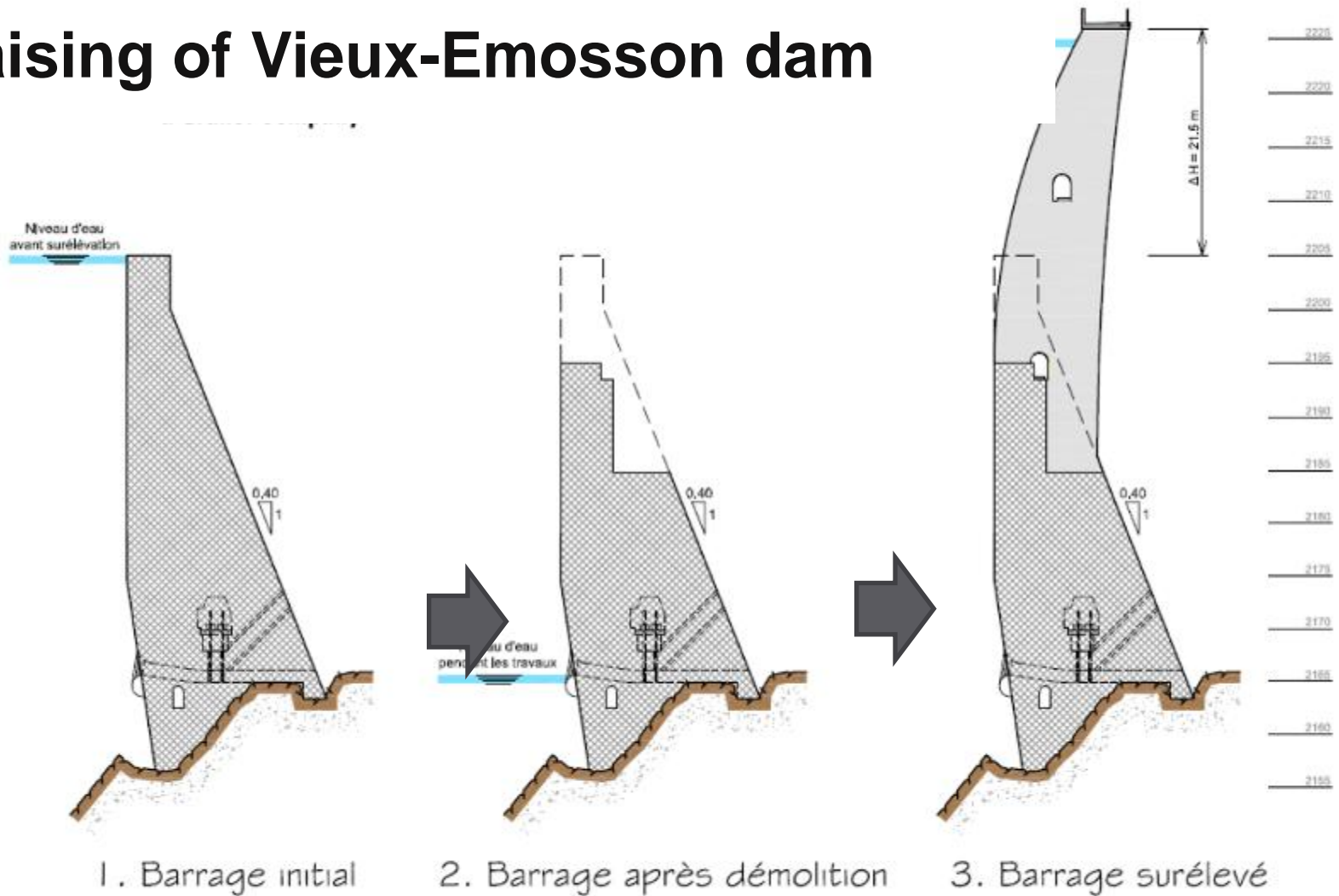


Vieux-Emosson dam

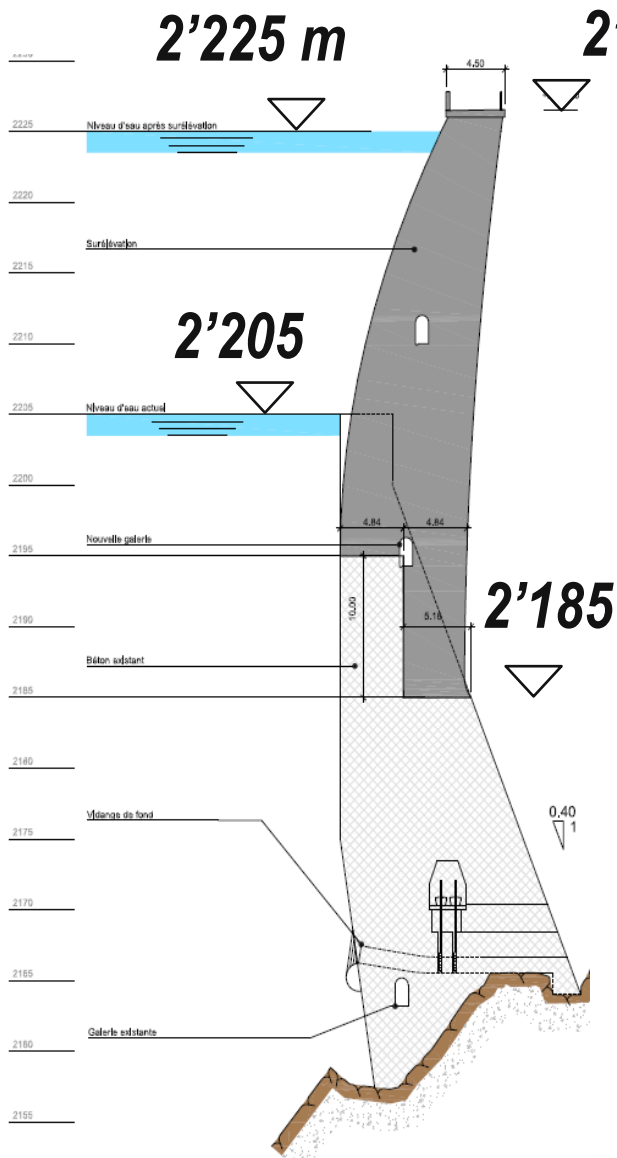
Initial dam



Raising of Vieux-Emosson dam



Raising of Vieux-Emosson dam



Raising

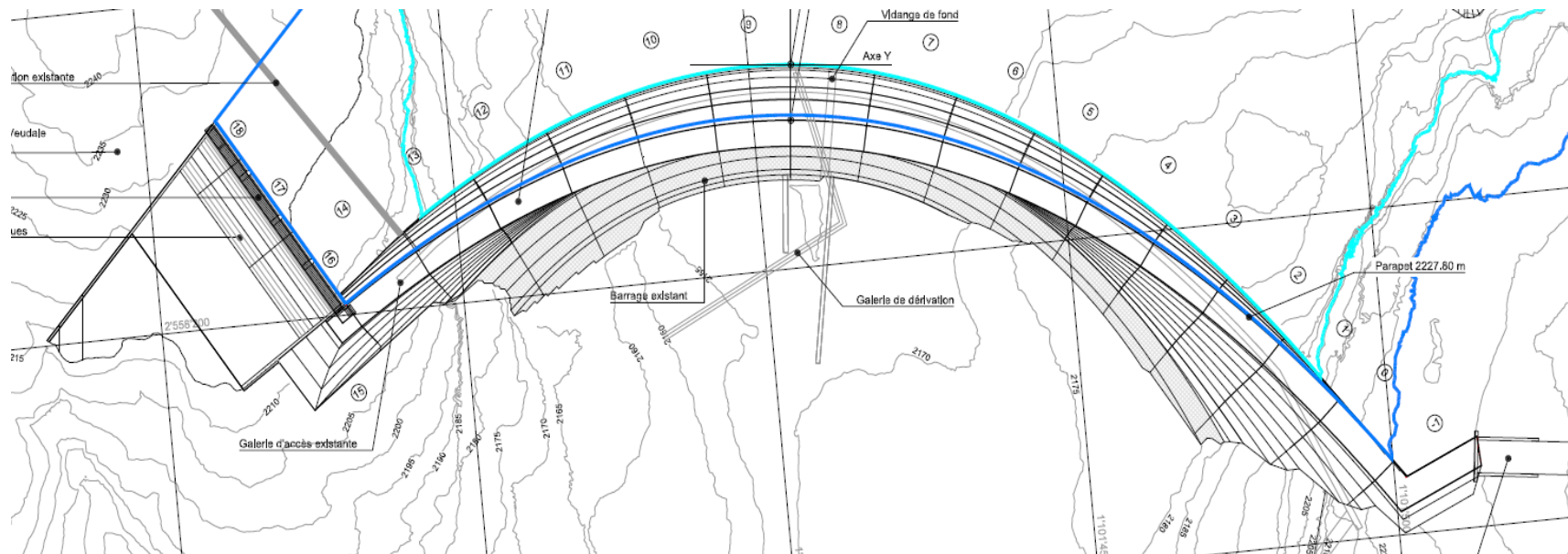
- Lake : 2'205 m → 2'225 m (+20 m)
- Crowning :
2'205 m → 2'226.5 m (+21.5 m)
- Height of new concrete:
2'185 m → 2'226.5 m (41.5 m)
- Total height: 76.5 m

Volume of the storage :
11.2 mio m³ → 24.5 mio m³

Raising of Vieux-Emosson dam

Characteristics

- Arch dam
- Parabolic shape
- Wingwalls on the banks
- Height max. 76.5 m
- Length 200 m
- Width in the crowning 4 m
- 20 blocks





Lowering of Vieux-Emosson

Raising of Vieux-Emosson dam

Equalization of the surface



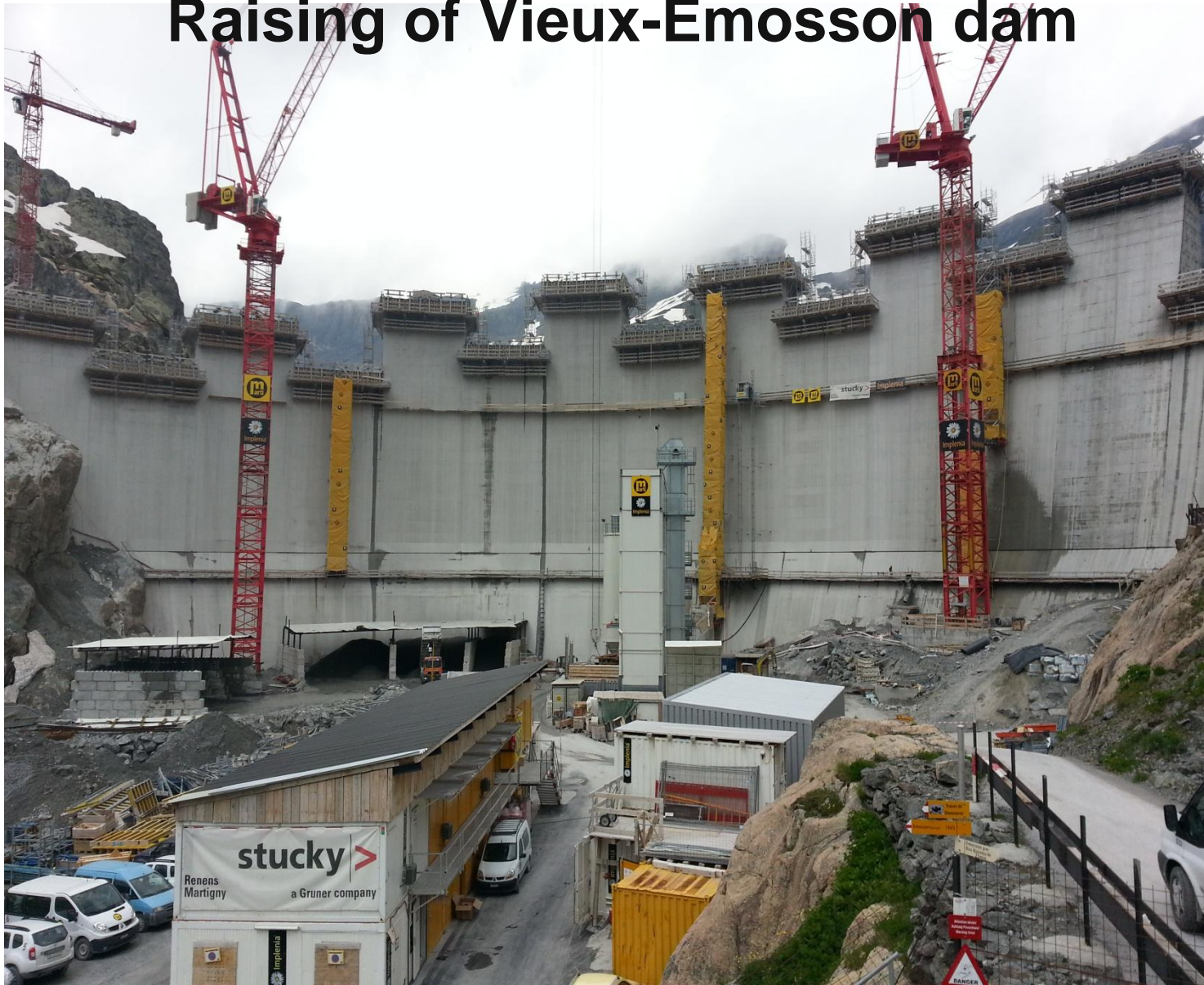
Raising of Vieux-Emosson dam



Raising of Vieux-Emosson dam



Raising of Vieux-Emosson dam



Vieux-Emosson's lake water intakes

Elevation 2163 m a.s.l.



Vieux-Emosson's lake water intakes



13.10.2016

Raising of Vieux-Emosson dam





Ultima benna : 25.09.2014



Thank you for attention !

www.nant-de-drance.ch