INNOVATION AND EXPERIENCE IN INTERNATIONAL HYDROPOWER PROJECTS: FROM PUMPED STORAGE TO DAMS HEIGHTENING

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WHO ARE WE?

> International engineering company with a Swiss heritage

> Founded in Basel in 1862 by Heinrich Gruner

> 34 offices in Switzerland and abroad

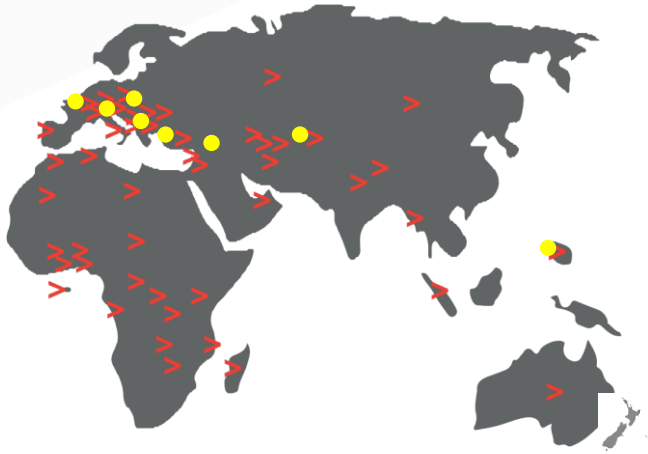
> Globally recognized experience in hydropower

> Italian branch opened in 2024 in Milano

BUILDINGS

INFRASTRUCTURE

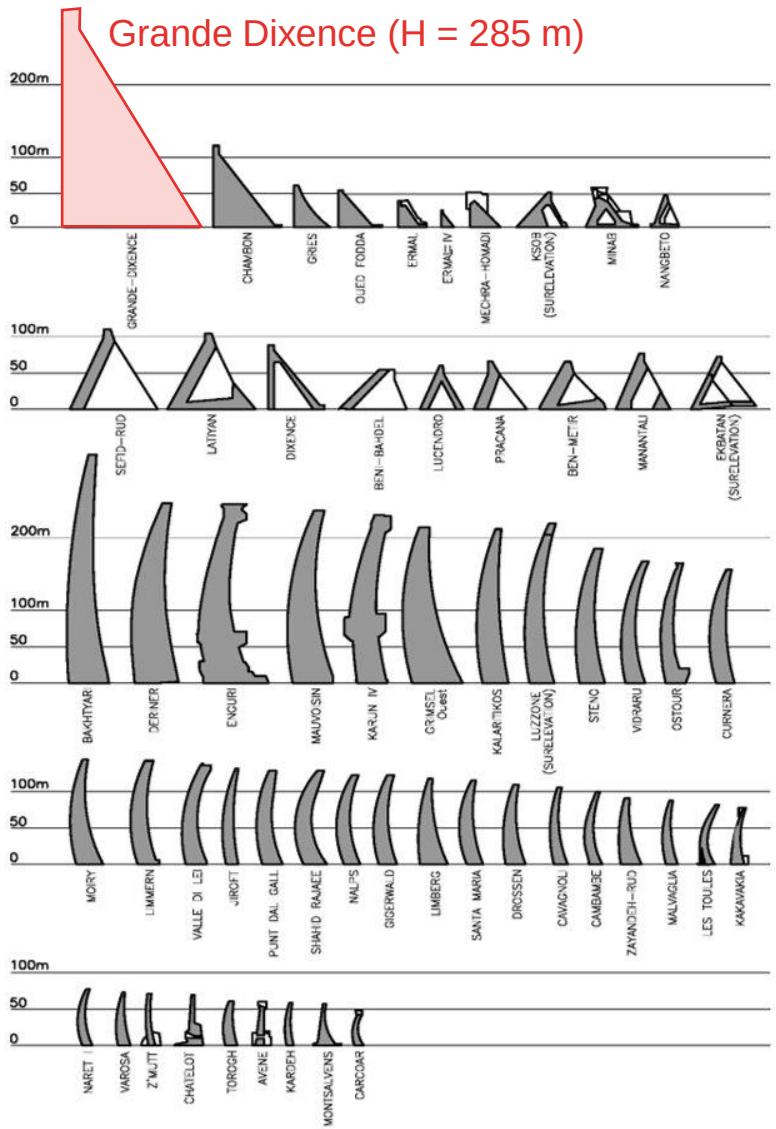
ENERGY

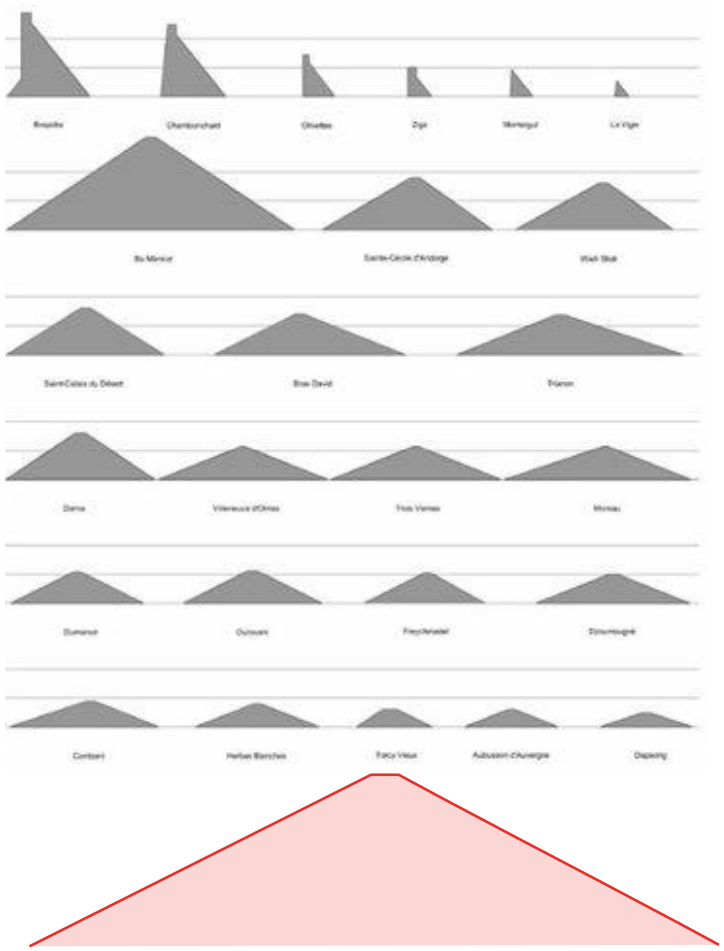


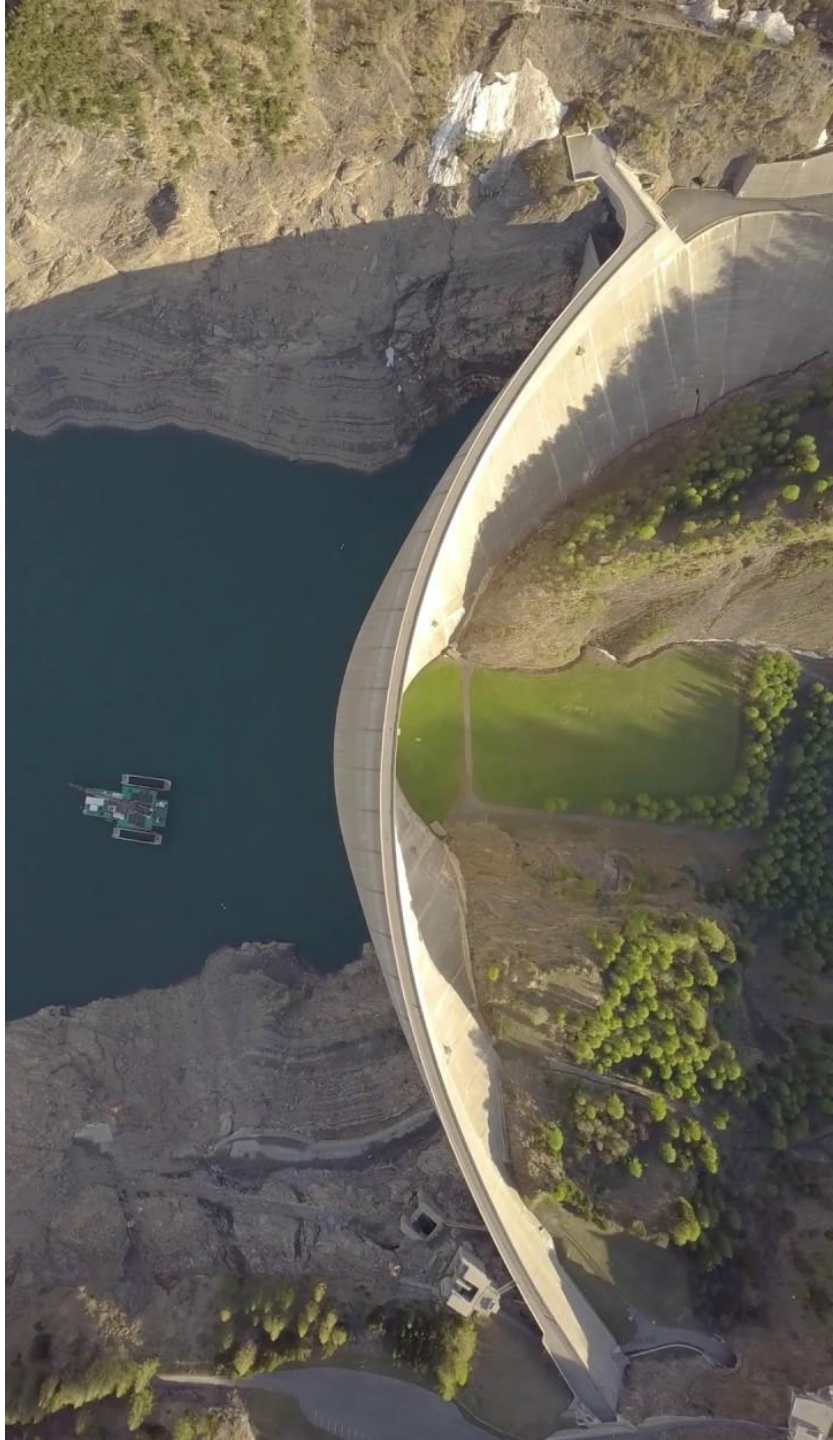
Branch Offices:

- Italy
- France
- Austria
- Germany
- Turkey
- Serbia
- Georgia
- Tajikistan
- Philippines

OUR TRACK RECORD OF DAMS







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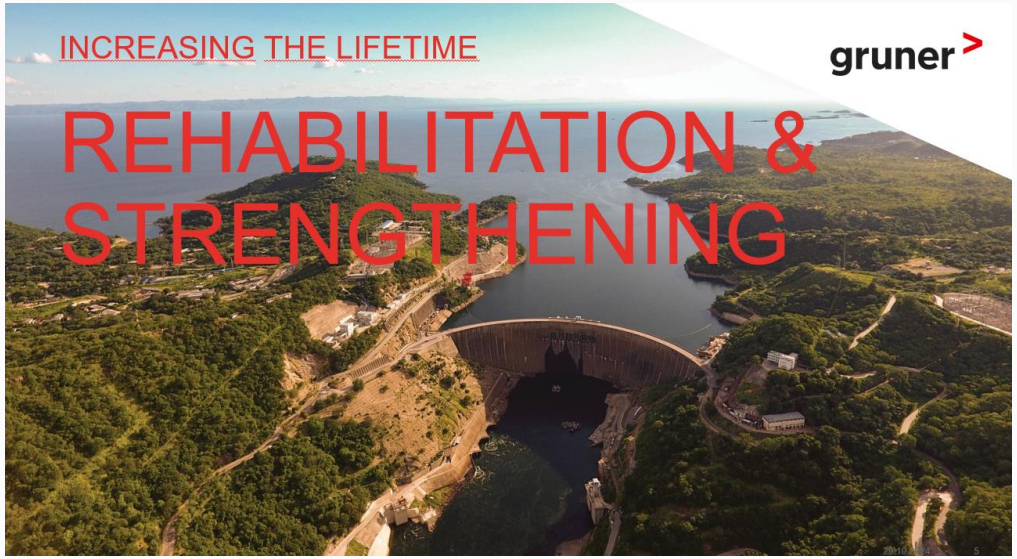
OUTLINE


INCREASING THE LIFETIME
REHABILITATION &
STRENGTHENING


FROM
PUMPED STORAGE
TO
DAMS HEIGHTENING


DIGITAL SOLUTIONS

INCREASING THE LIFETIME

REHABILITATION & STRENGTHENING

AGEING DAMS

> Construction of large dams largely decreased since 1980

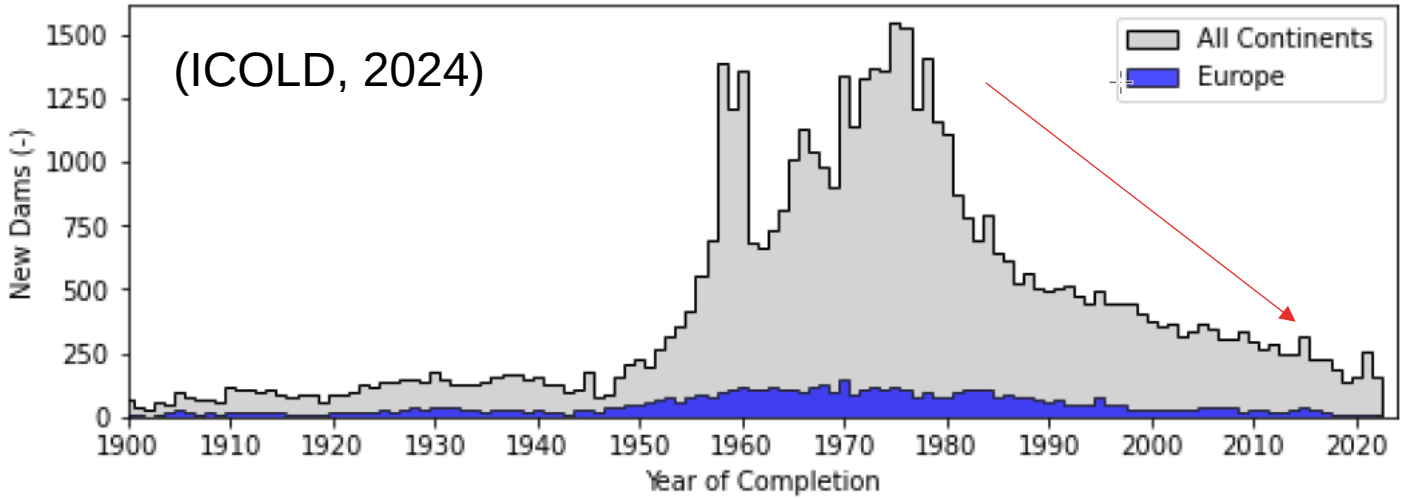
> Almost 62’000 dams. **53%** older than 50 years and **6.8%** over 100 years old

> Approximately 3,369 large dams in Europe are older than 50 years

→ **rising maintenance needs** and **costs**
→ **declining effectiveness** and **growing risks** to both **safety** and the **environment**

> The effects of climate change heavily impact dam safety

Rehabilitation and strengthening are vital to ensuring resilience



SPITALLAM DAM SWITZERLAND

Client: Kraftwerke Oberhasli AG (KWO)

Services:

- Feasibility
- Final and Tender Design
- Detailed Design

DAM Technical Data:

- Replacement of the 1932 arch dam with a new double-curvature arch dam
- New dam built downstream of the existing dam
  → limiting the lowering of the reservoir level and thus the loss of production
- Dam 113 high ; concrete volume of about 212'000 m3.

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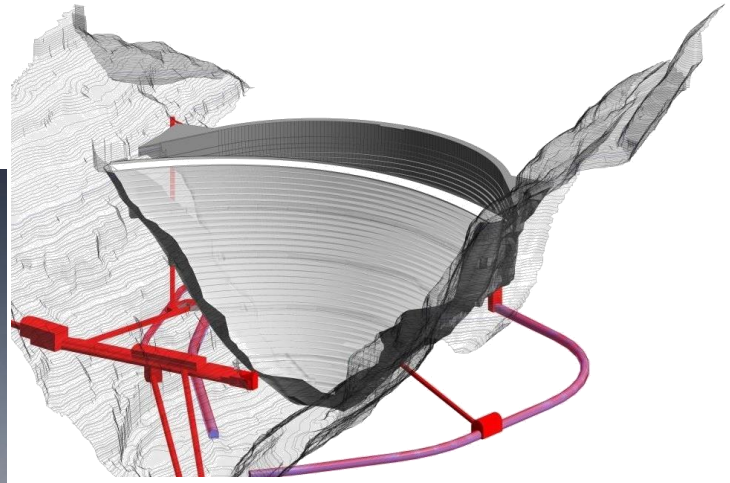
SPITALLAM DAM, SWITZERLAND

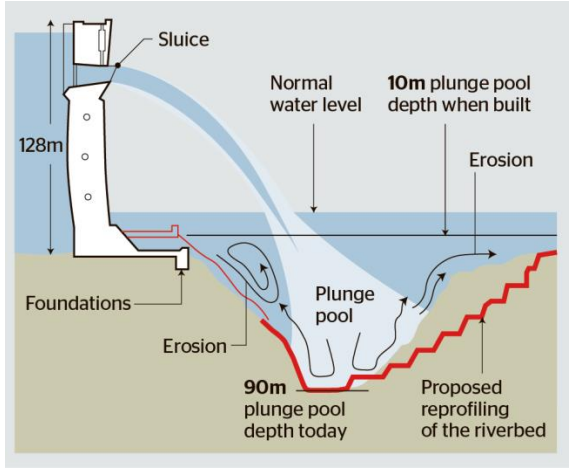


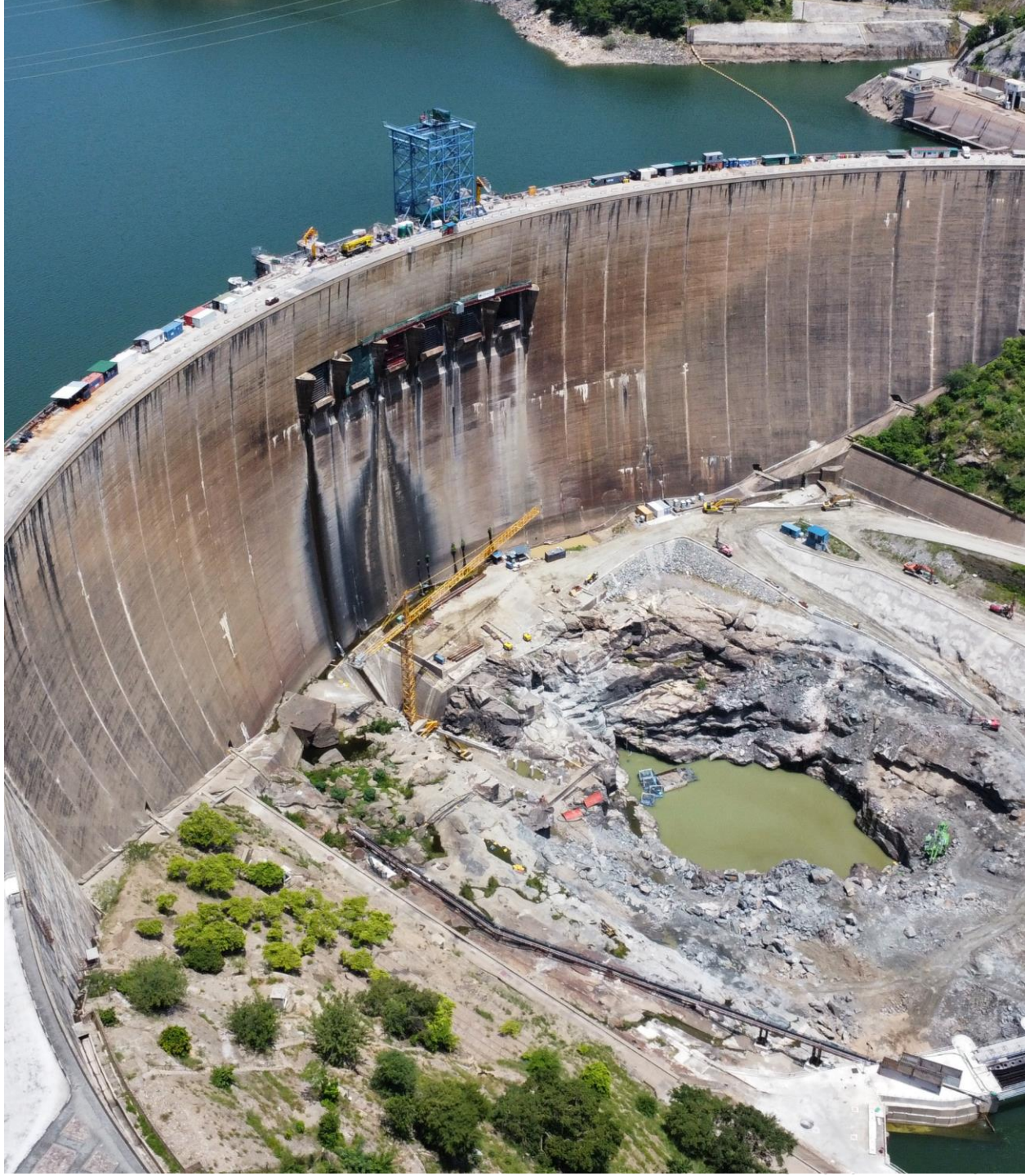
KARIBA DAM, ZAMBIA

Client: Zambezi River Authority, Zambia
Dates: 2016 - 2025

Services:
- Tender Design and Documents
- Detailed Design
- Supervision of Works

DAM Technical Data:
- Kariba is a 128 m high Arch Dam from 1950 on the Zambezi River
- 2 power plants totaling 1830 MW
- Complete refurbishment of the Spillway as well as the reshaping of the Plunge Pool to mitigate scour





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KARIBA DAM ZAMBIA

KARIBA DAM ZAMBIA

FROM PUMPED STORAGE TO DAMS HEIGHTENING

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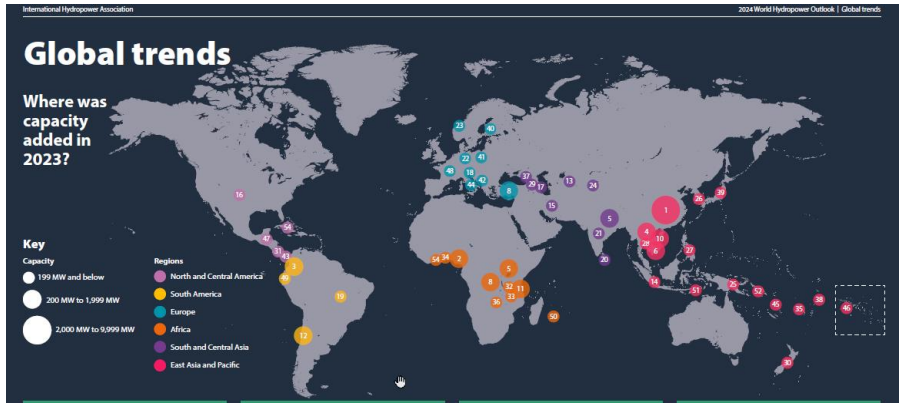
ROLE OF PUMPED STORAGE IN THE ENERGY TRANSITION

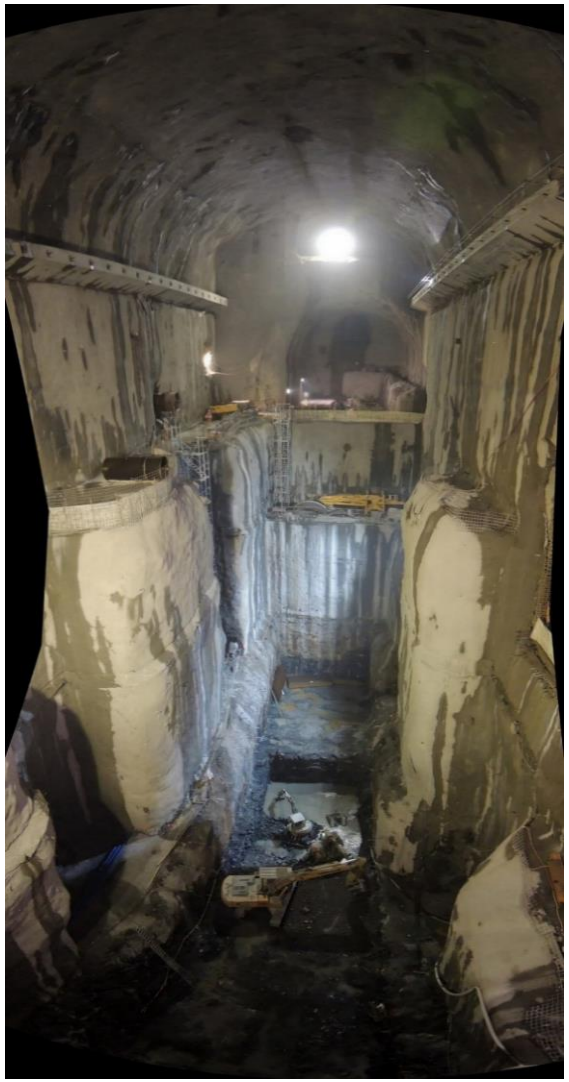
- Why do we need PSP?
  - Increase of power and energy storage capacity, with limited social-environmental impact and quicker implementation process;
  - Stability of power network, for a holistic energy use optimization.
- The implementation of HPP/PSP has increased worldwide quicker than in Italy
  - WORLD:
    - Total installed capacity: 1,416 GW vs 179 GW from PSP
    - HPP Capacity added in 2023: 14 GW (China 7 GW) → +1%
    - PSP Capacity added in 2023: 6.5 GW → +0,45%

IHA, 2024



  - ITALY:
    - Total installed capacity: 22 GW vs 7 GW from PSP
    - HPP Capacity added in 2023: 3 MW → almost 0%

FMHL+ HONGRIN-LÉMAN PSP, SWITZERLAND



Client: Alpiq, Switzerland
Dates: 2008 - 2020

Services:

- Feasibility study, outline, and conceptual design
- Tender documents, assistance in contract negotiations
- Final and detailed design
- Works supervision & Commissioning

Technical Data:

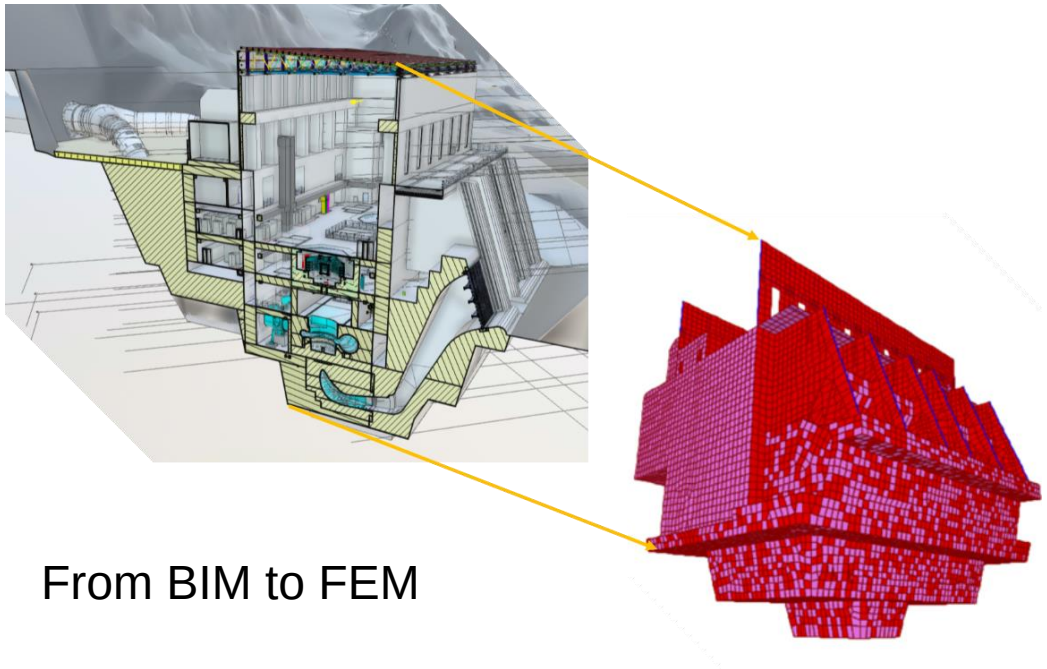
- Extension from 240 MW to 480 MW with a new underground powerplant
- 2 x 4 Pelton turbines and 4 pumps.
- Powerhouse in hard rock, 56x25x100 m
- Average annual output: 530 MWh
- Operation of the exiting powerplant during construction
- Hydraulic by-pass

AYA PSP (P = 100 MW), PHILIPPINES

Client: First Gen Hydro Power Corporation, Philippines
Dates: 2022 - Ongoing

Services:
- Detailed design

Technical Data:
- New pumped storage project to existing Pantabangan Complex, with:
  - Upper Inlet/Outlet Structure
  - Waterway and Powerhouse with two reversible pump-turbine units and full-size frequency converters.
- Project entirely executed with BIM



From BIM to FEM

PAKIL PSP (P = 1400 MW), PHILIPPINES

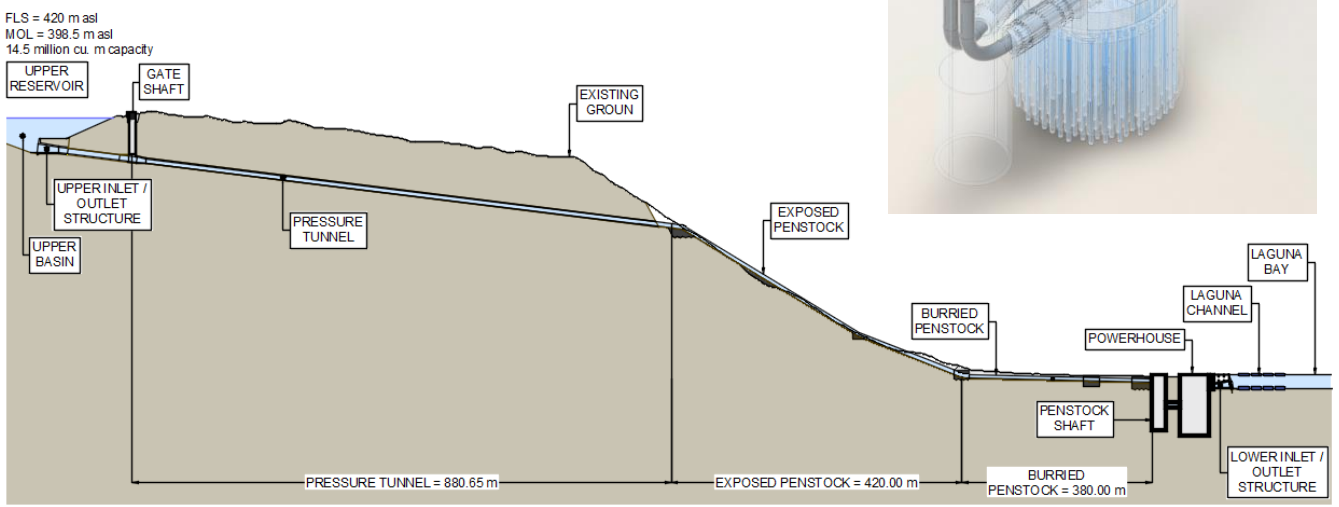
Client: Ahunan Power Inc., Philippines
Dates: 2023 - ongoing

Services:

- Value engineering, Feasibility Study, ECI,
- Tender Design and Documents,
- Detailed design

Technical Data:

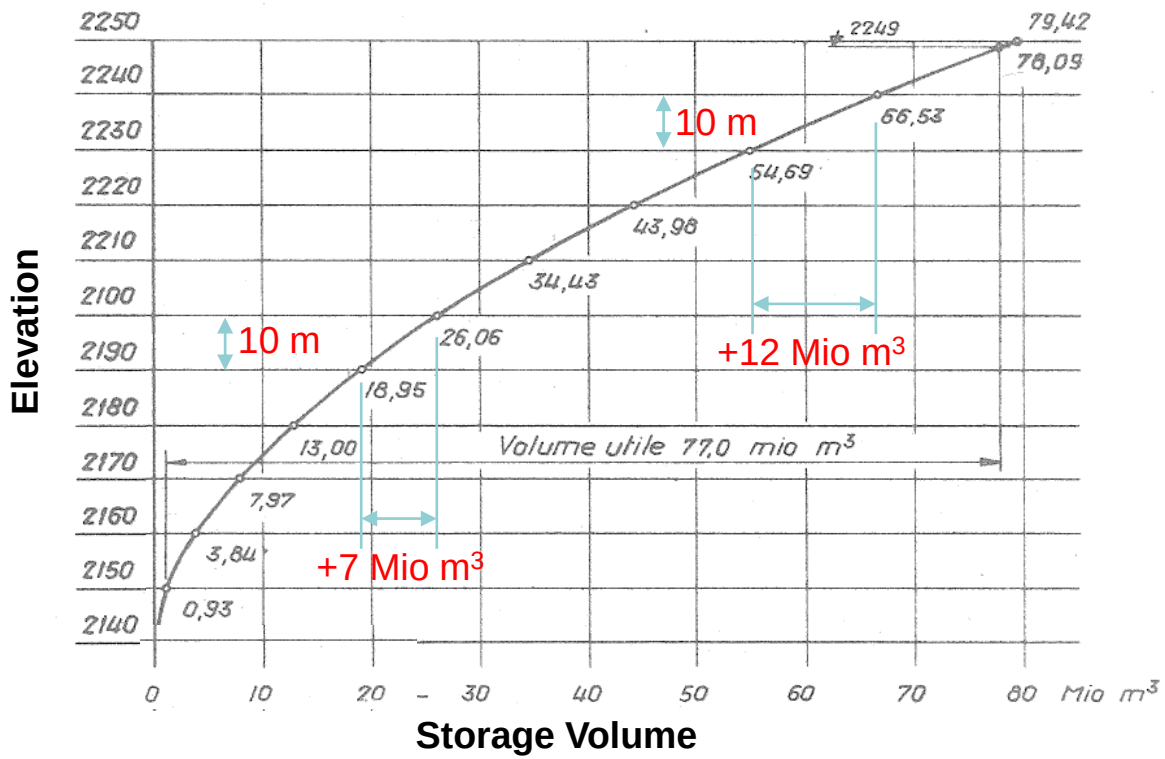
- Greenfield pumped-storage project using Laguna de Bay as a lower reservoir with a new upper reservoir (14 million m3)
- Two parallel waterways (tunnel, penstock) and two shaft powerhouses
- Four variable-speed, reversible pump-turbine units

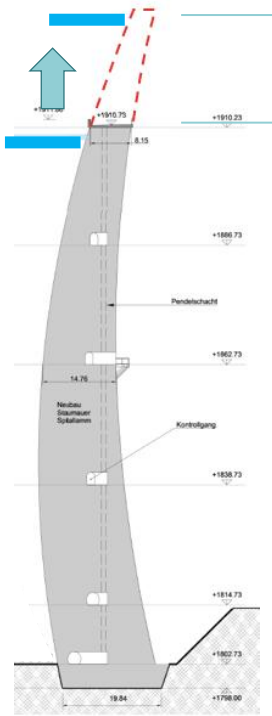


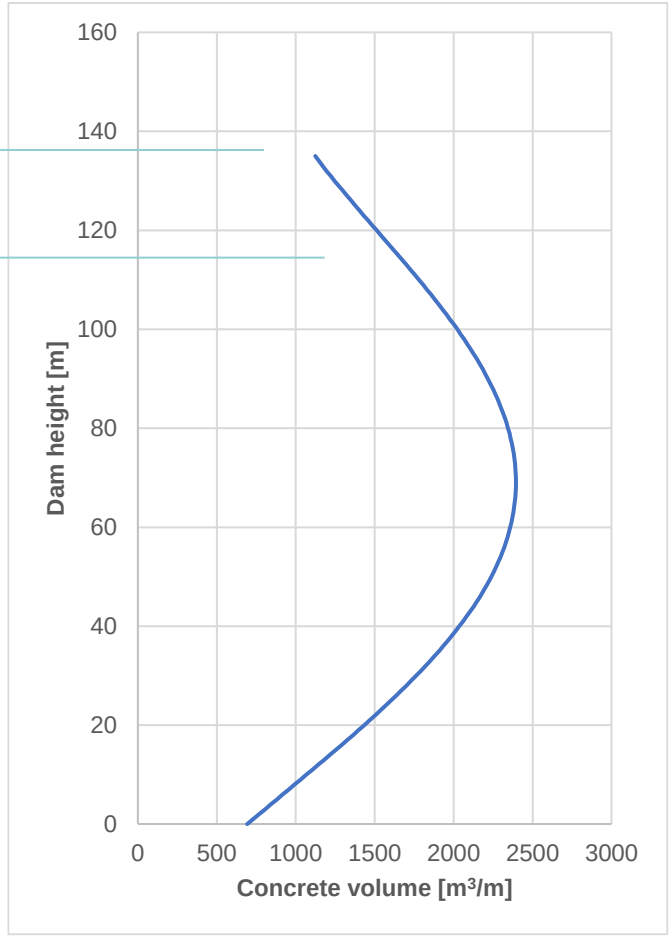
ROLE & FUTURE OF DAM HEIGHTENING

> Primary driver : Economics

Large gain of storage volume (flexibility) X relatively low investment cost







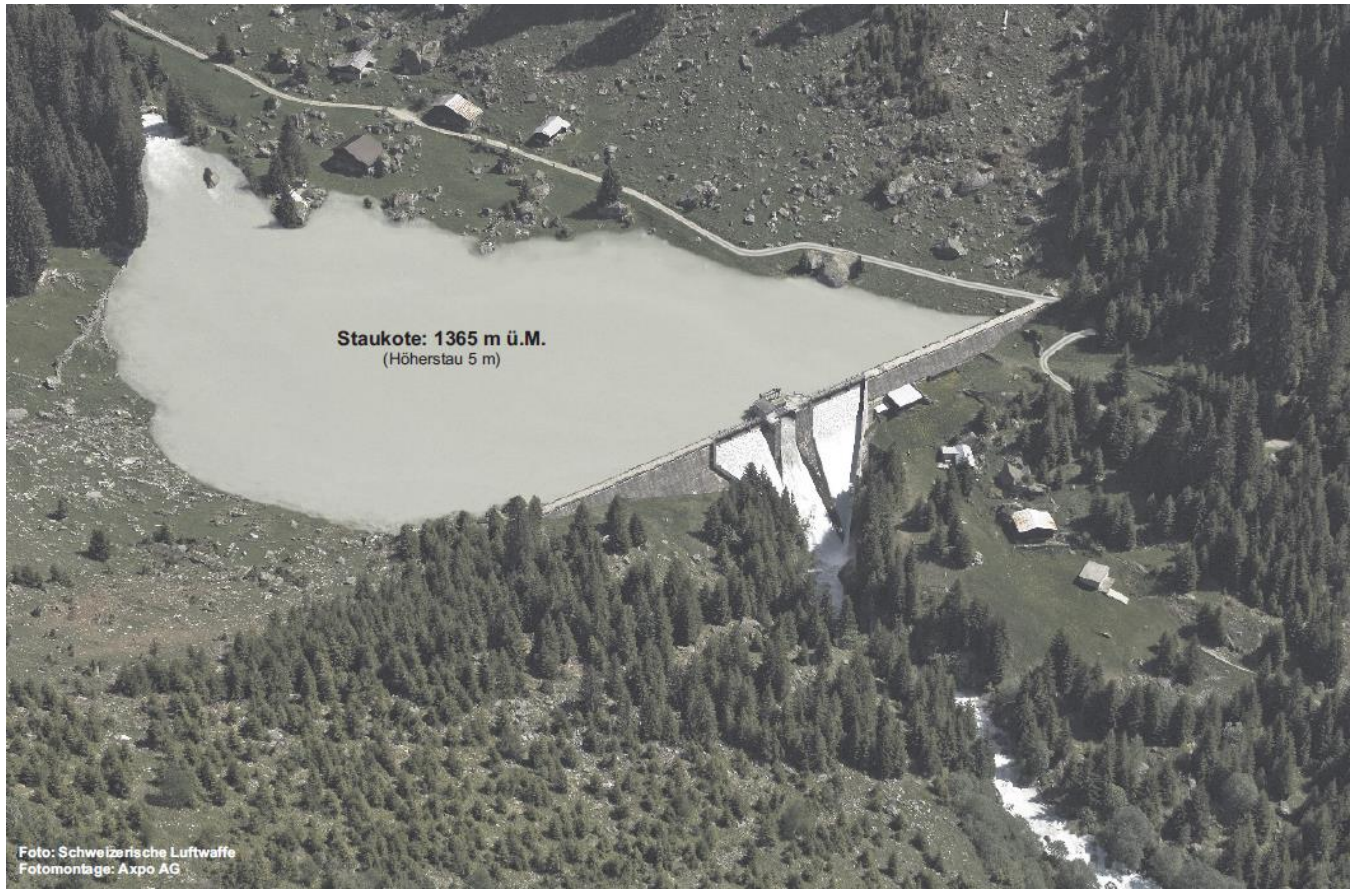
ROLE & FUTURE OF DAM HEIGHTENING

> And also

> Reduction of environmental impacts

> Increase of flood protection

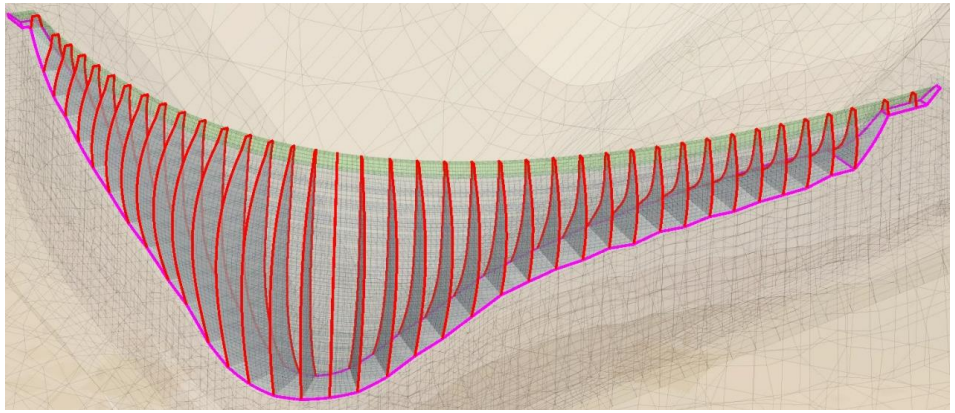
> Improvement in public acceptance

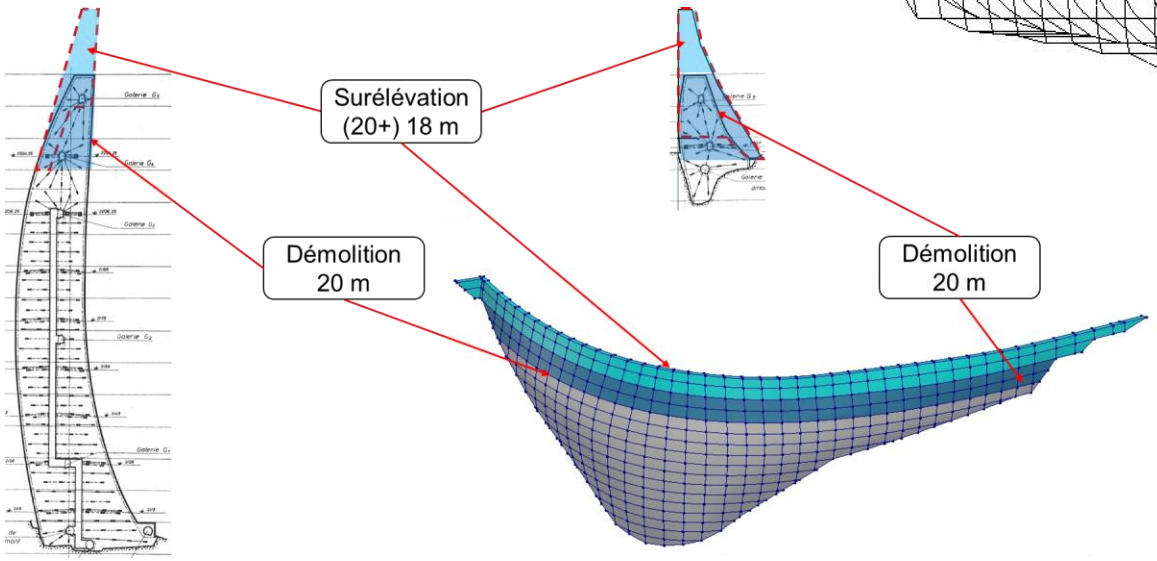


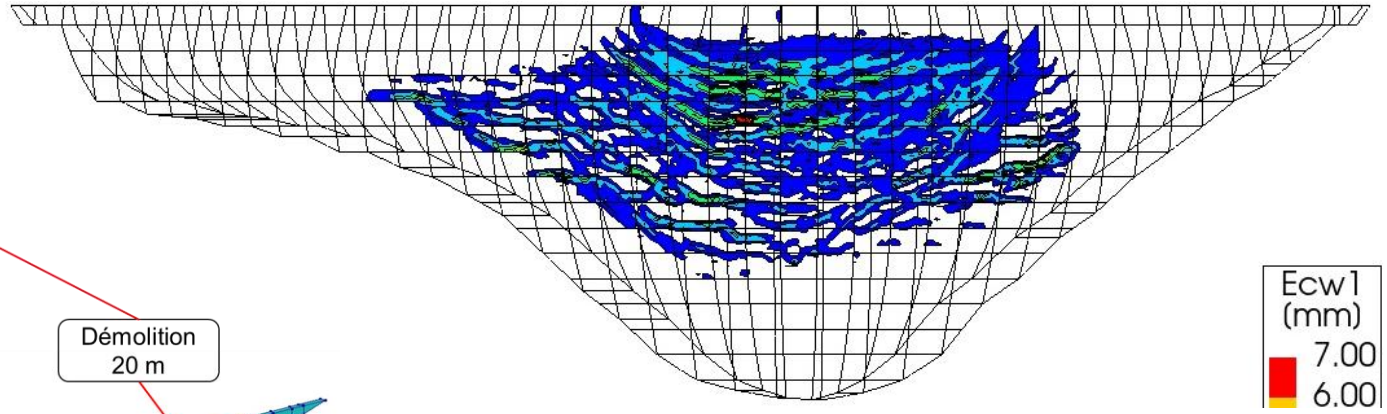
ROLE & FUTURE OF DAM HEIGHTENING

> Other considerations

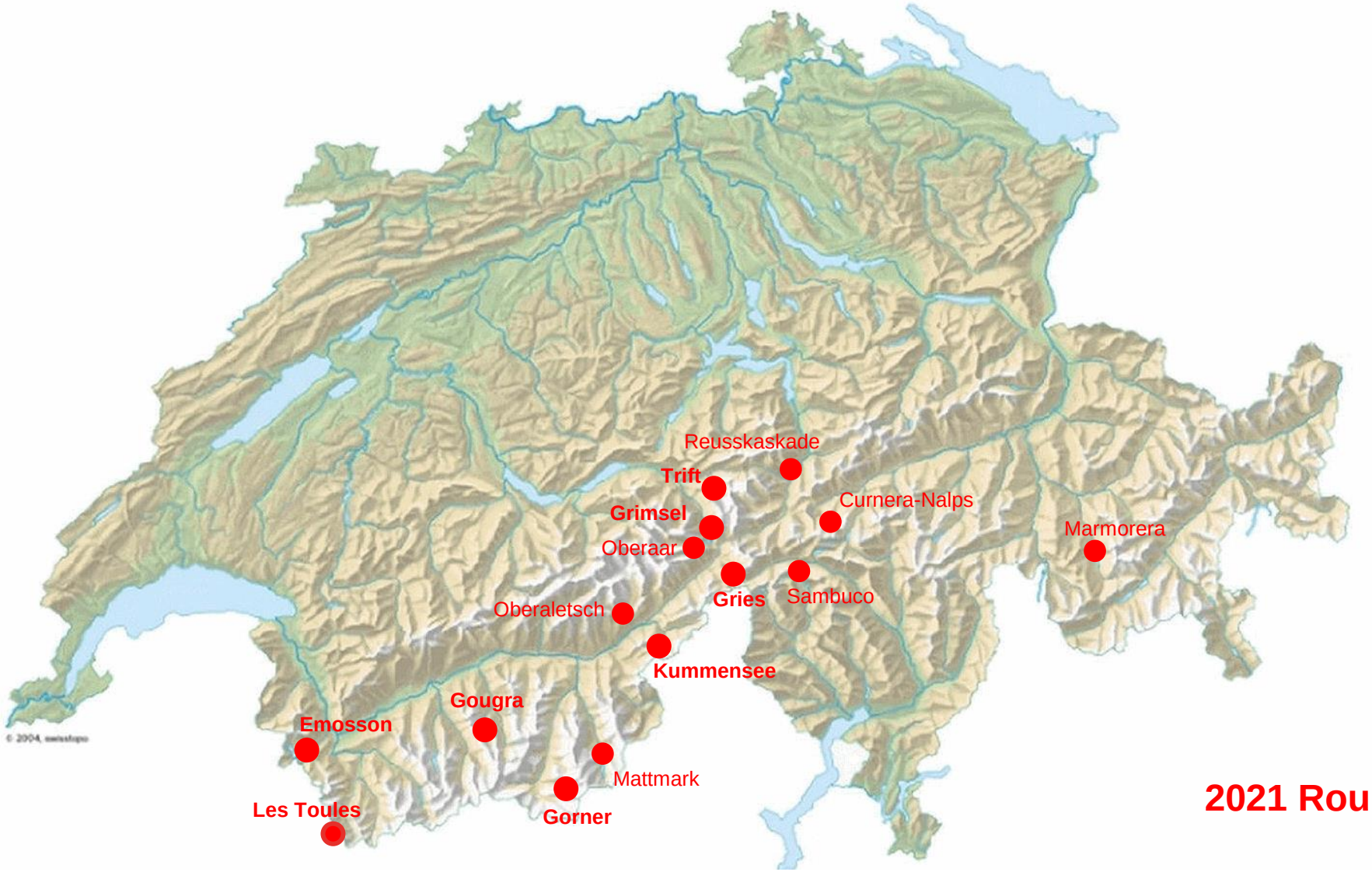
- > Heightening possible thanks to a ‘generous’ dimensioning, increased knowledge and more sophisticated design tools
- > In most cases, no need to empty the reservoir during heightening works → relatively low impact on the operation of the existing structure







DAM HEIGHTENING PROJECTS IN SWITZERLAND



- **Energy strategy 2050**
- **Concessions renewal**
- **Dam Safety**

2021 Round Table projects

WHAT ABOUT ITALY?

> 541 large dams in Italy

> Average age of 67 years (ageing dams)

> Very difficult to construct new structures

> Potential for increasing existing capacity as in Switzerland

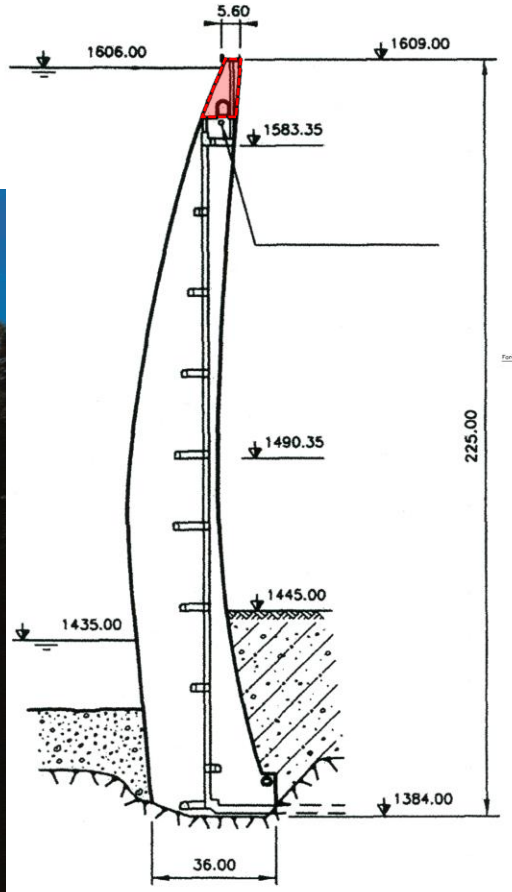
> Take advantage of eventual needs for upgrading flood release structures

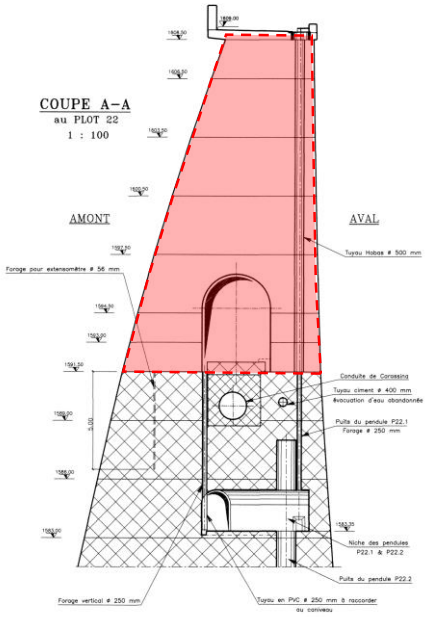
> Attention to be paid to understanding the behavior of the existing dams

Country	Number of Large Dams	Average Height (m)	Average Capacity (10^6 m^3)	Average Age (years)	Median Age (years)
China	23,841	26	38	46	51
USA	9,263	21	114	65	57
India	4,407	24	80	42	41
Japan	3,130	33	8	111	65
Brazil	1,365	26	655	51	50
South Korea	1,338	24	13	43	42
South Africa	1,266	23	26	45	43
Canada*	1,156	21	*	55	51
Mexico	1,079	30	165	61	52
Spain	1,064	39	70	56	52
Turkey	965	46	209	23	23
France	720	29	24	60	53
Iran	594	41	109	20	19
UK	580	23	13	106	111
Australia	567	31	170	57	49
Italy	541	42	27	67	65
Germany	371	26	12	70	53
Norway	347	30	163	56	53
Albania	308	27	19	44	44
Zimbabwe	256	25	36	36	31
Romania	241	32	43	42	42
Portugal	234	35	62	38	32
Austria	232	34	13	44	43
Thailand	220	25	376	35	36
Sweden	190	26	328	63	60

(Perera et al., 2021)

LUZZONE ARCH DAM (SWITZERLAND)

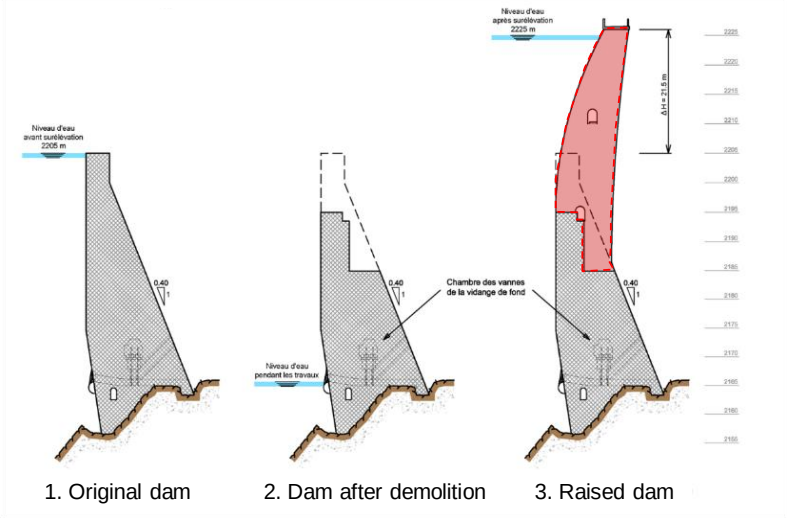




Luzzone Dam (Tessin)

Construction 1959-1963	H=208 m
Heightening 1995-1998	H=225 m (+17 m)

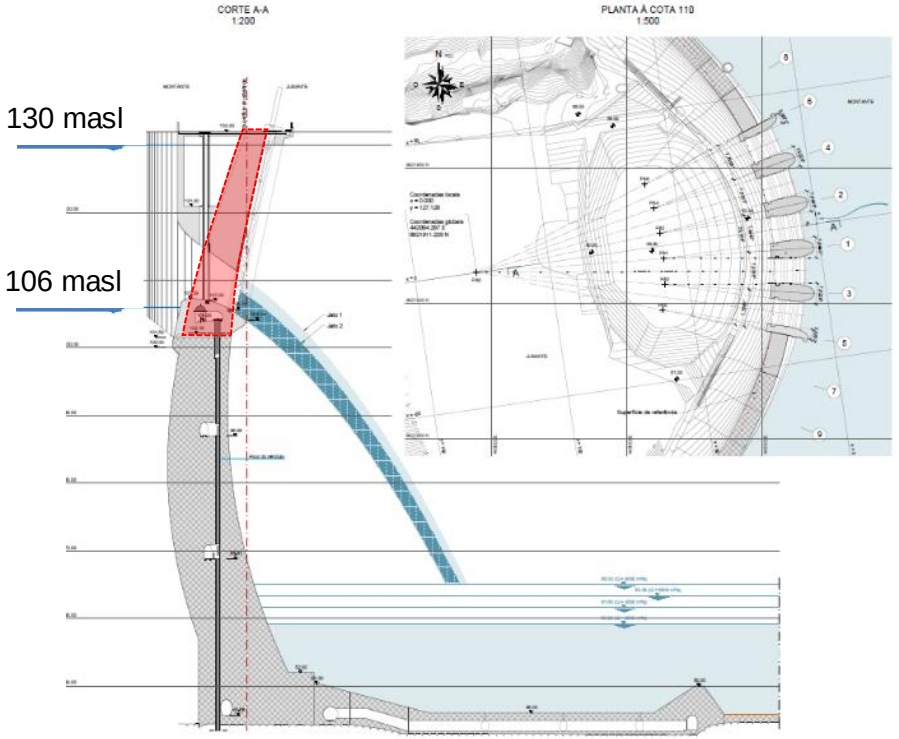
VIEUX EMOSSON DAM (SWITZERLAND)



1. Original dam 2. Dam after demolition 3. Raised dam

Vieux Emosson Dam (Valais)
Construction 1952-1956 H=55 m
Heightening 2012-2015 H=76.5 m (+21.5 m)

CAMBAMBE DAM (ANGOLA)



Cambambe Dam (Angola)

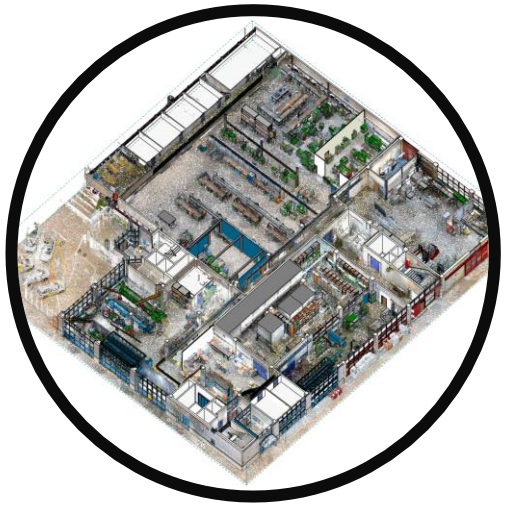
Construction 1959-1963	H=72 m
Heightening 2012-2018	H=92 m (+20 m)

DIGITAL SOLUTIONS

ROLE OF DIGITAL TRANSFORMATION

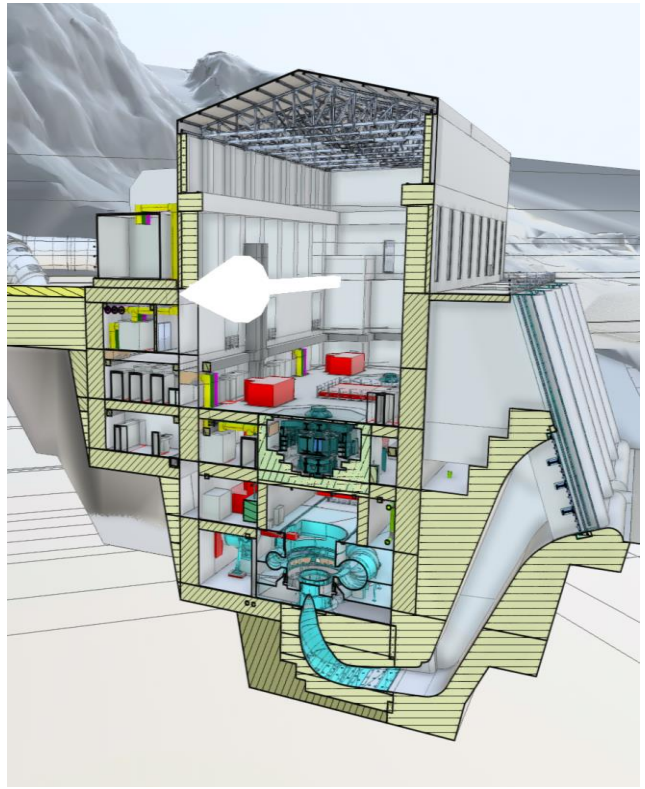
> SCAN2BIM

Data acquisition and processing of as built conditions



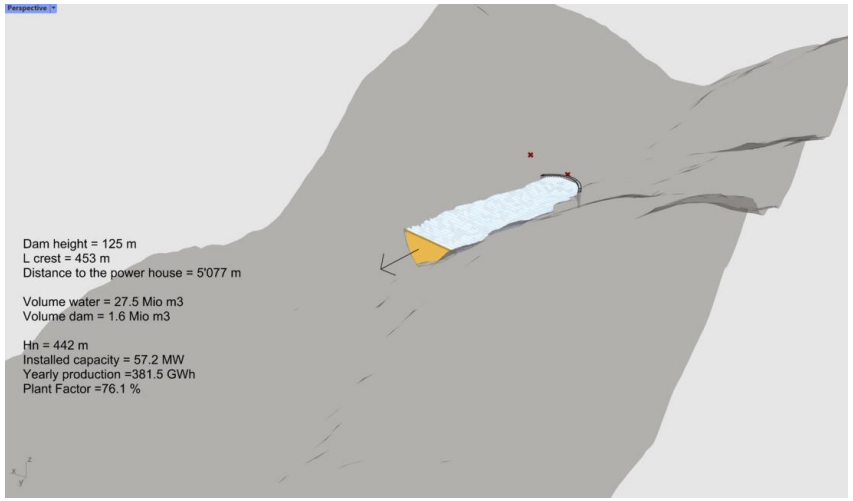
> DESIGN BY BIM

Combined design including 2D drawings, 3D rendering, BoQ, clash detection, work schedule analysis, …



> PARAMETRIC DESIGN

“Jumping Dams Gruner Tool” for the feasibility of Dam and HPP locations



KEY TAKE AWAYS

> **Strengthening and rehabilitating dams for resilience**

Ensure safety and extend infrastructure lifespan in the face of evolving environmental and operational demands.

> **Pumped storage plants as energy balancers**

Provide grid stability by storing and releasing renewable energy to meet demand.

> **Dam heightening to maximize existing infrastructure**

Increase storage and energy capacity sustainably, minimizing environmental and social impact.

> **Digital transformation for enhanced efficiency**

Optimize design, planning, and operations through BIM and data analytics

GRUNER
ALL ACCORDING TO PLAN

Thank you for your attention!