ETIP HYDROPOWER

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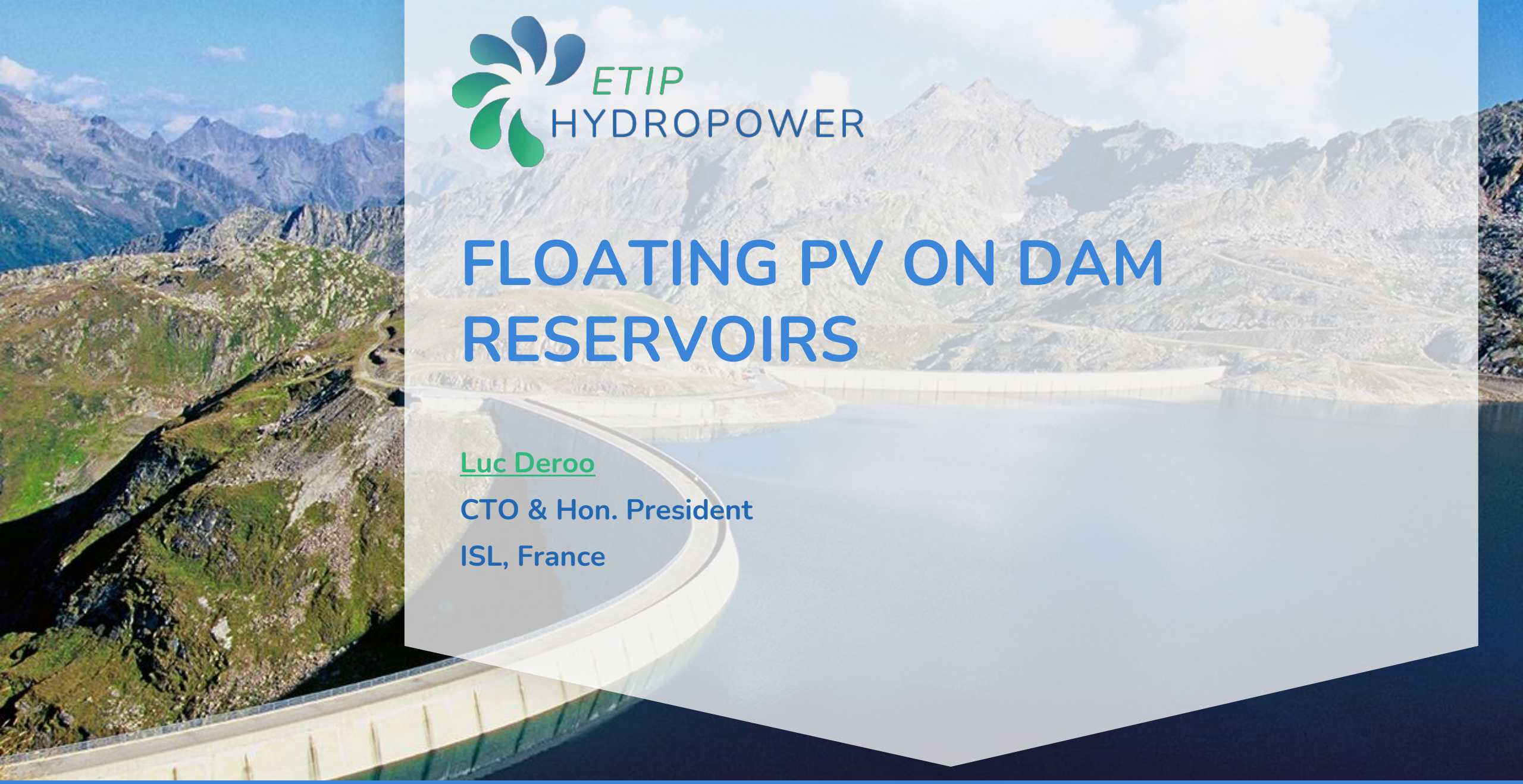

ETIP HYDROPOWER

FLOATING PV ON DAM RESERVOIRS

Luc Deroo

CTO & Hon. President

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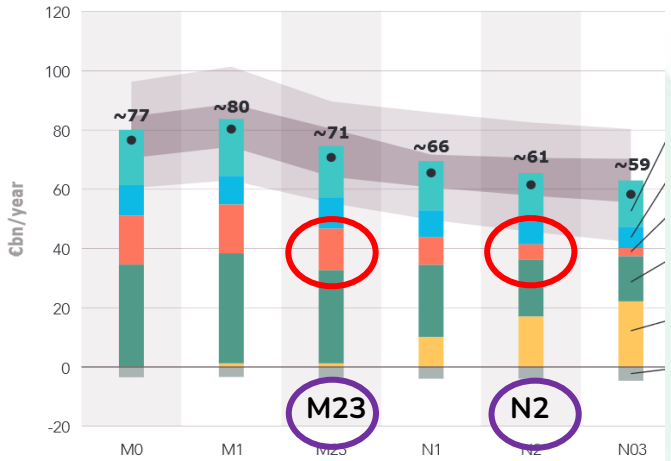
The future Energy mix needs Solar & Hydro

	GENERATION MIX IN 2050	INSTALLED CAPACITY IN 2050 (IN GW)* Solar	Onshore wind	Offshore wind	Historical nuclear	New nuclear	MIX OF FLEXIBLE RESOURCES IN 2050
M23 Large RES	Very robust development of all renewable technologies, driven notably by the installation of large onshore and offshore wind farms. Focus on economic optimisation and the technologies and geographic areas with the highest efficiency to allow economies of scale.	~125 GW (i.e. x12)	~72 GW (i.e. x4)	~60 GW	16 GW	/	15 GW; 1.7 GW (1.1 M EV); 20 GW; 13 GW
N2 RES + new nuclear 2	Launch of a programme calling for the faster development of new reactors (a pair every three years) from 2035 with a gradual ramp-up. Renewable energy development continues but at a slower pace than in scenarios N1 and M.	~90 GW (i.e. x8,5)	~52 GW (i.e. x2,9)	~36 GW	16 GW	23 GW (i.e. 14 EPR)	15 GW; 1.7 GW (1.1 M EV); 5 GW; 2 GW

RTE, Energy Pathways to 2050, key results, oct. 2021
https://assets.rte-france.com/prod/public/2022-01/Energy%20pathways%202050_Key%20results.pdf



Cost of transmission lines

Cost of flexibilities

The case of France 2050: two typical scenarios

M23 is a « without nuclear » scenario: **125 GW of solar** power (compared with 11 GW in 2021)

N2 is a « with nuclear » scenario: **90 GW of solar** power

⇒ France needs a lot of new solar. Challenging!

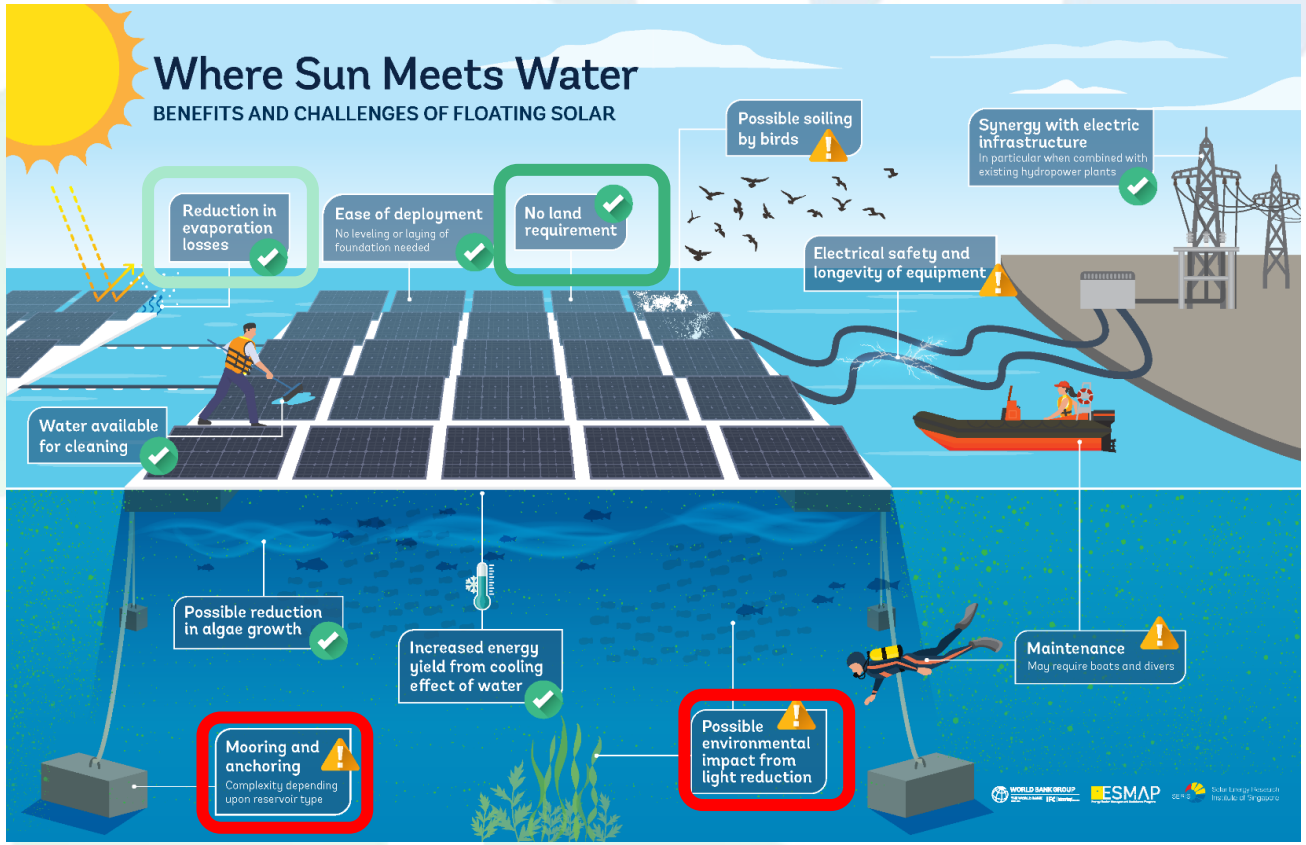
Scenarios with a lot of REN require « flexibilities »; these represent up to 20% of the full cost (and almost 50% of the cost of REN generation).

=> Mitigating the cost of flexibilities is key

Floating PV (FPV) brings land opportunities to meet the solar power objective

Hybridization brings opportunities to mitigate the cost of flexibilities

Floating PV



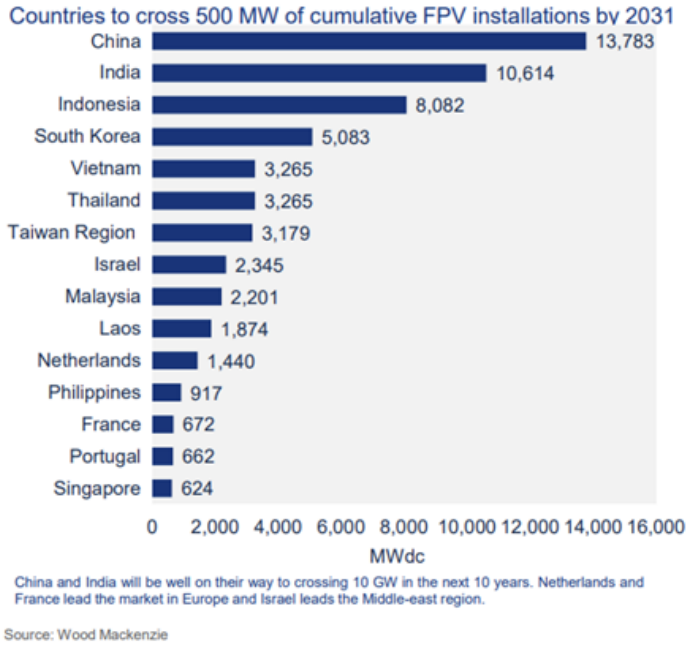
ESMAP, Where Sun Meets Water ; Oct. 2019
https://www.esmap.org/where_sun_meets_water_handbook

The first MW FPV project was built in Japan, 2013

Since then, many projects.

- Main driver: no land requirement
- Main challenges: mooring/anchoring and possible env. impacts

A strong trend is anticipated, especially in Asia



Most projects were built on shallow water bodies or stagnant water bodies (e.g. abandoned quarries or mine lakes)

FPV-DR: a new frontier

FPV on stagnant continental water bodies (quarry mines…) is becoming a mature technology

But the potential is limited, and two other options are considered:

- Floating PV at sea (out of the scope of this presentation)
- Floating PV on Dam Reservoirs

This is more difficult:

- Higher waves, Water level variations
- Dam safety issues

Source: asahi.com

It has more potential:

ELSEVIER

Renewable Energy

Volume 162, December 2020, Pages 1415-1427

Hybrid floating solar photovoltaics-hydropower systems: Benefits and global assessment of technical potential

Nathan Lee [a], Ursula Grunwald [a], Evan Rosenlieb [a], Heather Mirletz [a b], Alexandra Aznar [a], Robert Spencer [a], Sadie Cox [a]

Conclusions

In this work, we present an approach to estimate the technical potential of FPV deployed in hybrid systems with hydropower and identify significant global potentials from 3.0TW to 7.6TW for the scenarios considered (4,251TWh to 10,616TWh per year of generation). Additionally, we review potential operational benefits that these hybrid systems may provide. In conclusion, we present pathways to apply the knowledge from this work and potentially improve the assessment.

FPV-DR: what's new?

Some projects have been built recently

- Pilot or small projects in some countries
- Larger projects especially in Asia

Cirata Reservoir, courtesy Aries Firman
145 MWp ; 200 ha on a dam reservoir of 6,000 ha surface area
Cirata HPP : 1 GW ; concrete-faced rockfill dam

Technical standards available for FPV (DNV-RP-0584) do not cover the specific issues of Dam Reservoirs.

=> At least two initiatives, aimed at fostering the development of sound FPV-**DR** projects:

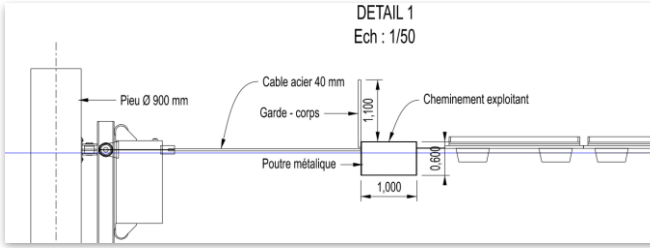
- ICOLD: preparation of a bulletin on FPV-DR
- Fr-COLD: a WG to prepare recommendations for owners, developers and designers, with focus on dam safety.

Development of **technical solutions** for dam reservoirs, e.g.:

- FPV Island simpler shapes
- Elastic mooring lines

Seaflex, developed within EU funded Fresher Project

- FPV Monitoring
- Piles+ bollards anchoring systems



- New types of floats

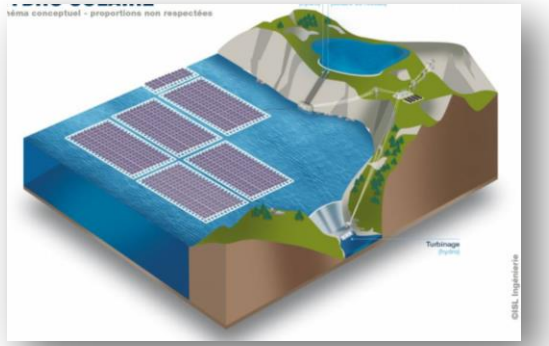
Beyond FPV: Hybridization

« **Solar-Hydro Hybridization** ». One concept, various implementations:

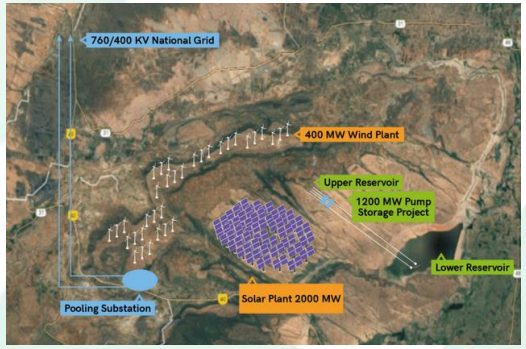
(1) The integrated **Solar-Hydro powerplant :** S + H + EMS, co-located

(2) The **Virtual powerplant** : several powerplants with a single operator

(3) **Independent Solar and Hydro powerplants** & control by the grid operator



Integrated « Full S-H » powerplant, conceptual sketch



Pinnapuram intergrated hybridized powerplant (under construction)

In Europe,

(1) is adapted to isolated grids, and is also tested at Alqueva (PT)

(2) is already practised by several operators

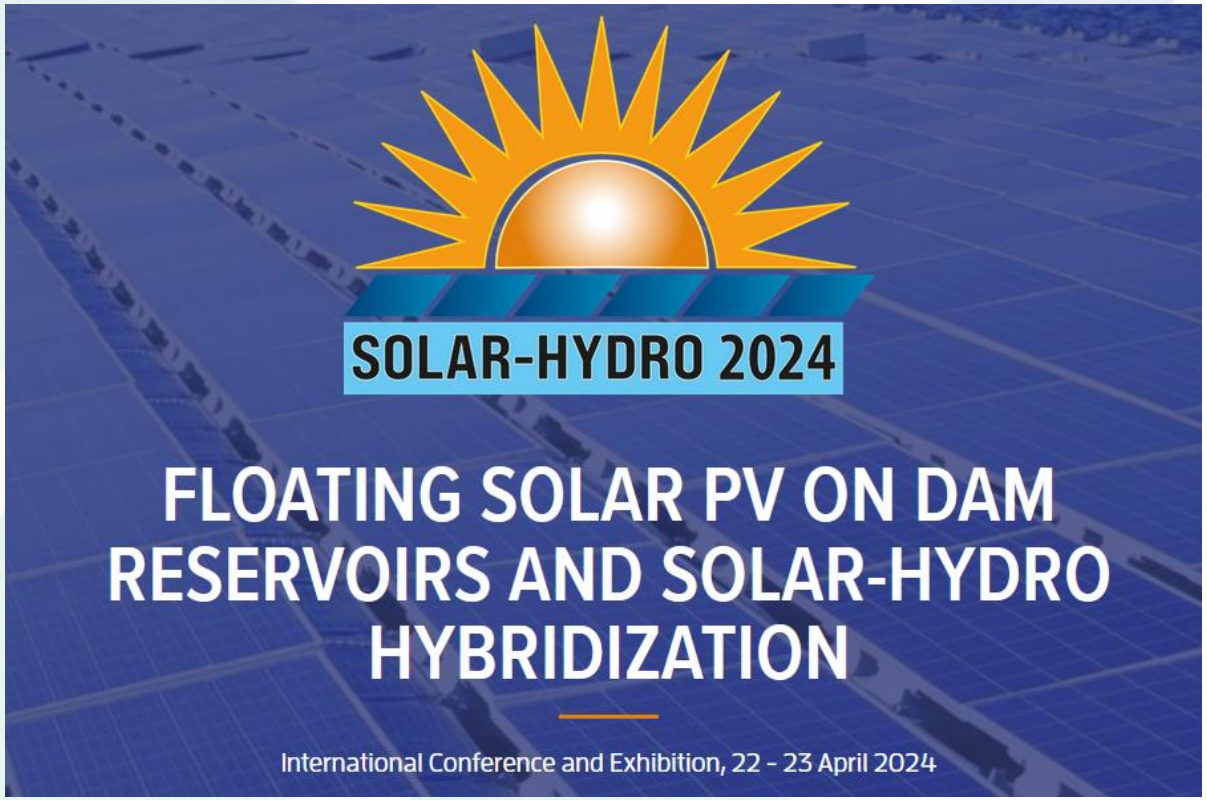
(3) is the main option

In Europe, things have changed a lot since the development of most of the hydropower plants and dam reservoirs.

We now need Flexibilities: new PSPs (even non-conventional), upgrading of existing HPP for improved flexibility, modification of HP reservoirs operation, and properly adapted remuneration for capacity & grid services

(And also: Support (or priority) to other purposes: drought & flood mitigation, biodiversity => modification of HP reservoirs operation)

These topics will be further discussed next week at the:



Antibes (France), 22-23 April 2024

THANK YOU!

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