Workshop

• Electricity Storage and Grid Management

for Maximum RES Penetration

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The role of Pumped Hydro Storage (PHS) in a net zero economy

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A mature and reliable technology, since the end of 19th century

- Pumped hydro storage is a balancing technology that allows low carbon electricity (variable renewables) to be stored for later use.
- With a total installed capacity of over 160 GW worldwide, pumped storage currently accounts for more than 90 percent of grid scale energy storage capacity globally, suiting the needs of changing power systems and providing a wide range of ancillary services.
- Their development requires specific geographical areas, with at least two reservoirs with significant altitude difference.

Sustainability

- With respect to the sustainability considerations, each energy storage technology has its own sustainability challenges in terms of on-site impacts, life cycle impacts and end-of-life treatment. A detailed comparison of battery and PSH, the dominant storage systems worldwide, was performed by Kruger at all. in terms of raw material cost, land requirement, annual lifetime investment cost and carbon emission (Ref.1). **The authors received the Technical Paper of the year award for the Market Trends and Strategies track.**
- For battery systems, the extraction of raw materials entails sustainability concerns, as well as the end-of-life treatment (recycling systems).
- For PSH there are significant impacts on local landscape, including flooding, dam, pipework, power station and electricity transmission lines.
- Further discussion on sustainability considerations are discussed in the Working Paper on Sustainability of Pumped Storage Hydropower (Ref.2) and relevant comparison of energy storage technologies cost, is presented in Ref. 3.
- The estimated lifetime of PSH plants is the longest, compared to other storage technologies. It ranges from 40 to 80 years.

High domestic value in National and European level

- Electricity industry developments have important employment impacts during their construction phase. Especially, the large pumped hydro stations have important employment impacts across local, regional and national economy. In terms of economic “multiplier” the benefits will be significantly greater at the construction stage.
- The supply of main E/M equipment by specialized European Suppliers, constitutes a serious boost for the European industry and the industry jobs chain.
- More generally, pumped hydro becomes important in terms of facilitating, and reducing the costs, securing a reliable and flexible electricity supply, particularly where other large-scale solutions are very costly, and they create dependency from imported fuels.

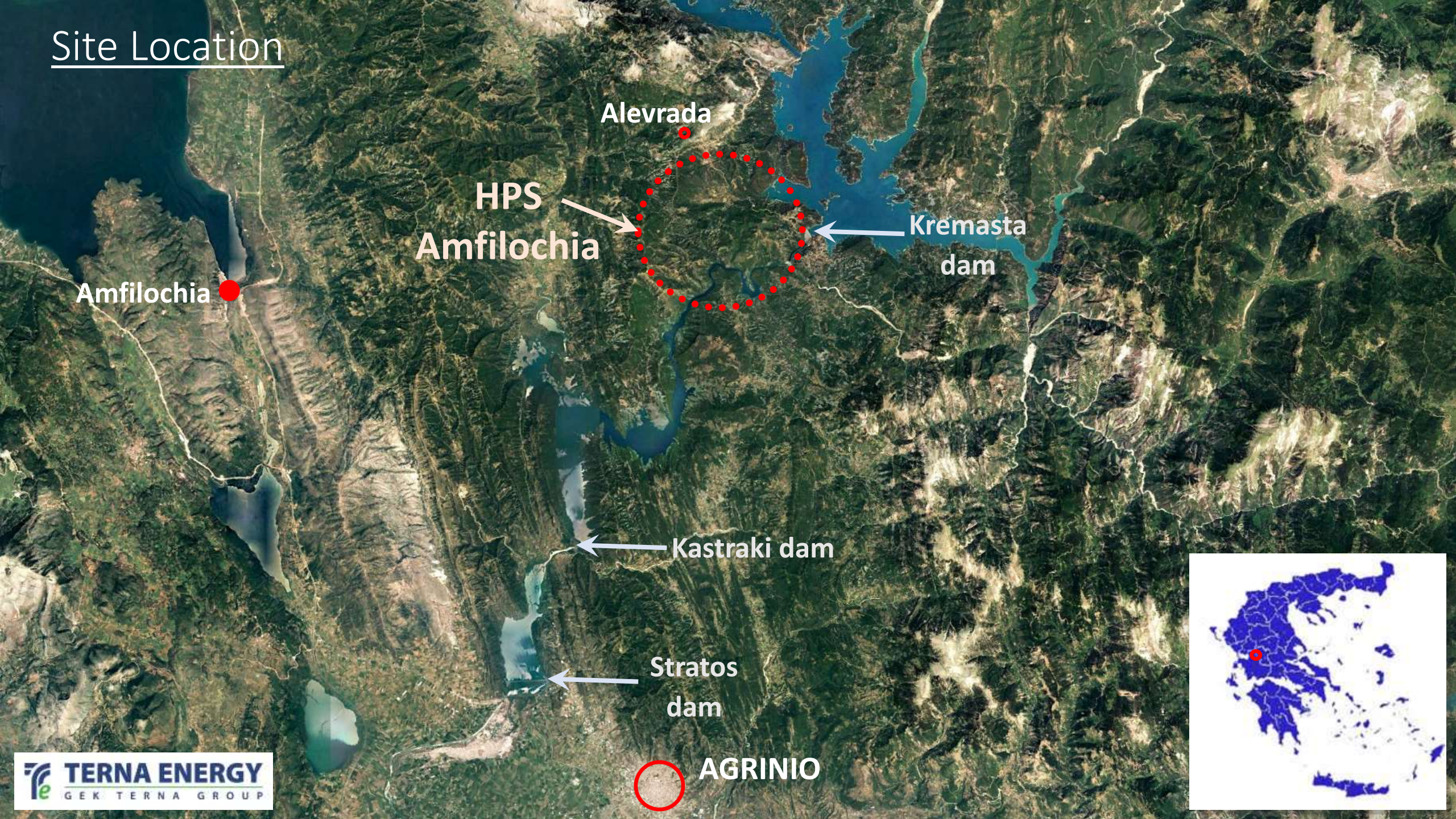
Pumped –Hydro Projects in Greece

- Two Pumped-Hydro projects (Sfikia and Thissavros), with total capacity of 700 MW, belonging to PPC, are in operation, since 1990s. Both are open-loop type (they harness natural inflows and pumped water).
- TERNA ENERGY entered in this promising field, since 2009. Two Projects are in more mature stage : Amfilochia in Western Greece and Amari in Crete island, which combines effectively wind and hydro production. Both are Strategic Investments.
- Many other Pump – Hydro are under development. TERNA ENERGY has received recently storage production permits for 2.500 MW.

Amfilochia PHS

- Amfilochia PHS was included by the EU in the List of Projects of Common Interest (PCI), since 2013. It is a critical project that has been declared a ever since 2013 and a Strategically Significant Investment ever since 2014.
- The “Pumped-storage system in Amfilochia” will be the largest energy storage investment in Greece, with a total installed capacity of 680 MW (production) and 730 MW (pumping).
- It includes two independent “upper” reservoirs, Agios Georgios and Pyrgos, of approximately five and two mil. cubic meters, respectively. PPC’s lake Kastraki is the “lower” reservoir. It is of close-loop type, because the upper reservoirs are located off-stream.
- The investment cost is 550 mil. euro and TERNA Energy will start the construction in a few days.

Site Location



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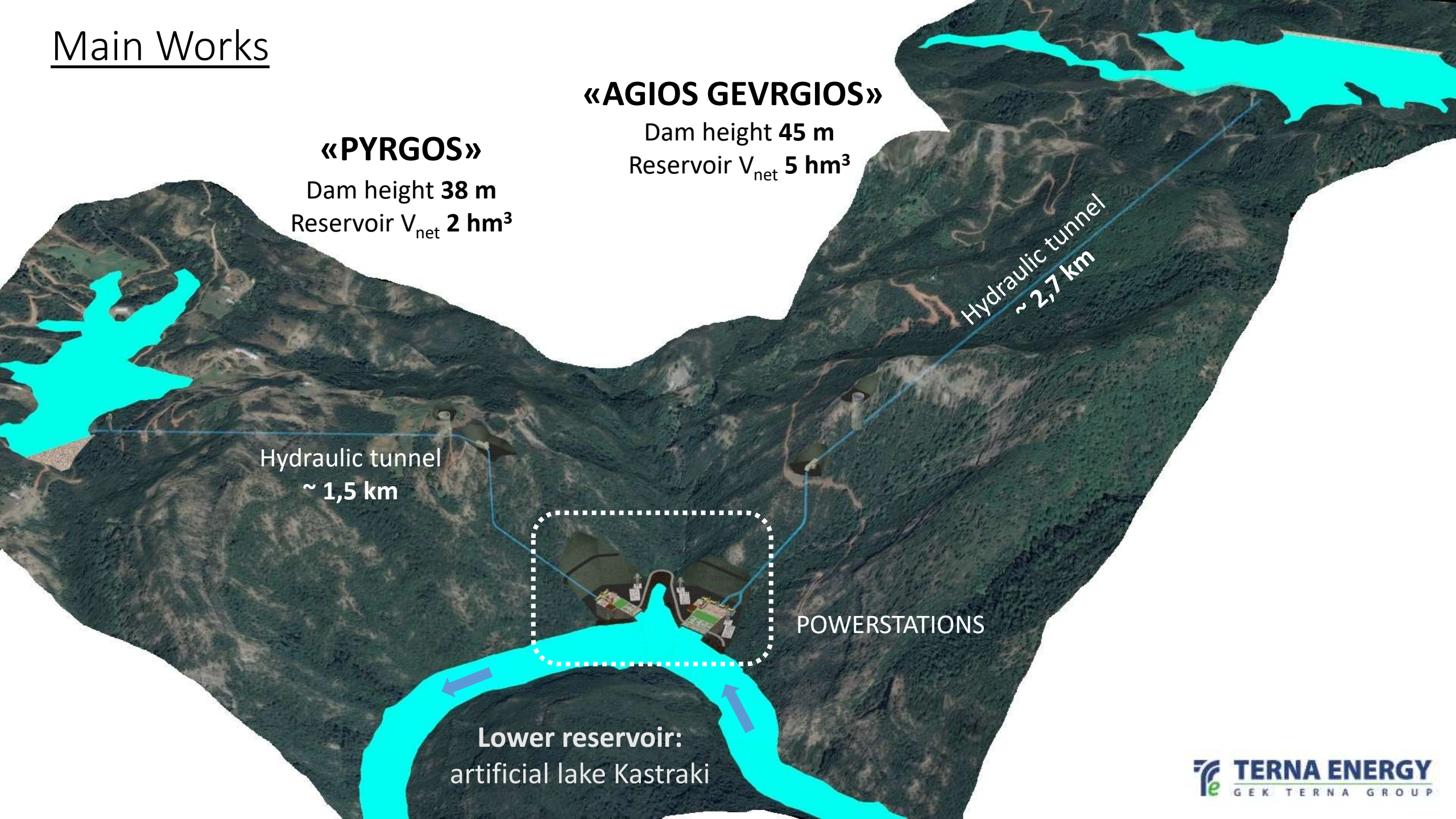
Main Works



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Main works:

Powerstations

Production capacity: **680 MW**

Pumping capacity: **730 MW**

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Agios Georgios

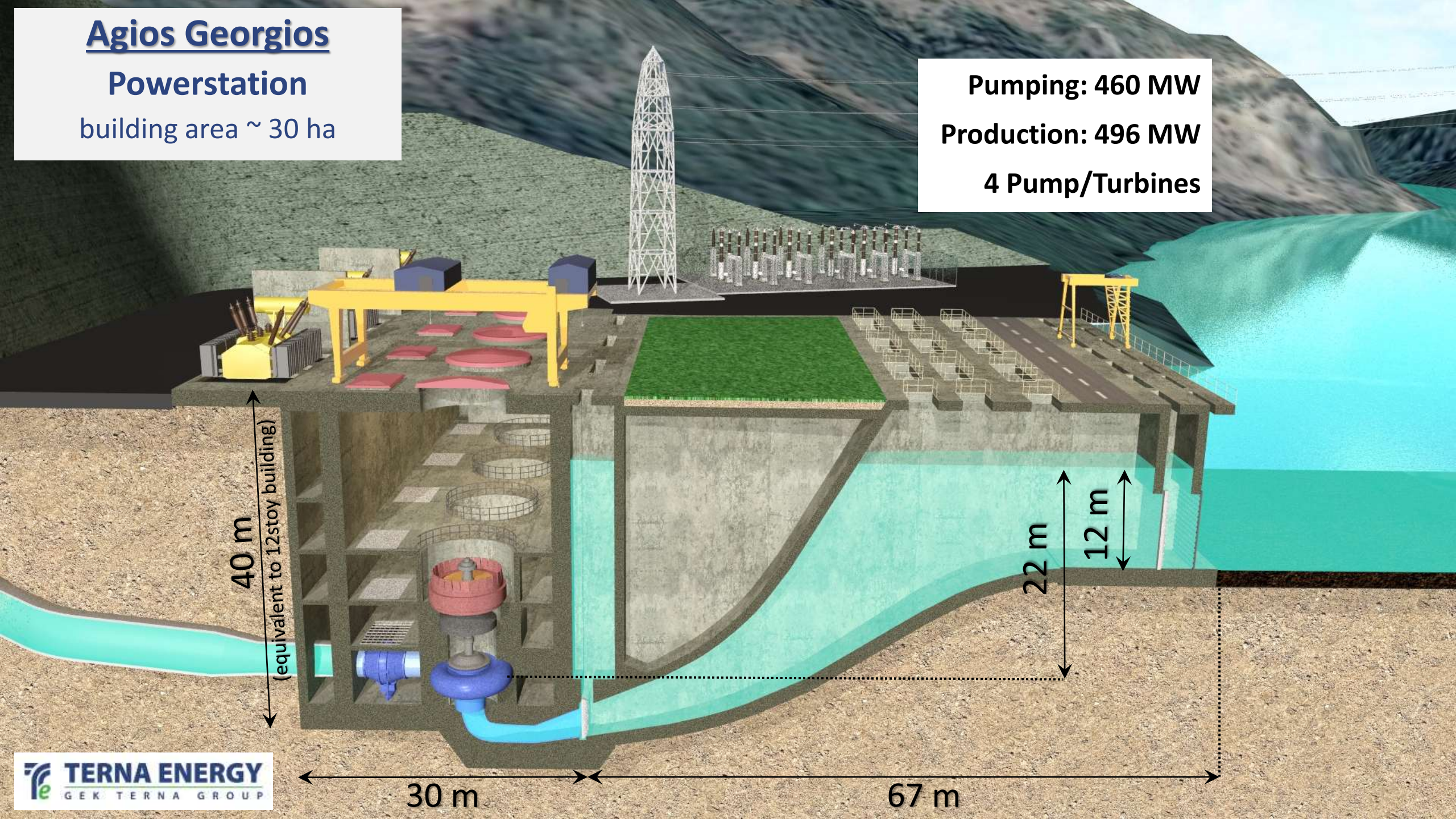
Powerstation

building area ~ 30 ha

Pumping: 460 MW

Production: 496 MW

4 Pump/Turbines



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Pyrgos

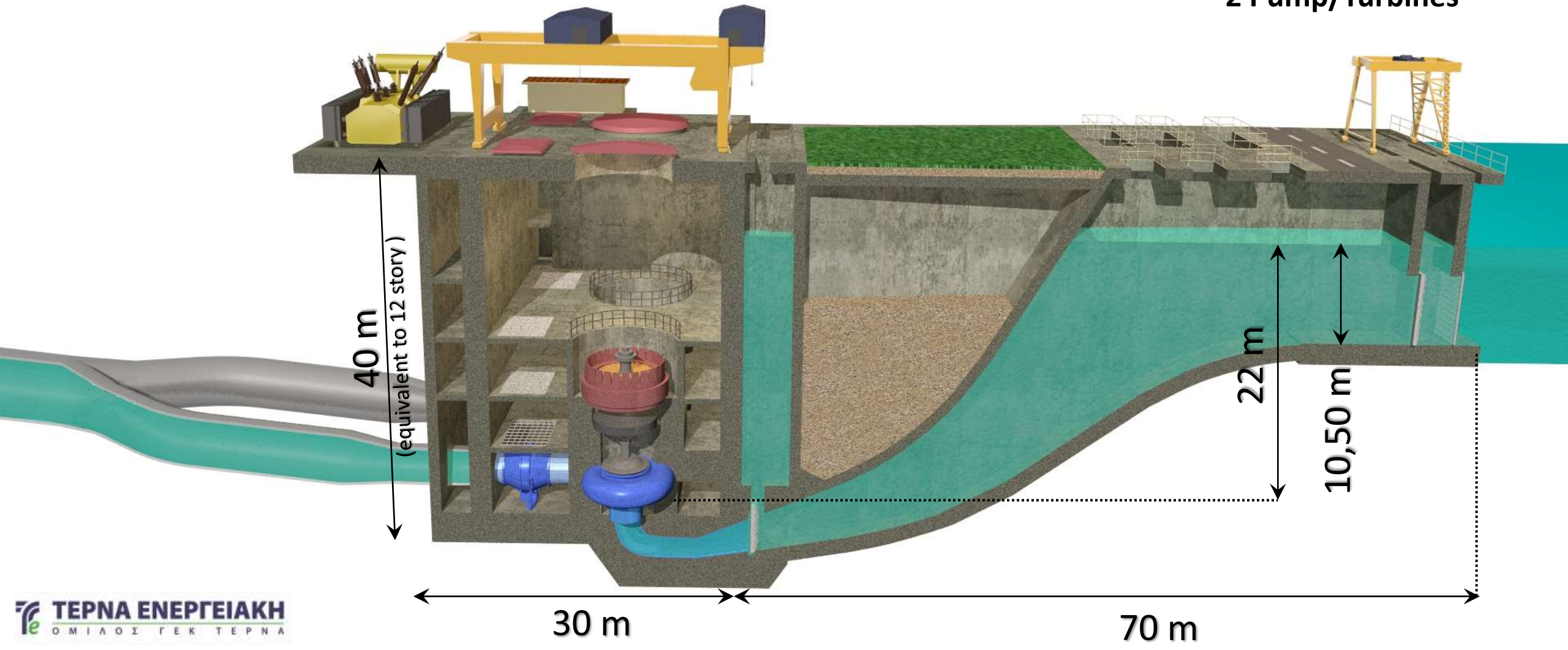
Powerstation

Building area ~ 18 ha

Pumping: 234 MW

Production: 220 MW

2 Pump/Turbines



ΤΕΡΝΑ ΕΝΕΡΓΕΙΑΚΗ
ΟΜΙΛΟΣ ΓΕΚ ΤΕΡΝΑ

European support

The project has been included since 2013, in the lists of Projects of Common Interest (reference code: PCI-3.24). It was considered as contributing to the market integration, sustainability and security of supply.

The project's technical studies and the Environmental Impact Assessment, were co-financed, by Connecting Europe Facility (CEF), during the period 2015-2016. Therefore, the Project reached a very mature status as concerns its technical status.

A recent Decision of DGCOMP (State Aid SA.57473) approved Investment grant during the construction and annual support during its operation in order to be assured its economic viability. The decision underlies, inter alia, that:

"…. the Project is the only new PHS project in Greece, which is fully licensed and at such an advanced state of engineering design that can be implemented in a timely manner, in order to fulfil the objectives, targets and requirements of Greece's national energy and climate plan ("NECP") over the 2020-2030 period, particularly the smooth and effective transition to energy from renewable energy sources ("RES") of the Greek power system, by supporting the operation of existing RES units as well as enabling the introduction of new ones".

References

(1) Li-Ion Battery versus Pumped Storage for Bulk Energy Storage-A Comparison of Raw Material, Investment Costs and CO2-Footprints. Krüger, I.K., M.S.P. Mann, M.S.N. van Bracht, and D.-I.A. Moser. USA, : HydroVision, North Carolina, 2018.

(2) Sustainability of Pumped Storage Hydropower (International Forum on Pumped Storage Hydropower–Sept. 2021)

(3) Pumped Storage Hydropower Capabilities and Costs (International Forum on Pumped Storage Hydropower–Sept. 2021)


Thank you.