

GO GREENER ?

SHOULD WE WASTE LESS ?

SHOULD WE BE LESS DEPENDENT ON CRITICAL RAW MATERIALS ?

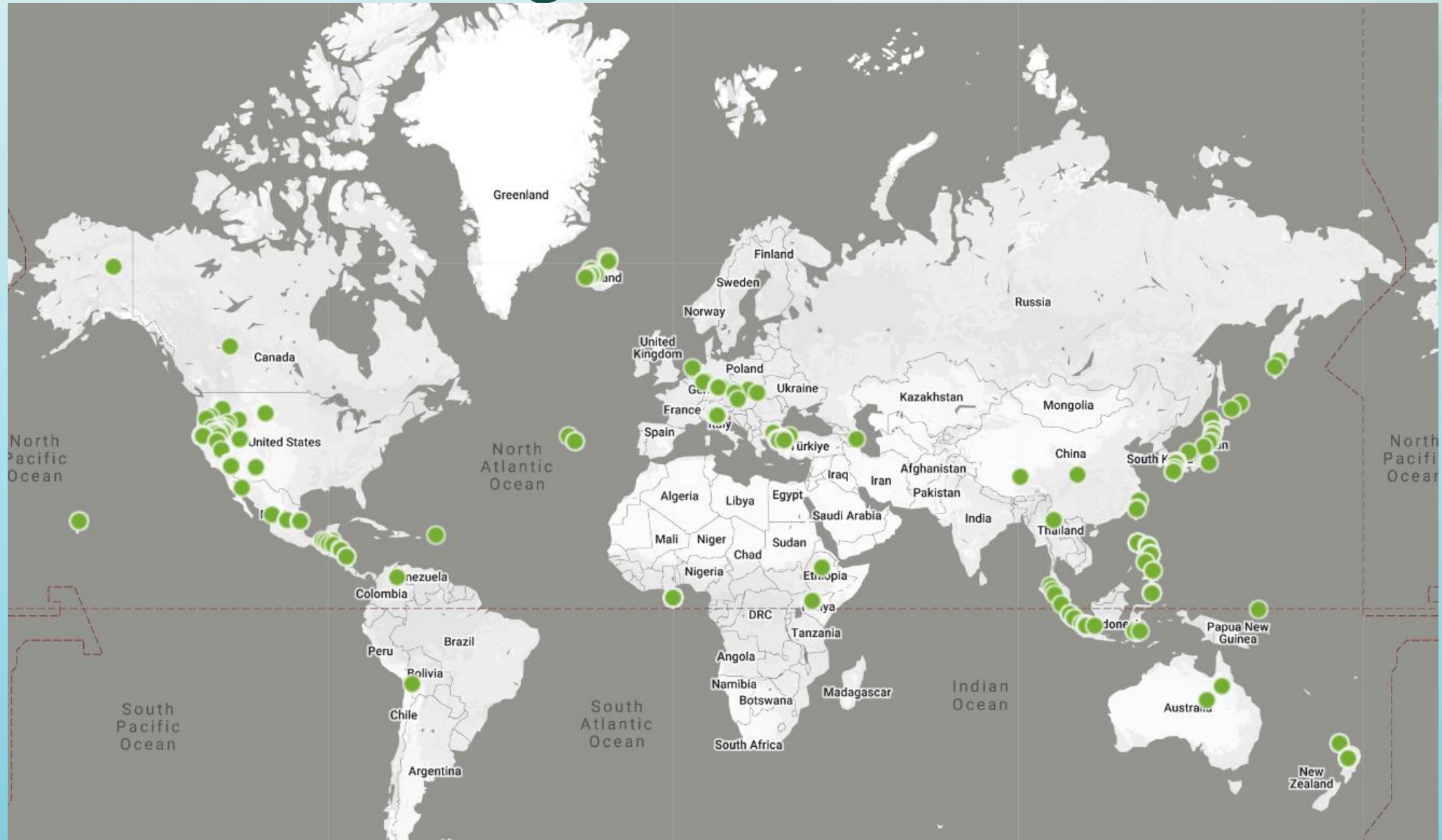
It is time to GO GEOTHERMAL !

Dr. Georgios Tsifoutidis

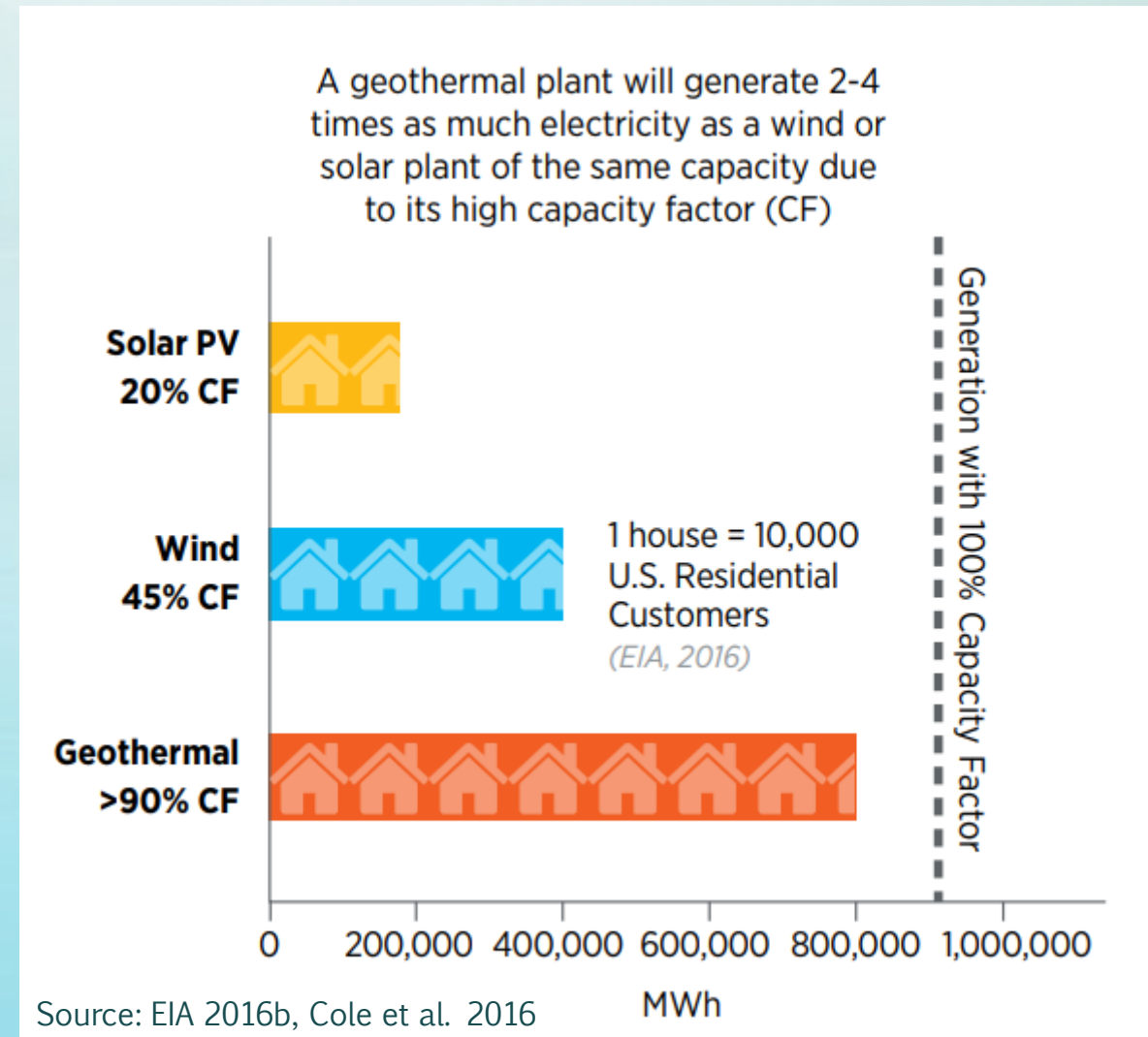
Head of Geothermal Energy Department, Ministry of Environment and Energy, Greece.



A lot of countries agree !



- Provides direct **BASE LOAD**, unlike other stochastic RESs.
- Supports grid reliability and flexibility [1].
- Higher Capacity Factor (>90%).
- Near zero emissions with geofluid injection binary systems.
- Low OPEX.
- Much less to recycle.
- Often a source of lithium !
- Geological derisking requires higher CAPEX.



[1] Geothermal generation in California is worth \$32/MWh more than generation from solar on a combined energy and capacity basis, (Orenstein & Thomsen 2017).

Geothermal energy is less demanding on critical raw materials. Nickel and Chrome are available in Greece

Critical mineral needs for clean energy technologies

	Copper	Cobalt	Nickel	Lithium	REEs	Chromium	Zinc	PGMs	Aluminium*
Solar PV	●	○	○	○	○	○	○	○	●
Wind	●	○	●	○	●	●	●	○	●
Hydro	●	○	○	○	○	●	●	○	●
CSP	●	○	●	○	○	●	●	○	●
Bioenergy	●	○	○	○	○	○	●	○	●
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	●	○	●	○	○	●	○	○	○
Electricity networks	●	○	○	○	○	○	○	○	●
EVs and battery storage	●	●	●	●	●	○	○	○	●
Hydrogen	○	○	●	○	●	○	○	●	●

Notes: Shading indicates the relative importance of minerals for a particular clean energy technology (● = high; ● = moderate; ○ = low), which are discussed in their respective sections in this chapter. CSP = concentrating solar power; PGM = platinum group metals.

* In this report, aluminium demand is assessed for electricity networks only and is not included in the aggregate demand projections.

SMALL VISUAL ENVIRONMENTAL
IMPACT IS AN EXTRA BONUS FOR
THOSE SOCIETIES THAT DEPEND ON
TOURISM

Geothermal 404 m²/GWhe,
Wind 1,335 m² /GWhe
Solar 3,237 m² /GWhe [2]

Wind 99 m² /MWhe
Solar 14 - 22 m² /MWhe [3]

Geothermal power plants can be
designed to “blend-in” to their
surroundings than other RES facilities

Added value, the creation of local
networks that enhance energy
security especially in island
communities



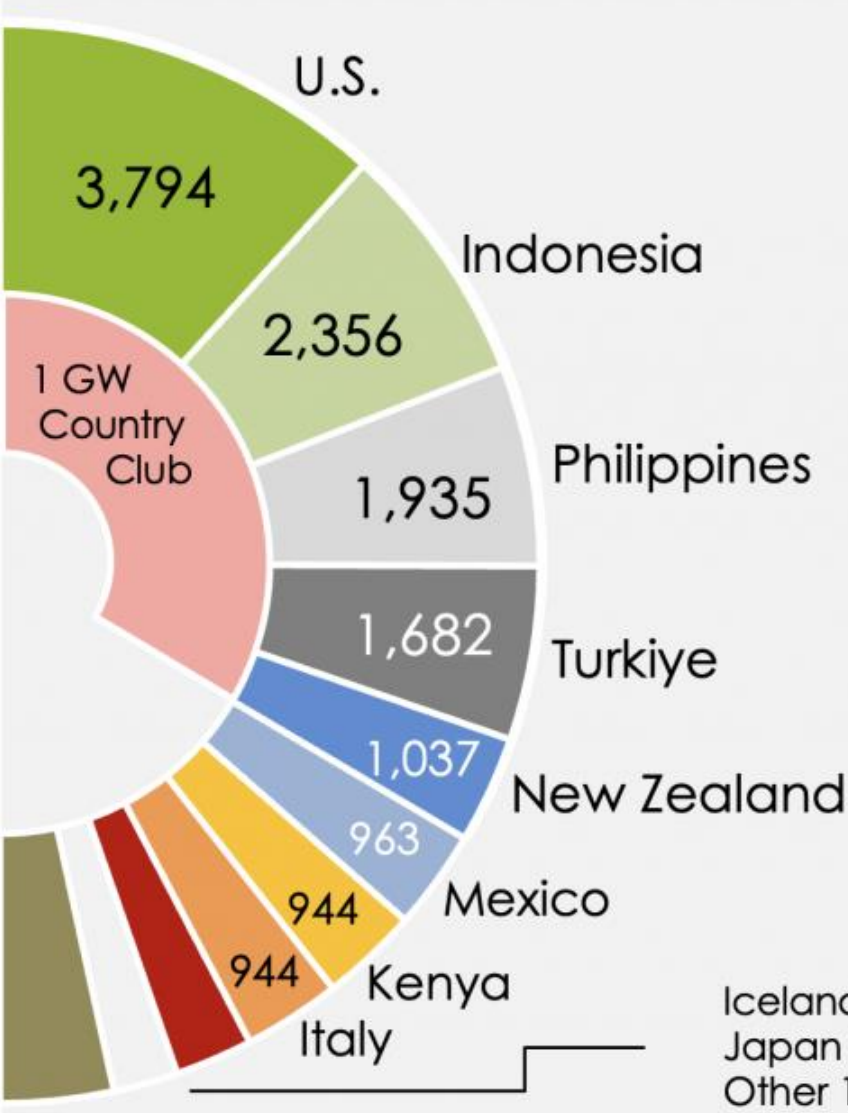
[2] Kagel et al. 2007

[3] UNECE (2021) Lifecycle Assessment of Electricity Generation Options

Top 10 Geothermal Countries 2022

Installed Capacity in MWe
January 2023

Total 16,127 MW



**THINK
GEOENERGY**

Source: ThinkGeoEnergy Research (2023)

Top 10 Geothermal



More than 250,000 homes enjoy geothermal heating in Paris, with fifty distribution networks. Since 2019 four more wells are drilled to expand the network!

Stelantis Group (Peugeot, Nissan, Open, Fiat-Chrysler) aims to power an Opel plant in Germany and a Peugeot plant in France using geothermal energy from deep wells !



THINK
GEOENERGY

Source: ThinkGeoEnergy Research (2023)

Geothermal Energy in Greece

New International Call for Tenders
Lease of geothermal exploration rights in
Central – East Macedonia and Thrace

Terms and procedure. Prospects for establishing geothermal
power generation as an alternative for Greece.

Dr. Georgios Tsifoutidis

Head of Geothermal Energy Department, Ministry of Environment and Energy, Greece.



Geothermal Potential in Greece is defined as :

“ The total of indigenous natural hot fluids, superficial or below ground level, and the heat of geological formations, with temperature exceeding 30°C ”.

L.4602/2019, (GG 45A).

The geothermal potential is regarded as a mineral resource hence all the rights to explore for, exploit and manage the resource lie with the State. The rights are either exercised directly by the State or leased by the State.

Mining Code, L.D. 120/1973, (GG 227A)

Is there geothermal potential in Greece?

YES

Greece has all the geological features that can generate sizeable geothermal potential.

32 established geothermal fields of local interest (30 - 90°C). Direct thermal applications at 85 MWth in 2021.

2 established geothermal fields of national interest (T>90°C) at Milos and Nisyros islands. Not leased.

Increasing use of ground heat pumps (GHPs) in urban and suburban areas for heating and cooling at 182 MWth (ΥΠΕΝ 2022), especially in Thessaloniki metropolitan area, regional units of East Attika and South Athens.



Andritsos, N.; Arvanitis, A.; Papachristou, M.; Fytikas, M.; Dalambakis, P.; Geothermal Activities in Greece during 2005 – 2009, Proc. World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010

Are we fully exploiting Greece's potential?

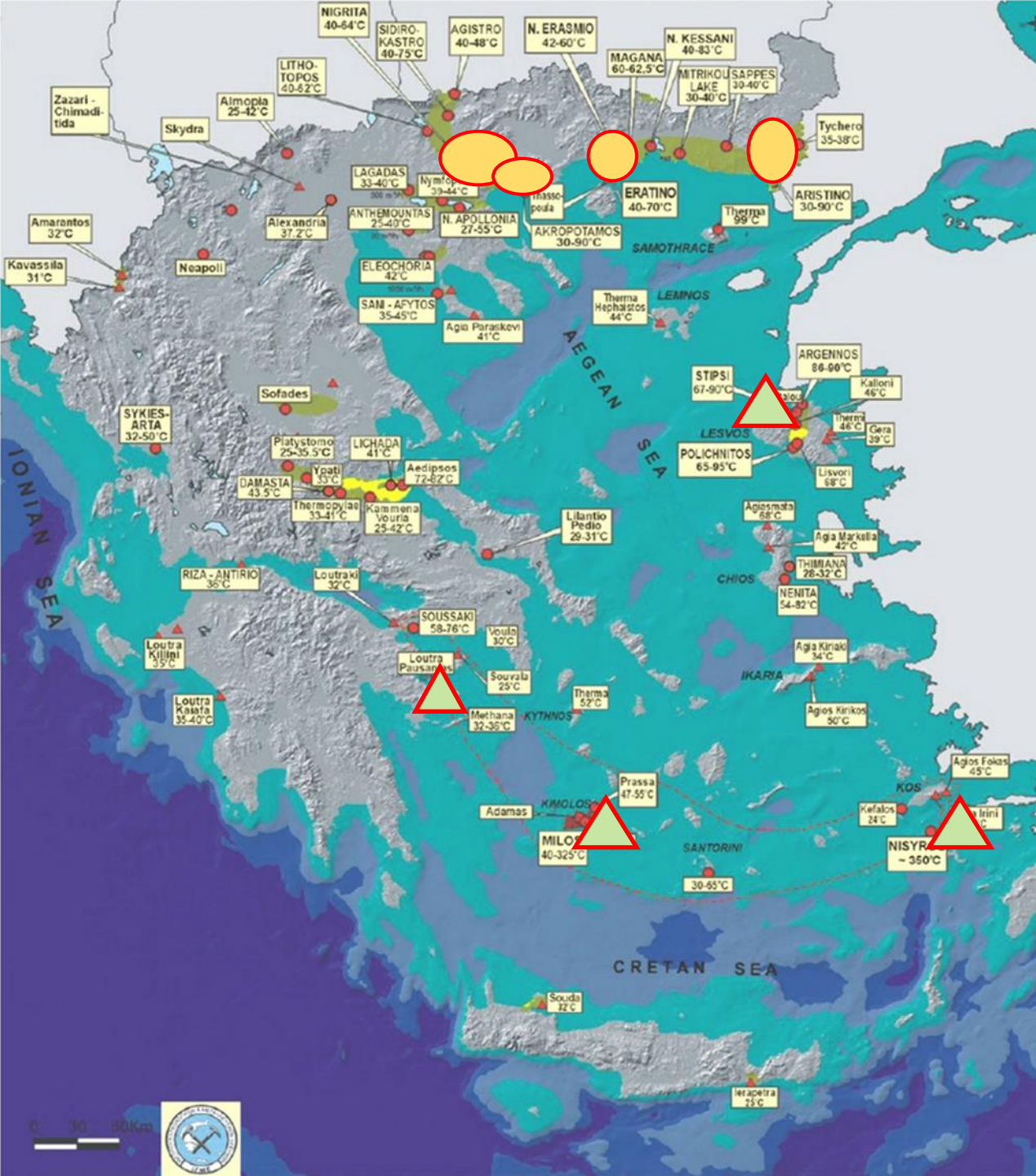
NOT YET

4 mining areas leased to PPC Renewables SA for exploration ($T > 90^{\circ}\text{C}$) and production, in the islands of Milos & Kimolos, Nisyros, Lesvos and the Methana peninsula, since 2011. No production yet.

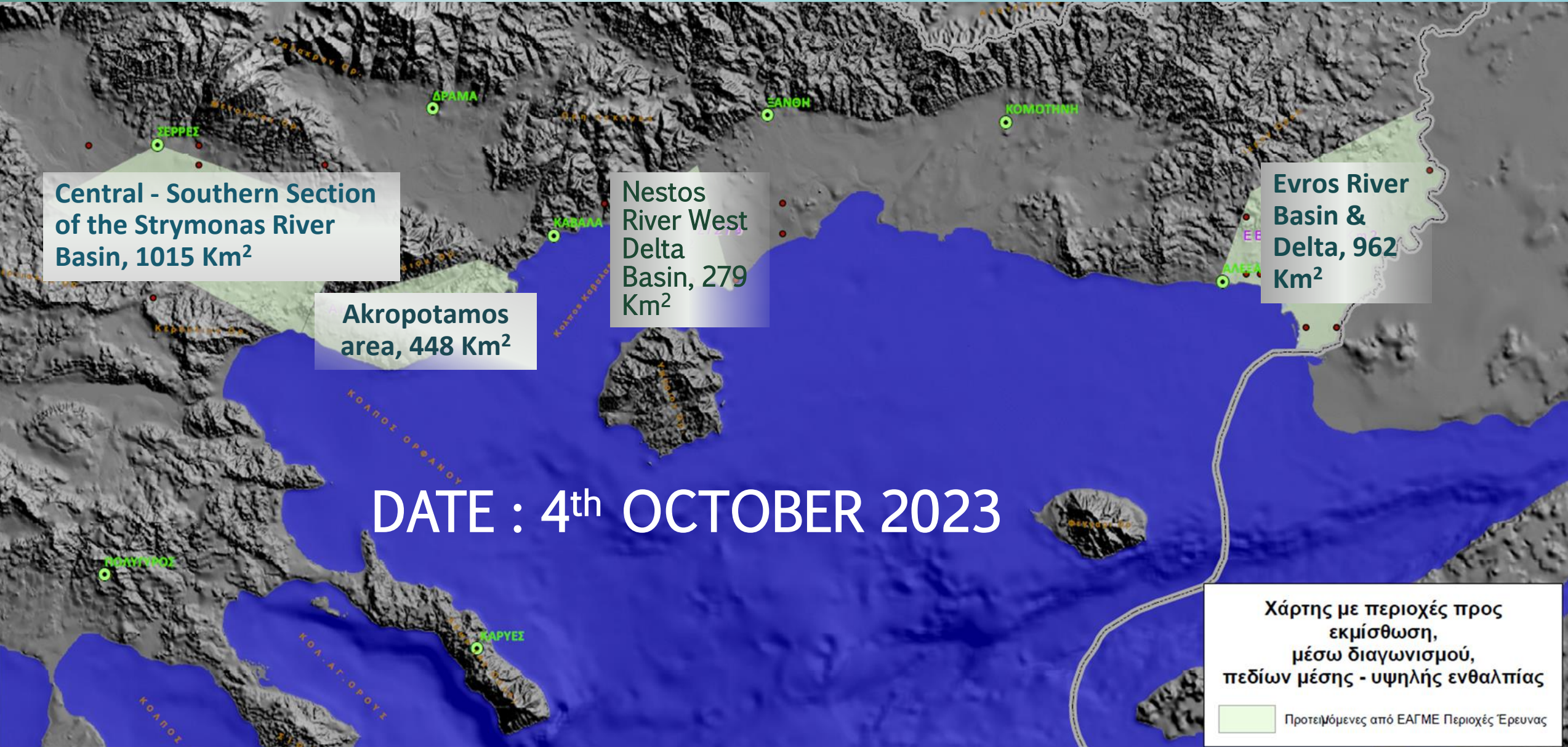
What is new?

- Commitment set in Greece's NECP 2030 to achieve geothermal participation in the RES mix at 100 MWe.
- New friendlier regulatory framework in place.

4 non characterised domains have been tendered on 19.05.2023 to lease exploration rights in C-E Macedonia and Thrace, suspected of $T > 90^{\circ}\text{C}$ potential.



The 4 non-characterised areas of the new Call for Tenders



Lease duration

The right to explore is leased for a period of **five (5) years** from the signing of each lease agreement with the right of unilateral extension by the lessee for **two (2) additional years**.

Eligibility

Natural and legal persons, Greek and foreign, their associations and joint ventures.

How to Participate

Participants submit their bids separately for each of the non-characterized areas. Each bid includes a Sub-folder A: Participation Documents and a Sub-folder B: Technical Bid. In their bid Participants must also include a Letter of Guarantee of Participation of indefinite validity, amounting to fifteen thousand euros (15.000,00 €), returnable at the end of the procedure.

Information Packages with geological – geothermal data for each area are available from the Hellenic Survey of Geology and Mineral Exploration (E.A.G.M.E.). Participants must purchase the corresponding Information Package for each area they intend to bid.

Evaluation Criteria

1. **Minimum exploration work program** with time and cost analysis.
2. **Financial commitment** on the minimum exploration work program.
3. **Supplementary exploration work program** (not binding).
4. Bidder's **technical experience**.
5. **Financial capability** of the bidder to support the project.
6. **Environmental management** capability.

The selected bidder will provide a letter of guarantee of indefinite duration for the proper execution of the terms of the contract, equal to the total amount (including VAT) of the financial commitment for the minimum exploration work program in the offer.

Upon discovery, the Lessee may enter an **exploitation and management right lease contract**, provided that they submit an acceptable by the Lessor business plan. The new contract has a duration of **thirty (30) years** with the right to extend for **twenty (20) more** years with the approval by the Lessor.

Legal Framework of the Bidding Process

Since 2019 a new regulatory framework for geothermal energy has been gradually introduced, taking into account the EU legal framework, fitting best practices and lessons learned from the successful oil & gas rounds in Greece.

- Law 4602/2019 governs exploration and exploitation of Greek geothermal potential (Gov. Gazette no 45, Vol A).
- The new Regulation of Geothermal Works was published in 2021, following 2 years elaboration and public consultation (G.G. 1960B).
- The Terms and Procedure for leasing rights to explore, manage and exploit geothermal potential in geothermal fields of national interest and non characterised areas of the country, was published in 2022, following 2 years elaboration and public consultation (G.G. 1460B).

N.B. Power station permitting, production and grid connectivity, follow the RES and relevant power generation and distribution legislation, e.g. Law 4658/2020, RAE decisions etc.

“ The economics of electricity production are influenced by the drilling costs and resource development (a typical capital expenditure or CAPEX quota is 30% for reservoir and 70% plant). The electricity productivity per well is a function of reservoir fluid thermodynamic characteristics (phase and temperature). The higher the energy content of the reservoir fluid, the lesser the number of required wells and as a consequence the reservoir CAPEX quota is reduced. Single geothermal wells can produce from 1–5 MWe, however, some producing as high as 30 MWe have been reported ”.

Source : World Energy Resources: Geothermal World Energy Council 2013

Recent geophysical and remote imaging technology advances allow for cost savings by enhancing substrata modeling which reduces the geological risk. There are smart insurance tools, feed in tariffs and good practices that can be adopted from other countries like the priority of grid connection.

Binary or Organic Rankine Cycle plants, Enhanced Geothermal Systems layouts allow for an increased ability to transfer and convert to electricity at the station. Any surplus heat can be used directly.

Total non-condensable gas emissions from geothermal resources typically make up less than 5% of the total steam emitted. Geothermal air emissions are significantly lower than those of a gas power plant, e.g. 0.16 kg/MWh of sulfur dioxide compared to 1 kg/MWh and 0 CO₂ compared to 550 kg/MWh

Geothermal Energy makes sense in
both heating and power generation

Let's go Geothermal !

THANK YOU FOR YOUR PATIENCE

Dr. Georgios Tsifoutidis

Head of Geothermal Energy Department, Ministry of Environment and Energy, Greece.



Other References :

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