



ALCUE NET

Latin America, Caribbean and European Union Network on Research and Innovation

Geothermal Energy

State of the art in Portugal

Elsa Cristina Ramalho

National Laboratory for Energy and Geology (LNEG)

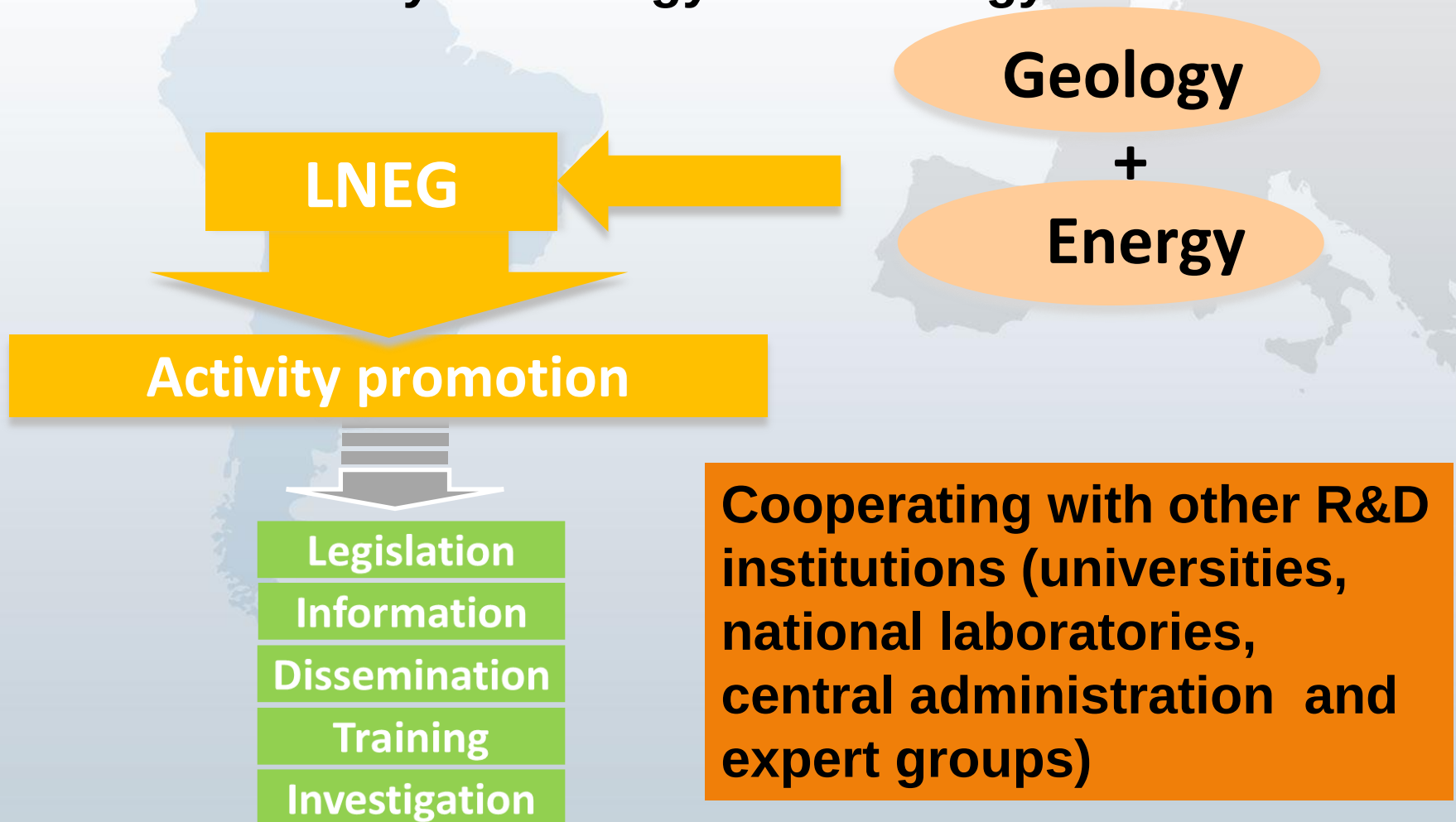
Geothermal Energy Workshop

Salta – December 2014

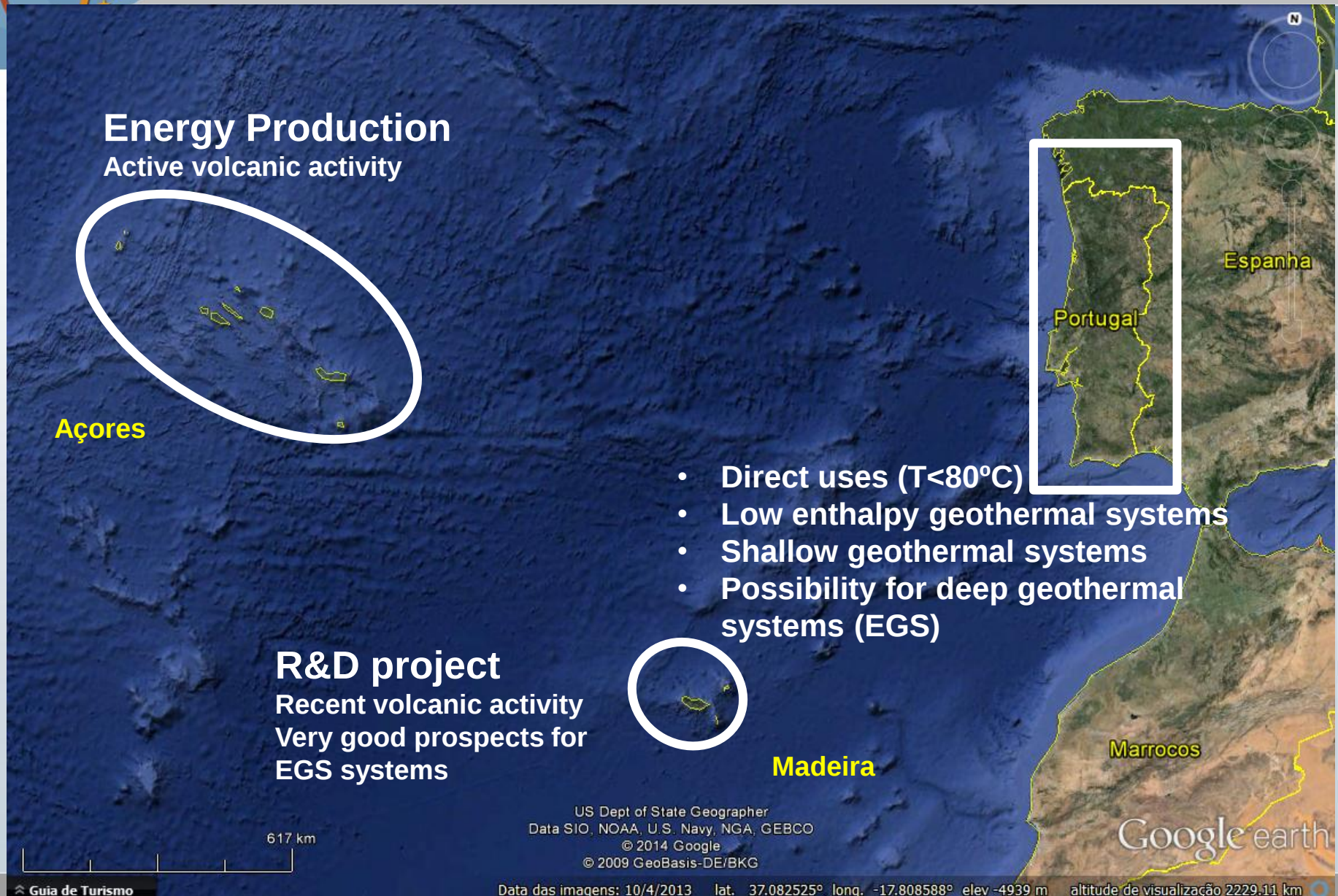


Geothermal Energy and LNEG

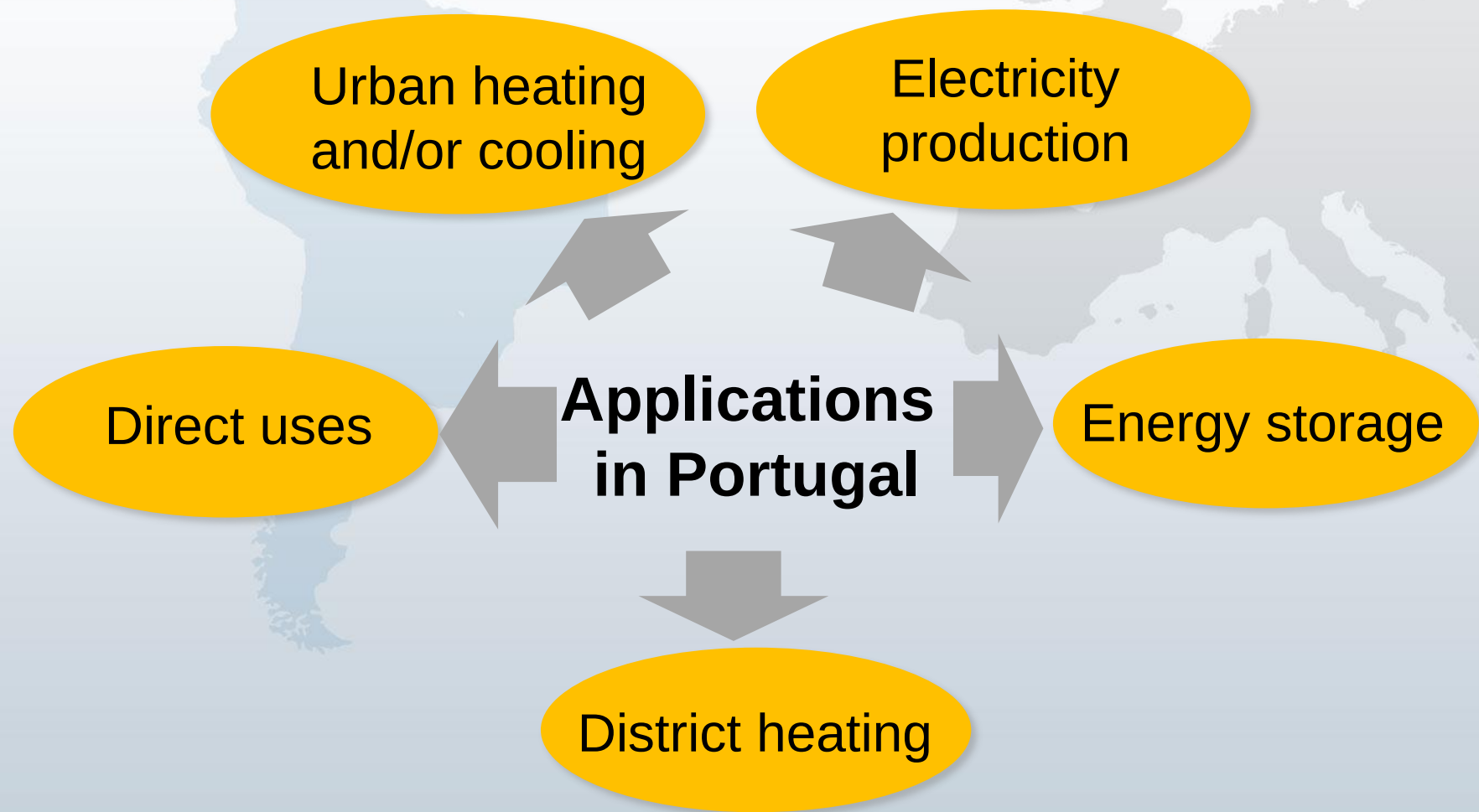
National Laboratory for Energy and Geology



Portugal location and geothermal characteristics



Geothermal Energy in Portugal





ALCUE NET
Latin America, Caribbean and European Union Networks on Research and Innovation

High Entalpy Geothermal Energy: Açores – S. Miguel Island

Ribeira Grande Power Plant
March 1994
13 MW
Possibility to expand + 5 MW



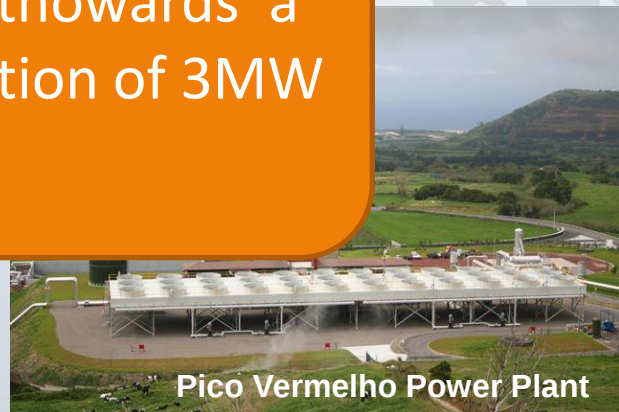
Pico Vermelho Power Plant
December 1994
10 MW

2014 will
43% total
22% of total in Açores

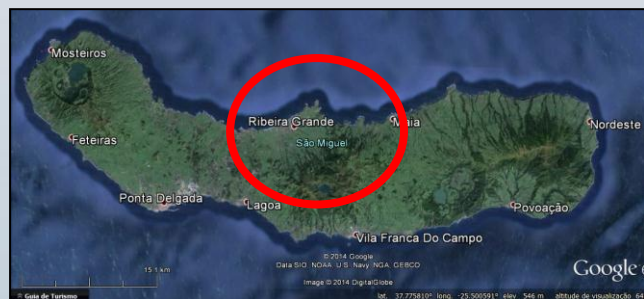
Prospecting activities and deep drilling are conducting to a the selection process towards a Geothermal Pilot Power Plant installation of 3MW in Terceira Island, Açores



Power Plant

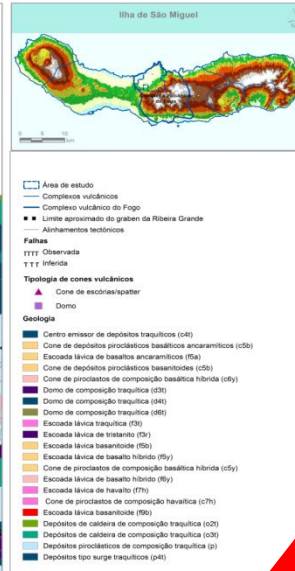


Pico Vermelho Power Plant



EDA RENOVAVEIS (2014)

Trota et al. (in press)



Trota, A., Rocha, S., Simão, J., Almeida, A., Oliveira, A. and Ferreira Gomes, L. M. (in press, Comunicações do LNEG) – Aplicação de uma metodologia termométrica expedita na identificação de zonas com anomalia geotérmica na Ribeira Grande, ilha de S. Miguel, Açores.

Support in investigation projects in low enthalpy energy (AVAC) and high enthalpy (reservoir engineering and power plants).

Trotta et al. (in press)

Geothermal occurrences in Mainland Portugal with geothermal applications

ALCUE NET

Latin America, Caribbean and European Union Networks on Research and Innovation



Monção

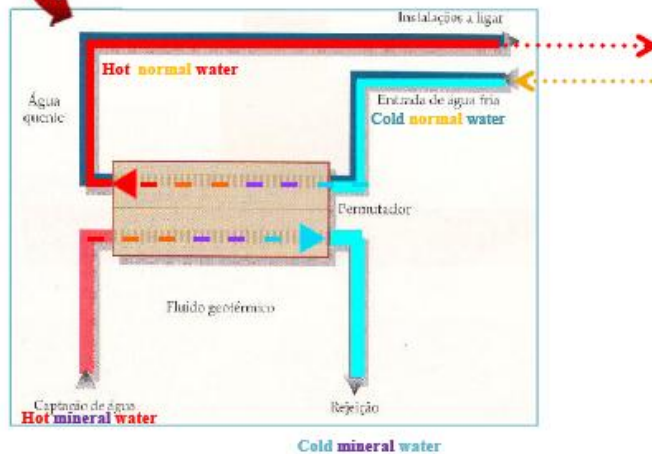


Carvalho



S. Pedro do Sul





Geothermal Applications

S. Pedro do Sul

Thermal Sector
Urban heating



(from Ferreira Gomes, 2014)

Direct uses: S. Pedro do Sul

Geothermal Applications S. Pedro do Sul

a) Greenhouses warming to produce tropical fruits



b)



c)

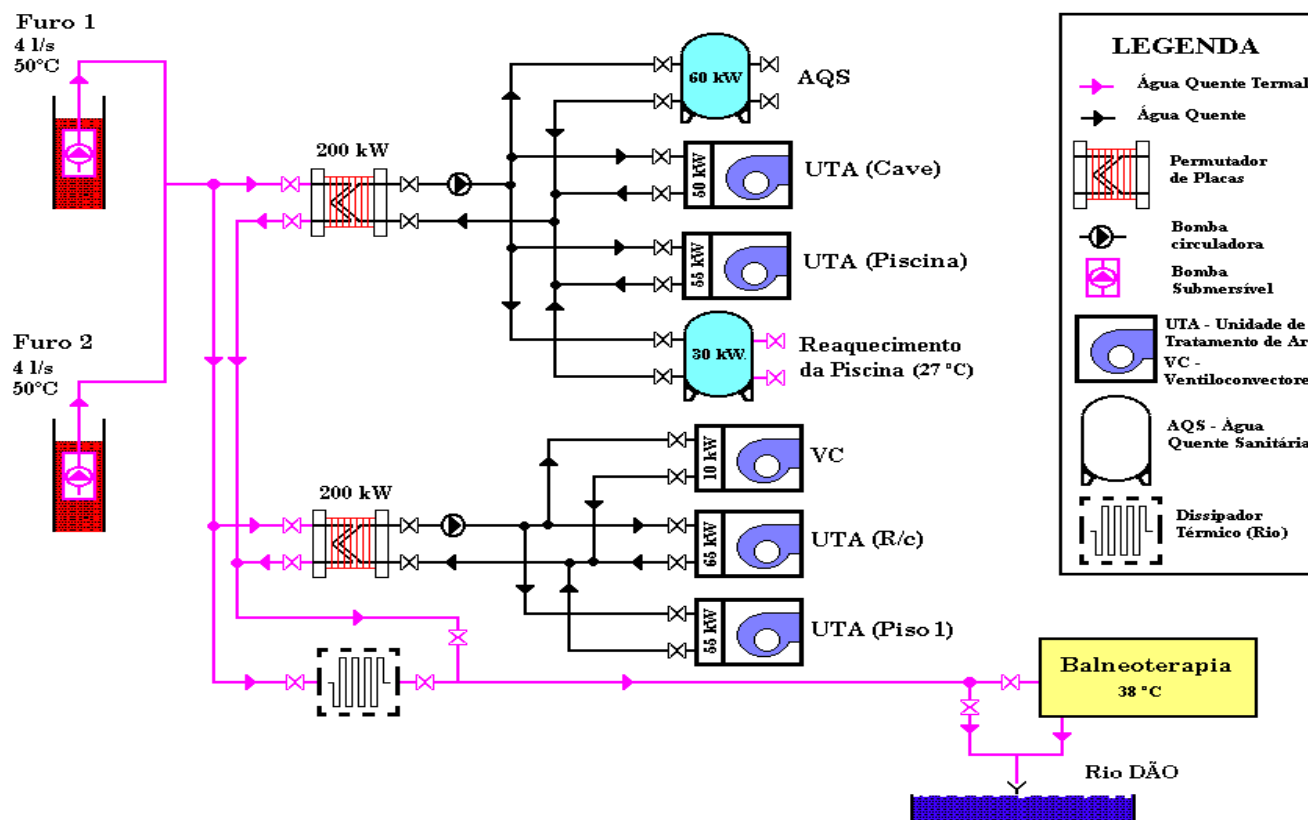


d)

(from Ferreira Gomes, 2014)

Greenhouses of the Vau Sector (a), with its typical aspect of interior (b) and details of produced tropical fruits (c, d)

Direct uses of low enthalpy geothermal: technical and economical feasibility study towards geothermal exploitation in Caldas de Sangemil spa

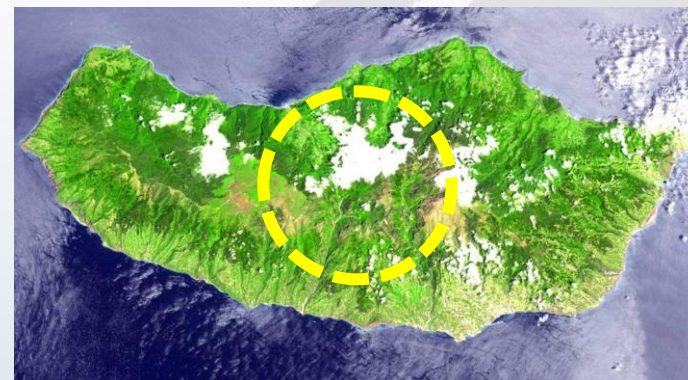
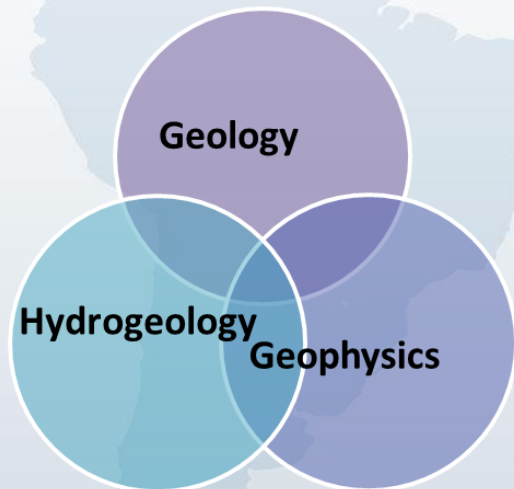




ALCUE NET
Latin America, Caribbean and European Union Networks on Research and Innovation

➤ **EGEM** – Enhanced Geothermal Energy (EGS) in Madeira Island

1st phase

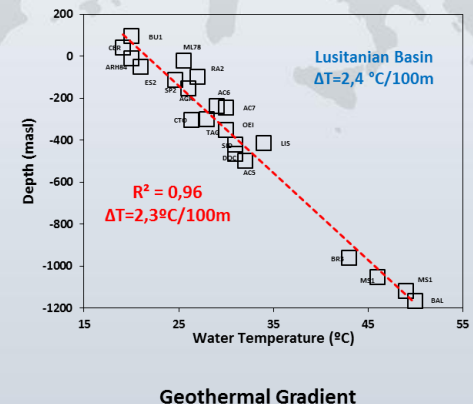
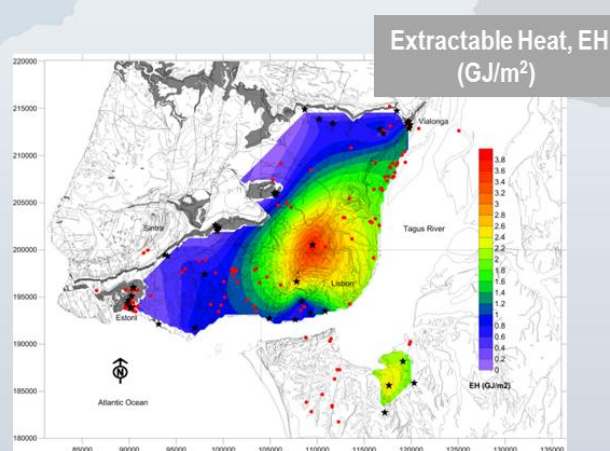
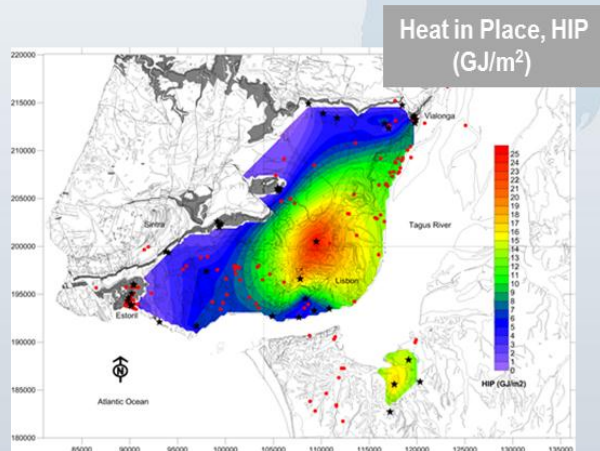


2nd phase

- Deep reservoir identification mainly from magnetotelluric studies to select the location of deep geothermal drillholes with core sampling and geophysical logging.
- Reservoir enhancement.

➤ Hydrothermal - Geothermal Assessment of Lower Cretaceous Aquifer in Lisbon Region, Portugal (LNEG)

Characterization, Protection and Management of Hydrothermal Resources of Lisbon within the Energetic and Environmental Sustainability Plan



Marrero-Diaz et al. (2014)

Geothermal Potential Assessment (Heat In Place - HIP) of the Lower Cretaceous Aquifer of Lisbon Region using the volumetric method (Muffler and Cataldi, 1978)

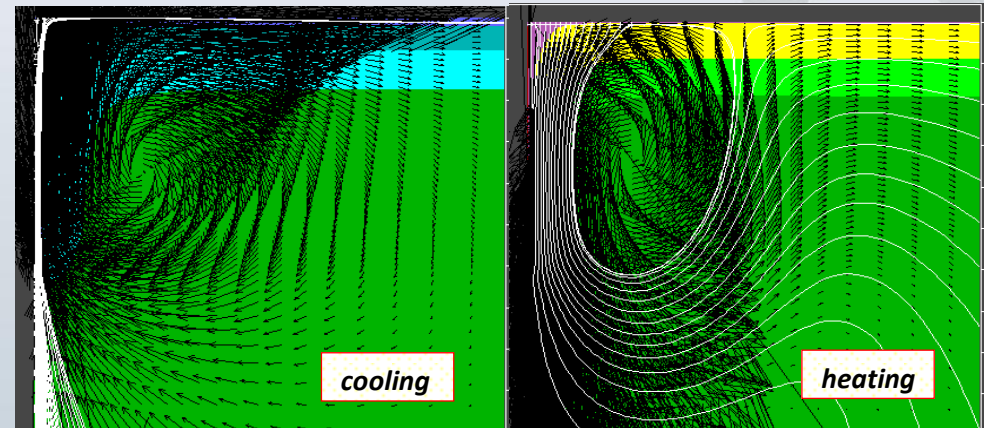
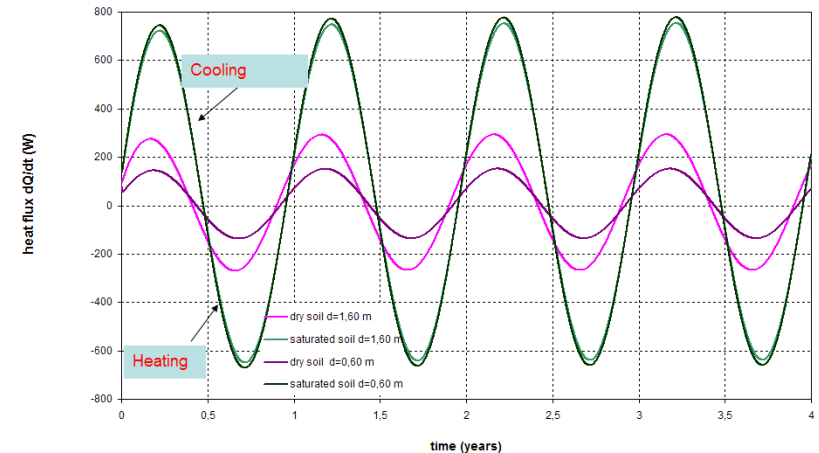
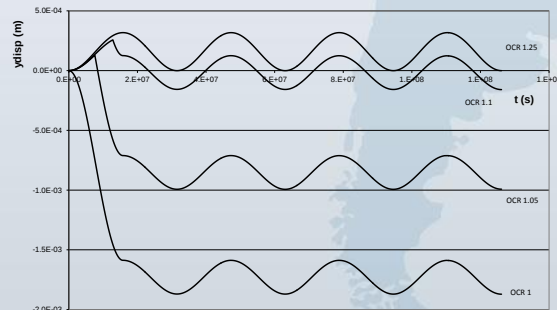


Goal

Identification and delimitation of the most favorable areas towards a future exploitation of this potential resource

Research Interests:

- Shallow geothermal energy
- Shallow geothermal systems (open, closed)
- Thermoactive geostructures, BHE
- Thermo-hydro-mechanical soil behaviour (advanced constitutive modeling)
- Thermal storage
- Long term effects
- Energy efficiency

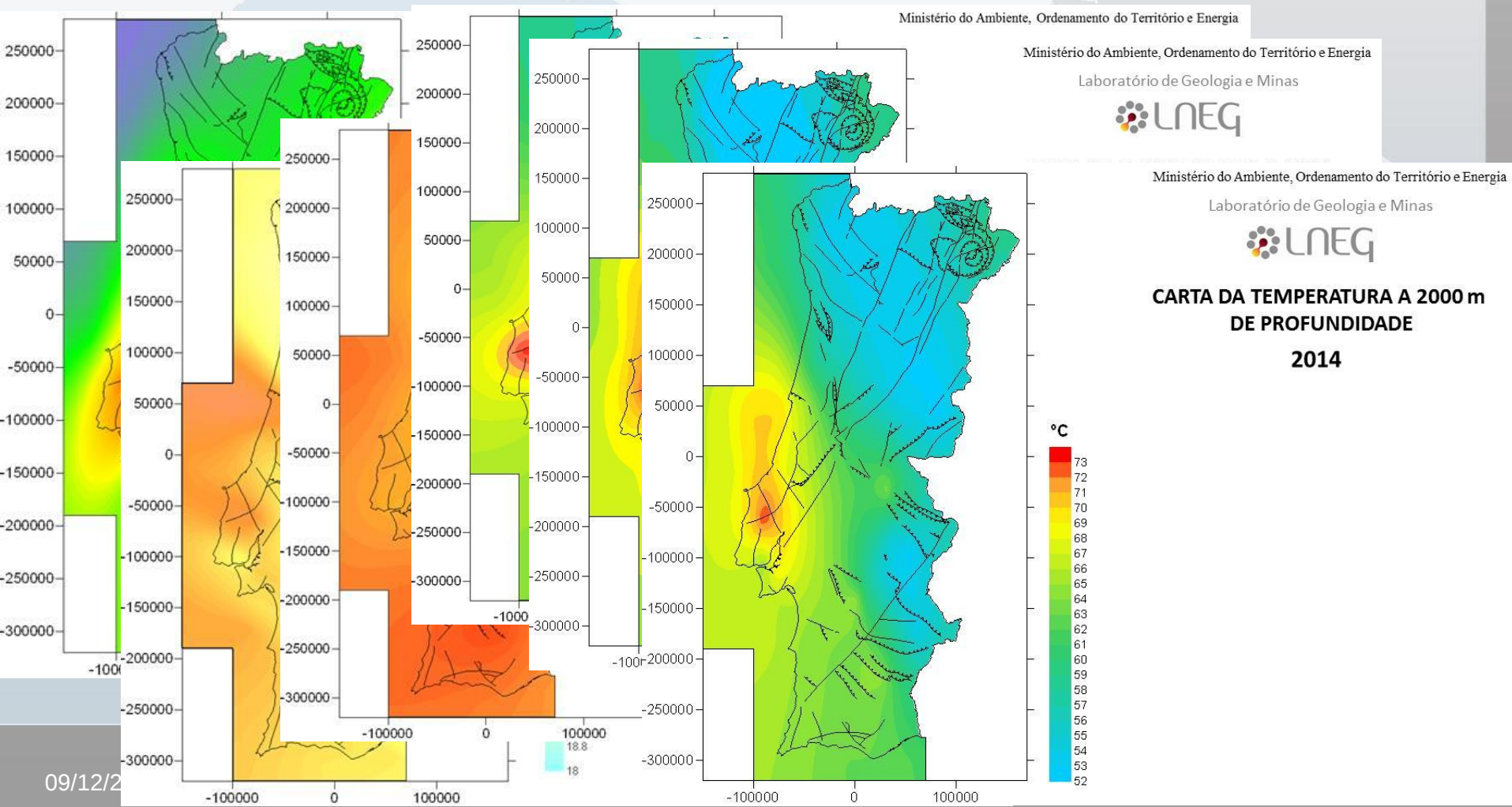


Research team members:

A. Vieira (avieira@lnec.pt); J.R. Maranhã (jrmarcha@lnec.pt)
L. Caldeira (Laurac@lnec.pt); A. Pinto (apinto@lnec.pt)



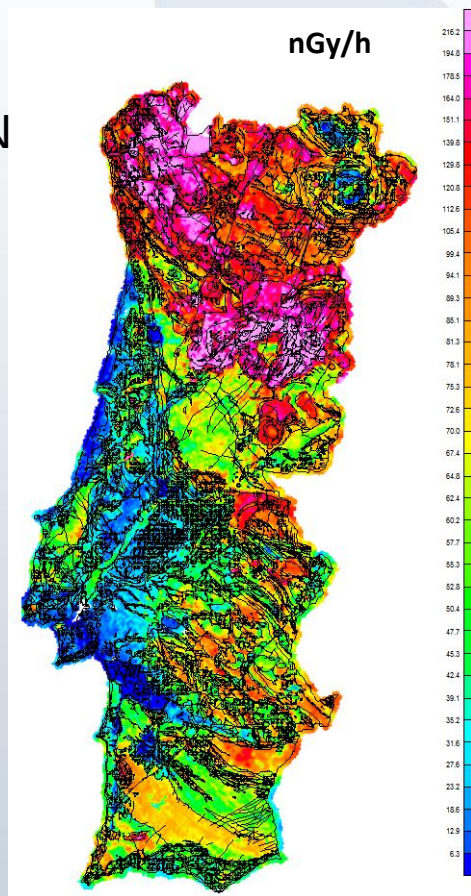
Thematic geothermal mapping production at various scales, with different goals, integrating information from different sources and institutions.



Thematic geothermal mapping

National Exposure Rate map –
Scintillometry and carborne
and airborne spectrometry

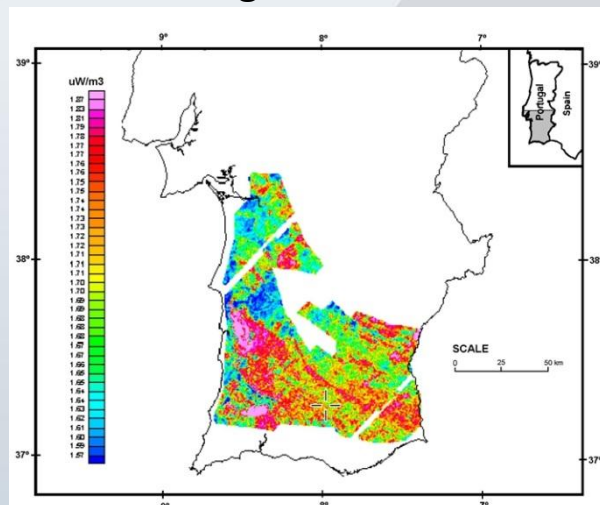
841 440
points



(Batista et al., 2013)

National mapping

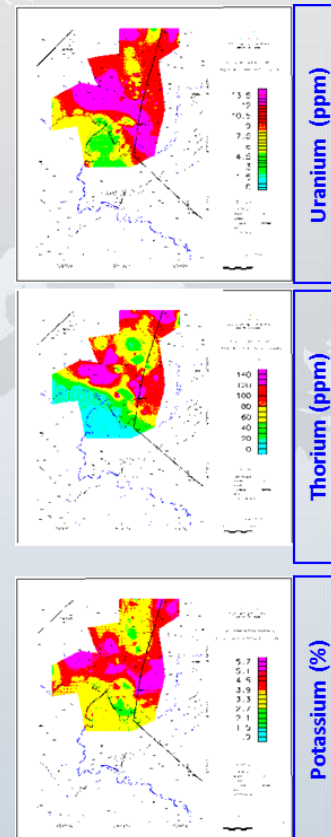
Radiogenic heat production ($\mu\text{W}/\text{m}^3$),
based on airborne surveys for
mining prospecting in the South
Portuguese Zone



(Torres et al., 2000)

Regional mapping

Natural gamma ray spectrometry
– S. Pedro do Sul Granite



(Saraiva et al., 1997)

Local mapping

Activities:

- Acquisition of thermo physical and radiogenic production data;
- Determination possible trends in depth for the former variables;
- Definition of the conceptual model for the crust in Central Portugal (also with supported in geophysical data);
- Estimation of the present temperature distribution in depth and of the surface heat flow.

Gamma-ray spectrometry for measuring U, Th and K content



R&D projects:

- Energy and Mobility for Sustainable Regions – EMSURE
- Evaluation of the geothermal potential in the central part of the Portuguese territory (Almeida)

TPS device for measuring thermal properties





R&D Projects and Activities (University of Évora)

Activities:

- Acquisition of thermal properties in laboratory and field work;
- Thermal conductivities and diffusivities in rock samples;
- Accurate deep borehole temperature logging;
- Gamma-ray spectrometry for heat production determinations.

Cooperation in Projects:

- Thematic geothermal mapping (National Geothermal Atlas);
- Geothermal reservoir evaluation.
- Deep geothermal studies in water, mining and oil wells (BHT).



ALCUE NET

Latin America, Caribbean and European Union Networks on Research and Innovation

PLATAFORMA
PORTUGUESA
DE GEOTERMIA
SUPERFICIAL

PPGS

National Platform for Shallow Geothermal (LNEG+DGEG+APG+ADENE)

PPGS is the Plataforma Portuguesa da Geotermia Superficial (Portuguese Platform for Shallow Geothermal Energy). It was created to disseminate and credibilize Shallow Geothermal Energy in Portugal, through the intervention in several relevant areas for the activity development and implementation, namely related with legislation, information, dissemination, training and investigation.

This was accomplished through the signature of a protocol that took place in **January 21st 2013**, among four institutions :

Coordination Group

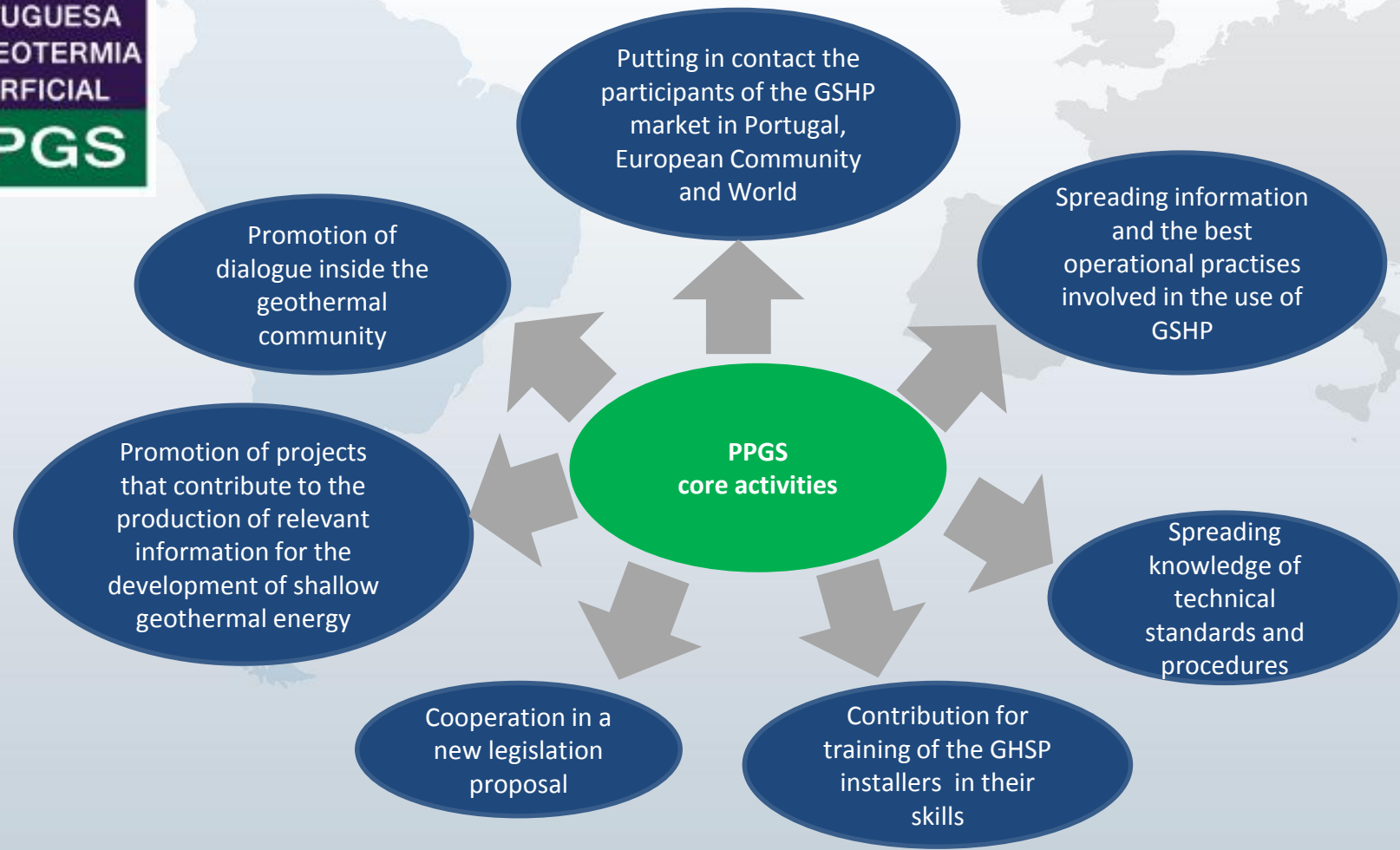
- 1 - **Direção Geral de Energia e Geologia (DGEG)**
National Directorate of Energy and Geology
- 2 - **Agência para a Energia (ADENE)**
Agency for Energy
- 3 - **Associação Portuguesa de Geólogos (APG)**
Portuguese Association of Geologists
- 4 - **Laboratório Nacional de Energia e Geologia (LNEG)**
National Laboratory for Energy and Geology

Other institutions have given their support, namely the Instituto Politécnico de Setúbal (IPS) and the Ordem dos Engenheiros Técnicos (OET) or Agência Nacional para a Qualificação e o Ensino Profissional (ANQUEP).



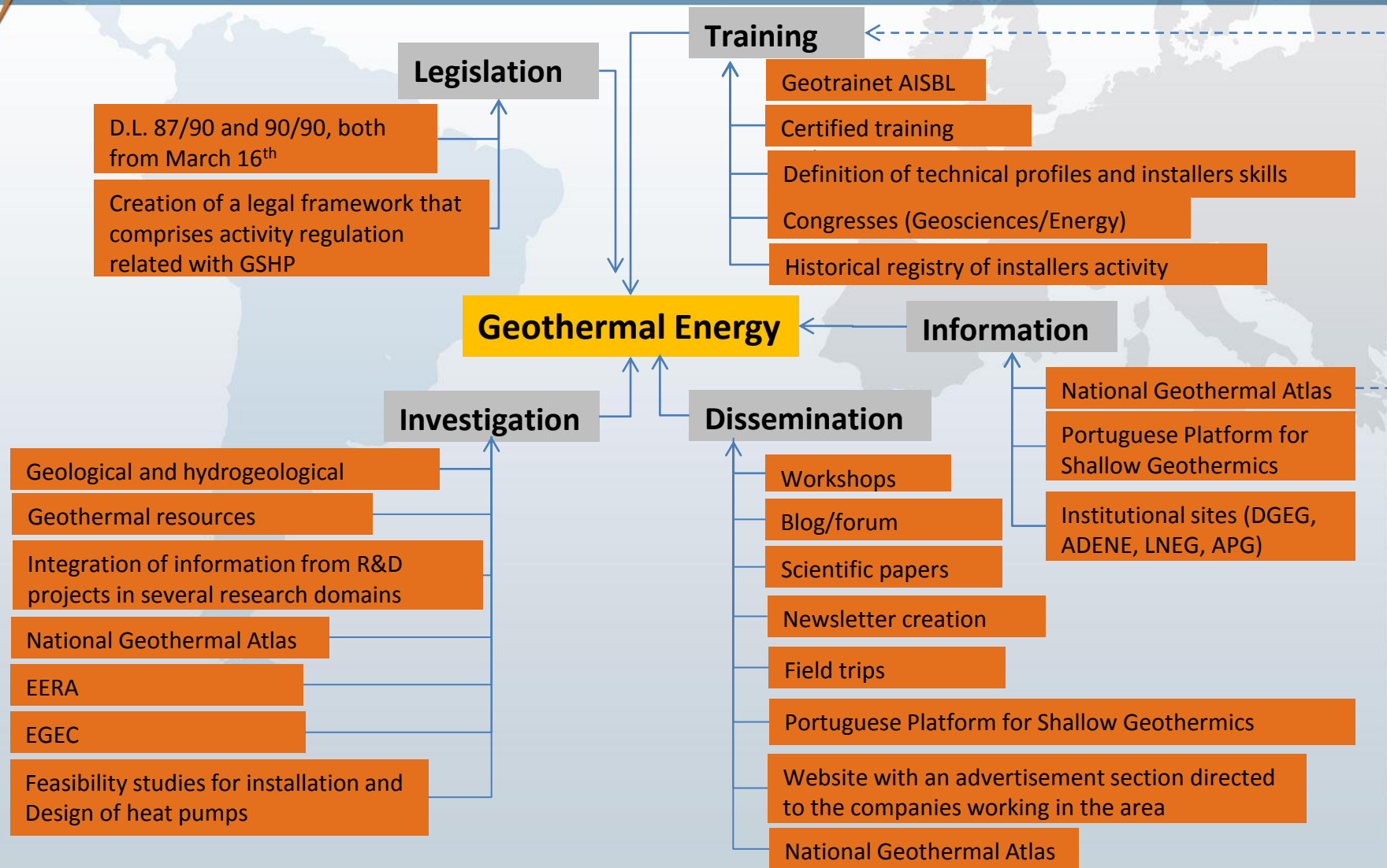
ALCUE NET
Latin America, Caribbean and European Union Networks on Research and Innovation

PLATAFORMA
PORTUGUESA
DE GEOTERMIA
SUPERFICIAL
PPGS





Geothermal Energy



Energy Production estimates in Portugal

Source	Energy
Power supply production	23 MW
District heating	1.5 MW
Greenhouse heating	1.0 MW
Bathing and swimming	25.3 MW
GSHP *	28.1 MW

*No accurate estimations are available. Calculations were made with full load capacity 1500 h/y and COP=3.5.

Nowadays, the use of GHSP is already higher than direct uses in thermal poles.

Data from:
EDA RENOVÁVEIS (2014)
Martins Carvalho (2013)
Cabeças et al. (2010)



Final Remarks

High enthalpy geothermal resources in Portugal are so far restricted to active and recent volcanic geological environments in Açores Islands.

EGS has good prospects in Madeira Island;

Low temperature geothermal resources are mainly exploited for direct uses, mainly for balneotherapy, local urban heating facilities and geothermal heat pumps in about 30 spas operating in the country.

Although private investors asked for exploration permits of geothermal resources in Mainland Portugal in a total area of 2,655 km² for EGS projects, this is not advancing.

Low geothermal heat pump installations are slowly being disseminated and implanted in the entire country.



Final Remarks

R&D institutions (Universities and National Laboratories) in Portugal are able and willing to cooperate covering a wide set of subjects related with geothermal energy.

National Laboratory for Energy and Geology (LNEG)

National Laboratory for Civil Engineering (LNEC)

University of Évora (UE)

University of Beira Interior (UBI)

University of Coimbra (UC)

University of Açores (UAC)

Instituto Superior Técnico (IST)

·
·

And others

(private companies, central administration institutions and expert groups)

Thank you for your attention

www.lneg.pt
elsa.ramalho@lneg.pt

**For more information
email:
visit:**

www.alcuenet.eu

ALCUE NET is funded by the European Commission under the 7th Framework Programme.