



Sustainable Geothermal Applications – The Case of Polichnitos

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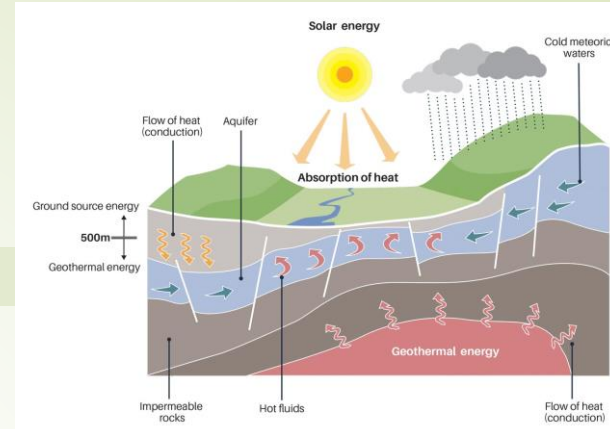
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Geothermal energy

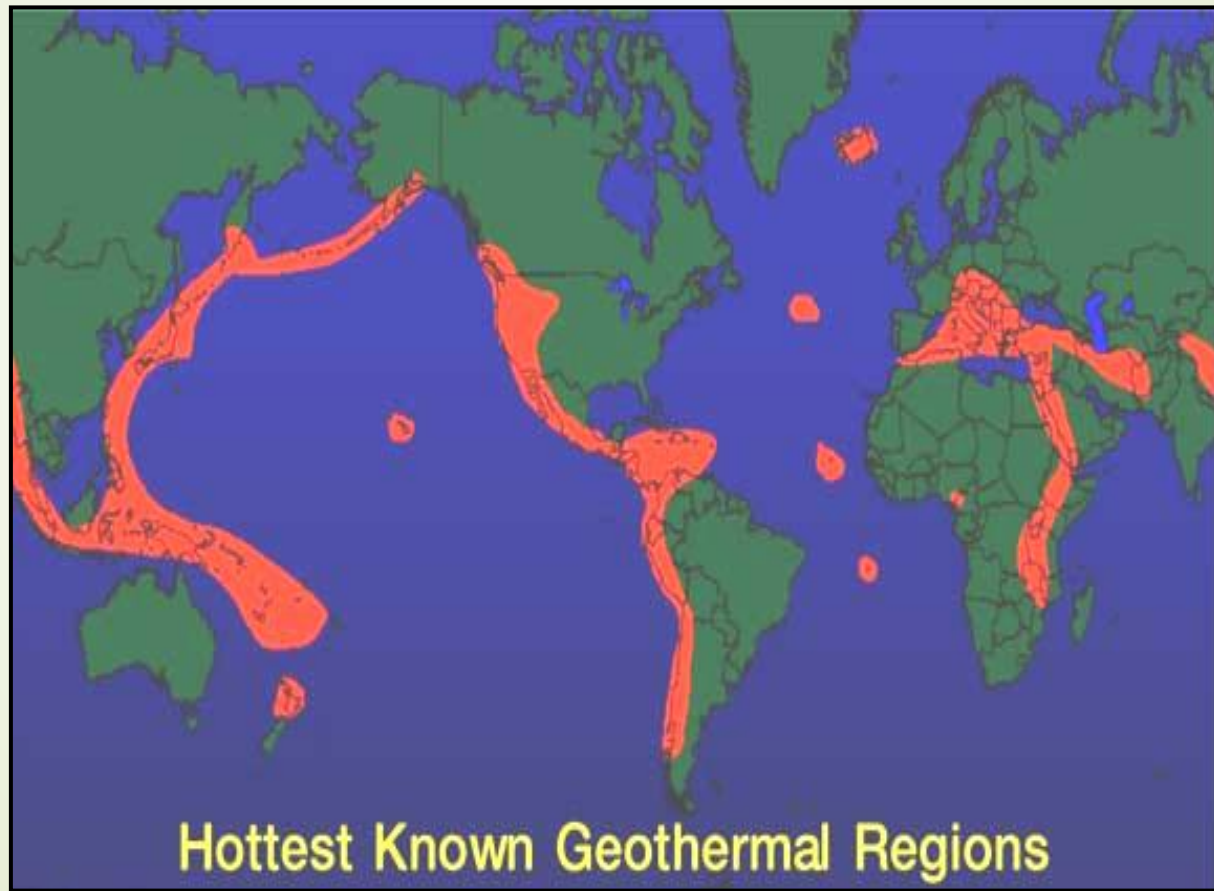
- Geothermal energy is heat derived from the earth's core.
- It is a **renewable**, **sustainable**, and **clean** form of energy.
- Geothermal fields depending on the temperature -of the fluid- are divided into:
 - **High enthalpy**, with fluid temperatures exceeding 150°C. It is usually a mixture of liquid steam and hot water.
 - **Medium enthalpy**, with fluid temperatures between 150 ÷ 90°C
 - **Low enthalpy**, with fluid temperatures between 100 ÷ 25°C
 - **Normal (shallow) enthalpy**, with fluid or soil temperatures usually equal to or lower than the average annual air temperature, about 20-25 °C for the Greek regions.
 - **Frost** (or Very Low Enthalpy with temperatures below 0°C or **Permafrost**)



In Greece, according to law 4602/2019, geothermal fields are distinguished according to the temperature in:

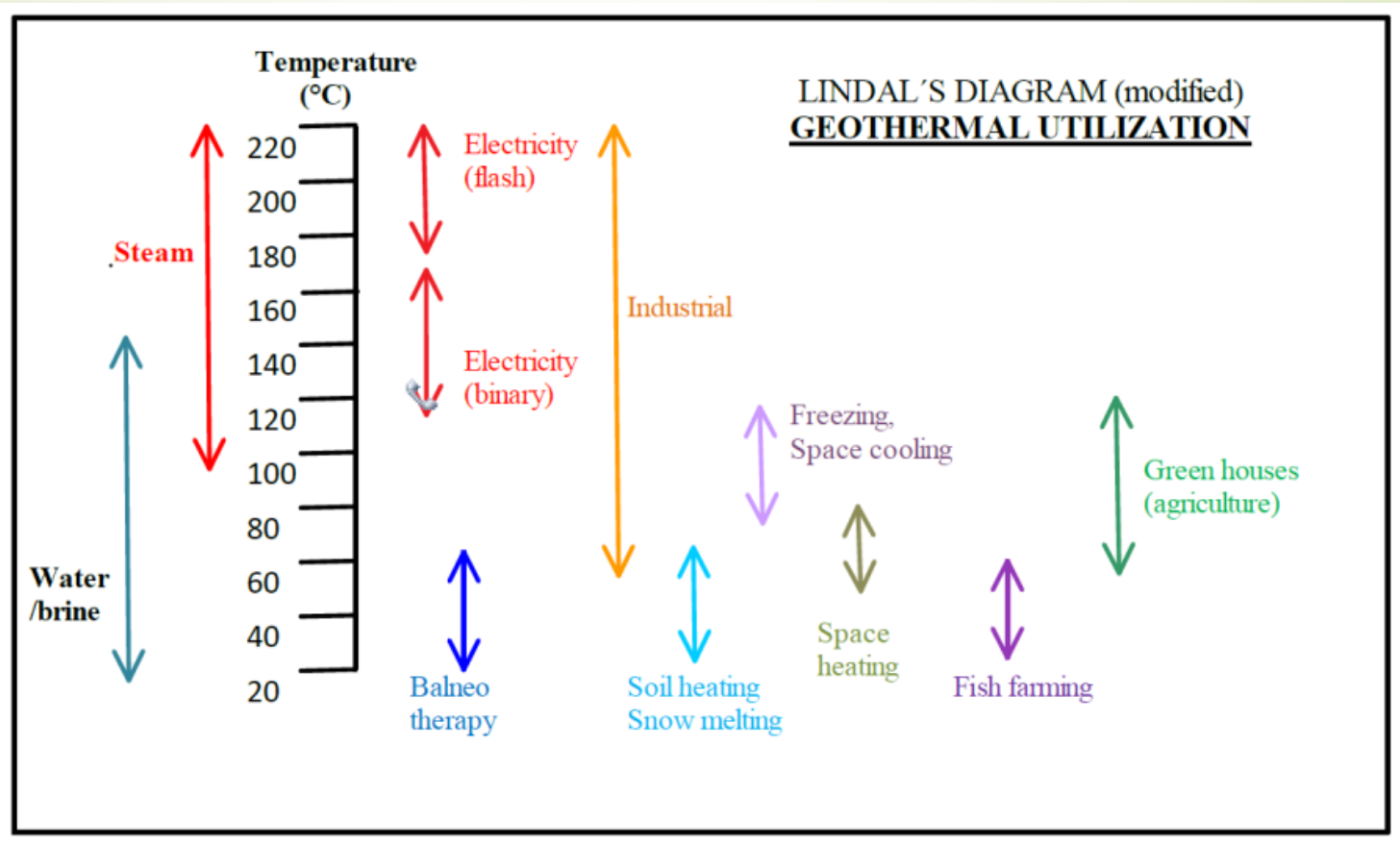
- Of **national interest**, when the temperature exceeds 90 °C.
- Of **local interest**, when the temperature varies between 30 ÷ 90°C

Geothermal energy



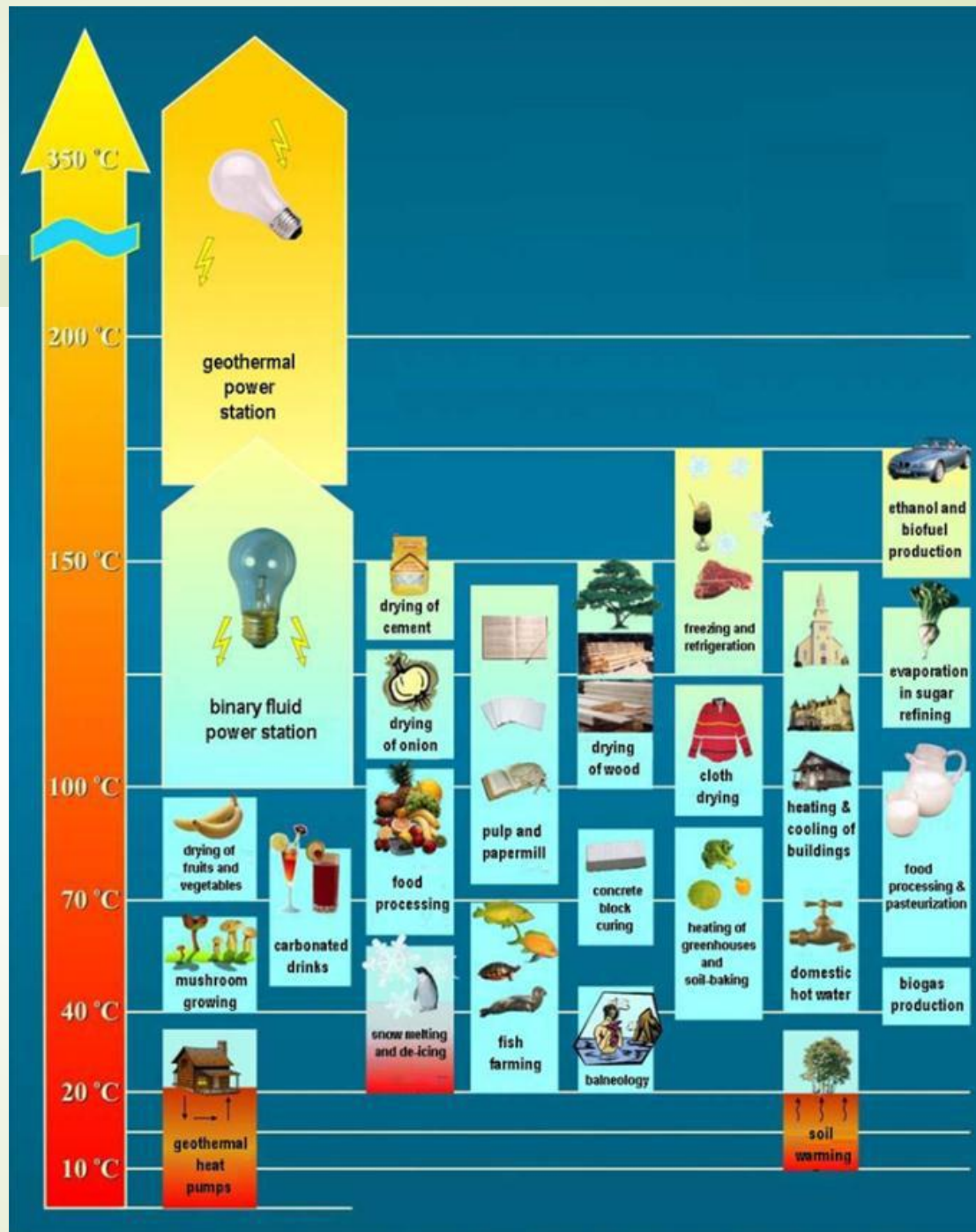
Source: <http://www.geni.org/globalenergy/library/renewable-energy-resources/geothermal.shtml>

Geothermal use and technologies



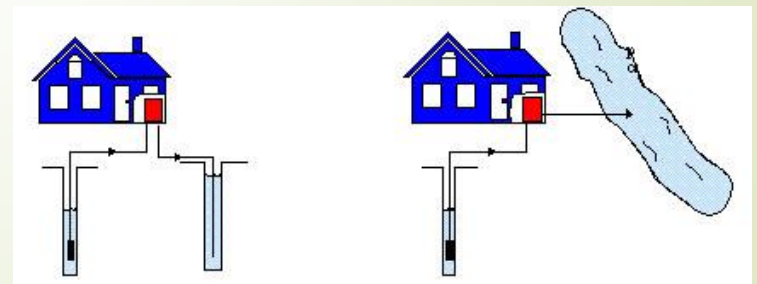
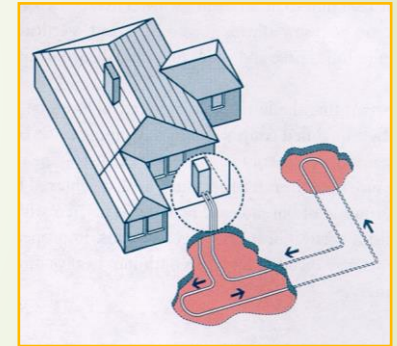
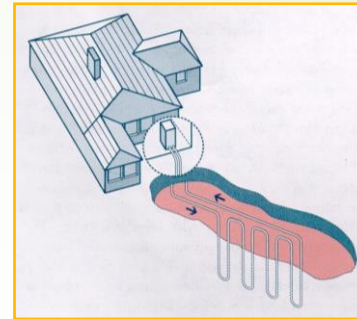
Source: Dickson, M. H., & Fanelli, M. (2003). *Geothermal Energy: Utilization and technology*. Bangalore, India: UNESCO Publishing

Geothermal use and technologies



Shallow Geothermal energy

- **Shallow** and **deep geothermal** exploitation could both play an important role in the reduction of greenhouse gas emission and environmental pollution.
- **Shallow Geothermal energy** is called the heat of the geological formations and the water, surface water and groundwater, which are not classified as geothermal potential.
- It may also be defined as the heat that exists below each subsurface, heat of lakes, rivers and the sea, with temperature less than the annual average temperature of the air in the area normally equivalent below 25°C.



Shallow Geothermal energy

- The exploitation of normal geothermal energy takes place through open and closed loop **Geothermal Heat Pumps** (Ground Source Heat Pumps, GSHP) or/and **underground thermal energy storage (Underground Thermal Energy Storage, UTES)**.
- European Union is a technology leader, especially in hydronic heat pumps and large heat pumps.
- The announced **heat pump action plan** by European Commission envisages at least **10 million additional heat pumps by 2027 and 30 million by 2030**.
- The plan encourages use of small and large geothermal heat pumps in buildings, heating and cooling systems, and in industry.



Geothermal District Heating - Parts

- District heating comprises the following parts:
 - **Heat generation source**, which includes geothermal fluid facilities, pumps, measuring instruments, etc.
 - **Pipeline network**, for the transfer of heat in the form of hot water.
 - **Delivery substations**, where the heat is transferred from the central network to the individual buildings.
 - **Building piping**, where heat is transferred from building substations to radiators and other consumers.



Geothermal District Heating - Benefits

- Some of the benefits of district heating are:
- **Space saving** in the buildings by the removal of the engine room, fuel tank, chimney.
- **Minimization of maintenance costs** of consumer facilities.
- **Minimal staff**
- Fire safety
- In the facilities combined with electricity production, **cheaper electricity**.
- Geothermal energy is a **long lasting, cost-effective** and **weather-independent** source of renewable energy.

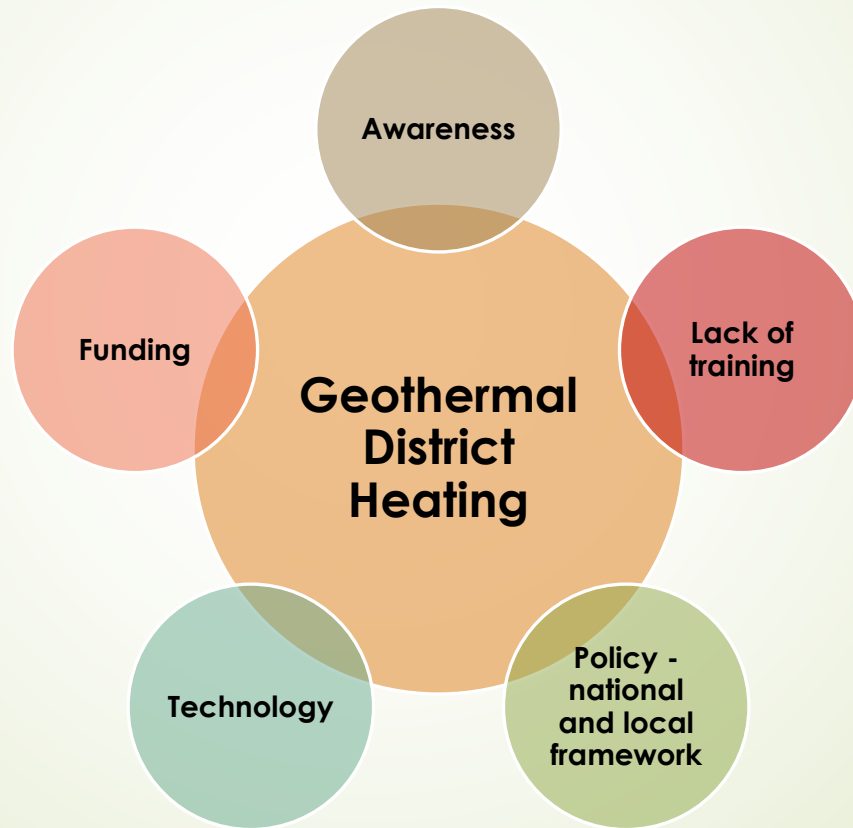


Geothermal District Heating – Factors to consider

- The **economics** of the installation.
- The **geographical location** of the heat source:
 - if possible the source of heat generation should be centrally located, which is not always possible
- The adequate **sizing**.
- Ensuring water.
- **Pricing configuration**.
- The imposition or not of **mandatory connection**.
- The production of thermal energy can be autonomous or combined with parallel production of electricity (cogeneration of electricity - heat in combined cycle stations - CHP).

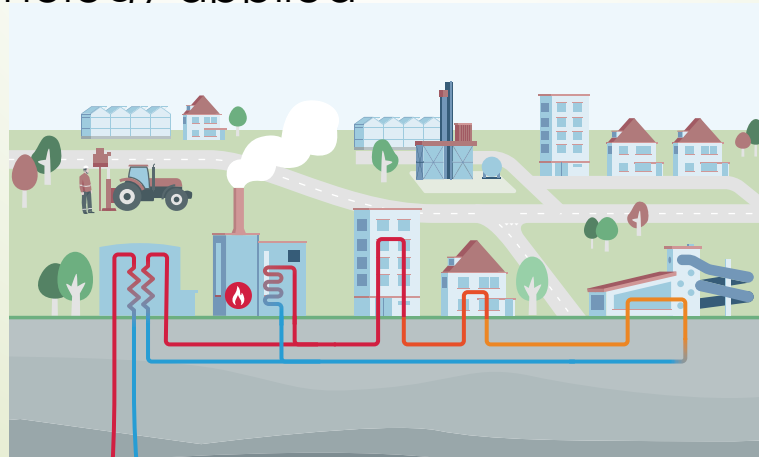


Geothermal District Heating – Factors to consider



Sustainability and Geothermal Energy

- **Sustainable** production of **geothermal energy** secures the longevity of the resource, at a lower production level.
- **Reinjection** enhances the sustainability level of geothermal development.
- Sustainability of geothermal exploitation in a given area depends on :
 - duration of the project;
 - rate and quantity of heat extraction – assure sustainability through reinjection of the fluid;
 - technology applied



Why Geothermal district heating in Municipalities?

- Geothermal district heating systems:
 - provide cheap and **clean renewable energy** at moderate maintenance costs;
 - generate **steady revenue for the municipality**, adding good potential for regional development as well.
 - can **contribute significantly to EU and national energy targets**, through a reduction in carbon emissions and a greater uptake in renewable energy.

The current European funding programmes offer calls for tenders to utilise the available geothermal capacities and thus increase the share of renewables in Municipalities energy mix.



Statistics - Future trends in EU

- According to the **European Geothermal Energy Council (EGEC)**, geothermal energy is able to satisfy around 25 % of heating and cooling consumption in Europe and around 10 % of electricity.
- More than 240 Geothermal District Heating plants in Europe.
- The geothermal district heating and cooling sector has seen a 6 % growth rate in installed capacity, reaching 2.2 GWth in 2021.
- According to the **International Renewable Energy Agency (IRENA)**, geothermal energy provides electricity generation in more than 30 countries worldwide, reaching a total installed capacity of around 16 GW in 2021.
- Switching from fossil fuels to geothermal energy can decarbonise up to 25 % of the EU population's energy needs and reduce energy bills.

Lesvos Island



- Non-Interconnected Island
- 85,330 permanent citizens
- 1,639 km² Island area

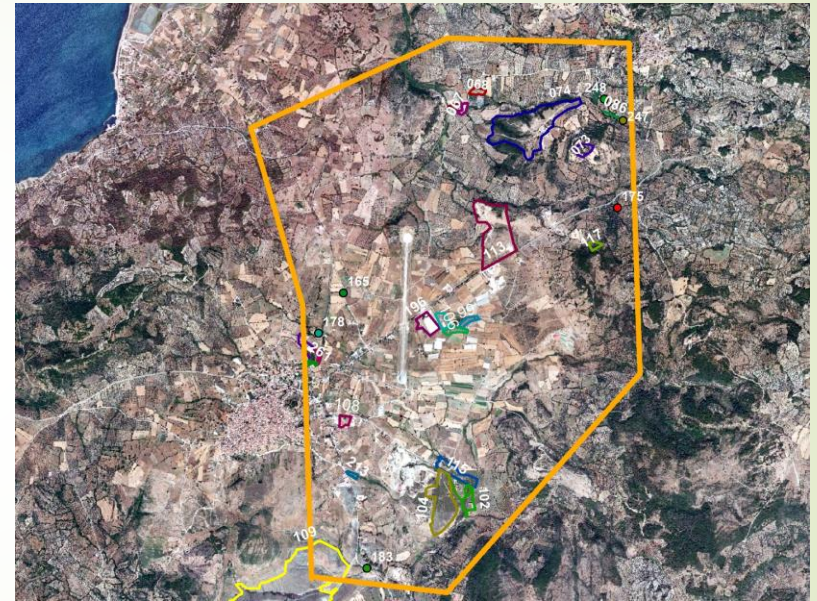
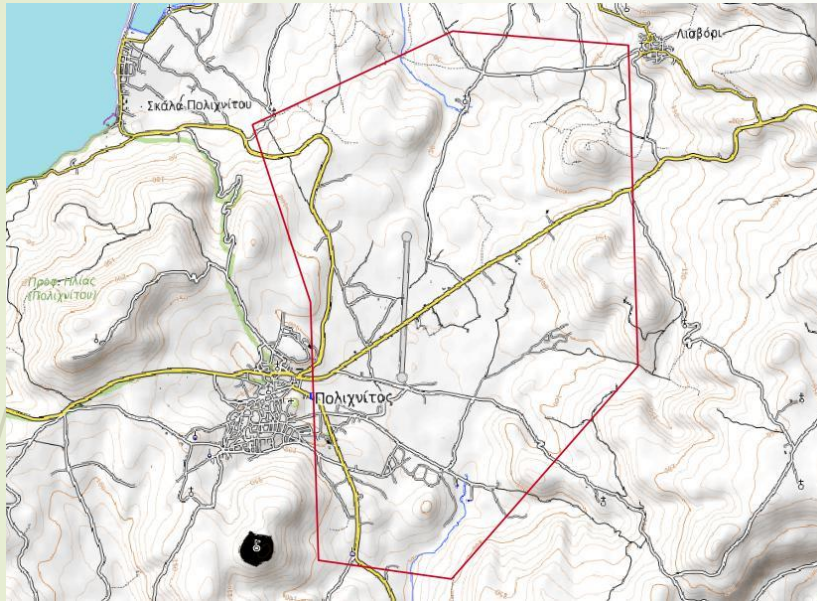
**Polichnitos
settlement**

The Vision of the Municipality of D. Lesvos

- The creation of a program to upgrade the standard of living of the Municipality as well as the development of the local economy.
- ↓
- The exploitation of a natural resource, the geothermal field of Polichnitos, which as a Renewable Energy Source is a key element of the energy and environmental policies, which are being shaped today in the European Union (EU), but also in the wider international arena.



Polichnitos Geothermal Field



- Position: southern and central part of the island of Lesbos and at a distance of about 45km WNW of the city of Mytilene.
- Area ~10 km²

Polichnitos Geothermal Field

- The area of Polichnitos is one of the three areas of Lesvos with special geothermal interest.
- In the axis of the elongated thermal anomaly found in the area of the hot springs of Polichnitos - Lisvori, 5 large diameter boreholes, 120-150m deep, with a distance of 500m between them, were executed. approximately, in order to find hot fluids for their use in heating greenhouses, with satisfactory results.
- Their total supply is expected to reach approximately 300 m³/h and the average temperature of the fluid is expected to reach 70.0°C.
- In a part of the flow, around 150 m³/h, the temperature of the fluid reaches up to 92.5°C.
- As part of the implementation of the "THERMOPOLIS" research project, a production well (YG14a) was drilled at an altitude of z=72m, with a final drilling diameter of 12¼" and a tubing diameter of 8 5/8".

Polichnitos Geothermal Field

- ▶ During the long-term monitoring of the geothermal field, it was observed that there are changes in the level and consequently in the hydraulic characteristics of the system.
- ▶ Therefore, the supply estimates only meet planning needs.
- ▶ Hence the necessity to reassess the possibilities of drilling in hydraulic and chemical terms.

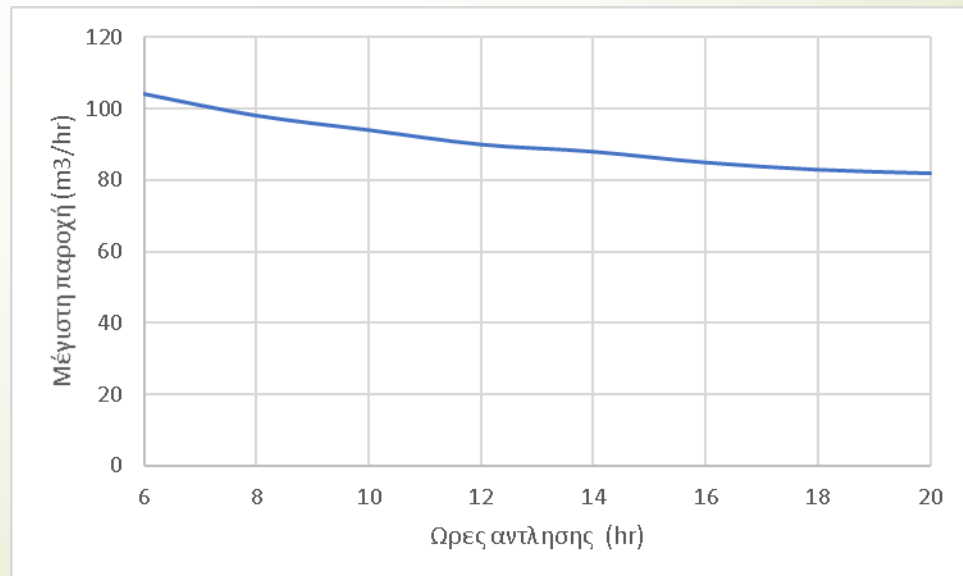
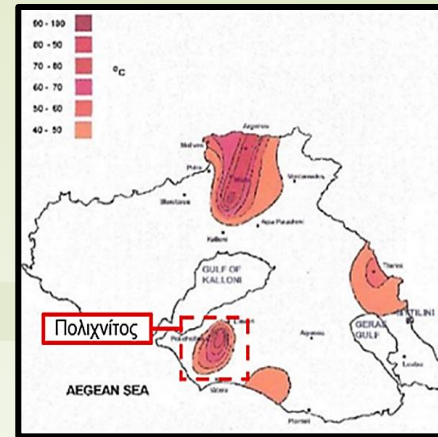


Figure for an existing well

The project in brief

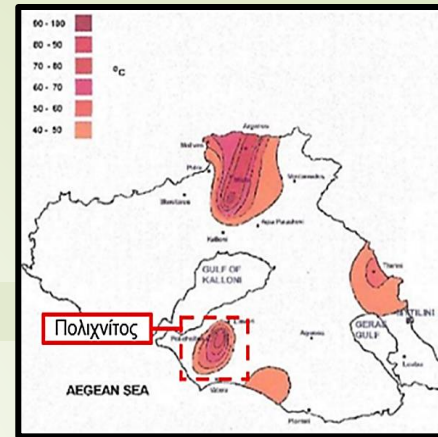


The heat production and distribution network concerns the full development and exploitation of the geothermal field in terms of central networks and potential consumption.

It is divided into the following parts:

- The **1st part** concerns the **district heating network of the settlement** with a length of about 3,600 meters and
- The **2nd part** concerns the **district heating network of greenhouses and other activities (thermalism, touristical use, ...)** in the area of the plain with a length of about 3,700 meters.
- The **pumping and re-injection network** of the geothermal fluid is the **third part** with a length of about 1,500m, and it is being developed in such a way as to protect the environment and the sustainability of the field.

The project in brief



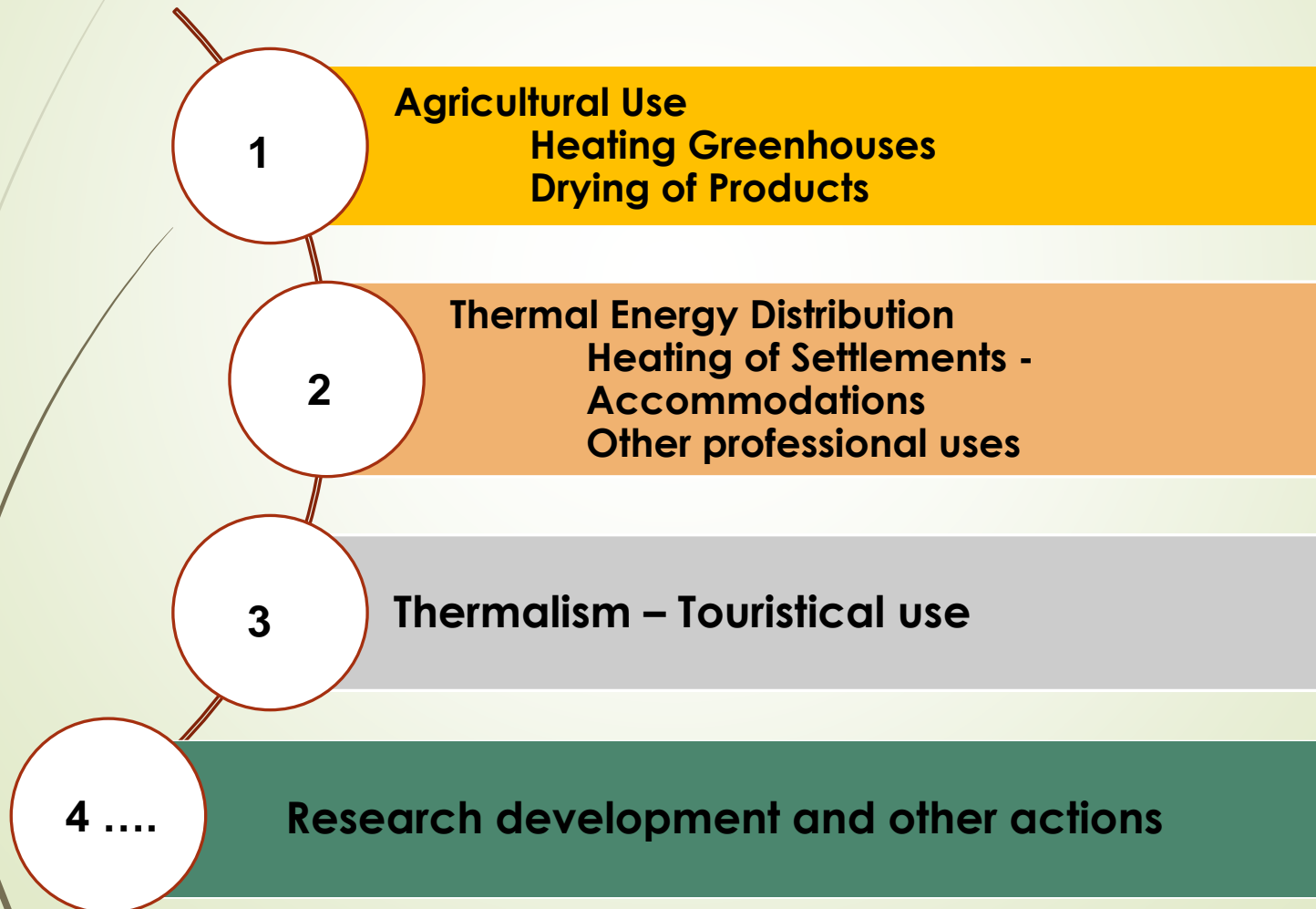
- The District Heating Network will use geothermal fluid (**85-90°C, 300 m³/h**) extracted from 1-4 boreholes, passed through plate heat exchangers to transfer its thermal energy to secondary closed circuits for distribution, before re-injecting the cooled fluid into the ground.
- The Municipality is considering establishing an **Energy Community (EC)** involving local residents and businesses for managing the project. This EC, if established, would also look into incorporating other renewable sources, such as photovoltaic stations for power, electric vehicle charging stations, and biomass utilization.

Geothermal field product exploitation



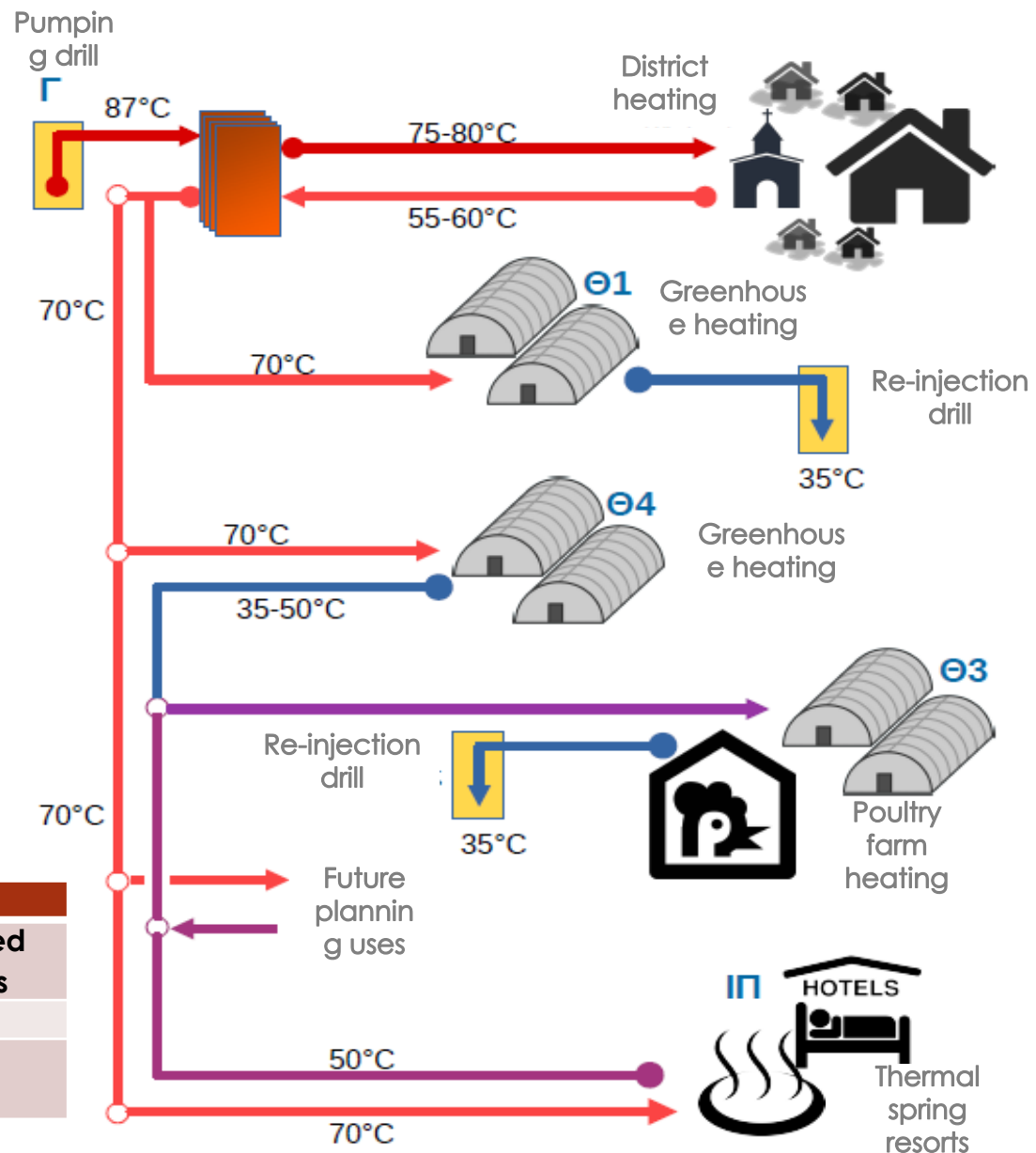
Network development area and locations of boreholes, distribution hubs, etc.

Geothermal field product exploitation



Geothermal energy exploitation scheme

Wells		
Item	Technical Characteristics	Required Pieces
Pumping Wells	15,5" - 150m	4
Reinjection Wells	18" - 120m	6



Geothermal field product exploitation

Agricultural use

- ▶ **Heating Greenhouses**
- ▶ Until today, the main use of the field was the heating of greenhouses (fruit and vegetable gardens and flower gardens).
- ▶ The goal is therefore their development and expansion in order to increase production and profitability, exports, etc.
- ▶ The operating greenhouses will use heat from the growing grid through the geothermal hot fluid distribution system.
- ▶ After the operation of the field, the demand is expected to increase and its coverage will result from the drilling of other wells.

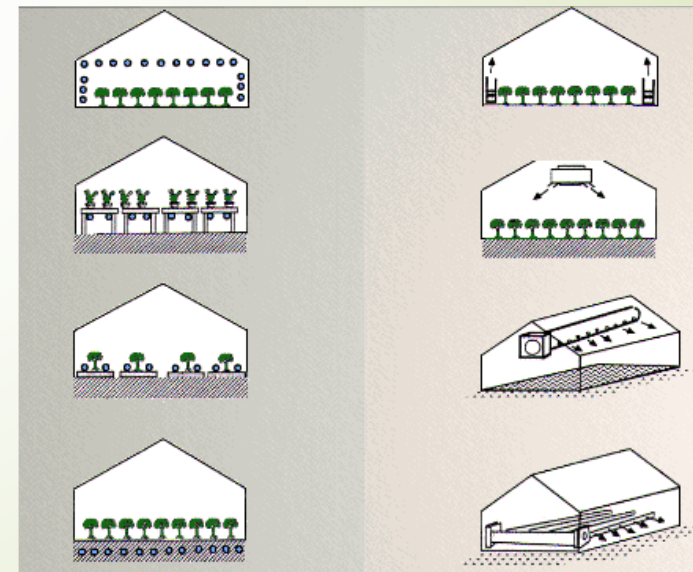


Geothermal field product exploitation

- **Agricultural use**
- **Heating Greenhouses**
- While in the past the return of the geothermal fluid was done by simply releasing the fluid to the aquifer through precipitation, now the reintroduction of the fluid will be done through drilling in a location characteristic of the field.



- In this way, the environmentally friendly utilization and sustainability of the field is protected without disturbing the natural environment and the ecosystem.



Geothermal field product exploitation

Agricultural use

- ▶ **Drying of Products (optional)**
- ▶ It is used in dryers that operate using hot air. The difference between geothermal dryers and conventional dryers is the use of geothermal energy to heat the air entering the dryer.
- ▶ Agricultural products that are dehydrated using geothermal fluids are onions, garlic, apples, pears, bananas, mangoes, pineapples, seaweed, timber, etc.



Geothermal field product exploitation

Thermal Energy Distribution - Teleheating

Open loop

- Geothermal fluid is pumped from the production well, gives up its heat through the central heat exchanger (titanium exchanger) in the second circuit and finally is injected into the re-injection well.

Central closed water circuit

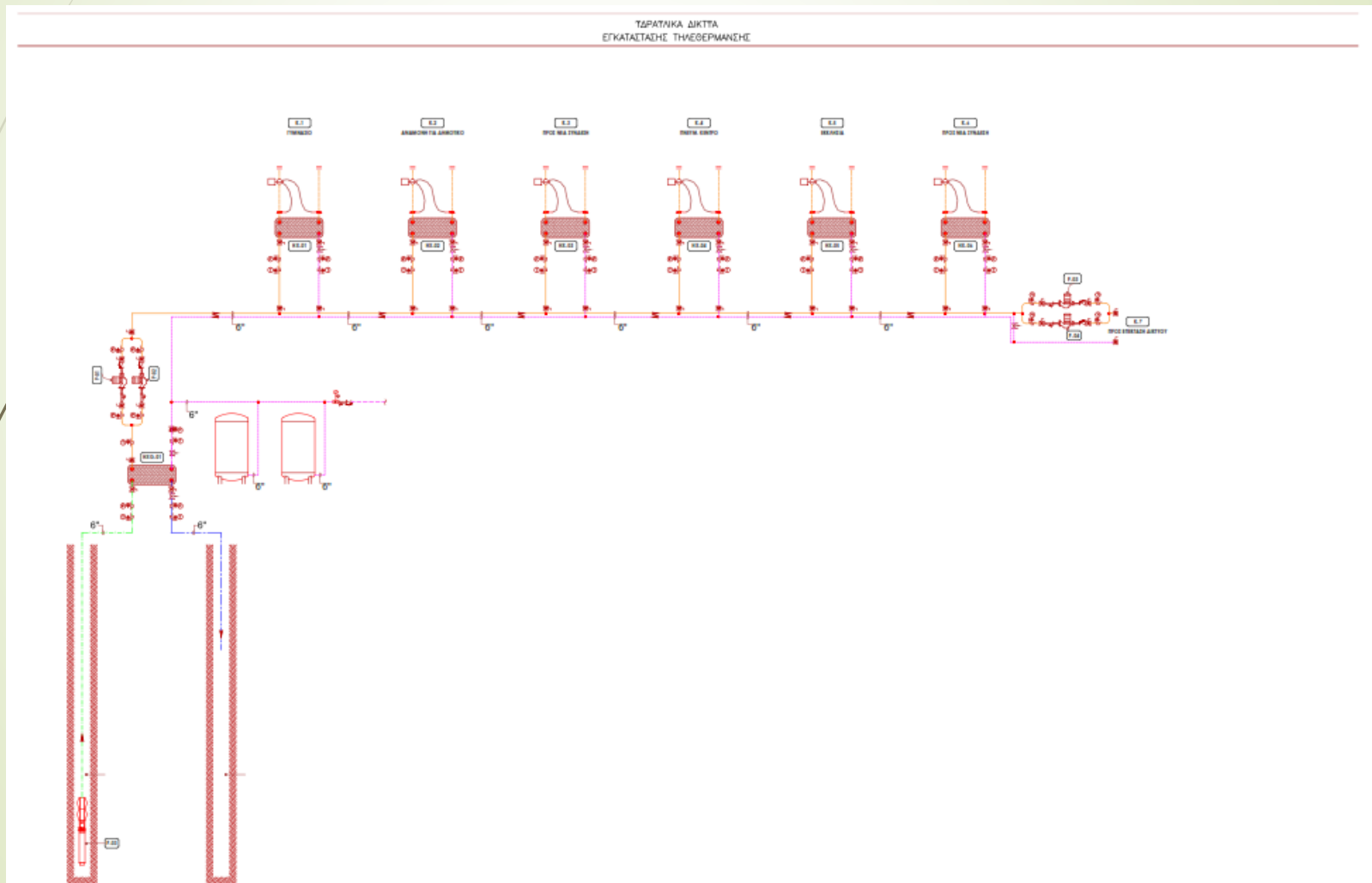
- For the transfer of the heat, which has been attributed from the central heat exchanger to the individual exchangers of each building.

Closed loops

- For the transfer of heat, which has been attributed to the individual heat exchangers in each building.
- The individual closed circuits are connected in parallel with the central closed water circuit, for heat transfer.

Geothermal field product exploitation

Thermal Energy Distribution - Teleheating



Geothermal field product exploitation

Thermal Energy Distribution - Teleheating

– existing connections

No	Building	Installed power kW _{th}	Flow rate m ³ /h
1	Church	70	4
2	Cultural centre	80	5
3	Gymnasium - Lyceum	100	6
	Total	250	15

Geothermal field product exploitation

Thermal Energy Distribution - Teleheating – NEW connections

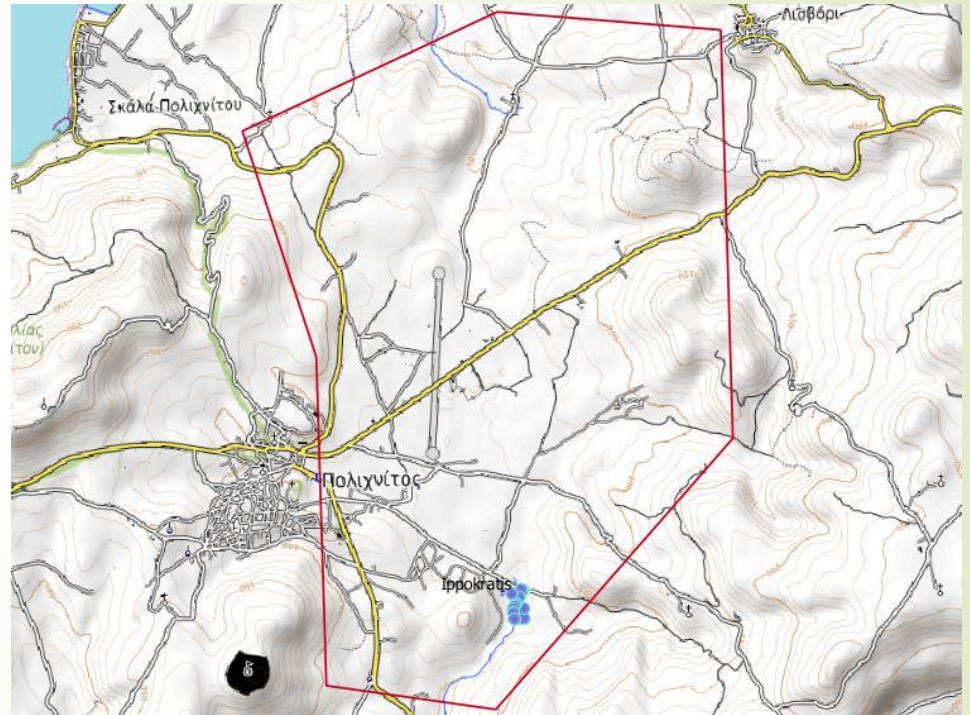
No	Building	Installed power kW _{th}	Flow rate m ³ /h
1	Health Centre	250	15
2	Old Town Hall	20	2
3	New Primary School & Police	80	5
	Total	350	22

- And ... in the Settlement - Residents & other professional activities

Geothermal field product exploitation

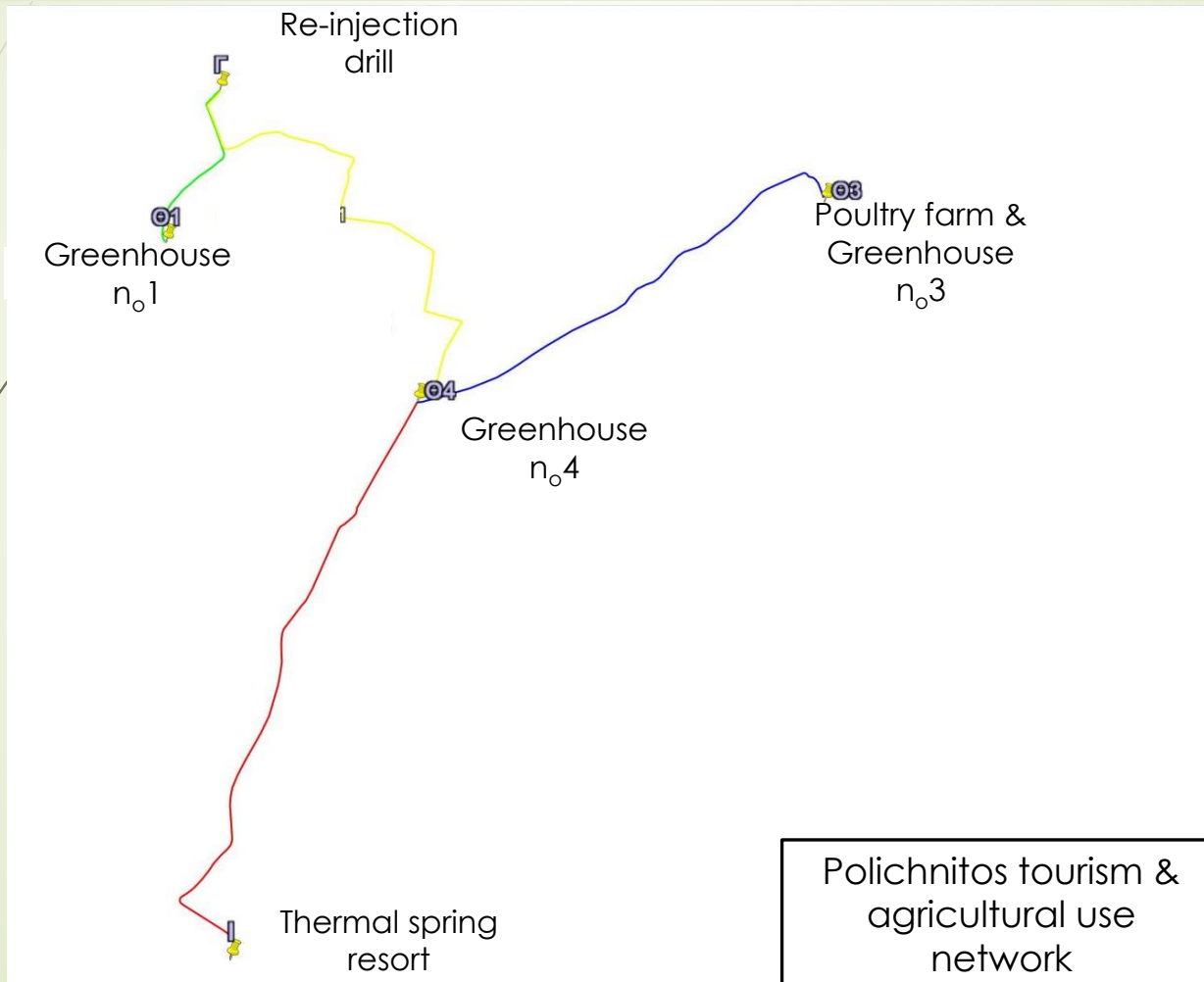
Thermalism

- ▶ Hot water springs appear in the southern part of the field.
- ▶ The municipal spring "Hippokratis" has been recognized as a thermal spring based on YA 4844 1291B/02.04.2021



The content of the natural water resource (Cl, Na, K, B) and its temperature (superheated) make it ideal for Bath Therapy with the method of whole-body (outside the head) immersion in water, with modern guided exercise in water for musculoskeletal conditions system, rheumatic and autoimmune diseases as well as skin diseases (free of microbial load).

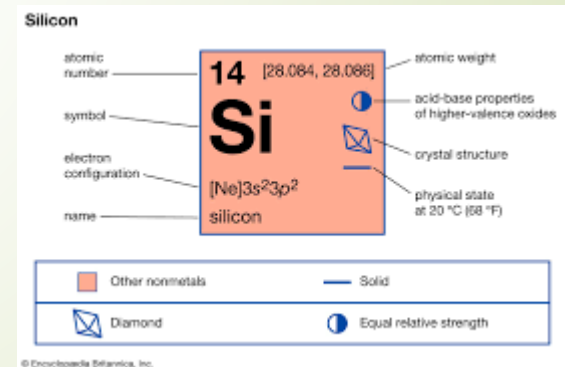
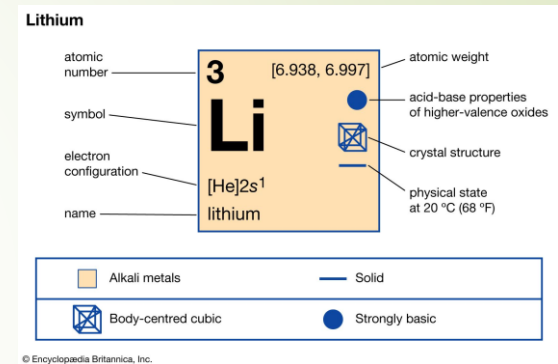
Tourism & agricultural use – open loop network



Geothermal field product exploitation

Mining exploitation

- Many components of geothermal fluids have value provided they can be separated and purified. The recovery of an exploitable material from a geothermal source depends on the condition and chemistry of the host rock.
- The interest in the Polichnitos field is focused on the extraction of **silicon** and **lithium***, elements that have the maximum potential to be extracted, based on the chemistry of the fluid, and are of economic interest.

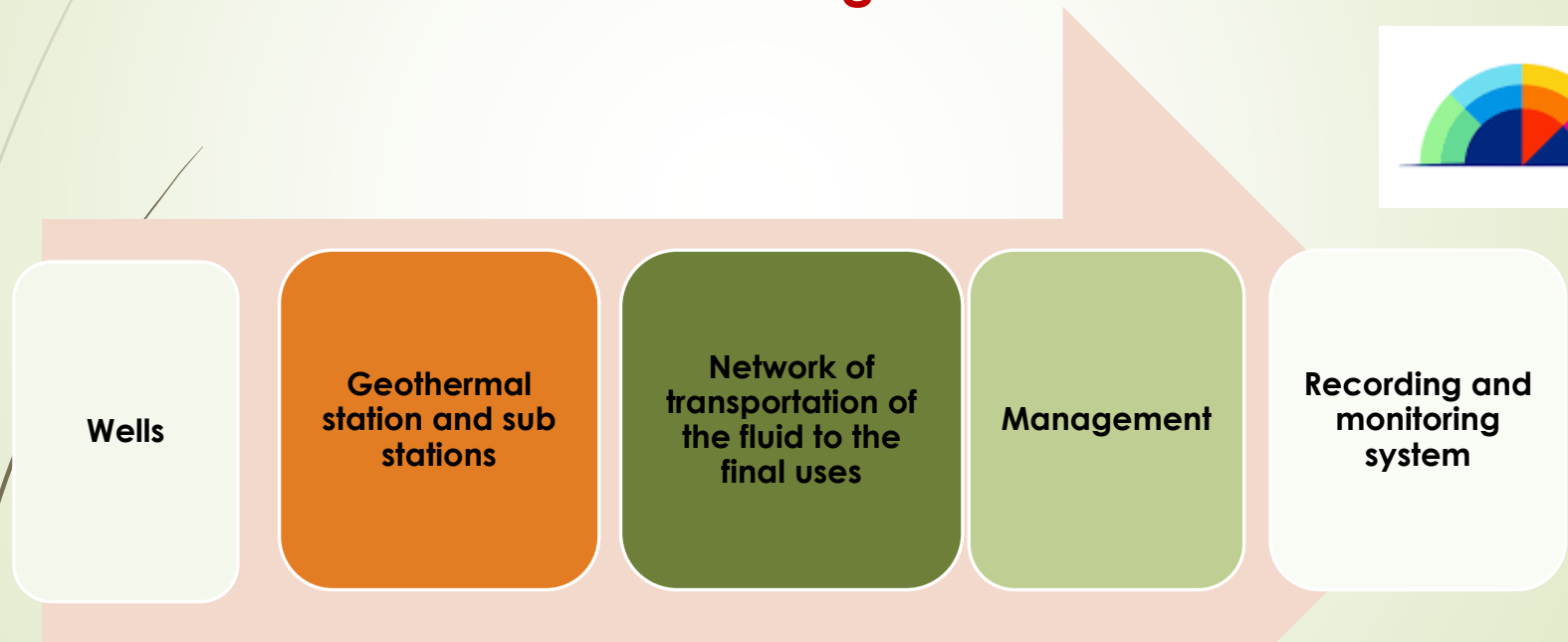


*today its exploitation is not sufficient for the percentages of its presence but the estimates after the development of research are particularly interesting at a global level

Geothermal field product exploitation

Thermal Energy Distribution - Teleheating

Stages



Key results



RES heat exported to District Heating	21.784	MWh/yr
RES-based heating installed Power	30,40	MW



GHG saved per year	5147	tonCO ₂ eq
Reduction in Annual Fossil Fuel Consumption (Primary)	19.278	MWh/year

Ways to stimulate geothermal district heating projects

- ✓ Increase awareness on the potential applications and benefits;
- ✓ Simplify regulations and improving national and local framework;
- ✓ Attracting financing;
- ✓ Transfer best practices;
- ✓ Train energy officers on geothermal district heating technologies.





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Thank you for your attention!