# Geothermal Energy Use, Country Update for Cyprus

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## ABSTRACT

This paper presents in brief the use of geothermal energy in Cyprus. The past and late geothermal exploitations have confirm that there is no high- or low-enthalpy geothermal resources in the island, and the only use of geothermal energy is limited to the shallow geothermal applications. The installed ground source heat pump capacity in 2018 is estimated to 10.2 $MW_{th}$, and it is slightly increased compared to with the figures presented in EGC2016. However, the energy statistics for Cyprus indicates that the total energy use from ground source heat pump systems remain constant at 19 GWh/a. Overall, in the last three years the geothermal heat pump market has been limited for the new applications and the main activities are restricted to the maintenance of the existing installations. This trend is forecasted to be continued in the next years as currently the market turns the interest into the competitive air-source heat pump systems.

## 1. INTRODUCTION

Cyprus can be considered as a poor country regarding the availability of geothermal reservoirs, since it is located at in an inactive tectonic area, in which no high- or low- enthalpy resources has been discovered. Thus, and until now, the ground source heat pump systems are the only locally available technology being in use for the exploitation of geothermal energy.

It was estimated that by the end of 2017 there were about 175 installations of geothermal heat pumps, introducing a total installed capacity of 10.2 $MW_{th}$. This figure is slightly increased compared to the data presented at the EGC2016 (Michopoulos and Zachariadis, 2016), but today the market remains static. The most common shallow geothermal system in Cyprus is the vertical closed loop one that occurs at the 95% of the existing applications, while the remaining 5% is served by horizontal loop, open loop, and combined systems.

This work reviews the use of ground source heat pump systems in Cyprus, focusing on the market behaviour and trends since EGC2016, and tries to project the near future activities on the horizon of the next three-year period.

## 2. ENERGY CONSUMPTION AND PENETRATION

The annual gross inland energy consumption in Cyprus has peaked in 2008 at 2,897.2 ktoe, after 18 years of almost continues increase. Figure 1 shows that between 2009 and 2013 energy consumption has rapidly decreased at 2,188.2 ktoe indicating an overall 24.5% reduction in comparison to the 2008 consumption. The last three years (2014-2016) of the available energy statistics, shows that the annual gross inland consumption start to increase again and it has already cover about 10% of its recent decrease. In 2016, petroleum products contributed the 93% of the inland energy consumption, as Cyprus is an isolated island without any other energy or power interconnection with neighbourhood countries.

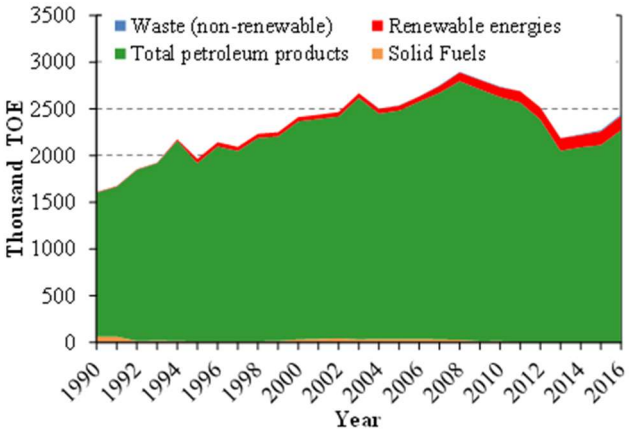


**Figure 1: Gross inland energy consumption (in ktoe) by fuel type for the period 1990-2016 (source: Eurostat, 2018a).**

Renewable energy sources accounted for 6.26% of the gross inland consumption in 2016. Traditional solar thermal systems have the main share of 45.1% in the renewable energy sources, following by wind energy, as seen in Table 1. The exploitation of geothermal energy remains limited and constant over the last 4 years, and it holds a contribution of 1.0% in the total energy supply. It is worth noticing that between 2014 and 2016 photovoltaic systems have rapidly increased their penetration to market by 42.4% due to the policy priorities with the aid of promotion activities and generous financial grand schemes.

**Table 1: Contribution of different energy sources to total renewable energy production in Cyprus in 2016 (Eurostat, 2019)**

| Energy Source | Energy Production (ktoe) | % share |
|---|---|---|
| Wind | 19.5 | 12.8 |
| Solar Thermal | 69.0 | 45.1 |
| PV | 12.5 | 8.2 |
| Solid Biofuels | 10.0 | 6.5 |
| Biogas | 11.8 | 7.7 |
| Biodiesel | 8.9 | 5.8 |
| Geothermal | 1.6 | 1.6 |
| Charcoal | 9.6 | 6.2 |
| Renewable Municipal Waste | 10.1 | 6.6 |
| Total | 152.9 | 100 |

A breakdown of final energy consumption in Cyprus by sector for 2016 is depicted in Figure 2. Transportation was the main energy consuming sector with a 53.0% share. Residential sector is the second energy intensive consumer with a share of 18.6%, following by service and industry sectors with 12.8% and 21.1%, respectively.

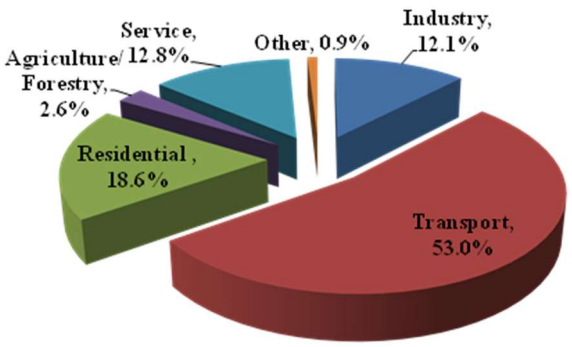


**Figure 2: Distribution of final energy consumption by sector in Cyprus in 2016 (source: Eurostat, 2018b).**

## 3. GEOTHERMAL EXPLOITATION AND POTENTIAL

The first geothermal exploitation in Cyprus was performed in late 1960s, resulting that there is no geothermal potential across the island (Morgan, 1973). During the next decades and until 2010 the exploitation of geothermal sources was almost absent. Starting from 2010 and till 2014 two research projects funded by Research Promotion Foundation of Cyprus has been performed, focused on mapping of ground temperatures and soil's properties in specific areas of the island. The results of these projects confirm that there is no direct geothermal potential in Cyprus, apart from the use of ground source heat pump systems.

## 4. DIRECT USES

### 4.1 Background

The utilization of geothermal energy in Cyprus includes only ground source heat pumps installations in residential and commercial buildings. There is also a pilot installation in a greenhouse.

### 4.2 Greenhouse

The use of geothermal energy in agriculture applications in Cyprus is limited to one pilot greenhouse installation in the facilities of the Agricultural Research Institute (ARI) in Zygi. The installation is in operation from 2014 and serves the heating and dehumidification needs of a 216 $m^2$ traditional greenhouse. The installed capacity of the system is 70 $kW_{th}$, and the annual use of shallow geothermal energy is estimated at 30 MJ/a.

### 4.3 Ground source heat pumps

The installation of ground source heat pump systems in Cyprus started in the middle of the past decade and maximized during the 2009-2011 due to a generous financial support scheme that has been lunched by the central government. In recent years, the economic recession in combination with the competition of the new generation of the air-source heat pump units have limited the interesting for new installations.

In early 2018, the author records 163 application of ground source heat pump across the island[1] with the total installed capacity of 9.6 $MW_{th}$. The total number of the GSHP installations is estimated to 175 with an installed capacity of about 10.2 $MW_{th}$. This differentiation is due to the fact that some small construction companies or partially involved ones have post-pone their business in past years. As a result, the exact number of the projects that they have been involved is practically unknown, and partially reported by the remaining companies, being responsible for the maintenance of such systems.

The majority of the recorded installations, 154 of 163, refer to vertical closed loop systems accounting for more than 1,600 boreholes, and an estimated total drilled length of more than 150 km. These applications are mainly installed in residential buildings, while only 12 of that belong to commercial and service buildings. The total number of ground source heat pump systems includes also three horizontal closed loop systems, two open loop systems, and three systems that combine vertical loops and horizontal or open loop ones.

An interesting and promising installation of a ground source heat pump system has finalized in 2017 and it is expected to start its operation in the next year. A vertical closed loop system contains 220 boreholes at the depth of 125 m is constructed as a part of heating and cooling system of the new facilities of the Faculty of Engineering at the new campus of University of

[1] in the areas that are controlled by the Republic of Cyprus

Cyprus. This installation is apart the largest one in Cyprus and is going to operate in parallel with the district heating and cooling network that serves the energy needs of the new campus. In addition to the energy conservation, the installation will be used for the education and training of young engineers and also as an experimental and research unit for the young researchers and the academic personnel. It is estimated that the annual energy production is going to be 2.65 GWh that it is equal to 14% of existing energy production for the ground source heat pump systems in Cyprus.

## 5. PROFESSIONAL GEOTHERMAL PERSONNEL

The number of professional personnel involved in geothermal activities in Cyprus has decreased during the last years. Today, in the private sector there are three (3) companies maintaining still equipment for geothermal installations, instead of fourteen (14) that existed in 2010. This situation affects also the number of employees that are working to the geothermal energy sector. In 2010 there are more than 200 employees working on fulltime or part-time basis contracts in shallow geothermal projects. Today, there is no employment in this sector, and the companies hiring seasonally employers from other sectors and only in case of a new project. In contrast, the public sector still employs three persons who, among other duties, have to assist in national geothermal activities. These are employed by the Ministry of Energy, Commerce, Industry and Tourism and the Ministry of Agriculture.

In addition, it should be noted that between 2015 and 2019 the research activities in geothermal energy are very limited due to the absence of funding projects. Today, the academic and research personnel working part-time in this topic are no more three people, including one Ph.D. student.

## 6. LEGISLATIVE ISSUES

In last four years (2016-2019) the legislation, in Cyprus, about the use of geothermal energy remains the same. Although, there are training courses accompanied with certification schemes for geothermal heat pump installers which exist from 2017, the interest of the employers and employees remains limited. This evidence introduces till now the lack of certified specialists for the installation and maintenance of the ground source heat pump systems.

It is worth noticing that in 2018 a financial supporting scheme for energy interventions in residential buildings was lunched by the Ministry of Energy, Commerce and Industry. Under this scheme, a series of intervention measures was eligible for subsidization and among them the installation of a ground source heat pump system was an option. This scheme was finalized by the middle of the year, due to the absorption of the available fund, but there was no interest about the installation of a shallow geothermal system.

## 7. CONCLUSIONS

The use of geothermal energy in Cyprus is limited to space heating and cooling applications mainly for the residential buildings. In the last three years the ground source heat pump market remained static, as it is estimated that today the total installed GSHP capacity is 10.2 $MW_{th}$ compared to 10 $MW_{th}$ in 2016. The utilization of geothermal energy however, remains constant at 1.6 ktoe, meaning that the existing installations continue their successful operation. It is estimated that these figures may remain the same in the next years as the current market trends indicate that the future expand of the market is restricted by the competition of the air-source heat pump systems and by the high associated initial construction cost that the geothermal heat pump systems introduce.

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**Tables A-G**

**Table A: Present and planned geothermal power plants, total numbers**

| | Geothermal Power Plants | | Total Electric Power in the country | | Share of geothermal in total electric power generation | |
|---|---|---|---|---|---|---|
| | Capacity ($MW_e$) | Production ($GWh_e$/yr) | Capacity ($MW_e$) | Production ($GWh_e$/yr) | Capacity (%) | Production (%) |
| In operation end of 2018 * | - | - | 1,478* | 4,495.6* | - | - |
| Under construction end of 2018 | - | - | - | - | - | - |
| Total projected by 2020 | - | - | - | - | - | - |
| Total expected by 2025 | - | - | - | - | - | - |
| In case information on geothermal licenses is available in your country, please specify here the number of licenses in force in 2018 (indicate exploration/exploitation if applicable): | | | | | Under development: - | |
| | | | | | Under investigation: - | |

* These numbers corresponds to the year of 2017

**Table B: Existing geothermal power plants, individual sites***

Geothermal power plants are not available in Cyprus

**Table C: Present and planned deep geothermal district heating (DH) plants and other uses for heating and cooling, total numbers***

Geothermal district uses are not available in Cyprus

**Table D1 and D2: Existing geothermal district heating (DH) plants, individual sites***

Geothermal district heating plants and other direct uses are not available in Cyprus

**Table E: Shallow geothermal energy, ground source heat pumps (GSHP)**

| | Geothermal Heat Pumps (GSHP), total | | | New (additional) GSHP in 2018 | | |
|---|---|---|---|---|---|---|
| | Number | Capacity ($MW_{th}$) | Production ($GWh_{th}$/yr) | Number | Capacity ($MW_{th}$) | Share in new constr. (%) |
| In operation end of 2018 * | 175* | 10.2** | 19 | - | - | - |
| Projected total by 2020 | 1 | 1.4 | 2.65 | | | |

* estimate, reported 163

** estimate, reported 9.6 $MW_{th}$

**Table F: Investment and Employment in geothermal energy**

| | in 2018 | | Expected in 2020 | |
|---|---|---|---|---|
| | Expenditures (million €) | Personnel (number) | Expenditures (million €) | Personnel (number) |
| Geothermal electric power | - | - | - | - |
| Geothermal direct uses | - | - | - | - |
| Shallow geothermal | 3 | 3* | 3 | 3* |
| **total** | **3** | **3*** | **3** | **3*** |

* Part-time personnel.

**Table G: Incentives, Information, Education**

| | Geothermal electricity | Deep Geothermal for heating and cooling | Shallow geothermal |
|---|---|---|---|
| Financial Incentives – R&D | none | none | none |
| Financial Incentives – Investment | none | none | DIS, LIL |
| Financial Incentives – Operation/Production | none | none | none |
| Information activities – promotion for the public | no | no | no |
| Information activities – geological information | no | no | yes |
| Education/Training – Academic | yes | yes | yes |
| Education/Training – Vocational | no | no | yes |

| Key for financial incentives: | | | | | |
|---|---|---|---|---|---|
| DIS | Direct investment support | FIT | Feed-in tariff | -A | Add to FIT or FIP on case the amount is determined by auctioning |
| LIL | Low-interest loans | FIP | Feed-in premium | | |
| RC | Risk coverage | REQ | Renewable Energy Quota | O | Other (please explain) |