ANALYSIS OF THE CURRENT REGULATORY FRAMEWORK OF THE GSHPs GREEK MARKET

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1. Introduction:

Greece is a country located in the Southern Europe, on the southern end of the Balkan Peninsula. The country ranges approximately in latitude from 35°00′N to 42°00′N and in longitude from 19°00′E to 28°30′E. Greece is surrounded on the north by Bulgaria, the Republic of Macedonia and Albania; to the west by the Ionian Sea; to the south by the Mediterranean Sea and to the east by the Aegean Sea and Turkey. It has a total area of 131,940 km². Out of this, land area is 130,800 km², internal waters (lakes and rivers) account for 1.140 km². Land boundaries measure 1,228 km and coastline measures 15.021 km.

Briefly, the geological settings are classified in the following categories

- Igneous Rocks and tuffs, lahars formed by the eruption of volcanoes in Aegean sea
- Sedimentary rocks deposited on land (streams, lakes, glaciers, dunes) or under sea (beach, reefs, deep sea)
- Limestone formed in shallow coastal waters in warm climates
- Clays deposits in Central Plain of Attica and in shallow lakes in Neogene sediments
- Metamorphic Rocks. Recrystallization of pre-existing rocks due to deep burial (heating and pressure) or intrusion of magma (heating), marble (metamorphism of limestone), equant inter-grown crystals
- Ophiolites, slivers of oceanic crust and mantle thrust up and exposed at surface and ophiolites present in Peloponnesus
- Recent alluvia deposits

The complicated geological structure of the country develops equally complicated “hydro-geological conditions”. Consequently, the various aquifer systems show great heterogeny and anisotropy as far as their pattern and mechanisms are concerned. The groundwater potential of the country, as it is calculated in the study of IGME, is of the rate of 20x109 m^3. An amount of 14,2x109 m^3 or 71% corresponds to the reserves of fissure flow systems (karstic aquifers), an amount of 4,2x109 m3 or 21% corresponds mainly to the reserves of inter-granular flow systems (porous aquifers) and sometimes the fissure flow systems (aquifer systems of post-alpine deposits) and the rest 1,6x109 m^3 or 8% corresponds to the reserves of fissure flow systems in semi-permeable

schists, gneiss and alike rocks. A significant percentage of this potential is discharged from springs and it is added to the surface runoff.

Limestones (marbles), marls (marlstones) and sandstones are the main soil types met in Greece. In relation with the thermal conductivity of rocks and soils, this is strongly dependent on their material formation (e.g. unconsolidated sediments or rock with voids). The range of the thermal conductivity values in unconsolidated rocks is extended from 0.2 – 4 W/m/K while in solid sediments this ranges from 1.1 – 7.7, in magmatites from 1.3 – 4.1 and in metamorphic rocks from 1.3 – 6. The hydraulic conductivities vary from 8,64m/d (limestones) – 0,15 m/d (marls, marlstones). In sandstones, the corresponding values are lying between 2.5x10-13– 5x10-11m/sec. The temperature gradient referring in ground has a mean value 33° C/km.

2. Context of development of GSHP

2.1 What is Geothermal Energy

Heat is a form of energy and geothermal energy is, literally, the heat contained within the Earth that generates geological phenomena on a planetary scale. 'Geothermal energy' is often used nowadays, however, to indicate that part of the Earth's heat that can, or could, be recovered and exploited. The origin of geothermal energy is the complex Greek word (Geo+thermia) that means heating (=thermotita) by the earth (=Gea).

Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few kilometers beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma.

The shallow ground or upper 3m of the Earth's surface maintains a nearly constant temperature between 10° and 16°C. Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger, a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the

heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

There is no direct definition of the Shallow Geothermal Energy in Greece. The term "geothermal energy" is commonly associated with the deep geothermal energy. The Shallow Geothermal Energy (SGE) is indirectly defined as the ground heat originated by the ground temperature less than 25 ^{o}C.

According to the provisions of the article 2.1 of the law 3175/2003, the definition of geothermal energy is given as follows: «*the Geothermal potential is the total of indigenous natural steams, surface or underground hot waters and the heat of geological formations that exceeds the 25^{o}C*».

Geothermal field is a single mining area in which an indigenous geothermal potential is located.

The geothermal fields are divided in two categories:

1. The low temperature geothermal fields in which the temperature of the product is ranged between 25 – 90 ^{o}C.
2. The high temperature geothermal fields in which the temperature of the product exceeds the 90 ^{o}C.

Given the a.m. distinction, the SGE is now well defined as:

«*The heat exploitation of surface geological formations and surface water and groundwater that is not characterized as geothermal potential and it's suitable for heating and cooling*».

By interpreting the above definitions, in this category belongs the geothermal energy stored in the earth's crust in a depth from 1 – 100 m and in subsoil temperature lower than 25 ^{o}C and remains constant throughout the year. According to the law provisions N. 3175/2003, the only restriction to regard SGE is the threshold of 25^{o}C temperature. No depth limit is clearly determined but implied by the temperature threshold.

The theoretical background of SGE is based on the fact that the temperature of the surface layers of the Earth's crust remains almost constant throughout the year, regardless of the weather conditions on the surface of the earth. The temperature in Greece ranges from 14 to 20 ° C in a depth from 2 to 100 m, while even in the 3 m depth does not change significantly. For the exploitation of the shallow geothermal energy, geothermal heat pumps are used combined with the use of heat exchangers.

2.2 State of the art: Geothermal energy market in Greece

The geological structure of Greece favours the existing of hot water or steam in economic exploitable depths in many regions characterized by geological recent volcanic activity. Such areas are St. Theodoros (Sousaki), Aegina, Methana, Milos, Santorini, Nisyros, South Kos, Patmos, New Lichades, Mikrothives, the basin of Aridaia and the highlands around and the region northern of Kilkis.

Validated and significant geothermal potential at temperatures higher than 300°C has been investigated and located in the islands Milos and Nisyros. In all the rest areas of Greece the geothermal potential remains not investigated so far. There is also some strong evidence for existing geothermal wells of temperature 100-200°C in depths 2 - 4 km under the sedimentary basins of Central Macedonia, Eastern Macedonia, Thrace and Sperchios River as well as in Sousaki. After using the reliable geo-thermometers in the Delta of Nestos and in the islands of Samothrace, Chios, Lesvos and Santorini are expected still higher temperatures.

As regards, the shallow geothermal potential (SGE) in Greece ($T < 25\ ^{o}C$), although it is considered capable to cover all the local needs for heating/cooling by direct use of geothermal energy, the GSHP systems accounted for only 135 MW_{th} as of November 2009. The estimated capacity installed in November 2009 exhibited an 80% increase compared with the capacity reported in the end of 2004 (Fytikas, et al, 2005).

The use of GSHPs in Greece is not as widespread as in other countries, especially in the Central and Northern Europe. However, this situation has been changing in the last 2-3 years with a considerable increase of the systems installed. In the last years, more than 360 applications of GSHP systems have been recorded in Greece with a

total estimated installed capacity of more than 33 MW_{th}. Specific numbers for all the installations are hard to estimate due to lack of any official statistics or inventories both in national and in regional level. Thus, conservative estimates can raise the above number at 50 MW_{th} (Table1).

Table 1: Summary table of geothermal direct heat uses (as of 30 November 2009)

Use	Installed Capacity[1] (MWt)	Annual Energy Use[2] (TJ/yr = 10^{12} J/yr)	Capacity Factor[3]
Individual Space Heating[4]	1.5	16.5	0.34
District Heating [4]			
Air Conditioning (Cooling)			
Greenhouse Heating	34.8	340	0.31
Fish Farming	9.0	74.3	0.26
Agricultural Drying[5]	0.3	1.5	0.19
Bathing and Swimming[7]	39.0	238	0.19
Subtotal	**84.6**	**670.3**	0.25
Geothermal Heat Pumps	50.0	270	0.17
TOTAL	**134.6**	**940.3**	**0.22**

[1] Installed Capacity (thermal power) (MWt) = *Max. flow rate (kg/s) x [inlet temp. (°C) - outlet temp. (°C)] x 0.004184* or *= Max. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.001*

[2] Annual Energy Use (TJ/yr) = *Ave. flow rate (kg/s) x [inlet temp. (°C - outlet temp. (°C)] x 0.1319 (TJ = 1012 J)* or *= Ave. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg) x 0.03154*

[3] Capacity Factor = *[Annual Energy Use (TJ/yr)/Capacity (MWt)] x 0.03171 (MW = 106 W)*

[4] Other than heat pumps

[5] Includes drying or dehydration of grains, fruits and vegetables

[7] Includes balneology

Note: the capacity factor must be ≤ 1.0 and is usually less, since projects don't operate at 100% all year

Table 2 summarizes the distribution of the systems installed for small systems (<100 kWth) and for large ones (>100 kWth) and classifies them according to the type of heat exchanger (closed-loop horizontal, closed-loop vertical and open-loop).

Table 2: Characteristics of recorded geothermal heat pump applications (as of November 2009)

	No of appl.	Type of pump system (kW_t)		
		Closed, horizontal	Closed, vertical	Open* groundwater
Large applications (>100 kW)	66	-	4152	18883
Small applications (<100 kW)	>300	2781	4164	2569
Total	>360	2781	8316	21452

The installed capacity of space-heating units in the country has been estimated to be a little higher than 1.5 MW_{th} (November 2009).

Agriculture and aquaculture are also significant fields of SGE use in Greece. Greenhouses, soil heating and fish farms represent this use. The first geothermal greenhouses in Greece were constructed in the early 1980s in Northern Greece. The installed thermal capacity of fish farms is exceeding 8.5 MW_{th}. This capacity is coming from two investments. It is estimated that both investments have been repaid during the first three years of operation.

Regarding balneology and SPAs, there are more than 60 thermal spas and bathing centres operating in Greece today. The majority of these centers is state-owned (or owned by municipalities) but only two of these centres are heated by geothermal waters. A conservative estimation of the total thermal capacity of the Greek SPA resorts is 38-40 MW_{th}, with a mean load factor of 0.19. These figures include the open and closed pools heated by geothermal waters.

SGE has also been used for industrial uses. The first tomato dehydration unit worldwide has been operating since 2001 in the geothermal field of N. Erasmio in the region of Xanthi (Thrace). The unit uses low - salinity geothermal water (with a temperature of 60 °C) to heat atmospheric air to 55 – 57 °C in finned tube air heater coils. Actually, the plant uses the same geothermal well which provides geothermal water for asparagus cultivation during the winter.

However, the declining economic conditions in Greece in the last years, introduces main market threats and constraints for the further spreading of geothermal energy and GSHP applications that should be ceased or mitigated such as the rising taxation, the small market segment, the strong competition from natural gas and split air conditioning units and the endogenous bureaucracy.

2.3 Barriers

In more detail, special care should be given to the following inhibiting factors that keep the GSHPs market in suspension.

2.3.1 Economic

The main barrier for GSHP systems resulting in the slow market development of geothermal heat pumps are the high investment costs at the start of the project in comparison with conventional systems. The uncertainties that come along with these longer pay-back times in combination with low profitability make it less attractive to invest in a project like this.

This barrier is expected to relief in the upcoming year 2013 with the place in effect of the gas emissions stock exchange.

Another major issue raised in the last 5 years, is the continuous deterioration of economic situation in Greece in which the productive sectors of economy encounter unexpected constraints and challenges.

1. The economic recession, the low liquidity, the loans in suspension and the high interest rates in the last 3 years constitute a limiting factor in investment attraction.
2. The suspension of the buildings construction activities constitutes another inhibitory factor introducing a further barrier for the larger GSHPs penetration in the RES H & C market.
3. The lack of particular subsidy schemes for GSHP systems. The subsidy schemes concern mostly the promotion of all RES in general and especially the electricity generation.

2.3.2 Organizational

With regard to organizational barriers, the following points should be stressed.

1. The lack of economic and structural incentives for SGE and GSHP systems. This does not stimulate commercial companies and customers to invest in geothermal systems.
2. The small market size in combination with the air heat pumps dominated in the market for years, results in small penetration of GSHPs use in the buildings.
3. The lack of experienced professionals. Few companies have the experience from such kind of projects up to now and only few projects have been realized. Furthermore there are few “best practice” projects to spread the fame.

4. The continuous modifications of the market rules and enactments in general and in particular, create an uncertain economic environment and put the potential investments in doubt or in suspense. In detail:
   i) The lack of a solid and simple taxation system for the companies and individuals.
   ii) The lack of a general long-term planning for obligatory use of GSHPs in the new or refurbished buildings.

2.3.3 Information

The information about the geothermal systems constitutes another barrier in Greece. Many people do not know the geothermal energy and the benefits from using this technology.

1. The higher complexity and the lack of knowledge run out the geothermal energy in comparison to conventional energy systems.
2. Not enough "know how" on how to design and construct these systems and the availability of supporting tools form a barrier.
3. The knowledge of the market stakeholders (project developers, architects and installation companies) in Greece regarding the GSPS market is not being in high level. This deteriorates the broader dissemination of SGE and GSHP technology in spite of the comparative technological advantages and the achieved high efficiencies compared to the air heat pumps.

This poor/limited knowledge of the parties in the market, and therefore increased risk on errors makes investors less eager to invest in these new systems.

2.3.4 Legal/Regulative

The regulative status in Greece regarding the RES development meets the severe reaction of gas and fossil fuel lobby. In detail:

1. The deformed regulative framework and the default state's energy policy which continue to subsidize excessively the natural gas and the fossil fuels (1.5 billion € for the year 2011) against the RES technologies (including geothermal energy) making RES more expensive and less competitive. The local investors lobby is still remaining strong and favourable to fossil fuel energy sources and natural gas, leading towards the prices deformation of

existing subsidies, in an unequal and extremely inequitable taxation and thus in the customer's undue economic burden up to 60% charged in the PPC bills for the Special Fee for Emissions Reduction (ETMEAR).

2. The process of legislation enacting is hindered by the current economic situation. Economic policy has been focused in austerity measures imposed by EU against the economic recession.
3. The unstabilised RES tariff policy and the continuous amendment of the enactments and regulations involves high risk of investment mostly in new markets such as the GSHPs market.
4. The complexity of the procedures, the heavy bureaucracy and the time required to get the permits is regarded a very serious obstacle that discourages the new investments in Greece.

2.4 Objectives and development of GSHPs in Greece

2.4.1 National Targets

According to the National Renewable Energy Plan (NREAP) for Greece, the expected energy produced from RES corresponding to the 2020 target is 4.341 ktoe which leads to a final share of 20.2%.

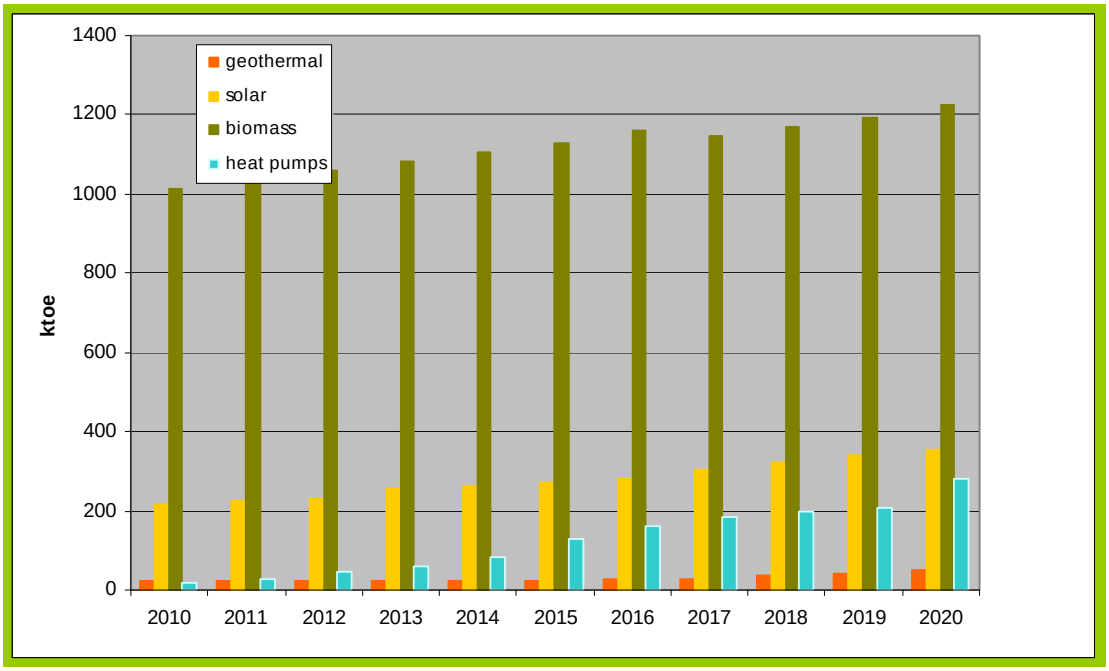
With regard to RES-H targets and in order to meet the EU RES-H targets (~580 GWh by 2020), the contribution of different technologies which leads to a final share 20% RES in heating and cooling is presented in the figure 1.

The estimated percentage of RES different technologies for heating and cooling according to NREAP is:

- Heat Pumps: 15,5%
- Geothermal: 2,6%
- Solar thermal: 18,7%
- Biomass: 63,2%

corresponding to an installed GSHP capacity of 265 MW by 2020.

Figure 1. Estimated contribution of the different RES technologies for heating and cooling until 2020 (CRES)



The major increase in this period comes from the enhanced use of heat pumps, which by 2020, will rival the contribution of solar thermal systems, a technology widely used in Greece with substantial local industrial base (Table 1).

ktoe	2013	2014	2015	2016	2017	2018	2019	2020
RES from Heat Pumps	60	81	127	161	181	199	206	279
- of which aerothermal	49	66	104	132	149	163	169	229
- of which GSHP[1]	6,6	9,9	14,6	20,6	27,9	35,3	42,7	50,0

Table 1. Estimation of total contribution (final energy consumption[2]) expected from Heat Pumps technology in Greece to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from heat pumps in heating and cooling 2013 - 2020 (*source: NREAP*)

From the above table is clear that the individual contribution of GSHPs must be installed up to 2020 meets the target of 50 ktoe (265 MW) of GSHPs installed capacity in order to meet the EU target of 20-20-20.

Sub-national energy scenarios or plans are not been elaborated in permanent basis since there is not any obligation by law. Only in volunteering basis, 27 out of 71 cities

[1] Calculated based on the Geo.Power Action Plan.
[2] Direct use and district heat as defined in Article 5(4) of Directive 2009/28/EC.

participating in the Covenant of Mayors have proceeded in submission of a Sustainable Energy Action Plan (SEAP).

In the context of NREAP's targets, the National Strategic Reference Framework (NSRF) 2007 - 2013 has established various programs managed by the National Management Authorities referring to RES H & C systems in order to reach the NREAP's national targets without focusing on targets per technology (e.g. GSHP systems installation) as NREAP reports.

A short description of the main parallel programs running in Greece is described below. These programs make reference in specific budget available for interventions in the public and private buildings by replacing or renovating the old heating systems and the installation of new ones using renewable technologies in the old and new buildings until the budget has been spent but specific quantitative targets connected to the number of installed GSHP systems are not defined.

The "Energy Efficiency at Household Buildings" Program

The Program 'Energy Efficiency at Household buildings' has been designed with a focus on energy saving in the household building sector. This programme concerns grant aid for energy efficiency interventions to buildings, throughout the country and is addressed to those who have the right of (full or bare) ownership or usufruct to a residence of low energy class.

The Program will be implemented through a Holding Fund entitled "Energy Efficiency at Household Buildings Fund" (Desicion no. 31654/ΕΥΘΥ1415/20.07.2010, Official Journal of the Hellenic Republic B/ 1262). The budget of the program is EUR 396 million; the program will be implemented throughout Greece, with an indicative regional allocation to the 13 Regions. Applications may be submitted until the program budget per region has been spent.

The program offers citizens incentives to carry out the most important interventions, aimed at improving their houses' energy efficiency, while at the same time contributes to the achievement of Greece's energy and environmental targets; once completed, the program will help save energy up to 1 billion kWh annually.

The interventions in which this program refers are the following:

1. placement of thermal insulation
2. replacement of door-casing systems
3. heating system upgrading (including GSHPs)

Residences fulfilling the following basic criteria can be financed:

1. Located in areas with zone price lower or equal to 2.100 €/m2.
2. With energy class lower or equal to D, based on the Energy Performance Certificate.
3. It has not been marked for demolition

The Program offers incentives for the implementation of interventions up to the amount of 15.000 € per residence. In cooperation with the Energy Auditor, the owner of the residence agrees on specific interventions necessarily fulfilling the ceiling of expenses so that the budget can be 'eligible'. Inclusion in the program includes three categories of incentives based on family status and incomes as in the following table.

Category of Beneficiaries	**A1**	**A2**	**B**
Annual Personal income - A.P.I. (single)	A.P.I. ≤12.000€	12.000€ < A.P.I. ≤ 40.000€	40.000€ < A.P.I. ≤ 60.000€
Annual Family income (A.F.I.) (married)	A.F.I. ≤ 20.000€	20.000€ < A.F.I. ≤ 60.000€	60.000€ < A.F.I. ≤ 80.000€
Incentives	70% grant of the works budget 30% Interest free Loan (100% subsidy up to 31.12.2015 except from the levy 0,12% according to L128/75)	35% Grant of the works budget 65% Interest free Loan (100% subsidy up to 31.12.2015 except from the levy 0,12% according to L128/75)	15% Grant of the works budget 85% Interest free Loan (100% subsidy up to 31.12.2015 except from the levy 0,12% according to L128/75)
Example	Works budget: 10.000€ Loan: 3.000€ Grant: 10.000€ (direct payment of suppliers)	Works budget: 10.000€ Loan: 6.500€ Grant: 3.500€ (direct payment of suppliers)	Works budget: 10.000€ Loan: 8.500€ Grant: 1.500€ (direct payment of suppliers)

Additional terms:

4. Interest rate: 100% subsidy of the fixed interest rate of 4.93% for both categories of incentives A1, A2 & B, except from the levy 0,12% according to L128/75. The levy will be applied only upon the loan amount which is funded by Piraeus Bank.
5. Duration: 4 or 5 or 6 years
6. Grace period: (optional) interest only period for one year
7. No expense on loan application process
8. Collaterals: no property pre-notation

Early repayment: partial or total early repayment at any moment without additional cost.100% subsidy of the fixed interest rate of 4.93% for both categories of incentives A & B, except from the levy 0,12% according to L128/75. The levy will be applied only upon the loan amount which is funded by Piraeus Bank.

Jessica Holding Fund Greece (JHFG) program

JESSICA is an initiative developed by the Commission and the EIB, in collaboration with the Council of Europe Development Bank ("CEB"). Under new procedures, Member States are being given the option of using part of their EU Structural Fund allocation to make repayable investments in projects forming part of relevant Integrated Plans for Sustainable Urban Development. JESSICA responds to the request by several Member States and the European Parliament to give special attention to the need for urban regeneration and urban investments, and is based on the scarcity of investment funds to finance integrated urban renewal and regeneration projects in pursuit of more sustainable urban communities.

The government of the Hellenic Republic, represented by the Ministry of Economy, Competitiveness and Shipping acknowledges that Greek regions are characterised by a considerable demand for urban regeneration projects in both the largest cities as well as small and medium towns. Areas which need regeneration include degraded parts of towns and cities, insular areas and post-industrial areas. Cities in the country are also interested in the long-term development of urban areas to stimulate their growth.

One of the axes of JHFG is focusing on the improvement in energy management and energy efficiency of public buildings.

In accordance with the Funding Agreement, the JHFG shall channel its funds to Urban Projects through Urban Development Funds (UDFs). The amount of the JHFG funds allocated to this Call is **EUR 258,000,000**. This amount will be increased by any accrued interest.

For more information about this program please click on the following link: http://www.eib.org/products/jessica/eoi/vp959.htm.

"Let's save energy II" programme

The “Let’s save energy II” programme supports the implementation of measures and best practices for the reduction of energy consumption by Greek Municipalities. The invitation was made under Greek Operational Programme 'Environment and Sustainable Development' and provided simplified procedures for assessment in order to allow the greatest possible participation of Municipalities in the Programme.
The programme was open to all First Grade Local Governments that had not been funded by the "Let's save energy I" programme.

Eligible activities involve:
A. Interventions on buildings and infrastructure (energy upgrade of the building envelope, energy upgrade of the electrical and mechanical facilities, upgrading of natural/artificial lighting system, energy management system installation), and;
B. Support and other activities (technical consulting services, technical studies, energy performance studies, energy audits and promotional actions).
One of thematic priorities is the use of RES systems for the heating/cooling and DHW demands of buildings by use of the solar energy, the biomass, the hydro and the shallow geothermal energy as well as the energy efficiency, the cogeneration, and the energy management.
The total programme budget is **EUR 107,000,000**. 70% of project costs will be financed from the Programme, while the remaining 30% will be covered by the Municipalities.
Depending on their population, municipalities are entitled to a maximum eligible total budget. These aforementioned populations exclude the population of a certain Municipality funded by the program "Let's save energy I".

2.4.2 Local Targets

No local targets set in Greece so far.

3. Interactions with the urban envirinment

3.1 The Building

The total number of buildings in Greece mounted in 4,250,000. The 21% of these are located in Macedonia while the 19% in Attica. Regarding the year of construction, the 64% of buildings in Greece were founded up to 1980, while the 36% of buildings from 1980 to 2006. The building construction activity in Greece counts an annual average of 52,500 buildings over the years 1986 – 2000. Regarding the type of buildings, 2.400.000 refers to family buildings and dwellings as well, while 700,000 buildings refer to multifamily residential buildings with a corresponding dwellings number of 2.650.000. Another type of buildings concerns the 1.150.000 buildings for other uses (commercial etc.) out of which 1.050.000 corresponds to dwellings. Since 1980, all new buildings are well insulated. As a result of this, the buildings constructed before 1940 (~15% of the stock) should need to be refurbished; while the ones built before 1980 (~50% of the stock) should need maintenance. The newer buildings (~35% of the building stock) are being in good condition.

The **Law 3851/2010** "*Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of the Ministry of Environment, Energy and Climate Change*", amends significant provisions of the current applicable legislation, aiming to establish specific regulations for the use of RES in buildings on the basis of the law released in 2010, "Energy Performance of Buildings Regulation" - KENAK (OJ 407/B/2010) and in line with the provisions of the directive 2000/91/EK of the European Parliament and Council. Additionally, L3851/2010 sets specific targets for 2020 regarding the share of RES in the final energy consumption, electricity production and contribution in heating, cooling and transport.

The article 10/par. 2 , 3 & 4 of the law 3851/2010 makes a reference in the obligation of all the new buildings to conduct and submit a study to the relevant Planning Authority, which includes the technical, environmental and economic rationale for the installation of at least one of the alternative energy supply systems including the systems for heating or cooling at a scale of a district or a building block, as well as heat pumps whose seasonal SPF (Heating Seasonal Performance Factor) is

greater than 1.15x1/ η, where η is the ratio of the total gross electrical energy production to the consumption of primary energy for the production of electrical energy in line with European Community Directive 2009/28/EU. The price of η, SPF must be greater than 3.3 until it is determined by law."

For the buildings in which a renovation plan is submitted to the relevant Urban Planning Authority after the 01.01.2011, it is obligatory that parts of the hot water use needs are covered by solar panels. The minimum percentage of the solar share on an annual basis is specified at 60%. This requirement is waived when the hot water use needs are covered by other energy supply systems based on RES, by co-production of electricity and heat, by systems of district heating as well as by heat pumps with an SPF (Seasonal Performance Factor) in line with the a.m. provisions. Inability to comply with the above percentage requires sufficient technical documented proof according to current legislation and prevailing conditions. The same provisions are done for all the new buildings that have to cover the total of their primary energy consumption with energy supply systems based on renewable energy sources, co-production of electricity and heat systems of district heating as well as by heat pumps up to 31.12.2019. For the new buildings housing services of the government and the broader government sector, this obligation will have to come in effect no later than 31.12.2014."

Corresponding provisions are in effect for existing buildings under entire or partly renovation. The provisions of the law refer that their energy efficiency must be upgraded to the degree which is technically, operationally and economically feasible in order to fulfill the minimum requirements for energy efficiency, as specified in the Regulation for the Energy Performance of Buildings (KENAK).

Basic provisions are also made in the context of the energy certification of buildings for boilers and heating systems. The auditors draw up a report, in which the efficiency of the boiler is assessed as well as its dimensions in relation to the energy needs of the building and instructions and recommendations are set down for possible required replacement of the boiler, modification of the heating system and alternative solutions.

The **Law 1577/1985** "*General Construction Regulation (G.C.R.)*" and the amendment **Law 2831/9-13-06-2000** make a general reference in the installation of renewables components for direct or indirect building services amongst them power distribution components, air conditioning, heating/cooling, water distribution, natural gas, thermal solar systems. GSHP systems are not clearly mentioned and considered as included in the heating/cooling systems.
This regulation determines the construction terms and conditions and clarifies issues related to the building design and plans integrating all the direct and indirect energy supply systems including passive systems in the building shell in order to facilitate better the use of RES systems. Special care is demonstrated for the solar energy use for heating buildings and the natural cooling techniques.

It is also cited the active solar systems for heating and/or cooling; such systems are particularly the solar collector hot water and photovoltaics and hybrid systems for electricity and heating/cooling supply in the buildings including bioclimatic buildings which are designed taking into account the features for every climatic zone using a combination of passive and/or active solar systems or other renewables for energy saving and environmental protection.

Further according to the study, the land planning authority conducts an architecture control in every building or facility in order to ensure the correct implementation of the law's provisions associated to the environmental protection and the best living conditions and dictated by the correct composition of the particular components on facades and generally the visible parts and to satisfy the aesthetic requirements both as a single unit or facility and in association with the natural and the urban environment.
By this law, norms and special terms (such as the building factor) are also set for the architectural protection of the traditional settlements and the heritage monuments regarding certain criteria (such as the maximum height of additional constructions).

3.2 The city

Currently, SGE pipeline and borehole networks are not integrated in the (subsurface) spatial planning. The Decision of the Minister of Development No Δ9Β,

Δ/Φ166/OIK 18508/5552/207 sets up specific criteria and restrictions with regard to the interactions between the underground networks of GSHP systems and other infrastructures (water supply, irrigation, drainage pipelines etc.) but there is not actually a complete master plan for the integration of SGE systems in the spatial underground infrastructure of the city because of not existence of a common database integrating all the underground utilities neither in national nor in local level.

This is the key point for the massive stimulation and the wider penetration of GSHP systems mostly in the underground infrastructure network of the crowded city centres. Therefore, in the urban environment of the cities the so called master plans for SGE must integrate the SGE technologies in the upcoming period.

By means of a master plan it is possible to arrange small or large scale areas for the implementation of SGE systems. Through organizing the subsurface utilization, interference between systems can be prevented and an optimal use of the subsurface can be guaranteed. The use of a master plan allows regulation by, for example, indicating exclusion areas where the implementation of SGE systems is not possible and others where SGE system installation is allowed under terms and explicit specifications. A master plan containing a map, rules and a written explanation might simplify the application for permits in the future. These rules give, for example, restrictions about the depth and the position of the wells.

3.3 The underground

Every city in Greece disposes drawings of pipelines, cables, sewers and other utilities plans even though some of them need to be updated. This information is administrated by municipalities and is available upon request to the public. On the contrary, no citation is made to the SGE systems integration in the underground infrastructure of the city/town.

In the context of the Decision of the Minister of Development No Δ9Β, Δ/Φ166/OIK 18508/5552/207, in case of the energy systems (GSHPs) installation, the borehole drilling or the pit construction, all these systems have to be placed within the boundaries of property where the air-conditioned space is situated.

In particular, the boreholes must be located at least:

a. Two meters far from the property's boundaries
b. Five meters far from existing neighboring building of different property
c. Five meters far from the boundary of expropriated zone of railway line
d. Ten meters far from the main natural gas transmission pipeline
e. Five meters far from the central underground infrastructure network (water supply, irrigation, drainage pipelines etc.)
f. Ten meters far from the HV power grid, unless the borehole intervenes between the transmission line and the building
g. Five meters far from the MV power grid, unless the borehole intervenes between the distribution line and the building.

The distances referred to the bullets f & g, in case of the overhead power lines, are measured based on the line projected on the ground.

The distances with the reference to the bullets b, e & g can be reduced when certain criteria are accomplished and after review and approval of the Development Division of the Regional Authority.

4. Support tools / flanking measures to boost the development of GSHP

4.1 Organisations and Bodies

4.1.1 National Level

The Institute for Geological and Mining Exploration (I.G.M.E.) is the National body which provides all the necessary information (geological maps, papers, articles, documentation etc.) for the evaluation, management and exploitation of geothermal fields. A National Database is maintained by I.G.M.E. for the validated geothermal fields and reservoirs in Greece but it is not accessed free of charge for the public.

The Center for Renewable Energy Sources & Saving which disposes a large experience and know-how in geothermal energy systems and in the building's energy saving, elaborates studies for the development and implementation of geothermal energy technologies, identification and assessment of geothermal resources, optimum design of geothermal energy exploitation systems and identification and solution of technical problems.

The Division of Natural Resources Management of the Ministry of Energy Environment and Climate Change provides all the necessary information (databases, studies etc.) related to the water resource exploitation in Greece.

In the Greek geothermal market only small and medium enterprises together with few individuals are acting in national level. According to the registry list of the Hellenic Association of Geothermal and Alternative Energy Sources Enterprises "H.A.G.A.E.S.E" (E.S.E.G.E.P.E.), there are 17 registered enterprises dealing with the SGE and GSHP systems. Foreign technology providers are predominantly in the Greek market whilst the scope of work of the vast majority of the registered companies is both installation & designing.

4.1.2 Regional/Local Level

The Hellenic Geothermal Association and the Geothermal Association of Greece are the only local associations acting north and south Greece respectively but without having official registries for the total GSHP capacity installed in Greece so far.

Furthermore, the local associations and/or bodies have not developed supporting tools (best practices databases and/or inventories) to assist the local investors in order to retrieve the necessary information.

4.2 Dedicated Websites

With regard to the dedicated web sites and GIS only the Institute for Geological and Mining Exploration (http://www.igme.gr/) and the Hellenic Association of Geothermal and Alternative Energy Sources Enterprises (http://www.esegepe.gr/) has active web sites so far and the access is free of charge for both.

4.3 Guidelines documentation

There are no conceptual (technical) guidelines available for a typical GSHP installation neither in the national nor in the local level. Instead of this many best practices used as technical guideline documentation fill this gap so far.

Recently, the Handbook named “Examples of GSHPs” gives an overview of the best practices of GSHPs installations in the National and European level together with important parameters and practical considerations for designing and performance indicators review related to the construction of the installation. This document is not a formal technical guideline, but is one of the deliverables of the GEO.POWER project.

In the course of the GROUND-MED program 8 demonstration projects from seven countries have been selected to create a standard database named “Demo project fact sheets” (http://www.groundmed.eu/deliverables/). Results achieved from extensive monitoring program of the demo projects have been reported to the database and have been presented in workshops.

Following the GROUND-MED project, further 52 case studies arising from a European-wide field test have been added to the new database of SEPEMO-Build project, including the air source heat pumps too. Consequently, the name of the database was changed to "Heat Pump Best Practice Database” (http://www.sepemo.eu/hp-best-practice-database/database/).

The aforementioned best practices handbook and databases have been created and used in the national level from installations operated throughout the Greece and Europe. These databases make a detail reference to each demonstration project’s energy performance (e.g. SPF) as well as other useful technical information No economic information is dealt with.

Technical guidelines on H & C systems concerning new and old constructions are given to the General Building Regulation and recently to the Regulation for the Energy Performance of Buildings (KENAK) but no reference is made to codes or specific normative for SGE installations.

4.4 Financial Incentives

Since the stimulating measures of RES are concerned, the primary focus of the Greek government for promotion of the electricity generation is to set an effective feed-in tariff scheme for power (electricity) production depending on the type of applied technology and in accordance with the obligation by the Public Power

Company (PPC) to buy the electricity on the basis of RES-E priority. In line with the vast majority of other RES-E types, the geothermal energy for electricity production involves high investment costs and relatively low labour costs. In that respect, the electricity derived by the geothermal energy is subsidized by a rate varies from 9.95 to 15 c€/kWh.

While the above mentioned guidelines are applied by the Greek energy policy, the same intention is not obvious in the case of RES-H including the direct uses of SGE (i.e. there are not corresponding the feed in tariffs dedicated to RES-H production such as SGE).

The use of SGE exploitation systems for heating production as a part of RES-H does not constitute so far a part of the general RES-E feed in tariff policy.

With regard to the general investment framework in Greece, a financial supporting mechanism for private investments was the 1st Investment Law 2601/1998 which replaced by the Law 3299/2004 "*Incentives for private investments for economic development and regional convergence*" and its amendment 3522/2006 expired in February, 2010. All the past Investment Laws provisions concerned either capital investment subsidies or tax rebates while it should be stressed that the use of heating and cooling systems was only supported by a set of certain fiscal instruments. Even now there is no regulatory support scheme (referring to targets or obligations) for the use of such systems.

At present, the new Investment Law 3908/2011 recently in force replaced the last version reflecting the new trends of RES market. The current law combines a bundle of financial incentives such as:

1. Tax releases on the pre-taxed profits, 6 years for existing enterprises and 8 years for new enterprises.
2. Selected capital investment subsidies under established terms and conditions.
3. Subsidies in leasing depending on the development target of each enterprise.

In parallel, another supporting mechanism is the SSF (Special Support Fund). The credit loan coverage from the Special Support Fund "SSF" (former Guarantee Fund for Small and Very Small Enterprises) which constitutes an alternative insurance mechanism for the SMEs and the innovative enterprises as well, can also play

significant role in the SGE market supplying direct guarantee of liquidity by issuing favorable and low rated loans for the enterprises willing to invest in the GSHP technology.

In addition, in the general framework of the National Strategic Regional Framework (NSRF) concerning all the RES spectrum, provisions for supporting measures also include incentives (grants, tax reduction, interest subsidy etc.) for geothermal district heating/cooling and GSHP installations in specific programs co-financed by EU and national funds as a part of a complete buildings renovation plan that concern specific categories of beneficiaries and professional sectors.

These incentives are illustrated in the following table.

Table 3. Incentives in RES-Heat investments in Greece

Technology	Investment grants	Feed-in Tariff (FiT)	Tax reduction	VAT reduction	Low or zero interest loans	White, Green certificates	Comments
DH	none	none	none	none	none	none	
GSHPs	Residential & commercial buildings up to 10.500€(1) hotels: 40%(2)	none(4)	Tax exemption up to 1.200 €	none	up to 4.500€(1)	none	Price reductions offered by suppliers(3)

The law 3851/2010 provides funds from the Public Investment Program (P.I.P) for projects aiming at the improvement of the building's energy efficiency using RES.
In detail, by common Decision of the Ministers of Environment, Energy and Climate Change, Economic Development, Competitiveness and Shipping, announce programs concerning interventions to building structures to improve the energy efficiency of buildings. The same decision determines the budget of the above programs, the eligibility criteria (eligible interventions, type & rate of funding, maximum plafond, beneficiaries obligations, monitoring process and certification of works, remuneration method, and other issues related to the program implementation).

(1) programme "Energy Savings at Home"
(2) programme "Green tourism"
(3) programme "Building the Future"
(4) a Ministerial Decree is under preparation towards a FiT of 3 c€/kWh$_e$ used by the GSHP

As regards the thermal energy produced by GSHP systems apart from usual tax rebates and refund there is no other benefit for the end-user (e.g. discount in the PPC household bills).

4.5 Insurance schemes

With regard to the insurance schemes, there are not specific provisions referred to SGE investments.

Installations subject to periodic monitoring/report based on performance indicators (SPF, COP etc.) exist and monitored either by institutes, research centres or installation companies but it's not the majority. Most of the installations are subject to a periodic maintenance for a guaranteed period of 2 years and are potentially extended for more years after contractual agreement between the owner and the EPC contractor on an annual fee basis.

The operational performance of an installation (Performance Ratio – PR –) is depending on the EPC contract terms and it's a matter of negotiation between the owner and the EPC contractor. When happens, the PR monitoring period might last from 2 years (guarantee period) to the end of equipment life but the latter case is not the common practice.

5. Management of the Resource

5.1 Legislation

The electrical energy generation from geothermal energy is described by the Law 2773/1999 as amended by the Law 3851/04.06.2010 "*Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of the Ministry of Environment, Energy and Climate Change*". The Law 3851/2010 refers also to the distribution of heat energy.

In spite of implementing the Law 3175/2003 for the electricity production from the high enthalpy geothermal energy and the Law 3734/2009 for the co-generation of heat and electricity, a specific legal framework for the installation and use of RES/CHP

systems for heating/cooling applications is still missing and thus the large scale exploitation of shallow geothermal energy is still remaining small.

There are no regulations or recommendations for temperature thresholds in the legislation of Greece. Groundwater with temperatures below 25 ^{o}C is not considered as a mineral resource. However, a water permit is needed for GSHP systems using groundwater temperature below 25 ^{o}C, according to the Minister's Decision (as described here below).

With regard to the geothermal energy, the following laws apply concerning the ground source heat pump systems and district heating:

a. **Law 3175. Utilization of geothermal potential, district heating and other issues** (Greek government gazette A207/29.08.2003)
b. **Ministerial Decree (MD) No.** D9B,D/F166/OIK.**13068**/GDFP2488/**2009. Definitions of a geothermal system, the specific terms, the required documentation and the procedures for the issuance of the relevant permits are regulated.**
c. **Ministerial Decree (MD) No.** D9B,D/F166/OIK.**18508**/5552/**207. Installation permits for ground source heat pumps** (Greek government gazette B1595/25.10.2004).
d. **Law 3199 on water protection and management – alignment with the directive 2000/60/EC of the European Parliament and Council** (Greek government gazette A280/9.12.2003).
e. **Ministerial Decree (MD), OIK. 1505591. Procedures, terms and conditions for granting the permits for existing rights of water use** (Greek government gazette 16.06.2011).

a. The **Law 3175/2003** refers to the utilization of the geothermal potential, which includes research, exploitation and administration of the geothermal potential. According to this law, ground and water heat content/capacity for temperatures below 25°C is not considered as a geothermal resource and belongs to the owner of the property. In this case, the installation for own use energy systems for

heating or/and cooling through exploiting the heat of geological formations and water, surface water and groundwater is allowed after permission granted to the property's owner by the Regional Authority.

b. In the **MD No. 13068/2009**. This decision except for the definitions of a geothermal system, determines the specific terms and conditions, the required documents and the permitting procedure for the building's owner for the installation of its own energy system for heating / cooling in each space of the building by exploiting the heat of geological formations and water, surface water and groundwater, which are not classified as geothermal potential. The aforementioned installation permit constitutes a uniform license for implementation / installation and operation of the project, and the positive decision of the Regional Authority is required. According to the article 6, in the installation permit and the exploitation of wells, the following information shall be included:

- The nominal power of the system, the maximum drilling depth and drilling locations.
- The time of completion of the system installation.
- The geological sections in drawings of scale 1:500 or greater for the drilling wells and complete information about their characteristics (depth, quantity of pumped & re-injected water/fluid per drilling well, pumping & re-injection temperature, temperature measurements in indicative depth of drilling, length of filter pipes and blind pipes etc.). These data can be used in relevant geological studies.
- The installation of water counters and recording thermometers at the drilling wellheads (production or re-injection).

A feasibility study should also provide information related to the following subjects.

1. During the boreholes drilling and the pits as well as the installation of heating / cooling systems (either for construction or operation period) the appointed study engineer and the supervisor must take into account all the required safety measures.

2. In each borehole drilling, protective steel tube and concrete have to be placed for the upper five meters at least.
3. In case of restricted area for water drilling works, the installation and operation of closed loop heat exchangers is allowed.
4. In case of heat exploiting by use of surface water or groundwater, the end-user is obliged to recover the total quantity and the same quality of water used and to re-inject it in the same reservoir from where it has been pumped up. Otherwise, the Law provisions (No. 3199/2003, Art. 11 & 16) are applied.
5. The pumps and systems used shall have to be certified by an accredited organization.

c. The **MD No. 18508/2004** refers to the permits for the corresponding heating/cooling systems (ground source heat pumps utilizing ground or water temperatures below 25°C) and are issued by local prefecture according to Minister's decision. This decision specifies no limitations for heat pumps coupled with a ground heat exchanger (either vertical or horizontal).

d. The **Law 3199/2003**, which aligns with the Directive 2000/60/EC of the European Parliament and Council of 23 October 2000, in the articles 10 and 11 refer to the general rules for water use for commercial uses (irrigation, industrial use, energy use and use for recreation). For each use, specific rules shall be applied in order to ensure the sustainable development and in parallel the long term protection of water, the adequacy of reserves, the quality reservation and particularly the prevention of water pollution. The water demands satisfaction shall be made based on the resource capacity, taking into account the ecosystems balance and conservation.

   Any legal entity or individual person may use water or carry out projects utilizing water resources to meet their real needs.

   In the case of open loop systems where production and reinjection wells are used and where 100% of the water used is re-injected, the Law 3199/2003 on water protection and management applies and additional 'water use' permit must be issued by local regional authority. In this case if the location is inside the city plan the wells should be located at specified distances from neighbouring buildings (5 meters) and natural gas or water main pipelines and high/medium voltage power lines (20 meters). If the location is outside the city plan there are

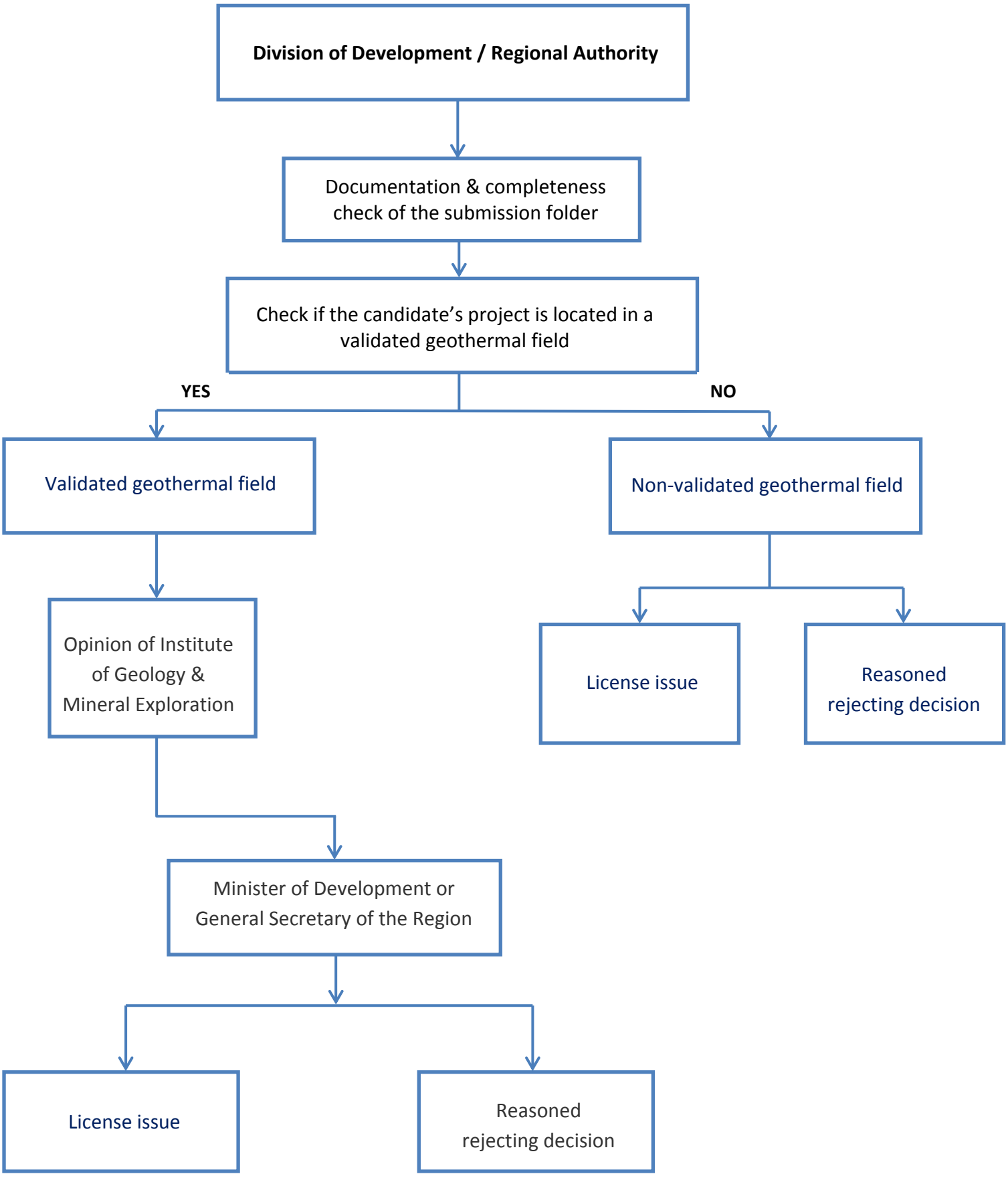
minimum distances from main roads that should be taken after (60 meters from the motorway, 45 meters from the national road, 20 meters from provincial road, 6 meters from municipal road etc). In order to obtain the necessary permit a feasibility study should be prepared by competent persons (engineers and geologists) in accordance with the Management Plan and the measures defined by the local Authority.

e. The **MD OIK. 1505591/2011** refers to the procedures, terms and conditions for granting the permits of water use rights. This decision defines the basic categories of water use supply (potable water, agriculture, industry, energy plant, tourist and sport installations). It also specifies the technical information, the kind and size of exploitation, the water origin (surface or underground water), the quantity and quality of resource, should be included in the application for granting the permit for water use rights from wells by the General Secretary of the Regional Authority.

For a typical one well installation, the following steps are mostly followed in which professionals and public services are involved in:

1. Pre-feasibility and Feasibility study (optional) from consultants
2. Folder submission to the regional authority
3. Permit granting
4. Drilling works from driller (company or individual)
5. Heat pump supplier and installation/designing company which provide the "As build" studies and subcontracting with other company or individual
   a. For electrical works.
   b. For plumbing works.
6. Well drilling carrying out

The typical procedure for acquiring the permits required for a GSHPs installation is illustrated in the following flow chart. Further permit for water use is required in open loop systems when surface water resources are used (ponds, lakes, rivers, sea).


Division of Development / Regional Authority
Documentation & completeness check of the submission folder
Check if the candidate's project is located in a validated geothermal field
YES
NO
Validated geothermal field
Non-validated geothermal field
Opinion of Institute of Geology & Mineral Exploration
License issue
Reasoned rejecting decision
Minister of Development or General Secretary of the Region
License issue
Reasoned rejecting decision

5.2 Tools for recource management

There are not official tools more than special maps in GIS digital format for resource management except maybe for the management plans concerning the water resource management. With regard to the geothermal energy the validated geothermal fields of high enthalpy have been recorded in GIS databases and an integrated management plan has lately elaborated for 4 of them. For the geothermal resource management the tools which are commonly used are the geological maps and the past field measurements. The SGE resource management is made mostly by individuals and private companies by using their own tools and resources.

5.3 Standards

In Greece there is a lack of labeling schemes, standards, codes or specific normative for SGE exploitation which are already established in the EU. There is also a lack of rules and regulations for the design, construction, control, and assembly/installation of equipment that uses SGE technology and an absence of accredited laboratories to issue power plants certificates.

Most of the companies in the field of SGE and GSHPs installations are acting based on the European Standards and Codes.

6. Professional structuration

The structuration of professionals in the Greek market is mostly under the umbrella of companies which hold a contractor's certificate for carrying out general field works such as excavations, earth works, and constructions including drilling works in general.

For all these companies a registry of contractor’s certificate administrated by the Ministry of Energy, Environment and Climate Change, classifies the companies according to the experience in categories from 1 to 7 (1-3 for SMEs and 4 – 7 for Ltd and S.A.).

6.1 Training activities dedicated to SGE

Training activities dedicated to SGE and GSHPs are not organized in a permanent basis except for some private commercial companies for promotional reasons. The university courses only supply general information on these systems.

6.2 Certification of professionals

No particular certification scheme for professional drillers, installers or companies is in place for SGE or/and GSHP systems.

This lack of certification scheme represents a barrier to the uptake GSHPs within Greece since the complexity of GSHP systems and their high cost means customers are reluctant to make the required financial commitment without the reassurance that a certified installer and driller should bring. Under these conditions, non-certified professionals play deterrent role in successful external evidence.

For this reason, a national certification scheme is regarded important to withdraw the barriers related to the customer's confidence to the professionals and contribute to the local GSHPs market development.

Certification is only restricted in engineering or technical level and concerns certificates or diplomas from various technical private or public schools in general knowledge (e.g. drilling operator, plumber, electrician etc.) and not in particular for installers or drillers of GSHP systems.

7. Conclusions

In pursuit of the accomplishment of the National Renewable Energy Action Plan and the "20-20-20" target, specific national energy policies has been developed establishing new financial incentives for building's energy saving including all the new technologies for heat production such as geothermal heat pumps, biomass etc., along with the implementation of all the technical measures that are described in the "Energy Performance of Buildings Regulation", aiming to achieve significant energy savings.

1. The validated Building's Energy Efficiency Regulation (KENAK) is expected to act as the main propellant tool by using RES and EE systems for heating and cooling in the tertiary and residential sector.
2. Further the implementation of the building's energy performance certificate and the body of energy auditors is expected to play a key role in the emerging SGE market and in implementation of GSHP systems in the city's buildings as well as in the district heating networks integration in the urban environment.

The above mentioned measures already taken are the first step amongst a bundle of measures in regulatory level that shall have to be undertaken in the future in order to foster further a solid GSHP market.

The legal framework for geothermal energy requires a revision with additional regulations for accelerating the geothermal energy use and for the most effective reduction of the heavy bureaucracy.

Currently, an amendment process of the basic geothermal Law (3175/2003) is being under consultation by replacing specific articles and by establishing an additional state enactment oriented to geothermal energy use (being as final draft so far), which refers to the own use of heating and cooling applications that exploit the shallow geothermal fields (i.e. groundwater and surface water that are not characterized as geothermal potential).

With regard to the SGE utilisation, technical and regulative measures targeted to exploit the ground and water source potential for the GSHPs propagation, to localize the existing underground infrastructure network planning the necessary infrastructure works in order to integrate new distributed district heating and cooling networks (DH) for the cities and to facilitate the gradual decommissioning of the old and outdated heating and air-cooled systems in the buildings replaced by modern GSHP systems have to be undertaken.

To this direction the following actions are necessary.

1. The legal framework in Greece requires several improvements. In particular it should simplify the licensing process for all closed loop systems.

2. It should also simplify the permitting procedure for geothermal applications, which are going to use sea, pond or river water etc.. At present, for GSHP applications coupled in open or closed loop with sea etc., the permit procedure imposes a lot of constraints and obstacles to the private customer and requires ministerial decree.
3. In addition, the development of specific policies regarding the integration of GSHP systems in the city's environment as well as the management system re-planning of the underground infrastructure networks is of utmost importance.
4. The successful implementation of energy saving targets in the end-use along with the development of new market mechanisms (i.e. ESCOs) for both the public and private sector are to be proved essential in order to achieve the projected RES share in heating and cooling.