Country update for the Spanish geothermal sector

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ABSTRACT

Spain has a high potential of geothermal resources. Therefore, with a suitable development of the sector, we could reach the levels of geothermal use of other European countries. However, geothermal energy in Spain still shows a low penetration, despite its great potential for both thermal and electrical uses.

In Spain there are no geothermal power plants. Some recent promising projects (i.e. in Canary Islands) have been stopped, mainly due to the difficult situation of the electricity sector. This fact, together with the inherent limitations of the deep geothermal sector – with its high upfront costs and its needs of public and private support to minimize risk associated with the geothermal resources investigation – has slowed down progress in the last period. However, geothermal energy for power generation could present a clear opportunity for development in Spain, given the significant potential of existing resources, not only in the Canary Islands but also in the peninsula, where the geological context is particularly favourable to the development of EGS projects.

The size of the Spanish geothermal heating and cooling market is difficult to quantify accurately, due to the lack of a centralized, systematic and complete statistic of the number and characteristics of renewable thermal installations in Spain. It is estimated that the current installed capacity corresponds to traditional applications of direct heat uses (mainly in spas and greenhouses), as well as shallow geothermal systems for heating, cooling and domestic hot water (DHW) linked to open and closed-loop borehole heat exchangers (BHE). Without any evidence of a change in the political and economic framework conditions, we expect that in the coming years the installed capacity of direct uses remains constant, since most of the existing potential has being already exploited (although some industrial uses could be implemented in a next future). As in the last period, the most relevant progress will likely come from the growth of the heating and cooling installations market in the residential and tertiary sectors, via shallow geothermal systems.

The geothermal sector report "*Análisis del sector de la energía geotérmica en España*" (Analysis of the geothermal energy sector in Spain) published in December 2015 by the Spanish Geothermal Technology Platform (GEOPLAT) confirms that the generation of heating, cooling and electricity from geothermal energy is a viable energy option in Spain; with the capacity to contribute to the Spanish energy mix as a solid and versatile renewable energy, with great potential to contribute to climate change mitigation policies to be implemented in Spain in the context of 20/20/20 energy policies and National Renewable Action Plans. The report also highlights the potential of job creation associated with a accelerated deployment of geothermal energy in its various forms.

1. INTRODUCTION

Spain has different types of high potential geothermal resources, which, if harnessed adequately through proper development initiatives, can decrease the gap in the level of use of these resources with respect to other European nations. To enable this development, it is essential that the sector undergoes sustained technological evolution.

Spain's geothermal potential can enable the inexhaustible use of this renewable energy source for the production of electricity in the industrial and agricultural sectors as well as for residential use and services. This would also allow us to reduce our

foreign energy dependency (one of the biggest among EU countries and shown by many authors to be one of the real burden to increase competitiveness of our domestic economy), as well as the consumption of non-renewable energy sources and contribute to ultimately guarantee a constant supply of energy that is independent of external factors.

The following table provides a summary of assessed geothermal resources in Spain.

Table 1. Geothermal resource potential in Spain. (Source: Evaluation of the geothermal energy potential. 2011-2020 PER technical study).

Type of use	Type of reservoir	Recoverable stored heat (10^5 GWh)	Power (MW)
Thermal	Low temperature (total resources)	15,682	7,710 (MWth)
	Low temperature (usable)	160	57,563 (MWth)
Electric	Medium temperature (total resources)	541	17,000 (MWe)
	Medium temperature (studied)	54	1,695 (MWe)
	High temperature (studied)	1.8	227 (MWe)
	Enhanced geothermal systems (known areas)	60	745 (MWe)

2. UPDATE OF CURRENT ACTIVITIES IN THE SPANISH GEOTHERMAL SECTOR

A description of the existing geothermal resources available in the Spanish subsurface is provided next. This description includes the characteristics and potential of each resource such as zones of interest, geological conditions, depth and temperature of the resource, fluid composition, etc.

The resources have been classified into the following groups in order to prepare such descriptions:

- Very Low Temperature Resources (T < 30 ºC).
- Low Temperature Resources (30 ºC < T < 100 ºC).
- Medium Temperature Resources (100 ºC < T < 150 ºC).
- High Temperature Resources (T > 150 ºC).
- Enhanced Geothermal Systems (EGS).

2.1 Very low temperature (<30 ºC) – shallow - geothermal resources

Closed-loop geothermal systems. These resources are available nationwide. There are two main groups depending on the average thermal conductivity and the physical and mechanical characteristics of the ground.

Consolidated formations extending over 60% of the territory area. Formed by sedimentary, igneous or metamorphic rocks ranging from Paleozoic to Mesozoic age, specific weight greater than 2.0 tm/m^3, thermal conductivity in saturated conditions over 2 W/mK and can be drilled without drilling mud or auxiliary casing except a few starting meters. These formations occupy the entire periphery as well as the central mountain ranges. The conditions for implementing very low temperature geothermal systems are optimal especially when they go hand in hand with continental type climatic conditions.

Unconsolidated formations occupy broad areas across the two plateaus and the eastern third of the country. Geological conditions are less favourable, increasing the installations cost. However, these areas frequently have continental climatic conditions, with a great and well equalized heating and cooling demand, improving the attractiveness of shallow geothermal systems in terms of LCE and cost.

Open-loop geothermal systems. There is a great use of groundwater, especially for urban and agricultural supply, in Spain. Many times groundwater extraction involves deep aquifers often with high pumping heights, increasing the energy cost over the shallow systems redlines. In addition, complex regulations and hydrological stress in broad areas of the country do not facilitate their use in thermal applications. In practice, the greatest potential can be found in cascade applications, still scarcely developed, or more usually in alluvial aquifers of Spanish main rivers such as the Ebro, Guadalquivir, Guadiana…. standing many of the country's main cities (Zaragoza, Seville, etc.). These aquifers, very transmissives (> 10^3 m^2/d), supplies open-loop geothermal systems of several hundreds of kW, pumping just a few meters.

Following the methodology provided in other sources (e.g., documents from the US Department of Energy such as "*Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers. December 2008*"), resource estimates in this case would not be limited by soil conditions, but rather by demand configuration and our ability to harness the resources in a technically and economically viable way. In this sense, there are great areas with potential demand, for Spain has many of the factors that favour geothermal heat pump based systems such as broad climatic areas with important seasonal temperature variations, large numbers of dwellings or buildings in rural or semi-urban areas with sufficient surrounding land and difficult access to gas or other sources and a deeply-rooted heating and cooling industry backed by broad experience. Also

worth noting are the dramatic changes that have taken place in the regulatory sphere (articulated by a diverse range of technical codes and regulations in the case of Spain) which have resulted in the implementation, since 2009, of the European Renewable Energy Directive relative to the promotion of the use of energy from renewable sources (hereinafter Directive 2009/28/CE) in buildings or other previous codes.

2.2 Low temperature (30 - 100 -ºC) geothermal resources

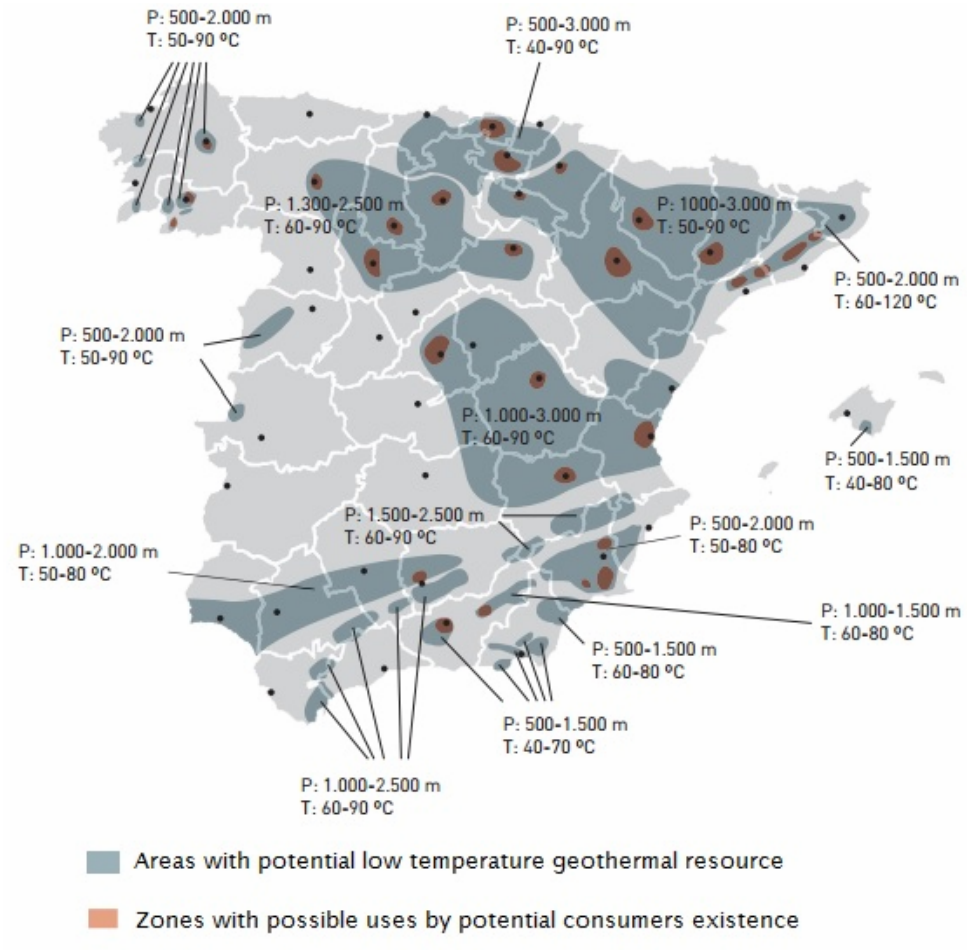
The Spanish subsurface has been classified into two main groups, for purposes of analyzing this type of resource: 1) large sedimentary basins and peripheral mountain ranges and 2) the Iberian Hercynian Massif.

The first group includes the Duero, Tajo-Mancha-Júcar, Guadalquivir, Ebro and North-Cantabrian basins. The second group includes the Bética Ranges in addition to the Pyrenees, the Catalan Coastal Ranges and the Iberian Hercynian Massif located in the west of the Iberian Peninsula. Within the areas that are included in the first group there are numerous Mesozoic and Tertiary permeable formations that fill said basins, as described in studies prepared by IGME (Spanish Geological Survey) in the 80's based on the information obtained from deep hydrocarbon exploration wells. Geothermal energy in the form of recoverable stored heat (geothermal reserves) in such formations has been estimated at a total of 15,126 x 10^5 (GWh). When applying the calculation to zones of influence in key urban centers that have significant thermal demand, this figure increases to 150.3 x 10^5 GW, which is approximately 1% of the total.

The areas included in the second group, which have been studied in detail by IGME from 1975, are characterized by significant regional fracturing coupled with a considerable vertical development of permeable formations that allow the proliferation of zones that host geothermal resources. Geothermal energy in the form of recoverable stored heat (geothermal reserves) in these zones has been estimated at 736 x 10^5 GWh. When applying the calculation to zones of influence in key urban centers that have significant thermal demand, this figure increases to 9.6 x 10^5 GW, which is approximately 1.3% of the total in these areas.

In summary, low temperature geothermal energy estimates in the form of recoverable stored heat in Spain's subsurface amount to a total of 15,862 x 10^5 GWh, of which 159.9 x 10^5 GWh are located proximal to areas that have a significant demand levels of this energy for direct heat applications.

Figure 1. Map of low temperature geothermal resources and zones with good potential for resource exploitation (Source: PER 2011-2020)

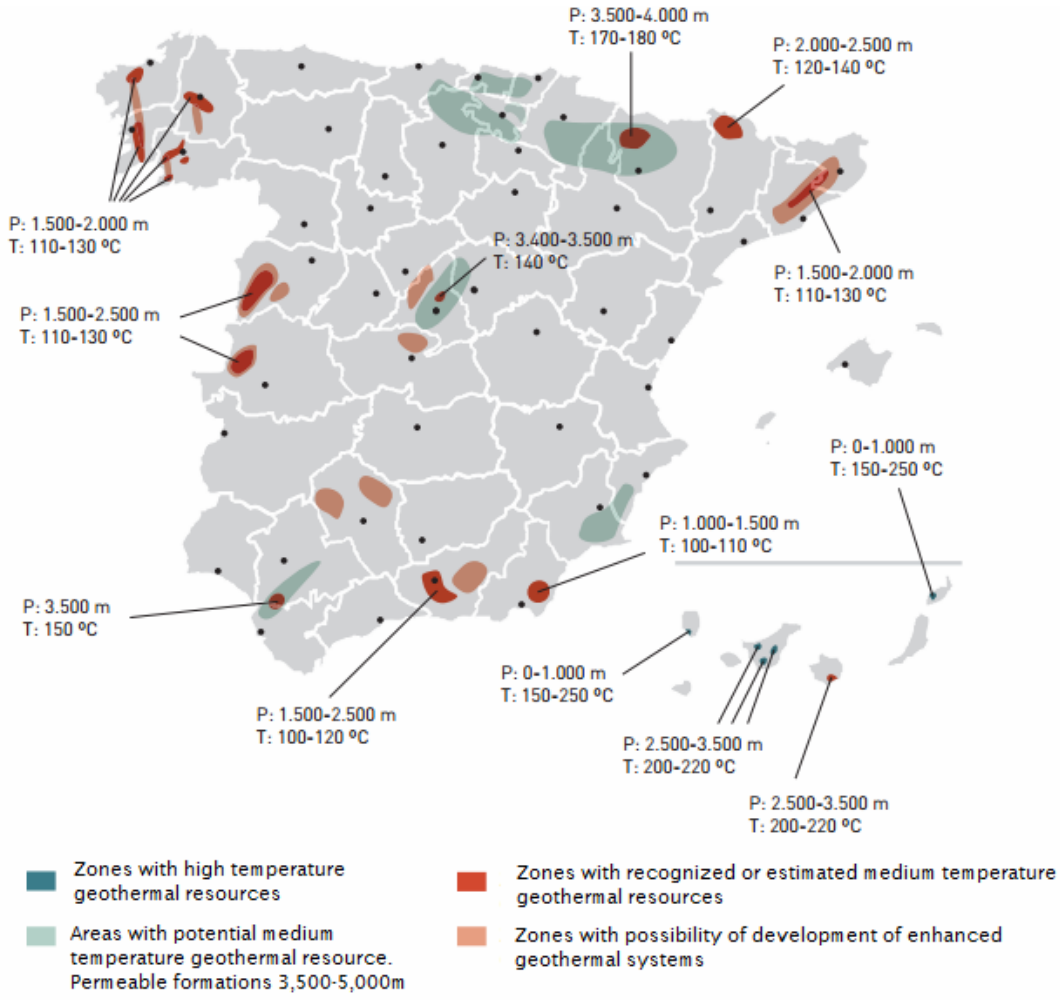


2.3 Medium temperature (150-180 ºC) geothermal resources

The great depths that characterize some geologic basins in Spain that normally host permeable formations at depths greater than 3,500 m, allows for the existence of medium temperature geothermal resources suitable to be used in binary cycles for the combined production of heat and power. At these depths, the temperature of water contained in permeable formations exceeds 100 ºC thanks to the geothermal gradient of the subsurface. In other zones, it is the considerable extent of regional fracturing that facilitates deep circulation of geothermal fluids. Thus, the areas located in the Cantabrian, Pre-Pyrenean, Tagus, Guadalquivir and Betic Range basins host deep permeable formations that contain fluids whose temperature exceeds 100 ºC. In regions where granitic materials predominate, such as Cataluña and the Hercynian Massif (mainly in Galicia, northwestern Spain), regional fracturing favors the existence of these reservoirs thanks to the presence of fluids that circulate at depth. The studies carried out by IGME as well as hydrocarbon exploration conducted by oil companies have allowed recognizing or estimating areas that can potentially host geothermal resources. These areas include La Selva and Vallés depressions in Cataluña, the zone of Jaca- Serrablo in Aragón, the northern zone of the Madrid Basin, Lebrija in the Guadalquivir River Basin, a number of internal depressions in the Bética Ranges such as Lanjarón in Granada or Sierra Alhamilla in Almeria and some disperse areas in Galicia, Salamanca and Cáceres.

The gross potential of these resources in the form of recoverable stored heat in unexplored areas amounts to 541 x 10^5 GWh, which is equal to an installed capacity of 17,000 MW(e). Geothermal resources in the form of recoverable stored heat in the abovementioned known or explored areas have been estimated at 54.23 x 10^5 GWh. Up to 1,695 MW (e) could be installed in binary cycle plants when taking into account performance, renewability and operating load factors.

Figure 2. Map of medium and high temperature geothermal resources and possible enhanced geothermal systems (Source: PER 2011-2020)



2.4 High temperature (> 150 ºC) geothermal resources

The conditions that enable the existence of high temperature geothermal resources associated with active volcanism (a phenomenon also known as conventional geothermal energy) have been confirmed in Spain only in the Canary Islands. Previous investigations conducted by IGME and other entities have highlighted the possible existence of steam reservoirs or reservoirs involving a combination of steam and water in several areas of Tenerife (in the NW, E and S of the island). In other islands (Lanzarote and La Palma), several important thermal manifestations at the surface exist which, nonetheless, do not appear to indicate any possible storage of geothermal fluid.

In the three areas mentioned earlier in the island of Tenerife, the potential existence of geothermal storage zones has been estimated at depths between 2,500 and 3,500 m and temperatures in the range of 200-220 ºC. Geothermal energy in the form of recoverable stored heat in such zone has been estimated at 1.82 x 10^5 GWh. Up to 227 MW(e) could be installed in conventional flash type plants when taking into account performance, renewability and operating load factors.

2.5 Enhanced Geothermal Systems (EGS)

The basic criteria used when selecting areas that have the potential for the development of EGS are: 1. the existence of a mass of hard granitic or metamorphic rock with low permeability at its matrix; 2. significant regional fracturing affecting this mass; and, 3. a certain degree of geothermal anomaly.

In light of these criteria, a detailed review of the peninsular geology has revealed a series of areas which, from a geological perspective, can allow the implementation of these enhanced geothermal systems. The areas considered are: the tectonic grabens of La Selva and Vallés in Cataluña, areas of deep fracturing in Galicia, the tectonic grabens in the SW of Salamanca (towns of Ciudad Rodrigo and Tormes), fractured areas west of Cáceres, the borders of the Tagus River depression, which are characterized by large-scale fractures that affect the Hercynian bedrock and lastly, areas in Andalucía where the granitic or Paleozoic bedrock are highly fractured, such as Sierra Morena or the more internal zone of the Bética Ranges in the vicinity of Sierra Nevada.

The geothermal energy that could be found in the form of recoverable stored heat in these areas has been estimated at 60 x 10^5 GWh, which would allow installing a total power capacity of 745 MW(e) when taking into account the already mentioned performance, renewability and usage load factors.

3. POLICY UPDATES

In Spain there is not any geothermal power plant mainly due to two main reasons. Firstly, the unfavourable regulatory situation within the electricity power generation sector, where the production of electricity from geothermal sources is not susceptible of receiving feed-in-tariffs of any king. Specially to mention in this context is the shift in regulation in the power sector (Order IET/1045/2014 of 16 June 2014, which completes the regulatory implementation of the new legal and financial regime applicable to electricity generation facilities based on renewable energy, cogeneration and waste) not including any mention to the production of electricity from geothermal energy.

Secondly, another limitation of the deep geothermal sector is the high investment of the first phase and the fact that it needs the support of both the public and private sector, in order to minimize risks associated with the geothermal resources investigation. Still, geothermal energy for power generation might present a clear opportunity for development in Spain given the existing potential. Also, these geothermal installations have the most competitive electricity generation costs, are 100% dispatchable and the Spanish geological frame is amenable for the development of Enhanced Geothermal Systems (EGS).

Meanwhile, the market size of the geothermal energy for thermal generation in Spain is difficult to quantify due to the lack of an official registration of the renewable heating system. Neverthelesss, certain indicators allow to estimate that the installed capacity of geothermal energy for thermal uses has kept on growing over the last three years, mainly due shallow geothermal heating/ cooling/DHW systems for residential and tertiary uses.

There has also been a progress in geothermal district heating & cooling systems. According to the information provided by the Spanish Association of Heating and Cooling Networks (ADHAC) , in Spain there are already three geothermal district heating & cooling systems. In addition, the support for the installation of geothermal heating and cooling systems and DHW in buildings (residential, industrial and tertiary sectors) is maintained through various programs and instruments:

- GEOTCASA Programme. Financing geothermal installations in building submitted by the ESCOs (Energy Service Companies). In 2015, GEOTCASA financed 12 geothermal installations in buildings, with a total installed capacity of 1,292 kW.

- GIT – GEOTCASA Programme. Financing to authorised firms of Large Thermal Installations running on geothermal in the building sector. In 2015, GIT-GEOTCASA, financed 1 project of 724 kW of installed capacity.

- PAREER - CRECE Programme - (Aids for Energy Rehabilitation of existing buildings), will continue to promote comprehensive measures to encourage energy efficiency and use of renewable energies in the existing building. It contributes also to the achievement of the objectives set out in Directive 2012/27 / EU on energy efficiency, and in the 2014–2020 National Energy Efficiency Action Plan

As long as R&D is concerned, in 2015 the Spanish participation, for the first time, in the ERANET Cofund - GEOTHERMICA initiative was announced, which was established in 2012. It co-finances R&D projects for geothermal power production by funds from the European Commission and the Member States. In Spain at least a couple of initiatives whose implementation would be strategic for the sector in Spain have been identified.

It is also to be mentioned, the relative high participation of Spanish public and private stakeholders within several Horizon 2020 projects which have been recently started within the EU Horizon Low Carbon Economy (LCE) program.

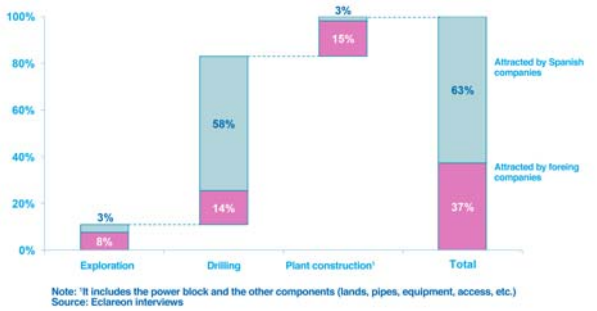
4. OUTLOOK

Generation of economic activity

The report '*Análisis del sector de la energía geotérmica en España*'. (Analysis of geothermal energy sector in Spain) published in December 2015 by the Spanish Geothermal Technology Platform (GEOPLAT), shows the economic activity that could be generated by the sector of **geothermal energy for power generation** in Spain. This indicator is calculated reducing the Spanish market value with the imports of the sector and adding the exports that generate companies based in Spain.

Analyzing the value that the Spanish companies could bring to a project of deep geothermal energy, it is concluded that over 40% of it would be attracted by domestic firms. The consulted experts point out that, as the market develops in Spain, this number could reach 50%.

Figure 3. Breakdown of investment costs and percentage attracted by Spanish companies. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)

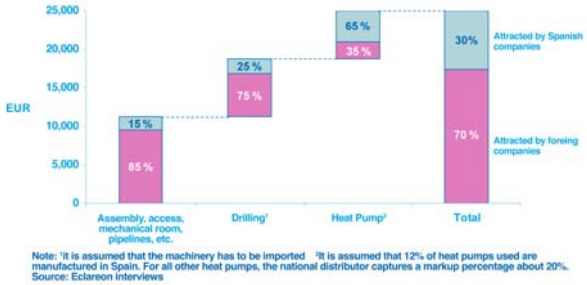


With regards to exports, it is estimated that the Spanish companies could provide engineering services and installation of the EPC, as well as other services, such as the execution of surveys and drilling. These services can be provided for plants with flash technology of a limited size (20 MW). The main focus market is Latin America. According to the experts consulted, Spanish companies could seize more than 40% of the investment value of these plants, which will have a positive impact on the national economic activity.

Figure 4. Estimated economic activity generated provided by the deep geothermal sector during the period 2012-2030. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)

Due to the moderate commercial implementation of geothermal facilities for thermal generation in Spain, almost all installer companies are local. The following figure shows the distribution of the value of a domestic-size facility, distinguishing between national and foreign companies.

Figure 5. Breakdown of the initial investment in a 15 kW geothermal heat pump for a single family home. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)

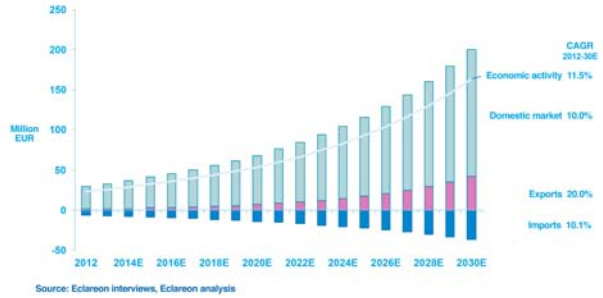


The level of the exports of the Spanish companies of the geothermal sector for thermal generation is low. It

is expected that in the coming years the exports will increase with the growth of the world market. The Spanish companies will then take advantage of the growth of the European market to increase their sales abroad.

Based on this, the economic activity created by geothermal energy for RES thermal production in Spain was estimated (see Figure 6, 7 and 8).

Figure 6. Estimated economic activity generated, provided by geothermal energy for thermal generation sector during the period 2012-2030. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)

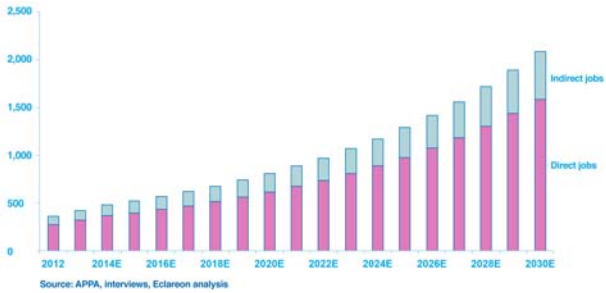


Due mainly to the growth of the domestic market, it is estimated that the economic activity generated by the sector in Spain could reach 164 million euros in 2030 with a compound annual growth rate (CAGR) f 11.5% for the period 2012-2030.

Potential employment of geothermal energy sector in Spain

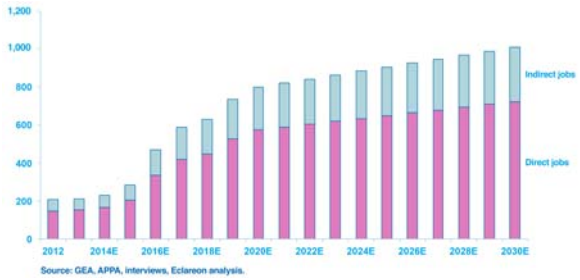
The Spanish geothermal energy sector is a 100% local industry, with potential to create thousands of new jobs. Specifically, as stated in the above mentioned report, it is estimated that geothermal energy for thermal production could generate about 20,000 jobs until 2030, concentrated particularly in operation and maintenance of facilities.

Figure 7. Estimated number of people employed annually by the geothermal energy sector for thermal generation in Spain until 2030. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)



Meanwhile, the number of jobs generated by the deep geothermal resources is particularly significant during the EPC phase, which extends from 4 to 5 years. Under this scheme, the market estimations within a 2030 scenario, considered in this report, involve the creation of 13,300 full-time jobs during the period 2012 to 2030, including direct and indirect jobs.

Figure 8. Estimated number of people employed annually by the geothermal energy sector for power generation in Spain until 2030. (Source: 'Análisis del sector de la energía geotérmica en España'. GEOPLAT, December 2015)



Technological position of geothermal energy in Spain and situation of R & D

Regarding the technological position of geothermal energy in Spain and the situation of R&D, the sector underlines the following necessary support measures that would facilitate the development of geothermal energy: the creation of geothermal departments in existing private and public R&D centres ; and new technology centres in the Spanish regions in which currently they do not exist to promote the involvement of the Spanish companies. Furthermore, according to GEOPLAT, it is shown that the stackeholders involved in R&D perform technological traction functions, and even boost the indirect development of the market in the areas of geographical influence where they carry out their research tasks.

5. CONCLUSIONS

The Spanish geothermal electricity sector needs financial support to boost the take-off of this market, through grants, soft loans or insurance during the early stages of the project, when the risk is high. Also, the sector considers that the investment and operation must be rewarded, so that the investor obtains a reasonable economic return within the project lifetime.

The Spanish geothermal sector states that there is an installed thermal capacity above 225 MWt in Spain, and that the potential of geothermal energy for thermal uses is able to exceed 50,000 MWt. In order to approach our potential, main challenges to overcome are the reduction of installation costs and the increase of system efficiency.

A further major challenge to achieve a higher implementation level is the promotion and development of district heating and cooling systems that supply residential and services areas, where geothermal energy acts as primary energy for the heating and cooling production. Moreover, in a scenario of stepwise reduction of subsidies, it is

necessary to enhance the design and development of systems for the competitiveness of shallow geothermal energy compared to conventional systems, and their implementation in areas with thermal demands beyond DHW.

6. ACKNOWLEDGEMENTS

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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 2015 *	0	0	108,299	268,508	0	0
Under construction end of 2015	0	0	-	-	0	0
Total projected by 2018	-	-	-	-	-	-
Total expected by 2020	-	-	-	-	-	-
In case information on geothermal licenses is available in your country, please specify here the number of licenses in force in 2015 (indicate exploration/exploitation, if applicable):						

* If 2014 numbers need to be used, please identify such numbers using an asterisk

Explanation to tables C, D1 and D2: 'Geothermal district heating or district cooling' (Geothermal DH plants) is defined as the use of one or more production fields as sources of heat to supply thermal energy through a network to multiple buildings or sites, for the use of space or process heating or cooling, including associated domestic hot water supply. If greenhouses, spas or any other category is among the consumers supplied from such network, it should be counted as district heating and not within the category of the individual consumer. In case heat pumps are applied in any part of such a network, the also should be reported as district heating and not as geothermal heat pumps. An exception is for distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings; systems of this kind should be reported in table E. For table D2, please give information on large systems only (>500 MW_{th}); installations with geothermal source temperatures <25 °C and depth <400 m should be reported in table E.

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for individual buildings		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2015 *	*See Table D1*		14,9*	26,2*			2,6*	14,6*
Under construction end 2015								
Total projected by 2018								
Total expected by 2020								

* If 2014 numbers need to be used, please identify such numbers using an asterisk

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

Locality	Plant Name	Year commis-sioned	CHP **	Cooling ***	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2015 produc-tion * (GW_{th}/y)	Geoth. share in total prod. (%)
Madrid	DH Aroyo Bodonal			Y	0.9			
Puerto de Pollensa (Balearic Islands)	DH&C Club Pollentia Resort			Y		8.5		
Olot (Girona)	DH Olot		Y (tri-generation system)	Y		0.97		
Total								

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** If the geothermal heat used in the DH plant is also used for power production (either in parallel or as a first step with DH using the residual heat in the brine/water), please mark with Y (for yes) or N (for no) in this column.

*** If cold for space cooling in buildings or process cooling is provided from geothermal heat (e.g. by absorption chillers), please mark with Y (for yes) or N (for no) in this column. In case the plant applies re-injection, please indicate with (RI) in this column after Y or N.

Table D2: Existing geothermal direct use other than DH, individual sites

Not applicable

Explanation to table E: 'Shallow geothermal' installations are considered as not exceeding a depth of 400 m and (natural) geothermal source temperatures of 25 °C. Installations with geothermal source temperatures >25 °C and depth >400 m should be reported in table D1 or D2, respectively. Distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings are not considered geothermal DH *sensu strictu*, and should be reported in table E also.

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

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2015 *		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2015 *		225*	315*			
Projected total by 2018						

* If 2014 numbers need to be used, please identify such numbers using an asterisk

Table F: Investment and Employment in geothermal energy

	in 2015 *		Expected in 2018	
	Expenditures ** (million €)	Personnel *** (number)	Expenditures ** (million €)	Personnel *** (number)
Geothermal electric power		206		430
Geothermal direct uses				
Shallow geothermal		549		717
Total				

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** Expenditures in installation, operation and maintenance, decommissioning

*** Personnel, only direct jobs: Direct jobs – associated with core activities of the geothermal industry – include "jobs created in the manufacturing, delivery, construction, installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration". For instance, in the geothermal sector, employment created to manufacture or operate turbines is measured as direct jobs.

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	Partially repayable loan with at subsidized interest rate. The funding modality for the project will be Partially Reimbursable Aid, with financial cover of up to 75% of the total approved budget which, by way of exception, may amount to up to 85%. Such aid may comprise a non-reimbursable tranche (NRT) which shall depend on the characteristics of the project and the beneficiary: For SMEs the NTR can vary from 10% to 30% (in case of an international cooperation project) For Big companies, the NTR can vary from 5% to 30 % (in case of an international cooperation project)		
Financial Incentives – Investment	-	-	DIS, LIL PAREER - CRECE Programme - (Aids for Energy Rehabilitation of existing buildings), Amount of subsidy for geothermal heating plants: granted by 30% http://www.idae.es/index.php/id.858/relmenu.409/mod.pags/mem.detalle

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Financial Incentives – Operation/Production	NO. The production of electricity from geothermal sources is not susceptible of receiving feed-in-tariffs of any king. Specially to mention in this context is the shift in regulation in the power sector (Order IET/1045/2014 of 16 June 2014, which completes the regulatory implementation of the new legal and financial regime applicable to electricity generation facilities based on renewable energy, cogeneration and waste) not including any mention to the production of electricity from geothermal energy.		DIS, LIL
Information activities – promotion for the public			YES
Information activities – geological information	NO	NO	NO
Education/Training – Academic	NOT YET	NOT YET	NOT YET
Education/Training – Vocational	-	-	YES GEOPLAT training course: Desing of geothermal systems. http://cursogeotermia.geoplat.org/

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)