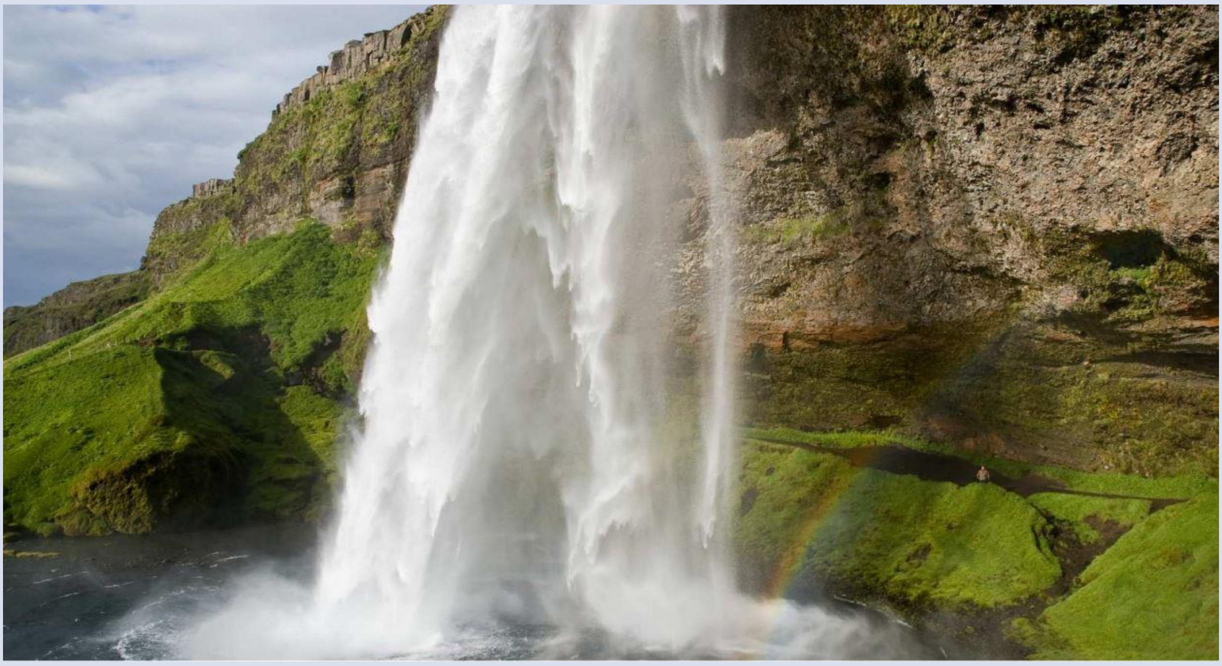
Geothermal energy status and policy review

PART A Analysis



December, 2013

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PART A Analysis

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NL Agency

December, 2013

Publisher:

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Website: http://www.geothermaleranet.is/

ISBN: 978-9979-68-356-8

The Geothermal ERA NET is supported by the European Union's Seventh programme for research, technological development and demonstration under grant agreement No 291866

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Abstract

The Geothermal ERA NET has brought together and analysed the status of and the policies concerning geothermal energy in its participating countries, including Slovenia, that has joined the consortium in a later stage.

The report is split between Part A Analysis and Part B Questionnaires. Part A is the current report and is publicly available. Part B contains the questionnaires of all countries. Please contact the relevant country contact(s) (see Appendix 1) if you want to use these

Executive Summary

The Geothermal ERA NET has brought together and analysed the status and the policies concerning geothermal energy in its participating countries, including Slovenia, that has joined in as an associated partner in a later stage.

The report is split between Part A Analysis and Part B Questionnaires. Part A is the current report and is publicly available. Part B contains the questionnaires of all countries. Please contact the relevant country contact(s) (see Appendix 1) if you want to use these.

The Geothermal ERA NET focuses on direct use and higher enthalpy uses of geothermal energy. The consortium does not consider shallow geothermal energy for geothermal heat pumps, which is a different market with its own characteristics and challenges.

Geothermal energy utilisation accounts for 66% of energy utilisation in Iceland, and one could say that the potential that this energy source holds for this country is largely deployed. Italy also has a significant geothermal production. It ranks as fifth country in the world for geothermal electricity production. After Turkey, Iceland and Italy, Hungary is ranked at 4th place regarding installed geothermal direct use in Europe. For all other participating countries, geothermal energy is an energy source with potential.

With the exception of Iceland, all countries have an ambitious agenda for an increase of the market for geothermal energy. In all countries except for the Netherlands and Slovenia, this includes a significant growth in electricity production with geothermal energy. Up to 2020, the Netherlands will focus on direct use.

In all participating countries, there are policy instruments in place to forward geothermal energy utilisation. This includes R&D efforts, but in some countries, there are also instruments to address the geological risk in the form of soft loans or guarantee funds. Also, most participating countries have a feed-in-tariff in place, for renewable energy production. Often, this tariff is only applicable to electricity generation, but in France and the Netherlands, there is also support for renewable (district) heat.

This review also discusses other relevant issues, such as the availability of geological data, legislation and statistics.

The Geothermal ERA NET sees much scope for collaboration on joint activities, such as joint research activities and joint activities to remove barriers for further market growth.

1 Background and methodology

The Geothermal ERA NET brings together energy agencies and ministries in Europe. Their aim is to cooperate on the topic of geothermal energy, to forward the joint goals of an increased use of this renewable energy source. Member countries are Iceland (coordinator), Switzerland, Germany, France, Hungary, Italy, the Netherlands, Slovakia and Turkey. Slovenia is associate member.

The work is organised in work packages. This report is part of work package 2 „Information exchange on national incentives and status of geothermal energy“. It presents the status and policies concerning geothermal energy in the member countries. Agency NL is responsible for work package 2.

The contents of this report has been brought together by member countries through questionnaires. These questionnaires had three main topics:

- the status and policies concerning geothermal energy in member countries;
- description of national programmes related to geothermal energy;
- description of national support schemes.

Besides information from the questionnaires, the authors included information from relevant international organisations, such as IEA, IEA IGA and EGEC.

The report is split between Part A Analysis and Part B Questionnaires. Part A is publicly available. Part B contains the questionnaires of all countries. Please contact the relevant country contact(s) (see Appendix 1) if you want to use these.

Data mentioned in this report stem from the questionnaires completed by the member countries, unless otherwise indicated.

The aim of this report is to support the work of Geothermal ERA NET and to identify potential for collaboration on joint activities. This will support the overall aim of the Geothermal ERA NET collaboration.

2 Status of geothermal energy in the Geothermal ERA NET Countries

2.1 Highlights on national situation per country

The ERA NET participating countries share the vision that geothermal energy has a potential that should be better deployed. In all countries except Iceland and Italy, there is an ambitious agenda to multiply the use of geothermal in the coming years. In addition, Switzerland, Hungary and Slovakia aim to produce power from deep geothermal resources, what they have not done earlier. The Netherlands and Slovenia limit their ambitions to direct use of geothermal heat. These are exiting times for geothermal industry in Europe.

Table 1 Highlights on national situation per country

CH	Relatively little use of deep geothermal energy. However, ambitious agenda for both direct use and electricity production.
DE	First geothermal power plants since 2003-2007, but the main current trend is direct use for district heat. Both direct use and power should see very significant growth until 2020.
FR	Significant use of geothermal resources, and ambitious agenda for both direct use and power generation until 2020 (more than triple the production).
HU	Huge geothermal potential, currently mostly used for horticulture and balneology. Planned is a 3,5 times increase of geothermal heat production and geothermal power production before 2020.
IS	Geothermal primary energy use contributed 66% in 2011, higher than any country in the world. Iceland wishes to increase the use of RES further (energy efficiency & smart use, transport).
IT	Long tradition in geothermal, and high potential. National ambitions are to expand the geothermal power production; however, the sector wants to develop both power and direct use.
NL	First geothermal project realised in 2007. However, steep take-off and ambitious agenda aimed primarily at direct use. Momentarily, main use in horticulture.
SI	Relatively little use of deep geothermal energy. Part of the renewable energy action plan is to expand the use of geothermal for district heat.
SK	Mapping of geothermal potential reveals average to above-average conditions, but little use at present. Direct use and power production part of energy targets 2020.
TR	Geothermal energy has a large potential, and the number of projects under investigation/construction is probably the highest among the ERA NET countries.

2.2 Geothermal energy production

2.2.1 The trouble with the data

Gathering data on geothermal energy production is not an obvious task. There are various formats and methodologies that organisations use to come to the relevant numbers. For Europe, the following data sources are relevant

- European Geothermal Energy Council (EGEC)
- IEA Geothermal implementing agreement (IEA-GIA) [1]

The net electricity production of a geothermal power plant is rather easy to assess. But how much input of geothermal energy is related to that, and – when waste heat is utilised, how is this waste heat considered in the energy balances? How about the energy for direct use, when there is no monitoring of the temperature at discharge or re-injection? How does balneological utilization count? In most cases, the abstracted amount of thermal water is used solely for swimming, and it might be necessary to cool the thermal water down before it is let in the pool. Do the data on geothermal use include the use of geothermal heat pumps? What is the efficiency that sits between production and end-use?

The Geothermal ERA NET has concluded that there is a significant difference in the magnitude and quality of data stemming from the different sources. It might be helpful to work on this issue by developing a protocol for measuring the input and the output of a geothermal energy installation, building on the existing methodologies.

2.2.2 Direct utilisation

Below, we present two graphs (Figure 1 and Figure 2) that show the magnitude of geothermal direct utilisation in the Geothermal ERA NET countries, because some countries had data on annnual production, and others on installed capacity. Between the two, there are the unknown factors of operating hours and the annual demand variation.

The graphs show the following:

- Iceland and Turkey are the largest countries when it comes to direct utilisation of geothermal heat
- Italy, Hungary and France also a sizeable market for geothermal direct utilisation, from 200-1000 MW installed capacity
- Germany and Slovakia are next in line when it comes to installed capacity and annual production
- Swiss production is almost entirely for balneology, Dutch production almost entirely for heating greenhouses.

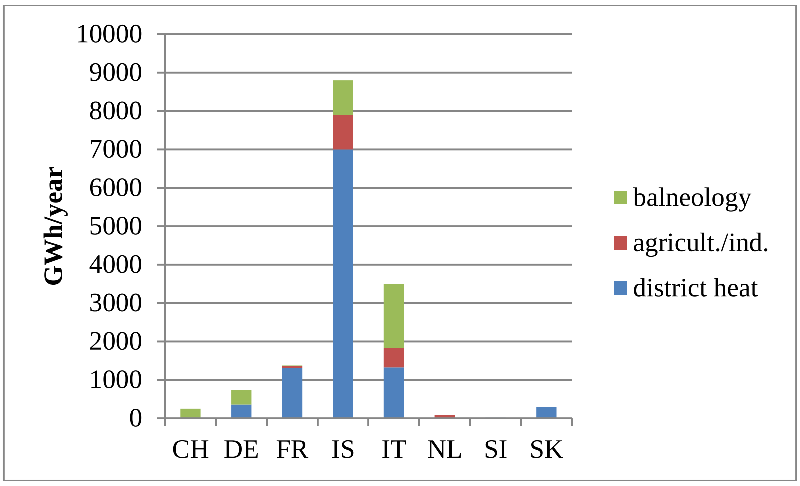

Figure 1 Produced geothermal heat in GWhth/year for different uses (2012)

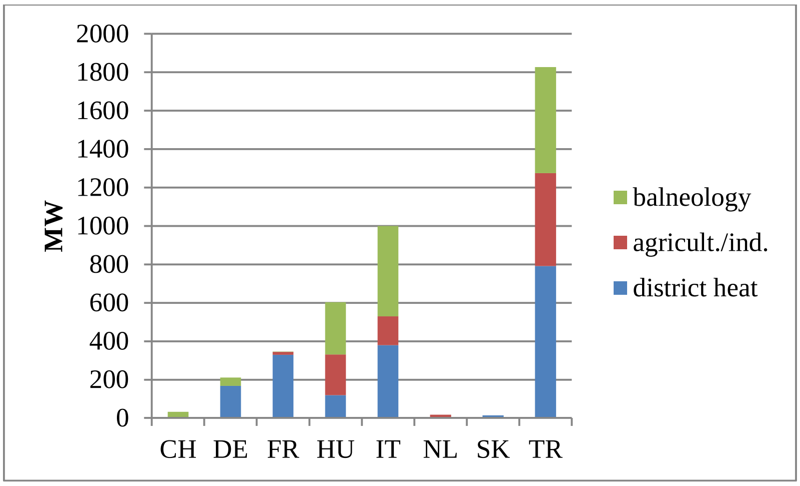

Figure 2 Installed capacity for geothermal heat production in MWth (2012)

It may be noted that the IEA data on end-use of geothermal energy for district heating show a different picture. Only DE, HU, IS, IT, SK and SI show this end use at all, and data are much lower than the data presented here.

2.2.3 Electricity generation

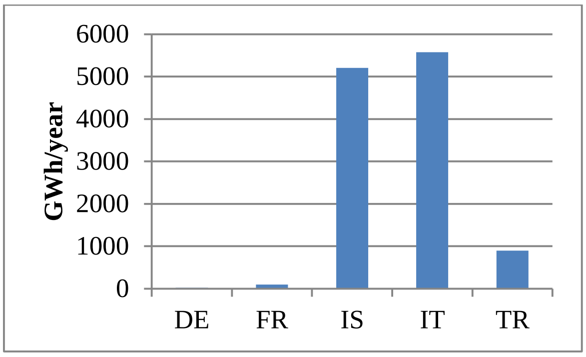

Figure 3 Electricity generation by country (2012).

Data from questionnaires (DE, FR) or IEA (2012).

There are five countries in the Geothermal ERA NET that have geothermal power plants in place today.

- Germany and France have a small annual production. In Germany, there is only 7.3 MW installed capacity. For France, there is about 18 MW installed capacity. It is noteworthy that the geothermal generation does not appear in IEA statistics for France.
- Turkish geothermal electricity production rose by a factor 10 in the past ten years, from 90 GWh in 2003 to about 900 GWh in 2012 [2]. Figure 4 shows the fast growth of Turkish geothermal power production.
- Italy and Iceland are the largest producers of geothermal electricity in Europe. Annual production was about 5600 GWh/year for Italy, and 5200 GWh/year for Iceland in 2012.

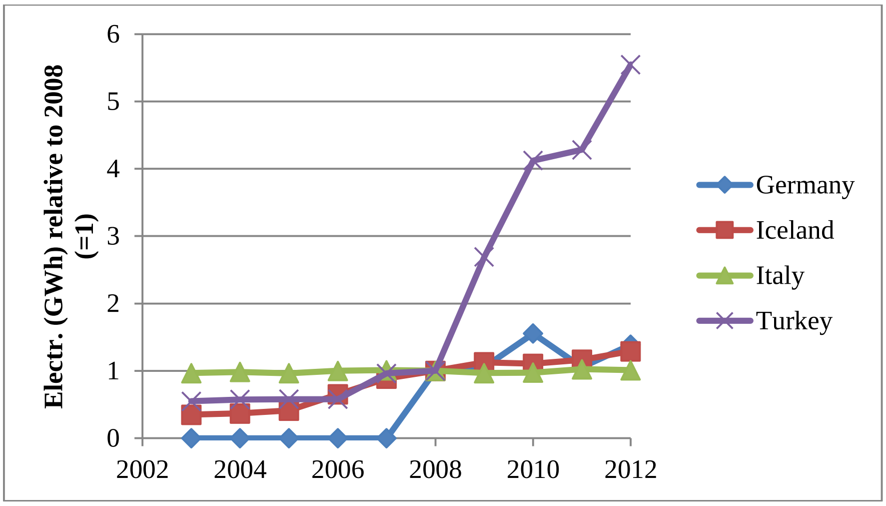

Figure 4 Evolution of electricity production relative to the year 2008.

2.3 Geothermal in current and future energy mix

To show the role of geothermal energy in the energy mix of the participating countries, we have consulted the „National Renewable Energy Action Plans“ (NREAP) of the participating countries [3] and the data from the NREAP database [4]. We have distinguished between energy for heating and cooling and electricity generation. First, the role of geothermal in heating and cooling is shown.

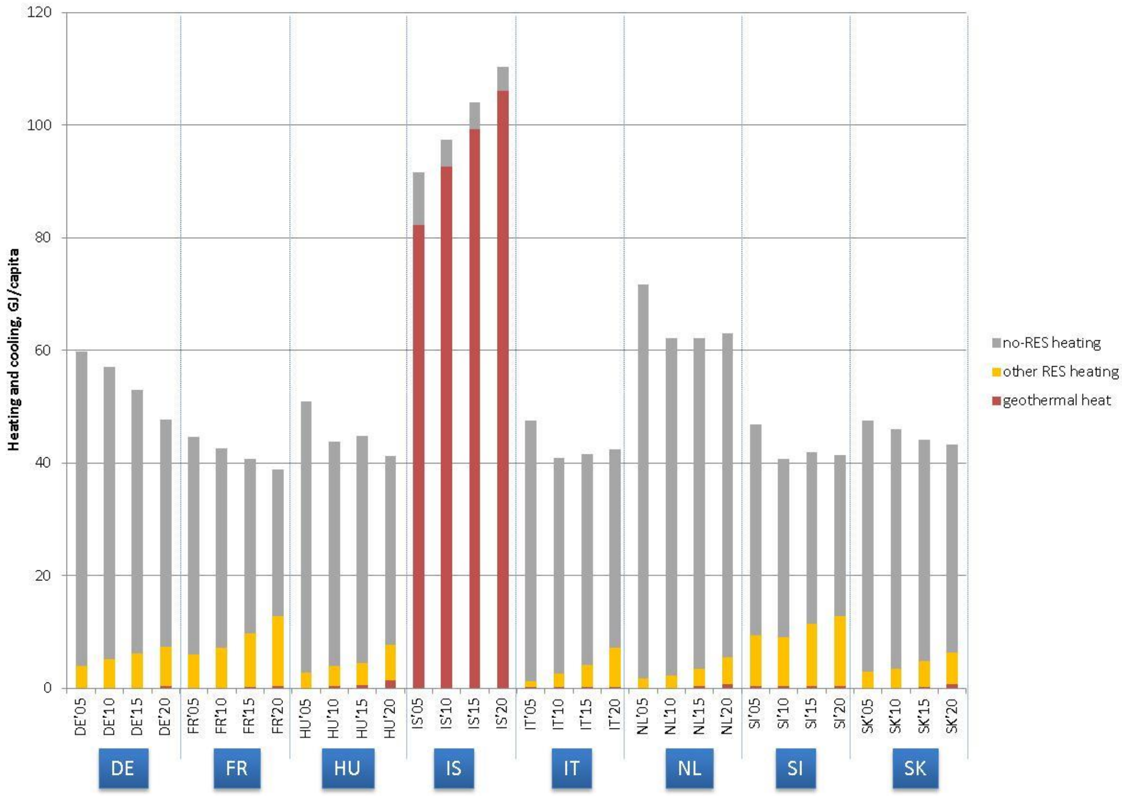

Figure 5 Final energy use for heating and cooling per capita and the role of geothermal and other RES (Renewable energy sources).

Data from NREAP (National Renewable Energy Action Plan) for DE, FR, HU, IS, IT, NL, SI and SK respectively for 2005-2010-2015-2020 years (the columns per country).

Figure 5 first and foremost shows that the role of geothermal energy in the energy mix for heating and cooling is modest for all countries in the EU. Notable exception is Iceland, where 96% of the heating and cooling energy is delivered by geothermal. For the year 2020, the countries, with the exception of Iceland, show between 0,2 and 1,5 GJ/capita heating and cooling from geothermal energy. The graph also shows that the switch to renewables is the direction for these countries, but a lot needs to be done.

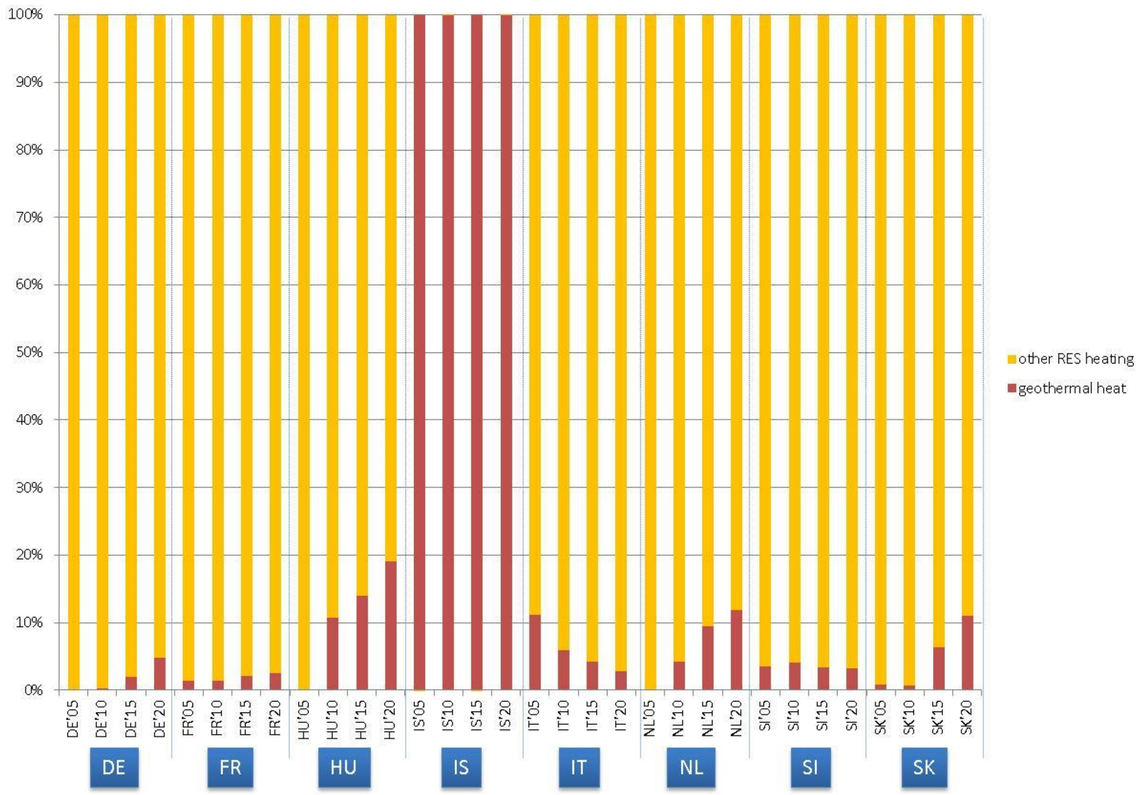

Figure 6 Role of geothermal heating and cooling as percentage of renewable heating and cooling for the years 2005-2010-2015-2020 by country.

Data from NREAP (National Renewable Energy Action Plan) for DE, FR, HU, IS, IT, NL, SI and SK.

Figure 6 shows the percentage of geothermal heating and cooling as a percentage of total renewable heating and cooling supply. In Iceland, this percentage is and will be 100%. In some other countries, such as Hungary, Netherlands and Slovakia, the percentage will be higher than 10% in 2020. In Italy, the total utilisation of renewable energy sources for heating and cooling will increase, causing a relative decrease of the percentage of geothermal.

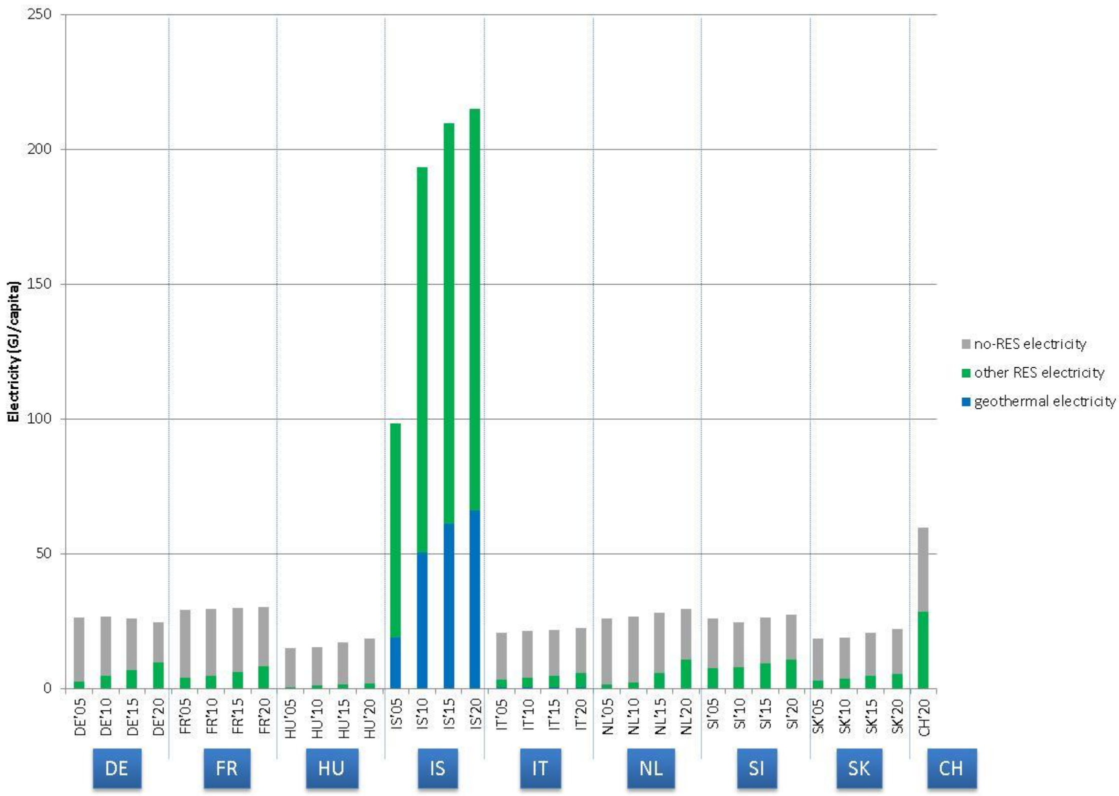

Figure 7 Electricity final use per capita and the role of geothermal and other RES (Renewable energy sources).

Data from NREAP (National Renewable Energy Action Plan) for DE, FR, HU, IS, IT, NL, SI and SK respectively for 2005-2010-2015-2020 years (the columns per country), and from the Swiss energy strategy.

Figure 7 - electricity final use per capita shows that the role of renewables in the future energy generation system will be significant. However, the role of geothermal electricity will be rather limited, except in Iceland. The differences in electricity per capita are largely due to differences in energy demand in industry, but may also a result of energy policies. E.g. Iceland is known to attract businesses with high electricity demand, such as aluminum smelters. Switzerland foresees a strong growth of electricity demand per capita.

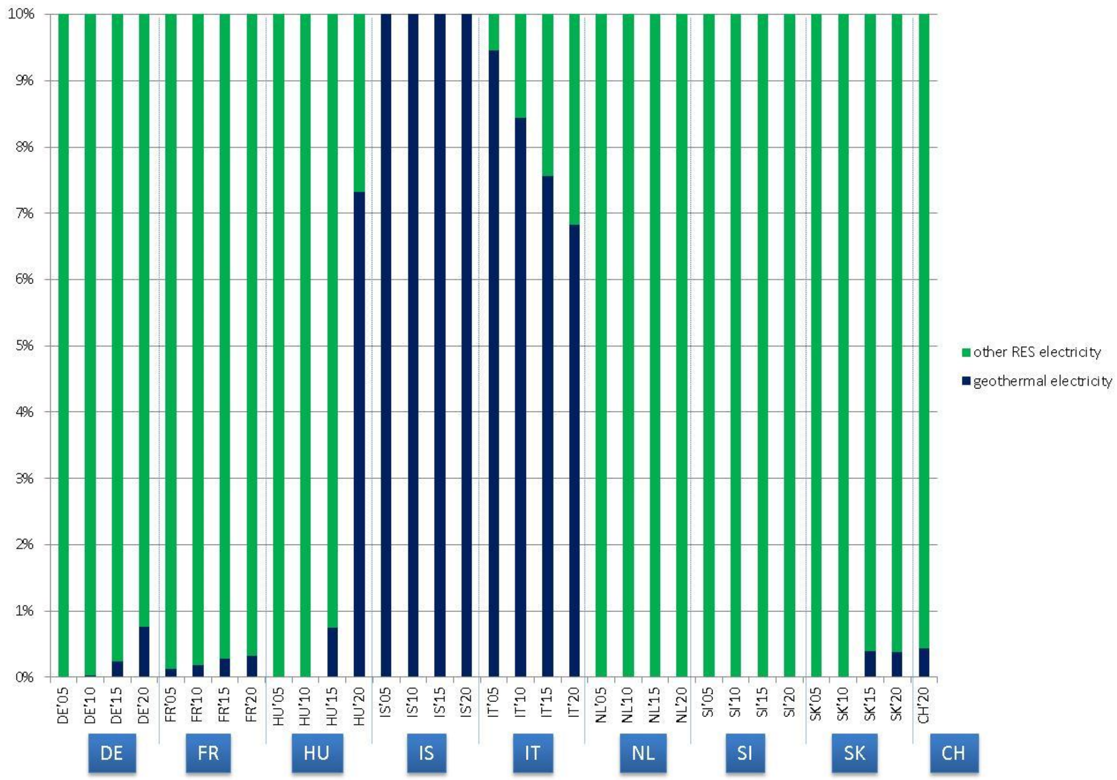

Figure 8 Role of geothermal electricity as a percentage of total RES end-use electricity for the years 2005-2010-2015-2020 by country.

Data from NREAP (National Renewable Energy Action Plan) for DE, FR, HU, IS, IT, NL, SI and SK and the Swiss energy strategy.

In Figure 8, the role of geothermal electricity is shown as a percentage of total RES source electricity. The figure shows that for Iceland, this value is above 10% - in fact, it is 30%. The scale is adapted to the other countries. There we see that in Hungary and Italy, geothermal is an important source of renewable electricity (however, Hungary is working on a revision of NREAP). There is a slight decrease in relative contribution of geothermal in Italy, as other renewable sources grow faster. For Switzerland, the relative contribution of geothermal remains rather low, but renewables and electricity demand grow very rapidly – which is also true for Germany.

It would be interesting to see these same complete data for Switzerland and Turkey. However, as they are not part of the EU, these data are not available.

2.4 Prospects

2.4.1 Direct utilisation

The participating countries presented an outlook on the prospects for the growth in geothermal heating until 2020.

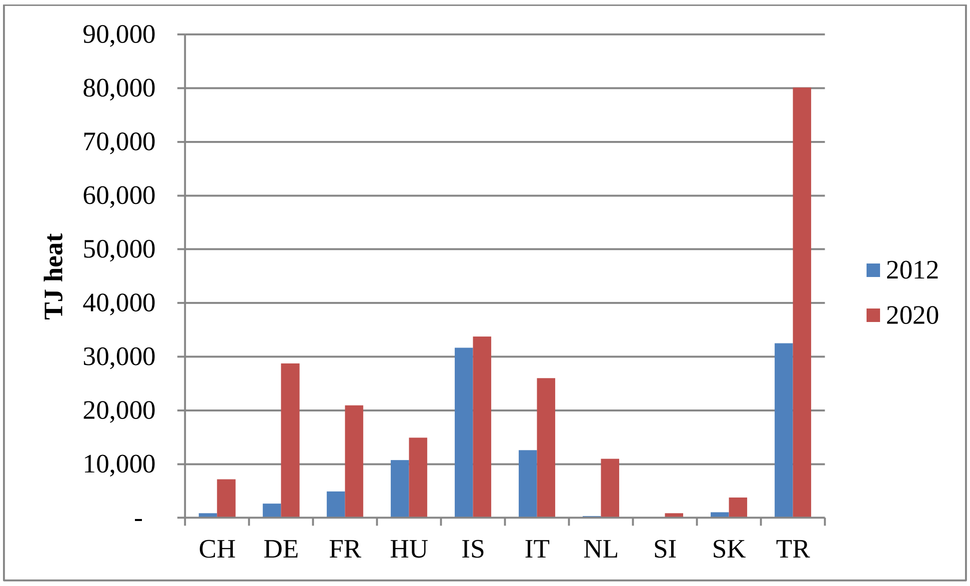

Figure 9 Ambitions for growth of direct heat utilisation, data for 2012 (total) and 2020.

*Data from questionnaires unless otherwise indicated. Data for SI from IEA. Data for HU, TR calculated from MW installed capacity in analogy to the other countries (MW*18); Ambitions for Turkey from [5] for 2015; ambitions for Italy from UGI (trade association).*

Figure 9 shows the significant ambitions of the ERA NET countries to increase the use of geothermal heat on their territory.

- Switzerland, Germany, the Netherlands and Slovenia aim to multiplicate their use by more than a factor of 10.
- Germany and Turkey expect to add more than 25.000 TJ heat utilisation to their energy mix. This is close to the order of magnitude of the full Icelandic geothermal direct utilisation. It should be noted that the ambitions for Turkey are estimations from an unauthorised source [5].
- France and Italy also foresee to add significantly to their stock. The Italian data are the strongest growth scenario of UGI, the trade association.

EGEC, the European Geothermal Energy Council, holds a different view on the potential growth of direct utilisation between now and 2015. The figure below shows the outlook of EGEC when it comes to district heating in terms of „number of systems/networks“. Remarkable is the more than doubling of the number in Germany, and also the increase by more than 10 systems in France and Hungary. Denmark and Switzerland follow suit with nearly 10 systems. In other countries, the growth remains limited according to EGEC.

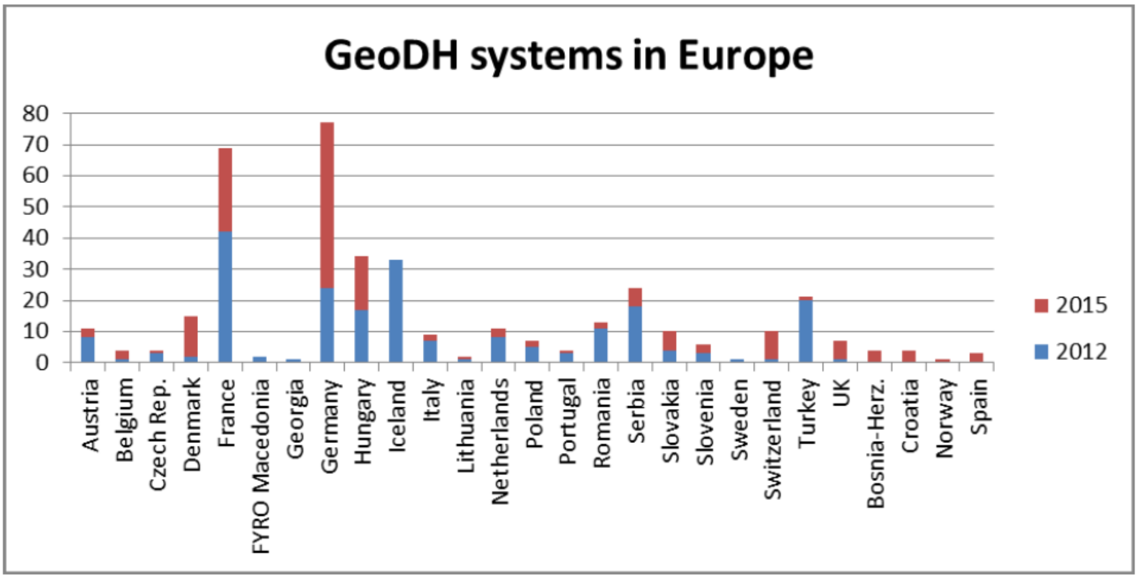

Figure 10 Number of geothermal district heating systems/networks in Europe in 2012 and expected growth through 2015 [6]

2.4.2 Electricity

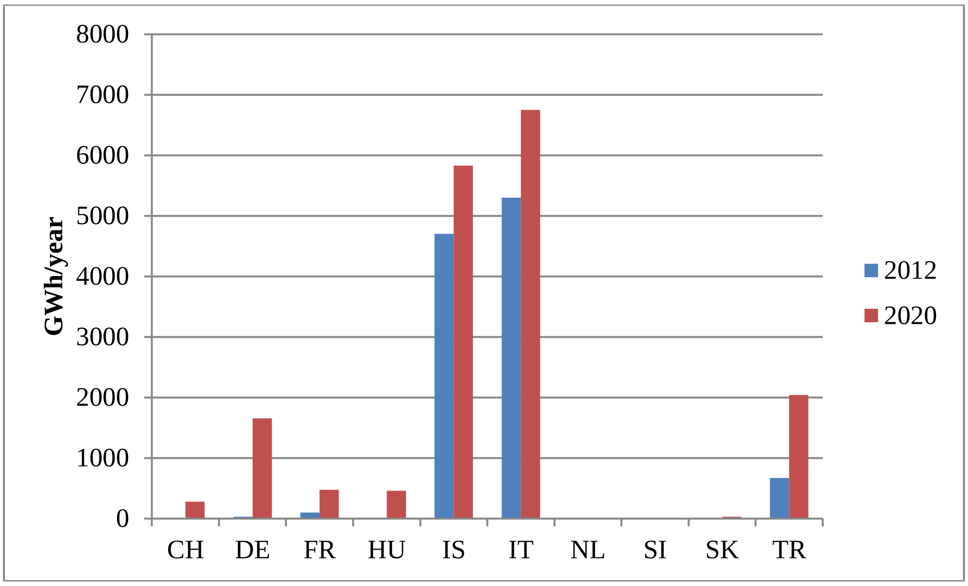

Figure 11 GWhel/year geothermal power production in ERA NET countries.

Data from questionnaires and NREAP (DE). Turkey: 2012 data IEA, ambition for 2015 instead of 2020. assumed capacity factor 0,5.

Figure 11 shows the significant ambitions of the ERA NET countries to increase the use of geothermal electricity on their territory.

- Switzerland, Hungary and Slovakia will develop the first geothermal power plants on their territory within the next few years.
- Germany, Iceland, Italy and Turkey will add about 1500 GWh/year to their produced amount of electricity. Germany starting from almost zero. (It should be mentioned that the questionnaire only informs us that Turkey will add 600 MW to its production capacity by 2015. These data have been recalculated in order to facilitate comparison. A capacity factor of 0,5 has been assumed.)

- Exceptions to this trend are the Netherlands and Slovenia, that do not aim to stimulate geothermal power production, but rather geothermal direct heat utilisation.

EGEC holds its own view on the expected growth of geothermal electricity generation. Figure 12 below shows the outlook of EGEC when it comes to electricity production capacity in 2016, compared to 2012. Noteworthy are the huge expectations for Turkey, with a growth by a factor of 10 in the next few years, surpassing Italy and Iceland. Also, it is noteworthy that many countries foresee to install their first plants in the next few years. Also Germany will – according to EGEC – multiply its installed capacity by a factor of 10, but the resultant capacity is still below 100 MW.

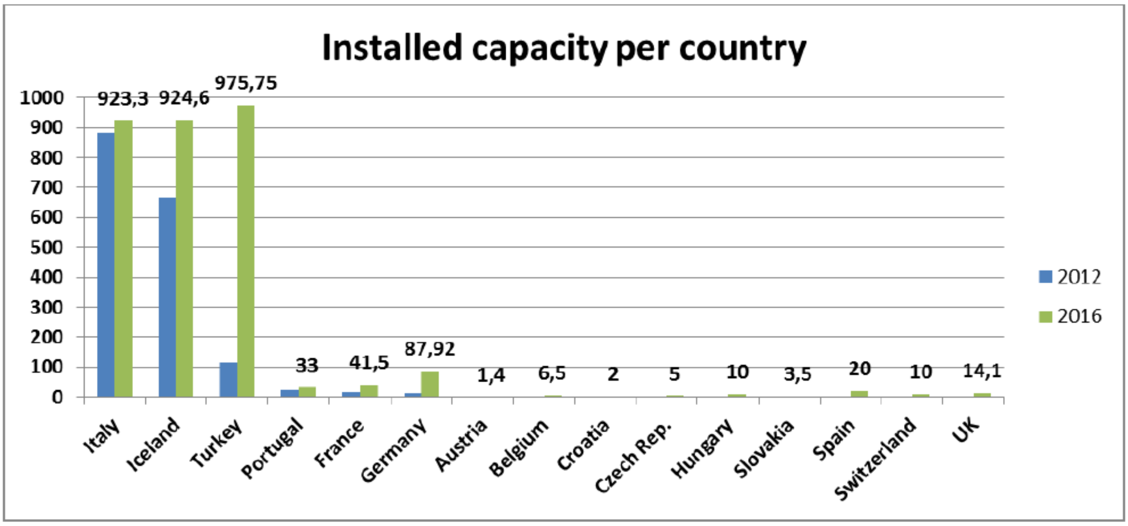

Figure 12 Installed capacity (MW) per country and outlook for 2016, according to EGEC [7]

2.5 Energy prices

2.5.1 End-use prices of electricity and gas

Energy price levels are relevant parameters when considering alternative methods of heat or electricity production. The graphs below show an overview of end-use energy prices per 2012 as gathered by IEA [8] and an additional reference for Iceland [9]

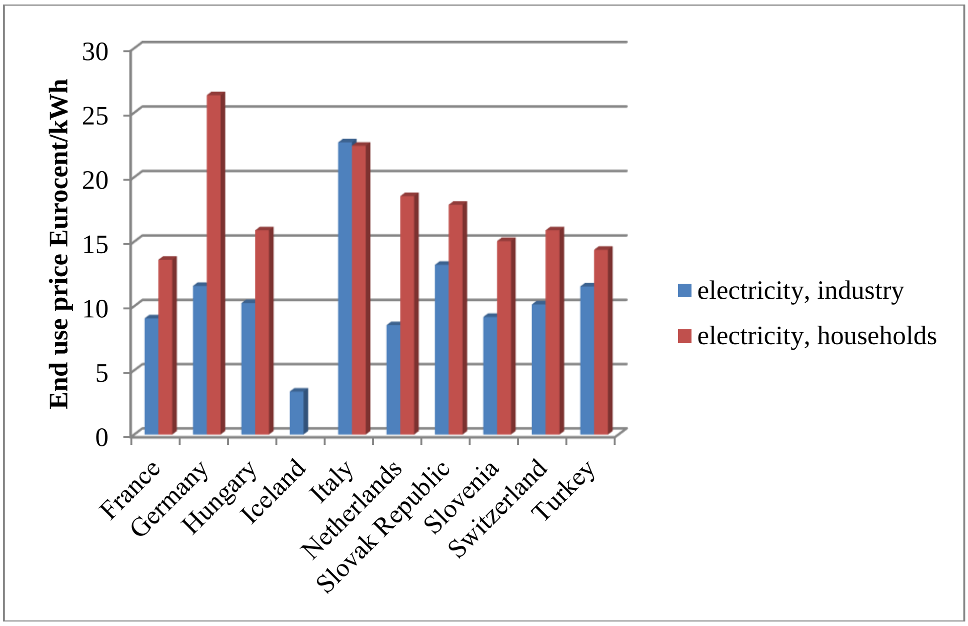

Figure 13 End-use electricity prices in participating countries

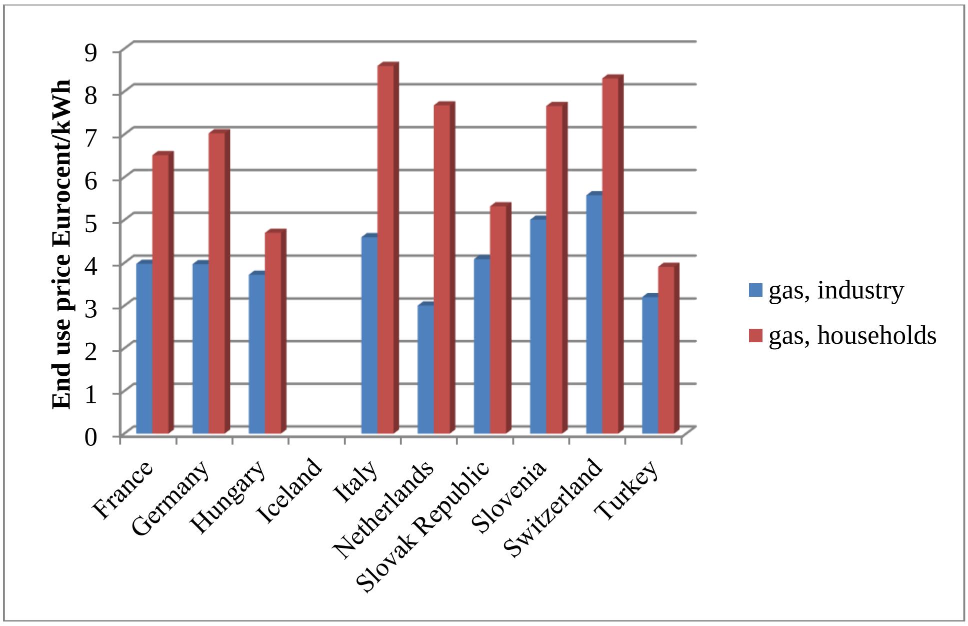

Figure 14 End-use natural gas prices in participating countries.

(Data from IEA; for Italy from Autorità per l'energia e il gas)

Concerning electricity prices it is noteworthy that electricity is very cheap for industrial uses in Iceland. Furthermore, it is noteworthy that Italian industry pays a high price compared to other countries, and the same is true for German and Italian consumers. These prices include taxes. German consumers pay about twice as much as French consumers for the same product. The potential electricity price evidently has an important impact on the profitability of geothermal power projects, though an analysis of the share of taxes would be required to reveal more detail.

Figure 14 represents the price for heat, in terms of the end-use prices of natural gas. A low price level is available for industry in the Netherlands. On the other hand, Dutch consumers pay a high price, comparable to the Swiss and Slovenian gas price situation. These people pay double compared to Turkish consumers. The prices also include taxes.

2.6 Prices of geothermal energy

Prices for production of geothermal energy will always show a range, because the price is very much dependent on the quality of the resource and technology. Also, the price comparison in this section can also be interpreted as "indicative" since the methodology in countries may have differed (e.g., is the investment in the district heating network considered as part of the price). This said, the ERA NET countries have brought together some information on the prices in their countries. These are production prices.

To convert from Eurocent/kWh to €/GJ, multiply by 2,78.

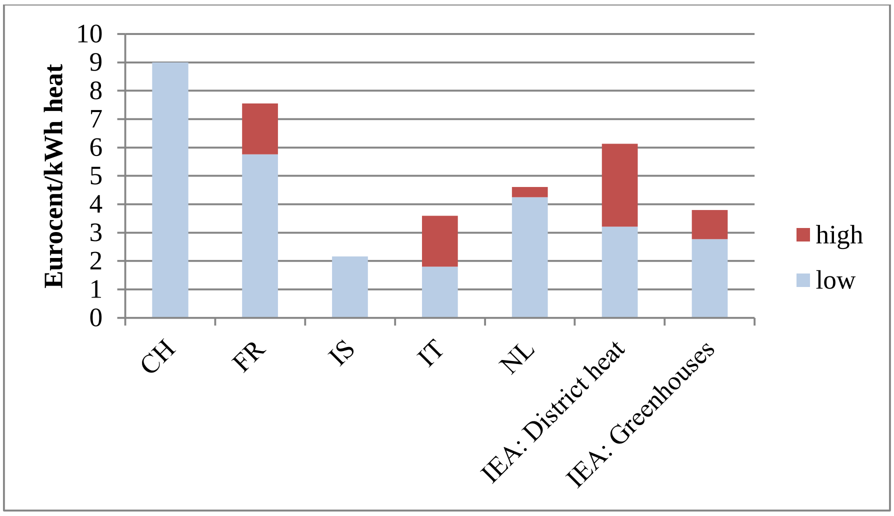

Figure 15 Indicative production prices of heat for direct utilisation. "IEA" prices from [10], differentiated between district heat and greenhouse utilisation.

Figure 15 brings together data on heat production. The figure compares the prices mentioned by the member countries with the estimations which IEA proposes in [10]. A comparison with the prices of natural gas, shown in Figure 14, suggests that in many countries, heating by fossils fuels competes with direct utilisation of geothermal heat. (Of course, the competing heating technology will not be gas in all countries.) The IEA view on the price of heat shows a limited range, compared to the range indicated by the ERA NET countries.

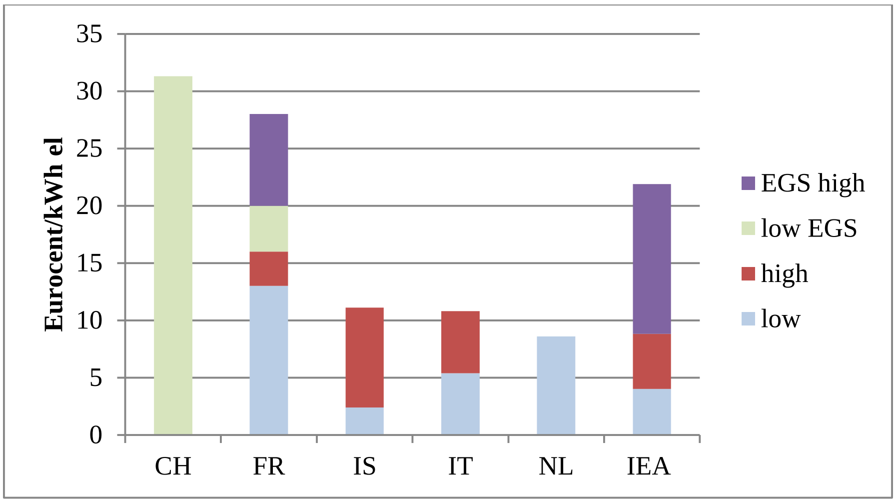

Figure 16 Indicative production prices for electricity. For Iceland: end-use prices; For the Netherlands, combined heat and power assumed; price per "total kWh".

Figure 16 brings together data on electricity production. The figure compares the prices mentioned by the member countries with the estimations which IEA proposes in [10]. A comparison with the end-use prices of electricity, shown in Figure 13, shows that in some countries, geothermal power seems more expensive than the current end-use price level, where in others, most notably Italy, the production of geothermal power would be one of the preferred options. The higher production price of geothermal electricity compared to conventional sources is evidently the reason why so many countries have feed-in tariffs in place – see sections 4.2 and 4.4. The IEA view on the price for geothermal power is more moderate than indicated by the ERA NET countries. Their database is broader than Europe-only and it evidently includes very good geothermal resources.

2.7 Highlights, policy and prospects of national situation per country

The table below brings together descriptions of the national situations and prospects per country. A few joint characteristics of the Geothermal ERA NET participating countries:

- All countries have geothermal projects in place. Most geothermal energy use is district heat use;
- Many countries have high ambitions for implementation of geothermal electricity generation compared to the capacity now in place;
- In some countries, there are instruments to further increase this renewable heat utilisation. But many countries see increasing the role of geothermal power production as their real challenge when it comes to geothermal energy today. Instruments for futhering renewable electricity generation are in place in all countries.

Table 2 Highlights of policies and prospects per country

CH	- Currently, a few direct heat utilisation systems in use.
	- Also, some ten new geothermal projects are in the pipeline, including electricity production and direct utilisation.
	- 2012: Parliament accepted Energy Strategy 2050, with the following characteristics:
	    o Reduce demand
	    o Exit nuclear in a phased manner
	    o Maintain ambitious goals for greenhouse gas emission reduction
	- Geothermal energy, including geothermal power production, is expected to play a key role in meeting the government’s targets. This means a very ambitious agenda for the increase of geothermal capacity in Switzerland.
	- Switzerland has a fund that covers a guarantee scheme for finding geothermal resources for power generation, and some cantons for heat.

DE	- Until the year 2000 deep geothermal energy was mainly used for district heating at a few locations. - From 2000: introduction of the Erneuerbare Energien Gesetz (EEG) / Renewable Energy Source Act; significant interest for geothermal power production rose up. - 2007: the first German industrial power plant for the generation of electricity and utilisation of heat with year round availability in Landau, Pfalz with an installed capacity of 3,3 MW electricity began operation. Early 2008, the CHP plant in Unterhaching followed suit with 3,4 MW. - 2008: “Act of the Promotion of Renewable Energies in the Heat Sector (EEWärmeG)”. All owners of new buildings are obliged to purchase part of their heat demand from renewable energy sources, e.g. heat pumps, geothermal heat. - 2009: “Market Incentive Programme” supporting renewable energies in the heat market, investment subsidies. - Loan programme for deep geothermal drillings, which hedges discovery risk. - From 2011: Feed in tariff €250/MWh for geothermal power and €300/MWh for EGS systems. However, business case very uncertain and depending on the actual nature of the resources found. - Current trend is for direct utilization of geothermal heat. Electrical power generation is still in focus, but in the development phase.
FR	- Long history of direct use since 1961 in the Paris sedimentary basin and also in Aquitaine. Presently, there are 36 geothermal doublets and 31 district heating networks in the Paris region. In Aquitane, there are 10 single-production wells. - Since 2007 renewed interest for these operations; 2-4 operations per year (new doublets or rehabilitations of old doublets). - 1986: The single French geothermal power plant has been installed in Bouillante (Guadeloupe, French West indies). A second unit there was started in 2004. - 2005: new policy ‘Grenelle de l’environnement’. Geothermal heat is expected to be multiplied by 5-6 between 2006 and 2020 and an amount of 80 MW of geothermal power is expected to be installed in the overseas department in 2020. - 2008: EGS pilot plant in Soultz-sous-Forêts entered operation. - 2013: a new EGS project is being drilled in the Rittershoffen area, aimed at heat production in the industrial sector (biorefinery). - 8 permits delivered for high temperature geothermal exploration in 2011-2013.

HU	- Hungary is a country with outstanding geothermal potential and a long tradition, due to the favorable geological, hydrogeological and geothermal conditions of the Pannonian Basin in Central Europe. - 1865: first geothermal well drilled, followed in 1868-1878 by the deepest well of Europe at 970 m, producing 1200 m3/day and 73.8°C. - 1958: agricultural use of geothermal energy began - 1990: expansion of direct heat utilization. There are 111 communities with district heating networks, but only 9 of them use geothermal energy. In addition, there are 17 heating networks for smaller groups of buildings, using geothermal, and only providing a base load. - Major use is in agriculture - 2011: Szentlőrinc, district heating 100% based on geothermal. A major new geothermal-based district-heating system (Miskolc-Mályi) is under construction (2013). - No electricity generation with geothermal yet – but a recently awarded NER 300 support for an EGS pilot project in SE-Hungary gives high hopes for geothermal-based power generation by 2020. - High ambitions for increasing the geothermal electricity production in NREAP.
IS	- Iceland has excellent geothermal resources and a long utilisation tradition. - 99% of houses are heated with renewable resources, of which 91% geothermal energy. - 100% of electricity generation is with renewable resources – most of which hydropower, and the remainder geothermal. - Some growth of geothermal electricity generation is expected. - The real challenge for Iceland is in the transport sector that is still dependent on fossil fuels.
IT	- Italy is has excellent geothermal resources in many large areas. Geothermal heat use has a very long tradition. Italy also hosts the world's first commercial geothermal electricity plant, which started operation in 1911. - Italy is the 5th country in the world for geothermal electricity production (after USA, Philippines, Indonesia, Mexico). - All geothermal power generation is located in Tuscany, Central Italy, with 35 units, 308 production wells and 69 reinjection wells. - There are 14 major district heating networks in operation. - Beside balneology (31%), there are also several direct uses including greenhouses (13%), fish farming (13%), and industrial process heat (3%). - Policies for increased utilisation of renewables include geothermal, but specific policies or roadmaps for geothermal energy do not exist. The 2020 targets for geothermal energy show no ambition for expansion. - From 2002: stimulation of electricity production from renewables by an increasing obligatory quota (2013: 8,3%) of renewable production per operator. - 2007: Green certificates modified: offer support for additional cost and average market price for electricity - 2012: new law for feed in tariffs. - Attention for direct heat utilisation recently experienced an upswing, which could lead to a policy more focused on heat utilisation as well. - The views of the Italian association for geothermal energy are more optimistic than the government's targets.

NL	- Utilisation of geothermal energy is in its infancy and growing fast in the Netherlands. - 2007: the first project started operation, in a tomato greenhouse. - 2009: introduction of a state risk insurance possibility - 2011: Government announced its “Action plan geothermal energy” (Actieplan Geothermie). Focus for 2011-2020 is on direct use. - 2012: introduction of a subsidy on renewable heat production - 2013: 8 projects are in operation, mainly in greenhouses and at least 20 additional projects are in the pipeline. - Outlook is that the market will grow at a quick pace, in the wake of the subsidy for renewable heat. - Interest to drill deeper and get higher temperatures is increasing, but there is debate concerning the geological situation that could be expected at that depth.
SI	- Not available
SK	- Slovakia has average to above-average conditions for geothermal energy uitlisation. - To date, no geothermal power plant; several geothermal sources for direct use (district heating and agriculture) - There are some new geothermal district heating systems in small towns - A geothermal power plant in Svinica-Durkov is under construction (3,5 MWe).
TR	- Geothermal energy is mostly used for direct heating applications. - Second largest application is for electricity production. - Turkey has good resources for use of geothermal energy - Prospects are an increase in the use of geothermal energy in Turkey, both for district heating and for electricity generation.

2.8 Conditions for growth

Conditions, necessary for further growth of the utilization of geothermal energy in general fall into a few categories:

- Financial: instruments that meet the challenges of high investments, uncertain success, long pay-back period for district heating systems;
- Legislation/regulation: a need for adequate and transparant legislation. Lead time for permits should be reasonable;
- Political: a policy is in place;
- Geological issues: knowledge of the resources, availability of relevant data, knowledge on re-injection issues;
- Geographical: match of availability of resources and demand;
- Education and training: (sufficient) trained personnel;
- Organisational: specialised and structured economic sector;
- Awareness: awareness of the possibilities of geothermal electricity/heat utilisation;
- Public acceptance: induced seismicity, visual aspects.

The table (Table 3) below summarises specific issues per country, which are conceived as hurdles to further growth of the geothermal market. The issues that are *not* conceived as hurdles in a specific country are not mentioned. This does not necessarily mean they do not exist, but they may be addressed by specific programmes or schemes.

Table 3 Perceived hurdles to growth of geothermal energy utilisation per country

CH	- Lack of knowledge with respect to the deep subsurface of Switzerland. - Lack of proven technology with respect to EGS reservoir development (i.e. stimulation). - Power production: lack of standardized power generation facilities - District heating: economics poor - Lack of geothermal operators and developers - Lack of a standardized (i.e. country-wide) regulatory framework
DE	- The main issue is financial, especially for electricity production, because its profitability is regarded as very risky
FR	- Needs for the further development of geothermal energy: o the development of economically optimised geothermal solutions, o the need of a specialised and structured economic sector, o the identification, characterization and valorization of the resources, o a sustainable development of geothermal energy and the minimization of environmental impacts. - Research, development and demonstration must be more intensively supported. - Financial: a higher feed-in tariff is needed in the overseas department, as well as a risk mitigation scheme for the geothermal projects generating electricity.
HU	- Insufficient know-how on re-injection into Upper Miocene (Pannonian) sandstones, which is the most deployed reservoir for geothermal. Complicated and non-transparant legislation - Lack of consistent and uniform geothermal data sets and statistics - Insufficient financial incentives, lack of risk mitigation schemes

IS	- For power – increase in capacity expected over next few years. However, environmental issues (e.g. visual impact) and low electricity prices are issues that may hamper further growth. - For direct use: 91% of households are heated with geothermal energy. Much growth cannot be expected. Subsidies for remote communities to compensate for higher price of oil decrease stimulus to convert to geothermal.
IT	- The (feed in) tariff is known only up to 2015, and operatars are not motivated to proceed further. - No policy for geothermal; too few incentives for thermal uses; no framework for strategic utilisation of funds for research activities. - Insufficient awareness - Some problems related to acceptance (NIMBY) - Regulatory gaps for small local utilisation and long lead time for permitting - Availability of geological data, even to research organisations - High risk in seismic and volcanic areas also in relation to high population density - Technical issues that need attention o Drilling technologies, to reduce timing and costs o Geothermal well completion (high temperature/pressure fluids) o Geothermal power plant efficiency o Technologies to exploit unconventional geothermal resources
NL	- Main hurdles for direct use: o Financial. Banks have become more hesitant when supporting projects. o In Eastern parts of the country, lack of geological data. o Number of drilling rigs limits growth. o Dealing with coproduction of oil & gas - Main hurdles for application of geothermal energy for electricity: o Very deep and therefore expensive drilling is required o Concerns about public acceptance of well stimulating/fraccing techniques.
SI	- Not available
SK	- Technical: o High costs to obtain reliable data o High construction costs o High drilling costs o High maintenance costs - Non-technical: o Missing funding and grant opportunities o Lack of adequate professionals and know how o Lack or inadequate facilities / incentives o Missing preferences (taxation, etc.)
TR	- Limited awareness - Limited educated personnel

2.9 Legal aspects

A smooth and transparent permitting process for geothermal projects is a prerequisite for a well-functioning market for geothermal energy production. There are several issues that need to be addressed in regulations:

- The ownership of the underground resources;
- Permits for exploration and exploitation of resources;
- In some countries, geothermal projects may fall under (ground)water laws
- Environmental and building permits;
- In case of electricity production, regulations related to electricity production;
- Requirements concerning public availability of geological data obtained during exploration and production;

Some countries mentioned a complex and non-transparent legislation, or regulatory gaps for smaller projects. This brings uncertainty to potential investors and needs to be addressed.

Table 4 Legal aspects for geothermal energy per country

CH	There is no standard set of acts, ordinances or any other regulation concerning geothermal wells. The cantons establish an ad-hoc procedure to permit deep geothermal wells. Of course, general regulations concerning infrastructure- and energy projects apply (e.g. Environmental Impact Assessment, Noise Impact Assessment etc.).
DE	Geothermal projects need permits on the basis of the following laws: - Pollution control legislation (local authority) - Building legislation (federal states) - Federal mining act (federal states)
FR	Exploration and production of geothermal resources fall under rules of licensing provided by mining law. Relevant aspects: - Different licensing authorities are competent and different rules of licensing apply depending on the temperature of the targeted resource (above or below 150°C) - Two-step process: license for exploration and license for production - Additional authorisations for underground works (drillings) regarding the prevention of environmental impacts.

HU	- Subsurface (ground)waters and geothermal energy are State property.
	- Two decisive parameters for legislation of geothermal projects: whether groundwater is abstracted (or reinjected), and the depth.
	    o Projects < 2500 m operate on a water license when they abstract water, and under the Water Management Act (which is permission for exploration and exploitation of geothermal energy too at the same time).
	    o Projects > 2500 m (amended 2010) operate under a concession system and under the Mining Act, whether or not they abstract water.
	- The Minister calls a public tender for concession. Prior to awarding a concession, a complex vulnerability and impact assessment (CVIA) is required. The concession is a 3D block starting below 2500 m.
	- Requirements for a water permit are an environmental impact assessment for groundwater abstraction activities (with or without reinjection) that exceed a certain amount.
	- 1995: Act on water management states the priority of use, where energetic utilization is ranked low. It also states that waters abstracted for geothermal-energy-only needs to be reinjected, however this is defined case-by-case.
	- Work is ongoing to harmonize requirements in Hungarian law, which are sometimes contradictory, stemming from the “water protection” aims of the legislation pertinent to water, and the “responsible use” aims of the mining laws.
	- Production of geothermal energy is subject to a mining fee and a water fee, while abstraction of water for balneology is only subject to a water fee.
	- The Hungarian input to the Status and policy review contains a thorough description of the Hungarian law pertinent to geothermal energy production.

IS	- Ownership of resources based on ownership of land – however, much land owned by the Icelandic State.
	- Exploration and utilisation subject to permitting, irrespective of ownership of the land.
	- Applicable law for geothermal projects:
	    o Act on Survey and Utilisation of Ground Resources
	    o Electricity Act
	    o Nature Conservation Act
	    o Planning and Building Act
	    o Environmental Impact Assessment Act
	For further information on Acts that regulate geothermal utilization see the following link: http://www.geothermal-energy.org/pdf/IGAstandard/WGC/2010/0319.pdf

IT	- Italian geothermal resources belong to the “mines” category, property of Italian State, and they are subordinated to a concession system.
	- Three types of resources:
	    o National resources: T > 150°C, Q > 20 MWt & offshore;
	    o Local resources: T<150°C, 2 MWt < Q < 20 MWt;
	    o Small local utilization: Q< 2MWt and depth < 400 m b.g.l.
	- Necessary licenses for National and Local resources are:
	    o Environmental impact assessment – approval required for mining permits
	    o Exploration permit: determination of geothermal resources on a specific area;
	    o Mining Lease: exploitation of geothermal resources on a specific area (30 years).
	- The “small local utilization” requires a simplified procedure.
	- Authorities in charge for National and Local resources are the Italian Regions; for off-shore and pilot plants, it is two Ministries and the Regions.
	- Data acquired during exploration and exploitation are provided to the reference Region and remain confidential up to 10 years after the end of the concession.

NL	- Environmental and planning permission, the so-called “WABO” permit. Application to local community. - Exploration and production licence (> 500 m depth) under the Mining Act. Application to the Ministry of Economic Affairs. After the exploration licence is granted, and the well performs as desired within 4 years, the exploration licence can be changed in a production licence. There are no fees. - Reinjection is required. - Data acquired during exploration are public from 5 years after acquisition. - The permitting process is also described in English on www.nlog.nl.
SI	No input
SK	- Exploration of potential geothermal resources is considered a temporary activity, which would in principle lead to removal of the geological constructions that have been used for exploration purposes. - Slovak law allows for the reclassification of such objects from category "geological work" to category "water works" and a subsequent transfer of property when such a construction will be used for geothermal energy production.
TR	The legislations are determined under the supervision of Turkish Republic Ministry of Energy and National Resources. Some information can be found here [6]

2.10 Where to find spatial data, monitoring and statistics?

2.10.1 Spatial data

Table 5 below gives an overview of geothermal spatial datasets available in the participating countries, along with the responsible organisation(s).

It is important to note that the mining law requirements for availability of the data differ widely between countries. In the Netherlands, the law requires that borehole data will be made available after 5 years after drilling. In Italy, however, the requirement is that data become available 10 years after the end of the concession (30 years).

Table 5 Spatial data sets, organisations and availability

	Name	Organisation(s)	Status
CH	Atlas des ressources geothermiques de la suisse occidentale; Geothermischen ressourcenatlas Der Nordschweiz	Swisstopo; cantonal administrations	🕮 n.p.a.
DE	Geotis information system (i) Geothermal potential (ii) Geothermal installations	LIAG	💻 f.a.
FR	(i) Infoterre: geological maps, boreholes; geophysics; (ii) BEPH: oil and gas data (iii) Therm2Pro: pilot tool for geothermal prospects and parameters	BRGM	💻 f.a. o.r. f.a.
HU	(i) National Geothermal Energy Register: “mining permit” 143 wells; (ii) Thermal water production register: 580 thermal wells; (iii) Geophysical data: borehole, geological maps	(i) Hungarian office for mining and geology; (ii) National Institute for Environment; (iii) Geological and Geophysical Institute of Hungary	n.p.a /o.r
IS	Geoportal: borehole, geothermal wells and power database in shp and excel	Orkustofnun Iceland GeoSurvey Icelandic Institute of Natural History	💾 o.r.
IT	(i) Exploration and production consessions (ii) National geothermal database	(i) Ministry of Economic Development (ii) CNR IGG	f.a./n.p.a. 💻 f.a./o.r.
NL	(i) NLOG: geophysical data: seismics, logs, boreholes; (ii) ThermoGis: geothermal potential data: temperature, permeability, reservoir thickness;	(i) (ii) TNO (Geological survey)	💻 f.a.
SI	n.a.	n.a.	n.a.
SK	Geothermal Atlas	State Geological survey of Dionýz Štúr	💻 f.a.

TR	Spatial data sets	Ministry of Energy and National Resources	☎ o.r

**Info:*
n.a. not available
n.p.a not publicly available
f.a. free access
o.r. on request

2.10.2 Monitoring data

Table 6 below gives an overview of monitoring activities in the participating countries, along with the responsible organisation(s). The information is very brief and there is little information on (public) availability. Concerning production data, proprietary information is at stake, and there are apparently no countries that have mechanisms in place to demand or make sure that such information would become public.

Table 6 Monitoring activities by country

	Context and purpose	Organisation	Available?
CH	Not a task of the federal government	-	
DE	No legal or governmental monitoring; but Geotis is a valuable source	LIAG	
FR	(i) Renewable heat fund (ii) Dogger database (Parisian deep aquifer) - collecting data from the running operations and the associated monitoring	(i)ADEME (ii) BRGM with ADEME financial support	?
HU	(i) Mining fee based on self-declaration (ii) Water production data abstraction (iii) Quality and quantity of water bodies;	(i) Hungarian office for mining and geology (ii) Regional Inspectorates for Environment (iii) National Institute for Environment	Quality of data is poor
IS	(i) to protect the environment; (ii) to prevent overexploitation; (iii) to secure occupational safety and safety of delivery at the power plants	Different public authorities; Article on this topic	?
IT	According to mining law, MW installed and running. Database on direct uses (development)	Ministry of Economic Development Italian Geothermal Union	

NL	(i) Monitoring for mining law: monthly geothermal extraction and injection m3 and temperature difference; (ii) Monitoring heat supply: m3 and temperature	(i) Ministry of Economic Affairs / TNO (Geological survey); (ii) NL Agency (not yet available)	
SI	n.a.	n.a.	
SK		Ministry of Economy	
TR	Tubitak (The scientific and Technological Research council of Turkey)	Republic of Turkey Ministry of Energy and National Resources; Republic of Turkey Energy Market Regulatory Authority	on request

2.10.3 Statistics

Table 7 below shows which organisations make available information on statistics of geothermal energy in a broad sense. The listing contain geological surveys, geothermal associations and national statistics offices.

Table 7 Sources of statistical information on geothermal by country

	Organisation
CH	Swiss Geothermal Society
DE	Working group renewable energy statistics (AGEE-Stat)
FR	French Geothermal Association (AFPG) Ministry for Ecology, Sustainable Development and Energy – Observation and statistics department (MEDDE-SOeS) ObservER – Observatory for Renewable Energies
HU	Hungarian office for mining and geology; National Institute for Environment; Geological and Geophysical Institute of Hungary
IS	Orkustofnun – National Energy Authority of Iceland Statistics Iceland The Environment Agency of Iceland
IT	ENEA GSE UGI - Italian Geothermal Union ENEL
NL	Statistics Netherlands (CBS)
SI	n.a.
SK	State Geological Survey of Dionýz Štúr
TR	Tubitak (The scientific and technological research council of Turkey)

3 Programmes on geothermal energy in the Geothermal ERA NET countries

3.1 Highlights of programmes and instruments relevant for geothermal energy

When governments want to achieve societal aims, they will put in place a programme or programmes to achieve these, and an instrument mix to nudge the research community and the market into the right direction.

We have seen from section 3.3 that geothermal energy is only a minor part of the energy mix in all ERA NET countries except Iceland and potentially Turkey. This is also reflected in the programmes on geothermal energy – which are mostly part of broader programmes, directed to renewable energy at large. The activities on geothermal energy contribute to a broader aim. Any collaboration within Geothermal ERA NET needs to have benefits for a number of the broad-scope programmes that are presented in this chapter.

The apparent focus of countries differs: where some (e.g. Germany) are mostly reporting on R&D efforts, others mostly focus on implementation (e.g. Hungary). This is sometimes only an *apparent* reality, since there are e.g. feed-in tariffs for geothermal power generation in all participating countries (except Iceland). These tariffs stem from governmental decisions. The implementation of such a decision may be embedded in a "programme" but may also be differently organised.

What also differs is the scope of programmes. They may or may not include district heat – or they may explicitly exclude work on electricity. The Netherlands and France, and also Slovenia, have programmes in place that focus on the use of geothermal energy for direct use applications.

The Icelandic programmes have a different focus than in other countries. They aim at continued research for this vital part of the country's energy supply, and training and education of experts from all over the world.

3.2 Highlights of public support and funding schemes

The programmes described in Chapter 4.1 use public support and funding instruments to achieve their goals for the research community and the market. There are various types of instruments. All countries have instruments relevant for geothermal energy in place; the table below shows type of instruments present in the participating countries.

Table 8 Overview of public support and funding by country

	R&D	Demo	Risk	FIT	Invest	Geology	Other..
CH	☑	☑	☑	☑		☑	
DE	☑	☑	☑	☑	☑		
FR	☑	☑	☑	☑	☑		☑
HU	☑	☑		☑	☑		
IS	☑	☑	☑	☑	☑		☑
IT				☑		☑	☑
NL	☑	☑	☑	☑			
SI				☑	☑		
SK				☑			
TR	☑			☑			

From the information supplied in the questionnaires, we can conclude the following:

- Many countries support R&D and demo projects in some way.
- A number of countries supports investors in geothermal energy, considering the geological risk connected to their project, either by soft loans or by risk insurance guarantees.
- All countries have Feed in Tariffs in place – generally for electricity from renewable energy sources, but in a few cases also for geothermal heat production.

3.3 Summary per country

The paragraphs below show a summary per country of programmes relevant for research, development en deployment of geothermal energy, and a short analysis per country, and the same for the public support and funding schemes.

3.3.1 Switzerland

Table 9 Programmes on geothermal energy in Switzerland

Name	**Managed by**	**Objectives**	**Annual budget**	**Geo-thermal p.a.**
EnergySchweiz	Swiss Federal Office of Energy	Renewable energy, energy efficiency and CO2 reduction. Raising awareness, providing information and advice, training, quality assurance, networking and funding. Geothermal energy in renewables focal area.	M€ 21 increase to M€ 44 discussed	~M€ 0,4

International partnership for Geothermal technology (IPGT)	IPGT steering committee	Facilitate the development of advanced, cost-effective geothermal energy technologies. US, IS, CH, AU, NZ participate. Main focus EGS.	Very small	Very small

In Switzerland, EnergySchweiz is the most prominent programme in the energy domain. The programme is very broad and included 6 topical focus areas and 3 transversal focus areas. Geothermal energy is part of the renewable energy focal area. As examples of activities related to geothermal, the EnergySchweiz programme sponsors training and undertakes workshops aimed at standardisation and quality assurance, and sponsors the Swiss Geothermal Energy Society. The programme owner is the Swiss Federal Office of Energy. The programme is funded by federal and regional authorities and it will be in operation until 2020.

Table 10 Public support and funding for geothermal in Switzerland

Name	**Type**	**Description**	**Annual budget**	**Geo-thermal p.a.**
Geothermal energy research programme	R&D	Applied research on energy technologies, including geothermal energy.	M€ 15	~M€ 1
SNSF Div II math, science, engineering	R&D	Swiss National Science Foundation programme for stimulating research in Switzerland. Scientific quality is leading criterion.	M€ 200	< M€ 0,5
Pilot- and demonstration programme	Demo	Maturation of technologies, showcase technologies. Geothermal energy is a priority.	As of 2013: M€ 8	~20%
Geothermal risk guarantee	Risk	There will be a payment from a M€ 120-fund if the intended geothermal resource cannot be developed because of the geological conditions.	M€ 120 for full operation period	M€ 120 To date two projects, M€ 7-19.
Feed-in tariff geothermal power	FIT	Feed-in tariff for renewable power. Income from levy on electricity bills. Capped resources.	M€ 250	- (no projects yet)

The Swiss support and funding schemes support the full chain for electricity production, except for investment. Utilisation of geothermal energy for heating purposes is not supported to an equal extent.

Interesting is, that the risk guarantee and the feed-in tariff are both paid with money from a levy on electricity bills. For the feed-in tariff, this also has the consequence that the amount of available money is limited, and that there is a queue of producers, intending to benefit from the scheme. Risk guarantees are aimed at electricity generation.

3.3.2 Germany

Table 11 Programmes on geothermal energy in Germany

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
6th Energy Research Programme of the Federal Government	PTJ	Research for an environmentally sound, reliable and affordable energy supply & accelerate adoption of renewable energy. Broad programme activities; from public awareness to funding and international cooperation.	2012: ~M€ 750	~M€ 12 2013: M€ 21

In Germany, the Energy Research Programme of the Federal Government is the central programme for energy research, but also for related activities such as raising public awareness, education, and international collaboration. The programme-at-large is funded by four Ministries, but the part related to geothermal energy is funded by BMU: the Federal Ministry for Environment, Nature Conservation and Nuclear Safety. The programme will be in operation until 2014.

Table 12 Public support and funding for geothermal in Germany

Name	Type	Description	Annual budget	Geo-thermal p.a.
6th Energy Research programme	R&D	Applied research to promote renewable energies and energy efficiency, as well as system integration. Geothermal energy specifically included	M€ 425	~M€ 12 (2013: M€ 21)
Utilisation of renewable energies in heat market	Risk Inv.	This measure is aimed at 14% renewable heat utilisation in 2020. For geothermal heat, there is a repayable grant installations and drilling, and an exploration risk facility.	M€ 366 (full program)	Unknown
Feed-in tariff geothermal power	FIT	Feed-in tariff for renewable electricity, see 1.1 in questionnaire.		

Germany has a strong national energy R&D programme, in which significant budgets go to furthering geothermal energy. Germany furthermore stands out as one of the few countries with actual support measures for increased renewable heat utilisation in place. This comes as investment support and an exploration risk facility. Also, there is an important requirements for owners of new buildings to have 10% renewable heat supply.

3.3.3 France

Table 13 Programmes on geothermal energy in France

Name	**Managed by**	**Objectives**	**Annual budget**	**Geo-thermal p.a.**
Call for R&D proposals – renewable energies including geothermal	ADEME	Financial support for geothermal R&D projects	n.a.	Not yet available
Call for R&D proposals – energetic uses of the underground including geothermal	ANR (national agency for research)	Financial support for geothermal R&D projects launched in 2013	n.a.	Not yet available
Investments for the future programme	CGI (general commission for investments) & ADEME	Very large programme funding various activities on decarbonated energies: (i) demonstration of new technologies, in private-public partnership, (ii) dedicated private-public technology institutes and (iii) public research laboratories.	Not relevant (very large)	Not yet available

Implementing France's national policy on the rational use of energy is one of ADEME's key missions, by supporting research programmes, providing financial and technical assistence, and raising public awareness. ADEME is a public agency under the authority of Ministry for Ecology, Sustainable Development and Energy and the Ministry for Higher Education and Research. The 2009 budget was M€ 638. The "Investments for the future" support measure constitutes a separate organisational entity in ADEME's organisation. Furthermore, there is a team working on renewable energies.

Table 14 Public support and funding for geothermal in France

Name	**Type**	**Description**	**Annual budget**	**Geo-thermal p.a.**
'Investments for the future' call for proposals – Geothermal	Demo	This is a specific call for proposals for demonstration projects on geothermal energy, within the "Investments for the future" programme mentioned above. Refundable and non-refundable grants.	M€ 1275 4 years (renew-ables; green chem.)	Not yet available
Risk mitigation schemes	Risk	Direct heat utilization only. Covers short term risk - success of the drilling - and long term risk - unexpected performance decrease during 15-20 year. In operation since 1980s.	M€ 26,4 total scheme, also from financial products	M€ 26,4
Renewable heat fund	Inv.	Fund over-cost of renewable heat utilisation in district heat, commercial buildings, industry. Investment support and support per GJ produced.	M€ 1200 4 years (full program)	~10%

Renewable heat fund – specific call on new energy technologies	Demo	Financial support for innovative demo projects in terms of renewable heat including geothermal and hybrid systems.	n.a.	Not yet available
Feed in tariff	FIT	Levy on energy bills is used to promote renewable electricity or CHP production. Special tariffs for overseas departments.	Variable	
Tax reduction heating networks	Tax Oth	District heating networks with >50% renewables have a VAT reduction and new buildings must connect to such networks.	n.a.	n.a.

France has a broad scope of support measures for geothermal energy in place. The most striking is the long history of the risk mitigation scheme, that has been in operation in various forms since the 1980s, be it with a pause in the early 21th century. Just like Germany and the Netherlands, there is financial support for geothermal heat production – as well as for electricity production. No applied research programme directed towards implementation of geothermal energy is mentioned.

3.3.4 Hungary

Table 15 Programmes on geothermal energy in Hungary

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
Environment and Energy Operative Programme (EEOP)	National Development Agency, National Environment and Energy Centre	One of the 15 operative programmes of the economic development programme. Programme has 7 priority areas, and 2 are relevant for geothermal: increased use of renewables and increased energy efficiency. Geothermal energy utilisation is 2nd priority (1st biomass/waste).	n.a.	M€ 20 in 4-year period inv. support
"HungIce"	National Environ-ment and Energy Centre	Contribute to the increase of geothermal energy utilisation in Hungary, and increase to the awareness and education through a specific small grant scheme. Part of EEA FM.	~M€ 8 in a 5-year period	~M€ 8 in a 5-year period

Hungary invests significantly in developing their geothermal resources, through the Environment and Energy Operative Programme and through a collaboration with Iceland within the framework of the EEA and Norwegian financial mechanisms, the EEA FM – PA 6: Renewable energy programme area. Through the specific HungIce programme, Iceland makes available budget for stimulating the use of geothermal sources in Hungary.

3.3.5 Iceland

Table 16 Programmes on geothermal energy in Iceland

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
GEORG – Geothermal research group	University of Iceland and GEORG	GEORG, an independent association, aims to contribute to the worldwide GHG emission reduction by making available Icelandic knowledge on geothermal and extending and deepening this knowledge at the same time.	M€ 2,8 for 7 years	M€ 2,8 for 7 years
Landsvirkjun Energy Research Fund	Landsvirkjun (National Energy Company)	Strengthen research on environmental and energy affairs through grants. (Mostly) post-graduate studies.	~M€ 0,3-0,4 per year	n.a.
Technology Development Fund	Rannis	Support innovative development activities from idea to product on the market. Broad scope.	M€ 7,5	n.a.
Icelandic Research Fund	Rannis	Enhance scientific research in Iceland. 3-year research projects.	M€ 7,8	n.a. - currently zero.
Orkusjóður	Orkustofnun	The Energy Fund aims reduce consumption of fossil fuels; it helps to fund e.g. search for geothermal, exploration, energy efficiency incl. education and information.	n.a.	M€ 0,15 annually
UNU Geothermal training programme	Orkustofnun (National Energy Authority)	UNU-GTP is a postgraduate training programme, aimin gat assisting transitional / developing countries with capacity building on geothermal.	M€ 2,2	M€ 2,2

In Iceland, there is a number of programmes that enable progress on geothermal energy. Two of them are exclusively working on geothermal energy: GEORG and UNU-GTP. Furthermore, geothermal energy is also an important issue in the Energy Fund, which has formerly supported many projects to find geothermal sources in situations where there were no district heating networks yet. The general Icelandic Research Fund, the Landsvirkjun Research Fund and the Technology Development Fund are open for any technology – including geothermal.

Table 17 Public support and funding for geothermal in Iceland

Name	Type	Description	Annual budget	Geo-thermal p.a.
Geothermal research and utilisation scheme	Inv.	- support geological research - loans for exploration if total cost of heating decreases.	M€ 0,4	M€ 0,4
Act on innovative enterprises	Tax	Companies with R&D projects can apply for a tax credit for such projects	n.a. (2013 ~M€ 7)	n.a.

Exploitation of geothermal energy is widespread and competitive in large parts of Iceland. However, there are incentives to facilitate conversion to geothermal in situations where there is no district heating system yet. Furthermore, there is evidently a developed market for geothermal heating and electricity production. Such companies are encouraged to invest in R&D by a tax reduction scheme (not specific for geothermal companies, though).

3.3.6 Italy

Table 18 Programmes on geothermal energy in Italy

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
Operative interregional programme – renewable energies and energy saving	Ministry of Economic Development	Increase renewable energy quota and energy saving. Three lines: renewable; efficiency; and accompanying actions. Line 1.4 is dedicated to geothermal energy production -> VIGOR project.	M€ 183	~3% i.e. ~M€ 5,5 p.a.; Project “VIGOR” is M€ 8 (total)
CNR for Italian southern regions	CNR (National Research Council)	Accelerate the technological development and the environmental sustainability of the southern Italian regions	M€ 19	k€ 500

The Italian national programmes for energy are the central programmes for increasing renewable energy utilisation and enhancing energy efficiency. The programmes have a broad scope of operation, and geothermal energy utilisation is explicitly mentioned among renewables.

Table 19 Public support and funding for geothermal in Italy

Name	Type	Description	Annual budget	Geo-thermal p.a.
Incentives for renewable electricity production – non PV	FIT	Feed-in tariff for plants < 1 MW and premium for plants > 1 MW (= difference feed-in tariff and E-price).	M€ 5800	Equivalant of max. 35 MW
Renewable Energy for Heating & Cooling Support Scheme / Incentives for production of thermal energy	Incentive	Scheme of support for small-scale projects of energy efficiency improvement and production of thermal energy from renewables.	M€ 200 p.a. Cumulative disbursement of M € 700 for projects implemented by private.	M € 200

In addition to the incentives, Italy has reported on a number of national projects on geothermal energy, that through R&D services forward the utilisation of geothermal energy in specific regions.

3.3.7 The Netherlands

Table 20 Programmes on geothermal energy in the Netherlands

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
"Sustainable Energy Economy programme"	NL Agency	- Optimal performance of Dutch energy market - Promoting supply security - Safe and sustainable energy supply Includes innovation, guarantee fund and RE subsidies	M€ 3120 incl feed-in tariff subsidies	M€ 1,4 innov.; M€ 20 guarant.; M€ 829 FIT (2012)
"Greenhouse as energy producer"	Marketing Board Horticulture	Limit CO_2 emissions from horticulture, develop knowledge, support deployment	M€ 17	M€ 0,1-0,5

The Dutch national programme for energy is the central programme for increasing utilisation of renewable energy (electricity and heat) and improving the sustainability of the Dutch energy sector. This large programme includes the management of the feed-in tariff subsidy, but also energy innovation, and several other instruments. Relevant for geothermal energy is also the "Greenhouse as energy producer programme". The greenhouse sector has huge ambitions for limiting its CO_2 emissions, and is specifically facilitated by the activities of this programme.

Table 21 Public support and funding for geothermal in the Netherlands

Name	Type	Description	Annual budget	Geo-thermal p.a.
Energy innovation subsidies	R&D, demo	Promote energy innovation in various stages, from exploratory research to full scale demonstration	~M€ 50	M€ 1,4
Guarantee fund geothermal energy	Risk	Mitigate financial risk of drilling a well with a disappointing productivity	~M€ 43 fund	~M€ 43
Stimulation renewable energy production	FIT	Increasing renewable energy production (including heat) in the Netherlands by subsidising the unprofitable top, for the production over 15 years	M€ 1700 (2013: M€ 3000)	M€ 829 (2012)

In the Netherlands, the focus on geothermal heat production rather than electricity stands out compared to other countries, though there is a provision for CHP in the feed-in tariff.

3.3.8 Slovenia

Table 22 Programmes on geothermal energy in the Netherlands

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
National Renewable Energy Action Plan 2010-2020	Ministry of Infrastructure and Spatial Planning	Implement NREAP in Slovenia, working on energy efficiency and RES. Geothermal direct use part of the programme's aims.	n.a.	M€ 4.14 over 10 years

The Slovenian national programme relevant for geothermal energy is the NREAP programme. This programme includes all, from awareness raising, administrative improvements, to investment support and feed-in tariffs for electricity. The NREAP goals show a 10% growth of the direct heat utilisation in Slovenia. Feed-in tariffs for electricity are available and applicable, but not intended for promotion of geothermal electricity.

Table 23 Public support and funding for geothermal in Slovenia

<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Annual budget</th><th>Geo-thermal p.a.</th></tr>
<tr><td>Renewable electricity production support</td><td>FIT</td><td>Guaranteed purchase price for new facilities, premium for price difference conventional/renewable for existing facilities.</td><td colspan="2">purchase: 152.47 €/MWh premium: 103.59 €/MWh annual budget n.a.</td></tr>
<tr><td>Energy restoration of publlic buildings</td><td>Inv.</td><td>In tenders for energy restoration of buildings, RES is also stimulated.</td><td>M€ 23</td><td>n.a.</td></tr>
</table>

Slovenia has a feed-in tariff and premium for renewable energy, and extension of the utilisation of renewable heat is stimulated through focusing on the building in which this heat may be used.

3.3.9 Slovakia

No specific information on national programmes supplied, however, there is certainly governmental action on increasing the role of RES in the energy system.

Table 24 Public support and funding for geothermal in Slovakia

Name	Type	Description	Annual budget	Geo-thermal p.a.
Renewable electricity production and efficient CHP	FIT	Feed-in tariff for renewable power generation, including geothermal, for 15 years	n.a.	n.a.

3.3.10 Turkey

Table 25 Programmes on geothermal energy in Turkey

Name	Managed by	Objectives	Annual budget	Geo-thermal p.a.
International Industrial R&D Projects funding programme	TÜBITAK	Encourage Turkish companies to participate in EUREKA, Eurostars etc.	n.a.	M€ 0,3-0,5 per project

The International Industrial R&D project funding programme is run by TÜBITAK, the scientific and technological research council of Turkey. The aim of the programme is to encourage Turkish companies to participate in European research projects. The programme has a broad scope. The target group is industry.

Table 26 Public support and funding for geothermal in Turkey

Name	Type	Description	Annual budget	Geo-thermal p.a.
Scientific and technological research council of Turkey	R&D	Scheme aimed at applied research. Companies are eligible, universities and institutes are funded by subcontracting.	M€ 2	n.a.
Feed in tariff	FIT	There is a feed-in tariff of € 0,105/kWh.	n.a.	n.a.

In Turkey, there is a focus on applied research and application. The support measures mentioned are general measures, directed at many (renewable) technologies. However, because of the geological properties of the country, geothermal energy has potential in Turkey.

3.4 Feed-in tariffs/premiums

Figure 17 below summarises the information on feed-in tariffs (FIT) and premiums gathered within the ERA NET. The dark blue bars indicate the base tariff/premium for electricity, the red ones the base premium for heat. Light blue and red bars represent additional tariffs, for smaller production capacities, innovative technologies and longer district heating networks.

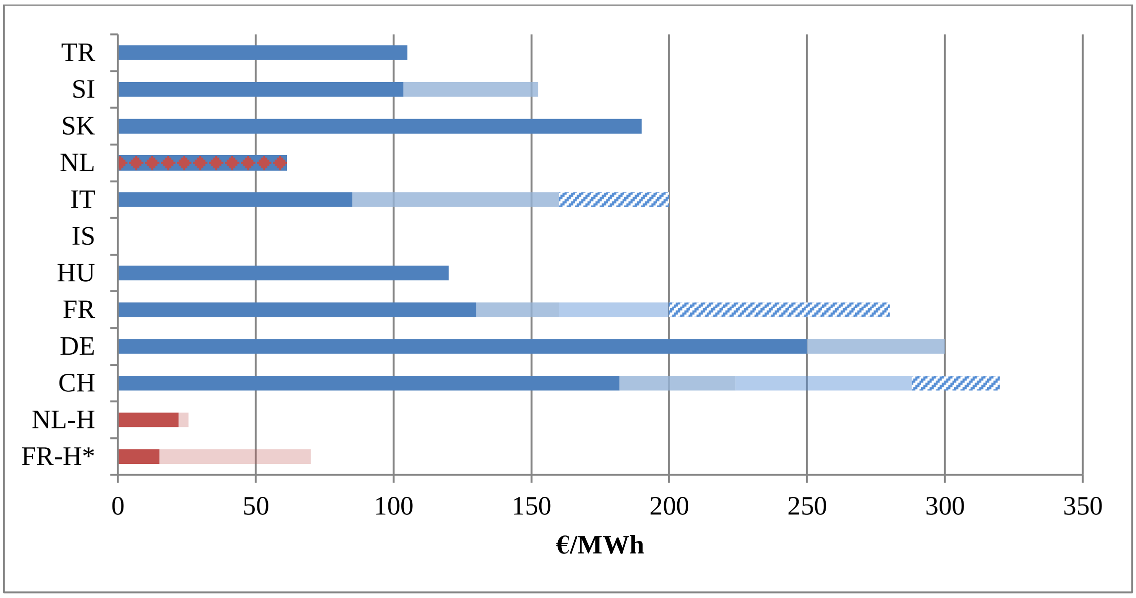

Figure 17 Feed in tariffs in various countries, for electricity (blue) and heat (red).

* French heat tariff very much dependent on the length of the district heating network, otherwise only 2,5 €/MWh. Dutch electricity tariff for CHP.

Feed-in tariffs range from € 85/MWh electricity (minimum tariff in Italy) to € 320/MWh electricity (maximum tariff in Switzerland). The geological conditions of both countries are widely different, which forms some explanation of the difference. The Dutch premium for electricity is in fact a CHP premium, which assumes that most of the heat is used for heating purposes anyway. The graph shows the premium (in other words, minus the reference cost).

3.5 Strengths and weaknesses

We have gathered data on perceived strengths and weaknesses of the support measures and programmes implemented. The specific data per country are confidential. However, this report shows remarks from our network, to learn what kind of issues are perceived.

3.5.1 R&D/demo programmes

Perceived strengths of the programmes include the following:

- good management, stability, efficiency
- benefits of bringing the research community on geothermal together (visibility)
- benefits to the country – innovation brings economic activity
- actually bringing projects from R&D to demo

Perceived weaknesses and challenges include for instance:

- geothermal not visible - part of large broad programme;
- geothermal market too small to justify sustained dedicated geothermal research efforts;
- R&D programmes not adapted to other policy instruments (research without deployment or deployment support without research);
- insufficient support for gathering subsurface data;
- money crossing borders is a challenge.

Table 27 Perceived strengths and weaknesses of national R&D and demo programmes

Well managed and stable scheme, appreciated over decades
Bottom-up approach is both a strength (flexibility and openness) and a weakness (driven by opportunities and less by integrated planning)
Creation of critical mass
Elimination of fragmentation (collaborative R&D programme)
Innovation means financial returns to the State
Channelling of research money and effort towards geothermal
Bringing projects from R&D to market
Platform for innovation (collaborative R&D programme)
Small country/market: no systematic topical calls possible in sustainable manner
Competitive and bottom-up instruments may discourage collaborative approach.
No support for studying geothermal potential, notwithstanding the feed-in tariff
Lack of formal review process – only informal learnings on instrument level
Longer-term vision lacking
Funds in programme not sufficient for acquiring new subsurface data.
Money crossing country borders in international R&D projects problematic in national programmes
Framework of exploitation of research lacking
Unique position of (demo/pilot) programme in energy innovation chain
No restrictions to type of applicant in demo/pilot scheme (strength)
Extremely wide scope (general demo programme) is a challenge
Geothermal sometimes very weakly present in broad programmes
Geothermal resource assesment, but lack of deployment project
Geothermal not explicitly included in broad programme strategy

3.5.2 Investment support / risk guarantee schemes

Perceived strengths of investment support and risk guarantee schemes are related to their goal. Most countries with such schemes in place conclude that the scheme really helps to get projects off the ground.
Perceived weaknesses and challenges for risk guarantee schemes are related to the more innovative projects for a country. The knowledge to adapt the scheme is hard to find, when there is no experience.

Table 28 Perceived strengths and weaknesses of national investment support and risk guarantee schemes.

Establishment of risk guarantee has really been a boost to the development of geothermal energy
Challenge: no experiences with drilling for power generation
Guarantee scheme very transparent and not-for-profit -> benchmark for the insurance sector.
Generous guarantee scheme, substantially decreases risked NPV of a project
In practice, the scheme gives preference to financially strong investors
Challenge to adapt scheme as necessary when the market for „standard“ cases will have developed and the governmental risk guarantee scheme will probably focus on innovative cases only.
Has proven to be very useful for (pioneer) projects to get financing in place

3.5.3 Feed-in tariffs

Just as in the case of investment support and guarantee schemes, countries perceive the strength of their national feed-in tariffs as getting projects off the ground. This is so evident, that it is hardly even mentioned. When it comes to challenges, countries report high cost, in some cases organisational problems of matching the number of intended investors with the available budget, and the challenge to make the instrument suitable for all regions (e.g. islands).

Table 29 Perceived strengths and weaknesses of national investment support and risk guarantee schemes.

Increase exploitation of renewable energy sources
High cost
Increases the attractiveness of geothermal energy greatly
Mismatch between funds available and number of applicants – RES-broad
Still not sufficiently attractive in specific regions (e.g. islands)
Stimulate electricity production from geothermal energy by guaranteeing a long term cash flow for the power producer

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