Proceedings World Geothermal Congress 2015
Melbourne, Australia, 19-25 April 2015

Regulatory Framework Conditions for Geothermal Direct Use Projects in France, Germany, Iceland, Sweden and Turkey

Marietta Sander

IGA, c/o Bochum University of Applied Sciences, Lennershofstr. 140, 44801 Bochum, Germany

E-mail address: Marietta.Sander@hs-bochum.de

Keywords: Direct use, heating, cooling, policy, regulatory framework, incentive scheme, subsidy, Renewable Energy Portfolio Standard, geothermal law, geothermal energy, heat pump, geothermal district heating

ABSTRACT

This technical paper focuses on supportive legal and regulatory frameworks, subsidy schemes and other incentive programs for geothermal direct use; particularly renewable heating applications, heat pumps and district heating schemes, in five countries (France, Germany, Iceland, Sweden, Turkey). The analysis includes a brief description of their geothermal development history, an investigation of regulatory frameworks and subsidy schemes for geothermal direct use applications, and an analysis of what worked best.

1. INTRODUCTION

Geothermal direct use installations utilize geothermal fluids which provide heat and/or cooling to buildings, greenhouses, aquaculture ponds, spas and industrial processes (Lund, 2010). Space and district geothermal heating installations are widely used. Similar to power projects the depth of the resource, temperature, expected flow-rate and chemistry of the fluid determine the project viability. Potential scaling problems must be considered when selecting equipment such as heat exchangers, well pumps, piping and space heating equipment.

Challenges facing direct use projects include; high upfront costs, the need for comprehensive geoscientific site investigations, only limited interest for heat projects by decision-makers, and often regulatory uncertainties or barriers. This technical paper focuses on supportive regulatory mechanisms and incentive schemes, with the aim of showing good practices in selected countries. Investigation topics include the enabling regulatory and financial instruments. Countries analyzed include France, Germany, Iceland, Sweden and Turkey.

The paper is structured as follows; Section 1 introduces the topic, Section 2 outlines the regulatory frameworks, targets and subsidy schemes in five countries, subsequently Section 3 closes with an analysis of the effectiveness and best practices, concluding remarks and recommendations.

2. REGULATORY AND FINANCIAL INCENTIVE SCHEMES FOR DIRECT USE PROJECTS IN FIVE COUNTRIES

This chapter provides an overview of legal, fiscal and regulatory instruments for direct use projects.

2.1 Legal, Fiscal and Regulatory Instruments

For geothermal project developers and public-private partnerships to be effective, the regulatory structure and any incentive schemes provide the baseline conditions for their projects.

The subsequent list shows geothermal-friendly regulations and incentives for renewable energy development in general, and specific to geothermal requirements (ESMAP, 2012). Legal and regulatory conditions include the following aspects:

- Fiscal incentives or government subsidies for the exploratory and exploitation phases (i.e. risk mitigation insurances),
- Feed-in-Tariffs,
- Low or zero interest loans, grants,
- Tax incentives,
- Drilling risk insurance schemes or other incentive schemes to decrease geological risks,
- Renewable Energy Portfolio Standards,
- Renewable energy policies and laws, giving priority to geothermal resource development and site specific privileges,
- Compensation obligations,
- Types, and clear definitions of, authorizations and permits (e.g. exploration permits, long term concessions), rules, processes, costs/ rents/ fees, development expectations, guidelines and market mechanisms,
- Definition of exploration and exploitation surface areas; definitions on shared reservoir use and preferred land use.

In France for example a fund exists for renewable heating of collective office buildings and low or zero interest loans are available for individual houses. Other subsidy schemes include VAT reductions such as in Hungary, Italy or the Netherlands. There is a need for an in-depth analysis of the geothermal direct use sector, in order to identify barriers and define what is required from decision makers and governments. As geothermal is a capital intensive technology that requires some years to develop, initial start-up support is needed.

Figure 1 shows a graph of the geothermal heat provision in Europe in GWh/year (AFPG, 2012) with Sweden and Turkey as forerunners in geothermal heat provision. Figure 2 shows the installed capacity in MWth of geothermal direct use and district heating systems in selected European countries (Antics, Bertani and Sanner, 2013).

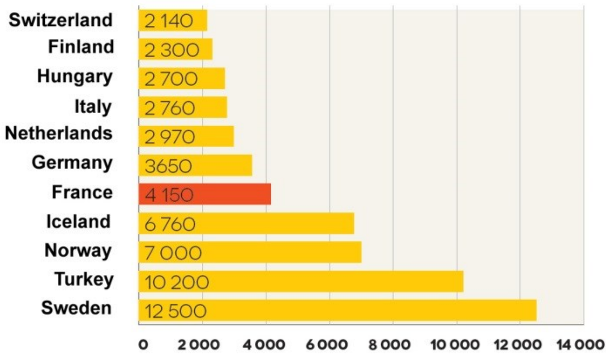

Figure 1: Geothermal heat provision in selected European countries (GWh/year).

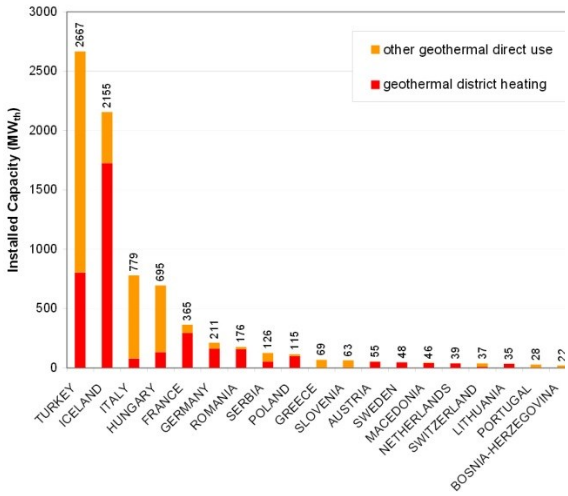

Figure 2: Installed capacity of geothermal direct use and district heating systems (MWth).

2.2 France: Supportive Legal, Institutional and Fiscal Incentive Schemes

2.2.1 Geothermal use and market situation

Geothermal development in France has gone through various ups and downs. Lund, Freeston and Boyd (2010) report that district heating supplies heat to 150,000 dwellings mainly in the Paris and Aquitaine basins. At present direct-use applications include: district heating (300 MWt and 4,900 TJ/yr), greenhouse heating (9 MWt and 155 TJ/yr), fish farming (19 MWT and 212 TJ/yr), bathing and swimming (17 MWt and 162 TJ/yr), and geothermal heat pumps (mainly individual homes) (1,000 MWt and 7,500 TJ/yr), for a total of 1,345 MWt and 12,929 TJ/yr.

2.2.2 Geothermal regulatory framework, policies and incentives

The use of geothermal heat pumps started in the 1980s as a consequence of the oil crises and provided about 20,000 units for heating individual houses in 2010 (Lund et al. 2010). Over the last decades geothermal development went through different phases: from a major development phase from sedimentary basis at the beginning of the 1980s; to a withdrawal in the 1990s; to a revival due to a change in French Energy Law in 2005; and the process 'Grenelle de l'environment' in 2007 (Lund et al., 2010). The ‘Grenelle de l’environment’ is a political action process that began in 2007 and brought together environmental stakeholders in order to agree on common long-term decisions (Ministry of Ecology, Energy, Sustainable Development and the Sea, 2009). In the wake of the process, a fund of EUR 325 million was granted for the period 2009 to 2012 to support demonstration projects in the field of environmental innovation. Based on its success, the French energy agency ADEME, which administered the demonstration fund 2009-2012, was entrusted by the French government with a budget of EUR 1.125 billion for the support of demonstration projects in the field of renewable energies. Subsequently in 2009, France set a target of 23% of renewable energies in its energy mix by 2020. This requires an additional annual 20 million toe (tons of equivalent oil) of renewable energies to be produced by 2020, with 50% of the additional production expected from renewable heat and 50% from renewable electricity.

In 2011 the installed power for heating and cooling reached 1,850 MWth (Boissavy, Vernier and Laplaige, 2013). One third of this is generated from the Dogger reservoir in the Paris area. Most however is derived from the strong development of shallow geothermal resources across the entire country. Boissavy (2013) reported that the low temperature installations of doublets at depths between 20 and 1,000 m have, since 2009, been supported by the Fonds Chaleur of ADEME (French Agency for Environment and Energy) which subsidizes the plants to be competitive with natural gas. The Fonds Chaleur has a yearly budget of about 200 million Euro. The fund was designed to support drilling operations of wells deeper than 200 m plus related reservoir engineering works (i.e. the refurbishment of old wells). Applications include heating, aquaculture, fish farming and greenhouses. For approximately 25 years, geological risk mitigation schemes have been in place in France for first wells, long term insurance for deep wells and AQUAPAC for shallow wells. AQUAPAC is based on two complimentary mechanisms:

(1) Research guarantee: cover risk of insufficient resource with regard to expected one and failure of injection,
(2) Long time productivity guarantee (10 years): cover risk of decrease/ deterioration of the resource during exploration.

The operations with heat pumps are included via the funding scheme PAC (Pompe à Chaleur = heat pumps) for wells below 200 m (ADEME 2014). Table 1 of Boissavy et al. (2013) shows an overview of the policies, subsidy schemes and education efforts of different actors in France.

Table 1: Financial incentives, information and education efforts in France (Boissavy et al., 2013).

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	Call for Expressions of Interest tendered by ADEME in the "investment for the future" framework	na	Na
Financial Incentives – Investment	FIT - Feed in tariff at 200 €/MWh (130 in ultra-marine departments and regions).	RC - Deep geothermal fund DIS - Fonds Chaleur (Heat Fund) for 2013 to be pursued in 2014	RC - Aquapac Fund DIS - Fonds Chaleur (Heat Fund) for 2013 to be pursued in 2014
Financial Incentives – Operation/Production	na	na	Na
Information activities – promotion for the public	ADEME-BRGM website: www.geothermie-perspectives.fr AFPG website www.afpg.asso.fr		
Information activities – geological information	na	Thermo2Pro tool and Dogger database	Regional shallow aquifer atlas
Education/Training – Academic	na	na	na
Education/Training – Vocational	na	na	na

Key for financial incentives:

DIS	Direct investment support	RC	Risk coverage	FIP	Feed-in premium
LIL	Low-interest loans	FIT	Feed-in tariff	REQ	Renewable Energy Quota

The Eco-loan scheme provides a zero-interest loan for energy-efficient renovations (Finance Law, Art. 99) for renovation activities which include the installation of heating systems using renewables. The limits are set to a loan amount of EUR 30,000.

French research covers the entire range of geothermal topics. The IEA (2012) reports that following a call for projects, 171 laboratories of excellence were awarded. ADEME manages the R&D national budget. A research focus lies on the development of innovative concepts such as combining various renewables and underground thermal energy storage. French industry funded research is conducted on equipment (thermodynamic cycles, pumps, etc.), with some investment also dedicated to geothermal exploration or exploitation. In addition, several national technological clusters have been established to develop collaborative industry and research institute R&D projects.

A strong point in France is also that the expertise exists in the country in GSHP and that the technology is mature. By 2020 the market is expected to reach 4,000 MWth (Boissavy, 2013). France also uses its expertise for the outlying French provinces in the Caribbean and slowly increases overseas consulting services in the geothermal sector.

Boissavy (2013) reports that administrative constraints and delays in issuing drilling permissions are barriers to more heat pump installations. The issuance of a drilling permission for a new doublet in Ile de France for example takes between 8 and 12 months. The author further explains that the legal support of small units for individual houses of less than 30 kWth still requires significant improvement.

2.3 Germany: Supportive Legal, Institutional and Fiscal Incentive Schemes

2.3.1 Geothermal use and market situation

In 2010 the total thermal installed capacity in Germany was estimated by Lund et al. (2010) to be 2,458 MWt with a direct use of 12,764 TJ/year, 3,546 GWh/ year and a capacity factor of 0.16. The majority of the energy use was for individual space heating (1.2 MWt), followed by district heating (209.3 MWt) and geothermal heat pumps (2,230 MWt and 10,368 TJ/year).

At the end of 2011 the total number of GSHP is estimated to be about 244,000, with a heating capacity of about 3,000 MWt and a geothermal contribution of 2,250 MWt (Ganz, Schellschmidt, Schulz and Sanner, 2013).

Most of the district heating plants are located in the Northern German Basin, the Molasse Basin in Southern Germany, or along the Upper Rhine Graben. The geothermal power plants at Neustadt-Glewe and Unterhaching also provide water for district heating. 19

plants were in operation for district heating or power generation in 2013 (Ganz et al., 2013). Besides large installations, a number of small and medium-size geothermal heat pump units are located throughout the country and heat/ cool office buildings and private houses. The number of geothermal systems reached 265,000 at the end of 2012, a considerable increase compared to 244,000 geothermal heat pumps in 2011. Of these the brine/water systems are the most common installations with a share of about 85%.

Multiple or cascaded uses are employed to help improve the economic efficiency of the direct use. Some installations combine district or space heating with greenhouses and thermal spas. Geothermal heat is produced in 170 larger installations using thermal waters and numerous geothermal heat pumps. Figure 4 shows the large GSHP systems in Germany.

Annual sales of GSHP in Germany changed significantly over the last years. Figure 3 shows the fluctuations from 1978 subsequent to the oil crises to 2012. Some fluctuations can be explained with legal and financial support schemes though the Renewable Energy Heat Act (EEWärmeG, in force since Jan. 2009) and through the renewed opening of the Market Incentive Program (MAP) for heat pumps.

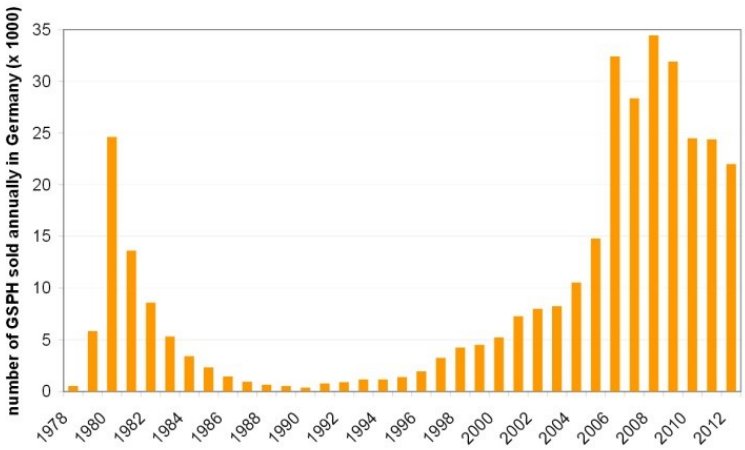

Figure 3: Annual sales of GSHP in Germany from 1978-2012 (Ganz et al., 2013)

City, Name	Year	Inst. capacity [kW_{th}]	Type
Duisburg, ZBBW	2011	1480 (H) / 1030 (C)	180 BHE each 130 m deep, 3 HP
Bonn, Bonner Bogen	2009	920 (H) / 620 (C)	3 + 3 groundwater wells 28 m deep, HP
Munich, Dywidag	2001	840 (H) / 500 (C)	Several groundwater wells for 500 m^3/h, HP
Schwabach, MF Niehoff	2009	600 (H) / 900 (C)	103 BHE each 85 m deep, 2 HP
Frankfurt/M, Ordnungsamt	2009	600 (H/C)	112 BHE each 85 m deep, HP
Bonn, „Bonnvisio“	2004	600 (H) / 550 (C)	2 + 2 groundwater wells 11 m deep, HP
Golm near Potsdam, MPI	1999	560 (H) / 360 (C)	160 BHE each 100 m deep, HP
Nuremberg, Panalpina	2008	560 (H) / 270 (C)	81 BHE each 75 m deep, 2 HP
Frankfurt/M, WestendDuo	2005	ca. 400 (H/C)	2 + 3 groundwater wells 140 m deep, HP
Münster, LVM 7	2008	550 (H/C)	91 BHE each 100 m deep, HP
Freiburg i.Br., Qu. Unterlinden	2011	ca. 500 (H/C)	108 BHE each 125 m deep, HP
Frankfurt/M, Maintower	1999	ca. 500 (C)	ca. 210 energy piles each about 30 m tief, cold storage
Gelnhausen, MK-Forum	2005	400 (H) / 440 (C)	96 BHE each 99 m deep, HP
Frankfurt/M, Cargo City Süd 577	2010	380 (H) / 480 (C)	38 BHE each 130 m tief, HP
Leinfelden-Echertdingen, HC	2010	340 (H) / 355 (C)	80 BHE each 140 m tief, HP
Langen, DFS	2001	330 (H) / 340 (C)	154 BHE each 70 m deep, HP
Frankfurt/M, Baseler Platz	2003	300 (H) / 180 (C)	2 groundwater wells 80 m deep, HP

H: Heating, C: Cooling, BHE: Borehole Heat Exchanger

Figure 4: Large GSHP systems in Germany as of August 2012 (Ganz et al., 2013)

2.3.2 Geothermal regulatory framework, incentives and market situation

The German Government supports the development of geothermal direct use with project funding for research, market incentives (i.e. Market Incentive Program -MAP), through the Renewable Energy Heat Act (EEWärmeG), credit offers and funding programs of the KfW banking group.

The National Renewable Energy Action Plan in accordance with Directive 2009/28/EC on the promotion of the use of energy from renewable sources (German Federal Government, 2009) describes the targets and support schemes of the Federal Government of Germany:

Within the Integrated Energy and Climate Program for Germany, the Government has committed itself to increasing the share of renewable energies in the heating/cooling sector to 14% of final energy consumption by 2020. The Renewable Energy Heat Act was adopted to achieve this goal – in addition to schemes already in place. In this act, owners of new buildings are required to provide a share of the energy used for heating/cooling from renewable energies.

Furthermore, there are laws and regulations that provide additional requirements for use of renewable energies for other actors. For example, the Energy Saving Ordinance (EnEV) prescribes component requirements for energy-saving renovation measures for buildings. Both builders and owners of premises are required to observe these provisions. In addition, there are funding programs which provide financial support to special target groups for the use of renewable energies.

KfW funding programs for energy-efficient construction and renovation (CO_2 building renovation program), which promote – if not exclusively – the development of renewable energies, i.e. Energy Efficient Construction (Energieeffizient Bauen), Energy Efficient Renovation (Energieeffizient Sanieren), Energy-efficient Renovation – Local Authorities (Energieeffizient Sanieren – Kommunen) or Social Investment- Building Refurbishment (Sozial Investieren- Energetische Gebäudesanierung).

Energy Saving Regulation (EnEV): The regulation lays down mandatory minimum requirements and rules for calculating primary energy needs and thermal insulation of buildings, without setting any targets. The EnEV is based on the Energy Saving Act. Builders and building owners are required to comply with it.

Heat-and-power Cogeneration Act (KWKG): The act regulates the funding of old and new combined heat and power (CHP) plants and the development and construction of heating networks into which heat from CHP-plants is fed. The purpose of the act is to contribute to the increase of electricity production from CHP in Germany to 25%.

Guidelines on the promotion of mini-CHP plants: Since 2008, these guidelines promote the new construction of CHP plants up to 50 kW_{el} through investment grants, to achieve the target of doubling the share of electricity from CHP-plants by 2020 to 25%.

Energy Tax Act (EnergieStG): The Energy Tax Act provides tax relief for energy products used for combined heat and power production if the CHP plant has a monthly or annual efficiency of at least 70%.

BMU Environmental Innovation Program: The program is used to finance projects with innovative character on an industrial scale.

Renewable Energies Heat Act (EEWärmeG): The EEWärmeG acknowledges compliance as part of an alternative measure if the heat energy needs are met directly from a local or district heating network to a significant share from renewable energies: at least 50%.

Market Incentive Program (MAP): This program supports the construction and development of a heating distribution network supplied from renewable energy sources. The support is suitable for large installations run by utility companies. A precondition is that the heating network must be supplied by at least 50% of heat from renewable energy sources. The support is granted through special loans of the KfW. In its first version in the 1990s, the MAP rules for application were not very favorable for geothermal project, but with new guidelines introduced in 2005 most of the previous obstacles were met and new plants built in Munich received support from the scheme.

The MAP also supported heat pump constructions with a given amount per kW installed heating capacity. Preconditions were that the efficiency of the system needed to be calculated (from design values) and that a minimum Seasonal Performance Factor of 3.5 had to be achieved. Since 2009 support through MAP is no longer available for new buildings.

Subsidy schemes for heat pumps included a subsidy which was paid per kW_{th} of installed heating capacity in the years 1995-1998. Subsidies ranged between 200-300 EUR/kW_{th} and were subject to certain installation conditions. Application and grant processing were conducted by the Federal Ministry of Economics in close cooperation with the relevant associations for geothermal energy and for heat pumps. On average 1,000 new installations were supported annually. Challenges of the grant program were that the application had to be submitted prior to construction and that the construction had to be finalized by the end of the same fiscal year (EGEC 2012).

Heat pump technology is generally supported and in many supply areas special tariffs are offered for using heat pumps technology. EGEC (2012) reports that 78% of market shares of the heat pump market concentrate on four German provinces: Bavaria, Baden-Württemberg, Brandenburg and Northrhine-Westphalia.

The R&D support by the German Government is substantial each year. From 2011-2014 for example some 3.5 million EUR are set aside under the 6th Energy Research Program. The Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) granted funding for 42 new projects with a total volume of 24.1 million EUR.

2.4 Iceland: Supportive Legal, Institutional and Fiscal Incentive Schemes

2.4.1 Geothermal use and market situation

The share of geothermal energy in the nation's primary energy supply is 69.2% (17.6% hydropower). According to Ragnarsson (2013) space heating is the most important direct utilization of geothermal energy in Iceland, covering 90% of all houses in the country. In a cold country like Iceland, the high demand for heating is understandable. Other direct uses include swimming pools, snow melting, industrial processes, greenhouses and fish farming (see Figure 5). The total direct use of geothermal energy was estimated to be 25,277 TJ (7,021 GWh) in 2011.

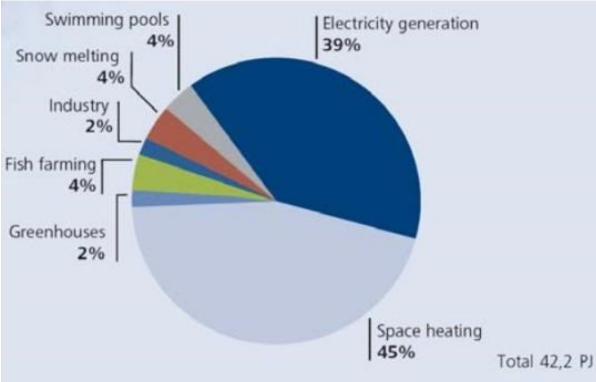

Figure 5: Geothermal use in Iceland in 2011 (Ragnarsson 2013)

Geothermal use for space heating began in Reykjavík in 1930. Following the oil price hikes of the 1970s, the government took the initiative in expanding district heating, with the result that the share of geothermal energy increased from 43% in 1970 to the current level of about 90%. Figure 6 shows the historical overview of space heating sources from 1970-2008. Public planning and public financial support significantly led to coal and oil heating to be replaced by geothermal water. Today, about 30 district heating systems are operated in towns and villages, plus some 200 smaller systems in rural areas.

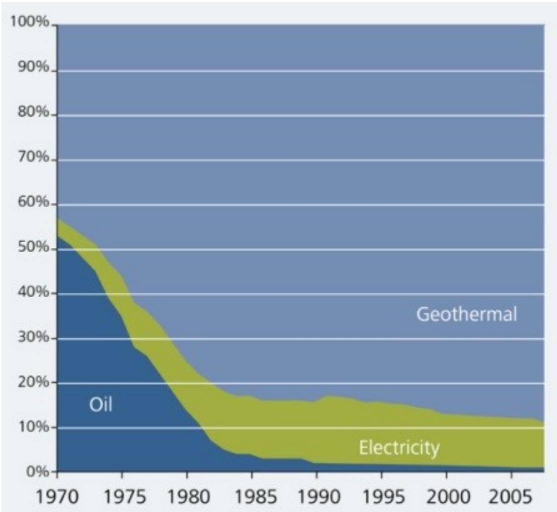

Figure 6: Space heating in Iceland from 1970-2008 (Ragnarsson 2013)

2.4.2 Geothermal regulatory framework, policies and incentives

Already in the 1930s the government started heating public buildings in the capital city of Reykjavik. The State Electricity Authority carried out several geothermal surveys to identify space heating opportunities. Loans were provided by the State for the construction of district heating systems. The cheap heating led to a movement of residents to Reykjavik. As a consequence, the Parliament then needed to take legal action in 1953 and established the Icelandic National Energy Fund (NEF). The fund provided low-interest loans to municipalities, firms or individuals for geothermal drilling and thereby shared the risk of drilling with developers. The loans covered 60% of drilling costs and could be converted into grants if the development of a new geothermal field proved unsuccessful (Haraldsson, 2012). By turning loans into grants in case of failed attempts an insurance mechanism was created. Additionally, a Geothermal Fund was established in 1961 through legislation which provided grants for reconnaissance and exploratory drilling.

Since 1999 the Icelandic Government develops the Master Plan for Geothermal and Hydropower Development in Iceland (Steingrímsson et al., 2006; Pálsson, 2012). Aims of the Master Plan are to rank power projects against their economic and preservation value, considering impacts, benefits, energy needs, man and nature. The country thus considers geothermal energy as a significant element in the functioning of their economic and social system and aims at developing it in a holistic manner.

New energy strategies deriving from the 2009 Government Coalition platform include formulating (i) a new Planning and Building Act, and (ii) a strategy how to fuel the transport sector. The National Energy Authority of Iceland (NEA; Orkustofnun) administers both surveying and utilization licenses on behalf of the minister (Ketilsson et al., 2010). In accordance with the Environmental Impact Assessment Act, geothermal power stations with a heat output of 50 MW or more and other power installations with an electricity output of 10 MW or more are always subject to an environmental impact assessment (Parliament of Iceland, 2000).

Policy makers in Iceland intensively promote the use of renewable energy resources. The State has also supported the mapping of geothermal resources in the country through the National Energy Authority and later through the state owned institution ÍSOR– Iceland GeoSurvey. Out of three major geothermal companies, one is owned by the State, another one by municipalities.

Iceland stands out in a geothermal perspective due to its extensive engagement in research, training and advisory services. Overseas extension and advisory activities are conducted by ISOR who acts as consultant offering expertise in geothermal energy development.

Iceland is also a partner in the International Partnership for Geothermal Technology (IPGT). IPGT as international collaboration of scientists, industry leaders, governmental representatives and geothermal experts uses synergies and geothermal expertise from Australia, Iceland, New Zealand, Switzerland and the USA.

In 2009 the Geothermal Research Group GEORG was founded which is a partnership of 22 entities combining all major players on geothermal research and utilization in Iceland and their key international collaborators. GEORG creates a platform for joint effort to strengthen research and innovative developments.

The University of the United Nations has a branch in Iceland, which implements the Geothermal Training Program (UNU-GTP). UNU-GTP undertakes significant geothermal training for participants from the whole world.

2.5 Sweden: Supportive Legal, Institutional and Fiscal Incentive Schemes

2.5.1 Geothermal use and market situation

According to Lund, Freeston and Boyd (2010) Sweden belongs to the five countries with the largest installed capacity together with USA, China, Norway and Germany accounting for 60% of the world capacity. Sweden is also one of the five countries with the largest annual energy use besides China, USA, Turkey and Japan, accounting for 55% of the world use (Lund et al., 2010). The countries thermal installed capacity in 2010 was 4,460 MWt with a direct use of 45,301 TJ/year and 12,585 GWh/ year.

Andersson and Bjelm (2013) report that the use of Ground Source Heat Pumps (GSHP) is the most common use of shallow geothermal energy in Sweden, especially for single residential units. An estimated 400,000 GSHP systems were installed in the country until the end of 2011. All systems extract approx. 12 TWh of heat with some 500 GWh of natural stored cold in addition (Andersson et al. 2013). The heat pump market is now self-sustaining and has reached maturity in the segment of single family houses. In the last few years the market for small scale GSHP systems peaked in 2007 and levelled since then (see Figure 7). The fields marked in green are the number of new GSHP system installed annually from 2004-2013. Reasons for the strong demand were high heating demands due to the age of many Swedish houses, the oil price shock in the 1980s, low operating costs of GSHP due to low electricity prices initially and that oil burners and electric boilers were replaced at a high rate in the 1980s and 1990s.

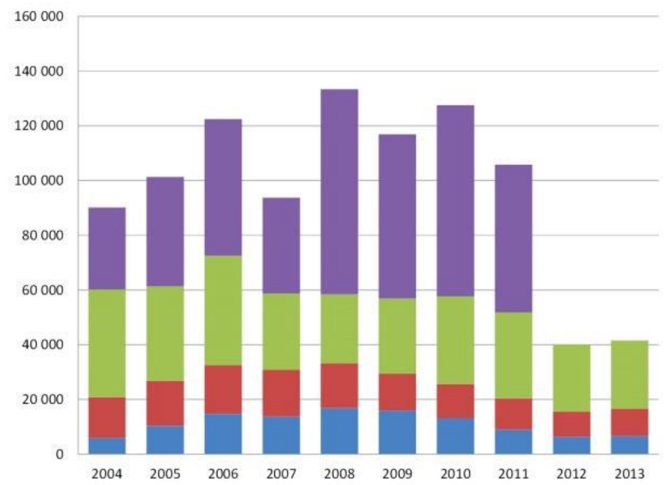

Figure 7: New GSHP installations from 2004-2013 in green color (SVEP, 2013)

Increasing growth of larger systems, often in urban areas is noticeable which often replace or compete with district heating (DH) systems. The increase in larger systems is also seen in statistics of the Swedish Geological Survey which collects data on application types and drilling depth (Andersson et al. 2013). Besides GSHP other systems are used such as UTES (underground thermal energy storage), ATES (aquifer thermal energy storage) and BTES (borehole thermal energy storage).

2.5.2 Incentive schemes

From 1981-1991 generous subsidies were given in the form of interest-free state loans and governmental grants for heat pump installations depending on the total cost of the installation. In the 1980s subsidies were available for single and multi-family houses. In the 1990s support was limited to single-family houses. Also, income tax reductions were available for single houses. Some incentives aimed to increase the number of heat pump installations while others aimed to stimulate the conversion of electric or oil heated buildings into geothermally heated systems. In summary, the subsidies resulted in an increase of heat pump sales. At first, the high incentives resulted in products of poor quality being offered, failures in installations and a market drop. Later on the market recovered, the industry established itself and started growing.

Nevertheless some incentives exist. Tax exemptions are today the main incentives to support renewable heating in Sweden (RES Legal 2014a). Act No. 2009:194 sets rules for the tax-deduction of RES (renewable energy system)-related installation works in households. Only labor costs are deductible, not material costs. Also, installations of new systems replacing conventional systems may be deducted from tax. The maximum amount shall not exceed SEK 50,000 annually (Euro 5,630). In the country, no national or regional legislation require the use of renewable heating sources in the building sector.

The Swedish market is today in a position where it is self-sustainable, without the need for much governmental support. From the beginning the government supported geothermal development with an extensive long-term marketing of the technology with contributions in the general press and on television. Heat pumps are now regarded as a 'natural heating' solution with a technology which is considered a ‘conventional’ heating system.

2.6 Turkey: Supportive Legal, Institutional and Fiscal Incentive Schemes

2.6.1 Geothermal use and market situation

Turkey has extensive geothermal resources. According to Parlaktuna, Mertoglu, Simsek, Paksoy and Basarir (2013) the capacity of direct heat applications of geothermal energy is 2,705 MWt including residence heating (805 MWt), greenhouse heating (612 MWt), thermal facilities heating (380 MWt), balneological use (870 MWt) and heat pump application (38 MWt).

About 95% of the 250 known geothermal fields are medium enthalpy fields suitable for direct use applications. Figure 8 provides an overview of the geothermal fields in Turkey.

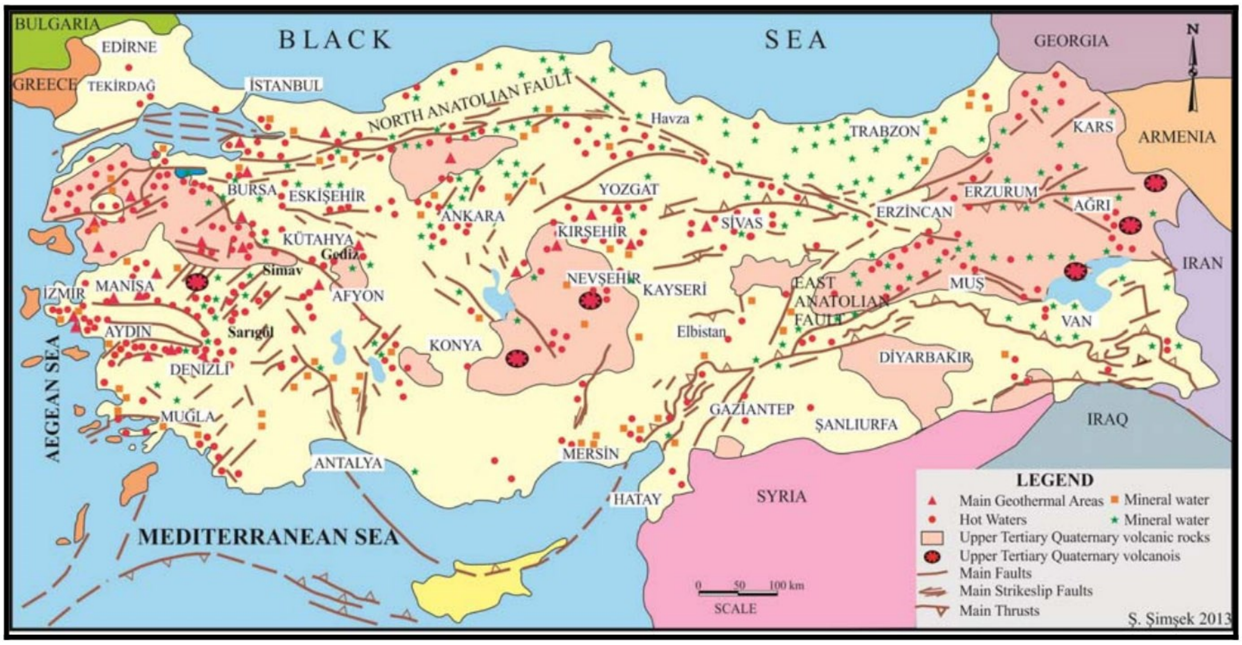

Figure 8: Distribution of hot springs and tectonic lines in Turkey (Parlaktuna et al., 2013)

In 2010 a total of 260 spas existed in the country which used geothermal water for balneological purposes. Selected towns with geothermal district heating systems are shown in Table 2.

Table 2: Geothermal district heating systems in selected towns/ provinces in Turkey

Town, Province	Year	Current capacity (RE*)
Gönen, Balıkesir	1987	3400
Simav, Kütahya	1991	7500
Kırşehir, Kırşehir	1994	1900
Kızılcahamam, Ankara	1995	2500
Balçova, İzmir	1996	35000
Afyon, Afyon	1996	8000
Kozaklı, Nevşehir	1996	3000
Sandıklı, Afyon	1998	6000
Diyadin, Ağrı	1999	570
Salihli, Manisa	2002	7292
Sarayköy, Denizli	2002	2200
Edremit, Balıkesir	2003	4881
Bigadiç, Balıkesir	2005	1500
Sorgun, Yozgat	2008	750
Bergama, İzmir	2008	450
Dikili, İzmir	2008	1160
TOTAL		**86853****

*RE = Residence equivalent, 1 RE = 100 m^2 heated space

** There are other district heating systems with 2590 RE install capacity whereas the heating systems are not operational due to different reasons and are not included into the list.

The first geothermal greenhouse heating project was supported by the United Nations development Program (UNDP) in Denizli-Kizildere in 1973. Now, the greenhouse area heated by geothermal energy reaches 2,811,000m^2.

The 'Hamam-Turkish Bath' culture and geothermal projects are supported by the Ministry of Culture and Tourism through investment certificates and the Ministry of Health through licenses.

For shallow geothermal systems heat pumps and underground thermal energy storage systems (UTES) are used for residential and office buildings, shopping malls and hotels. Borehole heat exchangers are applied for the Metro Meydan M1 Shopping Center in Istanbul and 1,584 energy piles were installed for the HABOM project at Sabiha Gokcen Airport (capacity 1,855 kW).

2.6.2 Geothermal regulatory situation

Geothermal activities in Turkey are regulated by the Law on Geothermal Resources and Natural Mineral Waters (No: 5686, June 3, 2007) and its implementation regulation (No: 26727, December 2007). The law targets exploration, drilling operations and production. Two types of licenses are described in the law, a prospecting license and an operating license. The legal setting descriptions include technical responsibilities, reporting, force majeure, bidding and tendering processes, fees, sanctions, confiscation procedures, etc. (Ministry of Energy and Natural Resources 2007). In its efforts to promote renewable energy, the government has focused on electricity, but has recently started to pay more attention to heat (geothermal and solar). However, only few incentive schemes were identified.

The Law of 5627 Energy Efficiency of 2007 (Art. 7) determines that all buildings need to have an Energy Identity Document (EKB). The document describes energy use, efficiency of heating/cooling systems and insulation properties. Paksoy and Cetin (2013) report that the green building movement is stimulated by building certificates (LEED, BREEM). The certificates are later on used by companies to create a positive marketing image. This energy labelling program of buildings is an important step towards improving energy efficiency in the buildings sector. Also, air-conditioning should be a focus of particular attention which would save money that the government is spending on the electricity sector. Heat pumps look particularly attractive as a technology option for providing both energy-efficient cooling and heating, and the government should consider stronger incentives for their uptake.

A perceived barrier which is described by Paksoy et al. (2013) entails that no suppliers of GSHP and piping materials exist in Turkey. Also a lack of expertise and human capacities are stressed.

Recently the Turkish Director General of Mineral Research and Exploration selected 20 cities who will obtain EUR 9.4 million for geothermal research projects. The cities include Ankara, Izmir, Manisa and Afyonkarahisar among others (EGEC 2014).

3. CONCLUSION

The enabling framework analysis shows that national governments are decisive in geothermal development. Governments set the legal and financial framework conditions for the electricity market, private sector involvement, research, politics and human capacity development in geothermal. Changing subsidy schemes and market conditions show especially in the examples of the Fonds Chaleur of France and the Market Incentive Program of Germany that the State is decisive for the market and product sales of renewable energy technologies. Direct correlations can be drawn from sales figures to national incentive schemes of the year. Also the generous support schemes for GSHPs in Sweden for single- and multiple-family houses in the 1980s and 1990s show the power of fiscal instruments. The Swedish shallow/ medium enthalpy technology market is today self-sustainable and does not need further government support.

Regulations and subsidy schemes in the construction of individual homes, public institutions, office buildings and district heating systems obviously directly influence the sales figures of GSHPs, UTES, BTES or ATES systems. The oil crises also showed its effects in the increase of sales in four of the five countries investigated.

Clarity, consistency, stability and predictability are important to geothermal developers, as uncertainties and ambiguities are perceived as risk factors that may delay or hinder development. Legal and regulatory frameworks thus need to address all aspects of development in a clear and consistent way, as gaps can lead to confusion and difficulties.

ACKNOWLEDGEMENT

The research was supported by the European Union through the European Regional Development Fund Investing in our Future and by the German federal state of Northrhine-Westphalia.

REFERENCES

ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie = French Agency for Environment and Energy) 2014. Energies et matières renouvelables - Géothermie. Website: http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=25162; 14 May 2014

AFPG (Association Francaise des Professionnels de la Géothermie = French Professionals Association) 2012. La géothermie en France - Le marché en 2011. Website: http://www.afpg.asso.fr/resources/Nos-actions/AFPG_ETUDE2012.pdf; 14 May 2014

Antics, M., Bertani, R. and Sanner, B. 2013. Summary of EGC 2013 Country Update Reports on Geothermal Energy in Europe. Proceedings of the European Geothermal Congress 2013 Pisa, Italy, 3-7 June 2013

Boissavy, C., Vernier, R. and Laplaige, P. 2013. Geothermal Energy Use, Country Update for France. Proceedings of the European Geothermal Congress 2013 Pisa, Italy, 3-7 June 2013

Boissavy, C. 2013. The geothermal energy market in France for heating and cooling. Proceedings of the European Geothermal Congress 2013 Pisa, Italy, 3-7 June 2013

Cetin, A. and Paksoy, H. 2013. Shallow Geothermal Applications in Turkey. Proceedings of the European Geothermal Congress 2013, Pisa, Italy, 3-7 June 2013. Website: http://www.geothermal-energy.org/pdf/IGAstandard/EGC/2013/EGC2013_SG6-01.pdf; 14 May 2014

EGEC (European Geothermal Energy Council) 2014. Turkish Government Support for Geothermal. Newsletter April 2014. p. 3. Website: http://egec.info/wp-content/uploads/2014/04/EGEC-April-Newsletter-2014.pdf; 14 May 2014

EGEC (European Geothermal Energy Council) 2012. K4RES-H - Key Issue 4: Financial schemes for geothermal energy. http://geodh.eu/wp-content/uploads/2012/11/K4RES-H_Geothermal_FinancialIncentives.pdf; 22 May 2014

ESMAP 2012. Drilling Down on Geothermal Potential: An Assessment for Central America. Washington DC; Website: http://www.esmap.org/sites/esmap.org/files/CentralAmerica_Drilling_Down_Geothermal_Potential_Optimized.pdf; 22 May 2014

German Federal Government 2009. National Renewable Energy Action Plan in accordance with Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Berlin. Website: http://ec.europa.eu/energy/renewables/action_plan_en.htm; 22 May 2014

Ganz, B., Schellschmidt, R., Schulz, R. and Sanner, B. 2013. Geothermal Energy Use in Germany. http://www.geothermal-energy.org/pdf/IGAstandard/EGC/2013/EGC2013_CUR-13.pdf; 14 May 2014

Haraldsson, I.G. 2012. Legal and regulatory framework - Barrier or motivation for geothermal development? Presented at Short Course on Geothermal Development and Geothermal Wells, in Santa Tecla, El Salvador, March 11-17, 2012. Website: http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-14-17.pdf; 14 May 2014

IEA (international Energy Agency) 2012. France Country Report 2012 – IEA Geothermal Implementing Agreement. Website: http://iea-gia.org/wp-content/uploads/2014/02/2012-France-Country-Report-IEA-GIA-with-Cover-Photo-19Feb14.pdf; 14 May 2014

Ketilsson, J., Olafsson, L., Steinsdottir, G. and Johannesson, G.A. 2010. Legal framework and national policy for geothermal development in Iceland. Proceedings World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010

Ketilsson, J. 2012. Geothermal Energy Iceland Perspective. Website: http://www.eu-japan.eu/sites/eu-japan.eu/files/Session1_J%C3%B3nas%20Ketilsson.pdf; 22 May 2014

Lund, J., Derek, Freeston, D., Boyd, T. 2010. Direct Utilization of Geothermal Energy 2010 Worldwide Review. Proceedings World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010

Lund, J. 2011. Development of direct-use projects. Proceedings, Thirty-Sixth Workshop on Geothermal Reservoir Engineering. Stanford University, California, January 31 - February 2, 2011 (http://www.geothermal-energy.org/pdf/IGAstandard/SGW/2011/lund.pdf); 22 May 2014

Ministry of Ecology, Energy, Sustainable Development and the Sea of France (Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer) 2009. National action plan for the promotion of renewable energies 2009-2020.

Ministry of Energy and Natural Resources of Turkey 2007. Law on Geothermal Resources and Natural Mineral Waters (No: 5686). Website: http://ocid.nacse.org/rewab/docs/Law_5685_Geothermal_and_Natural_Mineral_Waters_2007_En.pdf; 14 May 2014

Pálsson, B. 2012. Master Plan for Geothermal and Hydropower Development in Iceland. Proceedings of the 2012 Geothermal Workshop in Fukuoka “Toward new geothermal development strategies in Japan and in the world” , 26 March 2012, Fukuoka, Japan

Parlaktuna, M., Mertoglu, O., Simsek, S., Paksoy, H. and Basarir, N. 2013. Geothermal Country Update Report of Turkey (2010-2013). Proceedings of the European Geothermal Congress 2013, Pisa, Italy, 3-7 June 2013. Website: http://www.geothermal-energy.org/pdf/IGAstandard/EGC/2013/EGC2013_CUR-32.pdf; 14 May 2014

Ragnarsson, A. 2013. Geothermal Energy Use - Country Update for Iceland. Proceedings of the European Geothermal Congress 2013, Pisa, Italy, 3-7 June 2013. Website: http://www.geothermal-energy.org/pdf/IGAstandard/EGC/2013/EGC2013_CUR-16.pdf; 14 May 2014

RES LEGAL Europe 2014a. Sweden. http://www.res-legal.eu/search-by-country/sweden/

Steingrímsson, B., Sveinbjörn, B. and Hákon, A. 2006. Master Plan for Geothermal and Hydropower Development in Iceland. Proceedings Workshop for Decision Makers on Geothermal Projects in Central America, San Salvador, El Salvador, 26 Nov.-2 Dec. 2006

Swedish Heat Pump Association (SVEP) 2013. Statistics of heat pump installations. http://www.svepinfo.se/usr/svep/resources/filearchive/10/varmepumpsforsaljning_2004_2013.pdf; 22 May 2014