EUROPEAN GEOTHERMAL ENERGY COUNCIL

EGEC policy paper on the European Commission's "Energy Roadmap 2050"

April 2012

EGEC, the European Geothermal Energy Council, was founded in 1998 as an international non-profit association in Brussels, with the aim of promoting the use of geothermal energy in Europe.

EGEC has now more than 120 members from 22 European countries: private companies, national associations, consultants, research centres, geological surveys and other public authorities.

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EGEC key recommendations for a successful post-2020 energy strategy

1. *Member States should give the European Commission the mandate for setting ambitious binding renewable energy targets for 2030. Experience has shown that this is the right strategy in order to live up to commitments and to provide investors with the certainty they need.*

2. *Policy-makers should be aware of the huge potential of geothermal energy for both electricity and heating and cooling.*

3. *Starting from the current discussion on Horizon 2020 and persisting thereafter, Geothermal should be allocated higher RD&D funds to become more competitive.*

4. *A more balanced approach in the deployment of renewables would share and reduce investment requirements. Adequate support schemes should be set to incentivise geothermal and to reward its benefits for providing heat and power 24 hours a day as well as stability of the system.*

5. *Fair competition has to be the paramount priority before any serious discussion on the economics of the transition towards decarbonisation. Today, the price of energy does not include externalities (such as infrastructure and other costs incurred to society) and subsidies to mature technologies are often hidden to consumers' eyes. These market distortions need to be removed urgently.*

6. *Heating and cooling is crucial to decarbonise the European economy. Hence, an ambitious and comprehensive EU heating and cooling policy is necessary. In the next updating of the Roadmap, figures for this sector should be reported and analysed in a detailed manner. Further investigation and improved statistical data and modelling are therefore indispensable for the successful elaboration of a post-2020 energy strategy.*

7. *Geothermal and other renewable technologies have the potential to cover the entire heating demand in 2050. In order to ensure an affordable and reliable energy system, electrification of the heating sector should not be encouraged as long as other truly renewable and market-ready technologies are capable of delivering better solutions.*

It is the responsibility of policy-makers to provide affordable energy to everybody in a sustainable way. To this end, geothermal energy will clearly contribute to maintain reasonable costs for the entire society. However, it is crucial that there is a clear understanding of, and the convergence between, the prices to consumers and the costs to society, whereas the latter include system costs and other externalities such as environmental pollution and the resulting public health impact.

1. Introduction

The European Union (EU) is committed to decarbonising its economy while at the same time ensuring security of supply and preserving industrial competitiveness.[1] This objective implies the reduction of greenhouse gas (GHG) emissions by 80-95% in 2050 compared to 1990 levels.

As regards to the energy sector, this means some 85% GHG emission reductions by mid-century. In order to explore some decarbonisation pathways, in December 2011 the European Commission published its Energy Roadmap 2050 (hereinafter referred to as "the Roadmap"). This document will be followed by a further Communication on Renewable Energy Strategy[2].

The European Geothermal Energy Council (EGEC) promptly reacted to the publication of the Roadmap and welcomed the following main conclusions:

- Decarbonisation is possible and can be less costly than current policies in the long run;
- Renewables will be playing a central role in whatever decarbonisation pathways;
- Energy savings throughout the system are crucial;
- A transition from today's system with high fuel and operational costs, to an energy system based on higher capital expenditure and lower fuel costs will inevitably take place;
- Renewable heating and cooling is vital to decarbonisation.

Bearing in mind the mere illustrative nature of the scenario analysis undertaken by the Commission and the fact that the Roadmap is now the basis for a political discussion under the Danish EU presidency, this EGEC policy paper serves three main purposes:

1. To analyse in-depth not only the Communication, but also the Impact assessment of the Roadmap;
2. To illustrate its main implications for the geothermal sector and;
3. To put forward recommendations for EU and national policy-makers in order to further improve the Roadmap and to elaborate a successful post-2020 energy framework.

[1] "[…] in the context of necessary reductions according to the IPCC by developed countries as a group". European Council, Presidency Conclusions, October 2009, p.3.

[2] The Commission's Renewable Energy Strategy is expected to be published in May 2012. It aims to examine the necessary conditions for a further development of renewable energy in a medium term perspective – i.e. until 2030.

2. Background: Scenarios and main energy sector indicators

Scenario selection

The Commission's Roadmap illustrates the analysis of possible future developments of the EU's energy systems in two current trend scenarios and five decarbonisation scenarios. These are briefly described in Table 1.

The 7 Scenarios
1. **Reference scenario** - *also used in the Impact assessment (IA) for the "Low-carbon economy 2050 Roadmap" and for the IA for the "White Paper on Transport 2011", is a projection of developments in the absence of new policies beyond those already approved in March 2010.*
2. **Current Policy Initiatives (CPI)** – builds up on the Reference scenario, but *takes also into account some of the latest developments, i.e. the nuclear phasing-out in Germany and the rejection of nuclear power plans in Italy, the new policies on energy efficiency and infrastructure already adopted or planned in March 2010.*
3. **High Energy Efficiency -** *assumes a high political commitment to primary energy savings, notably in the building sector, leading to a decrease in energy demand of 41% in 2050 compared to 2005 levels.*
4. **Diversified Supply Technology (DST) -** *assumes that all energy sources can compete on a market basis with no specific support measures. In this scenario, decarbonisation is mainly driven by carbon price. It also implies full public acceptance of nuclear and CCS.*
5. **High Renewable Energy Sources (High-RES) -** *foresees that support measures to renewables would lead to a total RES share of about 75% in the entire energy sector. This scenario assumes a very high penetration (86.4% in power generation and 97% in consumption) of renewable electricity (RES-E). On the other hand, the penetration of RES-H is not clear as figures on renewable heating and cooling have not fully been disclosed for this scenario as well as for all other decarbonisation scenarios.*
6. **Delayed CCS -** shows the consequences of a delay in the development of CCS due to public resistance. Large-scale development of CCS is assumed between 2040 and 2050. This scenario, however, assumes public acceptance and larger deployment of nuclear.
7. **Low Nuclear -** *assumes low public acceptance of nuclear reactors besides those currently under construction. On the other hand, the Low nuclear scenario assumes high penetration of CCS*.

Table 1: The 7 Scenarios

The scenario selection does not appear to be too fortunate. Despite a number[3] of 100% renewable energy scenarios have been proposed, the Commission has failed to put forward such an ambitious route. Likewise, RES and energy efficiency have been recognised as two major pre-requisites for a more sustainable and secure energy system, but there is no scenario with emphasis on both, which have high synergies. Furthermore, the Roadmap does not assess a scenario in which neither CCS nor Nuclear are accepted to the necessary degree.

In order to provide the reader with some key background information on the Roadmap, the results of the Commission's 2050 modelling on fossil fuel and ETS allowances prices, as well as the total share of renewables and geothermal energy, are briefly illustrated.

[3] For instance see EREC, *RE-thinking 2050: A Renewable Energy Vision for the European Union*, 2010, WBGU, *A Social Contract for Sustainability*, 2011, and The Danish Government. *Energy Strategy 2050: From Coal, Oil and Gas to Green Energy*, 2011.

Price of fossil fuels

The decarbonisation scenarios are based on "global climate action" price trajectories for fossil fuels in line with the "Low-carbon economy 2050 Roadmap". The latter assumes that global action on decarbonisation will reduce fossil fuel demand worldwide and will therefore have downward effect on fossil fuel prices. Oil, gas and coal prices are therefore lower than in the Reference scenario and in the CPI scenario. This results, for instance, in an oil price of $70 in 2050, but strides with current oil prices which are already above $100[4]. Similarly it does not take into account the eventual and more expensive production of unconventional fossil fuels (e.g. oil and gas shale).

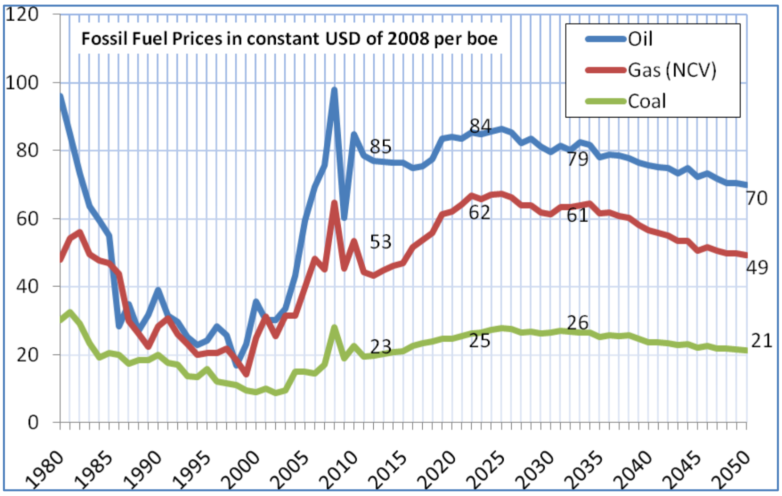


Figure 1: Fossil fuel prices in the decarbonisation scenarios (Source: European Commission, SEC (2011) 1565 Part 2/2 p. 3)

Cost of GHG emissions

EGEC regrets that the damage to the environment or human health is still completely borne by society rather than by polluters and that these externalities are not adequately integrate to cover the real costs of energy production and consumption. Against this background, according to the Roadmap's modelling, ETS allowance price rises moderately from current levels until 2030 and more significantly in the following two decades. Table 2 shows how carbon prices are the highest in the Low nuclear scenario and the lowest in the High Energy Efficiency Scenario. The second lowest carbon prices until 2040 are found in the High-RES scenario. Subsequently, the ETS price unjustifiably rises in High-RES and is the second highest. This is surprising as the price of allowances is rather supposed to decrease further with higher penetration of RES technologies.

ETS allowance price				
(€'08/t CO2)	2020	2030	2040	2050
CPI	15	32	49	51
Energy Efficiency	15	25	87	234
Diversified supply technologies	25	52	95	265
High RES	25	35	92	285
Delayed CCS	25	55	190	270
Low Nuclear	20	63	100	310

Table 2: ETS allowance price (€'08/t CO2)

[4] At the time of writing (17 February 2012), for instance, the WTI crude oil price was $102.94 a barrel.

Share of renewable energy

Following the High-RES scenario, with some 75% share of renewable energy in final energy consumption in 2050, the Low Nuclear scenario is the second highest with about 58% while the High Energy Efficiency scenario presents a share of RES with about 57% in 2050. EGEC regrets that the Roadmap does not clarify the contribution of renewable heating and cooling to the total share of renewable energy as reported in Table 3 below.

Share of renewable energy					
(%)	2010	2020	2030	2040	2050
CPI	11,4	20,6	24,7	27	29
High Energy Efficiency	11,4	21,3	27,6	41,3	57,3
DST	11,4	21,3	27,7	39,8	54,6
High-RES	11,4	21,3	31,2	50,6	75,2
Delayed CCS	11,4	21,3	28	42,6	55,7
Low Nuclear	11,4	21,2	28,8	41,3	57,5

Table 3: Share of renewable energy (%)

Member States have achieved a significant progress in the development of renewable energy sources since binding targets were set for 2020. On the other hand, non-binding targets in the energy efficiency field have proved not to be an effective instrument. The experience has so far shown that in order to live up to ambitious commitments and to give industry the investment certainty it requires, further binding renewable energy targets for 2030, covering electricity, heating and cooling as well as transport, is a vital step towards decarbonisation of the economy.

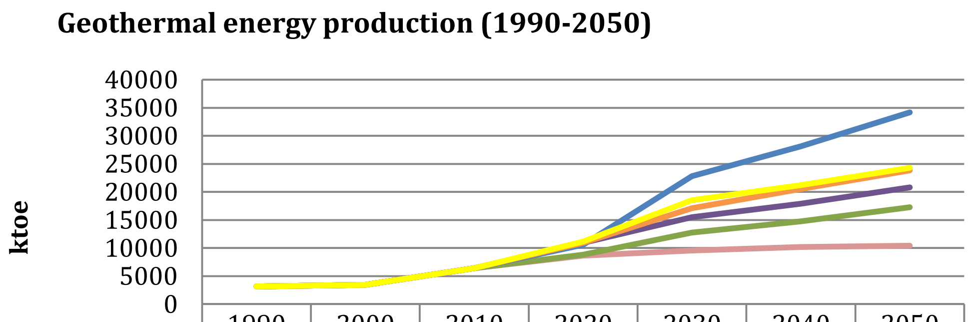
Against this background, it is worth noting that all the decarbonisation scenarios show a share of RES in 2030 of about 30% which would represent, however, no-more than business as usual as the share of RES H&C is not properly integrated. The model used for the Roadmap does not appear to be appropriate and cannot be taken as a reference for the post-2020 policy-framework. Member states should therefore follow up to the 2050 objectives by giving the Commission the mandate to set ambitious binding targets for 2030 on the basis of improved modelling.

Recommendation 1: Member states should give the European Commission the mandate for setting ambitious binding renewable energy targets for 2030. Experience has shown that this is the right strategy in order to live up to commitments and to provide investors with the certainty they need.

Geothermal energy production

Figures released in *Annex I* of the Impact Assessment show how the share of geothermal energy production rises from a minimum of 17.2 Mtoe in the High Energy Efficient scenario to a maximum of 34.1 Mtoe in the High-RES scenario. Such a trend, however, appears to be conservative if compared to the growth experienced in the last decade, during which geothermal energy production nearly doubled from 3.4 Mtoe in 2000 to 6.4 Mtoe in 2010 (see Figure 2 overleaf).

The reason behind the fact that Geothermal is not appropriately considered in the Commission's modelling of the future European energy mix, lies in some inaccuracies which will be thoroughly analysed in the next sections related to electricity and heating and cooling.



	1990	2000	2010	2020	2030	2040	2050
CPI	3190	3421	6398	8640	9537	10213	10427
High Energy Efficiency	3190	3421	6398	8803	12785	14775	17279
Diversified supply technologies	3190	3421	6398	10944	15480	17898	20801
High RES	3190	3421	6400	10617	22800	28134	34182
Delayed CCS	3190	3421	6398	10949	17094	20509	23861
Low Nuclear	3190	3421	6398	11137	18541	21188	24271

Figure 2: Geothermal energy production (ktoe)

Recommendation 2: Policy-makers should be aware of the huge potential of geothermal energy for both electricity and heating and cooling.

3. Geothermal in the future EU's electricity mix

Development of geothermal technologies underestimated

Geothermal is fully recognised to be a safe, reliable, environmentally benign renewable energy source. The *IPCC Special Report on Renewable Energy Resources and Climate Change Mitigation* compares the lifecycle GHG emissions for broad categories of electricity generation technologies (Figure 3) and highlights, *inter alia,* the huge potential of geothermal energy in reducing GHG emissions.[5]

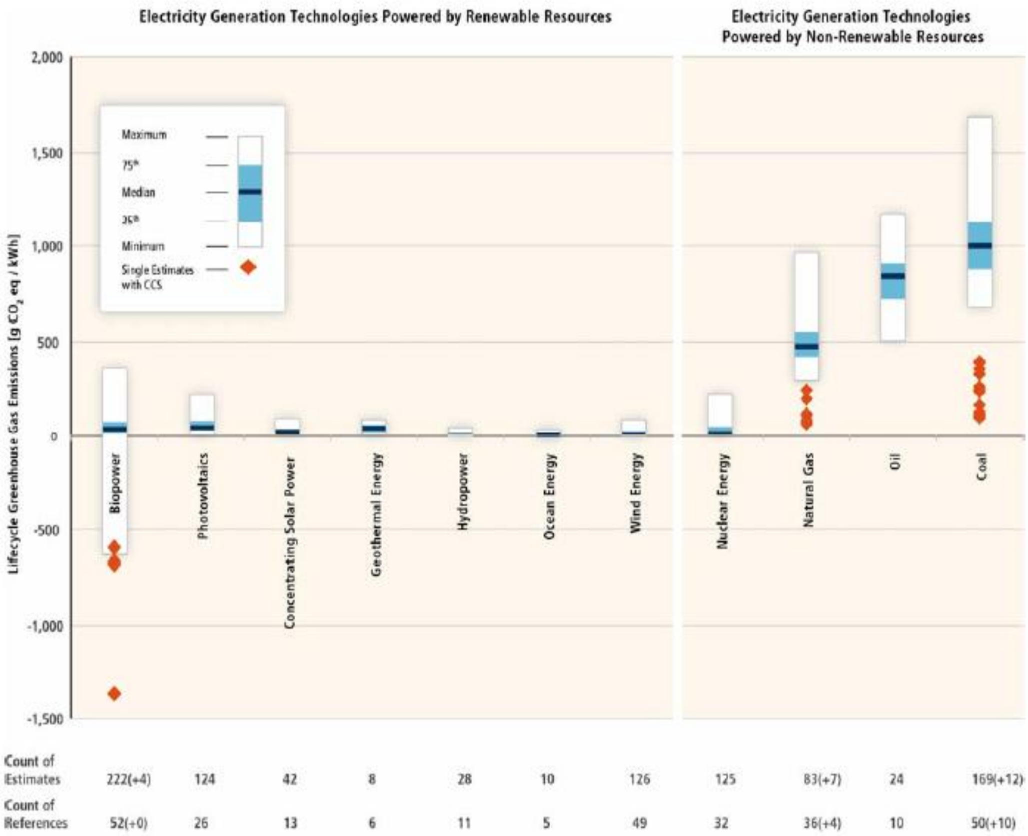


Figure SPM.8. | Estimates of lifecycle GHG emissions (g CO2-eq / kWh) for broad categories of electricity generation technologies, plus some technologies integrated with CCS. Land-use related net changes in carbon stocks (mainly applicable to biopower and hydropower from reservoirs) and land management impacts are excluded; negative estimates[10] for biopower are based on

[10] 'Negative estimates' within the terminology of life-cycle assessments presented in the SRREN refer to avoided emissions. Unlike the case of bioenergy combined with CCS, avoided emissions do not remove GHGs from the atmosphere.

Figure 3: Lifecycle GHG emissions by electricity generation technology. Source: IPCC, 201. Summary for Policymakers, p.17

Over the last 100 years, the production of geothermal electricity has been concentrated in areas where rich hydrothermal resources were available. However, the development of advanced technologies has enabled the production of geothermal electricity in all European countries. For instance, Enhanced Geothermal Systems (EGS), a breakthrough technology already successfully demonstrated, allow the exploitation of geothermal resources all over Europe, also where hydrothermal reservoirs are not directly suitable for electricity.

[5] For more information see Goldstein, B., G. Hiriart, R. Bertani, etc., *Geothermal Energy*, in IPCC Special Report on Renewable Energy Resources and Climate Change Mitigation, 2011.

As a result of technology developments and despite the limited financial support received, geothermal energy is now being developed anywhere in Europe with 109 new power plants under construction or under investigation in EU member states. Figure 4 below highlights how geothermal is already, and will be further, contributing to the EU's security of electricity supply, with a total installed capacity amounting to 923 MWe in 2011 and with a minimum estimated capacity of approximately 1500 MWe expected already in 2018.

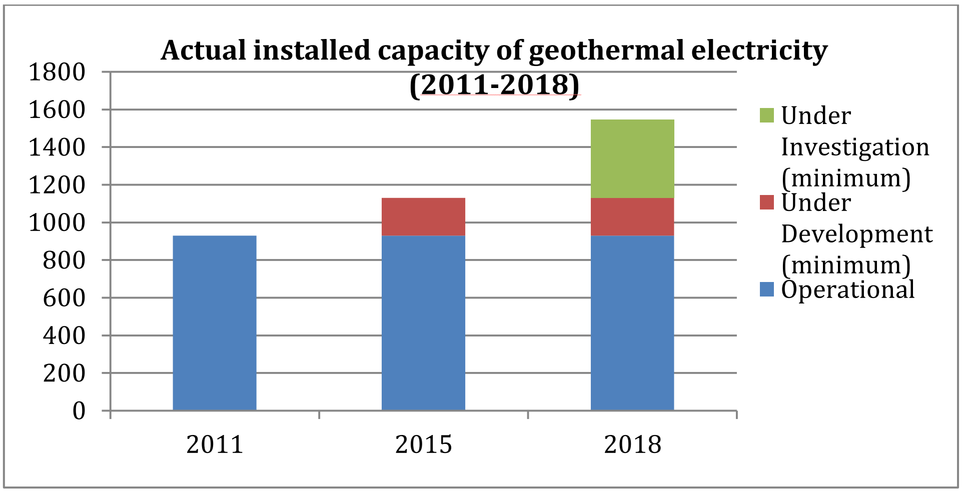


Figure 4: Actual installed capacity of geothermal electr.; MWe (2011-2018) Source: EGEC Deep Geothermal Market Report 2011

Despite these promising data, the Primes energy system model, which plays a critical role in the Commission's work on the Roadmap, does not seem to mirror the actual geothermal market and technological developments. As a matter of fact, it only envisages in 2050 a power net capacity ranging from 1030 MWe in the CPI scenario to 3562 MWe in the High-RES scenario (Figure 5 overleaf).

It is no wonder if the resulting geothermal electricity production (Figure 6) is all but satisfying. According to the Commission's modelling in 2050 it would range from 12 TWh of the High-Efficiency Scenario to the 26 TWh of the High-RES Scenario.

Given these results, it is therefore clear that the model does not take into account the potential of new geothermal technologies, notably EGS, which will allow the full deployment of geothermal power anywhere across Europe.

RD&D funds needed

The Roadmap points out that there is a need to invest in new renewable technologies and to improve existing ones. However, as new geothermal technologies have been ignored in the Commission's document, they are regrettably not listed among those needing further investments and development to bring down costs.

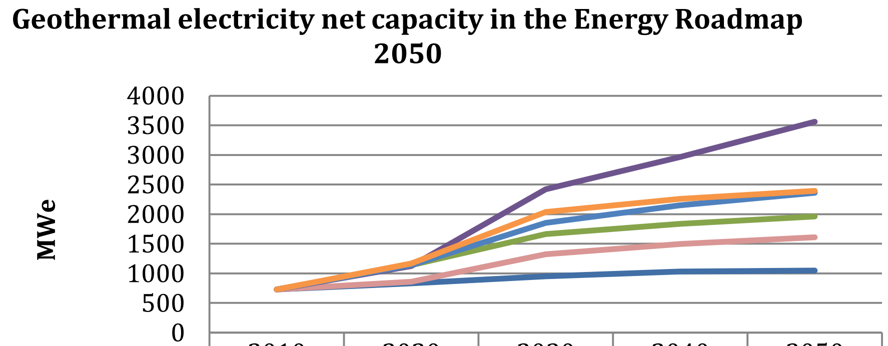
While conventional geothermal power is already a most competitive energy source, low-temperature systems and EGS will become competitive within a few more years if substantial research, development and demonstration (RD&D) resources are allocated to those technologies.

Likewise, the *EGEC Research Agenda for Geothermal Energy*[6] points out that also geothermal heating and cooling will still need R&D up to 2030, notably to further improve the efficiency of the systems and to decrease installation and operational costs.

[6] For more information see the EGEC Research Agenda for Geothermal Energy: Strategy 2008 to 2030.

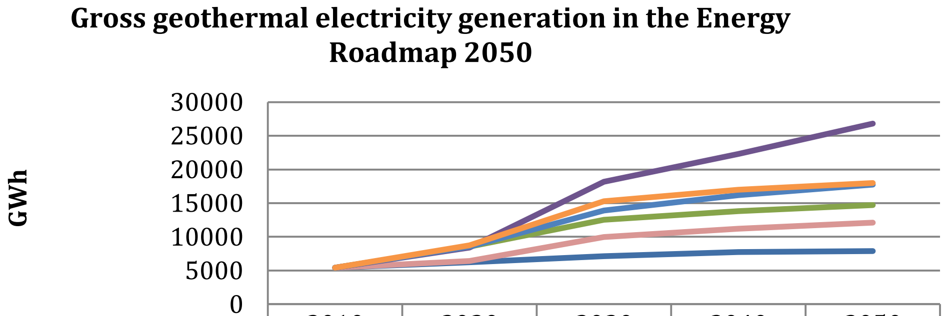
Hence, starting from the current discussion on Horizon 2020 and persisting later on, Geothermal should duly receive more attention as substantially higher RD&D funds are needed in order to become more competitive.

Recommendation 3: Starting from the current discussion on Horizon 2020 and persisting thereafter, Geothermal should be allocated higher RD&D funds to become more competitive.



	2010	2020	2030	2040	2050
CPI	727	829	950	1030	1049
High Energy Efficiency	727	856	1325	1495	1610
Diversified supply technologies	727	1138	1665	1839	1959
High RES	727	1121	2418	2964	3562
Delayed CCS	727	1139	1850	2151	2360
Low Nuclear	727	1164	2035	2259	2395

Figure 5: Geothermal electricity net capacity in the Energy Roadmap 2050 (MWe)



	2010	2020	2030	2040	2050
CPI	5400	6213	7122	7724	7872
High Energy Efficiency	5400	6418	9951	11229	12096
Diversified supply technologies	5400	8541	12513	13819	14724
High RES	5400	8409	18156	22294	26799
Delayed CCS	5400	8546	13904	16169	17743
Low Nuclear	5400	8733	15299	16985	18008

Figure 6: Gross Geothermal electricity generation in the Energy Roadmap 2050 (GWh)

Geothermal the right response for grid stability but rewarding and higher incentives should be provided

The results of the Commission's modelling exercise in terms of share of electricity production by fuel are depicted in Table 4 below.

Share of electricity production by fuel in 2050 (%)					
	High Energy Eff.	Div. supply techn.	High RES	Delayed CCS	Low-Nuclear
Nuclear	14.2	16.1	3.5	19.2	2.5
Coal & lignite	4.8	8.1	2.1	5.1	13.1
Natural Gas	16.7	16.6	7.5	14.9	19.5
Hydrogen	0.0	0.0	3.9	0.0	0.0
Hydro	9.2	8.0	7.7	8.1	8.1
Wind	33.2	31.6	48.7	32.4	35.6
Solar, tidal	10.6	9.9	16.4	9.9	10.8
Biomass & waste	10.9	9.3	9.6	9.9	9.8
Geothermal	0.3	0.3	0.6	0.4	0.4

Table 4: Shares of electricity production by fuel in 2050 (%)

In 2050, all decarbonisation scenarios would be dominated by variable renewable energy sources. The share of other sources such as nuclear and gas fluctuate from scenario to scenario. Being aware of the underestimation of geothermal technologies (see foregoing sections), it is not surprising that the contribution of geothermal appears nearly negligible. As a result of the assumptions in the Primes Model, geothermal electricity production would only contribute between 0.3% and 0.6% to the future EU's electricity mix.

In the Roadmap, the "European approach" towards the development of renewable energy appears to be limited to a massive concentration of wind in the Northern Seas and solar in the Mediterranean countries. The analysis of the Impact Assessment also shows that cumulative grid investment costs alone could be €1.5 to €2.2 trillion between 2011 and 2050, with the higher range reflecting greater investment in support the above-mentioned concentrated approach to the development of renewable electricity.

Such an approach would imply a disproportionately high concentration of capital investments into a small number of countries, making the investment requirements a potentially more significant challenge to the development of RES technologies. This challenge, furthermore, risks to turn into a true defiance if the public antipathy for new transmission corridors or major upgrades to existing lines (including bigger sub-stations and towers) are take into serious consideration.

In contrast, a more balanced concentration would share and reduce the investment requirements among the Member States, not to mention the benefits in terms of local competitiveness and growth in employment. In that regard, the benefits that geothermal can provide to the future EU's power system have been utterly overlooked.

Geothermal electricity can be produced as a base-load renewable resource, meaning it can run 7800h/ year as it is generally immune from weather effects and does not show seasonal variation. The base-load characteristic distinguishes geothermal electricity from several other renewable technologies that produce variable power.

Geothermal has by far the highest capacity factor[7] of all technologies, with new geothermal power plants capable of achieving rates above 90%. For instance, by using the data available in Annex I of the Impact Assessment related to the year 2010, it is possible to note that in terms of capacity factor geothermal (85%) clearly performs better than nuclear (79%). The results are depicted in Figure 7 below.

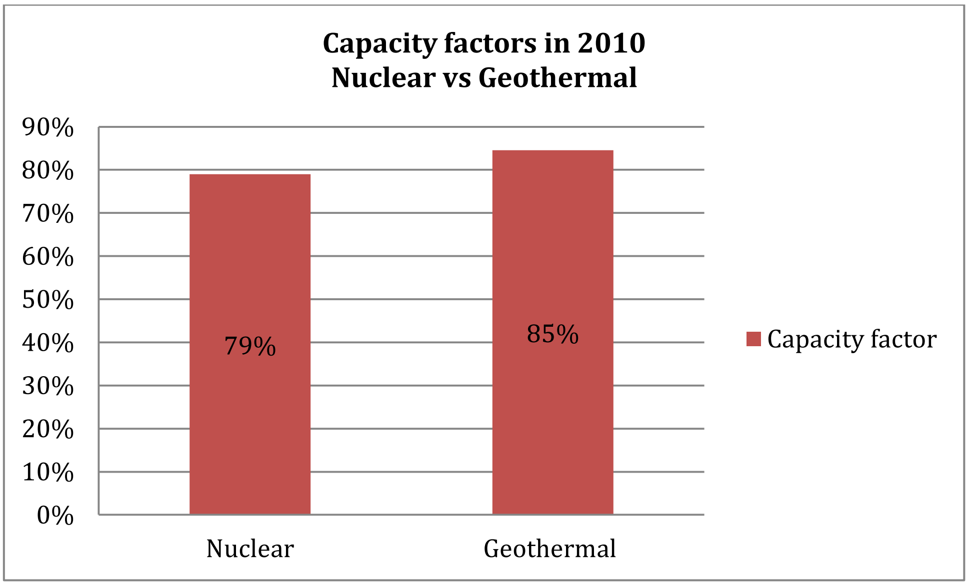


Figure 7: Capacity factors in 2010: Nuclear vs Geothermal

Further advantages of geothermal are its flexibility, as it can be ramped up or down in about six hours[8], and its scalability. Hence, it can easily be integrated in existing power systems providing balance to the grid to respond properly to the local or regional demand. Geothermal electricity is therefore well suited for the substitution of other non-RES base-load power sources such as coal and nuclear[9] and for covering variability in the net load, therefore limiting the need for additional grid infrastructure and storage.

Considering that Geothermal does not even have external costs as associated with other technologies, such as storage, grid and supply infrastructure or waste management, a major contribution from geothermal would be the most economic and balanced scenario for the 2050 electricity mix.

The above-mentioned advantages of geothermal in terms of GHG emission reductions and grid stability, however, should not only be stressed at the EU level but also at the national one. Its slower development compared to other technologies is mainly due to the gap in support schemes. For instance, feed-in tariffs for geothermal are in place in only ten EU Member States.

Feed-in tariff systems in other Member States will contribute to the further development of new geothermal technologies, primarily EGS, as it is happening in Germany where an adequate support (ct€25/kWh for all projects and additional ct€5 for EGS) is in place and where 41 new geothermal power plants are currently being developed.[10]

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[7] The capacity factor is the ratio of the actual output of a power plant over a period of time and its potential output if it had operated at full nameplate capacity the entire time.

[8] The IEA recently pointed out that "the additional flexibility from base-load plants maybe particularly important" as some case-studies suggest that is the ramping capability of the system on the longest timescale assessed (36 hours) which is the greatest constraint on the system's ability to manage variable net load. IEA, *Harnessing Variable Renewables: A Guide to the Balancing Challenge*, 2011.

[9] In the case of the latter, the development of EGS may bridge the gap between demand and supply caused by the nuclear phase-out in Southern Germany (Baden-Württemberg, Bavaria and Hessen).

[10] European Geothermal Energy Council, *EGEC Deep Geothermal Market Report 2011*.

Recommendation 4: A more balanced approach in the deployment of renewables would share and reduce investment requirements. Adequate support schemes should be set to incentivise geothermal and to reward its benefits for providing heat and power 24 hours a day as well as stability to the system.

Costs and prices: transparency is crucial

By analysing the Impact Assessment, it is possible to note that only capital cost figures are provided. As regards to geothermal, it is even further limited to learning rates of conventional technology.[11] Therefore, a comparison of totals costs between geothermal and other technologies is not feasible with the available figures being released.

As far as electricity prices are concerned, the roadmap reports that most scenarios suggest they will rise up to 2030 but fall thereafter. The largest share of these increases is already happening and is linked to the replacement of old generation capacity in the next 20 years. In the High Renewables scenario (97% share for renewable sources in electricity mainly from wind, solar and biomass) the modelled electricity prices continue to rise but at a decelerated rate - due to "high capital costs and assumptions about high needs for balancing capacity, storage and grid investments"[12]. The contribution that geothermal can provide to the affordability of the overall system is crucial, as it has already been analysed in the foregoing section.

Most importantly, the Commission highlights that prices in some member states are currently artificially low due to price regulations and subsidies. The price paid for energy today includes neither infrastructure nor other costs incurred to society such as air pollution and subsequent health costs. In this regard, the EU's Emission Trading System (ETS) has so far unsuccessfully tried to internalise part of those external costs and needs to be adjusted and completed.

Support schemes for renewable energy technologies, including geothermal, are needed to progress down the learning curves and to offset market failures. This financial support, very often in the spotlight, should be gradually phased-out as new technologies achieve grid-parity, provided that existing market distortions have been removed.

On the other hand, the often hidden subsidies to mature generation technologies such as fossil fuels and nuclear as well as the disproportionate allocation of feed-in tariffs among renewables, are preventing the creation of a fair level-playing field in which geothermal can compete. EGEC firmly believes that transparency is a matter of utmost importance and that price and costs of energy should go hand in hand. This issue should be urgently addressed and fair competition needs to be the top priority before any serious discussion on the economics of the transition towards a decarbonised energy system should take place.

Recommendation 5: Fair competition has to be the paramount priority before any serious discussion on the economics of the transition towards decarbonisation. Today, the price of energy does not include externalities (such as infrastructure and other costs incurred to society and subsidies to mature technologies are often hidden to consumers' eyes. These market distortions need to be removed urgently.

[11] The learning rate of conventional geothermal appears in any case to be conservative compared to other scenarios: costs per kW decrease from €4203 in 2010 to €4171 in 2020 and €3805 in 2050.
[12] European Commission, Energy Roadmap 2050. COM (2011) 885/2, p.6.

4. Heating and cooling: The missing piece of the puzzle

Renewable heating and cooling key to decarbonisation

Heating and cooling represents some 43% of the final energy consumption in the EU, either for domestic or industrial purposes. Hence, it is by far the largest energy end-use sector. The vast majority (81%) of heating is today produced through the combustion of fossil fuels, while cooling is predominantly produced from electricity-driven processes and, therefore, also largely relies on coal and gas. This is why the current heating and cooling system is not only boosting costly imports of fossil fuels into Europe, but is also major contributor to the overall EU's greenhouse gas emissions.

A shift towards carbon-free and locally produced energy sources is crucial if the Union wishes to reduce its greenhouse gas emissions by 80-95% by 2050. Accordingly, the Roadmap rightly recognises renewable heating and cooling (RES H&C), notably geothermal, as vital to decarbonisation.

Holistic approach missing

Against this background, one would expect a thorough analysis of heating and cooling, at least comparable with the one carried out for the electricity sector. Erroneously, the impact assessment accompanying the Roadmap fails to go beyond electricity and to provide a significant outline of heating and cooling.

Also the Final report of the Advisory group on the Energy Roadmap 2050[13] somehow criticises such a too narrow emphasis on the electricity sector:

> "Members raised the question of domain, and the extent to which the Roadmap should focus on energy in the wider sense, rather than place too much emphasis on electricity. The view was expressed that decarbonisation of electricity was more straightforward than other energy sources and uses, and that the Roadmap should explicitly recognise all these other energy dimensions, rather than focussing exclusively on electricity."

The Commission published all the results of the modelling for electricity as well as for transport. It is therefore incomprehensible why only distributed heat/steam numbers have been disclosed, while RES H&C figures have only been reported in relative terms and the total heating and cooling demand is completely omitted.

What is certainly true is that aggregate data on electricity are easier to gather while systematic collection of information on the heating and cooling markets is missing on a European level. The final result of the Commission's exercise is eventually a broken roadmap lacking in proper analysis and modelling. The next step to improve the Roadmap is to map the heating sector. The mapping should cover all dimensions of this complex sector as illustrated in Figure 8 overleaf.

In order to successfully elaborate a European energy strategy beyond 2020, EGEC together with a number of other associations, has therefore called for an ambitious and comprehensive EU heating and cooling policy.[14]

[13] The Ad Hoc Advisory Group (the Group) was set up with the aim to provide independent advice to the Commissioner for Energy in the preparation of the Roadmap.
[14] See the joint statement "Energy Roadmap 2050: Neither Hot nor Cool" published on 6 March 2012.

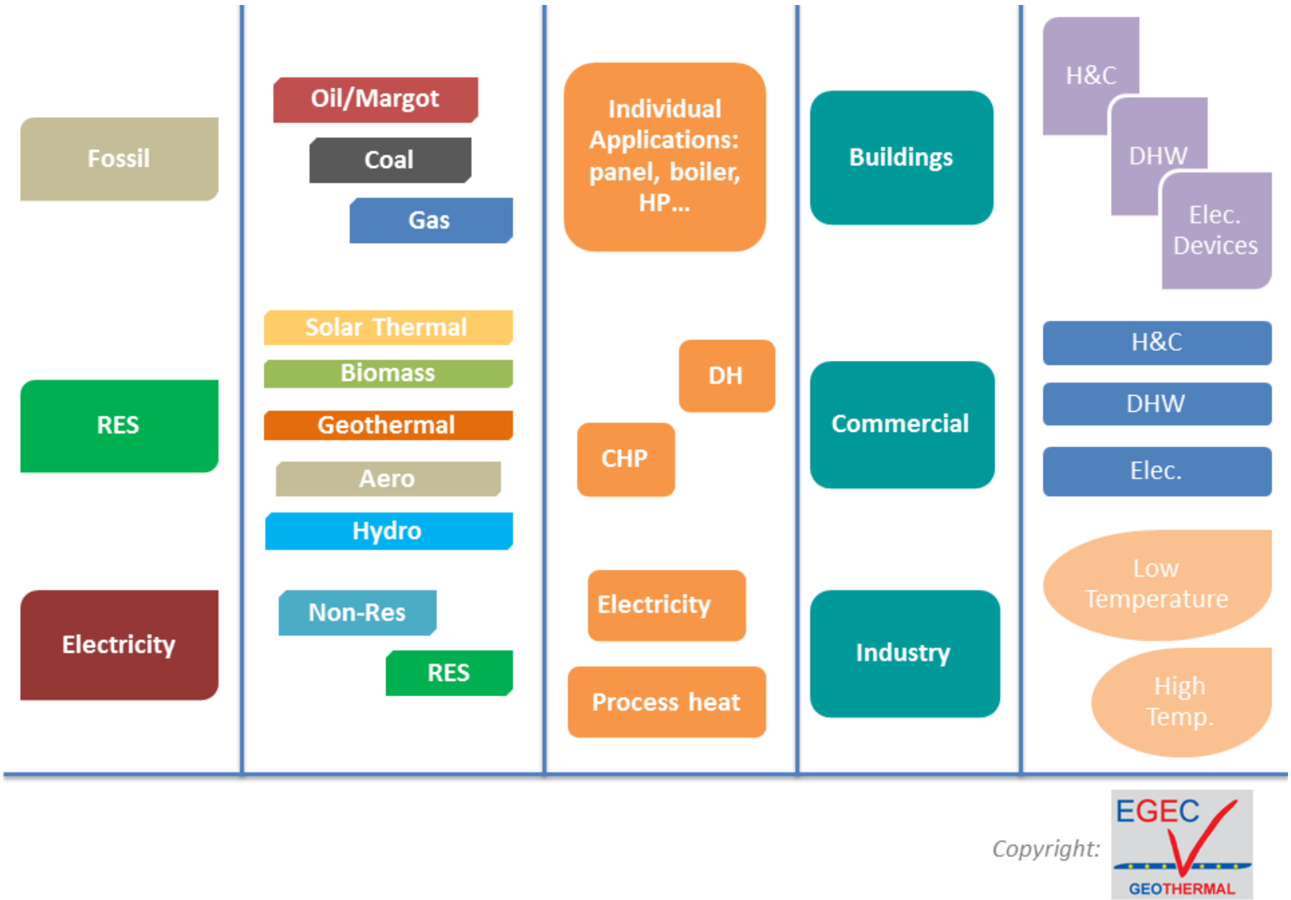


Figure 8: Map of the heating sector. Source: EGEC

Recommendation 6: Heating and cooling is crucial in order to decarbonise the European economy. Hence, an ambitious and comprehensive EU heating and cooling policy is necessary. In the next updating of the Roadmap, figures for these sectors should be reported and analysed in a detailed manner. Further investigation and improved statistical data and modelling are therefore indispensable for the successful elaboration of a post-2020 energy strategy.

Contradicting trends can be observed

The Roadmap praises geothermal and other renewable heating and cooling technologies for their contribution to the decarbonisation of the energy sector. In the Impact Assessment, however, only partial data in relative terms have been published. They are reported in Table 5.

Data related to 2020 originate from the National Renewable Energy Action Plans (NREAPs) that EU member states submitted in the framework of Directive 2009/28/EC (RES Directive). NREAPs project a doubling of the share of RES in heating and cooling in the EU-27 from 10.2% in 2005 to 21.3% in 2020.

Beyond the year 2020, the Primes model seems to forecast a very inconsistent increase of the RES-H&C share, notably in the timeframe between 2020 and 2030. In 2050 the largest penetration, i.e. 53.5%, is observed in the High RES scenario, while in other decarbonisation scenarios the average market share is around 44%.

Share of renewable energy in heating and cooling			
%	2020	2030	2050
CPI	20.9	22.7	23.8
High Energy Efficiency	21	23.3	44.9
Div. Supply Techn.	20.9	23.9	44
High RES	20.9	26.8	53.5
Delayed CCS	20.9	24.4	44.9
Low Nuclear	20.8	24.3	44.6

Table 5: Share of renewable energy in heating and cooling

However, it is important to note that while electricity demand rises, the energy demand in the decarbonisation scenarios is 34%-40% lower in 2050 than under reference developments. As a result, it is easy to conclude that the model's forecast would imply no or an insignificant increase of RES-H&C in absolute terms.

In a bid to account for the missing figures and to figure out the actual RES H&C production in 2050, EGEC has estimated approximately the trend in heating according to the Primes model[15].

In Figure 9 it is possible to observe a steep decline in heat demand due to substantial energy efficiency gains, notably in the building sector. Most importantly, Figure 10 overleaf compares the High Energy Efficiency and the High-RES scenarios and shows that despite its praised crucial role, there would be only a steady heat production from renewable energy between 2020 and 2040, with an increase in the High-RES scenario after 2040.

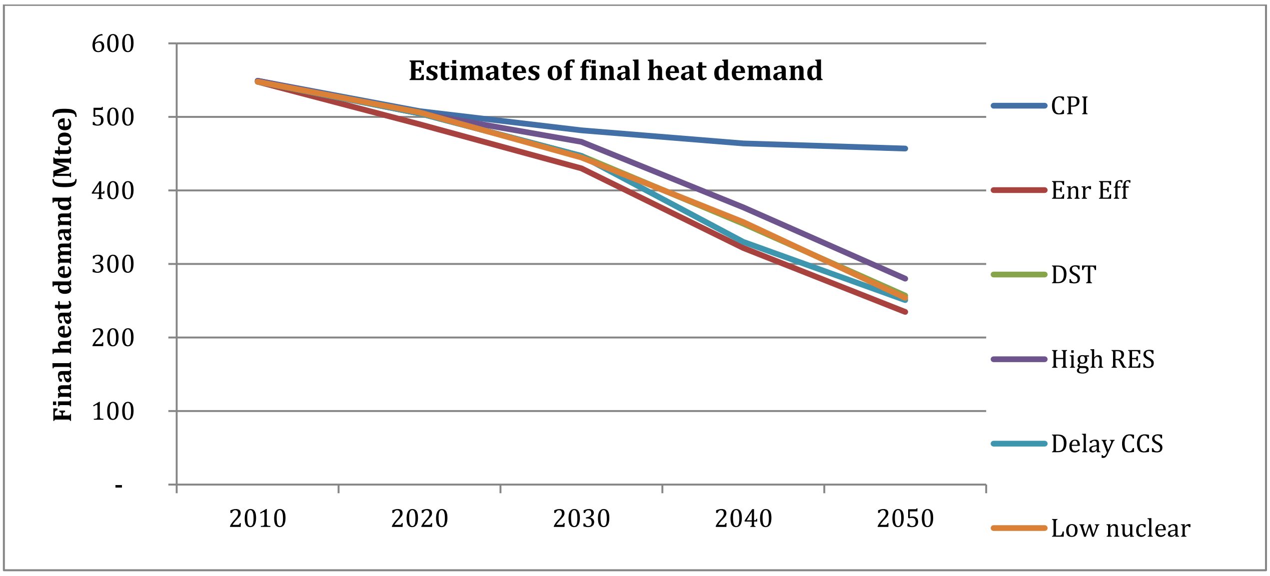


Figure 9: Estimates of final heat demand

[15] Calculation is our own and is based on the best available data from Annex I of the Energy Roadmap 2050. It was indeed not possible to avoid double counting the electricity assumed to be used in heating and cooling, and transport, as well as to deduct electricity losses. The exercise, however, does not aim to provide scientific evidence but to show a rough trend coming out if the Commission had gone further in its assessment on the basis of current statistics and economic models available.

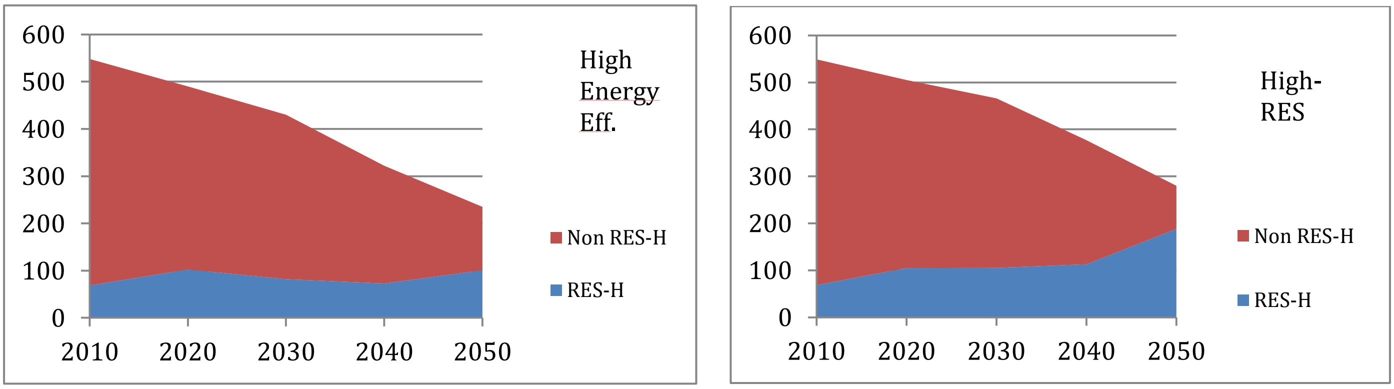


Figure 10: Estimates of heating and cooling: High Energy Efficiency vs. High RES Scenario

The above projections are all but ambitious and fail to cover the whole potential of renewable heating and cooling technologies. On the contrary, the Common Vision for Renewable heating and cooling sector in Europe points out that already in the current decade increasingly competitive GSHPs and Geo DH will gain market shares as efficiency rises. The Common vision also highlights how by 2030 geothermal heat pumps and geothermal direct use will be firmly established, especially in buildings and for industrial processes.

Instead of reporting the above potential, the Roadmap mainly refers to the heating sector in relation to its electrification without further clarifying what this exactly means. For instance, geothermal heat pumps hold enviable energy efficient potential as the external energy input amounts to approximately 25% of its final output produced. On the other hand, direct electricity uses for heating purposes in buildings (such as electrical radiator heaters) result in poorer energy efficiency (around 30%) at higher costs if compared to entirely renewable heat technologies. It is also worth noting that as the recent harsh winter has shown in France, a single energy source does not ensure a reliable supply under all circumstances.

Considering that all scenarios suggest that in the next 20 years electricity price will rise, encouraging the electrification of the heating sector would therefore bring about a trade-off with the objective of providing affordable supply. This should be avoided, notably when other truly renewable technologies, such as geothermal, are available and capable of delivering better solutions.

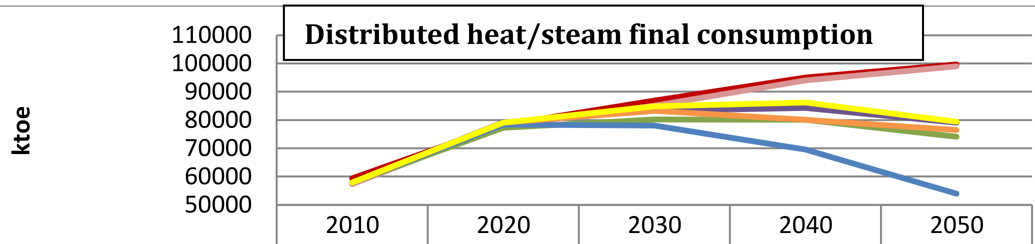
Recommendation 7: Geothermal and other renewable technologies have the potential to cover the entire heating demand in 2050. In order to ensure an affordable and reliable energy system, electrification of the heating sector should not be encouraged as long as other truly renewable and market-ready technologies are capable of delivering better solutions.

Potential of geothermal CHP and district heating disregarded

It is possible to observe in Figure 11 the model used for the Roadmap envisages a steep decrease of CHP and DH if compared with business as usual. Such a forecast is the result of projecting energy savings in the building sector.

Together with energy efficiency, however, the above trend is also due to the assumption that CHP and DH "lead to emission reductions compared to conventional systems, but is only decarbonised when fired with biomass"[16].

[16] European Commission, Energy Roadmap 2050, Impact Assessment and Scenario Analysis, p.133,135.



	2010	2020	2030	2040	2050
Reference	59328	78280	86854	94996	99656
CPI	57335	77936	85099	93998	98920
Energy Efficiency	57863	77278	80195	80089	74105
Diversified supply technologies	57860	79127	83271	84302	79040
High RES	57920	78393	78039	69538	53924
Delayed CCS	57826	79088	83257	80019	76437
Low Nuclear	57849	79028	84786	86190	79380

Figure 11: Distributed heat/steam consumption (ktoe)

Therefore, once again the Commission disregarded the zero-emission potential of geothermal CHP and district heating, with 130 district heating systems already in operation in the EU.

That said, in many EU member states, notably in Central and Eastern Europe, there is an enormous potential for switching from fossil fuel-based to geothermal-based district heating systems. In fact, a revival of geothermal district heating is already happening as shown by the 164 projects under development (Figure 12). In addition, much potential is still unknown and will be tapped following the deployment of EGS, if market distortions are removed and research and infrastructure funds are directed towards this local solution already available today.

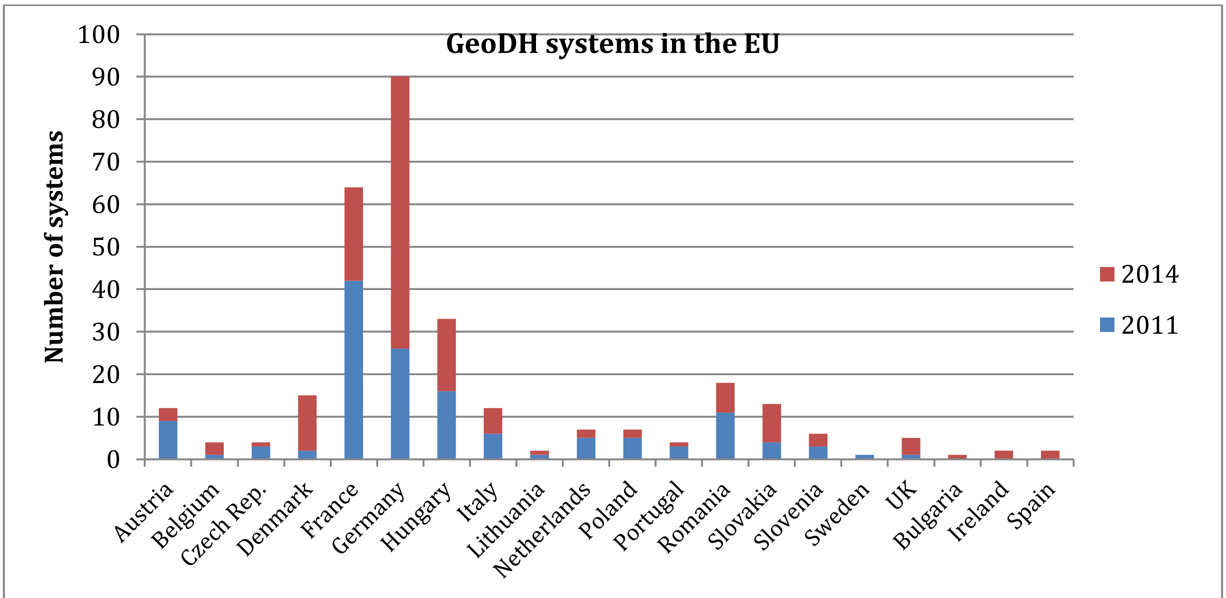


Figure 12: GeoDH systems in the EU (2011-2014) Source: EGEC Deep Geothermal Market Report 2011

5. Conclusions

The investments we choose today will bind us for decades to come. If the EU is to live up to its ambitious decarbonisation commitments, there is no room left for false moves. Commendably, the Commission put forward a first attempt to look at the 2050 horizon and to illustrate some possible pathways towards a low-carbon energy system.

The exercise proved that decarbonisation is possible and can be cost-effective. Renewable energy and energy efficiency have been repeatedly reported as the two no-regret options. Yet, research and incentives together with the withdrawn of long-standing market distortion, such as hidden subsidies to mature technologies, are needed more than ever.

Amongst other renewable energy technologies, Geothermal will play a key role towards the decarbonisation of the European economy. In the mid to the long-term, geothermal energy will increasingly provide affordable, indigenous and sustainable energy to the European people.

In order to favour such wider development, policy-makers should be more aware of all the benefits of geothermal energy. Likewise, it is important to highlight that the geographical constraints to geothermal have been overcome thanks to the development of new technologies such as EGS and geothermal energy can now be developed everywhere.

As shown in this policy paper, technological development is triggering a surprising mushrooming of geothermal projects in many EU Member States. In this initial phase of the transition, however, these new technologies will still need some RD&D and financial support to progress down the learning curve and become more competitive. Most importantly, a level-playing field with other energy technology as well as transparency regarding prices and costs to society are of utmost importance.

This document has also pointed out that heating and cooling is crucial if we want to decarbonise the EU economy. In that regard, therefore, an ambitious and comprehensive EU heating and cooling policy is indispensable for elaborating a truly successful EU's energy policy and to achieve the 2050 commitments.

To this end, the geothermal sector is keen to collaborate with European, national and local authorities. A constructive dialogue will be key to fill existing gaps and for moving together towards a more competitive, fair and environmentally sustainable energy future in Europe.

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