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Ten Years of Geothermal Trend Reporting and Statistics by IEA Geothermal

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ABSTRACT

The Geothermal Trend Report, an annual publication by the International Energy Agency Geothermal Technical Collaboration Programme (IEA Geothermal), provides an overview of geothermal energy statistics in member countries. The work for this report is accomplished within Working Group 10 - Data Collection and Information. The main objective of this working group is to collect data on geothermal energy uses, trends and developments in member countries in a standardised way, and to publish these data in a brief report on a yearly basis.

Data collection within the IEA Geothermal covers topics from specifications on geothermal power generation and heat uses, CO_2- and energy savings by geothermal energy uses as well as project highlights. All IEA Geothermal member countries are required to support the work on the Trend Report by providing information. Additional data from sources such as publications associated with the World Geothermal Congress and the IEA Geothermal Annual Reports have been compiled and analysed to show trends in geothermal energy uses in member countries from the year 2000 on. Based on the results of the first data collection, which started in 2011, and publication reviews, the Report Trends in Geothermal Applications - Survey report on geothermal utilization and power development in GIA member countries in 2010 with trends in geothermal power generation and heat uses, in short the Geothermal Trend Report, was published in 2012.

Thus, in the year of the World Geothermal Congress 2020, the work on geothermal energy statistics within IEA Geothermal has been running since 10 years. During this time there have been several changes in the approach of data collection. Among other things data collection was adapted to the one of the International Energy Agency in order to make geothermal statistics of different organisations more comparable.

Overall, the IEA Geothermal Trend Report adds substantial information on geothermal energy use on an international scale and helps to point out trends and market developments. Due to the fact that data on geothermal power generation is easier to access – compared to information on direct use applications and ground source heat pump data – IEA Geothermal decided to prepare a separate Power Report (IEA Geothermal Power Statistics) and publish this earlier in the year. The IEA Geothermal Trend and Power Reports are available on the internet at: http://iea-gia.org/publications-2/working-group-publications/#Annex-X.

1. INTRODUCTION

The International Energy Agency Geothermal Technical Collaboration Programme (IEA Geothermal) is a framework for international cooperation in geothermal development under the roof of the International Energy Agency (IEA). An Executive Committee heads the work program of the IEA Geothermal with one participant from each of the Country Members, the European Commission and of the Sponsor Members. IEA Geothermal members focus their activities into Working Groups. Working Group activity is further subdivided into tasks. Task involvement is determined by members' current interests and their research and development programs. Currently there are five active Working Groups.

The main objective of Working Group 10 – "Data Collection and Information" is to collect essential data on geothermal energy uses, trends and developments in the IEA Geothermal member countries, and to publish these data on a yearly basis. All current IEA Geothermal Country Members are required to support the work within Working Group 10 through their provision of information. The task is managed by the Leibniz Institute for Applied Geophysics (LIAG) in Germany as the responsible Operating Agent.

Working Group 10 was initiated at the end of 2010 with the aim to develop an annual report – the Trend Report – with essential statistical data and additional information on geothermal development in IEA Geothermal member countries. The idea to publish a IEA Geothermal Trend Report developed against the background of a growing demand for periodic data on geothermal energy uses on an international scale.

Basic geothermal applications data are also reported in the IEA Geothermal Annual Reports (e.g. IEA Geothermal, 2019). The Annual Reports provide comprehensive information about sponsor activities, work accomplished within the Working Groups, and national activities, whereas the Trend Report focuses on the aspect of geothermal energy uses, with a short overview of projects and developments in the reporting countries. The aim is to provide consistent statistical data and to follow trends in geothermal energy uses.

Data collection within Working Group 10 started in 2011. To provide comparable data in a consistent form, data is requested in form of questionnaires with several tables including calculations. The spreadsheets cover the following topics:

- Power generation: running capacity and power generation, newly installed capacity, capacity installed in different plant types, main activity producers and autoproducers, and more detailed information on latest geothermal power plants > 1 MW_{el}
- Direct use: installed capacity and heat produced in different use categories, main activity producers and autoproducers, and more detailed information on new geothermal heating plants > 5 MW_{th}
- Ground source heat pumps: number, capacity and heat use of geothermal heat pumps, geothermal cooling.

CO_2 and energy savings are calculated directly from the reported values for heat use and power generation using the IEA Geothermal conversion (Mongillo, 2005).

Complementary to the data collection within Working Group 10, data from additional sources, such as the publications associated with the World Geothermal Congress (e.g. Bertani 2012, 2016; Lund et al., 2011, 2016 and relevant country updates) and the IEA Geothermal Annual Reports from 2002 on (e.g. IEA Geothermal, 2004), were compiled and analyzed to show trends in geothermal energy uses in IEA Geothermal member countries from the year 2000 on.

Based on the results of the first data collection and publication reviews, the report "Trends in Geothermal Applications – Survey report on geothermal utilization and development in IEA-GIA Member Countries in 2010, with trends in geothermal power generation and heat uses", in short the Geothermal Trend Report, was published in 2012.

2. CHANGES IN DATA COLLECTION SINCE 2015

In order to meet the needs of reliable and continuous statistics there have been a number of changes in the approach of the data collection by the IEA Geothermal Working Group 10.

First of all, due to the fact that data on geothermal power generation is easier to access – compared to information on direct use applications and ground source heat pump data – IEA Geothermal decided to prepare a separate Power Report (IEA Geothermal Power Statistics, Figure 1) and publish this earlier in the year.

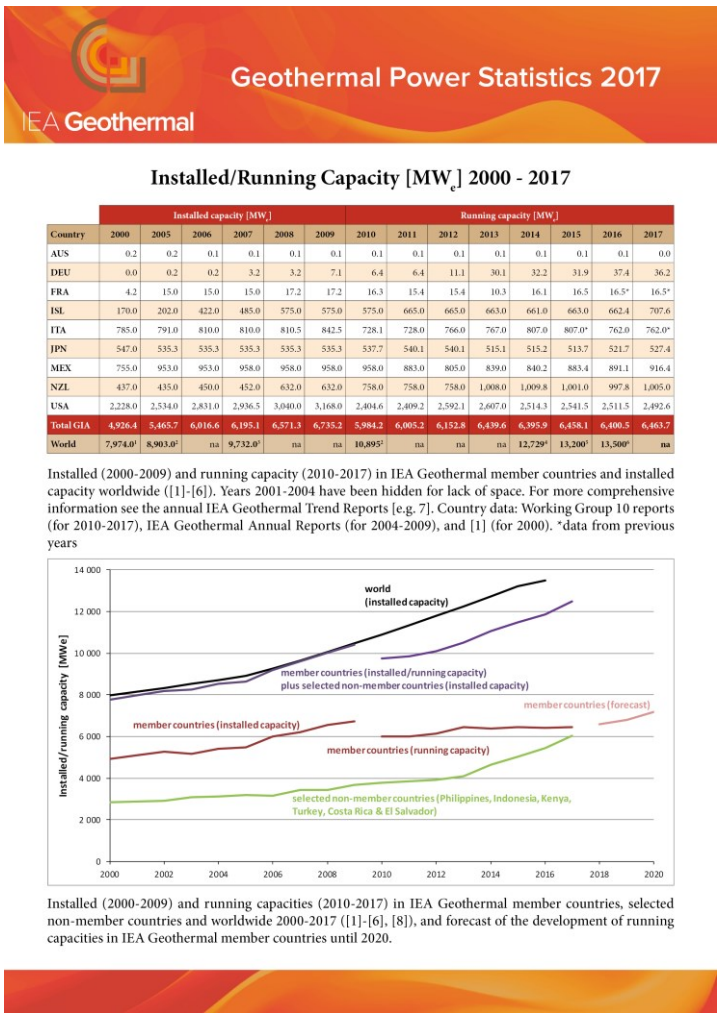

Figure 1: Cover of the newly introduced IEA Geothermal Power Report (http://iea-gia.org/category/publications).

Based on an initiative by the Geothermal ERA-NET (Ketilsson et al., 2015) the questionnaire of Working Group 10 has been revised several times to make geothermal statistics of different organisations more comparable. For example, the direct use categories have been changed to align with statistics of the International Energy Agency (IEA) as well as with statistics of the International

Geothermal Association (IGA). This is also the reason for the introduction of the terms main activity producers and autoproducers in the statistics of the IEA Geothermal. These terms are used by the International Energy Agency to distinguish between geothermal facilities that generate electricity and/or heat mainly for sale to third parties (main activity producers) and the ones that generate electricity and/or heat wholly or partly for their own use (autoproducers) (Ketilsson et al., 2015).

Working Group 10 also decided to collect and publish data on the operating/running capacities rather than on installed capacity in order to reflect the actual situation. This has the advantage that the average capacity factor for a country is not distorted by facilities that are out of service or temporarily not in operation.

One of the latest changes is the complete revision of the data collection on ground source heat pump applications. A new questionnaire was prepared by a task in Working Group 8 of the IEA Geothermal. For details see the WGC 2020 paper of Song et al. (accepted).

As result of the revisions, there are now three separate questionnaires for power, direct use and ground source heat pump applications.

But there are also several topics not covered any more by the Trend and Power Reports of the IEA Geothermal. Information on the number of jobs in the geothermal business, the costs of geothermal plants and capital investments in the geothermal market are difficult to collect for the majority of the IEA Geothermal country reporters. Therefore these, already very limited information are no longer published in the Trend and Power Reports.

Information on the energy market and the national policies, like the role of geothermal in national energy strategy, market incentives etc. are already covered by the IEA Geothermal Annual Reports. Therefore, these topics are not addressed anymore in the Trend and Power Reports to avoid duplication.

In order to expand the data collection to non-member countries Working Group 10 started to access available data on the main players in the geothermal power sector like for example the Philippines, Indonesia and Turkey. This approach will be expanded in the future, if possible also for direct use and ground source heat pump applications. To reach this goal, a cooperation with the International Geothermal Association should be established; several discussions and meetings have already taken place.

3. RESULTS

The current IEA Geothermal member countries (Figure 2) contribute a significant amount to the geothermal energy produced worldwide: in 2017 they accounted for 30% of the worldwide geothermal direct uses and contributed 50% to the geothermal power generation worldwide.

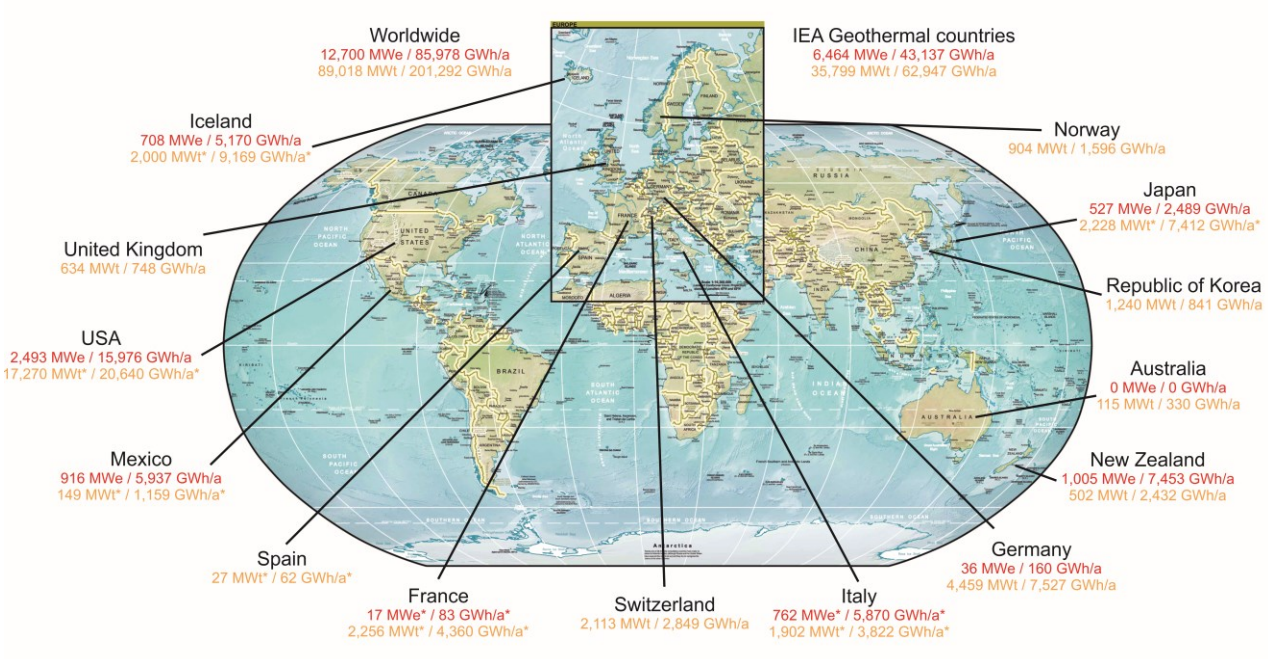

Figure 2: Overview of geothermal power (red) and heat (orange) utilization in IEA Geothermal member countries and worldwide 2017. Heat related data includes direct uses as well as geothermal heat pump use. Country data: IEA Geothermal Working Group 10 country reports 2017, electric capacities are running capacities; world data for power: IRENA (2019), electric capacities are net installed capacities; world data for heat: estimated assuming a compound annual growth rate of 7.9% for capacity and 6.9% for heat use. *includes data from previous years. Maps: The World Factbook 2013, CIA (www.cia.gov).

3.1 Geothermal power generation

Data for geothermal power is generally well documented and of good quality. In 2017, eight IEA Geothermal member countries operated geothermal power plants with a running capacity of 6,464 MW_{el}. The power generation amounted to 43.1 TWh, about half of the worldwide geothermal electricity generation.

With about 2,493 MW_{el} running capacity and about 16 TWh generated electricity in 2017, the USA is by far the biggest producer of geothermal power among the IEA Geothermal member countries, followed by New Zealand, Mexico, Italy, Iceland, and Japan.

Among the non-member countries, the Philippines with and Indonesia have the largest share in installed geothermal capacity, but also Turkey, El Salvador and Kenya contribute a considerable amount to the worldwide installed.

These countries account for the major part of the difference between the geothermal capacity worldwide and in IEA Geothermal countries: about 97% of the worldwide installed electric capacity and annual power production is covered by these five countries together with the IEA Geothermal member countries (Figure 3).

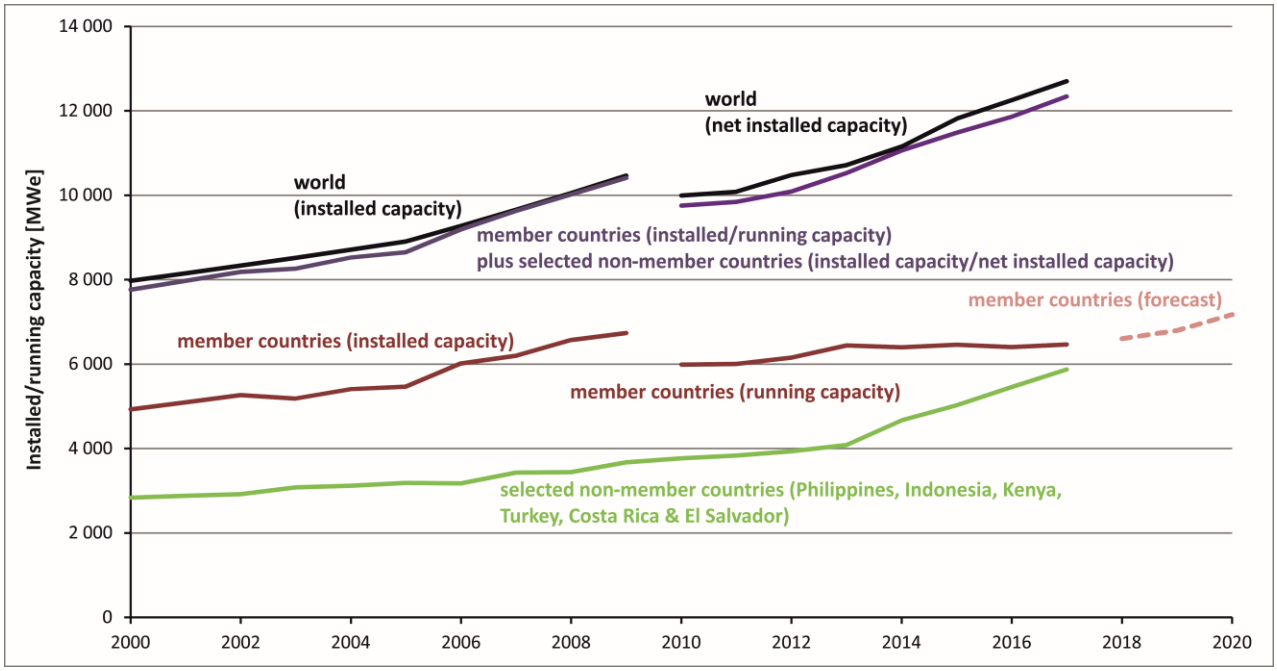

Figure 3: Installed (2000-2009) and running capacities (2010-2017) in IEA Geothermal member countries, selected non-member countries and worldwide 2000-2017 (Huttrer, 2001; Bertani, 2007; IRENA, 2019), and forecast of the development of running capacities in IEA Geothermal member countries until 2020.

3.2 Direct Use of Geothermal Heat

The data request showed that some countries lack detailed and periodic statistics on geothermal heat uses. Use categories such as bathing/swimming, greenhouses or district heating are often not clearly defined and the range of geothermal resources of energetic relevance can vary from country to country. Depending on the regional climate and national energy concepts, heat pumps may be used mainly for heating or cooling, and usual capacities and average full load hours can be variable.

If no data for the heat produced in various categories was provided, the heat use was calculated automatically from the given capacities using capacity factors for different categories given in Lund et al. (2011). A calculation was also offered for the heat produced by a given number of geothermal heat pumps. This procedure will change with the revised questionnaire for geothermal heat pumps (see Song et al., accepted, for details). For all direct uses it was intended to report the geothermal share of the heat produced in the Trend Report. For heat pumps, the geothermal contribution was calculated according to the EU Directive Renewable Energy.

In 2017, geothermal heat uses in IEA geothermal member countries reached a geothermal installed capacity of about 35.8 GW_{th}. Annual heat use amounted to 62.9 TWh (226.4 TJ).

With an annual heat use of 34,500 GWh (124,000 TJ) in 2017, geothermal heat pumps contributed the major portion of geothermal heat produced in IEA Geothermal countries. Of the direct uses, bathing and swimming made up the largest share of total uses amounting to 9,920 GWh (35,715 TJ), followed by district and space heating (8,490 GWh; 30,550 TJ), industry (1,719 GWh; 6,188 TJ) and aquaculture (1,547 GWh; 5,567 TJ).

4. CONCLUSIONS

The work program undertaken in the International Energy Agency Geothermal Technical Collaboration Programme (IEA Geothermal) consists of cooperative research, analysis and information sharing concerning the sustainable development and utilization of geothermal energy. With the Geothermal Trend and Power Reports, the IEA Geothermal wants to contribute to the information exchange on geothermal energy uses on an international scale.

Experiences from the data collections show that data on geothermal power generation in general are easily accessible and of good quality, whereas reliable statistics on heat uses have not been available in every country and for each use category. In countries where statistics on direct uses are not reported on a regular basis, like in Norway and Japan, data for geothermal heat use had to be estimated based on data from older sources.

The calculation of CO_2 and fossil fuel savings from given values for heat and power production proved to be a practicable way to show standardized data on the ecologic benefits of geothermal energy. Information on costs, investments and jobs in the geothermal sector showed not to be representative, here only few numbers from individual countries were available. Therefore, this data is no longer included in the recent reports.

Altogether, the IEA Geothermal Trend and Power Reports add substantial information on geothermal energy uses on an international scale and help to point out trends in geothermal energy use and market developments. It is intended to proceed with the effort of data collection and information as part of the IEA Geothermal work program and to expand collaborations with other organizations.

The IEA Geothermal Trend and Power Reports are available for free download on the IEA Geothermal homepage (http://iea-gia.org/publications-2/).

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