

# The GIA Trend Report, an Annual Survey Report on Geothermal Applications and Developments

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International Energy Agency – Geothermal Implementing Agreement (IEA-GIA)  
Annex X – Data Collection and Information

- International network operating under the auspices of the International Energy Agency (IEA)
- 14 member countries and three sponsors
- Tasks and goals:
  - Promote international cooperation in the field of geothermal utilization
  - Realize collaborative Research and Development Projects
  - Dissemination of information on geothermal energy
  - Outputs for decision makers, financiers, researchers and the general public

## Implementation of work program in currently six Annexes:

- Annex I: Environmental Impacts of Geothermal Energy Development
- Annex VII: Advanced Geothermal Drilling and Logging Technologies
- Annex VIII: Direct Use of Geothermal Energy
- Annex X: Data Collection and Information
- Annex XI: Induced Seismicity
- Annex XII: Deep Roots of Volcanic Geothermal Systems

## Implementation of work program in currently six Annexes:

- Annex I: Environmental Impacts of Geothermal Energy Development
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- **Annex X: Data Collection and Information**
- Annex XI: Induced Seismicity
- Annex XII: Deep Roots of Volcanic Geothermal Systems

→ collect data on geothermal energy uses in GIA countries

→ publication of annual report (web, hardcopy)

→ data trends (power and heat) + relevant political/ economic information



Request Information →

Home > Work Program > Annex X

## Annex X- Data Collection and Information

**Operating Agents:** Leibniz Institute for Applied Geophysics (LIAG), Germany; and the Federal Office of Energy (BFE), Switzerland

**Annex Leader:** Josef Weber, Leibniz Institute for Applied Geophysics (LIAG), Germany

**Status:** Ongoing

**Participants:** Mandatory participation of all GIA Country Members

### Description

The main objective of Annex X is to collect essential data on geothermal energy uses, trends and developments in GIA Member Countries and to publish these data in an annual reports available as hardcopy and on the GIA website for wide public distribution. This report will provide a brief overview of data trends such as installed capacities and produced electricity and heat, as well as relevant political and economic information. All Country Members are required to participate in this Annex, and all Sponsor members support this effort by providing supplementary material. There are plans to extend the data collection to non-GIA Member Countries, with emphasis on the remaining leading geothermal nations.

**Geothermal Applications Data:**

- Electricity:** plant types and numbers, newly installed plants, installed capacity, electricity produced in 2020
- Heat:** direct heat, installed and newly installed capacities, use categories, heat produced in 2020
- Economics:** Number of employees, costs for geothermal plants per kWh installed, costs for heat pumps, investments in geothermal energy, sales volume in heat pumps market
- CO<sub>2</sub> and Energy Savings:** Calculations for heat loss savings by geothermal energy production and CO<sub>2</sub> savings for substitution of oil, coal or gas per unit of geothermal energy
- Energy Market and National Policy:** Role of geothermal in national energy strategies, feed-in tariffs, support mechanisms, energy certificates, carbon tax
- Further Data Sources:** To show trends from 2000 on, supplementary data from other sources, the IEGC publications and GIA Annual Reports, is included

**Highlights and Managing Health, Security, Safety and the Environment:** New projects, political support and other positive developments, and challenges, such as technical problems, reduced seismicity

**Central Title:** Data Report for Annex X - TRENDS IN GEOTHERMAL APPLICATIONS IN GIA COUNTRIES

## POWER

Geothermal Power 2011		
>> Total number of geothermal power plants and plants newly installed in 2011 <<		
Table 1		
Total number of geothermal power plants in operation (2011)		18
Newly-installed geothermal power plants in 2011		0
>> Installed capacity in different plant types <<		
Table 2		
Plant type	MWe installed (cumulative) by the end of 2011	Number of units (end of 2011)
Dry Steam	53	1
Flash Steam	507	4
Binary (ORC/ Kalina)	77	9
Other	157	4
Total	794	18
if "other" plant type, which?	3 hybrid binary-flash, 1 combined heat-power	
>> Capacity and Electricity Production <<		
(power plants and combined heat and power plants)		
Table 3		
Capacity and Energy Production	unit	Value
Gross installed capacity by the end of 2011 [Mw <sub>e</sub> ]	Mw <sub>e</sub>	794.0
Operating capacity by the end of 2011 [MW <sub>e</sub> ]	Mw <sub>e</sub>	758.0
Newly installed geothermal capacity in 2011 [Mw <sub>e</sub> ]	Mw <sub>e</sub>	0.0
Geothermal power produced in 2011 *	GWh/yr	5,770.0
Capacity factor (2011)	-	0.87
Please note that the installed capacity is given in MW <sub>e</sub> and the energy produced in GWh/yr.		
* Combined heat and power plants: Please fill in here data for power produced and installed (electric) capacity. Heat production is asked for in a separate sheet.		
Difference between installed and operating capacity is caused by Ohaaki (installed 105 Mwe, but operating capacity as of 2011, 69 MW) Actual output was 340 GWh, i.e average capacity factor relative to operating capacity (69 MWe) was 0.56. Average capacity factor for all other plants was 0.9		

## Power

- Plant types
- Installed (+ new) capacity
- Electricity production

## POWER

## HEAT

**Direct use of Geothermal Heat 2011**

>> Installed capacity and heat use for various categories excluding heat pumps 2011 <<  
(geothermal contribution only)

**Geothermal Power 2011**

>> Total number of geothermal power plants

**Table 1**

Total number of geothermal power plants	
Newly-installed geothermal power plants	

>> Installed capacity in MW

**Table 2**

Plant type	Use (other than heat pumps)	Number of units	Installed capacity (geothermal) (MW) 2011	Geothermal heat use (geothermal heat produced in 2011) [GWh/yr]	Full load hours/ yr	Heat use/heat produced in 2011 (calculated) [GWh]
Dry Steam	District heating**			0.0		0.0
Flash Steam	Cascaded uses**	3.0	83.0	425.0		
Binary (ORC/ Kalina)	Space heating		20.0	250.0		
Other	Bathing / swimming		74.0	280.0		
Total	Greenhouses	8.0	24.0	105.0		
	Agriculture, crop drying			0.0		0.0
	Aquaculture / Fish farming			0.0		0.0
	Industry	5.0	194.0	1,730.0		
	Snow Melting			0.0		0.0
	Other			20.0		
	total		395.0	2,810.0		0.0

if "other" plant type, which?

>> Capacity and Electricity (power plants and combined)

**Table 3**

Capacity and Energy Production	
Gross installed capacity by the end of 2011	
Operating capacity by the end of 2011	
Newly installed geothermal capacity in 2011	
Geothermal power produced in 2011	
Capacity factor (2011)	

**Table 4**

The data specifications in this table are based on...	X	2011 statistics
		2011 estimate
		2010 data
		data older than 2010

\* including heat produced in combined heat & power plants  
\*\* cascaded uses: don't double count the values in the corresponding sub-categories.

**Calculation:** If values for produced heat and full load hours/year cannot be provided, the annual heat production will be calculated in the right column by using capacity factors for various categories of use given in Lund et al. (2011) by:  
 $E = (P * 8760 * \text{capacity factor}) / 1,000$   
with E = annual production in GWh, P = installed capacity in MW, 8760 hours = 1 year  
The formula included in the right column will only be activated if there is no value given for the heat

Difference between installed operating capacity as of 2011, (69 MW) Actual output was 340 GWh, i.e average capacity factor relative to operating capacity (69 MWe) was 0.56. Average capacity factor for all other plants was 0.9

## Power

- Plant types
- Installed (+ new) capacity
- Electricity production

## Direct use

- Installed capacity and heat use
- Categories
- Geothermal heat pumps (GHP)
- Geothermal contribution
- Cooling with GHP



# IEA-GIA Data Collection Activities

## POWER

### Geothermal Power 2011

>> Total number of geothermal plants

Table 1

Total number of geothermal plants  
Newly installed geothermal plants

>> Installed capacity in

Table 2

Plant type

Dry Steam

Flash Steam

Binary (ORC/ Kalina)

Other

Total

if "other" plant type, which?

>> Capacity and Electric

(power plants and combined)

Table 3

Capacity and Energy Production

Gross installed capacity by the

Operating capacity by the end

Newly installed geothermal capacity

Geothermal power produced

Capacity factor (2011)

Please note that the installed

\* Combined heat and power

(electric) capacity. Heat produced

Difference between installed

operating capacity as of 2011, (69 MW)

Actual output was 340 GWh, i.e. average capacity factor

relative to operating capacity (69 MWe) was 0.56. Average capacity factor for all other plants was

0.9

## HEAT

### Direct use of Geothermal Heat

>> Installed capacity and heat use (geothermal contribution only)

Remark Britta: We discussed about farming. However, I am not happy installed are also used/ cited in the installed capacity certainly can be please fill in the value for total in This item will be again on the op

Table 4

Use (other than heat pumps)

District heating\*\*

Cascaded uses\*\*

Space heating

Bathing / swimming

Greenhouses

Agriculture, crop drying

Aquaculture / Fish farming

Industry

Snow Melting

Other

Total

The data specifications in this table based on... (mark with a cross)

\* including heat produced in combined

\*\* cascaded uses don't double count

Calculations: If values for production will be calculated in the given in Lund et al. (2011) by:

$E = (P * 8760 * \text{capacity factor}) / 1,000$

with E = annual production in GWh, P = installed capacity in MW, 8760 hours = 1 year

The formula included in the right column will only be activated if there is no value given for the heat

## SAVINGS

### CO<sub>2</sub>- and Energy Savings for 2011

Tables 8, 9 and 10 are filled in automatically (you can skip this page).

To provide comparable data of the participating countries, energy and CO<sub>2</sub> savings by geothermal applications are calculated using the GIA conversion (Mongillo, 2005).

Values for power and heat are filled in by a cross reference to the respective tables.

Values for CO<sub>2</sub> and fossil fuel savings are calculated automatically.

>> Energy savings by geothermal applications in 2011 <<

Table 6

Geothermal energy produced in 2011	GWh/yr	Savings factor [toe/GWh]	Fossil fuel savings [toe]
Geothermal power produced in 2011 (Table 3)	5,770	253	1,462,118
Geothermal heat produced in 2011 (Table 7c)	2,822	127	357,581
<b>total (2011)</b>	<b>8,592</b>		<b>1,819,699</b>

toe = tonnes of oil equivalent

>> Carbon dioxide emission savings by geothermal application in 2011 <<

2011 CO<sub>2</sub> savings by geothermal power production

Total CO<sub>2</sub> savings by substitution of gas/ oil/ coal in tonnes [t CO<sub>2</sub>]

Table 9

Geothermal power produced in 2011 (Table 3)	CO <sub>2</sub> savings for natural gas [kg/MWh]	CO <sub>2</sub> savings for oil [kg/MWh]	CO <sub>2</sub> savings for coal [kg/MWh]
5,770	193	1,113,610	817
	193	4,714,090	953
	953	5,498,810	

2011 CO<sub>2</sub> savings by geothermal heat use

Total CO<sub>2</sub> savings by substitution of gas/ oil/ coal in tonnes [t CO<sub>2</sub>]

Table 10

Geothermal heat produced in 2011 (Table 7c)	CO <sub>2</sub> savings for natural gas [kg/MWh]	CO <sub>2</sub> savings for oil [kg/MWh]	CO <sub>2</sub> savings for coal [kg/MWh]
2,822	97	273,759	409
	97	1,154,306	477
	477	1,346,219	

Further remarks to CO<sub>2</sub> and energy savings:

## Power

- Plant types
- Installed (+ new) capacity
- Electricity production

## Direct use

- Installed capacity and heat use
- Categories
- Geothermal heat pumps (GHP)
- Geothermal contribution
- Cooling with GHP

## Fossil fuel and CO<sub>2</sub> Savings

Automatic calculation by produced energy and savings factors

## Jobs, costs, investments

- Plants costs, GHP costs
- Investments in geothermal market
- Employments

## JOBS & COSTS

Jobs, Costs, Investments 2011	
<b>&gt;&gt; Geothermal-related employments in 2011 &lt;&lt;</b>	
<i>Table 11</i>	
Total number of people employed in the geothermal sector* ending 31-12-2011	400
New employments in geothermal-related jobs in 2011	50
* estimation of the number of people employed in various geothermal-related jobs (not restricted to persons with university degrees), i.e. employments in consulting or engineering companies, drilling and exploration, plant construction, heat pump companies, R&D, governmental institutions and universities, geothermal associations, etc.	
<b>&gt;&gt; Costs &lt;&lt;</b>	
<b>Geothermal Power Plants</b>	Ngatamariki (82 MW binary) = \$4.7M
Total project costs in US\$/MW	
<b>Combined heat and power plants</b>	
Total project costs in US\$/MW	
<b>Heating plants</b>	
Total project costs in US\$/MW	
<b>Geothermal heat pumps</b>	
Total investment in US\$/kW (residential use)	
<b>&gt;&gt; Capital investments in the geothermal market in 2011 &lt;&lt;</b>	
<i>Table 12</i>	
<b>Investments in geothermal energy</b>	<b>US\$</b>
Investments in geothermal power generation in 2011	900,000,000
Investments in geothermal direct use in 2011	
Sales volume in the heat pump market in 2011	
<b>Total turnover 2011</b>	<b>900,000,000</b>
Further remarks to jobs, costs, investments:	

# IEA-GIA Data Collection Activities

## Jobs, costs, investments

- Plants costs, GHP costs
- Investments in geothermal market
- Employments

## Policy

- Role of geothermal in national policy
- Funding, feed-in tariff, market incentives, R&D programs

### JOBS & COSTS

**Jobs, Costs, Investments 2**

>> Geothermal-related employment <<

Table 11

Total number of people employed ending 31-12-2011

New employments in geothermal

\* estimation of the number of persons with university degree in drilling and exploration, plant construction and geology, geophysics and geothermal engineering, and geothermal research institutions and universities.

>> Costs <<

**Geothermal Power Plants**

Total project costs in US\$/MW

**Combined heat and power plants**

Total project costs in US\$/MW

**Heating plants**

Total project costs in US\$/MW

**Geothermal heat pumps**

Total investment in US\$/kW

>> Capital investments in total <<

Table 12

**Investments in geothermal energy**

Investments in geothermal power plants

Investments in geothermal district heating

Sales volume in the heat pumps

Total turnover 2011

Further remarks to jobs, costs, investments:

### POLICY

**Energy Market and National Policy - News for 2011**

>> Role of geothermal in national policy <<

How does geothermal fit into the national energy strategy? Is geothermal part of policy concepts to reduce greenhouse gas emissions? Which policy support mechanisms are provided? What is new in 2011 compared to the year before? Please describe principal points in field below.

Please keep your answer short.

**The role of geothermal in national policy:**

An emissions trading scheme introduced in 2010 has provided some assistance to geothermal projects by reducing the long run marginal cost relative to fossil fuel generators. The start-up flat rate of ~US21/Tonne CO2 has so far been discounted by 50% to ease financial pressure on the electricity market. The market carbon price has dropped significantly during 2011 from US\$16 to US\$6 per tonne, so the incentives for geothermal investment have also reduced.

The 2008 NZ National Policy Statement on Renewable Electricity Generation has been discussed and developed (EECA, Feb.2012) to guide implementation of the target 90% renewable by 2025, as set by the government. During 2011, the government introduced its new Energy Strategy which contained a more balanced recognition of the role of renewables than previous documents.

Both Waikato and Bay of Plenty Regional Councils undertook a public review of their Geothermal Policy statements during 2011.

## Jobs, costs, investments

- Plants costs, GHP costs
- Investments in geothermal market
- Employments

## Policy

- Role of geothermal in national policy
- Funding, feed-in tariff, market incentives, R&D programs

## Highlights & Challenges

- New projects
- Research and development
- Challenges and development constraints (induced seismicity, technical problems, legal aspects)

## HIGHLIGHTS & CHALLENGES

### POLICY

**Geothermal Highlights 2011**  
**Highlights:** Please give a brief overview about 2011's geothermal highlights, such as newly installed plants or planned projects, new research activities, or other positive developments in the geothermal energy sector. The focus should lie here on new projects, R&D activities and programs, and direct use expansions. Please keep your answer short.

### JOBS & COSTS

#### Energy Market and National Policy

##### >> Role of geothermal in national policy

How does geothermal fit into the national energy policy? Please compare to the year before? Please keep your answer short.

#### Jobs, Costs, Investments 2011

##### >> Geothermal-related employment

Table 11

Total number of people employed in geothermal energy ending 31-12-2011

##### New employments in geothermal energy

\* estimation of the number of persons with university degree in geothermal energy drilling and exploration, planning and research in geothermal energy institutions and universities.

##### >> Costs <<

#### Geothermal Power Plants

Total project costs in US\$/MW

#### Combined heat and power plants

Total project costs in US\$/MW

#### Heating plants

Total project costs in US\$/MW

#### Geothermal heat pumps

Total investment in US\$/kW

##### >> Capital investments in the geothermal energy sector

Table 12

#### Investments in geothermal energy

Investments in geothermal power plants

Investments in geothermal direct use

Sales volume in the heat pump market

Total turnover 2011

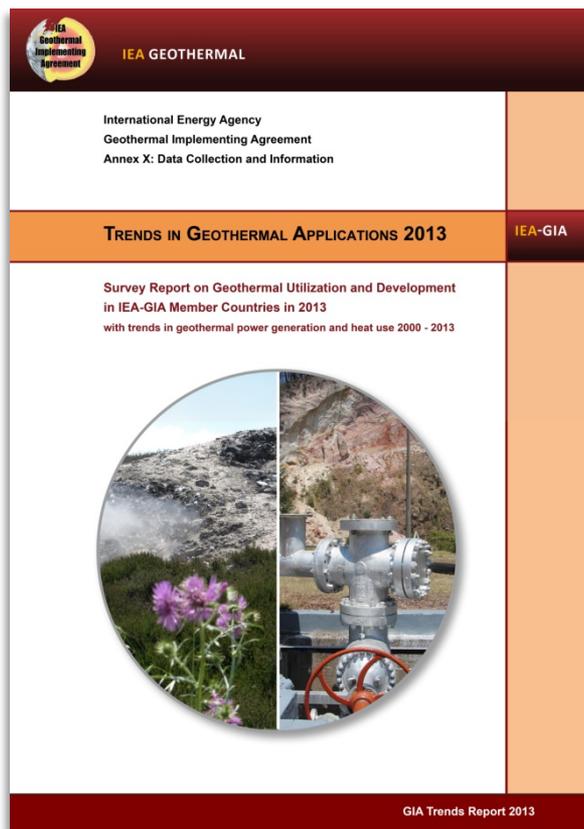
Further remarks to jobs, costs, investments:

The role of geothermal in national energy policy: An emissions trading scheme is reducing the long run marginal cost of CO2 has so far been discounted by carbon price has dropped significantly. geothermal investment have also increased. The 2008 NZ National Policy Statement on Geothermal Energy Development (NPS-GE) was developed (EECA, Feb.2012) to guide government. During 2011, the government recognized the role of geothermal energy in national energy policy. Both Waikato and Bay of Plenty Regional Councils issued statements during 2011.

#### Highlights:

All NZ geothermal power plants were operating at full capacity, averaging 90% capacity factor (with the exception of Ohaaki which is operating at ~65% of its current capacity of 69 MWe). A high level of drilling activity continues in the Taupo Volcanic Zone (~20 wells per year using ~5 rigs). Exploration drilling and discharge testing of 1 km deep slim holes at Taheke has been very successful, and Contact Energy are planning their next phase of development. Mighty River Power has signed an agreement with neighbouring land owners and Maori Trusts to explore the western side of the Taheke resource. Construction of Contact's Te Mihi (166 MWe) and MRP's Ngatamariki (82 MWe) power plants commenced, with completion dates expected in mid 2013. Construction commenced on a unique biological treatment facility to remove H2S from geothermal discharge cooling water at Wairakei Power Station, in order to allow continued operation of the 54 year old Wairakei Power Station, but with reduced impact on the Waikato River. Expansion commenced of the Kawerau wood processing geothermal facility (direct use for SCA tissue mill), and an embedded 25 MWe Ormat generator, in a combined heat and power operation. Preparations commenced for an application for resource consent by NITGA to undertake a larger expansion. The Kawerau Mills account for 50% of the direct use of geothermal in New Zealand. The Miraka Dairy factory geothermal heat plant for milk powder production, at Mokai, was fully commissioned. It was announced that Maori Trusts at Tikitere have signed an agreement with Ormat for a proposed 45 MW Geothermal BOT project. Consents were granted by the Waikato Regional Council for Contact's proposed Tauhara II 250 MW project. New research into 'hotter and deeper' geothermal resources in the Taupo Volcanic Zone was kicked off with a seminar in Taupo to discuss opportunities for drilling to ~4 km depth and supercritical conditions to explore a potential 10 GW resource. A very successful 33rd NZ Geothermal Workshops was held in November 2011, along with two seminars at the Clean Energy Centre in Taupo. The NZ Geothermal Heat Pump Association (GHANZ) was inaugurated and New Zealand officially joined the International Partnership in Geothermal Technology. Total research funding for geothermal in New Zealand amounted to about US\$3.3M in 2011, mostly split between providers GNS Science and University of Auckland.

# IEA-GIA Annex X Trend Report



- First published for year 2010
- 4th edition published March 2015
- Visit IEA-GIA booth for a free copy
- Free download at [www.iea-gia.org](http://www.iea-gia.org)
- Provides compact overview of geothermal developments in GIA member countries

# Direct Heat Use

## Direct heat use

- District heating
- Space heating
- Thermal spas
- Aquaculture
- Green houses

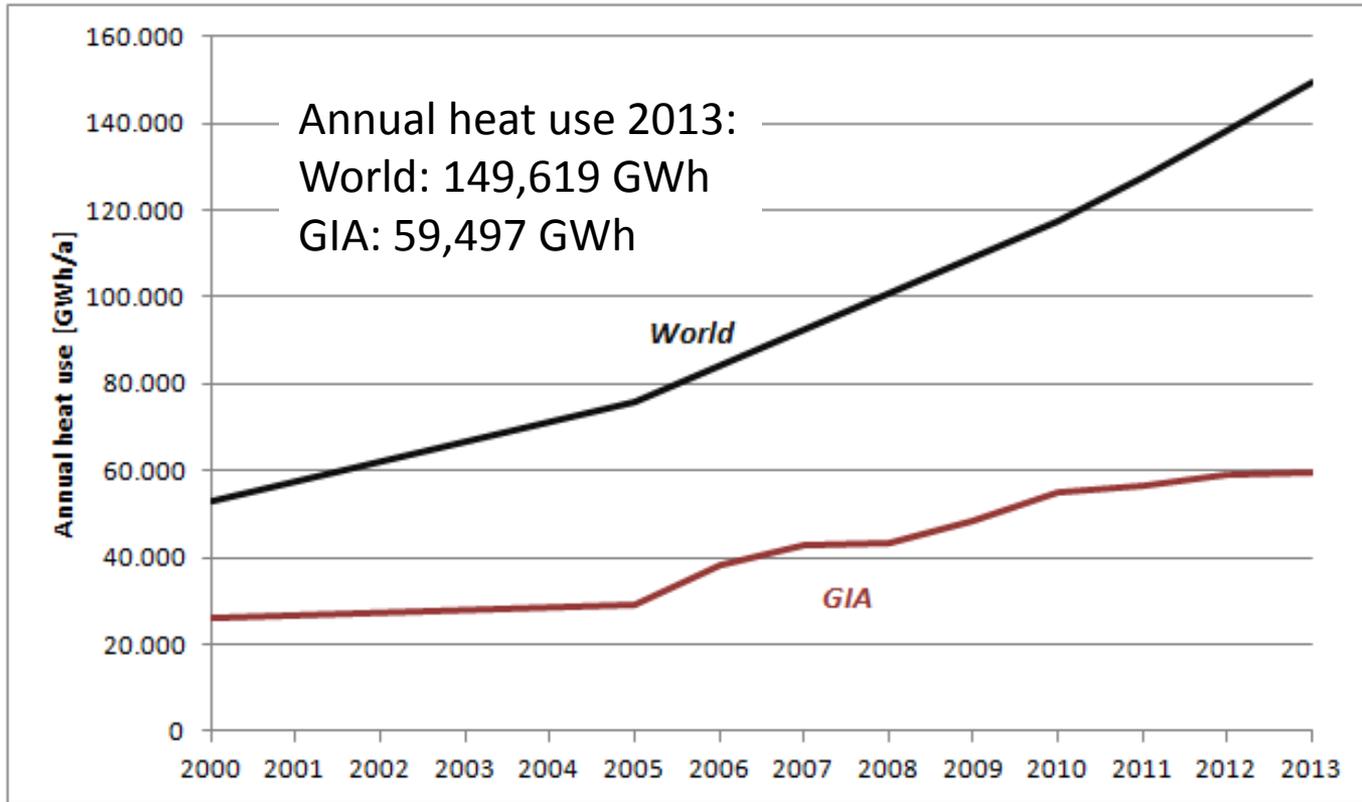
## Heat pumps



# Direct Heat Use

- GIA: standardized data from 2010 on, but reliable, up-to-date statistics often not available
  - Geothermal cooling: almost no official data
- 
- correct data from previous years
  - heat use data best possible estimation
  - aim to further improve data-base

# Annual heat use (GWh/a) 2000 - 2013



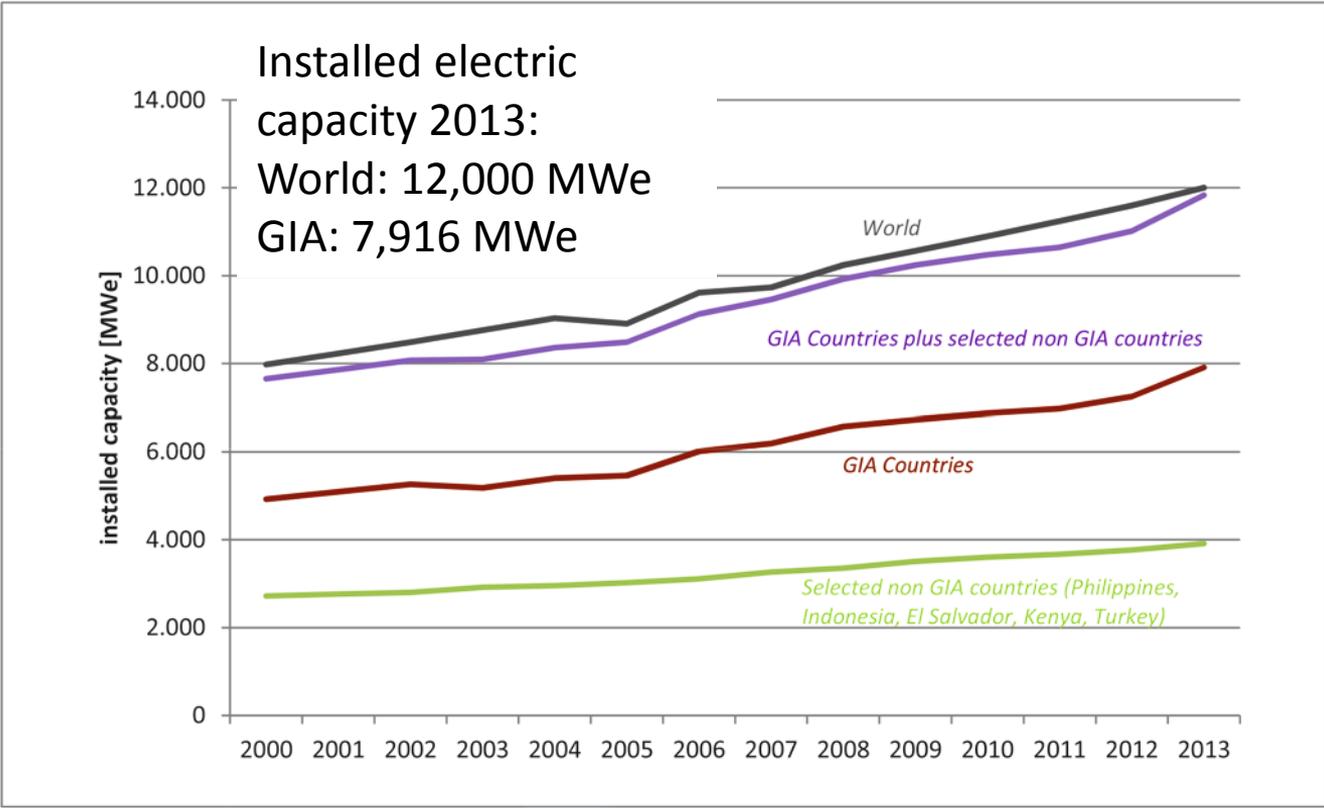
Installed thermal capacity 2013:  
World: 68,755 MWt  
GIA: 27,900 MWt

# Geothermal Power

- Data in general easily accessible
- Good quality
- Nine GIA member countries operate geothermal power plants
- Since reporting year 2012 Trend Report also includes data of non-GIA countries

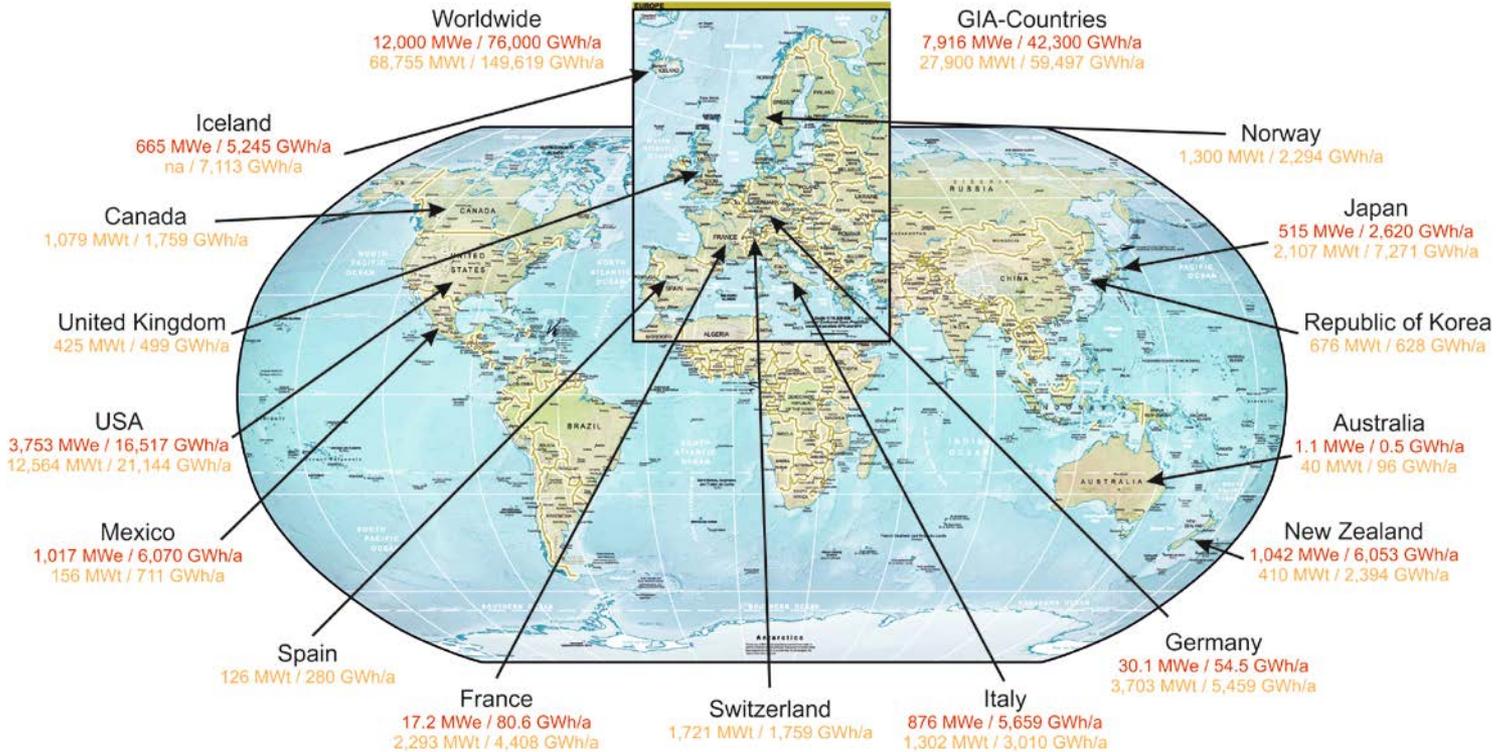


# Geothermal Power – Installed Capacity 2000 - 2013



Annual power production 2013:  
World: 76,000 GWh  
GIA: 42,300 GWh

# Overview



**Overview of geothermal power (red) and heat (orange) utilization in GIA countries and worldwide.**

Map: *The World Factbook 2013* (CIA, [www.cia.gov](http://www.cia.gov)).

# Conclusion

- Good data base for geothermal power
- Heat use data of less quality, but estimation of heat use in GIA countries possible
- Information on ecologic benefits (CO<sub>2</sub> and fuel savings)
- Relevant political and economic information (not always representative)
- Project highlights and R&D news from various countries
- Challenges for geothermal developments

# Conclusion

- Good data base for geothermal power
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- Relevant political and economic information (not always representative)
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- Challenges for geothermal developments

**→ GIA Trend Report adds substantial information on geothermal energy uses on an international scale and helps to point out trends and developments.**

- For more information visit the IEA-GIA booth 28 at the exhibition
- or
- [www.iea-gia.org](http://www.iea-gia.org)

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***Thank you for your attention***