„FINANCING RENEWABLE ENERGY TRANSITION"

Geothermal Energy

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POTENTIAL OF RENEWABLE ENERGY SOURCES

(WEA 2000)

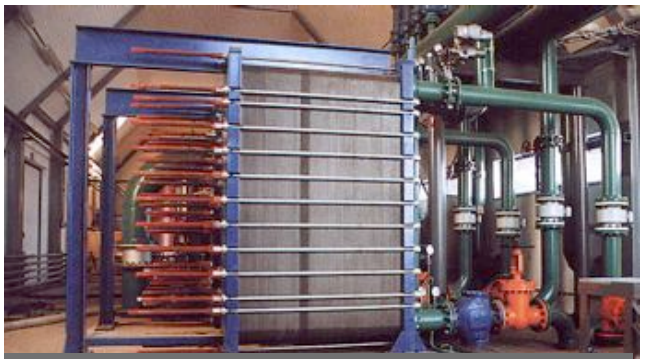
Energy source	Capacity (EJ/yr)*
Geothermal	5 000
Solar	1 575
Wind	640
Biomass	276
Hydro	50
TOTAL	7 541

*) 1 EJ = 10^{18} J

Geothermal – the energy stored in the form of heat beneath the solid Earth:

- Available round around the clock all year (in contrary to other RES)
- Economically and technologically exploitable to max. depths of 3 – 4 (5 km)
- Little or no GHGs >>> contributes to limitation of CO_2 emissions.
- Please note:
  High reliability of geothermal plants, which are operated at availability factors in excess of 70% - the highest among all RES! (other RES: 14 – 55%)

Nesjavellir power plant, Iceland



Heating plant, Podhale, Poland

Geothermal spa, Iceland

GEOTHERMAL USES, 2005 - 2007

- **Power generation (using steam):**

- Installed capacity: 9.7 GWe
- Production: 60 TWh

24 countries; 5 produce 15-22% of electricity from geothermal (Costa Rica, El Salvador, Iceland, Kenya, the Philippines).

R&D to use 87- 120ºC water to generate electricity in binary schemes (0.3-3 MWe) – USA, Austria, Germany, Iceland

- **Direct uses:**

- Installed capacity: 27 825 MWth,
- Production: 261 418 TJ/2005

~ 50% for heating (GHGs limitation!)
72 countries

- 2000 – 2004: 50% increase of installed capacity and heat use

FINANCING GEOTHERMAL DEVELOPMENT

Two pathways for financing geothermal development:

1. **Market penetration facilitation,**
2. **R&D (still needed)**

Substantial governmental funding is still needed as „geothermal industry" is only beginning

Financing must be accompanied by proper legal and economic tools creating stable systems for geothermal/RES development
(e.g. cases of France, Germany)*, including:

- **Stable long-term regulations tailored to geothermal specifics (introducing a special Act on RES promotion/support?),**
- **Simple and quick procedures** *(investors-friendly),*
- **Limited number of fees/taxes – still too many in many countries,**
- **Low VAT for geothermal heat price**
  (e.g. France: 5.5% if >60% heat from geothermal/RES),
- **Establish the Risk Guarantee Fund to cover geological risk**
  Such Funds exist in some countries; considered by other and WB/Geofund,
- **etc.**

*** some outcomes of Geothermal Regulations – Heat, GTR-H"" Project (EU-IEEA**

FINANCING GEOTHERMAL DEVELOPMENT (examples)

- **Worldwide level:**

Education: **UNU Geothermal Training Program, Iceland (since 1979; in 1999-2008: 14 083 mln USD (89% by Iceland); UNU/GTP Regional Training Centres for decision makers since 2006** (Central America, Africa, China)

Projects, investments:
The World Bank/GEF: grants, credits, loans, attempts to establish Geological Risk Quarantee Fund (*GeoFund*) for CEA and African states – in next 8 yrs – 25 mln USD /10 projects. Past 25 yrs - ca. 800 mln USD loans for projects.

- **Regional levels:**

E.g. European Union: support of research, R&D, projects by various programs (Energy/RES, Infrastructure, Environment, etc.). Specially important in the view of „*3 x 20% by 2020*" *Directive (2007 – 2013: significant funds allocated for RES sector in EU)*

- **Country levels:**

Different amounts of support from country to country.
Support by various institutions, banks and programs oriented to RES.
Usually not sufficient (stimulate investments rather than cover the costs).
Other tools: incentives and feed-in-tariffs systems (e.g. Germany)

CONCLUSIONS

- **Geothermal: a renewable – sustainable – proven – environmentally friendly – local energy source beneath our feets.**
  Large potential both for electricity generation as well as for heating.

- **These two lines have already contributed to CO_2 limitation.**
  Further deployment can avoid CO_2 emissions even more significantly.

- **Quantitative development trends until 2050 can only be estimated:**
  - electricity to at least 70 GW_e and to 140 GW_e by enhanced technologies,
  - direct uses to at least 5.1 EJ/yr, with heat pumps' portion at 4.2 EJ/yr.

- **„Geothermal industry" is only beginning – needs substantial international and governmental funding as well as *creating stable legal – regulatory – economic systems* which will facilitate a real geothermal development adequate to the potential and market demand.**

- **Geothermal can signicantly contribute to sustainable development, transition into the RES and combating the climate warming.**
  Shall be developed for the benefit of people and natural environment.

World Geothermal Congress 2010

Geothermal: „The Energy to Change the World“

25- 29 April 2010, Convention Center, Nusa Dua-Bali, Indonesia

http://www.wgc2010.org/

Welcome to the World Geothermal Congress (WGC) 2010 – Bali Website

The World Geothermal Congress 2010 (WGC2010) - Geothermal powering world's today energy, will take place in Bali Indonesia at the Bali International Conference Center (BICC), Nusa Dua, Bali's largest conference venue, named top in the category "World's leading Conference & Convention Centre 2006". Over 3000 participants from more than 80 countries are expected to attend and learn about the latest breakthroughs in the field. An Exhibition, held simultaneously with the Conference, will feature foremost companies and state-of-the-art products of the Geothermal industry

Co - Convened by:

International Geothermal Association (IGA)

Indonesian Geothermal Association (INAGA)

Ministry of Energy & Mineral Resources Republic Of Indonesia


INTERNATIONAL
GEOTHERMAL
ASSOCIATION, IGA
Many thanks for your attention !

ECONOMICS

Electricity production cost from renewables (WEA, 2004):

Power plant type	Generation costs (US cent/kWh)
Hydro	2 – 10
Geothermal	2 – 10
Wind	4 – 8
Biomass	3 – 12
Solar PV	25 – 160
Concentrated solar	12 - 34

- Installation cost of geothermal power plants: ca. 3.0 – 4.5 mln €/MWe,
- Production cost: 40 – 100 €/MWh,
- CO_2 taxing and feed-in tariffs will help in the future

- Direct uses: average unit cost of geothermal heat / district heating: 2.0 €/GJ,
- Geothermal heat pumps: cost of combined heating/cooling: 6.0 €/J,
- Return of investment time: 4 – 8 years for GHPs.

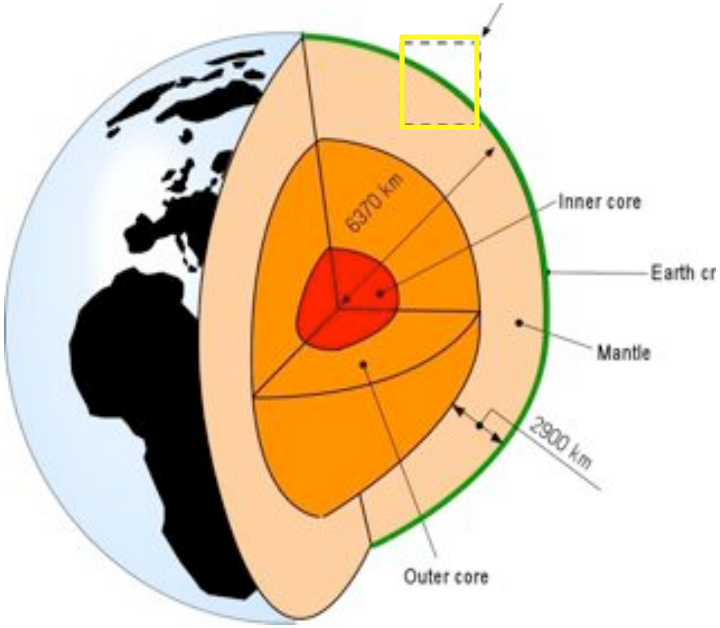
INTERNATIONAL GEOTHERMAL ASSOCIATION, IGA

- Founded in 1988
- Worldwide scientific and educational organization
- ~ 3,400 members in 65 countries
- ~ 30 Affiliated Organizations
- *IGA News* – Quarterly
- European and Western Pacific Regional branches
- Board of Directors: 30 elected members (3-year term)
- World Geothermal Congress held each five years

  (next: WGC 2010 Bali – venue same as COP13 Bali!)

  „Geothermal: the energy to change the world"

GEOTHERMAL: RENEWABLE – SUSTAINABLE – PROVEN – ACHIEVABLE – REALIST RESOURCE



1% of usable heat from beneath the Earth (to depth 6 km) is equal to the total energy demand of humanity for the next 10,000 years

- Geothermal – the energy stored in the form of heat beneath the solid Earth
- Available round around the clock all year (in contrary to other RES)
- Economically and technologically exploitable to max. depths of 3 – 4 (5 km)
- Geothermal cause little or no GHGs gas emissions - no burning processes involved. Contributes to limitation of CO_2 emissions.
- Further deployment will reduce CO_2 emissions even more significantly.

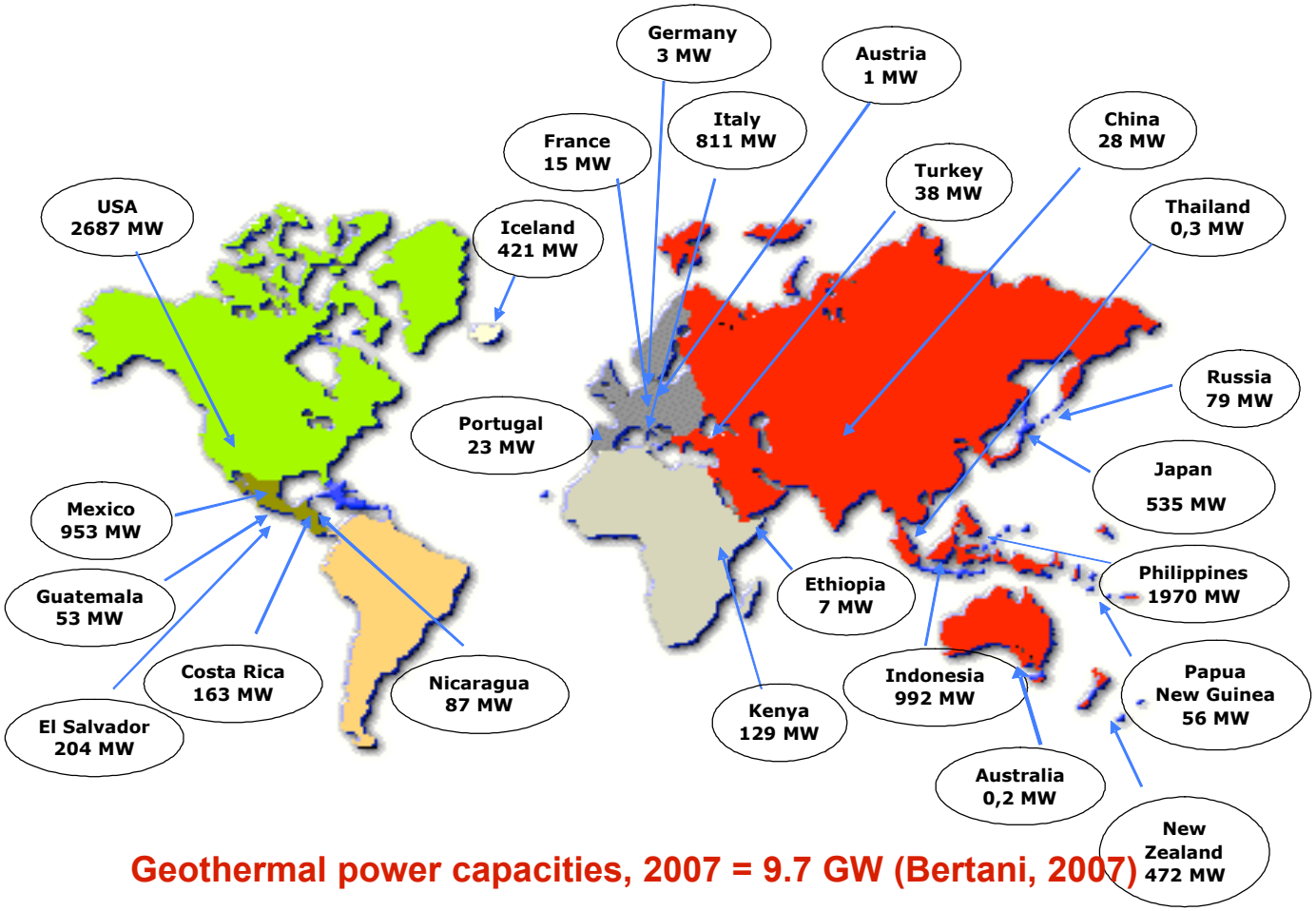
ELECTRICITY FROM RENEWABLE SOURCES, 2005

Compiled from Tables in 2007 Survey of Energy Resources (WEC, 2007)

RES type	Installed capacity		Production per year		Availability factor
	GWe	%	TWh/yr	%	%
Hydro	778	83.5	2,837	89	42
Biomass	40	4.3	183	5.7	52
Wind	94*	10.1	106	3.3	21
Geothermal	10**	1.1	57	1.8	72
Solar	9.1**	1.0	5	0.2	14
TOTAL	931.1	100	3 188	100	41***

* in 2008, ** new additions in 2007: 2.8GW, *** weighted average

Please note high reliability of geothermal plants, which are operated at availability factors in excess of 70% - the highest among all RES!



Geothermal power capacities, 2007 = 9.7 GW (Bertani, 2007)

- It is possible to produce up to 8.3% of world total electricity with geothermal serving 17% of world population
- 39 countries (Africa, C-S America, Pacific R.) can potentially obtain up to 100% of electricity from geothermal (*Dauncey, 2001*)

WORLD – DIRECT GEOTHERMAL ENERGY USES, 2005

(Lund et al., 2005)

Type of use	Installed capacity (MW_t)	Heat use (TJ/y)
Space heating – heat pumps („shallow geothermal")*	**15 723**	**86 673**
Space heating – „deep geothermal" (wells 1 - 3 km deep)	**4 158**	**52 868**
Bathing and swimming	**4 911**	**75 289**
Horticulture (greenhousing, soil heating)	**1 348**	**19 607**
Aquaculture	**616**	**10 969**
Industrial uses	**489**	**11 068**
De-icing	**338**	**1 885**
Drying	**157**	**2 013**
Other	**86**	**1 045**
TOTAL	**27 825**	**261 418**

- * **The highest growth rate is with geothermal heat pumps (GHP) – one of the fastest growing RES' technologies.**
- **Many countries (Europe, Asia) – prospects for wide geothermal use for heating, heating/cooling – what would result in significant GHGs avoidance**

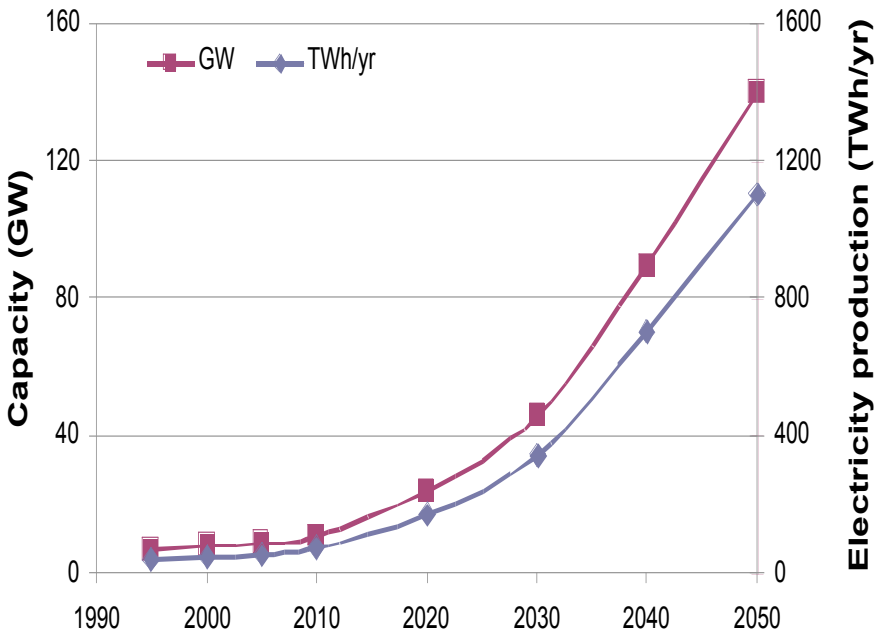
Iceland :
88 % of all buildings

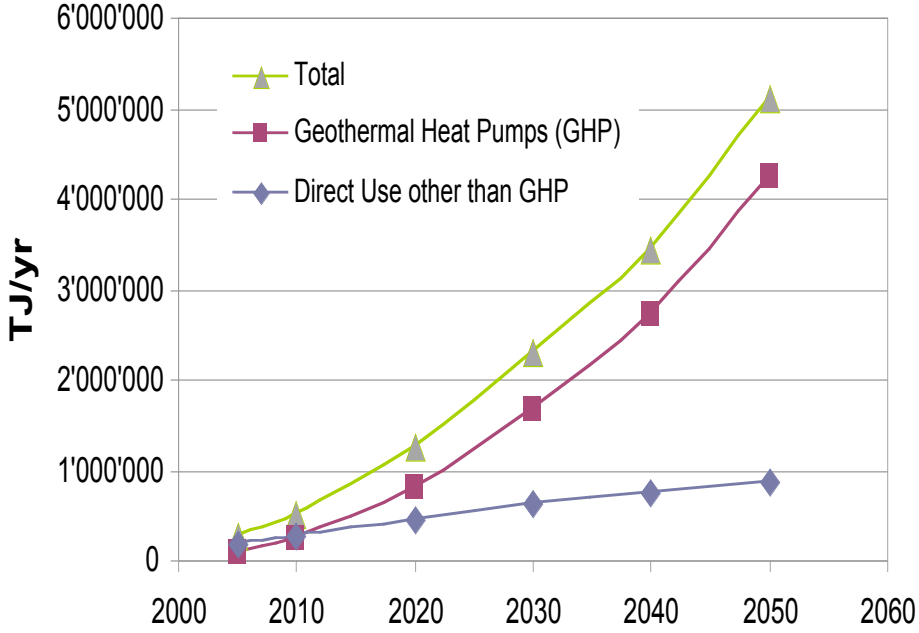
Paris Basin, France:
> 100‘000 apartment units

are supplied by geothermal district heating networks

GLOBAL SCENARIOS FOR GEOTHERMAL DEVELOPMENT TO 2050*

Quantitative development trends for coming decades can only be estimated





Electric power (v. conservative)

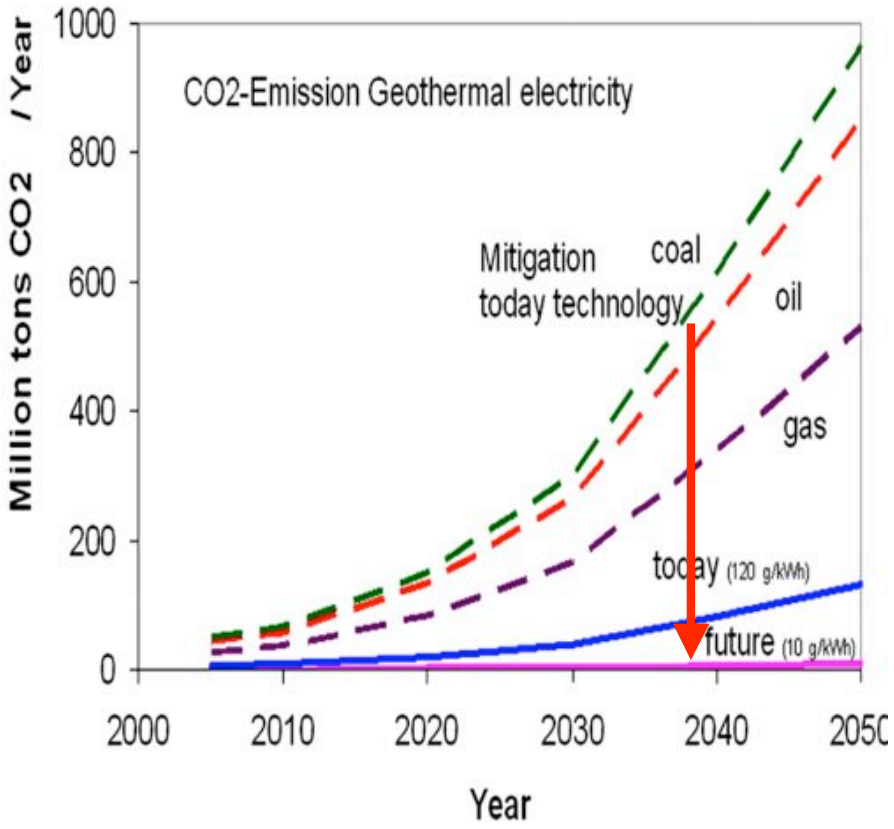
Possible to increase geothermal capacity from current 10 GW to 70 GW with present, and to 140 GW with enhanced technologies

Heat production (v. conservative)

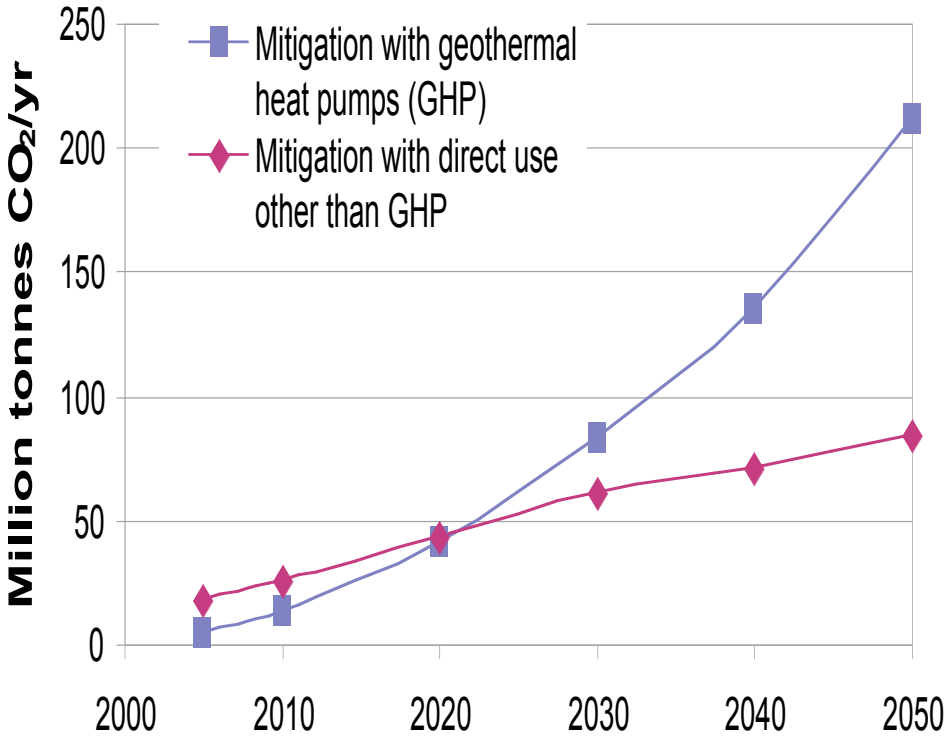
Heat production estimated to reach 5.1 J/yr, with Geothermal Heat Pumps' portion at 4.2 EJ/yr.

** Fridleifsson et al., 2008 – The possible role and contribution of geothermal energy to the mitigation of climate change. IPCC Meeting on RES. Luebeck. Germany. 2008*

GEOTHERMAL CO_2 EMISSION MITIGATION POTENTIAL



Mitigation potential of geothermal power plants in the world



Mitigation potential of geothermal direct heating use in the world,

when replacing fossil technologies
(based on the growth estimate data)