"An Overview on Geothermal Drilling and Projects in Turkey, 2017''

Tevfik Kaya

Country Managing Director | Turkey

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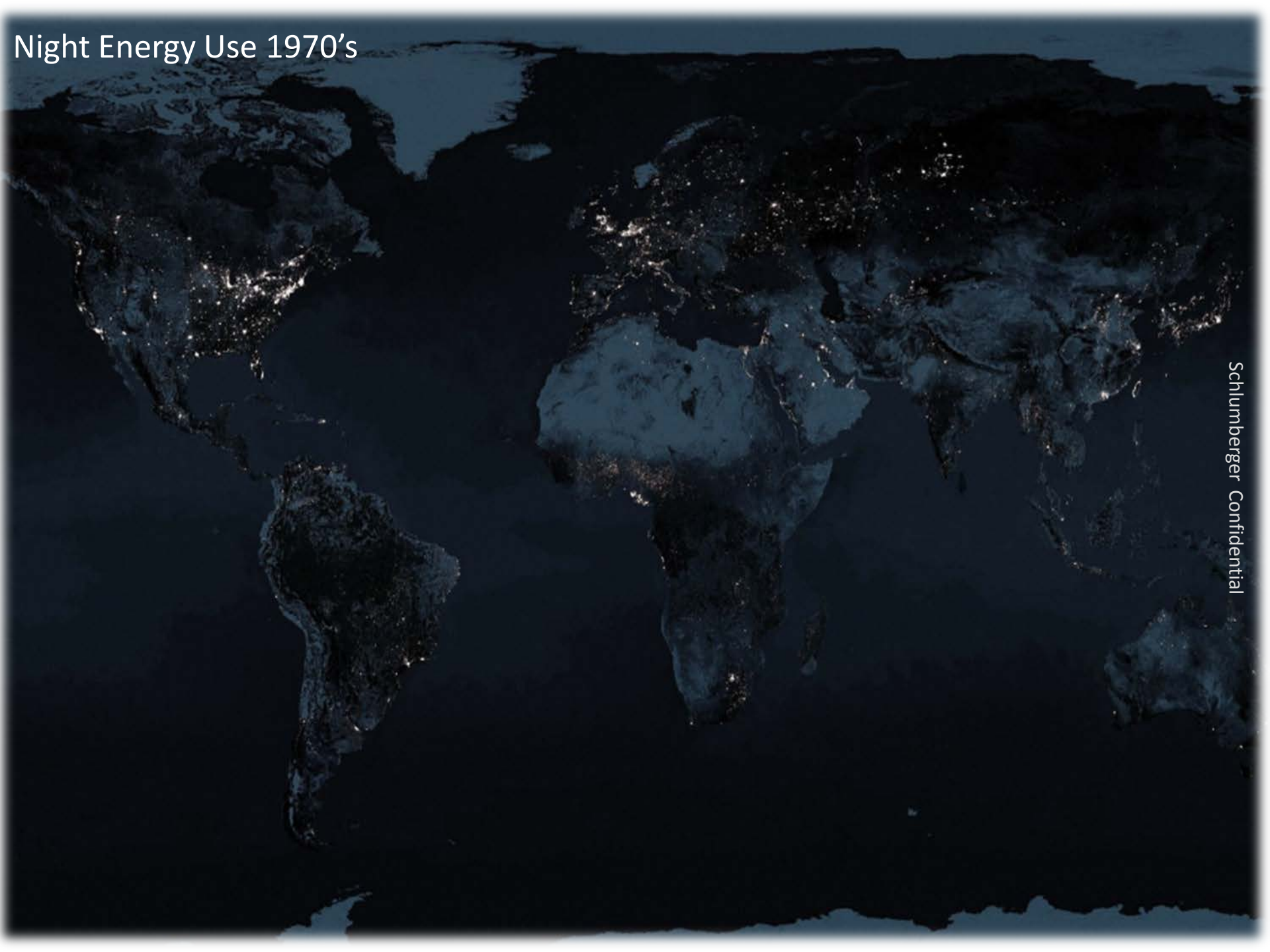
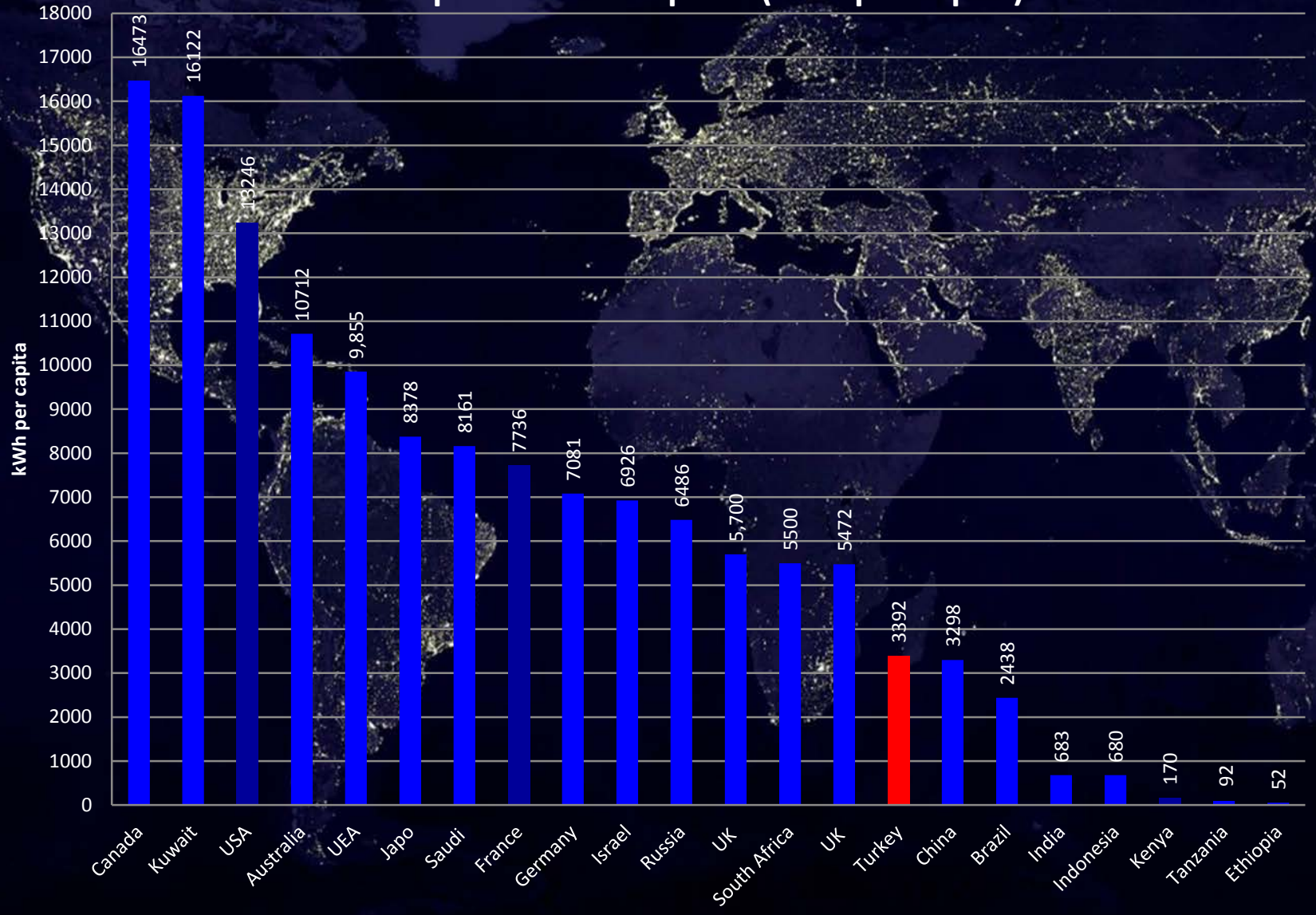
Night Energy Use 1970's



Night Energy Use 2010's

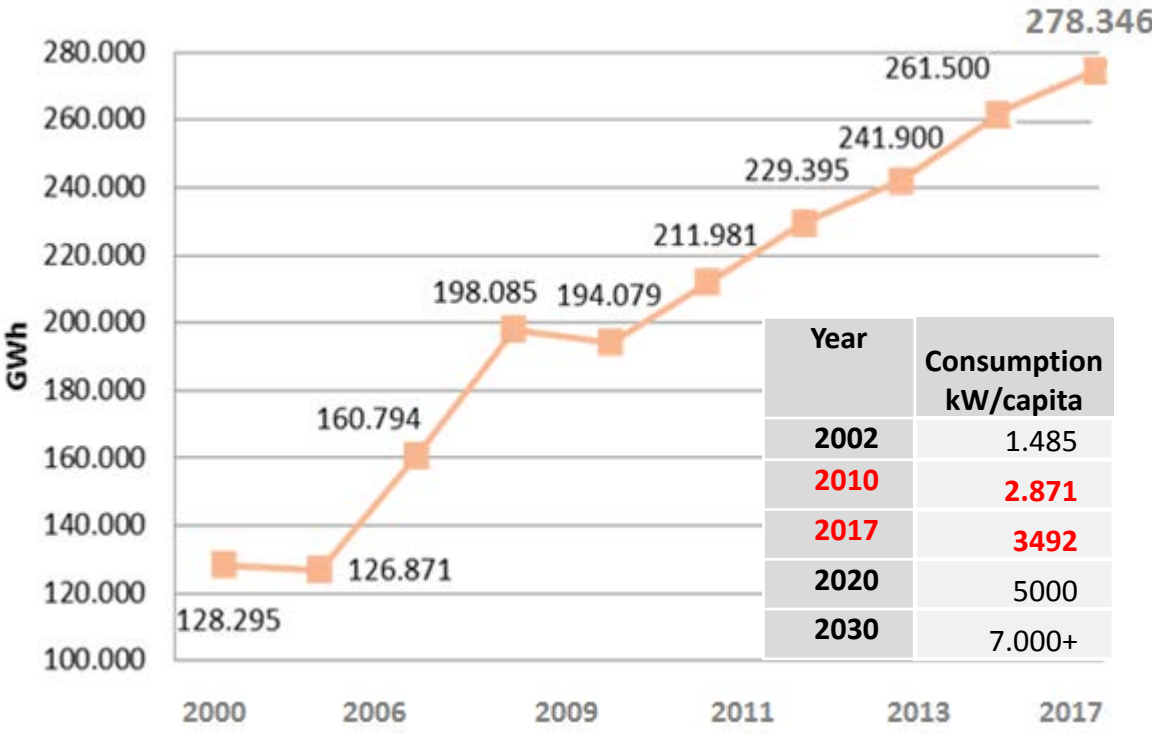


Electricity demand growth is strong in Turkey, renewable energy installed capacity almost 10% of total

National Installed (**79,621MW**)

2017 H1	Installed Capacity MWe	Installed Capacity Ratio
Natural Gas	22,403	28.02%
Hydro	26,919	33.67%
Lignite	9,873	12.35%
Imported Coal	7,474	9.35%
Fuel	369	0.46%
Solar	1,104	1.38%
Wind	6,052	7.57%
Geothermal	1,008	1.26%
Liquid fuels	523	0.65%
Asphaltite	4,021	5.03%
Others	209	0.26%
Total	79,955	

Demand Growth



Year	Consumption kW/capita
2002	1.485
2010	2.871
2017	3492
2020	5000
2030	7.000+

Installed Capacity and Demand Growth for Electricity Turkey (2017)

Energy import dependency 74 %, Electricity 51%

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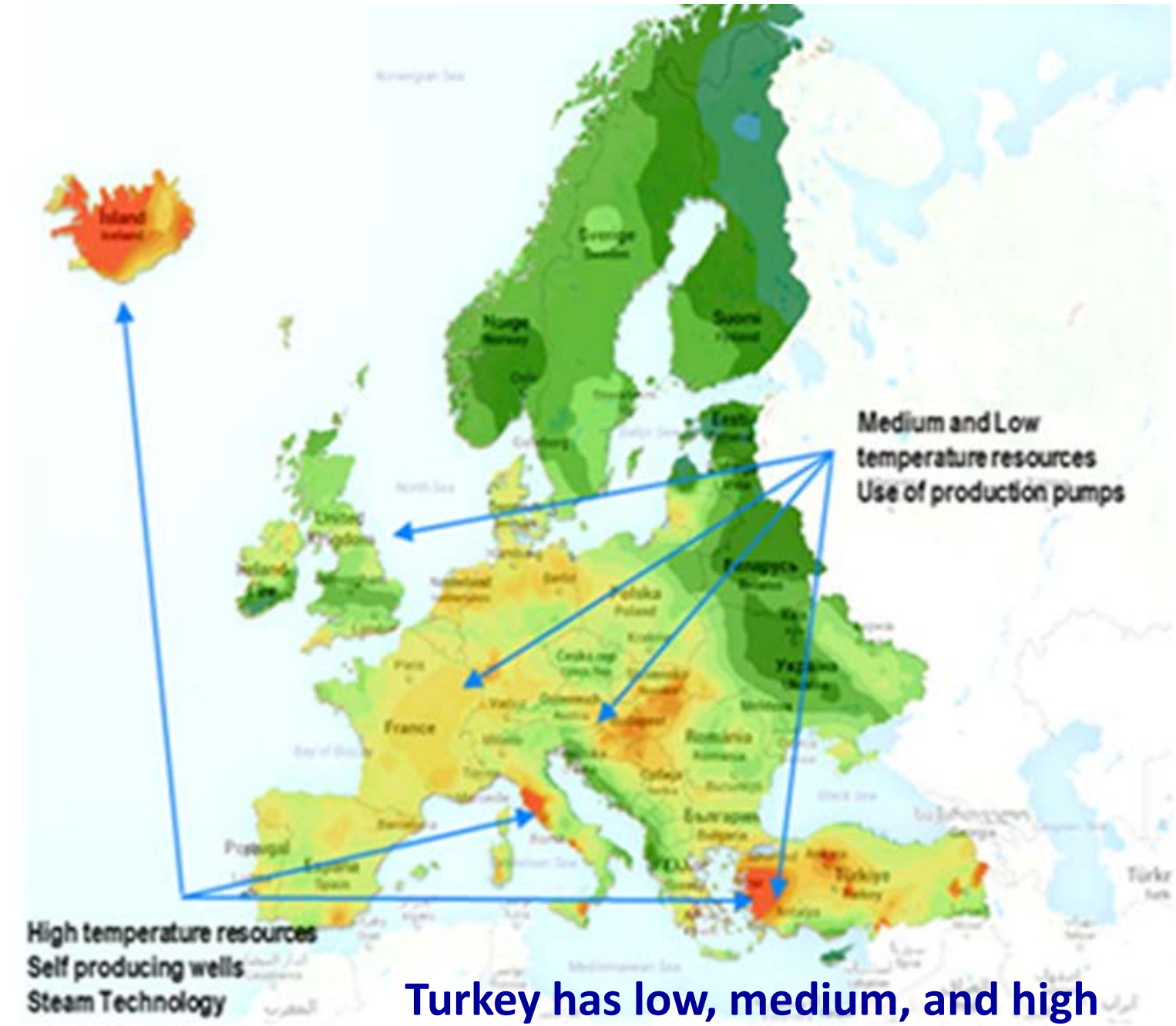
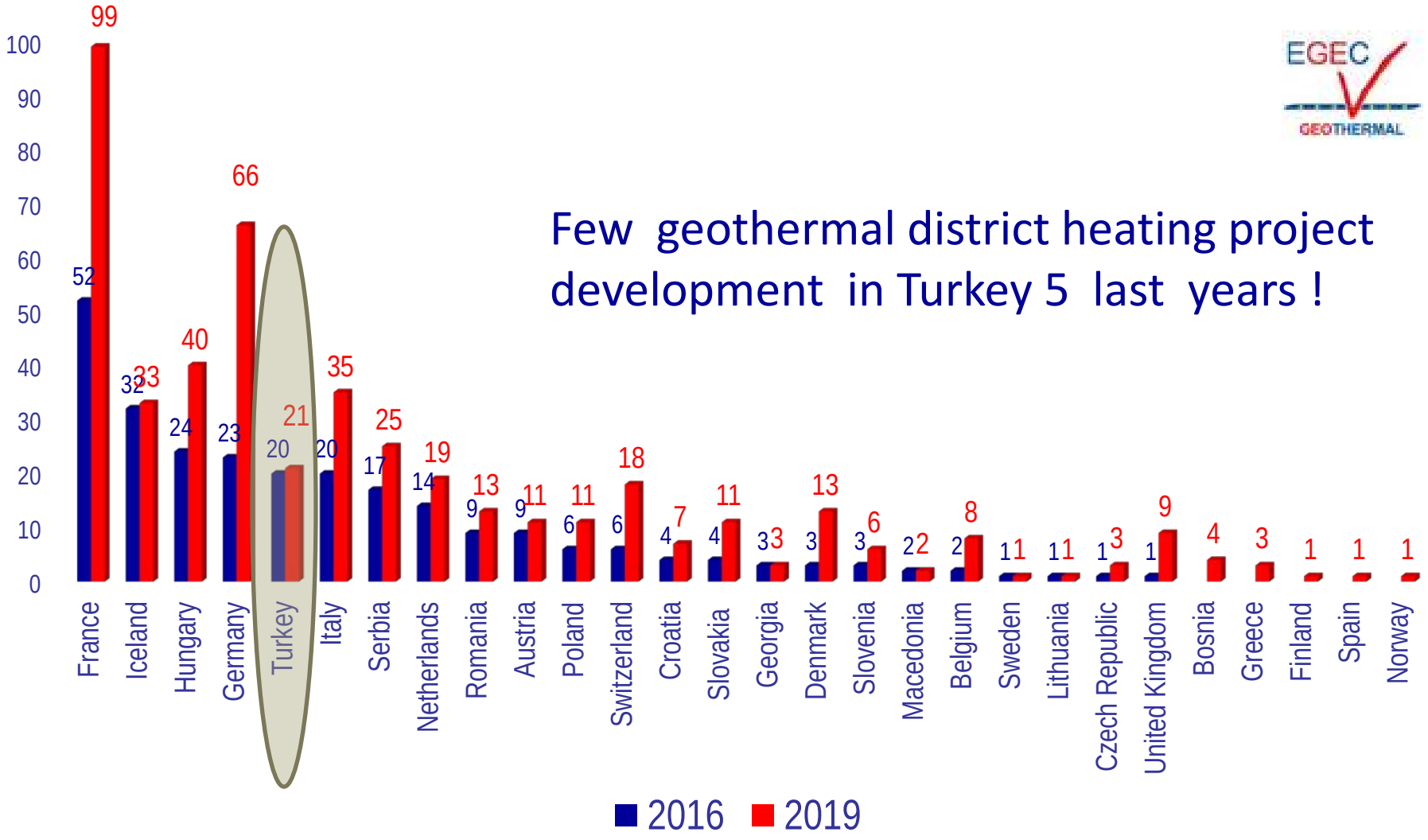
Source: T.R. Ministery of Energy



Turkey has low, medium, and high temperature resources!

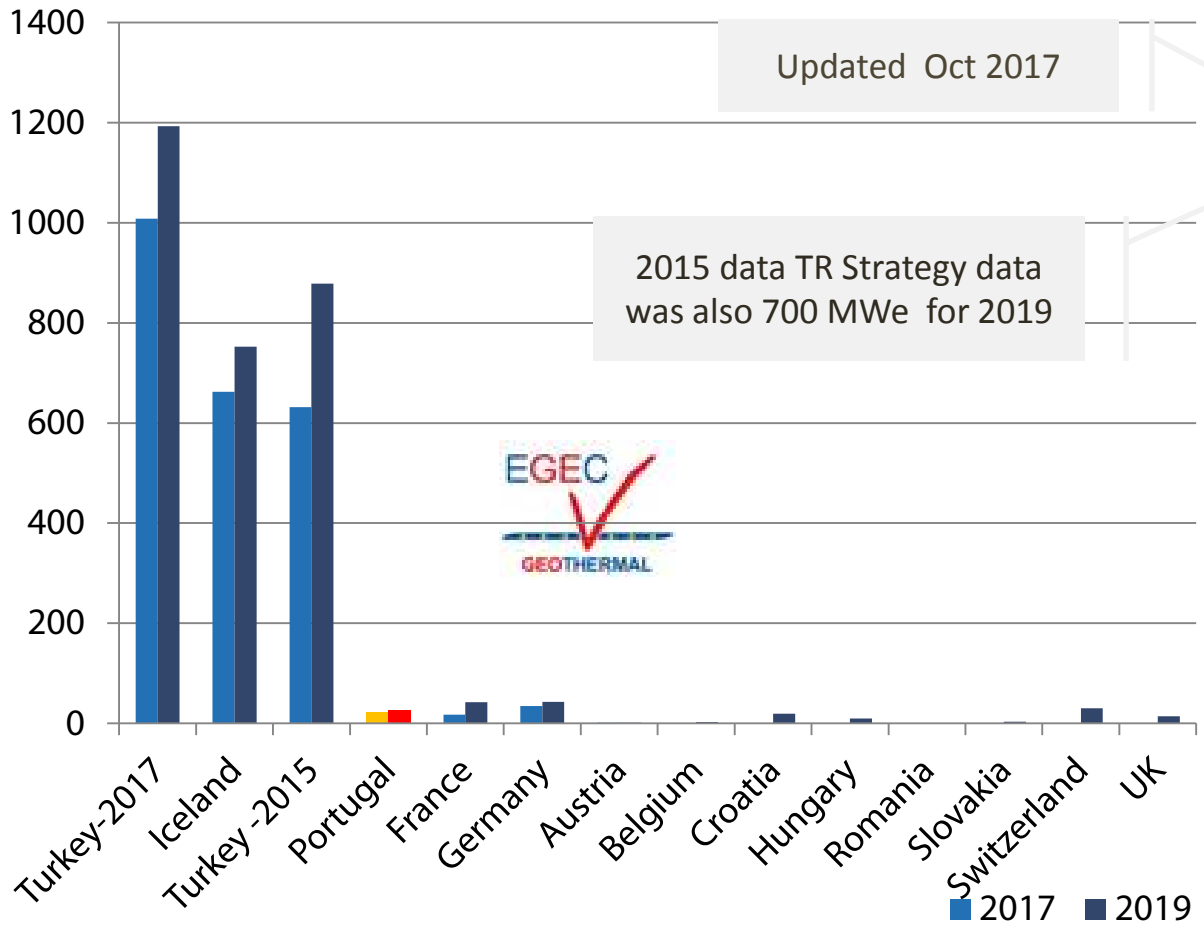
Number of GeoDH systems by country in CEU



Few geothermal district heating project development in Turkey 5 last years !

Source for Turkey : Tevfik Kaya- Schlumberger/GeothermEx

Installed Electricity capacity per country in CEU 2015-2019
Turkey is the highest Install Geothermal Capacity in Europe October 2017



Country	2017	2019
	MWe	MWe
Turkey*	772	1193
Italy	915.5	935.5
Iceland	662.6	752.6
Turkey (2015)	631	878.2
Portugal	23	26
France	17.1	42.1
Germany	34.4	43.2
Austria	1.2	1.2
Belgium		3
Croatia		19.6
Hungary		10
Romania	0.05	0.05
Slovakia		3.5
Switzerland		30
UK		14.1
Europe	2285.74	2759.04
EU	991.25	1098.2

*Updated for Turkey 2017

Source for Turkey : Tevfik Kaya- Schlumberger/GeothermEx

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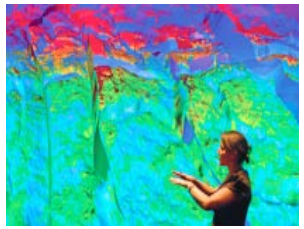
Top 60+ Geothermal Project Developers in Turkey 2007-2017



Western Turkey currently holds the greatest potential for development of geothermal resources (initially developed by MTA), with Central and Eastern Anatolia largely unexplored. **Developer and investor in geothermal power market are %100 private companies.**

Top 60+ Geothermal Project Developers in Turkey 2015-2017

Western Turkey
resources (initia
unexplored.

Developer and i

Top 60+ Geothermal Project Developers in Turkey 2015-2017

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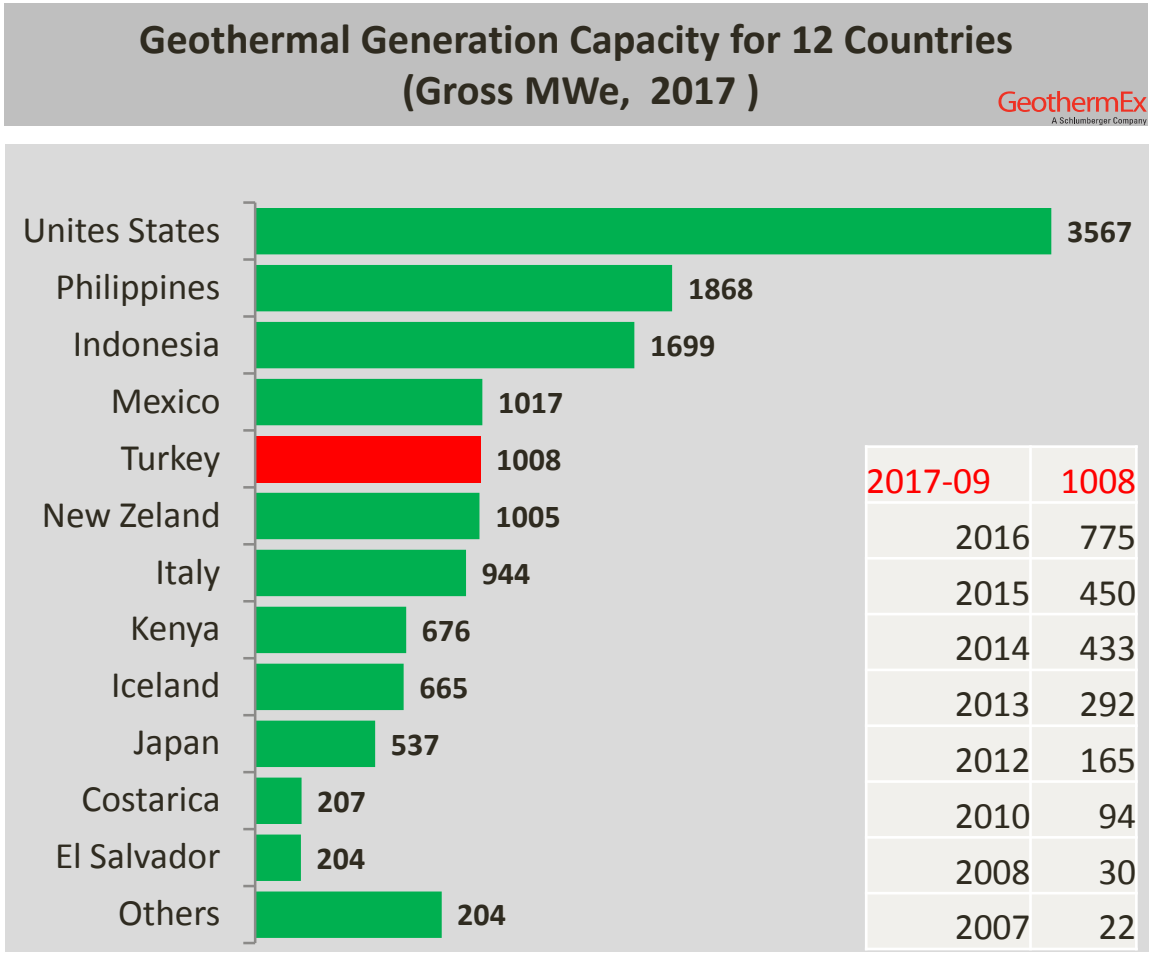
Geothermal installed capacity is growing in Turkey 2007-2017 more than 1000 MWe!



Installed Capacity, October 2017	1008 MWe
Growth, 200-2017	690%
Share of Global Installed Geothermal Capacity, 2015	7.1%

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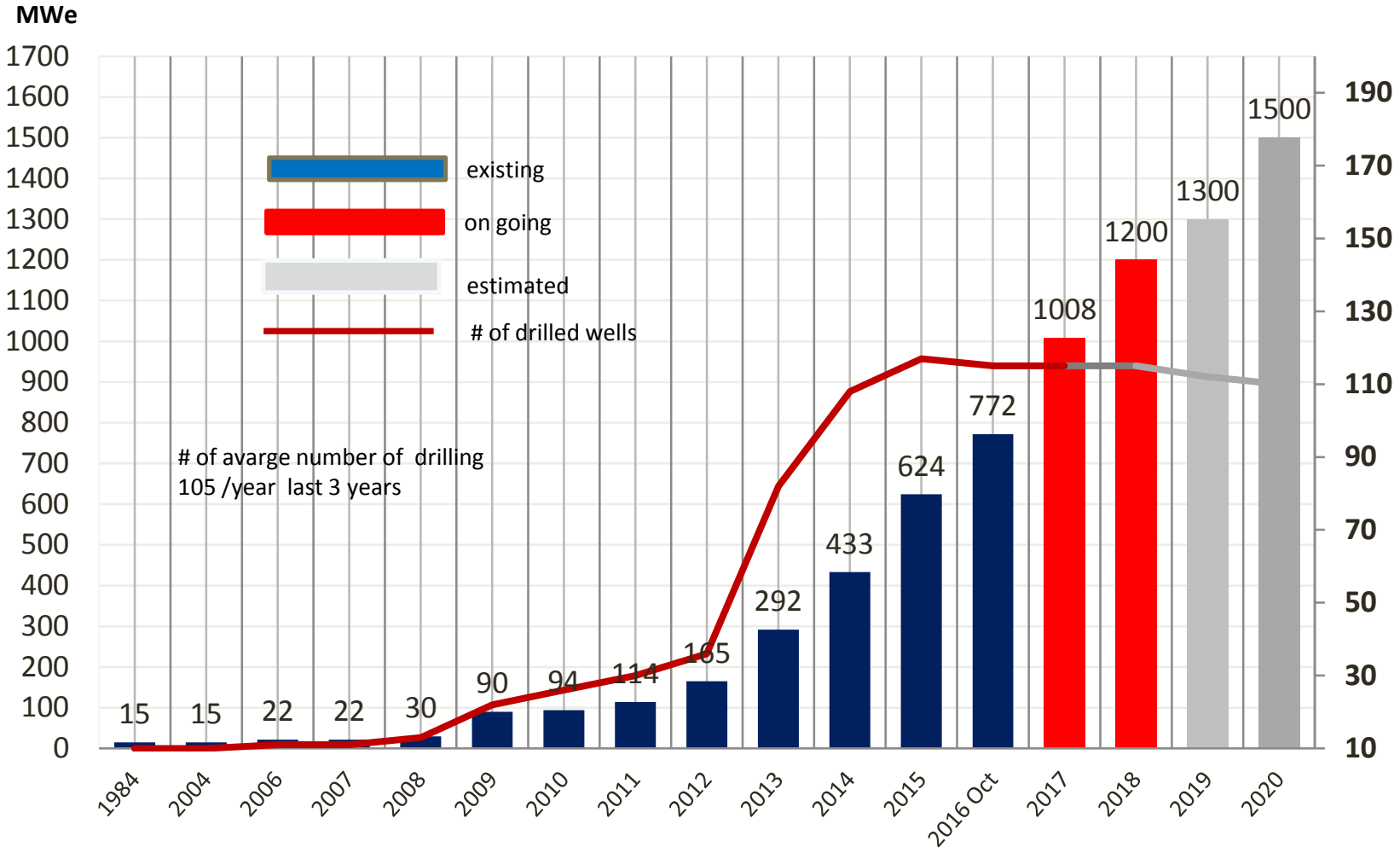
Peak well-drilling activity in next 3 years by 2020!



A total of about 1550 wells geothermal exploration, 1000 production and injection wells for electricity production 650 direct use

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Source: GeothermEx modelling and SLB Confidential data

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Existing and under construction Geothermal Electricity Power Plants

Turbine Companies	Under Construction (MW	Under Operation (MWe)	Total (MWe)
Ansaldo		15.0	15.0
Atlas Copco		155.0	155.0
Exergy	59.0	125.5	184.5
Fuji		60.0	60.0
Mitsibishi		94.9	94.9
Ormat	194.7	429.5	624.2
Pratt&Witney		0.8	0.8
TAS		31.3	31.3
Toshiba	52.0	93.0	145.0
Turboden		3.0	3.0
Total	**305.7**	**1008.0**	**1313.7**

Type of Plant	Under Construction (MW	Under Operation (MWe)	Total (MWe)
Binary	253.7	745.1	998.8
Flash	52.0	262.9	314.9

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Feed in Tariff and Legal Framework for Geothermal Energy in Turkey:

- Electricity Market Law No: 6446
- Renewable Energy Resources for Electricity Production Law No: 5346
- Geothermal Resources and Natural Mineral Waters Law No: 5686

- Fixed FIT for 10 years **10,5 US$ Cent/kWh (till 31.10.2020)**
- Additional financial benefits for five years inform of feed in tariffs when using Domestically manufactured equipment (2.7 US$ cent/kWh)

Power Plant Type	FIT	Domestic Manufacturing	Additional Local Content ($cebt/kWh)	Max FIT ($cent/kWh)
Hydro Power Plant	7.3	Turbine	1.3	9.6
		Generator and Power Electronics	1.0	
Wind Power Plant	7.3	Blade	0.8	11.0
		Generator and Power Electronics	1.0	
		Tower	0.6	
		Rotor and Nacel (all mechanic)	1.3	
Geothermal Power Plant	**10.5**	**Steam or Gas Turbine**	**1.3**	**13.2**
		Generator and Power Electronics	**0.7**	
		Steam Injector or Vacuum Pump	**0.7**	
Biomass	13.3	Equipments		18.9
Solar	13.3	Fotovoltaik Equipments		20.0
		Concentrated olar Power Equipments		22.5

Geothermal Main Business Risks In Turkey till 2020 !

Every geothermal project and resource is individual in terms of quality and risk. But there are four-4- fundamental performance drivers for geothermal developers in Turkey.

`Risk size is always looks BIGGER than yours !
but it is manageable, controllable!

Type	Impact	Diagnose
Resource Risk including drilling risk	Medium - Manageable with sciences engineering	• Many lessons learnt • Very good Experience • But attention to lesson leant !
Operational Risk	High- Manageable with engineering	• Interference effect just seen ! (license) • Lessons learning just started
Market Risk	Very Low-Manageable	• Purchasing guaranty, current incentives
Payment risk	Low-Manageable	• Purchasing Guaranty

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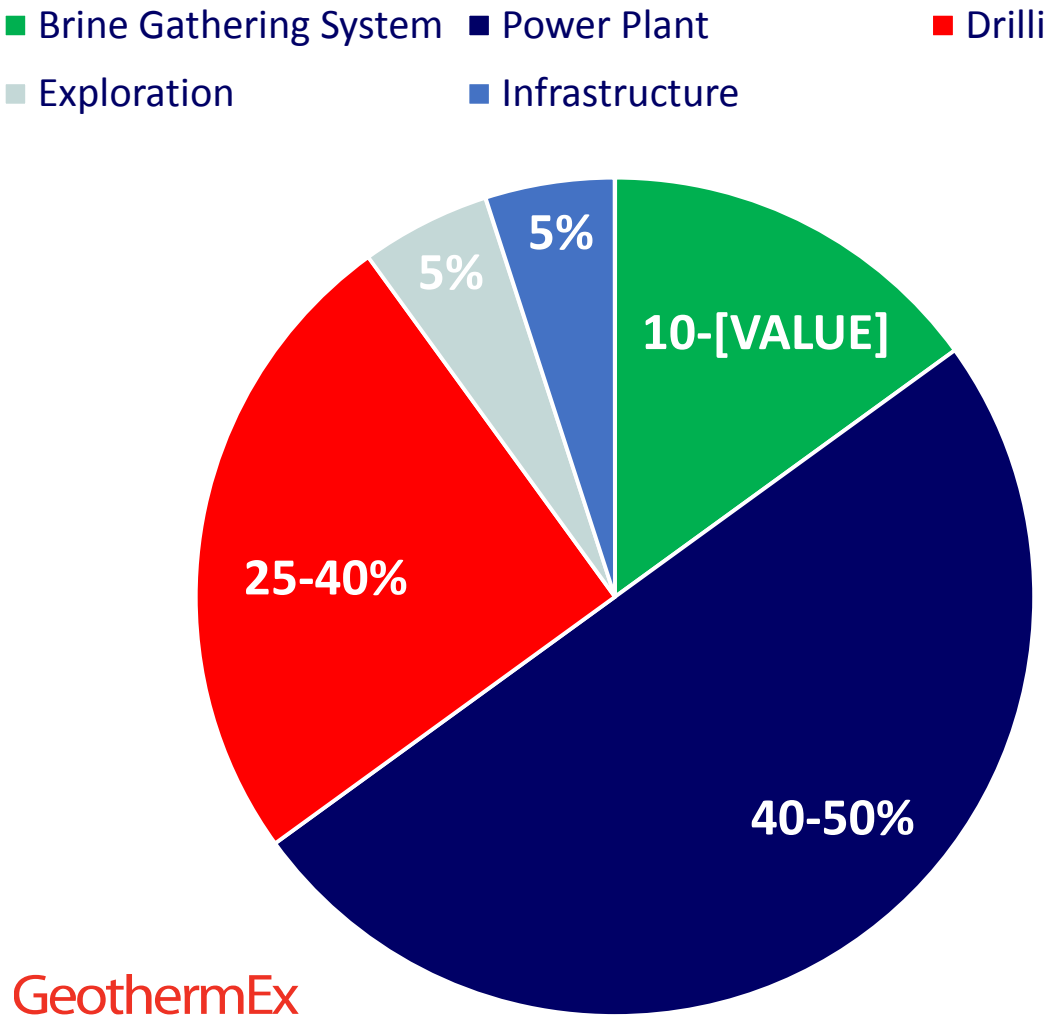
Cost of Geothermal Plant Investment & Importance of Drilling Cost



It is not easy to classify cost breakdown of each geothermal projects, It also varies in Turkey!

- Power Plant : 45-55%
- Brine Gathering : 5-15%
- **Drilling : 25-40%**

Significant part of GPP project's cost is drilling, % 15-20 lower cost of drilling % 5-8 cost reduction over all investment

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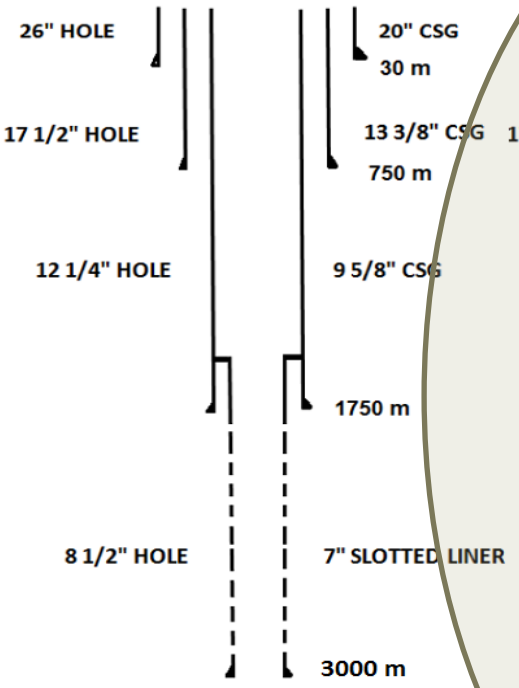
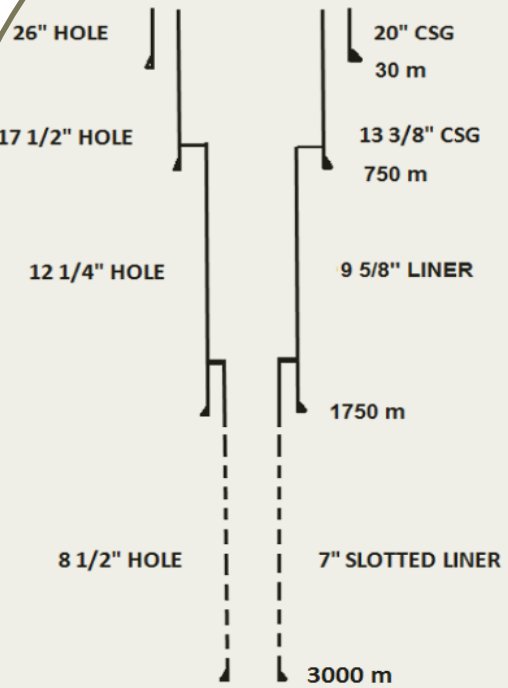
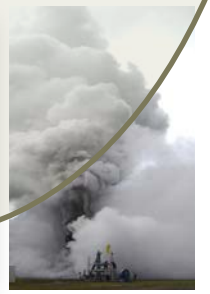
Cost of Drilling from world wide and Turkey -basic casing design…

Depths are around 2750 -4000 m high temperature well,
8-1/2“ hole with 7`` liner in production zone





Countries	Cost (M)
Turkey	**$ 2.5-3.5**
USA	$6-8
Indonesia	$6-8
New Zealand	$7-10
Philippines	$7
Japan	$10
Italy	$6-7
Iceland	$4-5
France	$7
Hollande	$6-7
Kenya	$5-7
Germany	$8-12
Switzerland	$8
Portugal(Azores)	$7



Information gathered some projects with various companies. Except data from Turkey all data was collected in 2014-2015.
So it is expected 10-15% reduction because of current business oil and gas environment in world wide.

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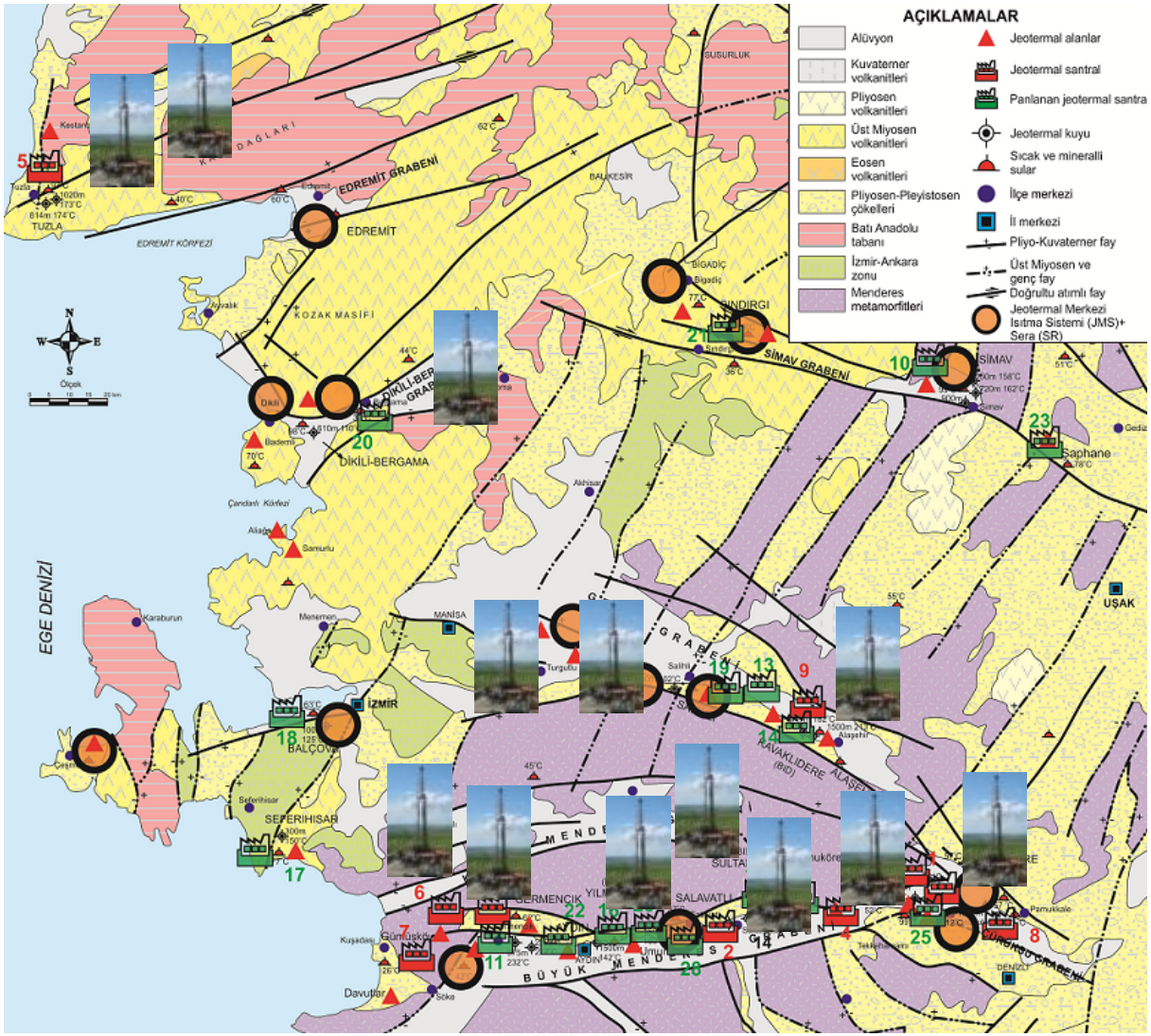
Geothermal is developing in Aegean Region!

24 Active rigs in Geothermal October 2017 !



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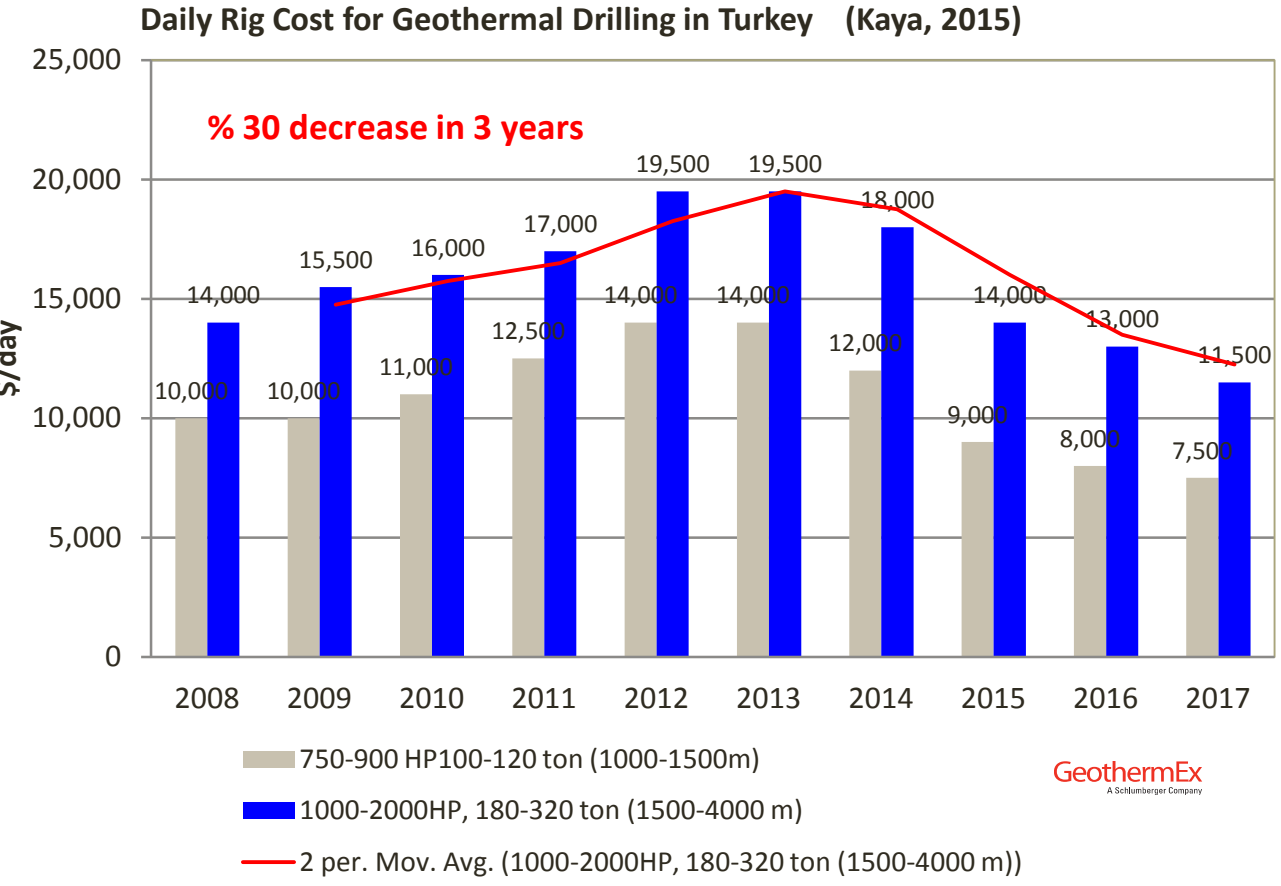
Rig Rent cost and Drilling Services Cost are decreasing !



Rig rate October 2017 : $10.500 -$11.500 day rate for 1000-1500 HP
$7.000- $8.000 day rate for 800-900 HP

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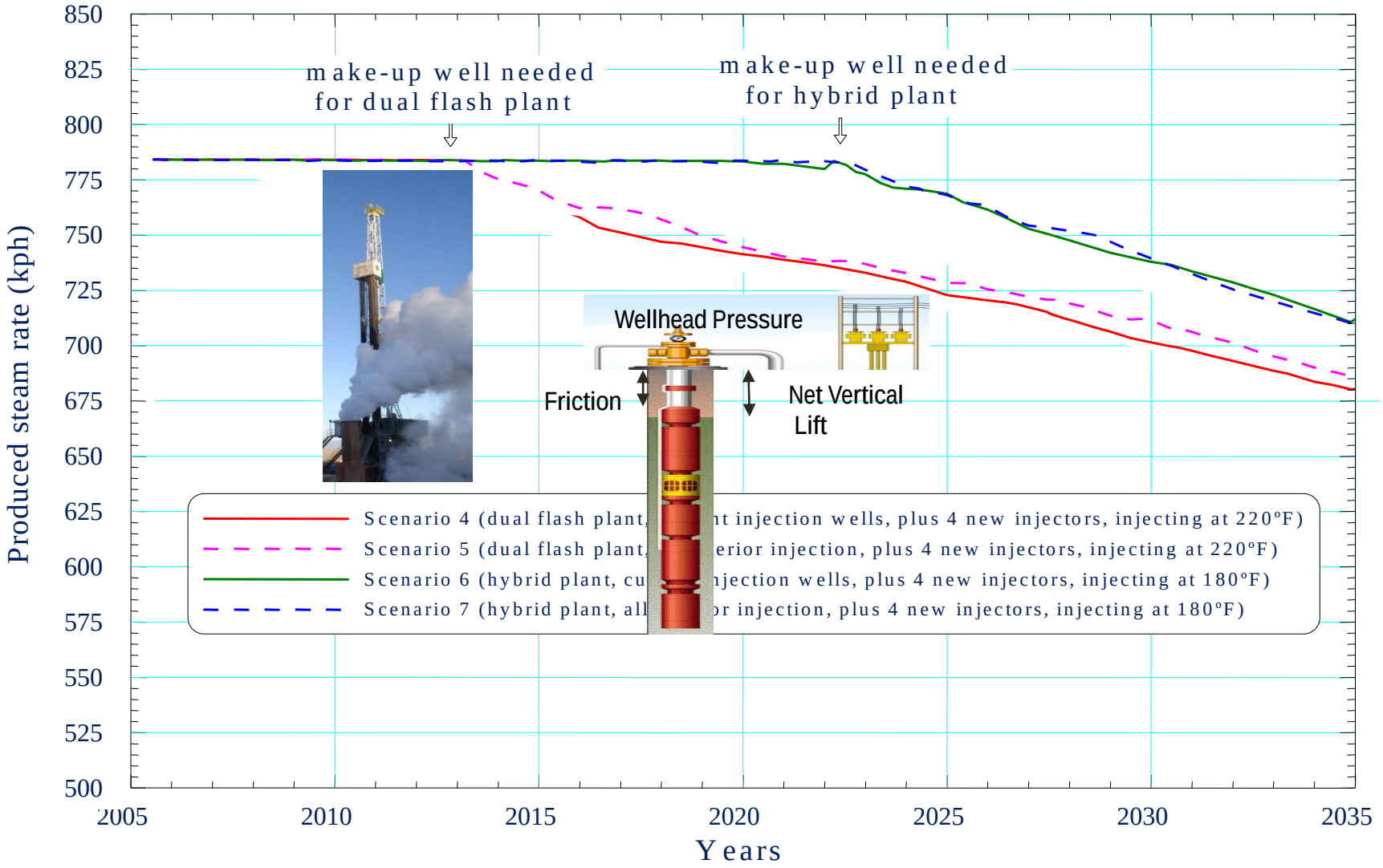
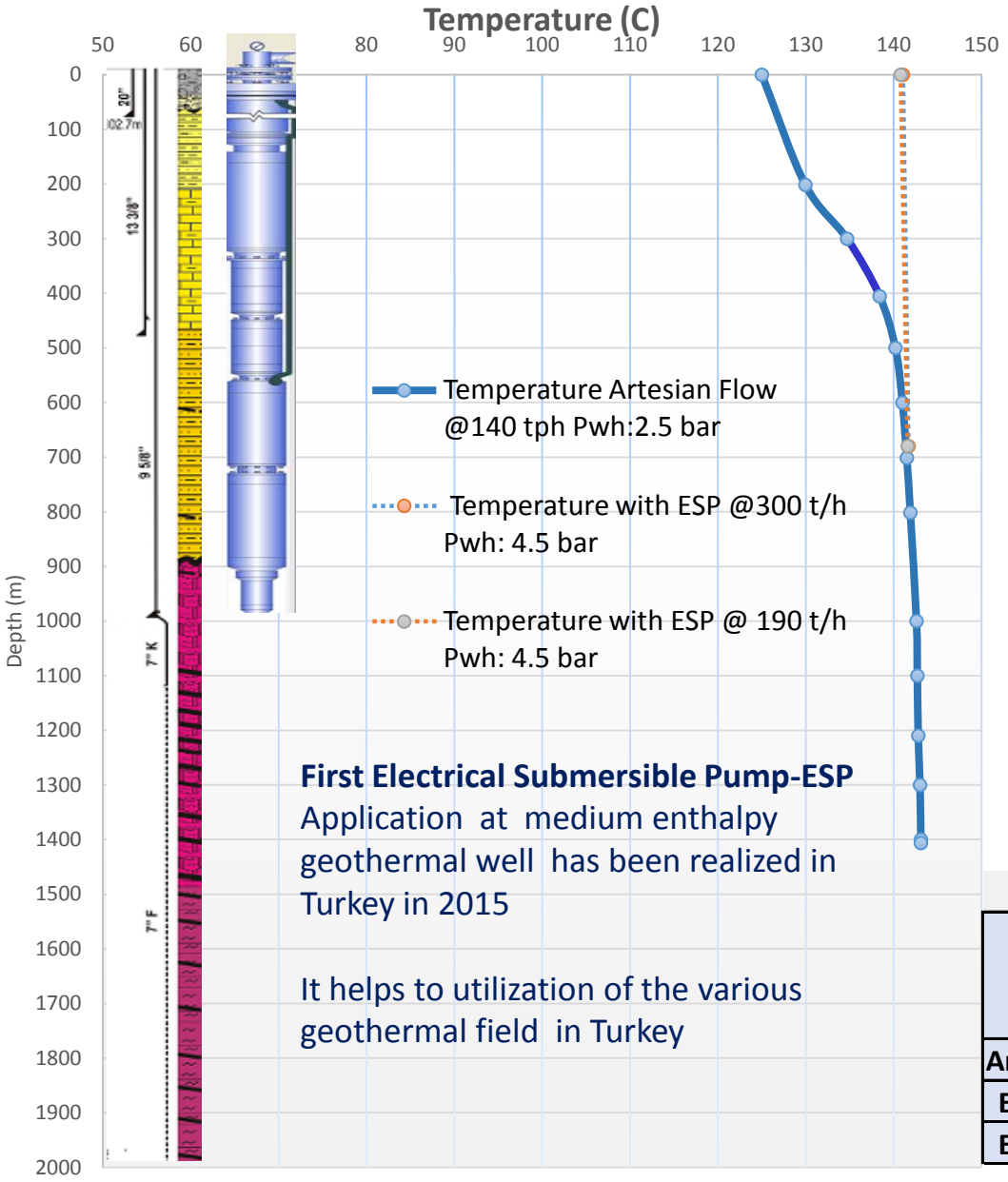
Prediction –Answering the Question of What If..

Forecast of Makeup Well or need artificial ...





First Electrical Submersible Pump-ESP Application at medium enthalpy geothermal well has been realized in Turkey in 2015

It helps to utilization of the various geothermal field in Turkey

Each well needs tailor made design and optimization by multidiscipline Engineering specially by Reservoir Engineering!

				KWe		
SLB Case Study in Turkey	Q (t/h)	T (C)	WHP (bar)	ESP Power Capacity	Gross Power Gen	Net Power Gen
Artesian Flow	140	125	2.5	0	830	830
ESP @ 30 Hz	200	140	4.5	235	1680	1445
ESP @ 50 Hz	302	141	4.5	508	2600	2092

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Thank you…
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內政部不動產交易實價查詢服務網 – 花蓮縣瑞穗鄉土地交易

(a) 瑞穗段 2221~2250 地號 單價: 1.6 萬/坪 (約 4850 萬/公頃)

(b) 溫泉段 781~810 地號 單價: 0.4 萬/坪 (約 1212 萬/公頃)

(a) 與 (b) 取中值: **3031 萬/公頃**

內政部不動產交易實價查詢服務網 － 台東縣太麻里鄉 (金崙地區)土地交易

(a) 金富段 901~930 地號　單價: 0.7 萬/坪 (約 2121 萬/公頃)

(b) 金富段 871~900 地號　單價: 0.4 萬/坪 (約 1212 萬/公頃)

(a) 與 (b) 取中值: **<u>1666 萬/公頃</u>**

正 本

檔　　號：
保存年限：

台灣電力股份有限公司　公告

發文日期：中華民國107年6月25日
發文字號：電輸供部規字第1078062135號
附件：如文

裝

主旨：修正「再生能源加強電力網工程費用分攤原則及計費方式」，並自107年6月12日起實施。

訂

依據：經濟部107年6月14日經授能字第10704095760號函。

公告事項：

一、「再生能源加強電力網工程費用分攤原則及計費方式」業於104年8月4日奉准實施，本次修正主要係更新104~105年陳報之設備工程費，並新增345kV GIS及23kV中壓GIS費用，另提供11.4kV、69kV及161kV採加強電力網工程時之費用計算範例供參(如附件1)。

線

二、本計費方式之適用範圍補充說明如附件2。

三、有關修正後計費方式內容，請至本公司網站(http://www.taipower.com.tw)首頁/規章條款/再生能源類項下點選參閱。

總經理 鍾炳利

106~107 年度再生能源加強電力網工程費用分攤原則及計費方式

一、現況

(一)再生能源發展條例第 8 條第 5 項規定：「再生能源發電設備及電力網連接之線路，由再生能源發電設備設置者自行興建及維護；必要時，與其發電設備併聯之電業應提供必要之協助；所需費用，由再生能源發電設備設置者負擔。」，第 2 項規定：「……；在既有線路外，其加強電力網之成本，由電業及再生能源發電設備設置者分攤」。

(二)本公司再生能源電能收購作業要點第 4 點規定：「設置者向本公司申請併聯躉售電能，致本公司需對所轄之既有電力網進行加強時，因而增加之費用，由設置者與本公司均攤。」另本公司於 104 年 8 月 4 日奉准施行「再生能源加強電力網工程費用分攤原則及計費方式」，依該計費方式每 2 年檢討 1 次。

(三)本次除更新設備工程費外，尚新增 345kV GIS 及 23kV 中壓 GIS 費用。

二、計費方式：

(一)係針對再生能源發展條例認定可永續利用之風力及太陽能等能源，適用於屬加強輸電電網及新（增）設配電饋線範圍。加強電力網設備產權屬台電公司。

(二)加強電力網設備費用可區分為變壓器、配電線路、輸電線路及變電設備。再生能源發電設備設置者每 kW 分攤單價，將依該區域加強電力網檢討變壓器需求及線路長度，再累加各項設備費用。

(三)參酌國外作法，以併網工程費實績加計 5%維護費訂之。

(四)變壓器每 kW 分攤單價係按裝設變壓器之實際工程費除以一定比例之變壓器容量(桿上式及亭置式 TR 為 100%、TR, DTR, MTR 為 80%、ATR 為 70%)；配電線路每 kW 每公里分攤單價：架空線及地下電纜分別以 5MW 及 10MW 線路容量均分費用；輸電線路每 kW 每公里分攤單價：按架空線或地下電纜每公里單價加計終端設備費用後除以線路容量之 70%均化計算。106-107 年各項設備工程費用計算，每 kW 之分擔費用如下表(每 2 年檢討 1 次)：

加強電力網設備		106-107 年每 kW 分攤單價
變壓器	桿上式及亭置式 TR(100kVA)	1005 元/kW
	TR(25MVA) (已含 69kV 及中壓 GIS)	1148 元/kW
	DTR(60MVA) (已含 161kV 及中壓 GIS)	1043 元/kW
	MTR(200MVA) (已含 69kV 及 161kV GIS)	529 元/kW
	ATR(500MVA) (已含 161kV 及 345kV GIS)	630 元/kW
配電線路	11kV/22kV	803 元/(kW*km)*架空線公里數(km)+2484 元/(kW*km)*地下電纜公里數(km)
輸電線路	69kV	350 元/(kW*km)*架空線公里數(km)+508 元/(kW*km)*地下電纜公里數(km) +2 套線路終端設備 222 元/KW
	161kV	131 元/(kW*km)*架空線公里數(km)+340 元/(kW*km)*地下電纜公里數(km) +2 套線路終端設備 62 元/kW
變電設備	中壓 GIS	42 元/kW (22.8kV 或 11.4kV 適用)

1. 本表各項計費方式(元以下小數四捨五入進整) ，以併網工程費實績加計 5%維護費訂之，並每 2 年檢討修訂。
2. 本表計費僅適用本公司未新建變電所情況。
3. 本加強電力網之計費方案適用於加強輸電電網及新(增)設配電饋線，未含括部分，則依再生能源發展條例第 8 條及電業法第 49 條辦理。
4. 有關「第三型再生能源發電設備屬屋頂型太陽光電發電設備」與本方案同時適用時，設置者得擇優適用。

四、範例 1：某業者預計以 100MW 容量併接本公司 161kV 系統，在系統分析時發現併接點之線路容量已經不足，且上游超高壓變電所主變壓器 ATR 已超載，均需要加強電力網增加主變壓器 ATR 及線路容量方可併網。該案經本公司評估後規劃以增設 1 台 500MVA 主變壓器，並且新建 161kV 一回線，線路長度 7 公里(其中 4 公里架空、3 公里地下電纜)，若該費用依 106-107 年度再生能源加強電力網工程費用分攤原則及計費方式，試問業者需負擔多少加強電力網費用？

ANS：106-107 年度再生能源加強電力網工程費用單價

500MVA 主變壓器費用(含 161kV 及 345kV GIS)=630 元/kW

161kV 架空線=131 元/(kW*km)

161kV 地下電纜=340 元/(kW*km)

2 套線路終端設備=62 元/kW

業者預計併網 100MW，其主變費用：

100000kW*630 元=0.63 億元

另 161kV 架空 4 公里與地下電纜 3 公里線路(含 2 最終端)，其費用共計：

(131 元*4km+340 元*3km+62 元)*100000kW=1.606 億元

依上計算方式，本案業者預計併網 100MW 所需負擔加強電力網費用為(0.63 億元+1.606 億元)=2.236 億元

範例 2：某業者預計以 99MW 容量併接本公司 69kV 系統，在系統分析時發現併接點之線路容量已經不足，且上游超高壓變電所主變壓器 MTR 已超載，均需要加強電力網增加主變壓器 MTR 及線路容量方可併網。該案經本公司評估後規劃以增設 1 台 200MVA 主變壓器，並且新建 69kV 一回線，線路長度 3 公里(其中 2 公里架空、1 公里地下電纜)，若該費用依 106-107 年度再生能源加強電力網工程費用分攤原則及計費方式，試問業者需負擔多少加強電力網費用？

ANS：106-107 年度再生能源加強電力網工程費用單價

200MVA 主變壓器費用(含 69kV 及 161kV GIS)=529 元/kW

69kV 架空線=350 元/(kW*km)

69kV 地下電纜=508 元/(kW*km)

2 套線路終端設備=222 元/kW

業者預計併網 99MW，其主變費用：

99000kW*529 元=0.524 億元

另 69kV 架空 2 公里與地下電纜 1 公里線路(含 2 最終端)，其費用共計：

(350 元*2km+508 元*1km+222 元)*99000kW=1.416 億元

依上計算方式，本案業者預計併網 99MW 所需負擔加強電力網費用為(0.524 億元+1.416 億元)=1.94 億元

範例 3：某業者預計以 4MW 容量併接本公司 11.4kV 系統，在系統分析時發現併接點之線路容量已經不足，且上游二次配電變電所主變壓器逆送已至 8 成，需要加強電力網增加主變壓器 TR 及架設新設線路方可併網。該案經本公司評估後規劃以增設 1 台 25MVA 配電變壓器，並且新建 11.4kV 一回線，線路長度 7 公里(其中 6 公里架空、1 公里地下電纜)，若該費用依 106-107 年度再生能源加強電力網工程費用分攤原則及計費方式，試問業者需負擔多少加強電力網費用？

ANS：106-107 年度再生能源加強電力網工程費用單價

25MVA 主變壓器費用(含 69kV 及中壓 GIS)=1148 元/kW

11.4kV 架空線=803 元/(kW*km)

11.4kV 地下電纜=2484 元/(kW*km)

業者預計併網 4MW，其主變費用：

4000kW*1148 元=0.4592 千萬元

另 11.4kV 架空 6 公里與地下電纜 1 公里線路，其費用共計：

(803 元*6km+2484 元*1km)*4000kW=2.92 千萬元

依上計算方式，本案業者預計併網 4MW 所需負擔加強電力網費用為(0.4592 千萬元+2.92 千萬元)=3.3792 千萬元

附件 2

再生能源業者併網費用分攤適用範圍及計費方式補充說明

項目	適用範圍說明
1. 第三型(500KW 以下)屬屋頂型太陽光電發電設備設置者之併網工程費用計費方式	1. 符合第三型再生能源發電設備屬屋頂型太陽光電發電設備。 2. 適用申請配電層級 110V、380V、11kV 及 22kV 併網者。 3. 屬未新(增)設饋線或新(擴)建變電所之情況。
2. 再生能源加強電力網工程費用計費方式	1. 屬中央主管機關認定之再生能源發電設備。 2. 適用於輸電電網或配電新（增）饋線。未涵括部分，則依現行計費規定辦理。 3. 適用申請配電層級 110V、380V、11kV、22kV 及輸電層級 69kV、161kV 併網者。 4. 屬未新建變電所之情況。
3. 現行計費規定: (1)加強電網:由台電及再生能源發電設備設置者分攤。 (2)再生能源發電設備及電力網連接之線路，由設置者自行興建及維護，電業應提供必要之協助；所需費用由設置者負擔。	1. 非屬項目 1 及項目 2 情況之再生能源發電設備併網者。 2. 新建變電所按實耗工程費計收。

註：第三型再生能源發電設備屬屋頂型太陽光電發電設備可由項目 1 及 2 收費方式中擇優適用

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GEOELEC

Deliverable n° 3.2.

Report on risk insurance

Date : **June 2013**

Authors: **S Fraser (BRGM), P Calcagno (BRGM), F Jaudin (BRGM), R Vernier (BRGM), P Dumas (EGEC)**

EUROPEAN GEOTHERMAL RISK INSURANCE FUND EGRIF

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EXECUTIVE SUMMARY

Geothermal energy is a renewable energy with many advantages: It is base load, local and environmentally friendly.

However, its penetration into the energy market remains difficult. Although profits can easily be made from a geothermal project, investors consider the geothermal resource as a risky parameter.

GEOELEC promotes geothermal electricity generation in the EU and aims at removing notably financial barriers. Investors should be encouraged to take part in its promising development. In this respect, this report puts forward a scheme for an EU Fund mitigating the risk associated with the geothermal resource and facilitating investments in geothermal electrical generation projects.

As explained in this report, where knowledge of the geothermal resource is lacking, exploration is of crucial importance to collect relevant data before drilling. Beyond exploration, the bankability of a geothermal project is threatened by the geological risk. The geological risk includes the risk not to find an adequate resource (short-term risk) and the risk that the resource naturally declines over time (the long-term risk).

Risk insurance Funds for the geological risk already exist in some European countries (France, Germany, Iceland, The Netherlands and Switzerland). The geological risk is a common issue all over Europe. Collaboration between Member States to remove it will allow them to save money.

It is the reason why the GEOELEC project calls for the establishment of a Geothermal Risk Insurance Fund at the EU level. This Fund could insure deep geothermal projects in the different EU countries.

This idea is not new. For about 15 years, the topic is discussed within the geothermal sector. But for the first time, this report proposes how such a structure could be established and managed.

INTRODUCTION

THE GEOELEC PROJECT

The GEOELEC project - *Develop Geothermal Electricity in Europe to have a renewable energy mix* - is dedicated to the promotion of geothermal electricity production in the EU, including combined heat and power (see Preliminary Chapter on geothermal electricity production).

The project is financed by the program Intelligent Energy – Europe (IEE) and led by the European Geothermal Energy Council (EGEC) through a consortium of 10 partners (see Appendix I).

THE BACKGROUND TO GEOTHERMAL ELECTRICITY PRODUCTION

Energy awareness

While the world is facing climate change, the depletion of its fossil fuels, oil and gas price volatility and the controversy surrounding nuclear power, it continues to show an unquenchable thirst for energy (*The World Energy Outlook 2011, International Energy Agency; BP Energy Outlook 2030*). In this context, renewable energies are deemed as a reliable alternative to tackle those issues and become a vital component to sustained economic growth.

A base load energy

Geothermal energy has many obvious qualities. A remarkable one is to be not dependent on climate conditions such as wind or solar energy may be. As a consequence, in addition to being renewable, local and environmentally friendly, it is also base load. Among all renewable energies, this makes geothermal the most reliable one with a load factor superior to 90%.

An untapped electricity potential

Considering geothermal qualities, geothermal electricity production is very promising. In the EU, it is far from optimum though. In spite of wide available geothermal resources and developed technologies to harness them, the EU gross geothermal electricity production reached 6 TWh in 2011. This is only a small portion of the geothermal power potential in the EU.

Financial triggers

Although geothermal energy benefits from low operating costs, it involves high upfront investments. This substantially hinders the penetration of geothermal energy into the energy market.

The risk associated with the geothermal resource

In addition to high upfront investments, geothermal developers face a specific risk associated with geothermal projects commonly known as the geological risk.

The geological risk includes:

- The short-term risk of not finding an economically sustainable geothermal resource after drilling;

- The long-term risk of the geothermal resource naturally depleting rendering its exploitation economically unprofitable;

Geological surveys help to find geothermal resources and give indications for their profitability but the only way to purge the geological risk and confirm the geothermal resource is to actually initiate the exploration and drilling work. This requires developers and investors to lay out significant amounts of cash beforehand without certainty as to the availability and perennity of the geothermal resource and hence the bankability of the project.

GEOELEC's commitment

GEOELEC endeavours to remove the risk associated with the geothermal resource. This report refers to this risk as the **'resource risk'**. A scheme for an European Fund mitigating the resource risk is put forward, namely the European Geothermal Risk Insurance Fund (EGRIF).

EUROPEAN GEOTHERMAL RISK INSURANCE FUND (EGRIF)

Rationale of the EGRIF

For now, the fairly small number of geothermal electricity operations in the EU does not provide a sufficient statistical basis to assess their probability of success. As a consequence, geothermal developers struggle to find insurance public or private schemes under affordable terms and conditions for the resource risk. In those circumstances, the EGRIF aims at alleviating the shortage of insurance policies for the resource risk and ease investments in geothermal electricity projects.

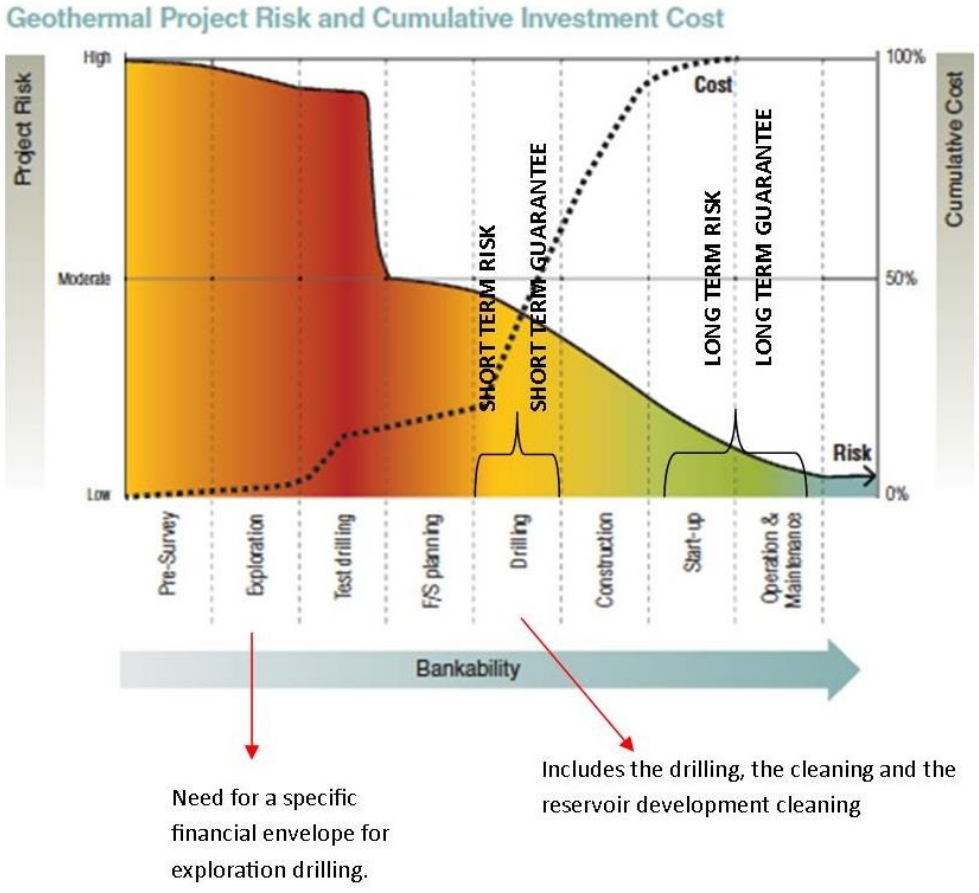


Figure 1 – Geothermal project risk and cumulative investment cost, modified from ESMAP, April 2012 - Until the first borehole has been drilled into the geothermal reservoir, developers cannot be sure about the exact parameters (temperature and flow rate) of the planned geothermal electricity project. Once drilling has taken place, in situ pump tests, temperature and hydrological measurements then reduce the resource risk and make it possible to attract external capital.

Principles of the EGRIF

EGRIF is meant to work through the pooling of the resource risk among geothermal electricity projects taking place in the EU. Besides, the Fund does not challenge the EU principle of subsidiarity nor act as a competitor to existing national insurance policies.

Figure 1 below shows the phases of a geothermal electricity project where the resource risk may occur and the insurance from the EGRIF be released.

Previous EU initiatives

GEOELEC praises previous EU projects dealing with the resource risk such as the 2011 GEOFAR report and the 1997 Altener report. However, GEOELEC shall be distinguished from such previous initiatives, as its scope comprehends deep geothermal and all types of geothermal technology including Enhanced Geothermal Systems (EGS).

WHY PUBLIC FUNDS SHOULD BE USED TO SUPPORT THE GEOTHERMAL INDUSTRY AND INTERFERE WITH THE MARKET?

Primary objective of financial incentive schemes such as a public Risk Insurance Fund is to compensate for market failures and unfair competition. They are also intended to favour the deployment of a given technology by creating a secure investment environment catalysing an initial round of investment and allow the technology to progress along its learning curve. Hence, support schemes should be temporary and can be phased out as this technology reaches full competitiveness in a (then) complete and open internal market where a level playing field is fully established.

Today, however, market conditions in the EU electricity and heat sectors prevent geothermal to fully compete with conventional technologies developed under protected, monopolistic market structures. The internal market is still far from being perfect and transparent. Firstly, in many countries electricity and gas prices are regulated, thus they do not reflect the full costs of the electricity, gas, and/or heat generation. Secondly, fossil fuel and nuclear sectors still receive many subsidies. Thirdly, there is lack of market transparency, including lack of information provision to customers and a clear billing.

Support measures for geothermal technologies are therefore needed to favour the progress towards cost-competitiveness of a key source in the future European energy mix and to compensate for current market-failures.

Factors that impede the functionality or cause the failure of markets

Geothermal energy projects, particularly those where technological progress, experience curves and hence cost reductions are required to reach commercial viability, do not have access to

private funds for financing. Poor knowledge of the deep subsurface over large parts of Europe and the capital intensity of the geothermal industry adds to this distortion. Further, the homogeneity of products derived from geothermal energy (e.g. power, heat, tradable emission reduction certificates) do not command a premium that can be levied nor enable the development of niche products. In addition, today's energy market has only had very limited success in internalizing negative externalities (e.g. major nuclear incidents, consequences of CO_2-emissions) so that price signals appear further distorted. Finally, in slowly liberalizing markets (e.g. electricity) prices are primarily driven by the cost of generation and less set by the market. A subset of these market deficiencies will need to be remedied via other political measures (e.g. overhaul of the ETS).

With the notable exception of a few European market participants operating in well-developed geothermal regions, project developers have very little capability to manage the financial risk owing to the poor knowledge of the deep subsurface, lack of technological progress and high cost. In effect the probability of success/failure weighted net present values of project cash flows tend to be overly negative, thus effectively shutting out private capital from investing in geothermal energy.

With respect to the geothermal energy market uncertain returns of investment and high capital investment do not represent a failure of the markets or government, and hence do not justify public sanctions. Such risks and exposure are omnipresent and must be managed accordingly by participants in the geothermal energy market.

However, with technology development (increasing the probability of success of finding and developing geothermal reserves) coupled with experience and thus reductions in cost, project developers will eventually be able to accept and, where appropriate, transfer project risks (technical, economical, commercial, organizational and political) in such manner that private funding will become available.

Until then, public funds may be used to facilitate the uptake of geothermal energy which is required under most energy and climate change mitigation scenarios of Europe. The EGRIF is thus viewed as public support measure for geothermal energy technology. While market or government failures will not be corrected (first-best option), this (second-best) option will be implemented to achieve particular goals with respect to future energy mix and greenhouse gas emission targets.

EGRIF is meant to work through the pooling of the resource risk among geothermal electricity projects taking place in the EU. Besides, the Fund does not challenge the EU principle of subsidiarity nor act as a competitor to existing national insurance policies.

The EGRIF should be first supported by public money, when mature this could be phased out and replaced by private schemes.

The report includes a preliminary chapter highlighting the specificities of geothermal electricity production. Chapter 1 focuses on the relevant parameters of the existing national insurance systems dealing with the resource risk in Europe. It relies on Appendix I, which provides a snapshot description of these national systems. Chapter 2 sets out the scenarios for the European Geothermal Resource Risk Mitigation Fund.

PRELIMINARY CHAPTER

INTRODUCTION TO GEOTHERMAL ELECTRICITY PRODUCTION

The efficiency of geothermal electricity production depends on the temperature and the flow rate of the fluid that carries the geothermal energy to the surface. Such a fluid may occur naturally or not; it can be liquid or vapour. Generally the fluid is used to run a turbine connected to a generator that produces electricity.

Fluids above 180°C are used since 1904 for geothermal electricity production. Historically, the production of electricity from geothermal sources has been developed in high enthalpy-related areas where natural hot fluid comes to the surface. Such production is called '**conventional**' but this context is quite rare in Europe, e.g. in Iceland or in Tuscany (Italy, Fig. 2).

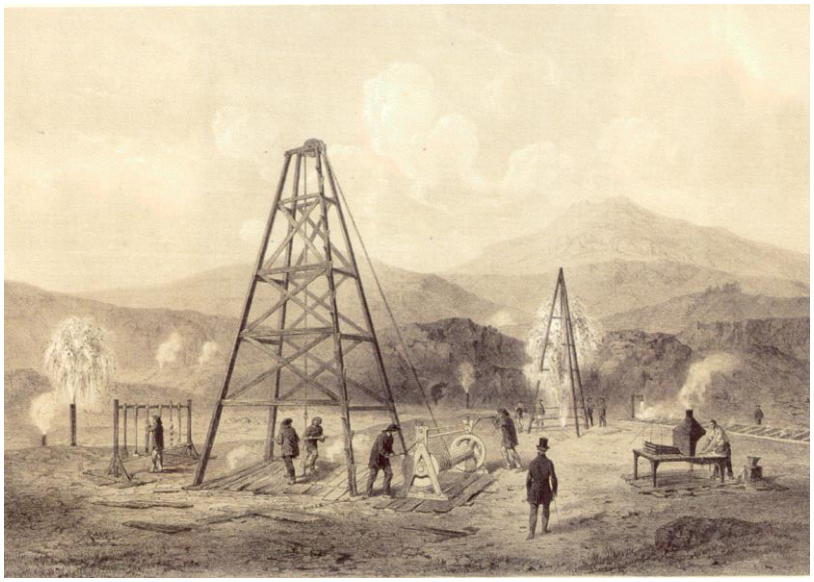


Figure 2. Geothermal bore-holes, Larderello, Tuscany, Italy. Lithography of the mid-19th century.

However, low temperatures can still be used for electricity production in an economically profitable way. To do so techniques such as '**binary cycle**' can be used to run the turbine: In these plants, the heat is recovered from the geothermal fluid, via a heat exchanger, to vaporize a low boiling point organic fluid and drive an organic vapour turbine. Adequate working fluid selection may extend the former design temperature range from 180°C to 75°C.

Besides, geothermal plants can produce electricity in a '**co-generation'** system; combining geothermal energy with another energy source. In addition, the thermal energy remaining after the electricity production can also be used in '**cascade**' for other purposes, e.g. district heating, heating of industrial process thereby enhancing financial profitability.

The 200°C isotherm is reached between 2 and 5 km depth in zones of present or recent lithospheric extension like in France, Greece, Iceland, Italy, offshore Spain, Turkey, or even in intracontinental geological settings like in Hungary, Lithuania, and Romania. These thermal anomalies constitute a source of energy potentially available throughout Europe. However, the use of geothermal energy is limited by the fact that it relies on a relatively limited number of geological reservoir formations. They have to be simultaneously water-bearing, hot and permeable, and lying at economically accessible depths.

In contrast to the conventional high-temperature steam or liquid-dominated reservoirs in volcanic environments, a way for enhancing and broadening geothermal energy reserves has been proven in 2007. This breakthrough technology already demonstrated is known as '**EGS**'. An 'Enhanced (or Engineered) Geothermal System' is an underground reservoir that has been created or improved artificially (definition TP Geoelec – 2010) i.e. a low permeable reservoir that has been enhanced to become economically viable. The enhancement consists in improving the connection between the geothermal wells and the reservoir by stimulations. As an example, an EGS pilot plant producing electricity is located at Soultz-sous-Forêts (France, Fig. 3).

Figure 3. The Soultz-sous-Forêts EGS pilot plant (France).

Considering these available technologies, the European geothermal potential can suitably be harnessed for electricity production.

CHAPTER I

OVERVIEW OF THE EXISTING NATIONAL INSURANCE SYSTEMS IN EUROPE: IDENTIFICATION OF RELEVANT PARAMETERS

There is a heterogeneous approach towards the resource risk in Europe and worldwide.

In some countries outside Europe, geothermal developers are willing to internalize the resource risk among other costs. This willingness is rooted in either a risk culture developed in relation to mining and oil activities or a high-expected return on investment in the light of abundant geothermal resources. This allows geothermal to be economically attractive through support schemes, without need for insurance policies covering the resource risk.

In other countries, the resource risk may not be internalized and remains a financial barrier to geothermal development. Regardless of any support scheme, any geothermal expansion is heavily dependent on insurance. All countries in Europe fall into this category.

This first part of the report summarises the existing national insurance systems dealing with the resource risk in Europe (see Figure 2). In so doing, it sheds light on their specific features ie on the relevant parameters that shall be taken into account for the establishment of an insurance Fund dealing with the resource risk on the European stage.

In this respect, all national systems have been considered, whether they provide insurance for electricity production, heat production or both of them.

1. OVERVIEW OF THE EXISTING INSURANCE SYSTEMS IN EUROPE

The chart below (Figure 4) shows the current state of the resource risk insurance in each EU country, plus Iceland and Switzerland. Details of the existing insurance systems can be found in Appendix II.

For each country, the chart specifies:

- Whether an insurance for the resource risk exists;
- Whether the insurance covers heat or electricity production;
- Whether the insurance process is handled by public authorities or private entities;
- Whether the insurance mechanism is purely insurance-related or serves as a financial support as well;
- Whether the insurance is made available on the national stage only or in foreign countries as well;

Figure 4 – Snapshot description of the national insurance systems in Europe (details in Appendix I)

Country	Insurance		Energy		Governance		Type of insurance		Location	
	Yes	No	Heat	Electricity	Public	Private sector	Purely insurance-related	Insurance mixed with financing	National	Foreign countries
Austria		X								
Belgium		X								
Bulgaria		X								
Cyprus		X								
Czech Republic		X								
Denmark		X								
Estonia		X								
Finland		X								
France	X		X		X		X		X	
Germany	X		X	X	X	X		X	X	
	X		X	X		X	X	X	X	X
Greece		X								
Hungary		X								
Iceland	X		X		X			X	X	
Ireland		X								
Italy		X								
Latvia		X								
Lithuania		X								
Luxembourg		X								
Malta		X								
The Netherlands	X		X		X		X		X	
Poland		X								
Portugal		X								
Romania		X								
Slovakia		X								
Slovenia		X								
Spain		X								
Sweden		X								
Switzerland[1]	X		X	X	X	X	X		X	
United Kingdom		X								

[1] For Switzerland, it should be understood that the Swiss federal risk guarantee scheme applies only to geothermal power projects. Cantons may offer risk coverage for heat projects (so far only one of 26 cantons has done so, on an ad-hoc basis for one project).

2. IDENTIFICATION OF RELEVANT PARAMETERS

The national insurance systems existing in Europe are characterized by a number of key parameters. These parameters are reviewed below and illustrated by the experiences of the existing systems in Europe.
The arbitral award may not be appealable.

3. TYPE OF NATIONAL INSURANCES IN RELATION TO THE RESOURCE RISK IN EUROPE

The first parameter to be considered is the type of insurance covering the resource risk.

In countries with mature geothermal markets where geothermal developers may not internalize the resource risk among the costs of their projects, they may resort to private insurance policies. In Germany for instance, insurance companies and brokers engaged in obtaining experience in relation to the resource risk. They provide insurance policies to geothermal developers. In the rest of Europe however, the private insurance sector stands back.

In this context, some governments have taken action to settle a national insurance Fund in order to further develop geothermal projects (France, The Netherlands, Germany, Iceland and Switzerland).

Where such a Fund has been created, two insurance patterns may be distinguished:

- The first one consists in a post-damage guarantee;
- The second one involves a guaranteed loan;

The hypothesis of a post-damage guarantee relies on traditional insurance principles (e.g. France, The Netherlands and Switzerland). The insurance is released once (insured) event takes place and covers a certain percentage of the costs initially deemed eligible (e.g.: 90% of the drilling costs in case of complete failure).

The guaranteed loan is first and foremost an upstream source of financing. However, when the risk occurs, the loan is forgiven and expenses considered as eligible may be reimbursed up to a certain level. In this respect, some Funds have introduced a guaranteed loan as an insurance mechanism. The State (e.g. Iceland) or financial institutions (e.g. Germany) may grant the loan. However, the financial responsibility ultimately falls upon the State, which guarantees the loan.

The set up of the Fund is the result of public authorities' commitment to develop geothermal. This gives the Fund quite a public dimension. However, in some countries (e.g. France and Germany), the Fund involves the private sector. Private entities may hold shares in the seed capital and/or take part in the insurance handling process. This is a means to raise the private sector awareness towards the resource risk.

The Fund is usually created to alleviate the shortage of private insurance policies. As a consequence, it is usually meant to be taken over by insurance companies. In absolute terms, this suggests that at some point the resource risk may be partly insured by the national Fund and partly insured by an insurance company. Apart from the Dutch system however, none of the existing insurance Funds have given consideration for a shared coverage of the resource risk.

For the European Geothermal Risk Insurance Fund, the insurance mechanism could take several forms:

- A post-damage guarantee;
- A guaranteed loan;
- A complementary mechanism to insurance made available on the national stage, whether from insurance companies or from national insurance Funds;

4. GOVERNANCE

As usual, the existence of a Fund requires some governance, including decision-making, treasury and administrative functions.

Most of the existing Funds work on a national stage and a certain public guardianship applies to the governance, which is handled by a State ministry or a public interest institution acting in the financial or energy field.

Some Funds however have been settled in relation to regional programs. This is the case of the GeoFund (Europe and Central Asia) and ARGeo (Africa). In these systems, the governance is fully or partly outsourced and handled by a supranational institution.

The European Geothermal Risk Insurance Fund (EGRIF) could apply to all European countries or some of them only. With that in mind, the EGRIF may rely on:

- An exclusive management by an EU institution;
- A shared management between an EU institution on the one hand and national insurance Funds/companies on the other hand;
- A shared management between an EU institution and national authorities;
- An exclusive management by national authorities;

5. RISKS INSURED

The exploration phase, taking place before the drilling and the operation of the geothermal plant, is meant to gather some data about the geothermal resource characteristics (see Figure 1). This phase is usually not concerned with insurance mechanisms. Instead, repayable grants may be provided for surface studies and some financing may support the exploration drilling (e.g. In France, public authorities may provide a repayable advance for the exploration phase). Here again, the exploration drilling is usually not meant to produce electricity or heat but to collect data about the geothermal resource.

With regard to geothermal electricity projects, the characterization of the resource is crucial and the insurance made available for the exploitation phase should be combined with an adequate financing of the exploration phase.

Following the exploration phase, the geothermal resource is threatened by two different risks:

- A short-term risk, which occurs after drilling when the geothermal resource discovered is not sufficient to be economically viable;

- A long-term risk, which occurs when the exploited geothermal resource depletes and/or degrades over time, compromising the economical perennity of the resource;

Most insurance systems are focused on the short-term risk (e.g. Germany, The Netherlands, Switzerland and Iceland). When covering the short-term risk, the insurance system usually covers the drilling costs. In this respect, the insurance may cover either one or several drillings. The insurance may also apply a revolving mechanism: the coverage is made available for one drilling but may be reused where the drilling is successful, thus allowing for the coverage of successive drillings until one proves unsuccessful.

The French Fund also insures the long-term risk. The perennity of the resource being of key importance to the bankability of the geothermal project, the European Geothermal Risk Insurance Fund could eventually cover both the short-term risk and the long-term risk.

But the long-term risk can be insured only upon certain conditions. The natural depletion is a standard technical risk that project developers should be able to deal with. Excessive depletion is often attributable to either excessive production (pressure-drop, lower inflow performance), ill-positioned reinjection wells that cool the inflow zones because of unwanted thermal short-cuts, poor reservoir surveillance, poor reservoir management etc. So its coverage by an insurance cannot be obligatory. As an alternative funding mechanism that supports the long-term risk one may consider a production tax credit system.

For the European Geothermal Risk Insurance Fund, three phases of the geothermal project may be concerned (see Figure 1):

- Some financing could be provided in relation to exploration;
- The Fund should insure the short-term risk ie one or several drillings for production and injection wells. It may apply a revolving mechanism in this respect;
- The Fund could also insure the long-term risk ie the quality and quantity of the geothermal resource over a certain time period; but with conditions.

6. CAPITAL AND FINANCIAL STRUCTURE

Existing insurance Funds have been launched with a seed capital filled with public funding. The private sector such as insurance companies, financial institutions and private stakeholders involved in the geothermal field should however be encouraged to take shares in the seed capital.

For the European Geothermal Risk Insurance Fund (EGRIF), the seed capital could be filled with funding from:

- The European Union;
- The Member States;
- The regional level authorities of the Member States;
- Insurance companies and brokers;
- Private and public financial institutions;
- Other reliable stakeholders;

Feedback shows that governance issues may arise when the distribution of the seed capital is not made transparent. This should be avoided in relation to the EGRIF. The arrangement of its seed capital should constantly be made publicly known.

Once the Fund is launched with a seed capital, it may rely on several sources of income. There are various incomes the existing insurance systems rely on: premiums, fees, proceeds of investments made with the treasury, taxes on the electricity transmission, and public funding.

Feedback shows that the more diversified the incomes are, the more stable the Fund is. Some insurance systems, which relied on a unique source of revenue, were eventually compromised when this source dried up (e.g. GeoFund, ARGeo).

The Fund can either be balanced over time when the incomes allow it. It may also run out and be filled periodically.

As any consistent insurance Fund, the EGRIF may call on reinsurance to a third body. Part of the resource risk would be transferred to the reinsurer, giving the Fund some financial relief. It could therefore issue more policies than its own incomes may allow and keep covering geothermal electricity projects while at the same time facing exceptional losses.

7. BENEFICIARIES

In the existing insurance systems, the insurance benefits the legal entity bearing the financial risk (e.g. In France, the insurance is provided to the entity on behalf of which work is done and holding the licenses, commonly known as the ‘maître d’ouvrage’).

Most national insurance systems existing in Europe consider that only national developers could benefit from the resource risk mitigation. However, German insurance companies provide policies abroad (e.g. in Denmark, in the Netherlands and in the U.S). Outside Europe some countries are determined to attract foreign investors in addition to national developers (e.g. Chile). In all cases, projects have to take place on the national territory.

For the European Geothermal Risk Insurance Fund, the beneficiaries could be private or public organizations wishing to develop geothermal electricity projects on the EU territory

8. ELIGIBILITY CRITERIA

When resource risk insurance exists, it usually relies upon two sets of criteria:

- The first one applies to the examination of applications made to the Fund/the insurance company;
- The second one applies to the examination of insurance claims submitted to the Fund/the insurance company;

With regard to applications, the eligibility criteria are usually threefold: technical, financial/economical and legal. Although the following list does not claim to be exhaustive, some criteria may be pointed out as follows:

- Technical: the expected parameters (flow rate and temperature); a reservoir development concept; the drilling path and well design; a stimulation concept; an estimate of the probability of success to generate the expected flow and temperature; the planned use of the energy depending on the achieved parameters;
- Financial/economical: available financing; a business plan; the expected return on investment;
- Legal: all necessary permits and licenses; information on contractors and key personnel; the legal form and identity of the operating society;

With regard to insurance claims, the eligibility criteria lie in the terms of the contract signed between the developer benefiting from the insurance and the Fund/the insurance company. The insurance is usually released when the expected flow and temperature, set in the reference contract and defining a successful drilling, are not achieved. Some insurance systems rely on additional criteria in relation to insurance claims. In France and Germany for instance, stimulation measures have to be undertaken.

Existing eligibility criteria are quite similar from one national insurance system to another. The European Geothermal Risk Insurance Fund could adopt such criteria, with regard to applications and insurance claims, the most important requirement being that these criteria be clearly displayed within the insurance process.

9. INSURANCE PROCESS

The existing insurance systems work through procedures dealing with applications and insurance claims.

These procedures rely on expertise. Independent experts are usually appointed according to their technical, financial and legal skills as well as their geothermal knowledge and experience.

These experts provide the governance/the insurer with their opinion, which may be binding and may include recommendations to be complied with by geothermal developers when drilling and/or operation of the geothermal plant is undertaken.

Applications schedules are handled in two different ways:

- The examination of applications may be permanent and applications be submitted at any time of the year (e.g. Iceland, France, Germany, Switzerland);
- The examination may take place on a tendering basis and developers required to submit their applications before an official deadline (e.g. The Netherlands);

When the insurance is granted, a contract is usually signed between the developer and the Fund/the insurance company to provide all details. Without giving an exhaustive list, some of

these details may consist in the success and failure criteria, the level of the coverage, the project's schedule, etc.

When an insurance claim is submitted to the Fund/ the insurance company, the experts usually assess the achieved results against the parameters set in the reference contract to decide whether the insurance shall be released.

Regardless of the insurance release, the developer is usually required to comply with reporting obligations. He is required to submit the governance with some regular information regarding the project's execution. In some systems, the governance specifically appoints an expert to supervise the geothermal site (e.g. Switzerland).

While the language used in the existing insurance system is the national one, this may not be the case for the European Geothermal Resource Risk Mitigation Fund. It should be clear which languages might be used within its handling process.

For the European Geothermal Risk Insurance Fund, the insurance process:

- Could rely on independent expertise;
- Could allow applications to be submitted continuously or on a tendering basis;
- Should systematically lead to the conclusion of a reference contract between the developer and the Fund;
- Should include some reporting obligations;
- Should apply one or several languages, which should be clearly chosen;
- Should be clear, transparent and lead to public and reasoned decisions;

10. LITIGATION

Most feedback from the existing national systems shows that disputes arising in relation to the insurance are settled on an amicable basis. However, contracts signed between developers and the Fund usually provide that any litigation should be brought before national courts and be settled on the basis of national rules.

For the European Geothermal Risk Insurance Fund, disputes may be settled on an amicable basis. Where no amicable arrangement can be found, it may not be appropriate to have disputes brought before various national courts as this could lead to divergent case law on the European stage.

In this respect, disputes could be settled:

- Through recourse to arbitration;
- Where the European Geothermal Risk Insurance Fund has some headquarters in one of the EU Member States, through recourse to this country's national courts;

11. FROM PUBLIC TO PRIVATE INSURANCE

An exit strategy from a publically funded program such as the EGRIF toward a public-private partnership or a fully private insurance has to be envisaged. In principle the conditions exist when geothermal developers are capable enough to accept the risks associated with geothermal energy development or when the private insurance/finance markets can develop products that cater to the need for a “geologic” risk insurance at a reasonable price.

CONCLUSIONS

The chapter I presents an overview and identifies relevant parameters for establishing a Geothermal Risk Insurance Fund at EU level: “governance”, “risk insured”, “capital and financial structure”, “beneficiaries”, “eligibility criteria”, “insurance process” and litigation.

The motivation for instituting insurance schemes is to compensate energy market failures and unfair competition. It is also intended to favour the deployment of geothermal technologies by creating a secure investment environment catalysing an initial round of investment and allow the technology to progress along its learning curve. Hence, such a support scheme should be temporary and can be phased out as geothermal technology reaches full competitiveness in a (then) complete and open internal market where a level playing field is fully established.

The lessons learnt from the national/regional programs (detailed presentation in APPENDIX I: snapshot description of national insurance systems in Europe) are the following:

- In France: The Fund proved its efficiency for 30 years. It compensates the lack of private insurance and allows the development of geothermal heat through a one-off guarantee based on risk pooling. This pooling helps sharing out the risks over projects expected to be successful and innovative projects. In 2012, the French government set geothermal electricity production as one of its priority target and now considers a guarantee system for such production, which may espouse the guarantee known to geothermal heat production.

- In Germany: The first insurance policy was issued in 2003 for the Unterhaching project in the Molasse Basin. The policy came from a private insurer the Munich Re Group. In recent years, other insurance companies offered several policies to geothermal projects. German insurance companies thus engaged in providing insurance for the resource risk, both in Germany and abroad. However, policies covering the resource risk in Germany are currently offered for projects located in two of the three main geothermal provinces in Germany (the Molasse Basin and the Upper Rhine Graben) and depend on the individual case. Private insurance solutions have been proposed because the geothermal german market in large enough. The size of the market is a key criteria for establishing a Fund, in order to allow some risk mitigation between the projects. A second reason is the lack of interest of project developers towards the Public fund. The public Fund was launched in 2009. Since then, geothermal project developers in Germany can choose between two options of mitigation their resource risk: the federal risk mitigation scheme (Fündigkeitrisiko Tiefengeothermie) and private market-based insurance. The main advantage of the public Fund is that it combines project financing via a credit and the mitigation of risk. However,

some pitfalls have been identified, such as the difficulty in finding a Hausbank to convey the application form to KfW and the uncertainty of interest rate and disagio prior to loan promise.

- In The Netherlands: The risk mitigation scheme was launched in 2009 through the regulation SEI Risico's dekken voor Aardwarmte. The scheme has been developed jointly by the Ministries of Economic Affairs and Agriculture together with NL Agency and TNO. After two tenders, the scheme is deemed to have helped projects get started by ensuring financing through a quick and non-profitable insurance process. The scheme is considered as a transparent and objective benchmark for the market and officials expect that more private insurances will enter the geothermal market and will take over from the scheme.

Risk insurance exists in Europe in non-EU countries: in Switzerland, a public insurance has recently been established and in Iceland such geological risk has been identified as a main barrier since the eighties and a Fund has been established since then.

The chapter II will present the design consideration for an European wide scheme like the EGRIF. This analysis would frame the scenarios.

CHAPTER II

SCENARIOS FOR AN EUROPEAN GEOTHERMAL RISK INSURANCE FUND (EGRIF)

The key parameters characterizing the existing national insurance systems dealing with the resource risk in Europe have been identified in the previous chapter.

This second part of the report draws all the necessary conclusions from the experiences of the existing national insurance systems and puts forward some proposals for the establishment of an insurance Fund dealing with the resource risk of geothermal electricity projects taking place on the European stage.

1. GEOTHERMAL MARKET DEVELOPMENT

The scenarios developed below are driven upon geothermal market development.

Prince Ginori Conti produced electricity from geothermal energy for the first time ever in 1904. In 1913, ENEL inaugurated its first geothermal electricity plant in Larderello, Italy. The trend shows us that until 1970-1980, only a few plants were installed in Italy and Iceland: between 1913-1970, the capacity installed increased by 0,23 GWe. Following the energy crisis in the 70s, more countries (for example France and Portugal) installed geothermal plants, leading to an increase in production of 1.41 GWe between 1970-2010. With the newest technologies developed in the geothermal sector, Binary turbines for low & medium enthalpy and Enhanced Geothermal Systems (an EGS is an underground reservoir that has been created or improved artificially), geothermal power has the potential to contribute to decarbonise the electricity sector and to ensure security of supply and grid stability.

The geothermal industry experienced significant growth in 2012, and the total installed capacity in Europe now amounts to around 1.71 GWe, producing some 11,38 terawatt-hours (TWh) of electric power every year. There are 62 geothermal power plants in Europe, with 48 of these located in EU Member States, mainly in Italy where there are 35 plants; meaning an EU installed capacity of ca. 0.9 GWe. According to the 73 planned projects (compared to 75 last year), capacity will grow from 1.7 gigawatts (GWe) installed in 2012 to 3 GWe in 2016, with this major increase linked to the rapid growth of the Turkish and Icelandic markets. In addition, 98 projects are now currently being explored (against 99 last year), representing a capacity of around 1 GWe.

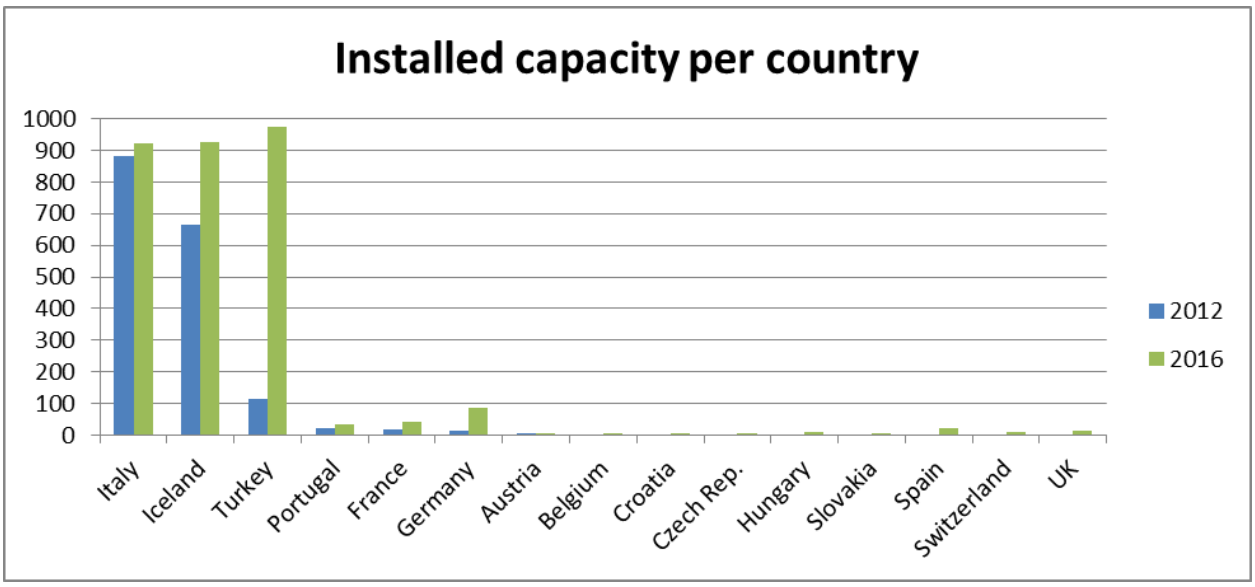


Figure 5: Installed capacity (MWe) per Country in Europe, 2012 and 2016, EGEC Market Report 2012

Geothermal Energy development, as well as that of all other renewable energy sources, is driven by a number of interacting factors, and the relationship between market and policy can be critical. For instance, it is clear that electricity can be produced from geothermal resources through many different processes, and with varying efficiency. However, policy recognition of all these differences and variations is somewhat lacking, resulting in the design of generalised incentives which do not reflect the large variety in the scale of technology, final utilization of the energy, or degree of maturity, meaning that in the end, the incentives may fail to provide any real benefit for geothermal actors.

In analysing the market, it should be noted that geothermal energy has a geological risk, at the beginning of the exploration that can be mitigated through systematic and thorough investigations. This is followed by a period of uncertainty (for example due to reservoir depletion) which can also be mitigated through various measures, e.g. monitoring, re-injection etc.

Therefore, the market and policy environment should be tailored to a suitable model which optimises development of geothermal resources. The development of the geothermal sector will require the establishment of a level playing field in the electricity market.

It can be noticed that the two main factors when developing a large number of geothermal projects are:

- The presence of high enthalpy resource and a political will to develop it, as seen in Iceland and Turkey
- The establishment of suitable support schemes, notably risk insurance fund, as seen in Germany and France

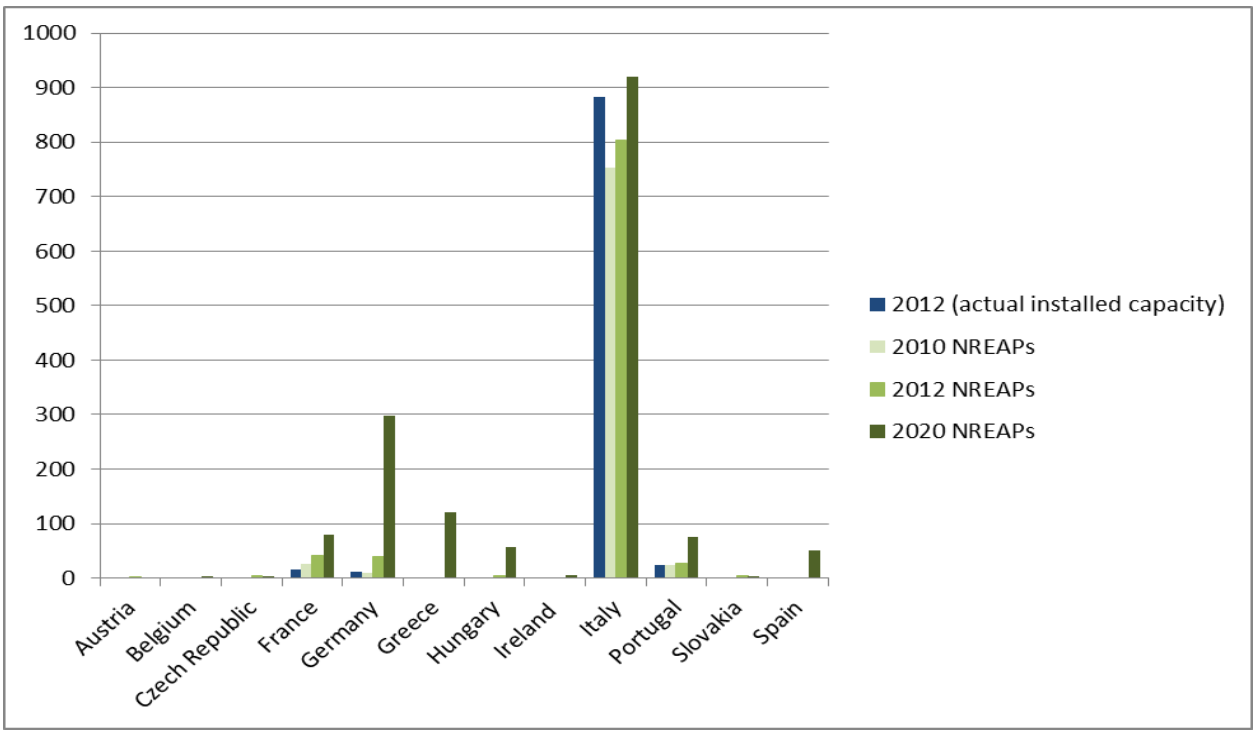


Figure 6: Actual installed capacity (MWe) towards 2020 targets for the Member States of the EU. (NREAPs: National Renewable Energy Action plans fo the EU-27 countries), EGEC Market Report 2012

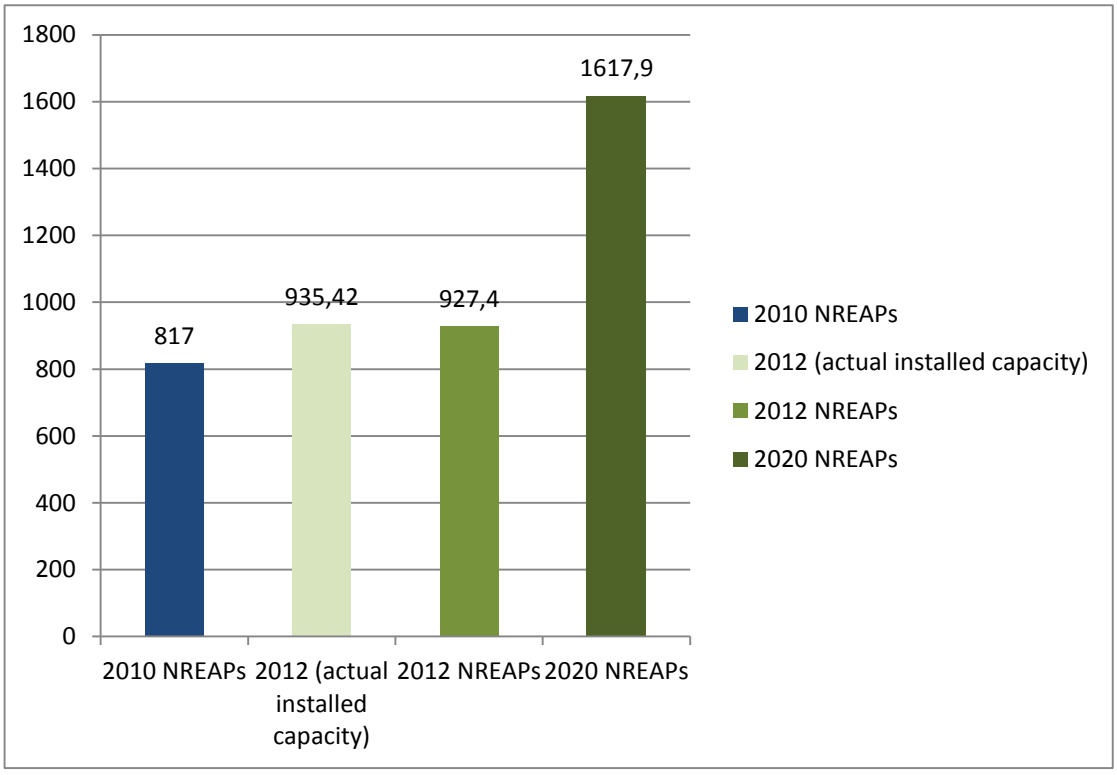


Figure 7: Installed capacity (MWe) per country in Europe, 2012 and 2016,, EGEC Market Report 2012

For now, the fairly small number of geothermal electricity operations in the EU does not provide a sufficient statistical basis to assess their probability of success. As a consequence, geothermal developers struggle to find insurance public or private schemes under affordable terms and conditions for the resource risk. In those circumstances, the EGRIF aims at alleviating the shortage of insurance policies for the resource risk and ease investments in geothermal electricity projects.

The EGRIF should be first supported by public money, when mature this could be phased out and replaced by private schemes.

The level and type of risk insurance scheme should depend upon the maturity of the technologies and markets. The objective is to present here support degression and the methodology for calculating the support level needed for the different geothermal technologies. The criteria mentioned some key costs elements needed to be used for the tariff calculation.

The table below summarises the EGRIF proposal on geothermal electricity technologies:

Market Maturity	**Juvenile**	**Intermediate**	**Mature**	**After 2020**
criteria	0-6 deep geothermal wells are existing < than 3 plants are operational	6-60 deep geothermal wells exist < than 10 plants are operational	Both geoelec & geoDH systems are developed all over the country	Costs reach grid parity with around 10 €ct/kWh
Level of risk	Very high	high	medium	Low
Costs: High temperature Low temperature EGS	 na 18 25	 7 16 25	 6 15 25	 5 10 12
Support schemes	(repayable) Grants for seismic exploration, slimholes, and the 1st well	Feed-in Tariff	Feed-in Premium	Grid premium
Flanking measures	**Public Risk insurance**	**Public or Private Risk insurance**	**Public & private Risk insurance**	**Private Risk insurance**

2. TYPE OF INSURANCE AND RISKS INSURED WITHIN THE EGRIF

As explained in the first part, where knowledge of the geothermal resource is lacking, exploration is of crucial importance to collect relevant data before drilling. Beyond exploration, two risks threaten the bankability of a geothermal project: the risk not to find an adequate resource (short-term risk) and the risk that the resource naturally declines over time (the long-term risk).
As for geothermal electricity generation in Europe, EGRIF shall be concerned with the exploration phase, the short-term risk and the long-term risk.

a) THE EXPLORATION PHASE

Here again, exploration aims at acquiring some data about the geothermal resource. This may be achieved through surface studies and/or exploration drilling.
The exploration drilling is not necessarily a production drilling. It is focused on data collection. However, if exploration proves favourable, the exploration well may be used as a production or injection well.
With exploration, there are no clear success and failure criteria. Success is determined on an empirical basis. This makes any insurance irrelevant in relation to exploration. Instead, exploration is usually supported by public financing.
Considering the importance of exploration for geothermal electricity generation in Europe, EGRIF shall provide some financial envelope to support exploration.
This financial envelope shall take the form of a repayable advance. This would allow for some financing of exploration, without depleting the Fund as the advance would be reimbursed.
The amount of the repayable advance shall be set contractually. It shall cover the costs of exploration drilling and tests. Exploration costs specific to EGS shall also be considered (see *infra* 'eligible costs and coverage ratio').

The advance would have to be reimbursed in case of production. In such a case, the amount to be repaid to the Fund shall be enhanced. A classical interest rate as well as a discount factor shall be applied. These shall be set contractually and modulated according to the estimated exploration risk (see *infra* 'eligible costs and coverage ratio').

b) THE SHORT-TERM RISK

With regard to the short-term risk, the insurance shall aim at covering the costs of one or several drillings in case of a geothermal resource being economically flawed (see *infra* 'eligible costs and coverage ratio').

Two types of insurance may apply: a post-damage guarantee or a guaranteed loan.
A guaranteed loan has the main advantage of serving as a source of financing while at the same time providing some insurance, as the loan is forgiven when the resource risk materializes. However, it requires an immediate disbursement of funds. This severely limits the financial flexibility of the Fund.
The post-damage guarantee does not serve as a source of financing for geothermal projects. Nevertheless, it proved to be an effective insurance design in EU Member States that provide it, as it allows geothermal developers to attract external capital. From an accounting point of view, the funds are frozen when the guarantee is granted but only released when the risk occurs. As such, it allows some financial relief to the Fund and this flexibility ensures that many projects can be covered at the same time.

With regard to the aforementioned considerations, a post-damage guarantee shall be favoured in relation to the European Geothermal Risk Mitigation Fund

c) THE LONG-TERM RISK

With regard to the long-term risk, the insurance shall aim at covering the remaining depreciable value of the wells and the geothermal loop as well as the loss of geothermal resource (see *infra* 'eligible costs and coverage ratio').
The coverage of the "long term" risk should take into account some specific elements. Natural depletion is a standard technical risk that operators can deal with proper reservoir management. Offering the option to have insurance coverage for the "long term" risk should not set up a classic moral hazard situation where "unsustainable reservoir management" is an unintended consequence.
As previously explained, the EGRIF shall provide a post-damage guarantee for the long-term risk considering the accounting advantages of this option compared to the guaranteed loan.

Guideline

The European Geothermal Risk Insurance Fund shall provide a repayable advance in relation to exploration and a post-damage guarantee where the short-term risk and/or the long-term risk materialize.
In particular, these mechanisms shall apply, whether geothermal heat or electricity is generated conventionally or through EGS.

3. GOVERNANCE

The existence of an insurance Fund on the European stage calls the establishment of some governance. Basically, the governance implies some administration to handle the insurance process and requires some decision-making as well as some expertise.

The most significant point in relation to governance is the level at which this governance shall be settled.

a) CENTRALISATION

The European Geothermal Risk Insurance Fund could be managed in various ways.
There could be:

- An exclusive management by an EU institution;
- An exclusive management by a national institution;
- A shared management between an EU institution and a national institution;

An exclusive management by an EU institution implies that all applications for the benefit of insurance and insurance claims be submitted to a unique institution operating on the EU level in a one-stop-shop process. In theory, such governance could exist.
An exclusive management by a national institution implies that on each national stage, a specific institution deals with applications and insurance claims. This option seems inadequate since:

- It would require specific technical, financial and legal expertise for geothermal electricity projects. Yet, some countries may not benefit from this expertise;
- The board shall include some representatives of each shareholder. Having an exclusive governance on each national stage would require these representatives to take part in each national governance, which may prove quite complex;

A shared management would imply some functions to be entrusted to national institutions and others to an EU institution. However, it seems undesirable to have the decision-making and the expertise split out between two different levels as this would presumably lead to a burdensome process. Nevertheless, there could be a secretariat on the national stage while the decision-making and the expertise would be dealt with on the EU stage.

Another governance pattern should be discussed regarding the possible existence of a national insurance system dealing with the resource risk for geothermal. Where a national insurance exist, this could lead to a shared coverage. Such a shared coverage would necessarily imply some kind of cooperation between the national Fund/insurance company and the EU institution.
In this respect, the national insurance company or the national insurance Fund shall address the EU or national institution in charge of the secretariat. The completed applications and insurance claims could then be examined by the national insurer and the EU institution either jointly or separately.

A joint examination, as opposed to a separate examination, would require:
- A one-stop-shop process;
- A unique application;
- A unique insurance claim;
- A unique expertise;
- A unique decision relating to the grant/the release of the insurance and the respective coverage ratio provided;

Presumably, a joint examination would therefore ensure a more efficient insurance process than a separate one.

Guideline

The secretariat shall take place on the national stage or the EU stage. Applications and insurance claims as well as any relevant document shall be submitted to the secretariat in English.
The board and the expertise shall be settled on the EU level to avoid any shortage of expertise and any governance issue.
Where a national insurance exists, cooperation shall be favoured. In this respect, the national insurance company/Fund shall address the EU governance. A joint examination shall be favoured involving a unique expertise on the EU level and a common final decision by the EU board. In this regard, a representative of the national insurance system shall be part of the EU board when final decision is made. An agreement between the EU governance and the national insurer shall be found on the provision of a shared coverage. The respective coverage ratio and all relevant criteria shall be set contractually.

b) ENTITIES

- **The secretariat**

The secretariat, whether on the national or the EU stage, shall be in charge of receiving applications and insurance claims, as well as any relevant document. Any information submitted to the secretariat shall be in English (applications, claims, reporting documents).
The secretariat shall acknowledge receipt of applications or insurance claims. If these are incomplete, the secretariat may require additional information. If the secretariat remains silent for two months, the application or insurance claim shall be considered as complete.

- **The board and the rapporteur**

The board shall be in charge of decision-making ie it shall ultimately decide whether the insurance should be granted and released, according to sound expertise. In this regard, the board shall also be in charge of appointing technical, financial and legal independent experts having sound knowledge of geothermal.

The board shall include 9 members being:

- Representatives of EGRIF shareholders;
- Geothermal professionals;
- Experts;
- In case of a national insurance being available and a shared coverage being considered, a representative of the national insurance system shall take part in the decision-making process;

Shareholders shall agree on the appointment of their representatives. They shall also agree on the appointment of representatives of the geothermal sector and experts. Members of the board shall be appointed for a renewable three-year term. They shall avoid any conflict of interests.
Members of the board shall elect an Executive Chairman for a renewable three-year term. He shall have a casting vote. He shall act in any circumstances on behalf of the board. He shall organize the board's work in coordination with the secretariat. In particular, he shall ensure that members of the board may carry out their functions and deal with suspicion of any conflict of interest. He may be dismissed *ad nutum* following a majority vote of the board.
An attendance quorum of 5 members shall be respected for decisions to be taken by the board. The Executive Chairman shall mandatorily be part of the attendance quorum.
The board shall decide by means of reasoned decisions that may not be appealable.

Each submitted application shall be entrusted to a member of the board. Each member of the board shall thus be a rapporteur for a number of projects. The rapporteur shall supervise the projects entrusted to him from beginning to end and report to the board.

- **The expertise**

The board shall rely on expertise regarding the submitted applications and claims. Experts shall be independent both from members of the board and from developers whose application or claim is being assessed. These experts shall be familiar with the geothermal field and have some proven technical, financial or legal skills.

4. CAPITAL AND FINANCIAL STRUCTURE

The European Geothermal Risk Insurance Fund shall rely on a strong capital and financial structure. This underlying principle raises the matter of reinsurance as well as the likelihood of a balancing of the Fund.

a) THE SEED CAPITAL

The seed capital shall have as many diversified sources as possible. Indeed, the more diversified the seed capital is, the more reliable the insurance system will be. The minimum seed capital shall be of 50 Mio – 100 Mio €.

The seed capital shall stem from all possible sources such as:

- The European Union;
- The Member States;
- The regional level authorities of the Member States;

- Insurance companies and brokers;
- Private and public financial institutions;
- Other reliable stakeholders;

In any circumstances, the distribution of the seed capital shall be made public and transparent.

b) OPERATING INCOMES

Among all possible incomes for an insurance system, the following shall be considered as suitable. They could apply cumulatively or not.

Fees

Insurance fees shall be charged in relation to each application made to the Fund (for the repayable advance, for the short-term guarantee and for the long-term guarantee).

In relation to each phase of the project, fees shall be charged according to the following ranges of values. These ranges of values are based on the existing insurance concepts for the resource risk in Europe:

- The exploration phase: a 6% to 8% interest rate could be charged as for the repayable advance;
- The short-term guarantee: a premium amounting to 3.5% to 5% of the eligible costs could be charged;
- The long-term guarantee: a fixed fee of 12 000€ to 13000€ per year could be charged;

These insurance fees might be modulated according the estimated resource risk. They shall be set in the reference contract signed between the developer and the governance.

Proceeds of investments made with the EGRIF treasury:

The governance of EGRIF shall be allowed to make investments with the treasury and use the proceeds of these investments as an income.

c) THE FUND BALANCE

Aforementioned incomes may not be sufficient to allow the balancing of the Fund. In addition, when relying on these incomes, the balancing would mainly depend on the success of insured geothermal projects.

In this context, the European Geothermal Risk Insurance Fund shall be able to exhaust and be replenished with available public and private funding. This would give the EGRIF more flexibility from an accountancy point of view.

d) REINSURANCE

Considering the financial stakes the EGRIF may face and the flexibility needed to insure as many reliable geothermal projects as possible, some reinsurance shall be applied to in order to provide the European Geothermal Risk Insurance Fund with some financial relief. This shall be achieved contractually between the EGRIF and a reinsurer.

5. BENEFICIARIES

The European Geothermal Risk Insurance Fund shall be made available to private and public organizations developing geothermal electricity projects on the EU territory.

6. ELIGIBLE COSTS AND COVERAGE RATIO

The European Geothermal Risk Insurance Fund shall be concerned with the exploration phase, the short-term risk and the long-term risk. In relation to each of these phases, the EGRIF shall cover some of the costs borne by the developer, where these are deemed eligible, and up to a certain level set contractually.

a) THE EXPLORATION PHASE

The costs considered as eligible regarding the exploration phase shall be the costs of the exploration well. These shall include in particular, but not exclusively, the costs relating to:

- Installing and breaking down the rig;
- The drilling itself;
- Tubing;
- The cleaning;
- Well testing and improvements;
- Drilling management;

Specific case of EGS: where EGS is considered, exploration may involve specific costs in relation to the reservoir development concept. These costs shall be eligible for coverage.

Eligible costs shall be specified in the reference insurance contract eventually signed between the developer and the EGRIF.

Regarding the exploration phase, a financial support taking the form of a repayable advance shall be provided to the applicant.

Depending on the risk assessed by the independent experts and the amount of the eligible costs, a certain amount would be released to cover the aforementioned costs. This amount shall be set contractually on a case-to-case basis. If the developer benefits from national subsidies with respect to the exploration drilling, these shall be removed from the amount of the repayable advance.

As the success and failure criteria cannot be determined exactly in the exploration phase, the advance shall be repaid when production begins. The reference contract shall specify the starting point and deadlines for reimbursement.

As for reimbursement, the amount to be repaid shall be enhanced. An interest rate as well as a discharge factor shall be set contractually.

b) THE SHORT-TERM RISK

The costs deemed eligible with regard to the short-term risk may differ depending on the kind of technology considered for geothermal electricity production:

Heat and electricity production using conventional technologies

The costs deemed eligible shall be the costs of the first production/injection drilling. These shall include in particular, but not exclusively:

- Installing and breaking down the rig;
- The drilling itself;

- Tubing;
- The cleaning;
- Well testing;
- Drilling management;

Electricity production using EGS

In addition to the aforementioned eligible expenses, where geothermal electricity is generated using non-conventional technologies, eligible costs shall also include in particular, but not exclusively:

- The reservoir development (e.g. seismic sensors and modelling);
- The reservoir stimulation (e.g. hydraulic pumps, pumping costs, chemicals, seismic monitoring);

Eligible costs shall be specified in the reference contract signed between the developer and the EGRIF. Subsidised costs shall be excluded from the eligible expenses. Lists of expenses considered as eligible for insurance coverage in France and Germany can be found in Appendix IV.

The insurance provided in relation to the short-term risk shall work through a revolving mechanism: the first drilling shall be insured. When successful, the insurance provided may be reused to cover a following drilling. The insurance may be successively reused in this way to cover several drillings until one fails and the insurance be released.

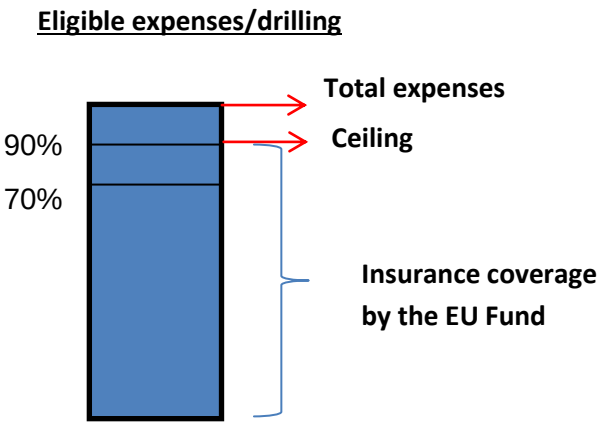
As for the coverage ratio in relation to the short-term risk, two options may apply:

1st option

The eligible expenses may be covered up to 70-90%. A ceiling shall apply for each drilling. In this respect, the costs insured shall be established on a case-to-case basis.

The rate eventually applied shall depend on the drilling being partially successful or unsuccessful. The rate shall also depend on the possible energy recovery, where for instance heat can be generated instead of electricity (see *infra* 'eligibility criteria').

In any way, the coverage rate shall be set contractually with respect to the above mentioned range of values. A franchise amounting to 100 000€ - 150 000€ shall be borne by the developers.



This option has pros and cons:

+ It provides a homogeneous rate for all EU developers;

+ It provides a generous rate encouraging the development of geothermal electricity generation;

-The generous rate provided may lead to competition with existing national insurances;

2nd option

The eligible expenses are differently covered depending on whether a national insurance coverage exists.

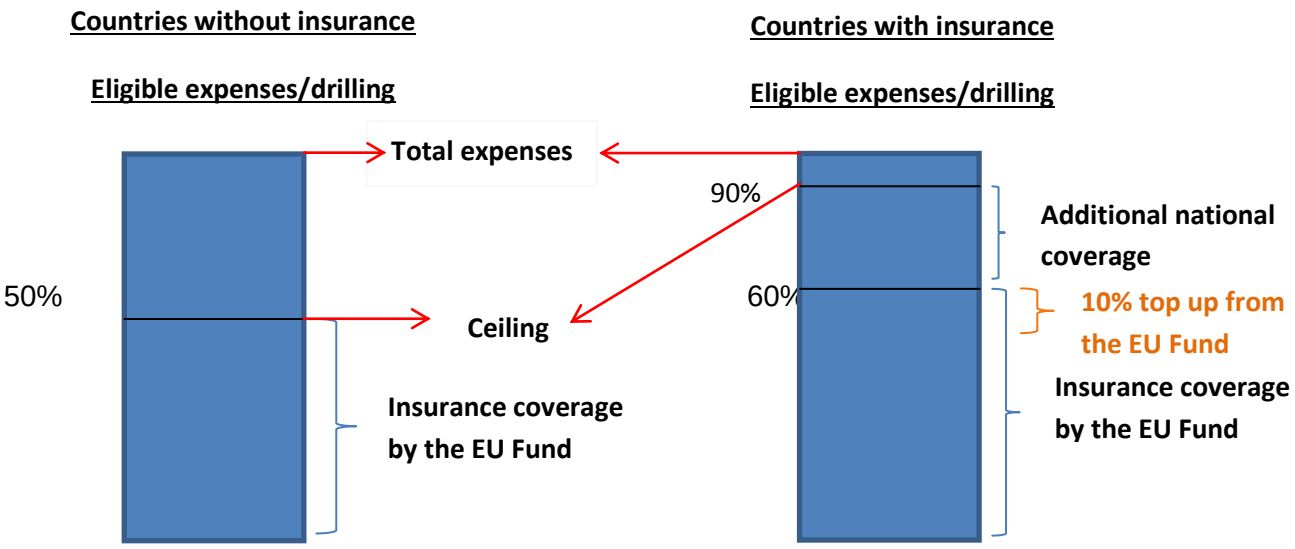
Where no insurance exists, eligible expenses would be covered up to 50%.

Where insurance for the resource risk exists, the EGRIF would provide an additional 10% coverage. The national insurance could then provide coverage up to 30% of eligible expenses, the overall coverage not exceeding 90% of these expenses.

A ceiling shall apply. In this respect, the costs insured shall be established on a case-to-case basis.

Here again, the rate eventually applied shall depend on the drilling being partially successful or unsuccessful and on the possible energy recovery (see *infra* 'eligibility criteria').

The coverage rate shall be set contractually with respect to the aforementioned range of values. A franchise amounting to 100 000€ - 150 000€ shall be borne by the developers



This option has pros and cons:

- Both rates (50% for countries without insurance and 60% for countries with insurance) are sufficient to encourage geothermal electricity development without competing existing insurances;
- The additional coverage offered by EGRIF acts as a lever for the development of national insurances;

-This option leads to a differentiated treatment and potentially favours countries where insurance is already available;

c) THE LONG-TERM RISK

The costs deemed eligible in relation to the long-term risk shall be:

- The remaining depreciable value of the well(s) and the geothermal loop(s);
- The stimulation measures;
- The loss of the geothermal resource, as a percentage of the enthalpy multiplied by the flow rate;

These eligible costs shall be clearly specified in the reference contract. If national subsidies are available on the national stage in relation to the perennity of the geothermal resource they shall be removed from the eligible expenses.

The coverage rate for the long-term risk shall depend on the results of the previous drilling(s) ie whether the drilling(s) was (were) completely or partially successful. The rate shall also depend on the possible energy recovery in spite of the resource depletion (see *infra* 'eligibility criteria'). It shall be set contractually.

Where a national insurance exists, a shared coverage shall be made available from the EGRIF. The national insurer shall address the EGRIF in this respect and the respective coverage rates shall be set on a contractual basis.

The long-term risk guarantee shall be provided for a period of 10 to 20 years, as set contractually between the developer and the Fund on a case-to-case basis.

A franchise amounting to 100 000€ - 150 000€ shall be borne by the developer.

7. ELIGIBILITY CRITERIA

Eligibility criteria shall enable the experts to assess applications and claims in relation to each insured phase of a geothermal electricity project. Eligibility criteria with respect to both applications and insurance claims are considered.

a) ELIGIBILITY CRITERIA FOR APPLICATIONS MADE TO THE EGRIF

Applications made to the EGRIF may vary depending on the coverage sought (repayable advance, short-term guarantee or long-term guarantee). Regardless of the phase concerned with the application, some requirements shall be common to each application.

Criteria common to all applications

- **The obligation to disclose the data collected**

Any developer willing to benefit from the guarantees provided by the European Geothermal Risk Insurance Fund shall engage to disclose to the EGRIF all data collected during his geothermal project.

This data shall be in particular, but not exclusively:

- The temperature;
- The depth and thickness of the reservoir;
- The flow;
- The geology;
- The porosity;
- The permeability;
- The geochemical analysis of the fluid;
- The seismicity measurements;

The reference contract shall determine the data to be disclosed as well as the term when this data shall be made public. It shall also provide that any breach of the disclosure obligation shall lead either to the termination of the insurance contract or the review of the insurance, in particular of the coverage rate.

The data shall be submitted by means of a unique and exhaustive report, with respect to the terms of the reference contract.

The data collected shall be used in the establishment of a Public Geothermal European Database.

- **The obligation to comply with schedules**

The developer benefiting from at least one guarantee under the EGRIF shall engage to comply with schedules. In other words, the reference contract shall specify the time limit for the exploration and drilling to be undertaken and achieved. In particular, the reference contract shall specify the starting point of the schedule as well as any possible extension of the term. This shall apply even where exploration/drilling/exploitation is successful.

These schedules and their relating considerations shall be set contractually depending on the specificities of each geothermal electricity project.

- **Reporting obligations**

Developers benefiting from one of the guarantee under the EGRIF shall abide by reporting obligations. Concretely, the developer shall inform the rapporteur appointed by the board to supervise his project about the project's execution, whether the insurance is granted for the exploration phase, the drilling phase or the production phase.

The reference contract shall specify the information to be submitted under the reporting obligation and the frequency of the reporting obligations. The rapporteur shall be allowed to require any information at any time.

- **Public and confidential information within the application procedure**

Among the information submitted to the European Geothermal Risk Insurance Fund, the reference contract shall set the one which shall eventually be made public and when it shall become public.

Besides, where the applicant desires to keep some information secret (e.g.: use of a specific industrial process) he shall submit this information under separate cover. The reference contract shall determine whether this information shall eventually be made public.

In this respect, the board and experts appointed by the board shall comply with confidentiality duties and shall not disclose any information until it is made public.

Criteria to benefit from the repayable advance

In order to apply for the repayable advance, the developer shall submit the following information to the secretariat:

- A detailed presentation (identity, legal form, information on contractors and key personnel);
- The location of the exploration site;
- Detailed surface studies and any relevant document or piece of information proving the probable existence of a commercially viable geothermal resource;
- A detailed program of exploration work;
- Available financing and proof of financial capacity to achieve the whole exploration program;
- Legal permits and licences;

Specific case of EGS: where EGS are considered, the developer shall in addition submit:

- The reservoir development concept;
- Seismicity studies;
- Stimulation modelling ie expected impact of chemical, hydraulic or thermal stimulations;

Criteria to benefit from the short-term risk guarantee

A developer shall be entitled to apply for the short-term guarantee whether he has benefited from the repayable advance or not.

In order to apply for the short-term guarantee, the developer shall submit the following information to the secretariat:

- A detailed presentation (identity, legal form, information on contractors and key personnel);
- Whether he has benefited from the repayable advance;
- The location of the drilling site;
- A prefeasibility study as a result of exploration, which proves the likelihood of electricity production for the considered geothermal project;
- A feasibility study, which should particularly insist on the expected flow rate and temperature;

- A detailed program of wells and tests;
- The power plant use concept (electricity generation/CHP) and the intended use of the energy. In particular, the developer shall submit a curve displaying the possible recovery of the energy (heat generation/CHP) according to the achieved flow rate and temperature;
- Seismic investigations and their analysis;
- Legal permits and licences required for exploitation and proof of compliance with legal requirements (e.g. environmental impact assessment, public information);

Where EGS are considered, the developer shall in addition submit:

- The degree to which the project involves technical innovation;
- The reservoir development program;
- The planned stimulation measures;
- The planned seismic monitoring;

Criteria to benefit from the long-term risk guarantee

A developer shall be entitled to apply for the long-term risk guarantee if he has benefited from the short-term guarantee only or if he may provide all relevant results of the drilling phase to the board.

Where the developer has not previously benefited from the short-term guarantee, the board shall decide whether the developer may apply for the long-term guarantee on a case-to-case basis.

In order to apply for the long-term guarantee, the developer shall submit the following information to the secretariat:

- A detailed presentation (identity, legal form, information on contractors and key personnel);
- Whether he has benefited from the short-term risk guarantee;
- The location of the geothermal site;
- The results of the drilling phase, in particular the achieved flow rate and temperature;
- The financial plan of the operational phase (e.g. return on investment, financing of the project, initial value of the well(s) and loop(s));
- The power plant use concept, the intended use of the energy in case of the resource depleting and a curve displaying the possible recovery of the energy according to the flow rate and temperature;
- Legal permits and licences required for exploitation and proof of compliance with legal requirements;
- The operations and maintenance program, including the frequency and method of control as well as the controlled parameters;

b) ELIGIBILITY CRITERIA FOR INSURANCE CLAIMS SUBMITTED TO THE EGRIF

Regardless of the phase concerned with the insurance claim, some requirements shall be common to each claim.

- **The obligation to engage stimulations measures before submitting the insurance claim**

Whether the project generates geothermal electricity using conventional technologies or EGS, the developer shall only be allowed to file an insurance claim where he has undertaken all relevant stimulation measures either to find a viable resource or to avoid its depletion.

Stimulation measures to undertake shall be determined by the board and supervise by the rapporteur.

- **Public and confidential information within the claim procedure**

The reference contract shall determine which of the information disclosed by the developer in its insurance claim shall eventually be made public and when this shall be made public.

In this respect, the board and experts appointed by the board shall comply with confidentiality duties and shall not disclose any information until it is made public.

8. INSURANCE PROCESS

Criteria for the guarantees to be released

It shall ultimately be up to the board to decide whether the short-term guarantee or the long-term guarantee has to be released. The decision shall be based on sound expertise. Criteria taken into account by the independent experts in determining whether the insurance has to be released shall be those set in the reference contract.

In relation to the short-term guarantee, the developer shall in particular, but not exclusively, submit the following information in his insurance claim:

- The achieved flow and temperature;
- The possible recovery of the energy in accordance with the curve provided in his application;

  In relation to the long-term guarantee, the developer shall in particular, but not exclusively, submit the following information in his insurance claim:
- The remaining depreciable value of the well(s) and loop(s) and supporting financial documents;
- The proof that the electricity/heat generation decreases;
- The proof that the geothermal resource depletes (flow rate and/or temperature) and the proof of the natural origin of this depletion;
- The proof of the causal relationship between the resource depletion and the decrease in the electricity/heat generation;

Each application and claim shall be duly assessed by experts and the board against eligibility criteria. In this respect, the insurance process shall take place as follows.

a) EXAMINATION OF APPLICATION

Applications could take place on a tendering basis or be submitted to the governance continuously. Considering that tenders may ease the insurance process by examining all completed applications at once, regular tenders (e.g. 3 to 4 times a year) shall be favoured.

Once the call for tender is launched, the secretariat shall acknowledge the receipt of applications. It shall then ensure that applications are complete. If not, it may require applicants to provide additional information. If the secretariat remains silent for two months, the application shall be considered as complete. Applications which are not complete at the time of the tender shall be resubmitted when a following tender takes place.

The secretariat submits all completed applications to the board. The board then appoints a rapporteur for each application. In relation to applications for the long-term guarantee, when the developer has not previously benefited from the short-term guarantee, the board shall also immediately decide whether the developer may apply for the long-term guarantee.

Independent experts are appointed to assess the technical, legal and financial viability of the geothermal electricity project. These experts shall be independent from members of the board as well as from developers whose application they are assessing. As soon as they are appointed, applications are submitted to them.

Independent experts shall submit their opinion to the rapporteur within three months from the date of their appointment. They shall be able to require any additional information from the rapporteur, any adequate interview with the developer and any visit of the geothermal site. Their opinion shall have a binding effect and experts shall be able to provide binding recommendations to be complied with by the developer when drilling or plant operation begins. In particular, the experts shall provide the board with recommendations as to the success and failure criteria as well as the curve displaying the possible recovery of energy as proposed by the developer.

From the date experts provide their opinion to the board, the board shall have two months to provide the applicant with a reasoned decision as to whether the repayable advance/the guarantee is granted. This decision of the board shall not be appealable.

The reference contract relating to the repayable advance, the short-term guarantee or the long-term guarantee shall be signed within two months from the date the board has provided the applicant with its reasoned decision.

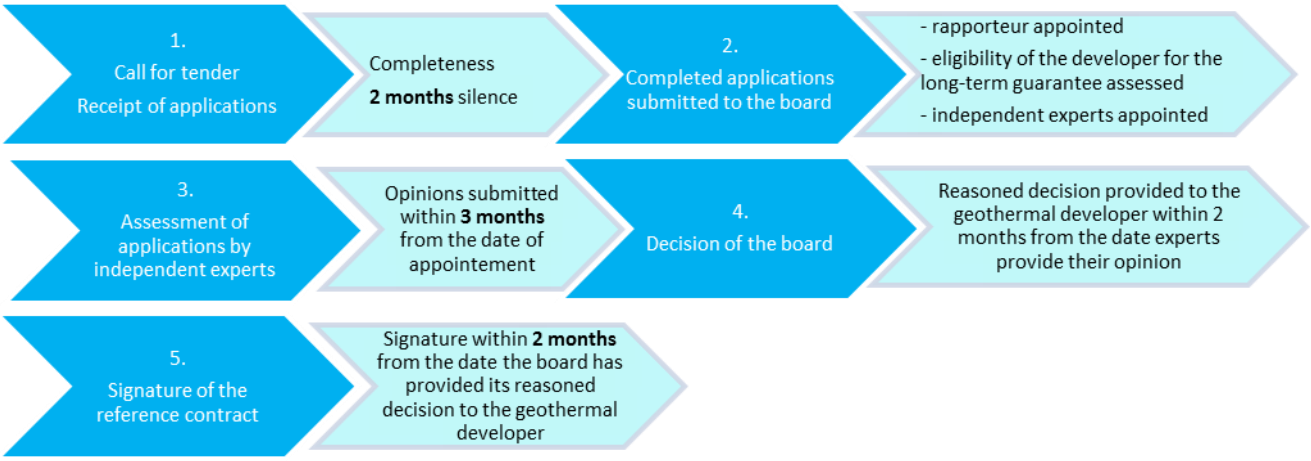


Figure 8 – Tendering procedure for examination of applications submitted to the EGRIF

Specific case of shared coverage

Where a national insurance is available, a shared coverage shall take place at the request of the national insurer. In this respect, a joint examination shall take place and a unique expertise shall be favoured. Experts from the European Geothermal Risk Insurance Fund shall assess the geothermal project. The national insurer shall then be part of the board when deciding to grant the guarantee and setting the respective coverage rate.

b) EXAMINATION OF INSURANCE CLAIMS

Where the short-term risk or the long-term risk realize, the developer shall file an insurance claim and submit it to the secretariat.

The secretariat shall acknowledge receipt of the claim. It may require additional information where the file is incomplete. If the secretariat remains silent for two months, the insurance claim shall be considered as complete. The secretariat forwards the claim to the board.

The board shall then require experts to provide an opinion on the release of the insurance.

Experts shall do so within three months from the date they have been provided with the insurance claim. In relation to both the short-term and the long-term guarantees, they shall assess the claim against eligibility criteria set in the reference contract (e.g. achieved flow and temperature compared to expected ones, the possible recovery of the energy). In addition, where the long-term guarantee is asked for, experts shall assess the claim in accordance with the proof provided by the developer in its insurance claim (see *supra* 'eligibility criteria for the long-term guarantee to be released'). Their opinion is binding.
Within two months from the date experts submit their opinion to the board, the board shall provide a reasoned decision to the developer as to whether the insurance shall be released. The decision of the board shall specify the amount of the coverage released in accordance with the reference contract. The decision of the board may not be appealable.

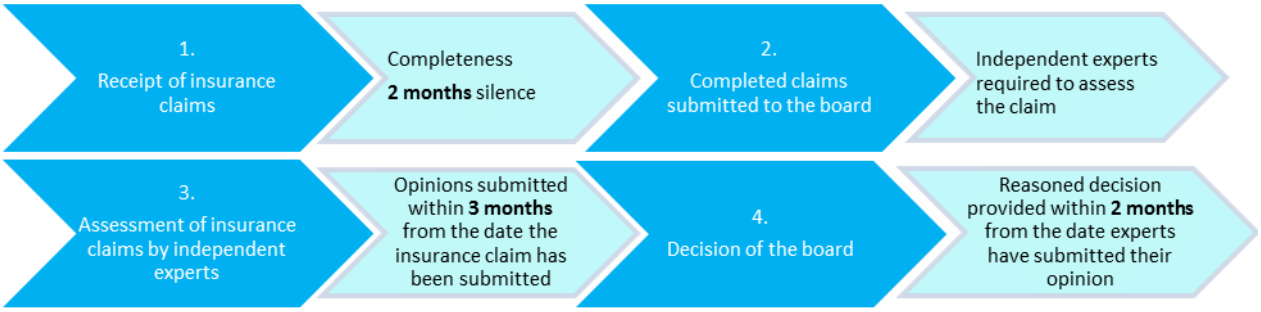


Figure 9 – Examination of insurance claims submitted to the EGRIF

Specific case of shared coverage

Where a shared coverage has been decided between a national insurer and the EGRIF, an insurance claim shall be submitted to the EGRIF. There shall be a joint examination of the claim and a unique expertise. On the basis of this expertise, the board shall decide to release or not the insurance according to sound expertise. In this respect, a representative of the national insurance system shall be part of the board.

9. LITIGATION

In case of dispute arising in relation to the insurance provided by the European Geothermal Risk Insurance Fund, amicable arrangements shall be favoured.

If the dispute cannot be settled on an amicable basis, it shall be brought before an Arbitral Tribunal.

The Arbitral Tribunal shall consist of three arbitrators appointed as follows:

- One arbitrator shall be appointed by the board;
- A second arbitrator shall be appointed by the developer;
- The third arbitrator shall be appointed by agreement of the developer and the board or, if they do not agree, by the President of the European Court of Justice or the President of the European Commission;

10. CONCLUSION

The proposals for the establishment of the European Geothermal Risk Insurance Fund put forward in this second part are consistent.

One scenario among others may be favoured at a given time. However, EGRIF shall be conceived as an evolutionary process whose ultimate purpose is to act as an insurance vector for the coverage of the resource risk encountered in geothermal electricity projects.

REFERENCES

- Handbook on planning and financing geothermal power generation, Energy Sector Management Assistance Programme, The Investment Bank for Reconstruction, April 2012
- European Insurance Scheme to cover Geological Risk related to Geothermal Operations, Final Report, June 1997, report coordinated by the BRGM for the European Commission
- Emerging financing scheme for fostering investment in the geothermal energy sector, GEOFAR project, 2011, report coordinated by Erlagen AG

BIBLIOGRAPHY

- Geothermal electricity and combined heat and power, European Geothermal Energy Council, 2009
- UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication
- Probability analysis and risk management for geothermal projects, Dr. T.Reif, GHC Bulletin, January 2008
- Probability concepts for the evaluation of the risk concerning temperature and the production and injection rate in hydrothermal reservoirs, H.Kreuter and C.Hecht, proceedings European Geothermal Congress 2007, Unterhaching, Germany, 30 May-1 June 2007
- Quantification of exploration risks for hydrogeothermal wells, R.Schulz et al., Proceedings European Geothermal Congress, >Unterhaching, Germany, 30 May-1 June 2007
- Resource risk and its mitigation for the financing of geothermal projects, S.K.Sanyal and J.B. Koenig, World Geothermal Congress, Florence, Italy, May 1995
- Geothermal market-based insurance schemes, H.Kreuter and C.Schrage, GeoFund-IGA Geothermal Workshop, Turkey, Istanbul, February 16-19, 2009
- Geothermal Energy Plant Unterhaching, Germany, B.Richter, Proceedings World Geothermal Congress, Indonesia, Bali, 25-29 April 2010
- Private and State Risk Mitigation Programs for Geothermal Exploration Risk, H.Kreuster and C.Schrage, GRC Transactions, Vol.33, 2009
- Managing the risk in renewable energy, A report from the Economist Intelligence Unit sponsored by Swiss Re, 2011

APPENDIX I

SNAPSHOT DESCRIPTION OF NATIONAL INSURANCE SYSTEMS IN EUROPE

Figure 2 gives an overview of the current state of the resource risk insurance in each country of the European Union, plus Iceland and Switzerland.

This appendix provides some details of the existing national insurances, as shown in figure 2. It also provides some references for each studied country. These references were used either as a reading support to understand the existing insurance mechanisms or as a means to determine the lack of insurance for the resource risk.

Country	France
Type of insurance	National Fund. Post-damage guarantee.
Governance	SAF-environnement. It is a subsidiary financing company of the Caisse des Dépôts et Consignations.
Capital and financial structure	The capital was initially filled by the Minister of Industry and later topped up by the ADEME (National Agency for Environnement and Energy Management). There are also shareholders from public and private financial institutions concerned with geothermal and more broadly with renewable energies. Fees are charged on the beneficiaries. As for the short-term guarantee, these fees amount to 3.5% to 5% of the insured costs. As for the long-term guarantee, a fixed fee of 13000€/year is charged. Incomes are also generated through proceeds of investments made with the treasury of the Fund.
Beneficiaries	The legal entity for which work is done and that holds the exploration and/or exploitation licenses, commonly known as the “maître d’ouvrage”. The insurance benefits national developers. These developers may be public, semi-public or private.
Insurance scope	Heat production. Deep wells.
Risks insured	The short-term risk (drilling). The long-term risk (exploitation).

Eligible costs	As for the short-term guarantee: The total cost of the first drilling. Subsidies are removed from eligible expenses. Eligible expenses include stimulation measures and tests. (*Details of eligible expenses for the short-term guarantee can be found in Appendix IV*). As for the long-term guarantee: The remaining depreciable value of the wells and the geothermal loop. Eligible expenses also include the flow and temperature of the geothermal fluid (as clearly specified in the reference contract).
Coverage ratio	As for the short-term guarantee: Compensation depends on the degree of success of the drilling ie on achieved flow and temperature regarding the expected IRR of the developer. Success, partial success or failure is determined according to a success/failure curve which shows, for each pair of flow-temperature values whether the drilling is successful, partially successful or unsuccessful. When drilling is successful no compensation is made. When drilling is partially successful, compensation is made so that the developer reaches profitability. When drilling is unsuccessful, total compensation is made. The Fund then covers 65% of the eligible costs. Some French Regions may provide an additional coverage of 25% leading to an overall ratio of 90% (e.g. Ile-de-France, Provence Alpes Côte d'Azur). A ceiling of 4 200 000€/drilling applies. As for the long-term guarantee: Where damage can be remedied, the Fund covers the repair costs and provides compensation for the plant's immobilization. Where damage cannot be remedied, compensation depends on the loss of thermal power. Where the thermal power remains between 50% and 75% of the reference thermal power, partial compensation is made in proportion to the loss suffered. Where the thermal power falls below 50% of the reference thermal power, full compensation is made. However a ceiling of 1 200 000€ applies. The long-term guarantee applies for 20 years from the date the reference contract has been signed. A franchise of 120 000€ applies.
Eligibility criteria	The developer shall submit to the Technical Committee: - A project description; - A technical, legal and financial feasibility study (including in particular the expected ROI, which shall be at least 8%, and a flow-

	temperature sensitivity curve); - A stimulation and test program; Within the long-term guarantee, the developer shall abide by rules of good technical practice.
Insurance process	A technical committee assesses applications and claims. Its members are representatives from several institutions (ADEME, private and public owners of geothermal plants, institutions specialized in renewable energy projects and SAF-environnement) as well as appointed experts.
Short additional comments	The Fund proved its efficiency for 30 years. It compensates the lack of private insurance and allows the development of geothermal heat through a one-off guarantee based on risk pooling. This pooling helps sharing out the risks over projects expected to be successful and innovative projects. In 2012, the French government set geothermal electricity production as one of its priority target and now considers a guarantee system for such production, which may espouse the guarantee known to geothermal heat production. French authorities are now considering the export of the national expertise acquired in the geothermal field abroad.

References

- The French geothermal risk guarantee system, Workshop on geological risk insurance Germany, World Bank Geothermal Energy Development Program (GEOFUND), 11-12 November 2008, S. Bézèlgues-Courtade, F. Jaudin;
- GEOFAR, The Geothermal Guarantee System, France Factsheet, 22 June 2009; http://www.energia.gr/geofar/articlefiles/factsheets/FranceFactsheet%20InsuranceMechanism.pdf
- Principes de fonctionnement et usages de la géothermie, Syndicat des Energies Renouvelables, Juin 2012 ;

  http://www.enr.fr/docs/2010104945_SERGothermie20100607LD.pdf

Country	Germany
Type of insurance	Private insurance policies. Post-damage guarantee.
Governance	Insurance companies acting as a direct insurer (Munich Re, Swiss Re, Axa, Goather, R&V) and as insurance brokers (Marsh, Willis).
Capital and financial structure	The insurance relies on premiums. Premiums are set on a case-to-case basis. In this respect, the higher the probability of success, the lower the premium.
Beneficiaries	Customers on the national stage and abroad (e.g. in Denmark and in the USA).
Insurance scope	Heat and electricity production. Deep wells. Hydrothermal projects only, as EGS are still considered as too risk-prone by the insurance private sector.
Risks insured	The short-term risk (drilling).
Eligible costs	Usually, all costs spent on drilling, stimulation and test program can be insured. The insurance policy may cover one or several drillings. (*Details of expenses deemed eligible by German insurance companies can be found in Appendix IV*).
Coverage ratio	Compensation depends on the degree of success of the drilling. A threshold value for either the reached thermal capacity or the reached pair of flow-temperature values defines the project's success or failure. This threshold value is set individually for each project and is based on economic considerations. A tested thermal capacity/flow-temperature below the threshold value results in the full payment of the insurance sum. Values above the threshold define a successful well. In individual cases, it is also possible to define a partial success in the transition zone where only a certain part of the insurance sum is paid out. According to the general concept of private insurance solutions, the insurance sum is negotiated between the beneficiary and the insurance company.
Eligibility criteria	The developer shall submit the insurance company: - A project description; - A technical, legal and financial feasibility study; - Seismic investigations including their interpretation; - A stimulation and hydraulic test program;

	- The power plant and heat use concept; - Information on contractors and key personnel; - An independent expert's report on the conclusiveness of all data; - An external report quantifying the probability of success to generate the requested flow rate and temperature (the POS-study): usually insurance companies only submit an offer where the probability of success exceeds 80%;
Insurance process	Contractual negotiations. By now, a number of insurance companies and brokers employ in-house experts for geothermal projects.
Short additional description	The first insurance policy was issued in 2003 for the Unterhaching project in the Molasse Basin. The policy came from the Munich Re Group. In recent years, other insurance companies offered several policies to geothermal projects. German insurance companies thus engaged in providing insurance for the resource risk, both in Germany and abroad. However, policies covering the resource risk in Germany are currently offered for projects located in two of the three main geothermal provinces in Germany (the Molasse Basin and the Upper Rhine Graben) and depend on the individual case.

References

- Private and State Mitigation Programs for Geothermal Exploration Risk, 2009, H.Kreuter, C.Schrage;
- Geothermal market based insurance schemes, GeoFund-IGA Geothermal Workshop Turkey, February 2009, H.Kreuter, C.Schrage;
- Best practice project Unterhaching, Germany – Risk management and concept of geological risk insurance, IGA News No. 68, April-June 2007, Ch. Schönwiesner-Bozkurt, K.Imolauer;
- Geothermieprojekte mit Fündigkeitsversicherung sind beliebte Anlage für Investoren, 6 Juli 2012;

  http://www.geothermie.de/news-anzeigen/2012/07/06/geothermieprojekte-mit-fundigkeitsversicherung-sind-beliebte-anlage-fur-investoren.html

Country	Germany
Type of insurance	National revolving Fund. Loan with an indemnification clause.
Governance	Kreditsansalt für Wiederbau (KfW) and Munich Re. The KfW-Bankengruppe is a bank owned by the German government and the federal states of Germany.
Capital and financial structure	The Fund was initially filled by the Bundesministerium für Umwelt (Federal Environment Ministry) with 60 M € through the Renewable Energy Incentive Program MAP. The application fee amounts to 65000€ covering the assessment of the documentation by Munich Re and KfW. A further 45000€ is charged for auditing and expert monitoring of the project progress. A high interest rate is charged until termination of the drilling work, stimulation measures and hydraulic tests, plus a specific disagio defined by the project risk.
Beneficiaries	National developers. These developers may be public (e.g. municipalities, local authorities), semi-public (e.g. private companies majority owned by municipalities) or private (e.g. small and medium-sized companies, non-commercial investors).
Insurance scope	Heat and electricity production. Wells deeper than 400 meters. Hydrothermal and possibly EGS projects.
Risks insured	The short-term risk (drilling).
Eligible costs	Drilling and stimulation costs with at least two drillings (one production drilling and one injection drilling).
Coverage ratio	Projects can apply for a loan up to 16 M€/ drilling (one doublet) covering a maximum of 80% of the eligible costs. The loan can be combined with a redemption grant for accrued stimulation costs (provided that a higher interest and a higher disagio are accepted).
Eligibility criteria	The developer shall submit the same project documentation as required by German insurance companies. However, no POS study is requested.
Insurance process	Applications are submitted by developers to their affiliated bank, called the 'Hausbank'. This bank conveys the application forms and guarantees the payback of the loan to KfW. The indemnity only applies until successful testing of the well. If the drilling

	is not successful (the thermal capacity is not reached), the loan is forgiven. If testing of the well is positive, the credit is continued without indemnity and at a reduced interest rate.
Short additional description	The Fund was launched in 2009. Since then, geothermal project developers in Germany can choose between two options of mitigation their resource risk: the federal risk mitigation scheme (Fündigkeitrisiko Tiefengeothermie) and private market-based insurance. The main advantage of the Fund is that it combines project financing via a credit and the mitigation of risk. However, some pitfalls have been identified, such as the difficulty in finding a Hausbank to convey the application form to KfW and the uncertainty of interest rate and disagio prior to loan promise.

References

- Geothermal Energy Plant Unterhaching, Proceedings World Geothermal Congress, 25-29 April 2010, B.Richter;
- Private and State Mitigation Programs for Geothermal Exploration Risk, 2009, H.Kreuter, C.Schrage;
- Geothermal market based insurance schemes, GeoFund-IGA Geothermal Workshop Turkey, February 2009, H.Kreuter, C.Schrage;
- Risk Mitigation in deep Geothermal Projects – Experience in Germany, Workshop on geological risk insurance Germany, World Bank Geothermal energy Development Program (GEOFUND), 11-12 November 2008, H.Kreuter;
- GEOFAR, Fündigkeitrisiko Tiefengeothermie, Germany Factsheet, 22 June 2009; http://www.energia.gr/geofar/articlefiles/factsheets/Germany%20-%20Factsheet%20Fundigkeitsrisiko%20Geothermie.pdf

Country	Iceland
Type of insurance	Loan converted into grant. The National Energy Fund.
Governance	ORKUSTOFNUN, the national energy authority.
Capital and financial structure	Capital is maintained with yearly State budget. A 6% interest rate on loans applies.
Beneficiaries	National private (e.g. firms or individuals) and public (e.g. municipalities) operators.
Insurance scope	Heat production, both for public supply (e.g. horticulture or similar economic activities) and heating of individual homes.
Risks insured	Exploration and short-term risk (drilling).
Eligible costs	Exploration and drilling costs.
Coverage ratio	The loan may cover up to 60% of eligible costs. The loans are offered for a period up to 10 years.
Eligibility criteria	The developer shall submit the National Energy Authority: - A project description; - A technical, legal and financial feasibility study, including in particular: ✓ recommendations of recognized geoscientists stating the estimated production capacity; ✓ a cost estimate for the planned hot water supply specifying the probable number of connected users and any causes to believe that some potential users will prefer no to connect to the hot water supply; ✓ feasibility calculations, based on the Fund's calculation model, where the estimated energy price from the proposed energy supplier is compared with the present energy price as well as other energy options; Loans can only be granted where geothermal heat production can help reducing the public cost of home heating.
Insurance process	The National Energy Authority provides its comments on the application. These comments are submitted to the National Energy Council, which decides on the granting of loans. However, loan documents will not be prepared nor registered, nor will loan payments begin, until the Minister provides confirmation of the loan.
Short	The National Energy Fund aims at developing the economic exploitation of

additional description	the country's energy resources. Beyond loans for geothermal exploration and drilling, it also offers grants for the exploitation of domestic energy resources. It is largely admitted that the success of geothermal development is owed to the insurance coverage provided by the National Energy Fund.

References

- Act on the National Energy Authority in Iceland No.87, 26 March 2003, as amended by Act No. 48, 27 March 2007, Act No. 167, 21 December 2007 and Act No. 70, 11 June 2008;
- Regulation on the National authority in Iceland, No.400/2009;
- GEOFAR, The National Energy Fund, Iceland Factsheet, 22 June 2009 http://www.energia.gr/geofar/articlefiles/factsheets/Iceland%20-%20Factsheet%20National%20Energy%20Fund%20Loan%20and%20Grant.pdf
- Geothermal development and research in Iceland, National energy Authority and Ministries of Industry and Research, April 2006;

  http://eng.idnadarraduneyti.is/media/Acrobat/Jardhitabaklingur.final.pdf

Country	The Netherlands
Type of insurance	Post-damage guarantee. National Fund.
Governance	Agentschap NL (Dutch National Agency for innovation, sustainability and international business & cooperation), Energy and Climate division.
Capital and financial structure	State budget of 43.35 M €. Premium of 7% of the maximum guaranteed amount is charged.
Beneficiaries	Public and private developers based in the Netherlands.
Insurance scope	Heat production. Two drillings (one production well and one injection well deeper than 500 meters).
Risks insured	Short-term risk (drilling).
Eligible costs	Drilling and test costs. Subsidized costs are not covered.
Coverage ratio	Up to 85% of eligible costs. A ceiling applies as follows: ✓ The power guaranteed < 7.08 MW, the ceiling is of 8.5 M € in the 2nd tender (7 M € in the 1st tender); ✓ The power guaranteed > 7.08 MW, the ceiling is of 7.2 M € in the 2nd tender (5.95 M € in the 1st tender); An additional coverage is possible, but the developer has to bear at least 5 % of the risk.
Eligibility criteria	The developer must provide a technical, legal and financial feasibility study. He must comply with schedules: the drilling must start within 6 months after guarantee approval, completed within 1 year after guarantee approval and lead to application of geothermal energy within 2 years. The developer has to abide by reporting and disclosure obligations.
Insurance process	Complete applications are evaluated in order of receipt. TNO has an advising role, both in the application phase and in the assessment of results. The guarantee scheme is operated through tenders. The first opening took place in 2009 and the second in 2010. A third tender is now being prepared.
Short additional description	The risk mitigation scheme was launched in 2009 through the regulation SEI Risico's dekken voor Aardwarmte. The scheme has been developed jointly by the Ministries of Economic Affairs and Agriculture together with NL Agency and TNO. After two tenders, the scheme is deemed to have helped projects get started

	by ensuring financing through a quick and non-profitable insurance process. The scheme is considered as a transparent and objective benchmark for the market and officials expect that more private insurances will enter the geothermal market and will take over from the scheme.

References

- Geothermal Energy and Guarantee Scheme in the Netherlands, Der Geothermiekongress, Bochum, 16 November 2011, P.Ramsak (NL Agentschap);

  http://geothermie.nl/fileadmin/user_upload/documents/bestanden/Congres/bochum/Presentatie_Bochum7def.pdf

Country	Switzerland
Type of insurance	Post-damage guarantee. The RPC Fund (the compensatory feed-in tariff Fund).
Governance	The National Society for Electricity Network (Swissgrid) and the Federal office for Energy (OFEN).
Capital and financial structure	The guarantee scheme is fed by the RPC Fund, through which CHF 150 million are made available. The Fund is fed by all electricity consumers who pays a tax on each consumed KWh.
Beneficiaries	National developers. - can be any project developer (see also the competition law), but the project has to be located in Switzerland
Insurance scope	Electricity production, including combined heat and power. The law does not specify the technology, hydrothermal or EGS.
Risks insured	The short-term risk (drilling).
Eligible costs	Drilling and testing costs. The law does not specify whether the coverage is concerned with one or several drillings but for now, the two insured projects (Saint-Gall and Lavey-les-Bains) both deal with one drilling. Include well pads, mob and demob, drilling of production, injection and observation wells, logs and well instrumentation, pump and circulation tests, stimulation costs, chemical analysis and wellsite geology. The two projects that have received the risk guarantee are centered around one well (Lavey-les-Bains/VD) and two wells (St Gall/SG) plus the trimmings.
Coverage ratio	Up to 50% of eligible costs, depending on the achieved flow and temperature.
Eligibility criteria	The developer shall submit Swissgrid: - A project description; - A technical, legal and financial feasibility study; All the documentation that a shareholder would want in the run-up to FID (final investment decision). This varies from case to case. It is usually ask for that – as a minimum.
Insurance process	Switzerland appoints a “god-parent”. A “supervisor” would have executive power over the project. This is not the case for the “god-parent” – s/he would ensure that the project plan is adhered to, that there is a due change management process if not and so on. The god-parent would be the primary person in the evaluation of failure/partial failure/success.

	Applications are submitted to Swissgrid. Swissgrid addresses the application to OFEN. OFEN appoints an expert panel for review and evaluation. The decision granting the guarantee also sets time schedules to be complied with, and which may be extended. In addition, Swissgrid appoints a project guide who evaluates the results and reports to the expert panel about success, partial success or failure. The panel in turn reports to Swissgrid who decides about payments.
Short additional description	Two projects have benefited from the scheme so far, the AGEPP project in Lavey-les-Bains and the Saint-Gall project. It seems that the insurance scheme would require complementary mechanisms such as adequate financing for exploration. Recently, local parliaments drew the Federal Council's attention on this particular point.

References

- The Swiss Federal Office of Energy's Path on the Road to utilizing Switzerland's Geothermal Resources – From Research & development to Pilot- and Demonstration projects, Swiss Bull. angew. Geol. Vol. 15/1, 2010 S. 79-93, G. Siddiqi, R.Minder;
- Legal and Regulatory Environment Favorable for Geothermal Development Investors, Proceedings World Geothermal Congress Indonesia, 25-29 April 2010, L.Rybach;
- The Energy Decree 730.01, 7 December 1998, as amended 1 October 2012;

REFERENCES FOR

COUNTRIES WITHOUT INSURANCE FOR THE RESOURCE RISK

In GEOELEC partner countries (see Appendix I), the lack of insurance for the resource risk has been certified by partners. This refers to **Belgium** (EGEC), **Greece** (CRES), **Italy** (CNR-IGG) and **Spain** (APPA).

With regard to other European countries where no insurance for the resource risk exists, the shortage of insurance has been deduced or ascertained on the basis of the following references.

- **Austria**
  - EGEC Final Evaluation of the NREAPs, Austria, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-FINAL-March-2011.pdf

- **Bulgaria**
  - Geothermal energy in Bulgaria

    http://www.geothermalbg.org/geothermal.html

- **Cyprus**
  - CYPRUS – Renewable Energy Factsheet, European Commission website

    http://ec.europa.eu/energy/energy_policy/doc/factsheets/renewables/renewables_cy_en.pdf
  - Investigation and determination of the geothermal parameters of the ground in Cyprus for the exploitation of geothermal energy and the impact of the results in the design of the geothermal systems, Proceedings from the 36th Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, 31 January - 2 February 2011, G. Partasides

    http://www.geothermal-energy.org/pdf/IGAstandard/SGW/2011/partasides.pdf

- **Czech Republic**

  - EGEC Final Evaluation of the NREAPs, Czech Republic, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-FINAL-March-2011.pdf

- **Denmark**

  - Oil and gas production in Denmark 2011, Danish Energy Agency

    http://www.ens.dk/Documents/Netboghandel%20-%20publikationer/2012/Oil_and_gas_production_in_Denmark_2011%20(2).pdf

  - International Geothermal Association website, Danish Factsheet,

    http://www.geothermal-energy.org/155,welcome_to_our_page_with_data_for_denmark.html

- **Estonia**

  - Policy Database Details for Estonia, 2012, Renewable Energy and Energy Efficiency Partnership (REEEP) website

    http://www.reeep.org/index.php?id=9353&special=viewitem&cid=3

- **Finland**

  - International Geothermal Association website, Finnish Factsheet,

    http://www.geothermal-energy.org/156,welcome_to_our_page_with_data_for_finland.html

- **Hungary**

  - EGEC Final Evaluation of the NREAPs, Hungary, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

- **Ireland**

  - EGEC Final Evaluation of the NREAPs, Ireland, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

- **Latvia**

  - International Geothermal Association website, Latvia Factsheet,

    http://www.geothermal-energy.org/165,welcome_to_our_page_with_data_for_latvia.html

  - EGEC Final Evaluation of the NREAPs, Latvia, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

- **Lithuania**

  - EGEC Final Evaluation of the NREAPs, Lithuania, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

  - Lithuania – Geothermal Energy Country Update, Proceedings World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010, F.Zinevičius, S.Šliaupa

    http://geotermijosasociacija.lt/dokumentai/031_Geotermin%C4%97%20energetika%20Lietuvoje.pdf

- **Luxembourg**

  - International Geothermal Association website, Luxembourg Factsheet,

    http://www.geothermal-energy.org/168,welcome_to_our_page_with_data_for_luxembourg.html

- **Malta**

  - EGEC Final Evaluation of the NREAPs, Malta, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

- **Poland**

  - EGEC Final Evaluation of the NREAPs, Poland, March 2011

    http://egec.info/wp-content/uploads/2011/03/NREAP-Evaluation-August-2011.pdf

- **Portugal**

  - Portugal Country Geothermal Update 2010, Proceedings World Geothermal Congress 2010 Bali, Indonesia, April 2010, R.Cabeças

    http://www.isep.ipp.pt/assets/userfiles/file/Portugal%20Country%20Geothermal%20Update%202010.pdf

- **Romania**

  - Geothermal Energy in Romania, International Trade Fair Energy 2011, Hannover, 4-8 April 2011, Marcel G. Roşca

    http://www.dena.de/fileadmin/user_upload/Veranstaltungen/2011/Vortraege_BEE_EE/05.04._15.30_Presentation_Rosca_Geothermal_in_Romania.pdf

- **Slovakia**

  - Geothermal energy in Slovakia, Intensive program “Renewable Energy Sources”, May 2011, S. Kušnír

    http://home.zcu.cz/~tesarova/IP/Proceedings/Proc_2011/Files/Kusnir.pdf

- **Slovenia**

  - International Geothermal Association website, Slovenia Factsheet,

    http://www.geothermal-energy.org/180,welcome_to_our_page_with_data_for_slovenia.html

- **Sweden**

  - International Geothermal Association website, Swedish Factsheet,

    http://www.geothermal-energy.org/182,welcome_to_our_page_with_data_for_sweden.html

- **United Kingdom**

  - Deep geothermal resource has potential to produce up to 20% of UK electricity and heat for millions, UK Renewable Energy Association News, 30 May 2012

    http://www.r-e-a.net/news/deep-geothermal-resource-has-potential-to-produce-up-to-20-of-uk-electricity-and-heat-for-millions

  - Deep Geothermal Challenge Fund: outcome from first round, UK National Archives website

    http://webarchive.nationalarchives.gov.uk/20110508074721/http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/explained/geothermal/challenge_fund/dgcf_round1/dgcf_round1.aspx

  - Deep Geothermal Challenge Fund, UK department of Energy and Climate Change website

    http://www.decc.gov.uk/en/content/cms/meeting_energy/geothermal/dgcf/dgcf.aspx

  - Energy – A strategic framework for Northern Ireland, the Department of Enterprise, Trade and Investment

    http://www.detini.gov.uk/strategic_energy_framework__sef_2010_-3.pdf

APPENDIX II

SNAPSHOT DESCRIPTION OF

NATIONAL RISK MITIGATION MECHANISMS

OUTSIDE EUROPE

This appendix gives an overview of the current state of the resource risk mitigation mechanisms in geothermal electricity pioneer countries outside Europe. It also provides some details of two regional programs dealing with geothermal projects.

The African Rift Geothermal Facility (ARGeo)

The ARGeo program was endorsed by GEF (Global Environment Facility) in September 2009 at the World Bank's and UNEP's request. However, the World Bank withdrew in December 2011. This led to a program overhaul. The centerpiece of the ARGeo program is the Geothermal Risk Mitigation Facility (GRMF). ARGeo is also concerned with regional networking, technical assistance and a technical assistance facility for post drilling activities.

Following the World Bank's withdrawal, the management was entrusted to the African Union Commission and KfW Entwicklungsbank jointly. The program covers both heat and electricity production. Countries involved are Rwanda, Ethiopia, Kenya, Uganda and Tanzania. The GRMF provides direct and contingent grants covering 40% of exploratory and appraisal drilling cost (the scheme also covers 80% of surface exploration costs and preparatory studies and 20% of costs for infrastructure). The Facility was fed by public funds (20 M€ from the German Federal Ministry for Economic Cooperation and Development and 30 M€ from EU-ITF). It is also fed through a grant premium for successful wells amounting to 30% of the drilling costs if developers ensure financing of subsequent development steps within a certain period of time.

All legal entities (public, private and PPP) may apply for a grant. Grants are provided through a

competitive two-stage application process. The 1st stage is an open prequalification process inviting all potential applicants to submit their expressions of interest. Shortlisted developers are then invited to participate in the application round. In the 2nd stage, applications are accepted by a specified closing date each year.

Applications have to include work plans for surface studies and for exploration drillings. Consulting services from GRMF's consultants are required to provide advice regarding the exploration drilling programs. The consultant plays a very active role by carrying out himself all necessary steps for a successful operation in cooperation with GMRF and under the supervision of an Oversight Committee. The consultant team comprises international and/or local long-term professionals with expertise and experience in geothermal projects and tender procedures. All applications that score over certain threshold are eligible for support through the Facility, according to availability of funding. Applications that receive the highest score receive funding first.

Following the withdrawal of the World Bank, the whole program was revised. From a post-damage guarantee it shifted to a grant mechanism. The governance was transferred to the local level and is now fed with foreign funds and equity. This reshuffle allowed the system to remain.

References

- The African Rift Geothermal Facility (ARGeo) Status, 19 November 2010, M. Njoroge Mwangi;
- Global Environment Facility website; http://www.thegef.org/gef/project_detail?projID=2119

The Geothermal Energy Development Program (GeoFund)

The GEF Council approved the GeoFund program in May 2003. It is a multi-country umbrella facility of $25 million with the objective of systematically promoting the use of geothermal energy in the Europe and Central Asia (ECA) region. The program does this through three instruments: technical assistance, geological risk insurance (GRI) and direct investment funding.

GeoFund is implemented through a series of subprojects over a period of eight years. The program is implemented on a project-to-project basis. The Program has experienced two phases so far. The first phase (APL 1) included two subprojects: a grant for technical assistance to the International Geothermal Association (IGA) and a Geological Risk Insurance (GRI) grant

to MOL in Hungary. The second phase of the program (APL 2) is still ongoing and deals with technical assistance in Armenia.

GeoFund is managed by the World Bank. It provides contingent grants to countries from Europe and Central Asia (ECA) undertaking geothermal heat and electricity projects. The grant covers up to 85% of the estimated costs (well completion, surface facilities, testing process, administration). To benefit from a grant, the developer must prove that the country has an established program on renewable energy or that one is being established, that the project sponsor is committed to financing in a ratio of 1:5 and that the project readiness relies on a sound screening package. The success criteria is the ability of the geothermal well to produce the necessary quantity and quality of geothermal fluids to fuel the proposed geothermal electricity/direct use application. Those parameters are set on a case-to-case basis in a Grant Agreement. The Fund is fed with $ 10 million from GEF and with fees charged on the developers.

The Hungarian Oil and Gas Public Limited Company (MOL) Geothermal power plant project for electricity production is the only one to have benefited from the risk insurance mechanism under the GeoFund program. The grant was signed in November 2006 and amounted to $3.72 million. It covered the short-term geological risk associated with the drilling and testing activities. MOL paid a processing fee of $10 000 and a 3% fee on the insured amount.

The project was assessed by the GeoFund Group of Scientific and Technical Experts (STE) which was not a permanent body but which called on an expert community based on a roster of geological, technical, environmental, financial, economic and legal experts.

The results of the exploration and testing activities indicated that the two wells would not produce adequate geothermal flow rates for any geothermal-based operation. This was verified in a technical report produced by MOL, and further verified by a team of independent experts hired by the World Bank. An international auditing firm also verified the expenses for the payment claim. According to the Grant Agreement, a payment of $3.3 million was made.

The time and resources needed to identify and supervise the projects as well as the constraints faced by the project team to settle an application format caused the depletion of the GEF administrative budget for the overall GeoFund program after three years of implementation. No additional subprojects could be financed. It also caused he transfer of the program execution to the International Finance Corporation’s responsibility (IFC). In the beginning of 2010, a $10 million budget was released and the IFC invited resource developers to express their interest in Geothermal Well Productivity Insurance (GWPI) for their projects.

References

- Implementation, completion and results report, Report ICR00001516, The World Bank;
- The World Bank GeoFund for Geothermal Energy, Proceedings from the Wolrd Bank's GeoFund-IGA International Geothermal Workshop, 16-19 February 2009, Istanbul, Tirkey, K. Shimazaki;

The United States

The United States is one of the largest consumers and producers of geothermal energy in the world. Since the 1970s, there have been a number of government-sponsored loans to boost the geothermal industry. Of significance regarding the resource risk was the User Coupled Confirmation Drilling Program which aimed to reduce risk by cost sharing with industry the confirmation of hydrothermal reservoirs and included drill holes, drilling, flow testing, reservoir engineering and drilling injection wells. If developers would finance the project out of in-house funds or a loan could be obtained from a commercial institution, the Department of Energy would pay between 20% (success) and 90% (failure) of the project cost based upon a formula, which took into consideration the usability of thermal fluids for the planned application. Later, the Reservoir Confirmation Loans provided loans up to a maximum of $ 3 million for determining the economic viability of electrical generation or direct use and drilling exploratory wells. The loan term was a maximum of 20 years. If revenues were inadequate to fully repay the principal and accrued interest within 20 years after production began, the remaining unpaid amount was to be forgiven. This program was designed to replace the User Coupled Confirmation Drilling Program, which only promoted heat production. Incentives in the forms of grants have also been part of the American policy.

In the US, much of the emphasis has therefore been placed on direct financial support. However, owing to a long history of exploration and development of natural resources (mainly in the oil industry), geothermal developers accepted the resource risk as an inherent part of geothermal development and most surface exploration and drilling was done by private entities at their own risk and expenses.

Recent programs such as the Geothermal Technologies Program do not deal with the risks associated to geothermal projects but include funding to establish geothermal industry as an economically competitive contributor instead.

References

- Geothermal Risk Mitigation instrument and Incentive Program, The World Bank, September 2007, R. Gordon Bloomquist, S. Petty, R. Wagner;
- Managing geothermal resource risk – Experience from the United States, Workshop on geological risk insurance, World Bank Geothermal Energy Development Program GEOFUND, 11-12 November 2008, A. Robertson-Tait, R. Henneberger, S. Sanyal;

Indonesia

Indonesia is blessed with geothermal resources. The 2003 geothermal law opened geothermal development up to private participation through competitive tendering. However, the information on the resources at hand that was available at the stage of tendering for geothermal working area was quite limited. In 2010, the government proposed to the Parliament to allocate a sizeable fund in the 2011 budget for financing the initial geothermal exploration activities (geological, geophysical and geochemistry surveys and drilling initial exploration wells). The fund is to enhance the existing geological data, which should make the resource risk more defined and manageable when a pre-selected area is offered for tender. The Geothermal Fund is concerned with both direct use and electricity production. It is managed by the *Pusat Investasi Pemerintah* (the Indonesian Investment Agency responsible in the field of infrastructure within the Ministry of Finance).

In exchange for the exploration data, the prospective bidder pays data compensation to the tender committee who passes it to Pusat Investasi Pemerintah. The costs of drilling deep well(s) are passed to the winner.

Initially, the Geothermal Fund receives money from the State Budget for five geothermal prospects each year over a period of five years beginning 2011. Aside from the seed money from the State Budget, financing can be expanded by co-financing from other international institutes. The Asian Development Bank showed its interest to participate in the program.

References

- Geothermal Fund for hastening the development of Indonesia's geothermal resources, Proceedings, Thirty-Seventh Workshop on Geothermal Reservoir Engineering, Standford University, California, 30 January – 1 february 2012, A. Wahjosoedibjo, M. Hasan;
- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010;

http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

Japan

The geothermal resources of Japan are owned by the Nation. Research and exploration began in the 1920s, involving government and university scientists. In the 1970s, the Agency of Industrial Science and Technology (AIST) began the process of systematic investigation of Japan's geothermal resources. Work was concerned with the major elements of surface exploration and therefore of risk reduction, all sponsored financially by the government. In 1980, responsibility for continued work was assigned to the newly created New Energy Development Organization (NEDO). Together with AIST, NEDO funded an extensive multi-year program of research. Surface exploration was then carried out by private entities under contract to NEDO. The cost of drilling exploratory wells was shared equally between the government (50% grant), via NEDO, and the private developer. In addition, NEDO undertook to pay 25% of the cost of drilling development and injection wells in 1986. This great expenditure of public funds for geothermal exploration and drilling greatly reduced resource and financial risk for the private entities involved in Japan's geothermal industry.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

The Philippines

The geothermal resources of the Philippines belong to the Nation. The exception to this is that in tribal areas, free and informed consent of the tribes is required.

Initial research and surface exploration was conducted by the National Volcanological Institute of the Philippines. By 1970, a joint venture combining an offshore private company (Union Oil Company of California, Unocal) and the Philippine National Power Corporation (NaPoCor) had begun the drilling of deep exploratory wells. Under their agreement, Unocal assumed the responsibility and the risk for drilling and well field development and operation, which was financed from their ongoing oil and gas operations.

In 1976, the Philippine National Oil Company (PNOC) was created and established a subsidiary, Energy Development Corporation (PNOC-EDC) to explore and develop new geothermal reservoirs. All resource risk was borne by PNOC-EDC and thus by the government of the Philippines.

By the year 2000, NaPoCo faced insolvency. Private Philippine entities bought the geothermal well fields. No specific risk mitigation measures have been adopted apparently because each field is a proven entity with significant power generation capacity.

Beginning in 2006, the EDC was also privatized. The Renewable Energy Act passed in December 2008 provides specific and attractive benefits to companies involved in geothermal exploration and development. Terms include a 7-year tax holiday on capital goods, reduction in corporate income tax from 30% to 10%, exemption from VAT and reduction in royalty to be paid to the government on sale of electricity from 6% to 1%. Although not specifically designed to reduce exploration risk, these incentives are encouraging private entities to perform surface exploration and drill exploratory wells at their own risks.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

Mexico

The geothermal resources of Mexico are part of the national patrimony and may not be sold or leased. All generation of electricity, including from geothermal sources, is reserved to the national monopoly, Comisión Federal de Electricidad (CFE). Funding for geothermal development came from the national treasury and the revenues earned by CFE from the sale of electricity. The government, through CFE, has taken on all responsibility for the development of its geothermal resources and continues to absorb the resource and other risks. Mexico remains the prime example of a successful totally government-run geothermal operation.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf
- Drilling down on geothermal potential, An assessment for Central America, The Wolrd Bank, March 2012;

Chile

Exploration began in 1967 under terms of an agreement between the government of Chile and the United Nations Development Program (UNDP). Although the geothermal resources of Chile belong to the Nation, laws were passed to attract offshore private investors. Now Chile is granting a large number of concessions for the exploration and exploitation of its geothermal resources.

Chile's state development agency Corfo together with the national energy commission CNE have established a US$ 400 million fund to reduce the risk and share the costs of developers for exploration and transmission lines with renewable energy. Nevertheless, apart from the initial project led by the State with support of the UNDP, the resource risk remains significant for other projects which may take place in awarded concessions and is not mitigated yet.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf
- Geothermal energy in Chile, Market profile, February 2012, New-Zealand Trade & Enterprise;

El Salvador

El Salvador supplies 25% of its energy needs from geothermal resources. The geothermal resources belong to the Nation. Initial exploration was conducted by the national electric utility

CEL, financed by grants from the Government of Italy and loans from the Inter-American Development Bank. However, the resource risk was ultimately borne by the government of El Salvador. In the late 1990s, CEL was broken into different organizations including a geothermal corporation, La Geo. Nowadays, La Geo is a public private partnership (PPP) including CEL and ENEL (Italy). The enterprise has developed two geothermal fields and is exploring others. The government initially bore all resource risk. Now the resource risk is shared between the PPP.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf
- Drilling down on geothermal potential, An assessment for Central America, The Wolrd Bank, March 2012;

Costa Rica

The national power company, Instituto Costarricense de Electricidad (ICE), is the only developer of geothermal resources in the country. ICE entered into a loan agreement with the Inter-American Development Bank in 1974, which aimed at exploration and development of geothermal electricity. Regardless of the degree of success or failure, ICE had to repay the entire sums. Although ICE used electricity tariffs to pay back, it means that the government backstopped all resource risk. To help mitigate resource risk, the Development Bank required that ICE used the services of a panel of independent consultants for advice on each step of operations. Later, ICE entered into agreements with independent power producers. Because the resource is owned by the Nation, the independent power producers carried the risk of financing, constructing and operating the power plants, while ICE, who sold the steam from wells that it drilled still borne the resource risk. Therefore, resource risk has so far been entirely borne by the autonomous agency ICE. Nowadays, developing new geothermal resources is constrained due to the location of the resources in national parks.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010;

http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

- Drilling down on geothermal potential, An assessment for Central America, The Wolrd Bank, March 2012;

Australia

According to the Australian legislation, Australia is to have 20% of its electric power generation come from renewable sources by 2020. This includes geothermal power. Encouragement for this has taken the form of State and Federal legislation, policies and programs to stimulate EGS exploration, define and conduct proof-of-concept studies and define and conduct demonstration projects.

The $500 million Renewable Energy Fund was originally made up of three programs, the Geothermal Drilling Program, the Renewable Energy Demonstration Program and the Renewable Energy Equity Fund, and is now providing two additional schemes namely the Emerging Renewables Program and the Renewable Energy Venture Capital Funds. Geothermal industry is thereby well supported through research and development funding.

As far as the resource risk is concerned, the relevant program seems to be the Geothermal Drilling Program (GDP). It is a $50 million fund for proof-of concept projects helping get the industry over the short-term hurdle of high drilling costs and enabling proof-of-concept demonstration. The GDP is a competitive merit-based grants program provided as a dollar for dollar matched funding and is capped at $7 million per proof-of-concept project. A proof-of-concept project involves a suitable geothermal resource existence to be proven. It then requires drilling an initial deep well to the required depth to reach the desired temperature, drilling a second well to intersect the reservoir hundreds of meters away from the first hole and eventually testing to provide information on how much fluid can be circulated through the underground heat exchanger and at what temperature.

Payment is made against the achievement of milestones. Eligible companies can apply for funding to offset the costs of drilling, reservoir deployment and flow testing. To be eligible for GDP, the applicant must be an Australian resident company, hold license permits, demonstrate within a period of 3 months of being awarded a grant that it can fund the costs of the project not met by the GDP, demonstrate access to any intellectual property necessary to carry out the project, provide the Commonwealth with all data gained during the project, demonstrate with a reasonable level of certainty using indirect methods that a potentially commercially viable geothermal resource exists in the project area, start the project within a certain time period and declare any previous funding from other State programs for the purposes of deep drilling.

Eligible applications are assessed against eight merit criteria: 1) technical strength of the project (demonstration of a probable geothermal resource); 2) technical capability and resources available to the applicant; 3) management capability; 4) financial capacity (submission of a credible project budget); 5) involvement in consortia to address the issue of drilling capabilities shortages; 6) degree to which the project involves technical innovation; 7) project contribution to a portfolio of locations funded by the GDP; 8) the additional benefit that can be obtained from the private sector and from the applicant to the Commonwealth's contribution.

The scheme is handled by the GDP Management Team (Department of Resources, Energy and Tourism). So far, the program has known two rounds of applications.

References

- Geothermal drilling program (GDP), Supporting "proof-of-concept" projects for geothermal industry, Australian government, Department of Resources, Energy and Tourism;
- Geothermal drilling program, Factsheet Round 2, Australian government, Department of Resources, Energy and Tourism;
  - Australian geothermal Industry Technology Roadmap, Commonwealth of Australia, 2008;
  - Clean Energy Council Geothermal Industry, October 2010;
  - An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

New-Zealand

Geothermal energy produces about 13% of New Zealand's electricity supply. In its 2010 report, the Ministry of Economic Development identified the resource risk at initial site exploration phase as a barrier to progression (*Geothermal Energy: Summary of emerging technologies and barriers to development*). It discussed the possibility of introducing financial incentives such as tax breaks or grants as ways to reduce this barrier. However, it seems that high costs and initial risks are not seen as particular constraints and that geothermal actors are more concerned about the lack of electricity demand growth. Besides, risks and costs have been reduced through a legacy of Crown exploration wells drilled in previous decades. Subsequently and following the deregulation of the electricity market, risk has been borne both by state corporation

Mighty River and by private entity Contact Energy. In this context, there does not appear to be a sufficient economic case to consider insurance-related measures at this time.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010; http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf
- Low Enthalpy Geothermal Energy: Technological Economics Review, CRL Energy Ltd and East harbor Energy Ltd, 27 October 2011;
- Geothermal Position Statement, New-Zealand Geothermal Association, June 2012;

Kenya

The Kenyan Nation owns the geothermal resources. Serious exploration began in 1970 under an agreement between UNDP and the Kenyan government. The resource risk was ultimately borne by the government. Later in 1972, UNDP withdrew. The World Bank became the principal co-financier of the Olkaria geothermal project. The World Bank financed the riskiest elements of exploratory drilling, covered by a sovereign guarantee from the Kenyan government. As part of the risk mitigation, the World Bank required that KPLC (the Kenyan Power & Lighting Company) hire an experienced consulting firm.

At the request of the World Bank, it was later agreed to divide the Olkaria field into two parts. The western part was offered to private investors for development. The private offshore company Orpower drilled additional exploration and development wells at its own risk. The company later obtained financing from a consortium of German banks led by Kreditsansalt für Wiederaufbau (KfW).

There had been other donors and lenders to Kenya's geothermal project (UNDP, the Italian government, the Japanese International Cooperation Agency), but none of these included the high-risk stage of exploratory drilling.

In 1997, KPLC was split into two entities, one being partially privatized. KPLC became the distributor of electricity throughout Kenya, whereas the other entity, Kenya Power Generating Company (KenGen), now 3 % in private hands, owns and operates the power generation facilities previously owned by KPLC. KenGen has been removed from all resource risk which is

borne by the government.

References

- An assessment of geothermal resource risks in Indonesia, by Geothermex Inc., prepared for the World Bank, June 2010;

  http://www.ppiaf.org/sites/ppiaf.org/files/publication/REPORT_Risk_Mitigation_Options_Indonesia.pdf

APPENDIX III

EXAMPLES OF ELIGIBLE COSTS

FOR THE RESOURCE RISK INSURANCE

IN FRANCE AND IN GERMANY

Example of eligible expenses in relation to the short-term guarantee:

- Access work, platform civil engineering, pre-drilling of wells and restoration;
- Bringing and installation of drilling machines;
- Slipping of the machine between boreholes;
- Disassembling and removing the machine;
- Drilling (number of days * daily cost) + fuel oil;
- Tubing and equipment + screwing;
- Drilling tools;
- Sludge products and drilling fluids;
- Cementation of tubes and accessories;
- Deflection work;
- Logging;
- Reservoir stimulation and acidification;
- Surveys and tests – Sampling and analyses;
- Processing of wastes and sloughs disposal;
- Transport and handling, water and phone calls;
- Wellhead;
- Geological monitoring;
- Engineering and monitoring;

再生可能エネルギーの 2018 年度の買取価格・賦課金単価等を決定しました

本件の概要

経済産業省は、再生可能エネルギーの固定価格買取制度の 2018 年度の新規参入者向け買取価格及び賦課金単価等を決定しました。

1．2018 年度以降の新規参入者向け買取価格

調達価格等算定委員会の「平成 30 年度以降の調達価格等に関する意見」を尊重し、以下のとおり決定しました。

（1）太陽光

住宅用太陽光（10kW 未満）

昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定しない。

電源	規模	（参考） 2017 年度	(参考) 2018 年度	（参考） 2019 年度	2020 年度
太陽光 （出力制御対応機器設置義務なし）	10kW 未満	28 円	26 円	24 円	--
太陽光 （出力制御対応機器設置義務あり）	10kW 未満	30 円	28 円	26 円	--
太陽光 （出力制御対応機器設置義務なし、ダブル発電）	10kW 未満	25 円		24 円	--
太陽光 （出力制御対応機器設置義務あり、ダブル発電）	10kW 未満	27 円		26 円	--

非住宅用太陽光（10kW 以上 2,000kW 未満）

2018 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	2018 年度
太陽光	10kW 以上 2,000kW 未満	21 円＋税	**18 円＋税**

非住宅用太陽光（2,000kW 以上）

2017 年度より入札制に移行。2018 年度は入札を 2 回（上期・下期で 1 回ずつ）実施。

（2）風力

陸上風力

2018 年度より 20kW 未満と 20kW 以上の区分を統合。

昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
陸上風力	**全規模**	20kW 以上：21 円＋税 20kW 未満：55 円＋税	20 円＋税	19 円＋税	**18 円＋税**
陸上風力 （リプレース）	**全規模**	18 円＋税	17 円＋税	16 円＋税	**16 円＋税**

洋上風力

着床式洋上風力は、昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定しない。

浮体式洋上風力は、昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
着床式洋上風力	全規模	36 円＋税	36 円＋税	36 円＋税	―
浮体式洋上風力	全規模	36 円＋税	36 円＋税	36 円＋税	**36 円＋税**

（3）地熱

全区分で昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
地熱	15,000kW 未満	40 円＋税			**40 円＋税**
地熱	15,000kW 以上	26 円＋税			**26 円＋税**

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
地熱 （全設備更新型リプレース）	15,000kW 未満	30 円＋税			**30 円＋税**
地熱 （全設備更新型リプレース）	15,000kW 以上	20 円＋税			**20 円＋税**
地熱 （地下設備流用型リプレース）	15,000kW 未満	19 円＋税			**19 円＋税**
地熱 （地下設備流用型リプレース）	15,000kW 以上	12 円＋税			**12 円＋税**

（4）中小水力

全区分で昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
中小水力	200kW 未満	34 円＋税			**34 円＋税**
中小水力	200kW 以上 1,000kW 未満	29 円＋税			**29 円＋税**
中小水力	1,000kW 以上 5,000kW 未満	27 円＋税			**27 円＋税**
中小水力	5,000kW 以上 30,000kW 未満	20 円＋税			**20 円＋税**

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
中小水力 （既設導水路活用型）	200kW 未満	25 円＋税			**25 円＋税**
中小水力 （既設導水路活用型）	200kW 以上 1,000kW 未満	21 円＋税			**21 円＋税**
中小水力 （既設導水路活用型）	1,000kW 以上 5,000kW 未満	15 円＋税			**15 円＋税**
中小水力 （既設導水路活用型）	5,000kW 以上 30,000kW 未満	12 円＋税			**12 円＋税**

（5）バイオマス

一般木材等・バイオマス液体燃料

一般木材等とバイオマス液体燃料を 2018 年度から別区分化。

一般木材等（10,000kW 以上）とバイオマス液体燃料（全規模）は 2018 年度から入札制に移行。2018 年度は 1 回（下期）実施。

一般木材等（10,000kW 未満）は、2018 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	2018 年度
バイオマス（一般木材等） **（バイオマス液体燃料以外）**	10,000kW 未満	24 円＋税	**24 円＋税**

その他の区分

その他の区分は、昨年度 2019 年度までの買取価格を決定しており、今年度は 2020 年度の買取価格を決定。

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
バイオマス （メタン発酵ガス化発電（バイオマス由来））	全規模	39 円＋税			39 円＋税
バイオマス （間伐材等由来の木質バイオマス）	2,000kW 未満	40 円＋税			40 円＋税
バイオマス （間伐材等由来の木質バイオマス）	2,000kW 以上	32 円＋税			32 円＋税
バイオマス （建築資材廃棄物）	全規模	13 円＋税			13 円＋税

電源	規模	（参考） 2017 年度	（参考） 2018 年度	（参考） 2019 年度	2020 年度
バイオマス （一般廃棄物・その他のバイオマス）	全規模	17 円＋税			17 円＋税

2.2018 年度の賦課金単価

- 1.の買取価格を踏まえて算定した結果、2018 年度の賦課金単価は、1kWh 当たり 2.90 円（標準家庭（一ヶ月の電力使用量が 260kWh）で年額 9,048 円、月額 754 円）と決定しました。
- なお、2018 年度の賦課金単価は、2018 年 5 月検針分の電気料金から 2019 年 4 月検針分の電気料金まで適用されます。

＜賦課金単価算定根拠＞

賦課金単価 2.90 円/kWh＝

$$\frac{\text{①}\ \text{買取費用}\ 3\text{ 兆 }694\text{ 億円} - \text{②回避可能費用}\ 6,971\text{ 億円} + \text{費用負担調整機関事務費}\ 2.9\text{ 億円}}{\text{②}\ \text{販売電力量}\ 8,184\text{ 億 kWh}}$$

（内訳）

	2017 年度における想定	2018 年度における想定	主な要因
① 買取費用	2 兆 7045 億円	3 兆 694 億円	・2018 年度から新たに運転開始する再エネ発電設備
② 回避可能費用	5644 億円	6971 億円	・再エネ電気の買取量の増加
③ 販売電力量	8106 億 kWh	8184 億 kWh	・前年の販売電力量実績から、2018 年度の販売電力量を前年と同程度と推計※

※減免費用のうち、賦課金負担となる分の電力量を控除

担当

資源エネルギー庁 省エネルギー・新エネルギー部 新エネルギー課長 山崎

担当者：梶、山王、小松、鳥居

電話：03-3501-1511（内線 4551～6）

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公表日

平成 30 年 3 月 23 日(金)

地熱發電業者意見:

單位: 八方能源科技股份有限公司
發言人: 執行長 張明富

台灣地熱發電技術滯後，必須引進國外新技術，不能再閉門造車，目前國內毫無足以成功參考的數據做為躉購價的依據，往年參考國內造價均太低保守，這也是至今還無法成功地熱發電的主要原因之一。另外，躉購價未考慮或低估的成本計算因子應加入以符合現況。

(A) 鑽井費用應政策性鼓勵提高

- 目前全世界地熱發電平均鑽井深度 2750 – 4000 m; 除了土耳其因量體大造價較低外，3000m 鑽井平均約$7,000,000.- USD (參閱 2017 GRC ANNUAL MEETING & GEA GEOEXPO,P17, 附件一); 即 2333.33USD/m 換算成台幣每米鑽井費台幣 70,000.-NTD/m
- 台灣除大屯山地區火山型地熱，其他地區都是變質岩地質地熱，屬中溫型熱焓(150℃-200℃)地熱區域，若以每口 3000m 的井可發 1000 kW 發電量算，每 kW 的費用應為(3000 m X 70,000.-NTD/m)/1000 = 210,000.-NTD/m
- 107 年鑽井成本為 136,900.-NTD/m
- 建議鑽井成本每 kW 至少提高為 210,000.-NTD/m
- 建議初期成本最低為 35.17 萬元/瓩(目前是 27.86 萬元/瓩)

(B) 躉購價未考慮或低估:

- 道路用地及道路開闢 (500 萬 ~ 3000 萬)
- 電廠用地取得購買或租用價金 (1500 萬/公頃 ~ 2000 萬/公頃;每一 MW 地熱發電廠用地約 3 公頃。即每 MW 地熱發電的土地取得成本是 4500 萬~6000 萬)
- 台電併聯饋線費用 (加強電網費用攤提) (高地熱徵兆區均需新建加強電網，若依據台電頒布的再生能源發電系統併聯作業要點，地熱發電開發商需分攤加強電網費用，以台電初步估計每公里加強電網費用約為 6000 萬，而地熱發電廠併聯引接距離平均 6 公里計算，強電網費用約為 3.6 億元，兩座變電站 1.6 億元，合計 5.2 億元，與台電平均分攤，地熱發電開發商需分攤加強電網費用 2.6 億元!
- 部落會議回饋金/回饋條件，地熱徵兆區 95%位在原住民傳統傳統領域，所以必須朝開相關部落會議取得同意，而取得同意 100%是要地熱發電開發商回饋部落，一般以 10%的收入作為回饋金，也就是躉購價需有 0.6NTD/kWh – 1NTD/kWh 的回饋金。
- 融資資金成本低估，幾乎無金融機構承攬。資金成本約 10% - 12% 不是 5.25%
- 未列入風險保險費用。應再列入資金成本外加 2.5% -4%

大部分地熱產能高的國家均為高熱焓的火山型地熱區，FIT 價較台灣低，躉購價建議仍應參考與台灣最相似的鄰國日本，發電量小於 15MW 的躉購價是 40 日幣/KWh，換算成台幣是 40 x 0.278 = 11.12NTD/kWh。初期先將產業帶動後，造價才會逐步降低。不然，地熱發電仍將無法達到預期政策目標。

佐證計算說明:

- 目前全世界地熱發電平均鑽井深度 2750 – 4000 m; 除了土耳其因量體大造價較低外，3000m 鑽井平均約$7,000,000.- USD。換算成台幣每米鑽井費台幣 70,000.-NTD/m

  參閱 "2017 GRC ANNUAL MEETING & GEA GEOEXPO,P17" 附件一

- 電廠用地取得購買或租用價金 (1500 萬/公頃 ~ 2000 萬/公頃;每一 MW 地熱發電廠用地約 3 公頃。即每 MW 地熱發電的土地取得成本是 4500 萬~6000 萬)

  用地成本參閱 " 內政部不動產交易實價查詢服務網 (花蓮 瑞穗地區+台東 金崙地區)" 附件二

  建議採 5000 萬/MW

- 道路用地及道路開闢 (500 萬 ~ 3000 萬)

  道路寬度需求 6m; 連接主要道路採經驗平均值 500m. 面積為 6 x 500 = 3000 m2; 用地取得購買成本如前款土地成本 (附件二)計算後為 1350 萬~ 1800 萬

  (建議採 1500 萬/MW)

- 台電併聯饋線費用 (加強電網費用攤提)

  詳見 " 再生能源加強電力網工程費用分攤原則及計費方式(107.6.12)" (附件三)

  (高地熱徵兆區均需新建加強電網，若依據台電頒布的再生能源發電系統併聯作業要點，地熱發電開發商需分攤加強電網費用，以台電初步估計每公里加強電網費用約為 6000 萬，而地熱發電廠併聯引接距離平均 6 公里計算，強電網費用約為 3.6 億元，兩座變電站 1.6 億元，合計 5.2 億元，與台電平均分攤，地熱發電開發商需分攤加強電網費用 2.6 億元!)

  另外，台電併聯饋線費用也可諮詢台電目前開發中宜蘭仁澤土場地熱發電廠併聯預算成本!!

- 部落會議回饋金/回饋條件

  一般以 10%的收入作為回饋金，也就是躉購價需有 0.6NTD/kWh – 1NTD/kWh 的回饋金

- 融資資金成本低估，幾乎無金融機構承攬。

  目前國內公私銀行均無承作地熱發電融資經驗，民間資金成本 10% - 12%

- 未列入風險保險費用。應再列入資金成本外加 2.5% -4%

  目前國內風險保險公司均無承作地熱發電融資經驗，風險保費可採參歐盟地熱風險保險分析，參考 ” GEOELEC-report-on-risk-insurance “(page 28) (附件四)

- 日本發電量小於 15MW 的躉購價是 40 日幣/KWh，換算成台幣是 40 x 0.278 = 11.12NTD/kWh。參閱 日本経済産業省 ” 再生可能エネルギーの 2018 年度の買取価格”(附件五)