



# New Concepts – New and Innovative Applications of Geothermal Energy

Proceedings of the Geothermal ERANET/IEA Geothermal Joint Workshop, Geneva, Switzerland, 30-10-2015



# Joint Workshop on “New Concepts – New and Innovative Applications of Geothermal Energy”

Geothermal ERA-NET / IEA Geothermal Joint  
Activity

Report

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Orkustofnun, RVO

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## **Acknowledgements**

The workshop was organised by partners involved in the IEA Geothermal and Geothermal ERANET together. The organisers want to thank everybody who has been involved in the preparation and organisation of the workshop, all speakers, and all those who brought all the speakers together. Special thanks go to Katharina Link, Alicja Wiktorja Stoklosa, Brian Carey and Paul Ramsak, who have invested much time and effort in getting everything right, and to Gerdi Breembroek for writing the minutes. A warm word of thanks also goes to the moderator Þóra Margrét Þorgeirsdóttir, who led us through the programme with excellent flexibility and enthusiasm. Then a word of thanks to the Swiss Federal Office of Energy that financed the involvement of Switzerland in the organisation of this workshop. The last “thank you” goes to the City of Geneva that hosted the workshop at the lovely location “Domain des Penthes” and really made us feel welcome to Switzerland.

## **Abstract**

The report gives an overview for stimulating innovative ideas in geothermal utilization discussed during the workshop in Geneva on October 30, 2016. Workshop organised by Geothermal ERA NET leaders, Iceland and the Netherlands, together with IEA Geothermal and also supported by Swiss Federal Office of Energy. Meeting showcased and contributed to the awareness of opportunities in the geothermal sector and stimulate growth of the geothermal industry in Europe.

## Executive summary

This report presents the proceedings of the workshop ‘New concepts – new and innovative applications of geothermal energy’ that was held in Geneva, Switzerland on October 30, 2016. The workshop was organised by the Geothermal ERA NET together with IEA Geothermal. These two multi-national organisation recognised a mutual interest in ‘New concepts’ with a focus on concepts for heating and cooling, but not excluding new developments in electricity generation from geothermal energy.

The aim of the workshop was to bring together new ideas and inspire each other with what is innovative throughout the world in geothermal energy utilisation. The workshop had four sessions with presentations on ‘new concepts’, highlighting Enhanced Geothermal Systems (EGS), direct use applications in the built environment, direct use applications in the industry and other sectors, and a session where direct use applications worldwide were in focus. The closing session considered the future of geothermal.

The closing session of the meeting showed that there is much potential for expansion of geothermal energy through smart and innovative applications. An important conclusion of the meeting was that there is scope for a joint call for demonstration of new concepts in geothermal. The Geothermal ERANET countries and a number of new European partners have therefore joined forces in a follow-on proposal, for the ERANET Cofund GEOTHERMICA

# 1 Introduction

The proceeding provides an overview of the Joint Activity workshop of the Geothermal ERA-NET at a European level. New and innovative applications of geothermal energy utilisation was one day workshop event in Geneva organised by Geothermal ERA NET leaders, Iceland and the Netherlands, together with IEA Geothermal and supported by Swiss Federal Office of Energy. Meeting was a part of a Work Package 7 of the Geothermal ERA NET programme and be meant as a Joint Activity to develop a contractual framework. The Geothermal ERANET New Concepts may convey its aspirations to its stakeholders by communicating effectively and efficiently the benefits of such a framework and, eventually receive their long-lasting support in the development of this framework.

## 1.1 Geothermal ERA-NET

The Geothermal ERANET is a network of Ministries and National Agencies from 11 European countries, supported by the European Commission, seeking to promote innovation and greater utilization of Geothermal Energy in Europe. The network enhances European cooperation on geothermal energy at national and administrative levels targeting improved integration of national RD&D programs and knowledge sharing. Iceland, the Netherlands, France, Switzerland, Germany, Italy, Hungary, Turkey, Slovakia, Portugal and are working together in this ERA-NET to propel Geothermal Energy to a higher level in Europe. The website [www.geothermaleranet.eu](http://www.geothermaleranet.eu) gives access to more information.

A key strategy of the Geothermal ERA-NET is the development of Joint Activities. These activities have been selected through an analysis of barriers and opportunities for geothermal energy in the participating countries. One of these joint activities was called “New Concepts”, recognising the opportunity that the development of new concepts offers to the European geothermal industry and its stakeholders. Iceland and the Netherlands led the organisation of the ‘New Concepts’ joint activity on behalf of the Geothermal ERANET.

## 1.2 IEA Geothermal

The International Energy Agency (IEA) – Geothermal Technical Collaboration Programme (IEA Geothermal) provides a framework for international cooperation under the auspices of the IEA on geothermal technology and research topics. Collaboration among member country experts, industries and organizations increases capability; avoids duplication; improves cost effectiveness; provides easier access to important information, research results and technological resources; and more. IEA Geothermal actively contributes to IEA’s promotion of global sustainable energy policies and the mitigation of climate change.

IEA Geothermal membership comprises 13 countries; Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Switzerland, United Kingdom, United States; the European Commission, one industry member (Ormat Technologies) and two national organisations (CanGEA from Canada and the Geothermal Group APPA from Spain). Specific collaboration projects are called Annexes in the IEA Technical Collaboration Programmes. IEA Geothermal is pursuing activities in six Annexes. More information can be found through [www.iea-gia.org](http://www.iea-gia.org).

IEA Geothermal Annex VIII “Direct Use of Geothermal Energy”, initiated in 2003, includes all aspects of geothermal heat use. Annex VIII seeks to provide sound information, communication strategies and knowledge transfer to mitigate the barriers and to enhance deployment of geothermal energy. Cooperation, knowledge sharing and increasing the use of existing and new technologies are important objectives. There are five Tasks in Annex VIII. Members of Annex are the Canadian Geothermal Energy Association (CanGEA), France, Germany, Iceland, Japan, New Zealand, Republic of Korea, Switzerland, United Kingdom, and United States of America. Read more about Annex VIII at: <http://iea-gia.org/work-program/annex-viii/>.

Task A “New and Innovative Geothermal Direct Use Applications” focuses on innovative applications, such as opening up new possibilities for utilization, enhancing efficiency, and reducing cost.

### **1.3 Annex VIII – Task A “New and Innovative Applications of Geothermal Energy”**

Annex VIII “Direct Use of Geothermal Energy” initiated in 2003 includes all aspects of geothermal heat use. Annex VIII seeks to provide sound information, communication strategies and knowledge transfer to mitigate the barriers and to enhance deployment of geothermal energy. Cooperation, knowledge sharing and increasing the use of existing and new technologies are important objectives. There are five Tasks in Annex VIII. Members of Annex are the Canadian Geothermal Energy Association (CanGEA), France, Germany, Iceland, Japan, New Zealand, Republic of Korea, Switzerland, United Kingdom, and United States of America. Read more about Annex VIII at: <http://iea-gia.org/work-program/annex-viii/>.

Task A “New and Innovative Geothermal Direct Use Applications” focuses on innovative applications, such as opening up new possibilities for utilization, enhancing efficiency, and reducing cost. The Task is led by Brian Carey (New Zealand) along with expressed interest from Paul Ramsak (Netherlands) to take up an active leadership role.

### **1.4 Workshop information**

As a first step towards showing and stimulating new opportunities in Europe and beyond, the Geothermal ERA-NET “New Concepts” group and IEA Geothermal Annex VIII organized a joint workshop entitled ‘New concepts - new and innovative applications of geothermal energy’ on the 30th of October 2015 in Genève (CH).

The aim of the workshop was to stimulate creative concepts for European innovators in geothermal utilization and technology. The concepts of interest included opportunities in direct utilization of low enthalpy geothermal energy such as geothermal heating & cooling for smart cities, food production, and other uses. Also, new concepts in geothermal electricity generation and process heat were part of the programme.

The workshop ‘New Concepts’ had six sessions:

- Welcome and Introduction by hosts
- Session I: EGS projects + direct use applications



- Session II: Direct use applications (new concepts – built environment)
- Session III: Direct use applications (new concepts – other sectors)
- Session IV: Innovative Applications of Geothermal Direct Use worldwide
- Visionary Panel Discussion, Conclusions and Next Steps

Each session has the significant importance on different geothermal application issues. Detailed agenda and speakers list available in [chapter 3](#)

## 2 Innovative thinking

In the beginning of the workshop, participants were asked to draw their vision on future of geothermal. To solve this assignment, they were supplied with colourful wax pencils and blank white page (Please see Figure 1).



Figure 1 Figure presents tools used to create the vision of future of geothermal, vaxlitir and blank page

Their drawn visions showed amongst others heat transport by chemicals; and simple, easy to use, away-from-tailor-made systems. Also, the visions showed a bright and loving future, with geothermal families, the warm heart of mother earth, and peace to the world from using indigenous resources. After a day of discussion and listening to visions of individuals from different countries, participants summarised their art work in few sentences and compare the image of future in geothermal energy between each other.

The results of task are presented as collage in [Appendix II](#)

### 3 Programme of the workshop

Friday, 30<sup>th</sup> of October 2015:

08:30 - 09:10 **Welcome and Introduction to Geo Innovative Opportunities**

- 8:30 - 8:40 **Welcome** – Katharina Link + Gunter Siddiqi  
(Annex VIII Leader resp. ExCo member, IEA Geothermal; host country)
- 8:40 - 8:55 **Geothermal ERA-NET + New Concepts** – Paul Ramsak  
(Co Leader Geothermal ERA-NET New Concepts group)
- 8:55 - 9:10 **IEA Geothermal + Annex VIII** – Brian Carey  
(Secretary and Annex VIII Task Leader, IEA Geothermal)

09:10 – 10:30 **Session I: EGS projects + direct use applications**

- 9:10 - 9:30 Switzerland – Peter Meier (Geo Energie Suisse AG)  
**EGS-Projects of the Geo-Energie Suisse AG: the new concept**
- 9:30 - 9:50 Hungary – László Adam (Mannvit)  
**What are the challenges and new concepts in South Hungarian Enhanced Geothermal System (EGS) Demonstration Project?**
- 9:50 - 10:10 France – Martino Lacirignola (ADEME)  
**ECOGI - an EGS project for the industry in the Upper Rhine Graben**
- 10:10 - 10:30 Discussion

10:30 - 10:45 **Coffee break**

10:45 – 12:30 **Session II: Direct use applications** (new concepts – built environment)

- 10:45 - 11:05 Iceland – Kristin Vala Matthiasdottir (Resource Park/ HS Orka)  
**HS Orka Resource Park – Society without waste**
- 11:05 - 11:25 Switzerland – Matthias Kolb (Amstein + Walthert AG)  
**Smart thermal grids: operational experience with low temperature grids in Zurich**
- 11:25 - 11:45 Germany – Christian Hecht (Stadtwerke München, SWM)  
**The Projekt GRAME - One Step towards our 2040 Vision of 100% Renewable District Heating in Munich**
- 11:45 - 12:10 Netherlands – René Verhoeven & Herman Eijdemans (Mijnwater B.V)  
**Minewater Heerlen - Development of carbon neutral areas with thermal smart grids and geothermal**
- 12:10 - 12:30 Discussion

12:30 - 13:45 **Lunch**

13:45 – 15:25 **Session III: Direct use applications** (new concepts – other sectors)

- 13:45 - 14:05 Italy – Adele Manzella, CNR  
**Direct use of heat for industrial and civil processes**

- 14:05 - 14:25 [Netherlands – Henk de Beijer \(SolabCool®\)](#)  
[Cooling with Geothermal energy and local storage](#)
- 14:25 - 14:45 [Switzerland – Dirk Arndt & Philip Klingler \(Gruner AG\)](#)  
[District heating coupled with a seasonal heat storage in a deep aquifer](#)  
[\(city of Oftringen\)](#)
- 14:45 - 15:05 [Italy – Ruggero Bertani \(Enel Green Power\)](#)  
[Geothermal for Agriculture and Food](#)

15:05 - 15:25 Discussion

15:25 – 15:40 **Coffee break**

15:40 - 17:00 **Session IV: Innovative Applications of Geothermal Direct Use worldwide**

- 15:40 - 16:00 [Northern America – Arlene Anderson \(US Department of Energy, USA\)](#)
- 16:00 - 16:20 [Asian region – Kasumi Yasukawa \(National Institute of Advanced](#)  
[Industrial Science and Technology \(AIST\), Japan\)](#)
- 16:20 - 16:40 [New Zealand and Australia – Brian Carey \(GNS, New Zealand\)](#)
- 16:40 - 17:00 Discussion

17:00 - 18:00 **Visionary Panel Discussion, Conclusions and Next Steps**

- 17:00 -17:20 [Alicja Wiktoria Stoklosa \(Startup Energy Reykjavik, Iceland\)](#)
- 17:20 -18:00 [Paul Ramsak \(RVO\), Hjalti Pall Ingolfsson \(OS\) & Brian Carey \(GNS\)](#)

18:00 - 19:00 **Networking Réception**

Moderator **Póra Margrét Þorgeirsdóttir**

## Appendix I - List of participants

Below there is a presentation of all participants attended the event in Geneva.

Surname	First name	Organisation / company	Country
Arndt	Dirk	Gruner AG	Switzerland
Baria	Roy	EGS Energy	United Kingdom
Bendall	Betina	Department Manufacturing Innovation Trade Resource and Energy (DMITRE), State Government of South Australia	Australia
Bertani	Ruggero	Enel Green Power	Italy
Breembroek	Gerdi	Rijksdienst voor Ondernemend Nederland	Netherlands
Bromley	Chris	GNS Science	New Zealand
Busby	Jonathan	British Geological Survey	United Kingdom
Carey	Brian	GNS Science	New Zealand
Cunha	Matilde	Electricidade dos Açores, S.A. (EDA)	Azores/Portugal
de Beijer	Henk	SolabCool®	Netherlands
Eijdens	Herman	Mijnwater B.V	Netherlands
Faessler	Jérôme	Université de Genève - systèmes énergétiques	Switzerland
Glass	Hylke J.	Camborne School of Mines, University of Exeter	United Kingdom
Hecht	Christian	Stadtwerke München SWM	Germany
Ingólfsson	Hjalti Páll	Orkustofnun	Iceland
Jaudin	Florence	Bureau de Recherches Géologiques et Minières (BRGM)	France
Klingler	Philip	Gruner AG	Switzerland
Kobler	Rita	Swiss Federal Office of Energy (SFOE)	Switzerland

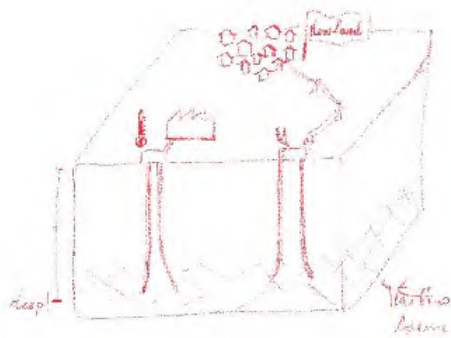
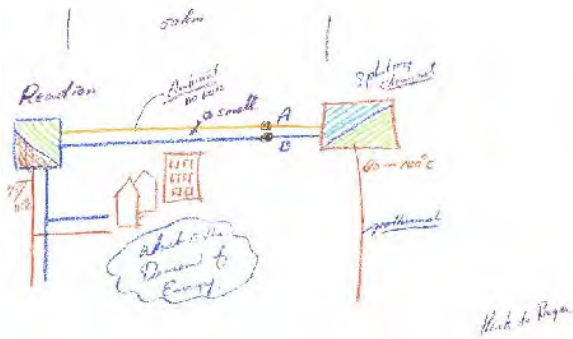
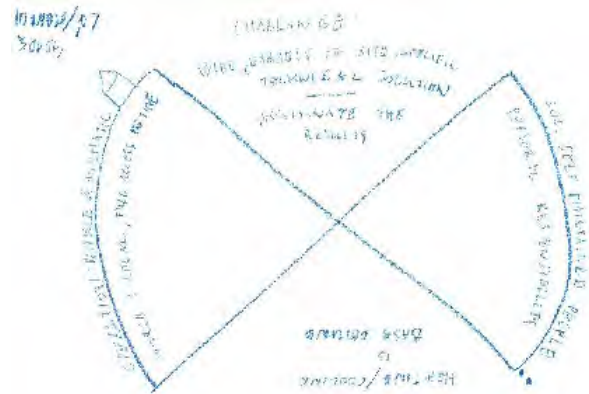
Kolb	Matthias	Amstein + Walthert AG	Switzerland
Lacirignola	Martino	French Environment and Energy Management Agency (ADEME)	France
Lapanje	Andrej	Geological Survey of Slovenia	Slovenia
László	Ádám	Mannvit	Hungary
Link	Katharina	Dr. Roland Wyss GmbH	Switzerland
Manzella	Adele	National Research Council (CNR)	Italy
Mathiasdottir	Kristin Vala	Resource Park / HS Orka	Iceland
Meier	Peter	Geo-Energie Suisse AG	Switzerland
Meyer	Michel	Services industriels de Genève (SIG)	Switzerland
Minder	Rudolf	Swiss Federal Office of Energy (SFOE)	Switzerland
Muller	Jiri	Institute for Energy Technology	Norway
Nádor	Annamária	Geological and Geophysical Institute of Hungary	Hungary
Ramsak	Paul	Rijksdienst voor Ondernemend Nederland	Netherlands
Richter	Manuela	Project Management Jülich (PTJ)	Germany
Sidiqqi	Gunter	Swiss Federal Office of Energy (SFOE)	Switzerland
Song	Yoonho	Korea Institute of Geoscience & Mineral Resources (KIGAM)	Republic of Korea
Stoklosa	Alicja Wiktoria	Orkustofnun / Startup Energy Reykjavik	Iceland
Verhoeven	René	Mijnwater B.V	Netherlands
Weber	Josef	Leibniz Institute for Applied Geophysics	Germany
Wissing	Lothar	Project Management Jülich (PTJ)	Germany
Yasukawa	Kasumi	National Institute of Advanced Industrial Science and Technology (AIST)	Japan

## **Appendix II- Drawings initiative /Innovative thinking**

The Future of Geothermal Energy- how do you see it? It is time to present results of participants work during the workshop. Their drawn visions are spread among different solutions connected to the geothermal energy. It goes from peace and love to the world using indigenous resources, warm heart of mother Earth, bright future build up on the flower “Daisy model”, which shows integrity and differential understating of geothermal energy. Visions are spread to the more technical tailor- made solutions which innovative thinkers bring out from their minds such as energy systems and their influence on the family integrity, geothermal heat and cooling solutions and other easy to use energy models, all to discover on next pages.

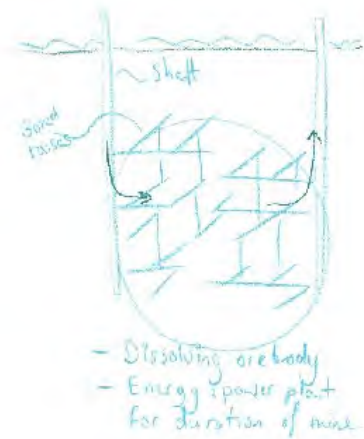
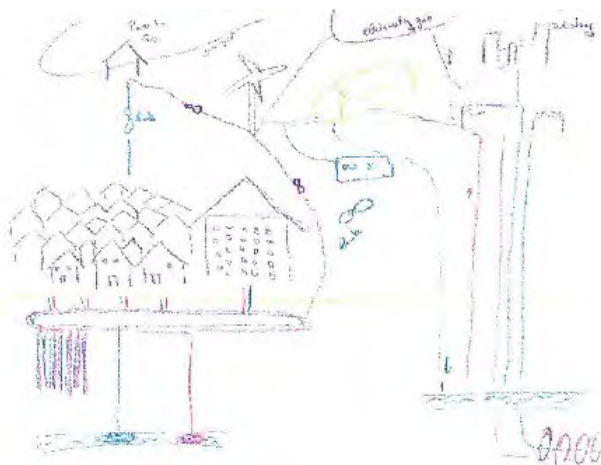
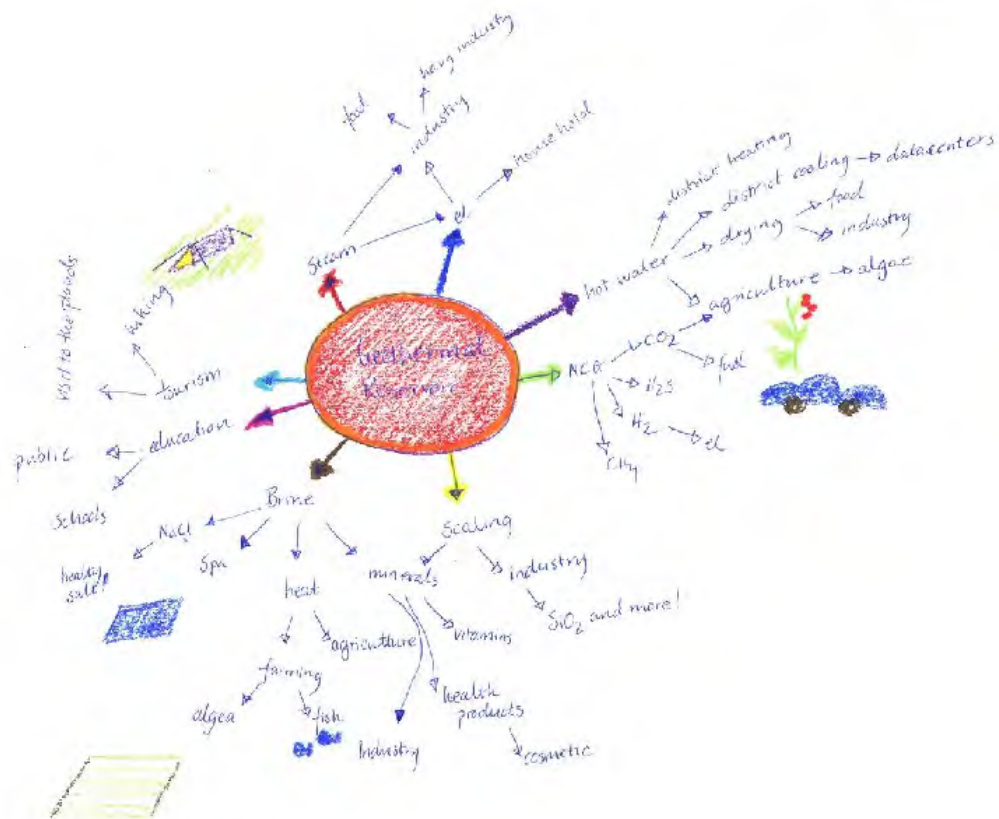


**Drawings presenting Future of Geothermal by participants**





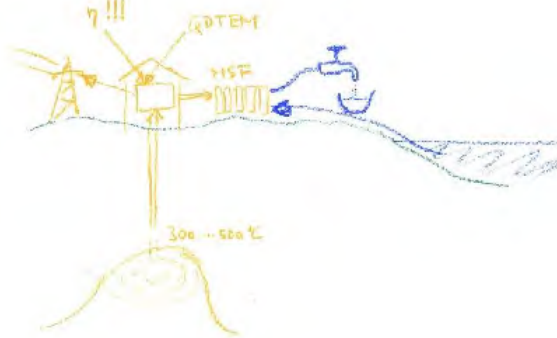
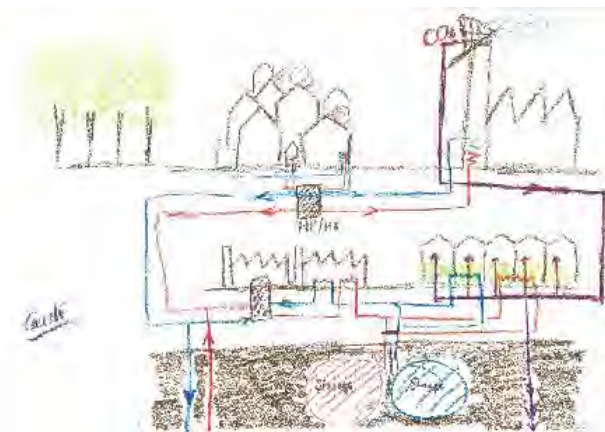
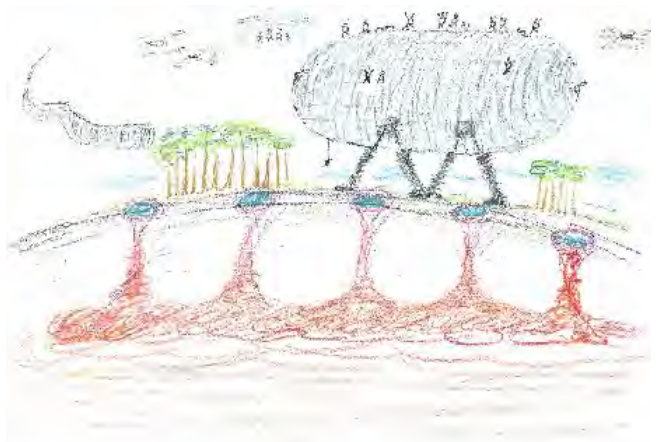
Kristin Vela Martinus  
Iceland

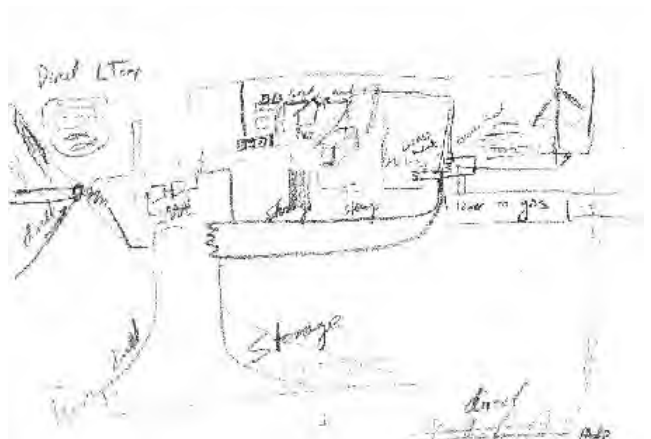
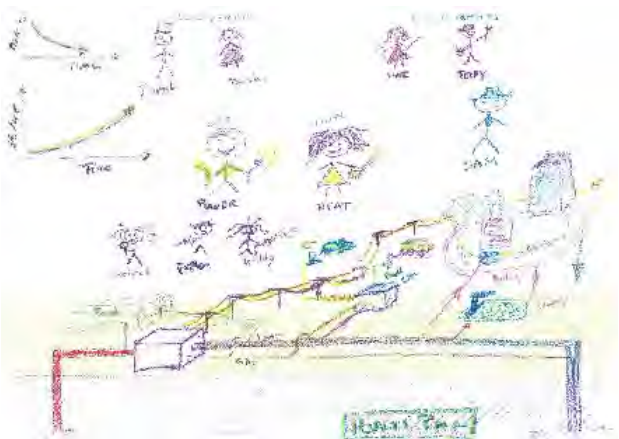
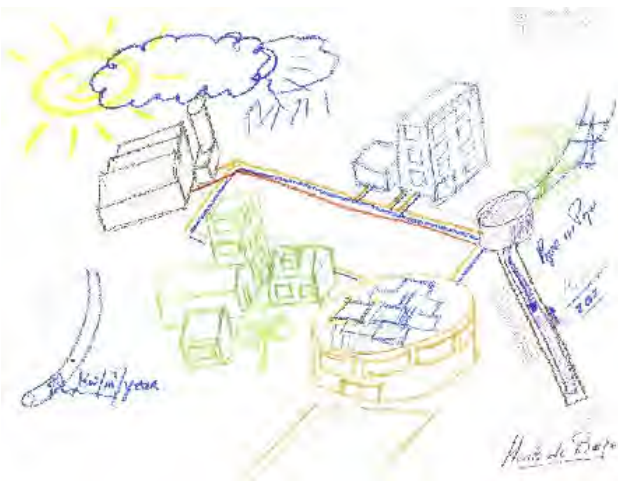
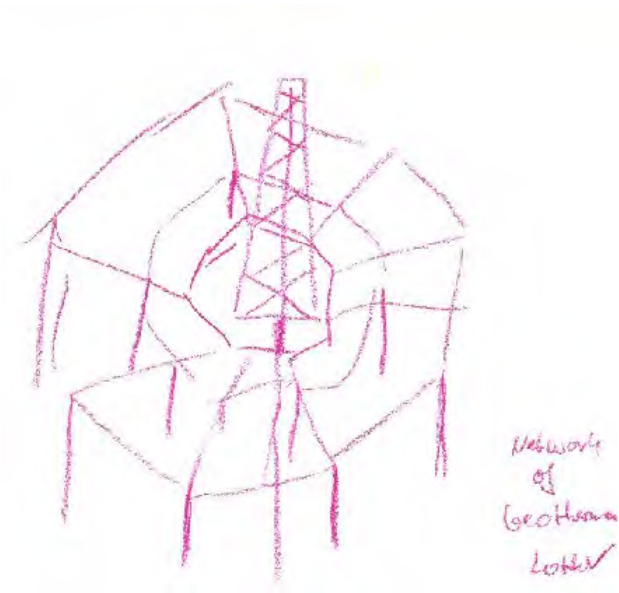






Brian Carey





## Appendix III- Presentations

The appendix III offers all presentations given during the workshop. Each presentation is followed by short introduction of the speaker and abstract of the project. All presented slides are available as pdf file also on Geothermal ERA NET website the <http://www.geothermaleranet.is/publication/presentations/> under presentations page

### Welcome and Introduction by hosts

Welcome note began by Katharina Link, on behalf of Swiss Federal Office of Energy which kindly supplied the facilities and catering for the meeting, the workshop started with an introduction by Paul Ramsak, representing the Geothermal ERA NET and Brian Carey representing the IEA GIA. Meeting was moderate by Þóra Margrét Þorgeirsdóttir, a business specialized lawyer working as strategy consultant at Capacent, and a tax and legal consultant at Deloitte. She participated in the creation and operation of Iceland Geothermal, which is an industry driven geothermal cluster cooperation in Iceland.

*Please find presentations with presenter information and project abstract below or online as pdf version at [www.geothermaleranet.eu](http://www.geothermaleranet.eu) under publication page*


[Back to the program](#) ↑



## **Presentation Geothermal ERA NET – Paul Ramsak (RVO, The Netherlands)**

New Concepts an introduction

**Paul Ramsak** comes from the Energy Innovation Team within the *Competitive and Sustainable Energy Sector* sub-directorate. He has been involved in geothermal energy since the year 2000, and has been one of the key-persons to get geothermal energy off the ground in the Netherlands. Paul Ramsak is the central contact for geothermal energy within *RVO (The Netherlands Enterprise Agency)*. Paul Ramsak has been involved in the work of the Geothermal ERANET from the start and was one of its founding fathers.

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Netherlands Enterprise Agency



## New Concepts an introduction

**Paul Ramsak**

Netherlands Enterprise Agency  
Geothermal ERANet KnowlEx leader  
New Concepts steering committee

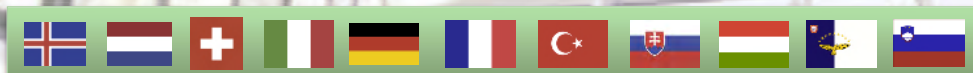
New Concepts workshop  
Genève (CH)  
30 oct 2015



# European

# Network

# Cooperation



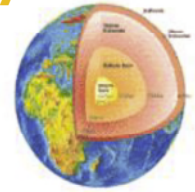
# Geothermal Energy





# Geothermal Energy contributes to the Energy Union

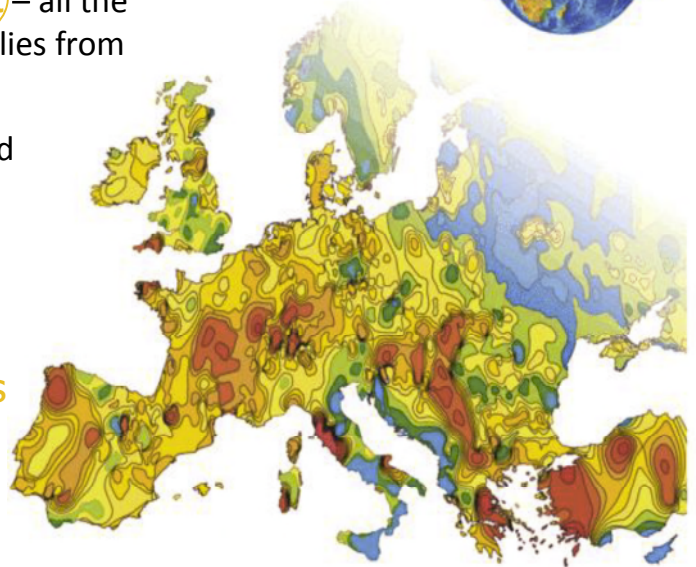
Geothermal energy is environmentally friendly.



It produces reliable baseload **power** and **heat** – all the more important to balance intermittent supplies from other renewable energy sources

Geothermal is a renewable energy source and independent of weather conditions.

Geothermal energy is indigenous and contributes to Europe's security of supply



**Lead partner is Orkustofnun**  
(National Energy Authority of Iceland)

**11 partner countries**  
up to now

**NL Enterprise Agency**  
leading **Knowledge Exchange** activities

**Looking for knowledge exchange + cooperation possibilities**



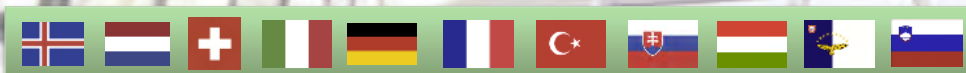




# Geothermal EraNET consortium

-  IS Orkustofnun (National Energy Authority),
-  NL Rijksdienst voor Ondernemend Nederland
-  CH Swiss Federal Office of Energy (SFOE)
-  I National Research Council of Italy (CNR)
-  D Jülich (PTJ)
-  F ADEME ( BRGM as third party)
-  IS Icelandic Centre for Research (RANNÍS)
-  TR TÜBITAK (Scientific and Technological Research Council of Turkey)
-  SVK Slovak Ministry of Education, Science, Research and Sport
-  H Hungarian Geological and Geophysical Institute
-  SLO Slovenian Energy Directorate
-  P Electricidade dos Acores

## Cooperation between European (member) states



**Ministries and National Agencies**  
programme owners & managers



**Paul Verhoef**  
Head of Unit - New and Renewable Energy Sources, DG RTD at European Commission

## Three important EU pillars to strengthen the geothermal sector in Europe

*"The Geothermal ERA NET is one of the few European initiative we have to strengthen the geothermal sector"*

### Geothermal ERA NET VISION

- Minimize the fragmentation of geothermal research in Europe
- Build on European know-how and know-who to utilize geothermal energy
- Contribute to a framework to realise large opportunities in the utilization of geothermal energy through joint activities



Industry

Public authority

Research

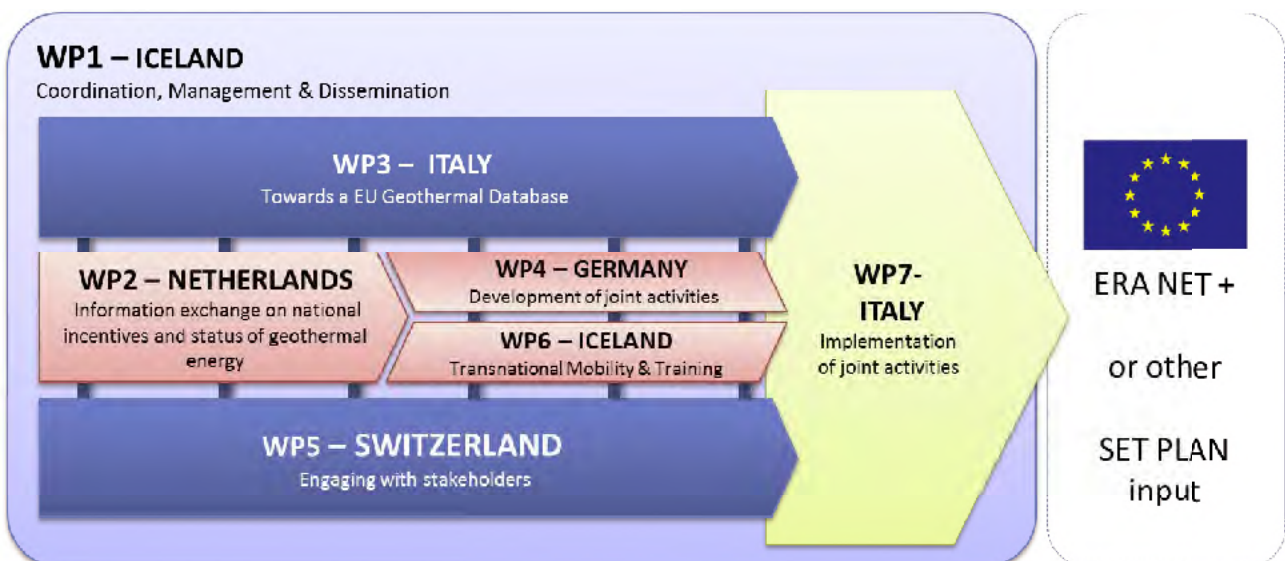
Geothermal ERA NET  
Coordination Office  
Orkustofnun, Iceland

7

Paul Ramsak 30/10/2015



# Organisational structure / work packages



8

Paul Ramsak 30/10/2015

» Focus on energy  
and climate change

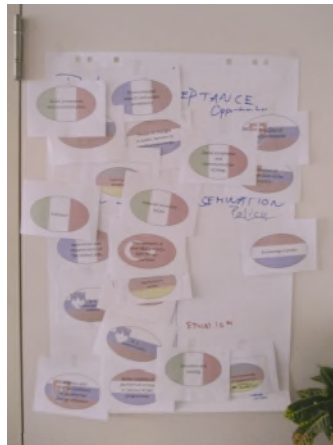
# Technical & non-technical barriers & opportunities (task 2.2a CNR/RVO)

Short list of barriers and opportunities for geothermal development

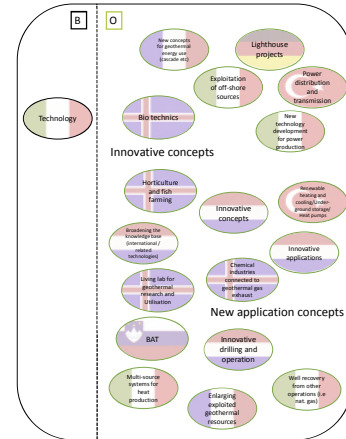
Example:

Barrier	Opportunity

10-bullet lists (per country)



clustering workshop



Report (barriers & opportunities)

# Technical/non-tech. barriers & opportunities

7 B&O clusters

<b>A1 Regulations</b>	
<b>A2 Economics &amp; risk-mitigation</b>	a investment
	b operational support
	c risk mitigation
<b>A3 New/innovative concepts and applications</b>	
<b>A4 Operational issues</b>	
<b>A5 Sub-surface knowledge/data</b>	
<b>A6 Structuring the geothermal sector</b>	
<b>A7 Public and education</b>	a public acceptance
	b visibility & dissemination
	c education and training



report  
> ready  
sep'14





## RD&D needs

### RD&D clusters

<b>B1 Reservoirs</b>	A reservoirs (general)
	B reservoir modelling
	C reservoir exploration
<b>B2 Operation</b>	A operational issues
	B injection issues
	C pumps & components
<b>B3 PR &amp; data</b>	A dissemination
	B acceptance
	C reporting code/statistics
<b>B4 New concepts</b>	A innovative concepts
	B heat
	C power cycle
<b>B5 Anthropogenic influence</b>	A reservoir creation
	B seismicity
<b>B6 Drilling</b>	



report  
> ready  
sep'14



## Propose (joint) actions to bridge gaps, overcome barriers and promote the use of geothermal energy in Europe (task 2.2c RVO)

> ready nov '14

> basis for wp4:  
**development of joint activities**

> **All reports available on:**  
[www.geothermaleranet.eu](http://www.geothermaleranet.eu)





# Common Challenges in Geothermal EraNet countries

Barriers & Opportunities clusters

	A1 Regulations	...
	A2 Economics & risk-mitigation	...
	A3 New/innovative concepts and applications	↔
	A4 Operational issues	↔
	A5 Sub-surface knowledge/data	↔
	A6 Structuring the geothermal sector	...
	A7 Public and education	↔

RD&D needs clusters

B4 New concepts	
B2 Operation	
B1 Reservoirs	
B3 PR & data	
B5 Anthropogenic influence	
B6 Drilling	

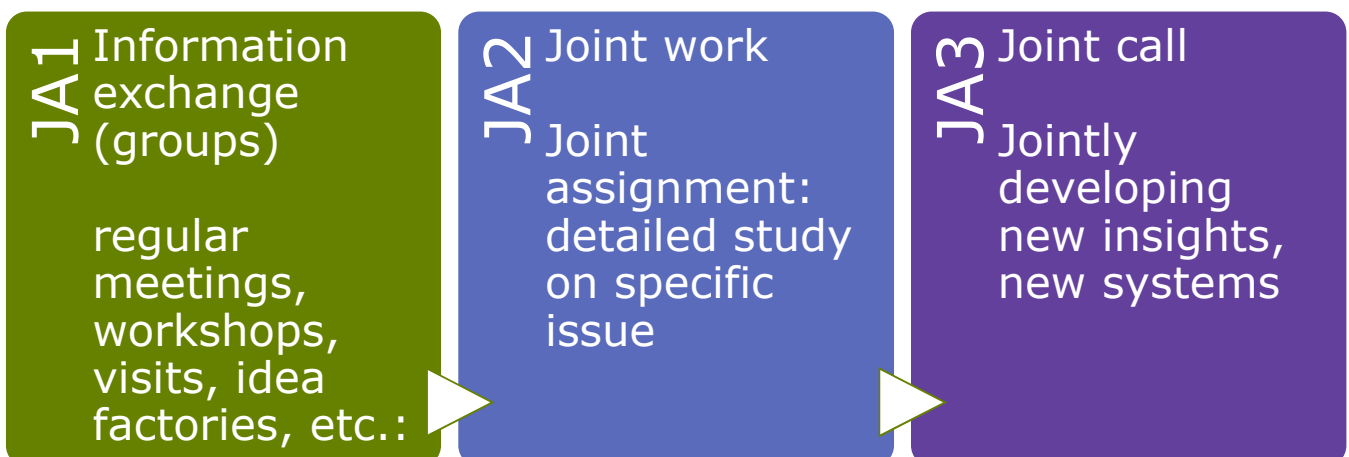
## 9 clusters

- 1.Regulations (A1)
- 2.Economics & Risk-mitigation (A2)
- 3.New/innovative concepts & applications (A3/B4)
- 4.Operation (A4/B2)
- 5.Subsurface/reservoir knowledge (A5/B1)
- 6.Structuring the geothermal sector (A6)
- 7.Public & Education (A7/B3)
- 8.Anthropogenic Influence (B5)
- 9.Drilling (B6)

**All clusters are relevant for the progression of geothermal energy in Europe**



## How to collaborate?



- Appropriate (and feasible) JA-type should be chosen for a specific challenge
- JA's can evolve from JA1 > JA2 > JA3
- Effectiveness/Impact more important than amount of €'s



## How to start/organise joint activities ?

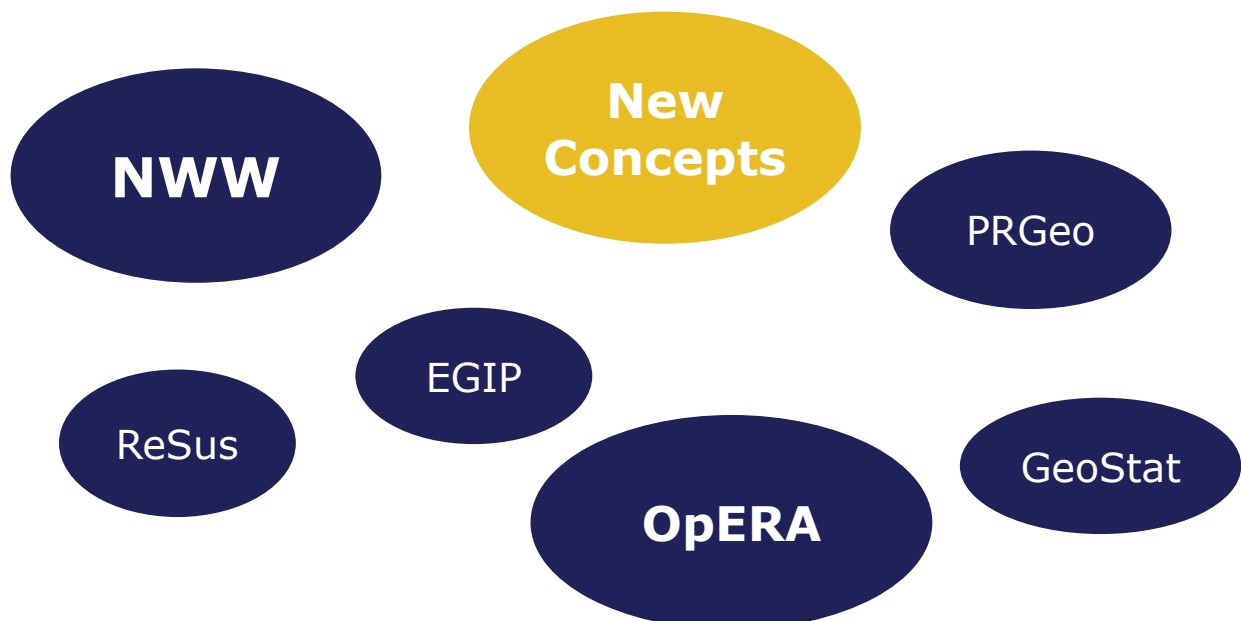
- Bottom-up
- Bi- or multilateral
- Based on countries preferences (within the clusters)

At least two countries to take the initiative

**The Geothermal Era Network as a continuing vehicle to launch JA's !**



## 7 Joint Activities





## First Joint Activity: **OpERA**

- **OpERAtional issues** of geothermal installations
- **workshop – 1+2 oct 2015**
  - Scaling
  - Corrosion
  - Gas content
  - Reinjection
- **follow-up**
  - Expert group > solved/unsolved issues/best practices (JA1)
  - Joint studies (JA2/JA3)
  - ...



## OpERA workshop 1+2 okt 2015 Vaals, Dutch Mountains (NL/D)



OpERA Magna Carta





# Common Challenges in Geothermal EraNet countries

Barriers & Opportunities clusters

A1 Regulations	...
A2 Economics & risk mitigation	...
A3 New/innovative concepts and applications	↔
<b>A4 Operational issues</b>	↔
A5 Sub-surface knowledge/data	↔
A6 Structuring the geothermal sector	...
A7 Public and education	↔

RD&D needs clusters

B4 New concepts	
<b>B2 Operation</b>	
B1 Reservoirs	
B3 PR & data	
B5 Anthropogenic influence	
B6 Drilling	

9 clusters

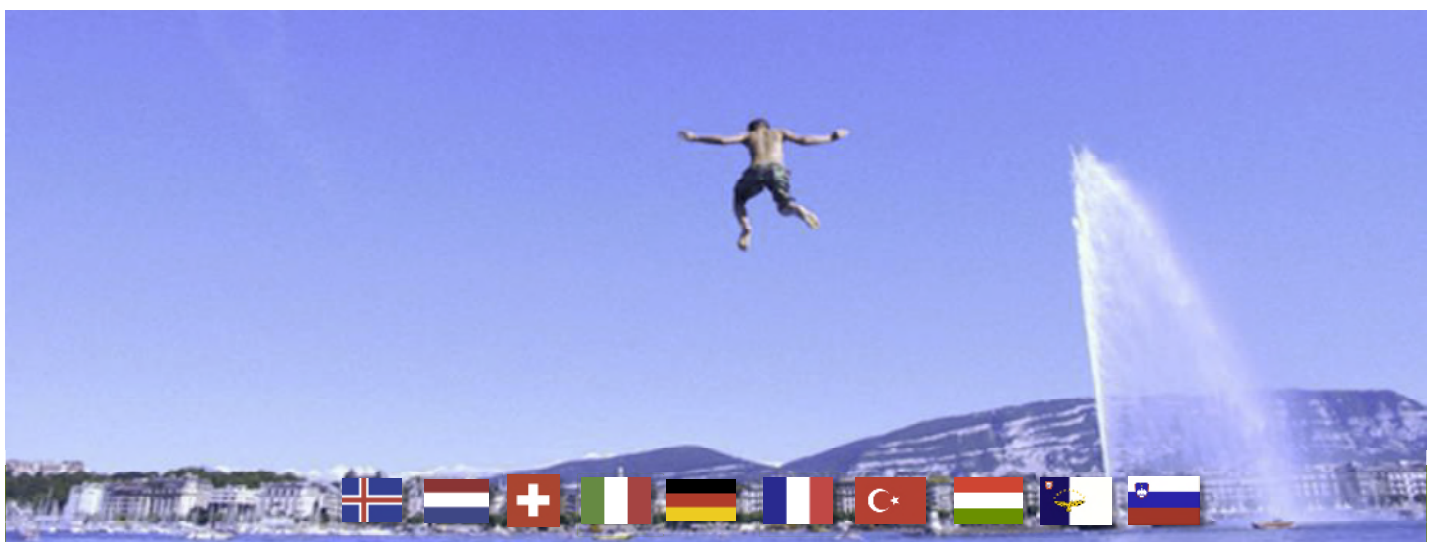
- 1.Regulations (A1)
- 2.Economics & Risk-mitigation (A2)
- 3.New/innovative concepts & applications (A3/B4)**
- 4.Operation (A4/B2)
- 5.Subsurface/reservoir knowledge (A5/B1)
- 6.Structuring the geothermal sector (A6)
- 7.Public & Education (A7/B3)
- 8.Anthropogenic Influence (B5)
- 9.Drilling (B6)

**All clusters are relevant for the progression of geothermal energy in Europe**



## JA New Concepts

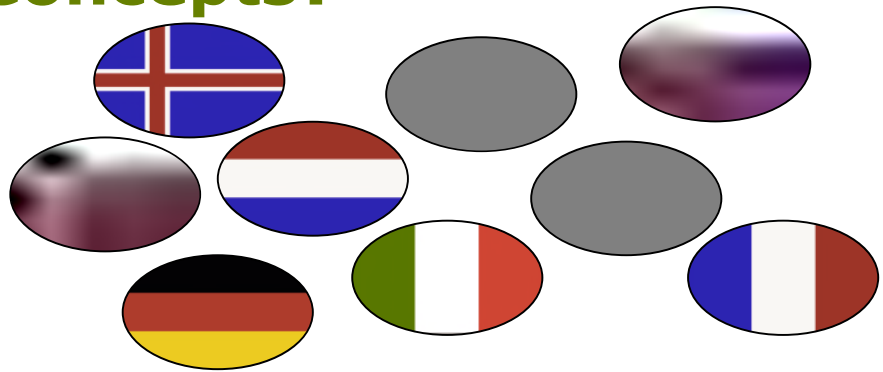
imagine the **opportunities** of **Geothermal**





# Why New Concepts?

- Mentioned by all:



- Crucial cluster full of **opportunities** ! (not barriers)
- New Concepts/Innovations in technology and application **crucial for future of geothermal**
- Strategic positioning of geothermal in the (EU) Energy System

# New Concepts – the EuRopeAn team

## Coordination

IS + NL  

## EraNet Partners

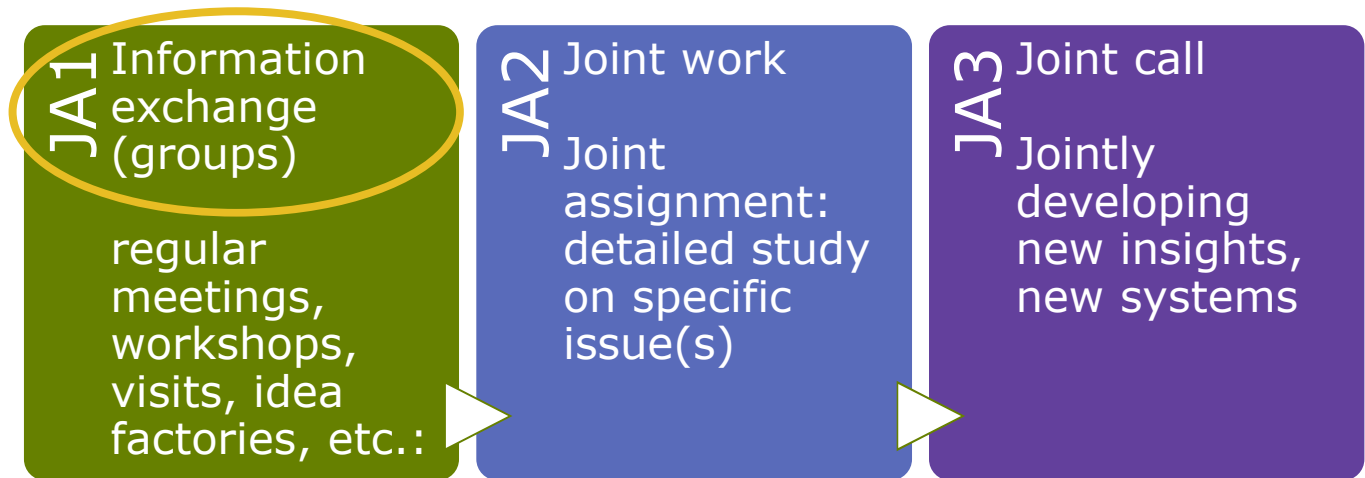
CH + I + H + F + D + SLO



+P +TR



## How to collaborate?



- Appropriate (and feasible) JA-type should be chosen for a specific challenge
- JA's can evolve from JA1 > JA2 > JA3
- Effectiveness/Impact more important than amount of €'s

## The **New Concepts** Concept

Two types of events:

- 1) **Showcase** new concepts/innovative projects in Geothermal
- 2) Creative **idea generating** events (Idea Factories/Labs)

### **INSPIRATIONAL POSITIVE CREATIVE PEOPLE + EVENTS**

Today in Geneva first event of the first type

*Building the **base for a vibrant geothermal community***

*open to innovations and opportunities*

# Geothermal EraNet Cofund Action Geothermica continued cooperation

*Creating a European research & innovation framework*

- organize and pool national financial and human resources as well as national research infrastructures, **to accelerate research and innovation.**
- Building on relationships with industry and researchers and bridge the gap between research and the market with **innovative solutions.**
- Focus on what is often called “deep” geothermal energy. The scope includes the **integration of geothermal reservoirs into novel energy system concepts** (e.g. use of reservoirs for energy storage, CO<sub>2</sub> storage, integration with near-surface geothermal applications).



## New Concepts workshop Participants

- Innovative Project developers & entrepreneurs
- Country representatives for Geothermal Innovation
- Positive, inspirational, creative, motivated

*40 participants from 11 European countries  
+ 4 non-European countries. 20 speakers*

- Building a network
- New Concepts JA as a platform to stimulate creativity and innovation in Geothermal
- You're part of that network!

*We need **Creativity and Innovation** and a **Positive Vibe**  
for Geothermal Energy to flourish*



# Your task

What is your vision of -  
How do you imagine  
**the Future of Geothermal ?**







1915



Fondation de la Fabrique Genevoise de Crayons à Genève.

# CARAN D'ACHE

Genève

MENU

1924

Arnold Schweitzer acquiert la Fabrique Genevoise de Crayons et la renomme "Caran d'Ache" en l'honneur du célèbre caricaturiste français Emmanuel Potté.



f t y CARANDACHE.COM

0  
DÉFILEZ POUR EN SAVOIR PLUS

29

Paul Ramsak 30/10/2015



## Your tools



vaxlitir

30

Paul Ramsak 30/10/2015



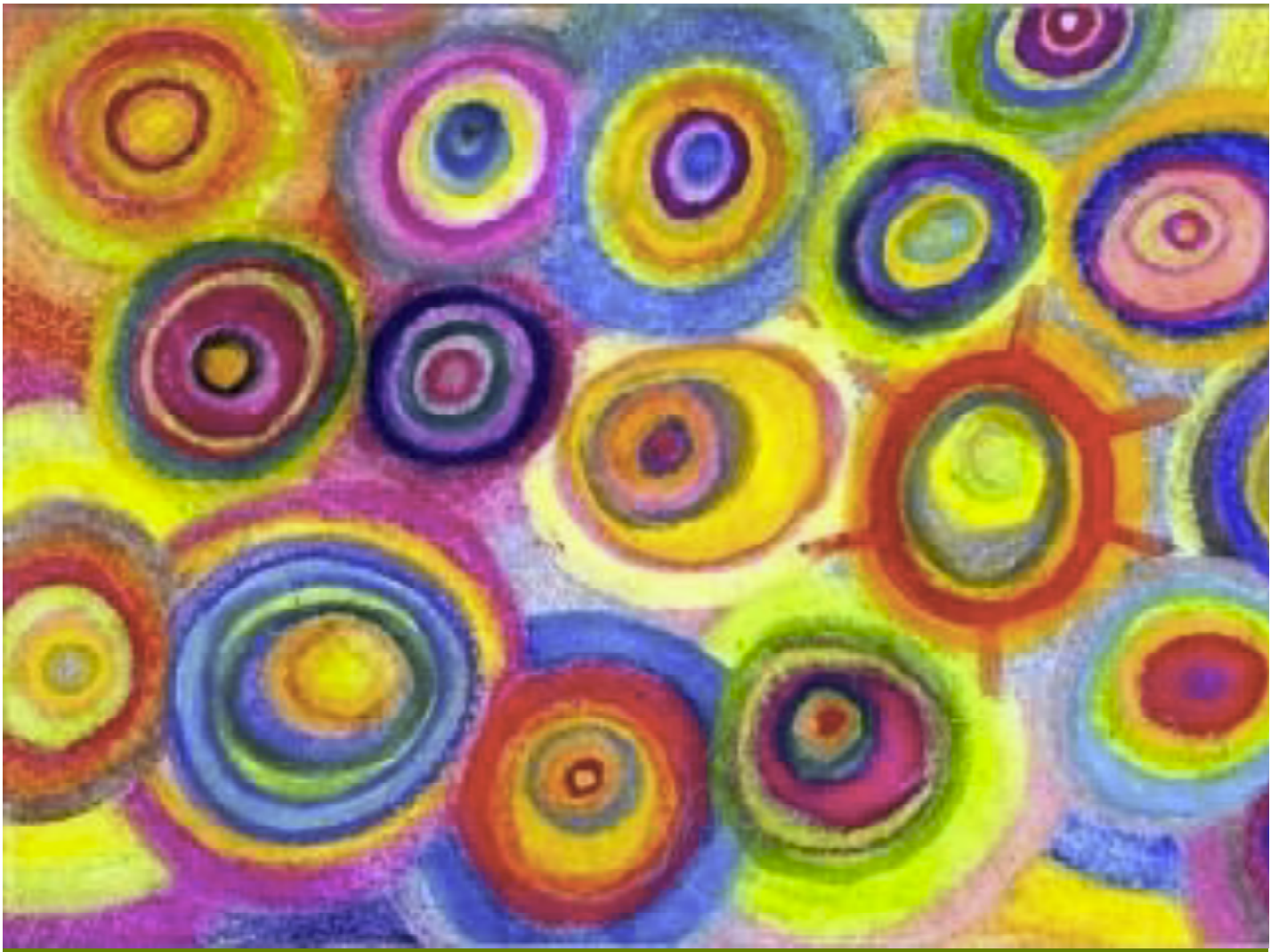


## Your instructions

What is your vision of -  
How do you imagine  
**the Future of Geothermal ?**

**Draw it !**  
be inspired  
use your imagination  
your name on front side  
any tekst comments on the back  
**you have to be ready at 17:00h**





# New Concepts Program

30 oct 2015

Morning 8:30-12:30

afternoon 13:45-19:00

## Welcome & Introduction



### I EGS + Direct Use



*Break*

### II Built Environment NewCon



*Lunch*

## III Other Sectors NewCon



*Break*

## IV Worldwide InnovApp



## Visionary Panel, Conclusions & Next Steps



*Networking Réception*





Geothermal ERA-NET / IEA Geothermal  
Joint Workshop on "New Concepts –  
New and Innovative Applications  
of Geothermal Energy"

Friday, 30<sup>th</sup> of October 2015:

- 08:30 - 09:10 Welcome and Introduction to Geo Innovative Opportunities**
- 08:30 - 09:40 **Welcome** – Katharina Lök + Gunter Stöckli  
(Annex VIII Leader resp. ExCo member, IEA Geothermal; host country)  
IEA Geothermal + Annex VIII – Brian Carey  
(Secretary and Annex VIII Task Leader, IEA Geothermal)  
Geothermal ERA-NET + New Concepts – Paul Ramsak  
(Co Leader Geothermal ERA-NET New Concepts group)
- 09:10 - 10:30 Session I: EGS projects + direct use applications**
- 09:10 - 09:30 **Switzerland** – Peter Meier (Geo Energie Suisse AG)  
EGS-Projects of the Geo-Energie Suisse AG: the new concept
- 09:30 - 09:50 **Hungary** – László Adam (Mátravid)  
What are the challenges and new concepts in South Hungarian  
Enhanced Geothermal System (EGS) Demonstration Project?
- 09:50 - 10:10 **France** – Martine Lachignola (ADEME)  
ECOGI - an EGS project for the industry in the Upper Rhine Graben
- 10:10 - 10:30 Discussion
- 10:30 - 10:45 Coffee break**
- 10:45 - 12:30 Session II: Direct use applications (new concepts – built environment)**
- 10:45 - 11:05 **Iceland** – Kristín Vala Matthíasdóttir (Resource Park/ HG Orka)  
HS Orka Resource Park – Society without waste
- 11:05 - 11:25 **Switzerland** – Matthias Kolb (Amstein + Walthert AG)  
Smart thermal grids: operational experience with low temperature  
grids in Zurich
- 11:25 - 11:45 **Germany** – Christian Hecht (Stadtwerke München, SWM)  
The Projekt GRAME - One Step towards our 2040 Vision of 100%  
Renewable District Heating in Munich
- 11:45 - 12:10 **Netherlands** – René Verhoeven + Herman Eijlerts (Mijnwater B.V.)  
Mijnwater Haarlem - Development of carbon neutral areas with  
thermal smart grids and geothermal
- 12:10 - 12:30 Discussion
- 12:30 - 13:45 Lunch**
- 13:45 - 15:25 Session III: Direct use applications (new concepts – other sectors)**
- 13:45 - 14:05 **Italy** – Adele Manzoni, CNR  
Direct use of heat for industrial/civil processes (the TBC)
- 14:05 - 14:25 **Netherlands** – Henk de Bejer (SolarCool®)  
Cooling with Geothermal energy and local storage
- 14:25 - 14:45 **Switzerland** – Erik Anct + Philip Klingler (Gruener AG)  
District heating coupled with a seasonal heat storage in a deep  
aquifer (city of Oltraringen)
- 14:45 - 15:05 **Italy** – Ruggero Bertani (Enel Green Power)  
Geothermal for Agriculture and Food
- 15:05 - 15:25 Discussion



Geothermal ERA-NET / IEA Geothermal  
Joint Workshop on "New Concepts –  
New and Innovative Applications  
of Geothermal Energy"

Friday, 30<sup>th</sup> of October 2015:

- 15:25 - 15:40 Coffee break**
- 15:40 - 17:00 Session IV: Innovative Applications of Geothermal Direct Use worldwide**
- 16:40 - 18:00 **Northern America** – Arlene Anderson (US Department of Energy, USA)
- 16:00 - 16:20 **Asian region** – Kazumi Yasukawa (National Institute of Advanced  
Industrial Science and Technology (AIST), Japan)
- 16:20 - 16:40 **New Zealand and Australia** – Brian Carey (GNS, New Zealand)
- 16:40 - 17:00 Discussion
- 17:00 - 18:00 Visionary Panel Discussion, Conclusions and Next Steps**
- 17:00 - 17:20 Aljona Wiktoria Stoklosa (Startup Energy Reykjavik, Iceland)
- 17:20 - 18:00 Paul Ramsak (RVO), Hjalfr Páll Ingólfsson (GG) & Brian Carey (GNS)
- 18:00 - 19:00 Networking Réception**
- Moderator Þóra Margrét Þorgeirsdóttir**

Venue [Le Domaine de Penthes](#) | Pregny-Chambésy, Genève, Switzerland  
Chemin de l'Impératrice 18



Supported by the Swiss Federal Office of Energy  
Swiss Confederation  
Swiss Federal Office of Energy 2015



Geothermal Era-Net project is supported by the European Union's Seventh Programme for  
research, technological development and demonstration under grant agreement No 291855



# Your New Concepts Moderator



**Þóra**  
Þorgeirsdóttir





## Contact Geothermal Energy leader WP2 Information Exchange

## NL Enterprise Agency Geothermal ERA-NET

[www.rvo.nl/aardwarmte](http://www.rvo.nl/aardwarmte)  
[www.rvo.nl/topsector-energie](http://www.rvo.nl/topsector-energie)



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Netherlands Enterprise Agency  
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Geothermal Energy


Slachthuisstraat 71  
P.O. Box 965  
6040 AZ Roermond, The Netherlands

[www.geothermaleranet.eu](http://www.geothermaleranet.eu)

## **Presentation IEA GIA – Brian Carey (GNS, New Zealand)**

New Concepts Joint Activity

**Brian Carey** has over 25 years' involvement in geothermal energy developments at a commercial and project level. Since 2007 he is working at GNS. He has a strong, established network of geothermal contacts both in New Zealand and overseas, supported by membership of a number of professional organisations, including IPENZ and the NZ Geothermal Association. Brian's professional interests include geothermal resource utilisation specialising in reservoir utilisation, steam field engineering, steam field energy management, electric power generation and environmental planning.

[Back to the program](#) 





# New Concepts

30th October 2015

8:30 am to 5 pm Penthes Geneva

## Today



- **Dream – how high can geothermal use go**
- **Growing geothermal energy**
- **Great opportunities for networking**
  - Broadening your geothermal connections
- **Thank you**
  - Gunter Siddiqi, SFOE for hosting
  - Katharina Link for the inspiration for today
  - Geothermal ERA-NET for working together
  - Presenters

# Introduction - Brian Carey



- **Geothermal Resource Management Specialist**
  - GNS Science
- **President**
  - New Zealand Geothermal Association
- **Chair**
  - Geothermal Heat Pump Association of NZ
- **Executive Secretary**
  - IEA Geothermal
- **Co - organiser**



# Geothermal at Heart



- 30 + years in Geothermal Energy
  - 1981 to now
- 20 + years – resource operations
  - 1985 - 2007
- Trained
  - Mechanical Engineer

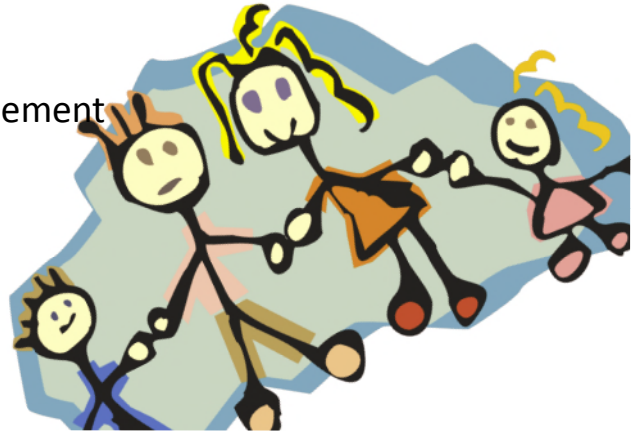


# IEA Geothermal



- **Cooperation and collaboration**
  - National, organisational and industry geothermal programmes
- **17 members**
- **Sharing Information**
- **Developing technologies, techniques and best practice**
- **Preparing & disseminating authoritative information**
- **Operative since March 1997**
  - IEA - Geothermal Implementing Agreement

IEA - GIA



# 17 IEA Geothermal Members



- **13 Countries.**
  - Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Switzerland, United Kingdom, United States.
- **European Commission**
- **Three Industry / Organization Members**
  - Ormat
  - CanGEA
  - APPA

## Technical Activity



- **Working Groups**
  - Called Annexes
- **Geothermal has five**
  - Environmental
  - Direct Geothermal
  - Deep Roots of Volcanic Systems
  - Emerging Geothermal Technologies
  - Data and Information Collection
- **Web presence**

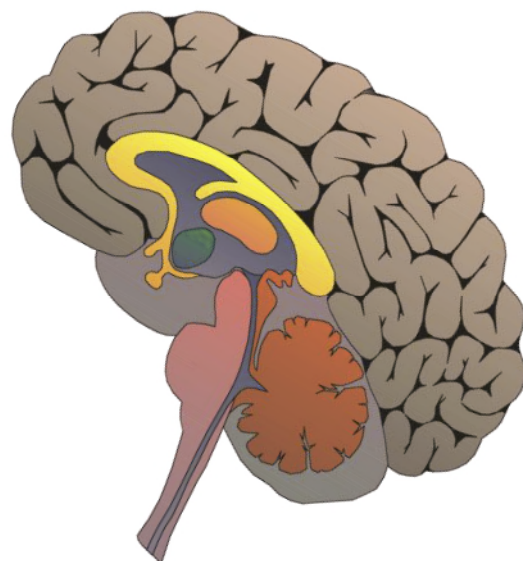
[www.iea-gia.org](http://www.iea-gia.org)



## Great Information



- Trend reports
- Country reports
- Annual Summary Reports
- Technical Reports
- Workshop Presentations





# Direct Use - Annex VIII

Includes Geothermal Heat Pumps



Request Information →

Browse: Home / Work Program / Annex VIII – Direct Use

## Annex VIII- Direct Use of Geothermal Energy

Operating Agent: GEOTERMIE.CH, Swiss Geothermal Society, Switzerland

Annex Leader: Katharina Link, Dr. Roland Wyss GmbH, Switzerland

Status: Ongoing

Participants: CanGEA, France, Iceland, Japan, New Zealand, Republic of Korea, Switzerland, United Kingdom, United States

Description

# Direct Use



## Lead by Katharina Link

Dr. Roland Wyss GmbH, Switzerland

Email: [link@rwgeo.ch](mailto:link@rwgeo.ch)

- A New and innovative direct use applications**  
Brian Carey, GNS Science, New Zealand
- B Communication**  
Alison Thompson, CanGEA, Canada
- C Guidelines for Geothermal Energy Statistics**  
Jonas Ketilsson, Orkustofnun, Iceland
- D Guidelines for GSHP statistics**  
Yoonho Song, KIGAM, Korea
- E Design Configuration and Engineering Standards**  
Rudolf Minder, SFOE, Switzerland



## Direct Use - Objectives



### ➤ Cooperation and sharing

International arena

- Increasing the use of direct geothermal energy technologies
- Raising awareness of the advantages of direct geothermal
- Targeting several different topic workshops each year

## Get involved



- If your nation is a member of IEA Geothermal
  - You can be actively involved in leading work activity.
- If not organise your government to join, or
- Work with a sponsor organisation to join.

## Future Workshops



- Geothermal cooling
- Direct use
  - Mexico, and Central and South America
- Keep a look out

## Today's Programme



- **Fantastic**
  - Variety
  - Novelty
  - Conceptual
  - Implemented
- **Paul Ramsak will introduce the programme**
- **From IEA Geothermal a very big thank you**
  - Katharina Link
  - Paul Ramsak
  - Alicja Stoklosa
  - Hjalti Ingolfsson



**Enjoy**

## Session I EGS projects + direct use applications

### Switzerland – Peter Meier (Geo Energie Suisse AG)

**Title:** EGS-Projects of the Geo-Energie Suisse AG: the new concept

**Presenter** Mr. Peter Meier a civil engineer for rural areas from the Federal Institute of Technology in Zürich. Since 2011 he is CEO of Geo-Energie Suisse AG, a company founded in November 2010 by seven Swiss utilities with the objective to get a break-through of deep geothermal energy in Switzerland.

#### Abstract

The Haute-Sorne pilot project in Canton Jura, Switzerland, is the first project worldwide that foresees multistage stimulation to achieve water circulation between two deep boreholes drilled through the crystalline basement. The project is in the final phase of obtaining the risk guarantee from the State that covers up to 60% of the exploration costs in case of failure. As a pilot and demonstration project, subsidies from the State can be expected. There are three stages of implementing it: 1<sup>st</sup> Phase: 2016-2018, 2<sup>nd</sup> Phase: 2018-2019, 3<sup>rd</sup> Phase: 2019-2020.

[Back to the program](#) ↑

# MULTI-STAGE EGS HAUTE-SORNE PROJECT

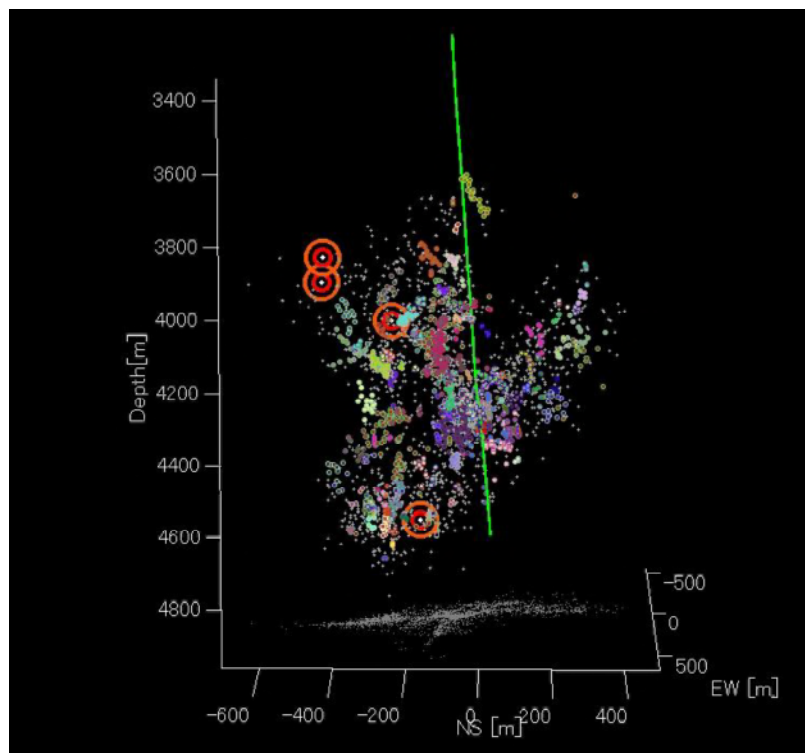
DR. PETER MEIER, CEO

GEO THERMAL ERA-NET NEW CONCEPTS PROGRAM, GENEVA 30.10.2015



Basel reservoir stimulation in principle successful, but  
1) induced seismicity too strong, 2) permeability too low

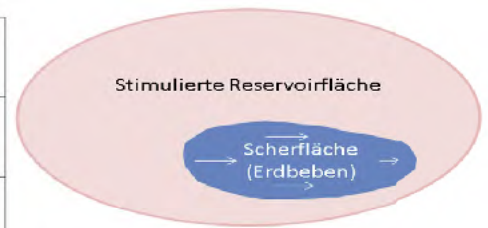
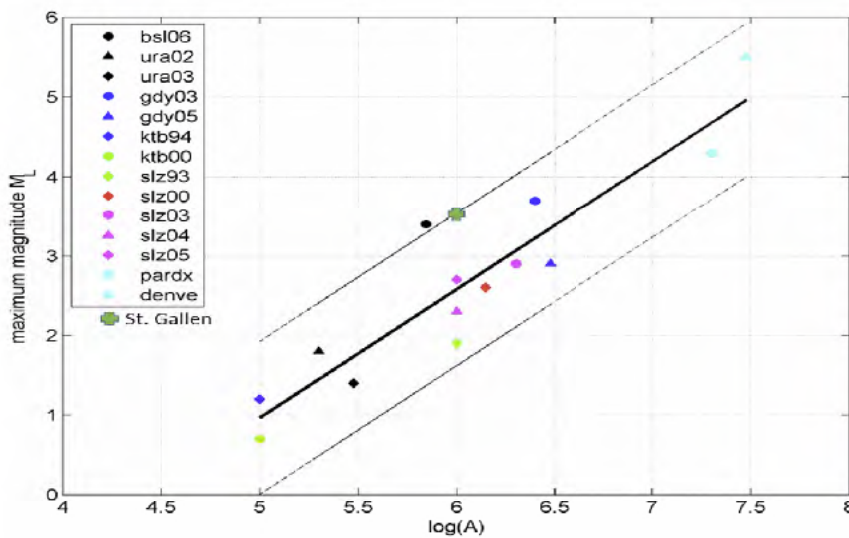
2





## Key findings seismicity (Serianex, 2009): Magnitude of induced seismicity increases with stimulated reservoir area

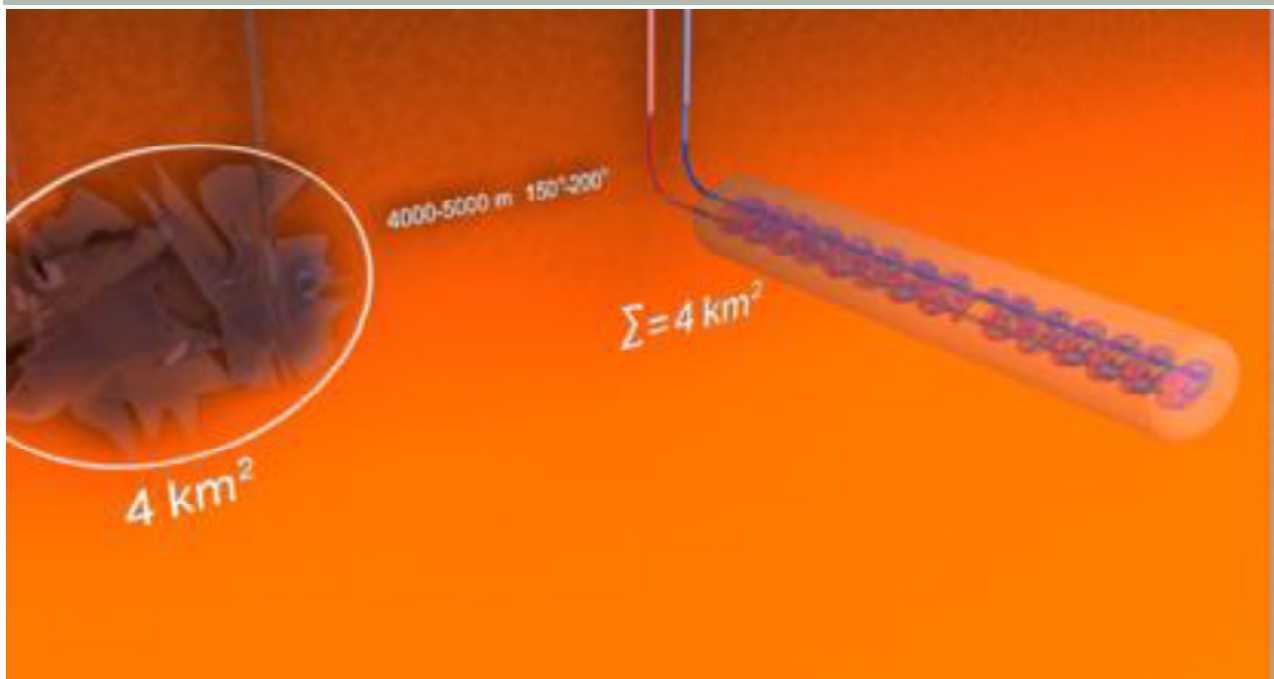
3



Nach St.Gallen:  
Stimmt unser  
Konzept?

Detailed analysis of the Basel data set and numerical simulations corroborate this general relationship from many data sets worldwide. Also the project in St. Gallen follows this relationship.

## Concept DHM Basel vs. „new“ horizontal multi-frac system



# Drilling

5

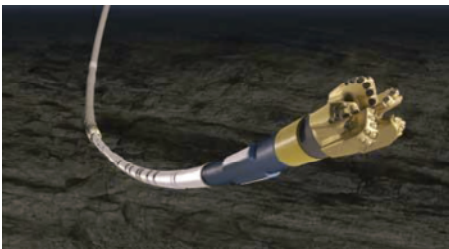
Weight on Bit



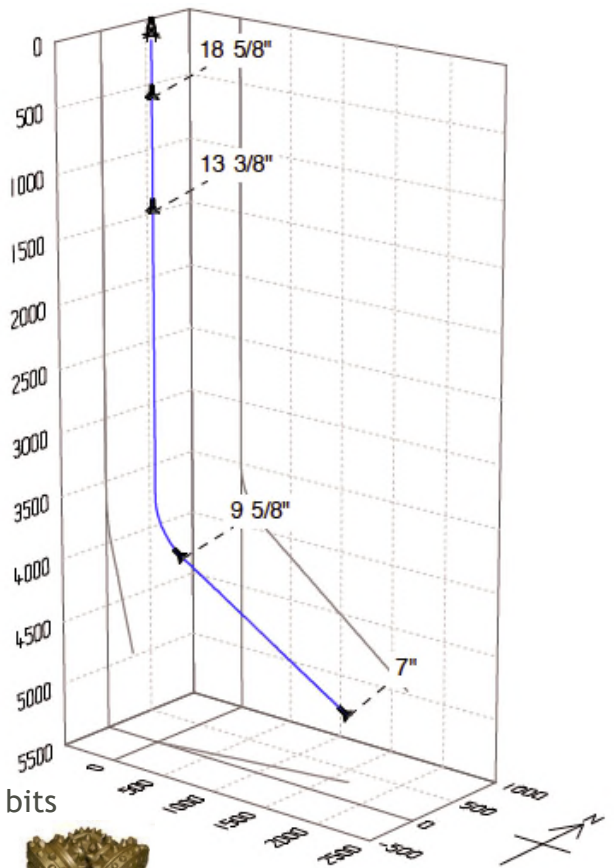
PDC bit



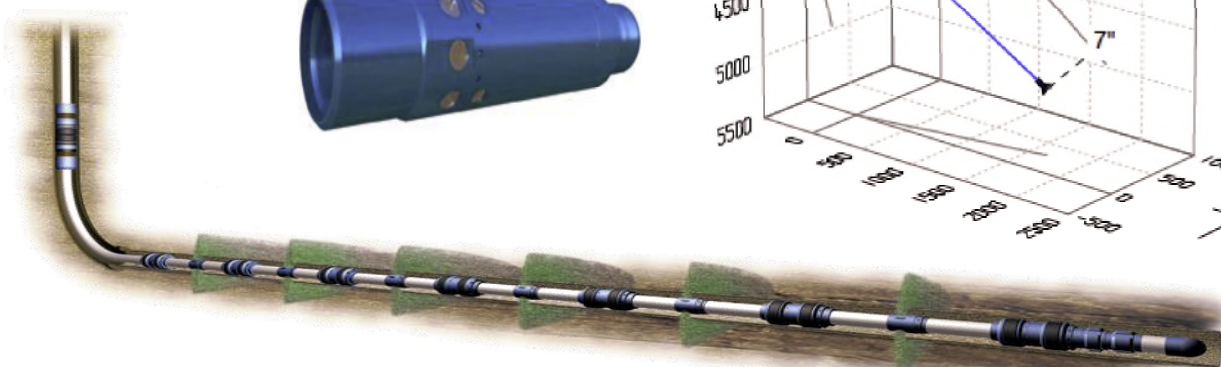
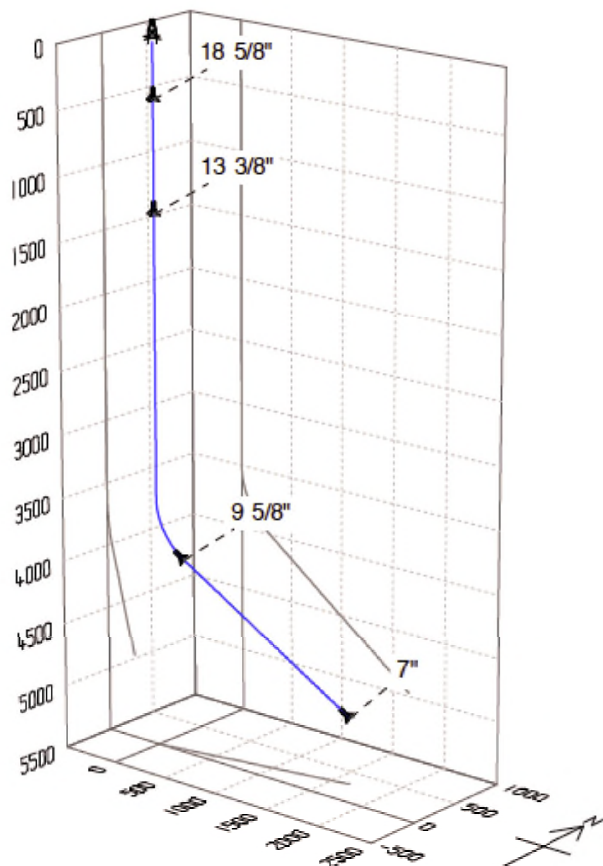
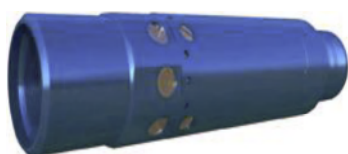
Rotary steerable



Tricone drill bits



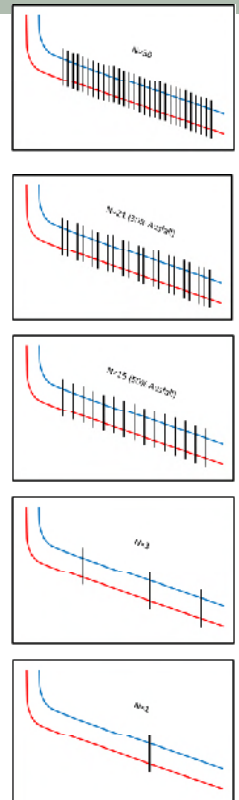
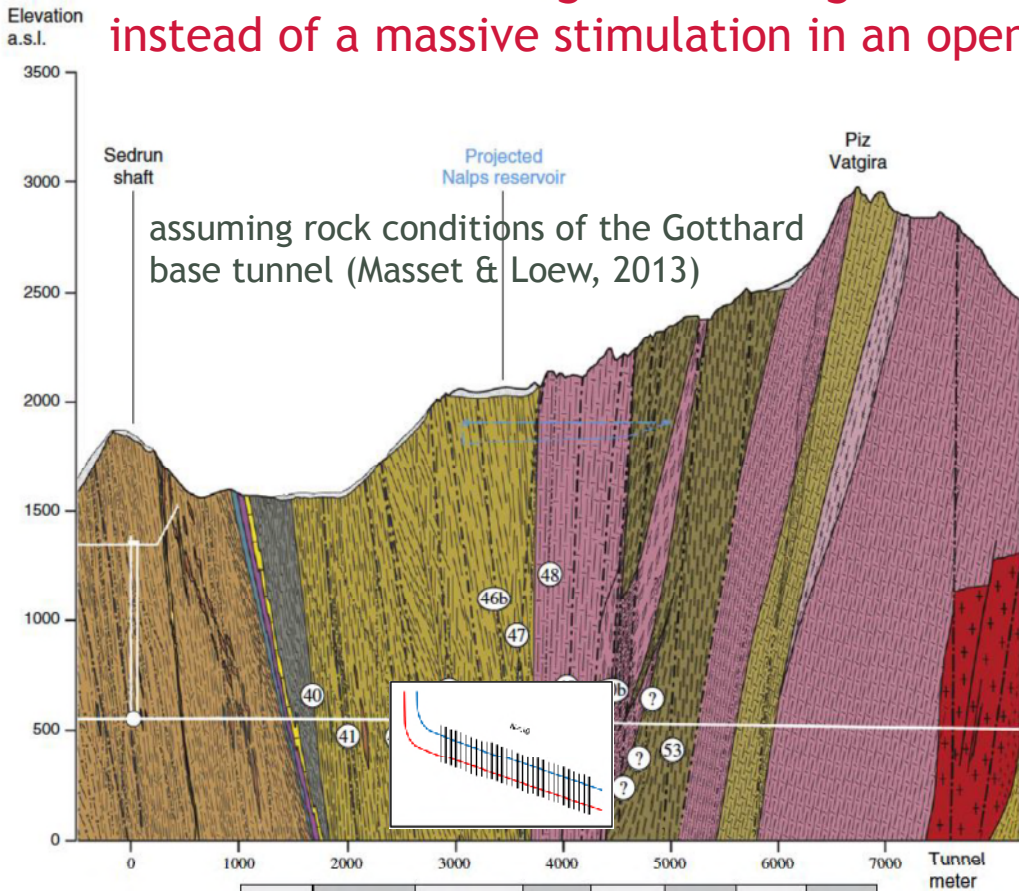
# Multi-zonal isolation



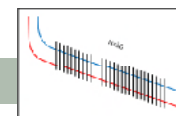
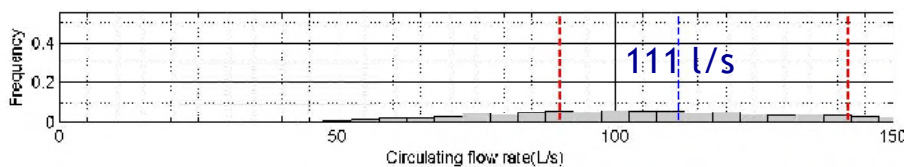


# Monte Carlo simulations demonstrate the improvement of circulation rates using a multi-stage stimulation system instead of a massive stimulation in an open borehole

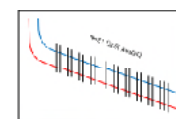
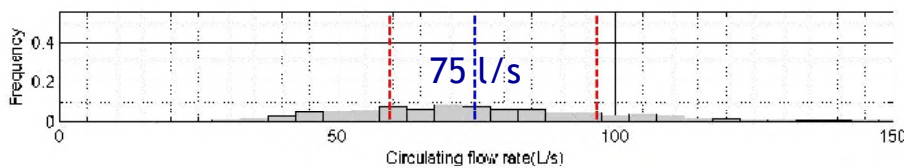
Masset & Loew, Engineering Geology 119 (2013) 50-61



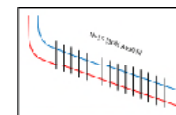
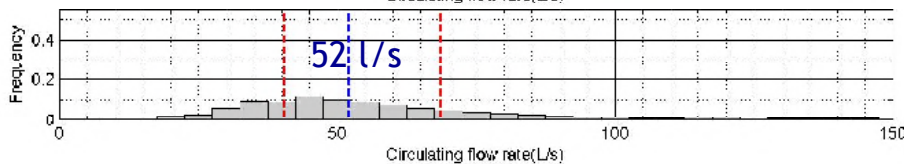
## Flow rates from MC calculations for different numbers of successful stages versus open-hole stimulation



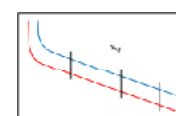
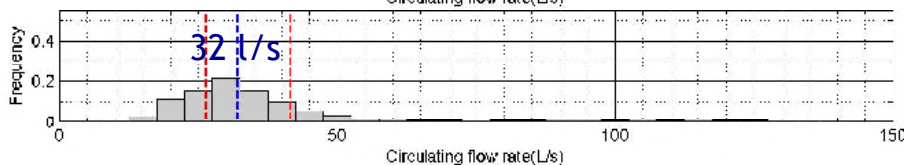
30 stages



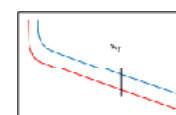
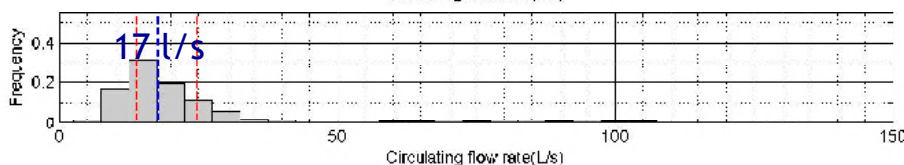
20 stages



15 stages



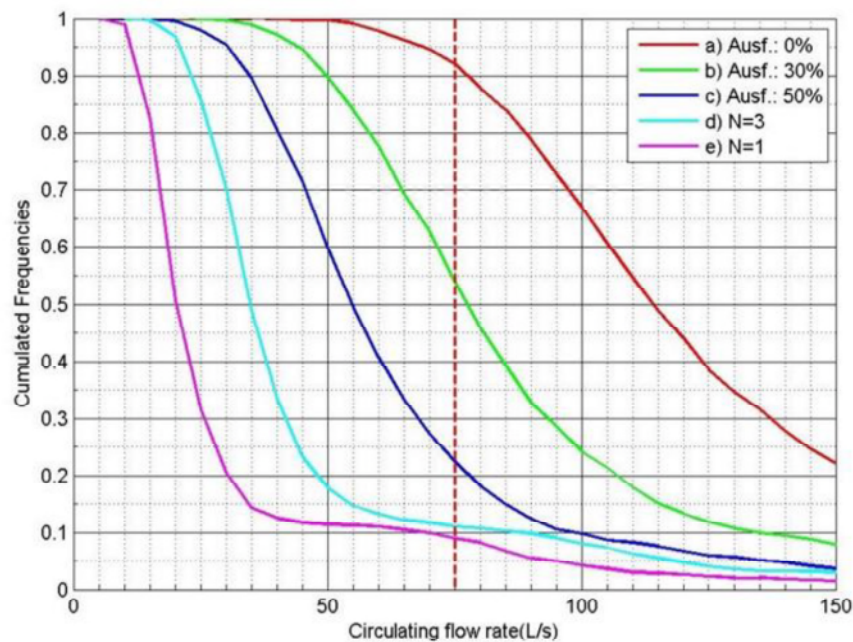
Open-hole stimulation of 3 fractures



Open-hole Stimulation of 1 fracture


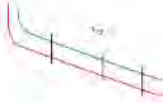



Medium Transmissivity (Gneiss, Masset & Loew 2013, Higher Bound K)

Monte-Carlo simulations of circulation flow rates assuming fractured Gneiss of the 50 km Gotthard Base Tunnel in Switzerland  
Horizontal 30-(or 20 or 15 or 3) stage-stimulations vs. Open-hole stimulation



## Efficiency of the multi-stage vs. single open-hole systems

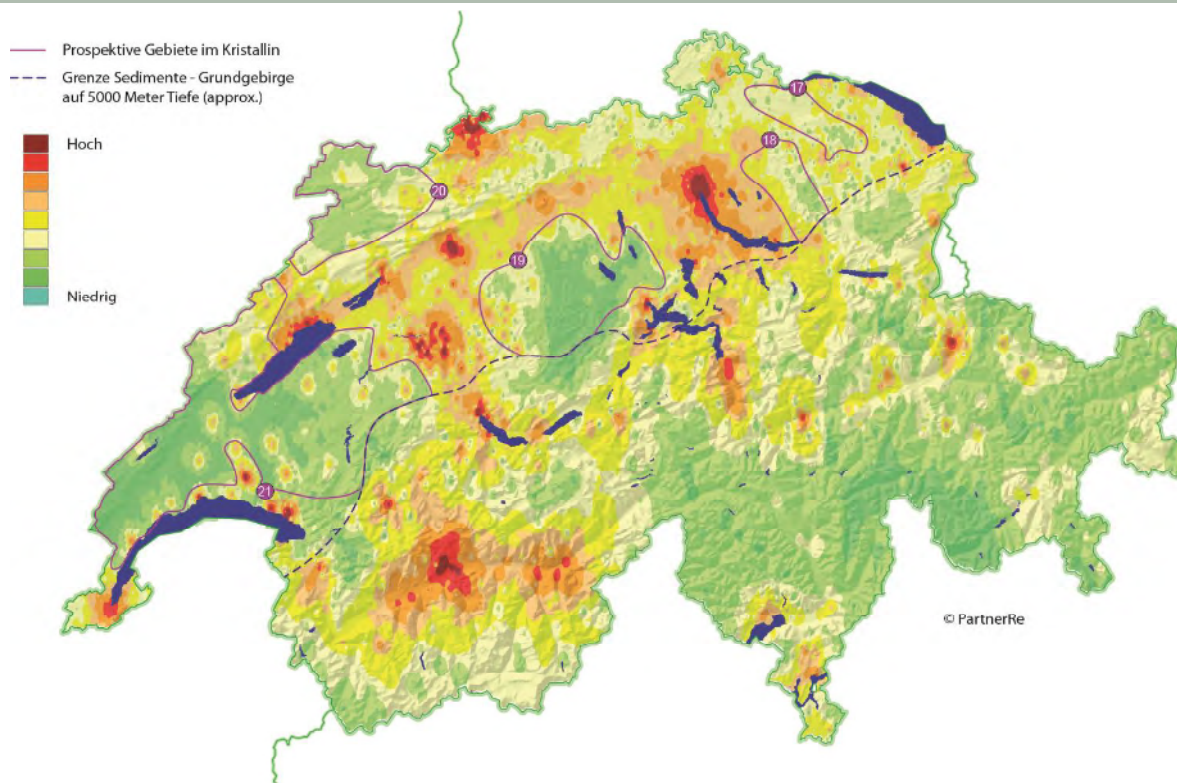
10

Utilisation System	Increase Factor of:	
	El. Power	Costs
 Vertical Single-Open-Hole-System, 1 fracture	1	1
 Single-Open-Hole-System, 3 fractures	1.8	1.2
 Multi-Stage-System; 50% failure rate of stages.	2.9	1.6
 Multi-Stage-System; 30% failure rate of stages.	4.2	1.6
 Multi-Stage-System; 0% failure rate of stages.	6.2	1.6



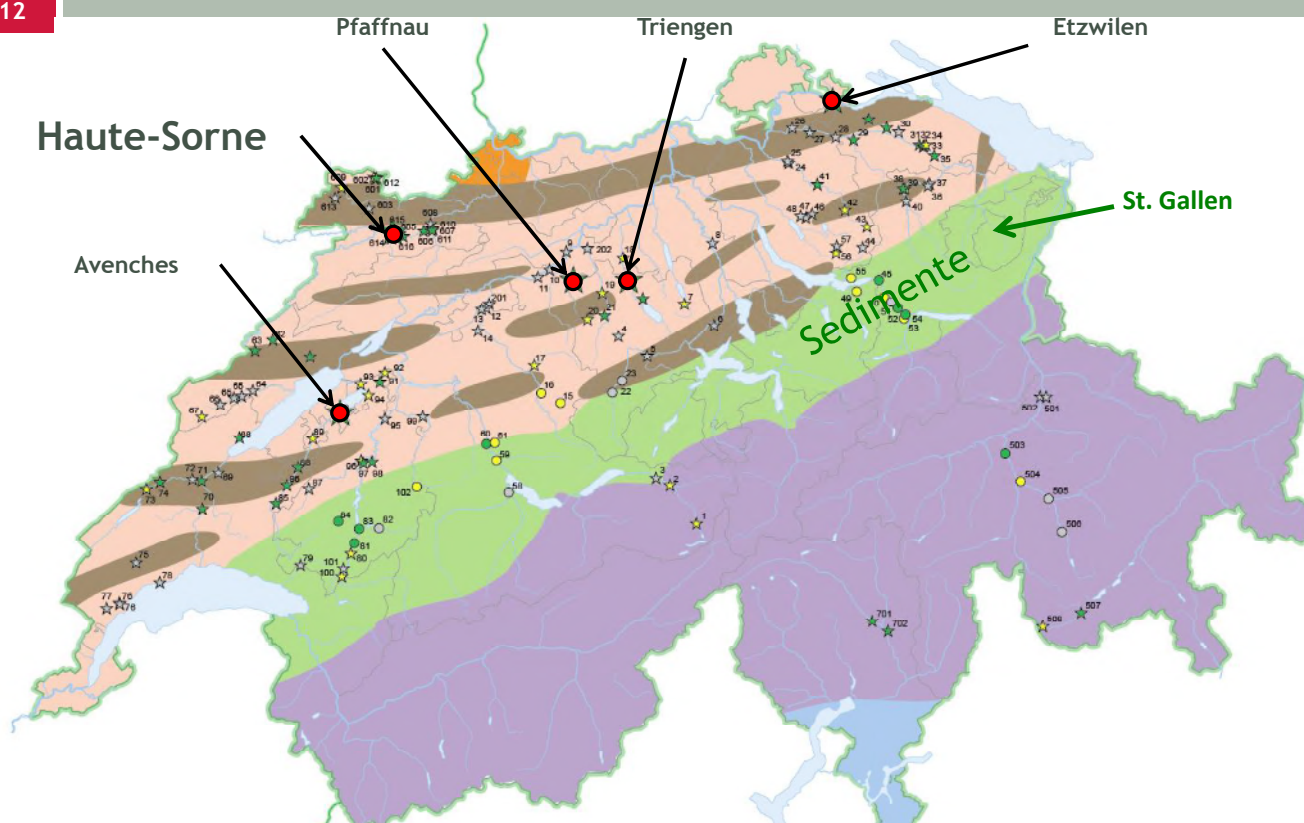
# Low risk areas for first pilot projects and safety distance to large fault zones

11



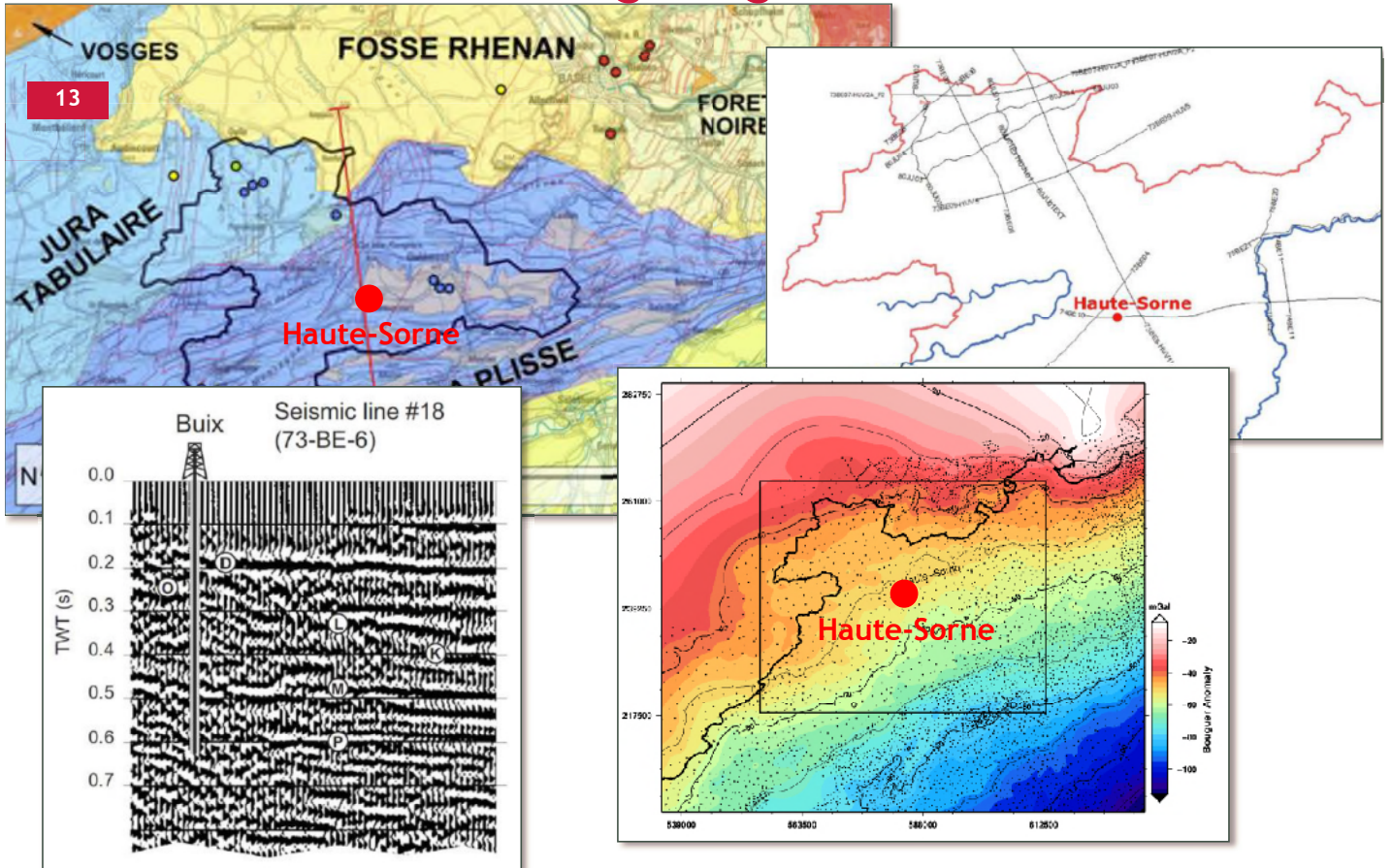
130 potential sites for pilot projects were evaluated within different plays within crystalline basement and sediments

12

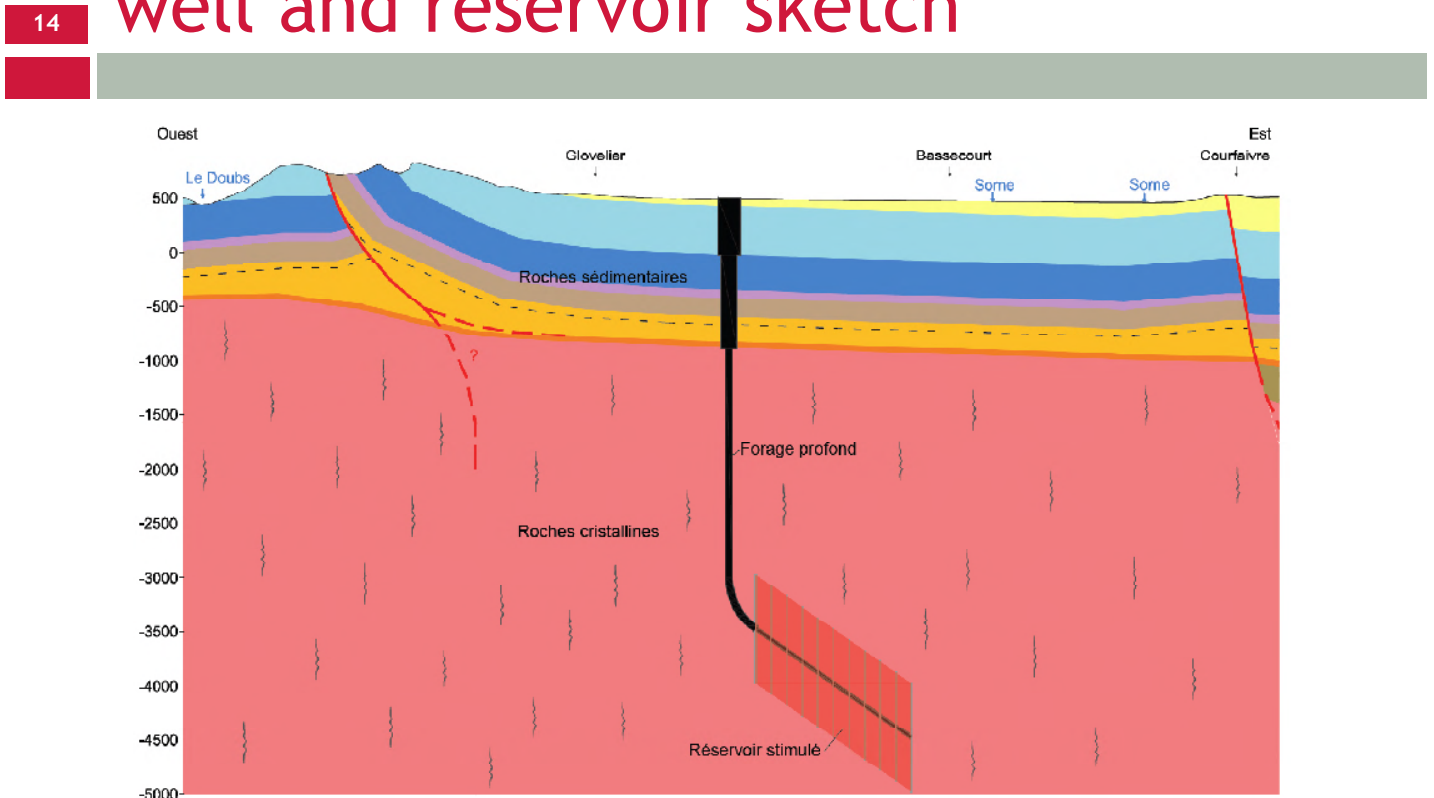


# Regional geology

## Construction of the geological model

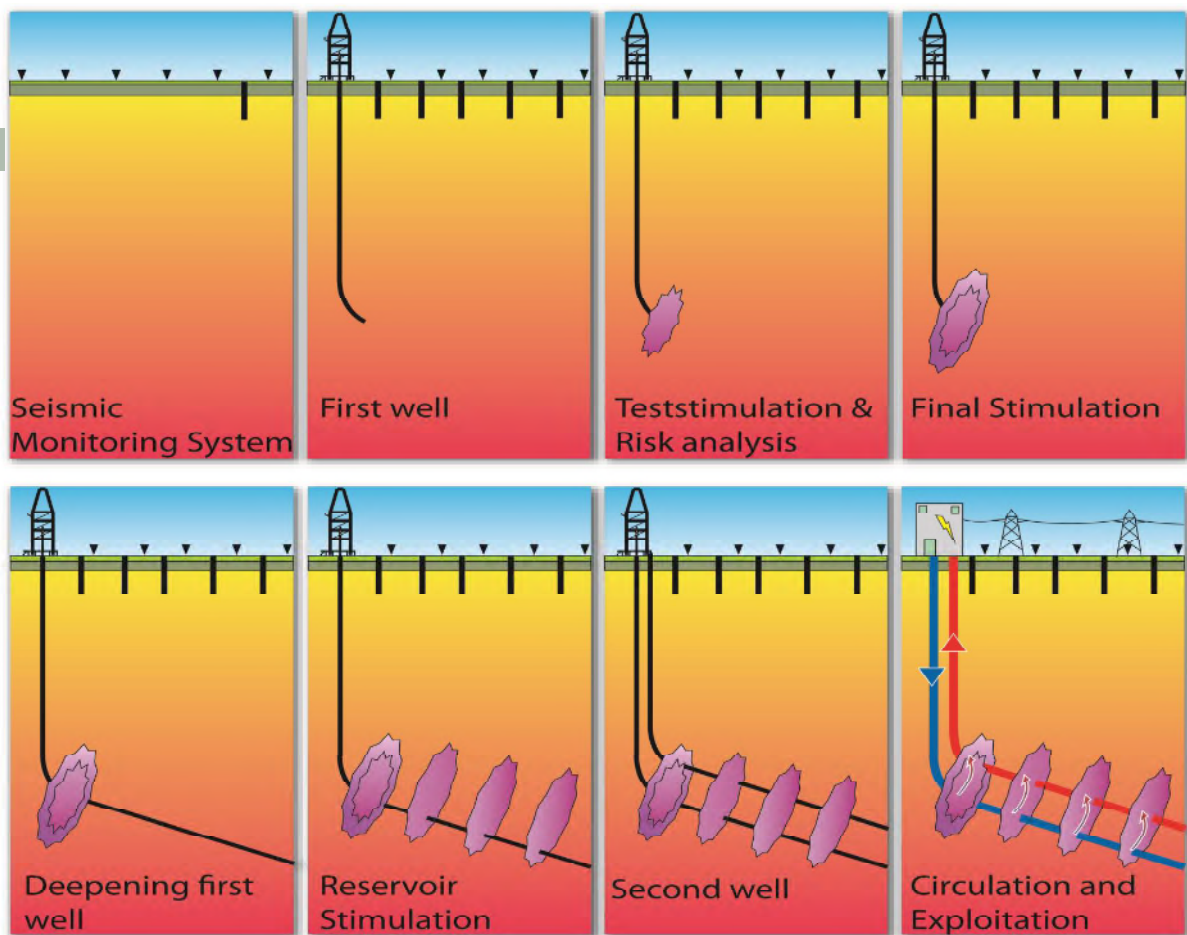


# Geological cross-section with well and reservoir sketch



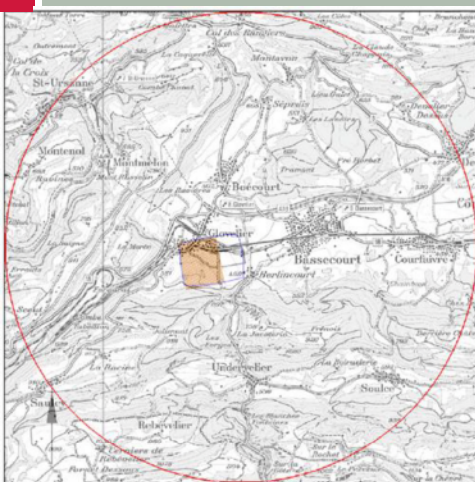


# Conceptual design

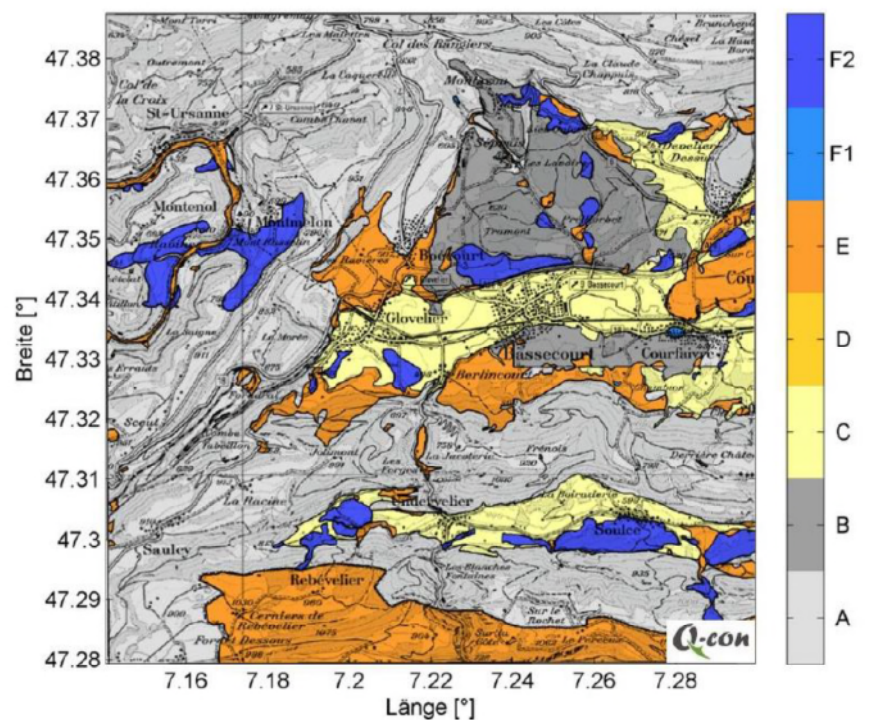


## Deterministic study (Q-con) Numerical modeling of ground motions

16



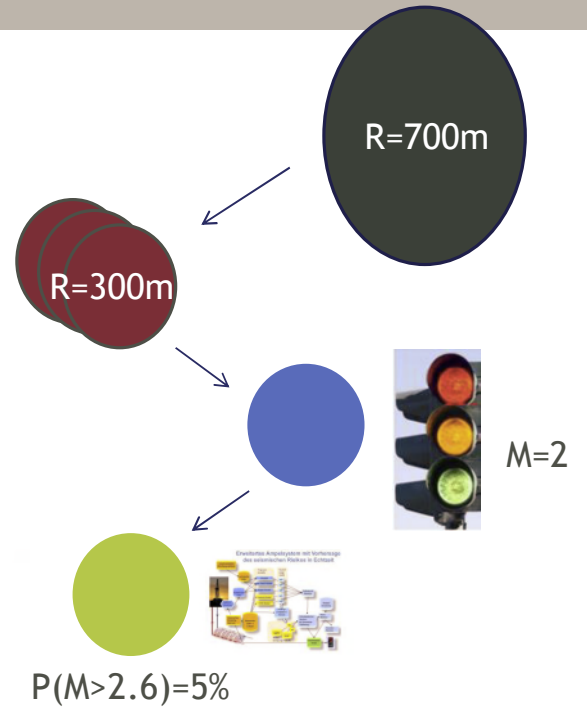
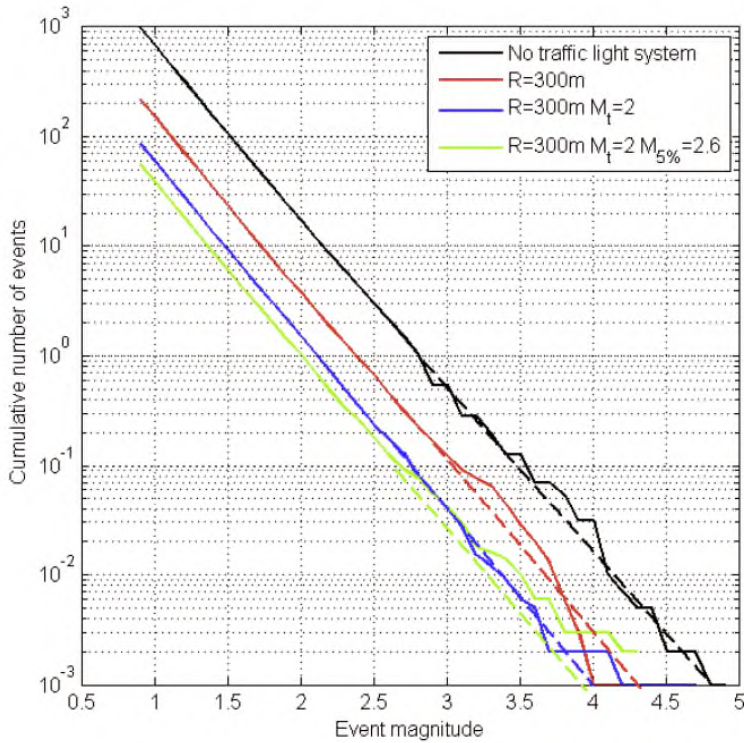
- Mw=2.6
- Damage < 5000 CHF





# Probabilistic risk study according to SED philosophy & ATLS

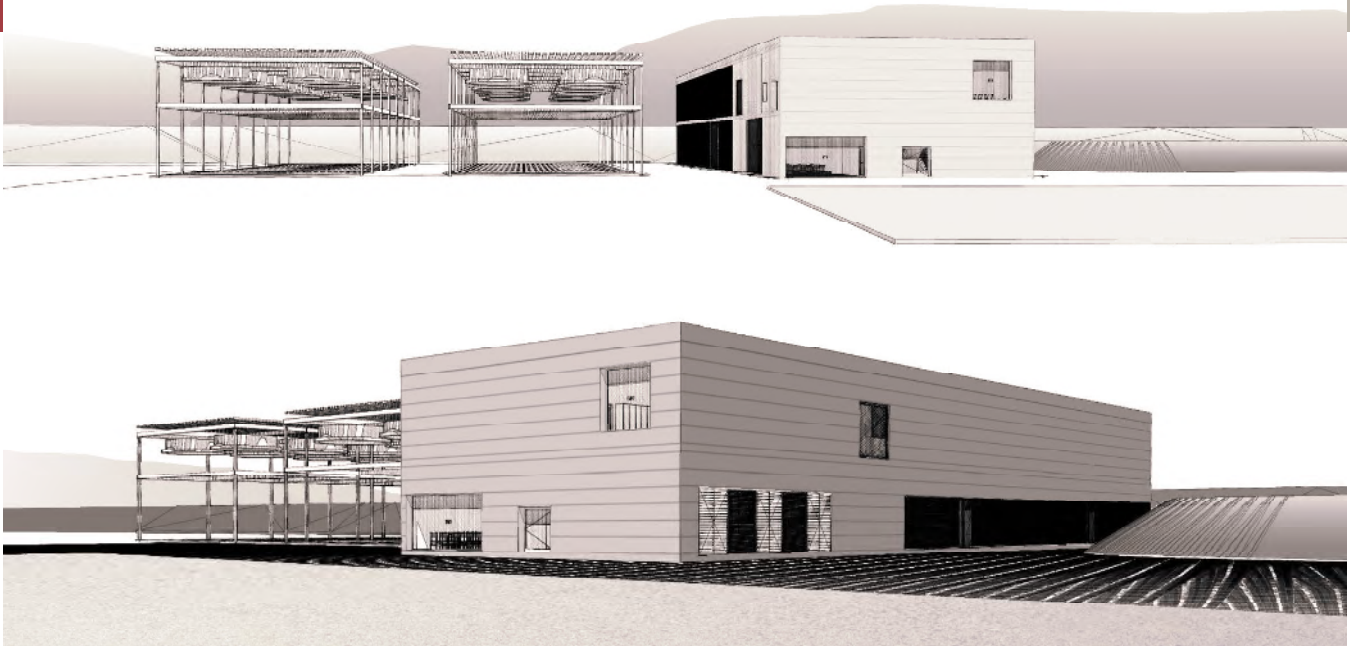
17



## Project site in Haute-Sorne

18





plans: Kury&Stahelin

## Request for construction permit: environmental impact study & extensive risk study



January 2014





# Accompanying Group

21

- Deliver detailed information to all stakeholders
- Communication relay with the population
- Project improvement driven by the group's feedback



## Press

22

### Un an pour étudier et affiner le plan spécial de la centrale géothermique de Glovelier

Si ces types évolués de forage sont aujourd'hui techniquement possibles et économiquement abordables, les trois plus prometteurs: Eitzwilen (TG), Avenches (VD) et Haute-Sorne.

Un an pour étudier et affiner le plan spécial de la centrale géothermique de Glovelier

La commune de Haute-Sorne a été sélectionnée parmi 130 en Suisse pour accueillir une centrale pilote de géothermie profonde. Le sous-sol du Jura recèle un haut potentiel de cette énergie propre, inépuisable et continue. Ayant profité de cinquante ans d'expérience, les techniques de forage ont beaucoup évolué, devenant plus sûres et efficaces. Associations et population de Haute-Sorne ont été consultées lors de la séance publique de concertation.

La centrale pilote de géothermie profonde sera implantée à Glovelier, au lieu-dit Pré Beuchin, à la sortie du village en direction de Bassecourt.

Toutes les précautions sont prises pour protéger l'environnement et habitants, assure le gouvernement dans une réponse à une question écrite du Parlement.

La population sera largement informée grâce à un tous-ménages distribué d'ici la fin du mois, tandis qu'une adresse électronique dédiée, [geothermie@haute-sorne.ch](mailto:geothermie@haute-sorne.ch), recueille d'ores et déjà questions et doléances.

Un faisceau de critères a conduit au choix de ce groupe de trois parcelles, situées en terres agricoles et proches de zones humides.

Le bâtiment de dépollution de la future centrale géothermique de Glovelier avec, à côté, les pompes thermiques qui abaisseront la température du fluide géothermique au chauffage du village.

Un trou scruté à la loupe

Ces trois sujets préoccupent naturellement le groupe CS-POP/Vers. Dans une question au Parlement, le député Emmanuel Martinoli s'enquiert des mesures d'accompagnement de cette centrale pilote. Le Gouvernement montre sa volonté d'associer la population à ce projet novateur. « Imprimé ces jours en Haute-Sorne, un tous-ménages va être distribué prochainement aux habitants. Une adresse électronique est également à disposition pour plus d'informations. »

Particulier à la surveillance des risques sismiques, la nuisance sonore et la sauvegarde des eaux souterraines et de surface, que retienne, dit le député, est sensiblement de celle employée à malheureux de Saitz type hydrothermal. Il y aura de petites secousses, car la sismicité tectonique sera pour nous le seul moyen de savoir ce qui se passe dans le sous-sol, a expliqué Olivier Zingg, chef de projet chez Geo Energie Suisse qui a établi un certain bâtonnet qu'en cas de dégat, nous puisse tout de dédommager les victimes.

Répondre à nos interrogations

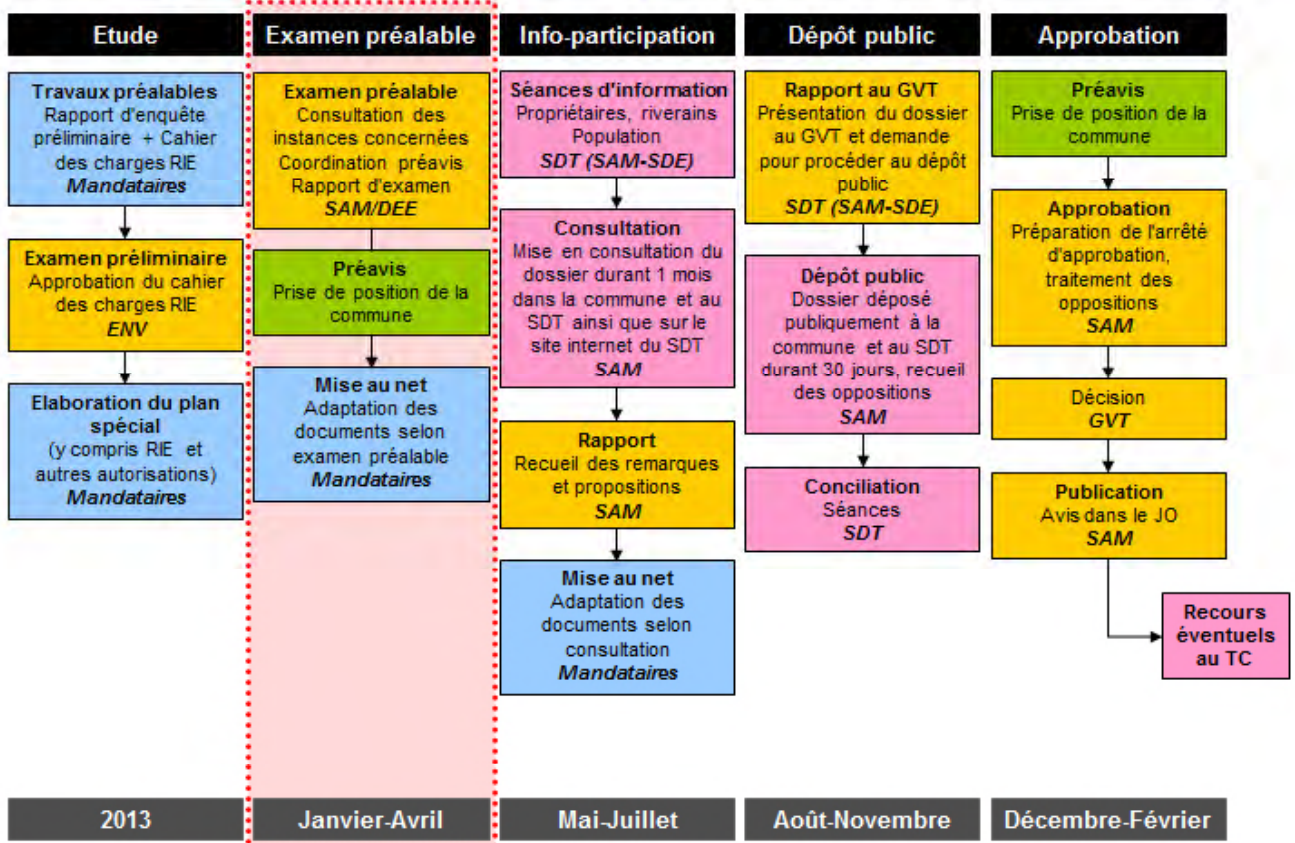
Conseiller de Haute-Sorne, Christophe aux tr pas d'accompa jet, qui compt techniciens de la nature des milieux, mes pas l' mais pour mations f exte raper voi dor objectif.

Un trou à Glovelier

All press releases and news can be downloaded at: <http://www.geo-energie.ch>



# Plan spécial cantonal – procédure



## Haute-Sorne: construction permit from the République and Canton du Jura (15.6.15)

Signature of the collaboration contract Canton Jura, Community of Haute-Sorne And Geo-Energie Jura SA



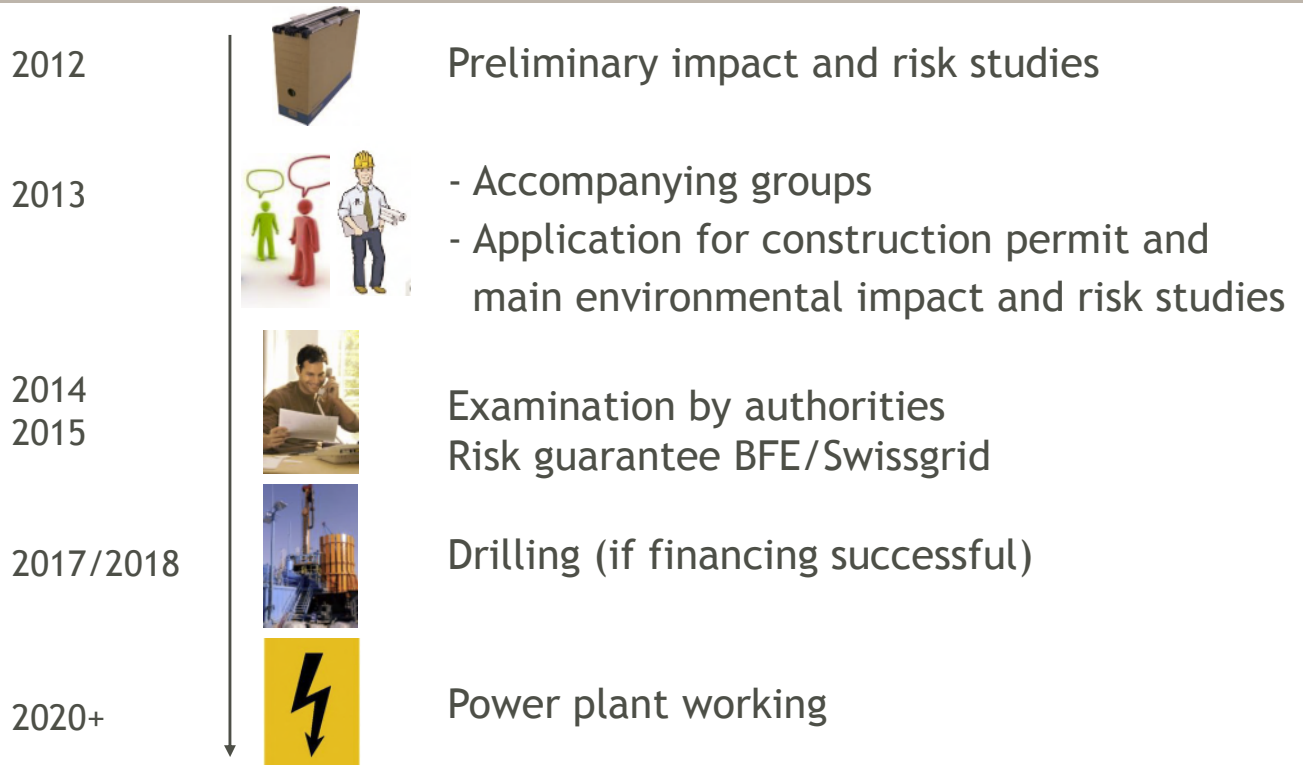
P. Meier, CEO Geo-Energie Suisse

Ph. Receveur, Minister Canton Jura

J.- B. Vallat, Mayor Haute-Sorne

# Time plan Haute-Sorne

25



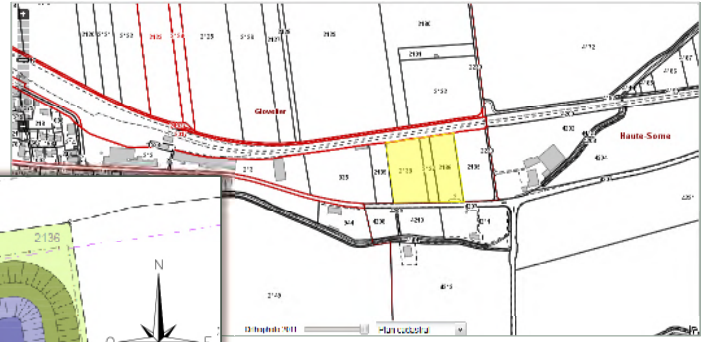
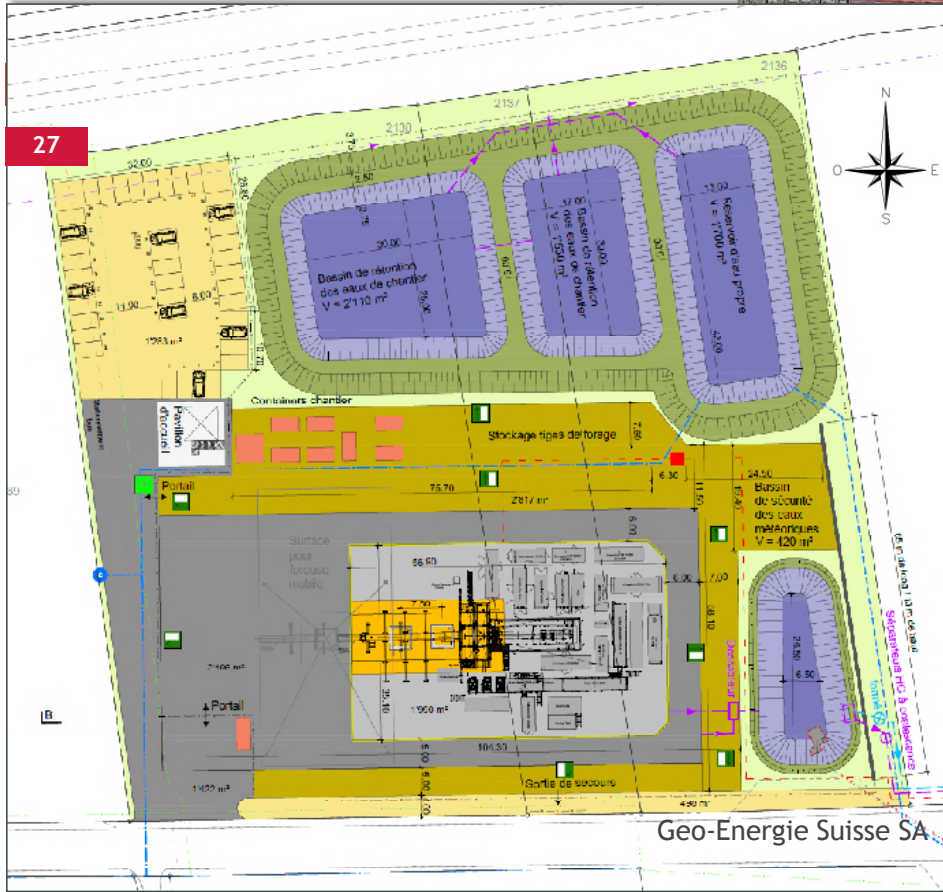
Two visits of geothermal power plants in Germany organised for the accompanying group and representatives of the communal and cantonal authorities

26

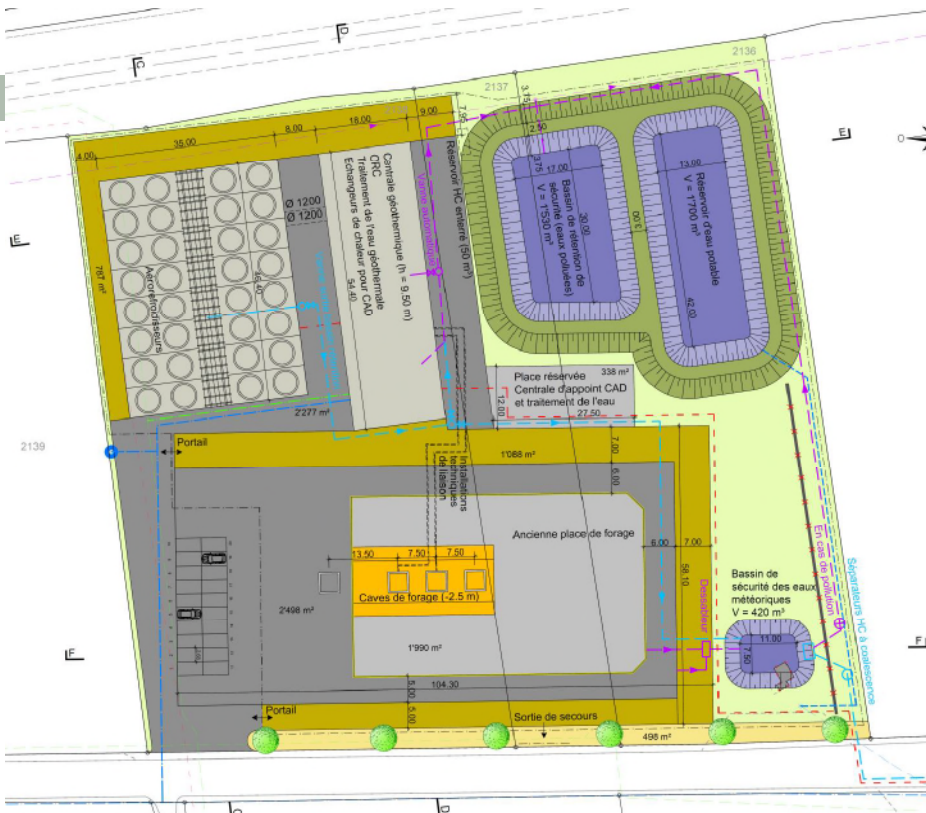




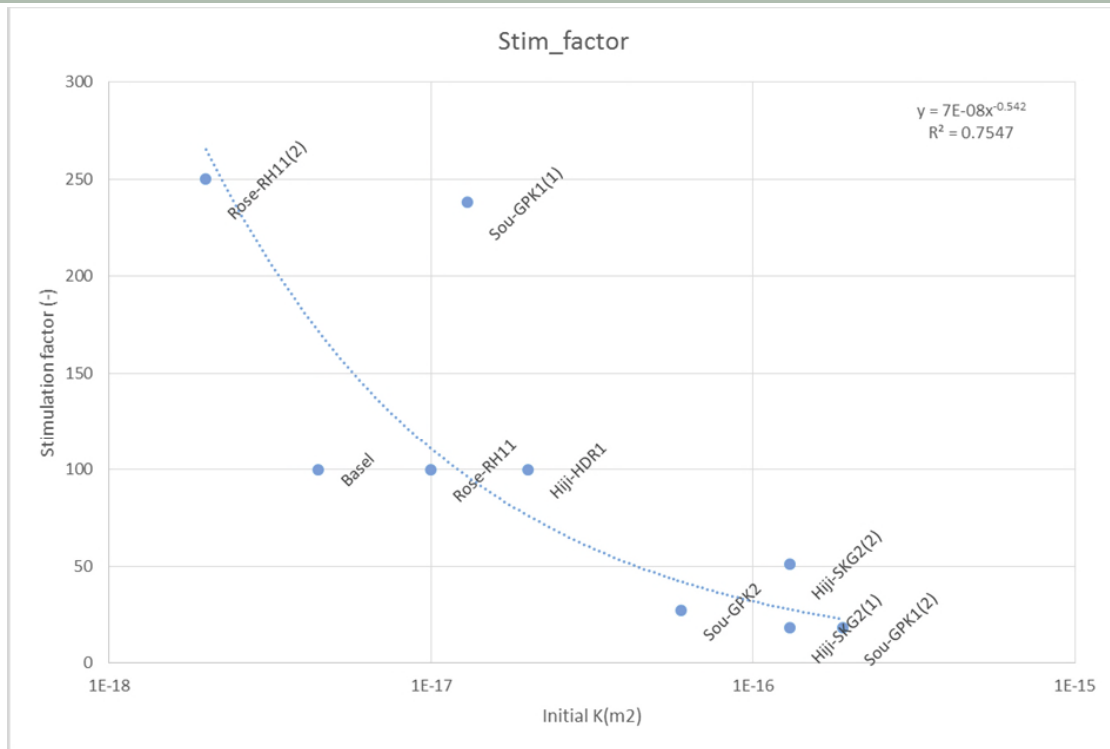
# Drillpad



# Power plant



# Stimulation factor (Evans, 2013)

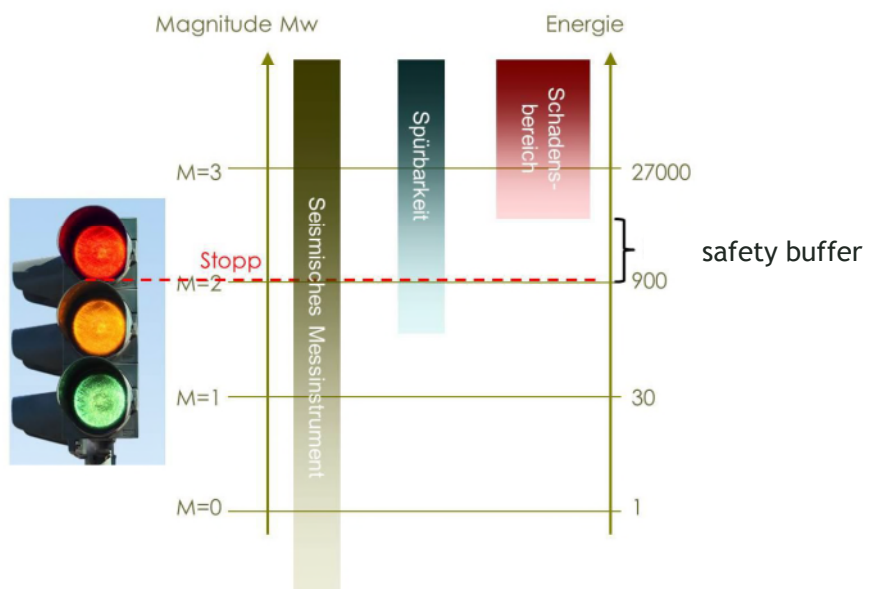


## Traffic light system with lower thresholds

30

### Ampelsteuerung

A system of predefined thresholds allows an automated stop before damage occurs





# Convention Tripartite

## Fondation de Geo-Energie Jura SA

31



1. Société de projet domiciliée dans la commune
2. Possibilité de participation des collectivités publiques
3. Accès de la Commune et du Canton à toutes les informations relatives à la société

Geo-Energie Suisse SA 15 juin 2015

# Convention Tripartite

## Rémunérations

32



1. Redevance de 0.5 cts / kWh électrique produit
2. 60% au Canton et 40% à la Commune. La Commune l'investira dans les énergies renouvelables et l'efficacité énergétique
3. Redevance unique de 100'000 francs à la Commune et au Canton

Geo-Energie Suisse SA 15 juin 2015

# Risque sismique

33

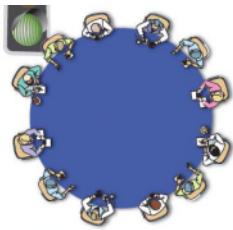


SED  
Schweizerischer Erdbebendienst  
Swiss Seismological Service

Expertise du Service  
sismologique suisse



Etude de risque  
très poussée



Groupe d'experts  
neutres

**Maîtrise  
du risque**

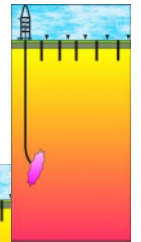


Seuils d'arrêts  
plus bas -Energie S

Surveillance en  
temps réel



Test de  
stimulation



Réalisation  
en étapes



## Etablissement des preuves et assurances



### Etablissement des preuves

- Protocoles de fissure
- Mesures de vibration
- Mise en œuvre avant le début du forage



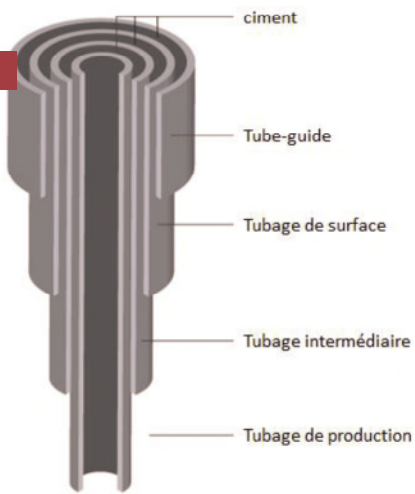
### Assurance RC

- Couverture risques sismiques et environnementaux
- Expertise aux frais de Geo-Energie
- Police validée par le Canton

# Protection des eaux souterraines

## Protection contre le bruit

35



Protection des  
eaux souterraines

Contrôle des  
émissions sonores

Geo-En



## Hungary – László Adam (Mannvit)

**Title:** What are the challenges and new concepts in South Hungarian Enhanced Geothermal System (EGS) Demonstration Project?

**Presenter:** Mr. László Ádám, a head geologist employed by Mannvit with professional experience in geothermal research, tectonics, sedimentology, environmental geology and GIS. In the implementation of SHEGSDP he is responsible for evaluation of geological and geophysical data for locating EGS wells, description of expected circumstances, interpretation of seismic data, mapping of fracture zones.

### Abstract

Project SHEGSD- the South Hungarian Enhanced Geothermal System project, which jointly promoted by NER300 funding program, Hungarian Government and the Steering Group of the EU Strategy for the Danube Region is a technological initiative to test the suitability of implementation of an EGS pilot plant in Pannonian basin, Central Europe. The project aims 8.9 MWe net power to grid expecting 280 kg/s sum production flow rate, 170 °C inlet and 90 °C outlet temperature of power plant by drilling approximately 10 wells into 3000-3500 m depth interval. The project is in Exploration Phase, the Technical Operation Plan for drilling has been approved and the expected date for drilling of first EGS well is 1st half of 2016. The project will be executed in Békés County, in the vicinity of towns of Mezőkovácsháza and Kunágota. Technology resulting power increase, cost savings and reduced operational risk, in good case both at once. Special attention will be given for EGS characterization tools. By using stress and fracture analysis from BHTV, hydro shear model, interpretation of size and shape of induced seismicity and data of distributed temperature sensing system significant dataset will be gathered to evaluate and characterize relationships between observed phenomena and processes.

[Back to the program](#) 

# Challenges and new concepts in South Hungarian Enhanced Geothermal System (EGS) Demonstration Project?

László Ádám  
Head geologist  
Mannvit Kft.

Geothermal ERA-NET / IEA Geothermal  
Joint Workshop on „New Concepts – New and Innovative Applications of Geothermal Energy”  
Geneva, 30th October 2015



Expertise  
Success  
Value

## Abstract

The South Hungarian Enhanced Geothermal System Demonstration Project jointly promoted by NER300 funding program, Hungarian Government and the Steering Group of the EU Strategy for the Danube Region is a technological initiative to test the suitability of implementation of an EGS pilot plant in Pannonian basin, Central Europe, which is a compressional tectonic setting.

The project aims 8.9 MWe net power to grid expecting 280 kg/s sum production flow rate, 170 °C inlet and 90 °C outlet temperature of power plant by drilling approximately 10 wells into 3000-3500 m depth interval. The project is in Exploration Phase, the Technical Operation Plan for drilling has been approved and the expected date for drilling of first EGS well is 1st half of 2016. The project will be executed in Békés County, in the vicinity of towns of Mezőkovácsháza and Kunágota.

The area is a plain, agricultural area characterized by low population density within Hungary. The EGS reservoir will be created in the likely fractured, pre-Tertiary basement, in which the expected rocks are granitoids (granite, granodiorite) and metamorphic crystalline schists (gneiss, mica-schist). Well-explored sediments of Neogene and Quaternary age overlie pre-Tertiary basement. The first well will be deviated one with 3500 m true vertical depth respectively. The expected bottom hole temperature is 200 °C.





# Abstract

The main professional requirements of the well are: protection of shallow aquifers with a separate casing string, minimum 1000 m long casing for protecting the top part of the basement, because of excess formation fracturing, and minimum 1000 m long open hole. By drilling technical point of view the crystalline basement is poorly explored, in addition to risk of overpressure is anticipated. During the reservoir stimulation several thousands cubic meter water will be injected at moderate well head pressure inducing shearing processes within the rock frame. Due to prevailing present stress the slipping fractures remain open because of self-propping characteristic of uneven surfaces.

The growth of seismic cloud will be monitored by micro seismic array, and traffic light system described in induced seismic risk mitigation plan will be used avoiding damages caused by induced seismicity. Most of the stimulation job performed in EGS could induce only one fracture system per well. The multi-zone stimulation, when succeeding fractures zones are temporary closed and stimulated at the same time by adding thermally-degradable zonal isolation materials (TZIM) could provide solution to increase the power output of a well. SHEGSDP will use AltaRock TZIM Technology resulting power increase, cost savings and reduced operational risk, in good case both at once. Special attention will be given for EGS characterization tools.

By using stress and fracture analysis from BHTV, hydroshear model, interpretation of size and shape of induced seismicity and data of distributed temperature sensing system significant dataset will be gathered to evaluate and characterize relationships between observed phenomena and processes. Increasing the reliability of stimulation job two, electric, centrifugal, 14 stage pumps connected by 10 inch pipes and four valves will be used.



MANNVIT



NEMZETGAZDASÁGI  
MINISZTERIUM



## France – Martino Lacirignola (ADEME)

**Title:** ECOGI - an EGS project for the industry in the Upper Rhine Graben

**Presenter:** Mr. Martino Lacirignola is a project officer and scientific advisor for the French Environment and Energy Management Agency (ADEME). He is involved in the coordination of several supporting programs for renewable energies, including the *Investments for the future* scheme and the *Renewable heat fund*. Martino represents ADEME as the French delegate for the geothermal ERA-NET program.

### Abstract

The ECOGI geothermal project, located in the Upper Rhine Graben, was initiated in 2011. It is designed to deliver a power of 25 MW<sub>th</sub> at the “Roquette Frères” bio-refinery in Beinheim in order to cover around 25% of the process heat needed by this industrial site. The drilling site is located in Rittershoffen, 6 km east of Sultz-sous-Forêts, in Northern Alsace, France. The project is supported by the “ADEME”, the “Conseil Régional d'Alsace” and “SAF Environnement”. ECOGI is a joint venture; the shareholders are “Electricité de Strasbourg” Group, “Roquette Frères” and a public institution “Caisse des Dépôts et Consignation”

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# ECOGI : an EGS project for the industry in the Upper Rhine Graben

Martino LACIRIGNOLA, M.Eng.

**ADEME**

French Environment and Energy Management Agency



## About ADEME

French environment and energy management agency

ADEME is a **public agency** under the joint authority of the *Ministry for Ecology, Sustainable Development and Energy* and the *Ministry for Higher Education and Research*.



### Missions:

- ✓ supervising & coordinating the application of **environmental policies** and supporting public authorities for their **design**
- ✓ encouraging and **animating** the sector, providing **expertise** and advice
- ✓ facilitating and undertaking operations of private & public entities with the aim of **protecting the environment** and **managing energy**

## ECOGEI:

### Exploitation de la Chaleur d'Origine Géothermale pour l'Industrie (*Exploitation of geothermal heat for industrial applications*)



- ✓ **First geothermal project** at high temperature ( $>150^{\circ}\text{C}$ ) in France for a heat application (target of  $24\text{MW}_{\text{th}}$ )
- ✓ **Lessons learned from the Soultz-sous-Forêts EGS** successfully applied for enhancing permeability and targeting the second well
- ✓ **15 km** transport loop
- ✓ Development of **expertise** for stimulations, optimized well emplacement and hydraulic testing of deep fractured rocks

3

## The application

### Roquette Frères bio-refinery in *Beinheim*

- Major player in starch manufacturing (3.1 B€ turnover, >8k employees, 21 sites)
- Products: Polyols (Sugar alcohols), Proteins & Derivatives, Starches
- Markets: Nutrition, pharmacy, green chemistry



- Beinheim site energy needs:  $\sim 100\text{MW}_{\text{th}}$   
→ Geothermal project: 25% of the energy demand
- Global strategy: reduction of the gas consumption by 70%: geothermal energy, biomass, reduction of the demand

4



## The project



Joint venture:

- Groupe *Electricité de Strasbourg* (energy provider): 40%
- *Roquette Frères* (bio-refinery): 40%
- *Caisse des dépôts*: 20%



- 55 M€ Total investment
- 18+6 M€ French incentive from the *Renewable Heat Fund* (ADEME)
- Risk insurance mechanism:
  - *Short term guarantee covering 10% to 60%*
  - *Long term guarantee*

5



## Technical data

<b>2 Wells</b>	2500-3000 m
<b>Operating Hours</b>	8.000 h/year
<b>Temperature</b>	170° C
<b>Transport Loop</b>	15 km
<b>Thermal Power</b>	24 MW <sub>th</sub>
<b>Reduction of GHG emissions</b>	40 kt/y



6



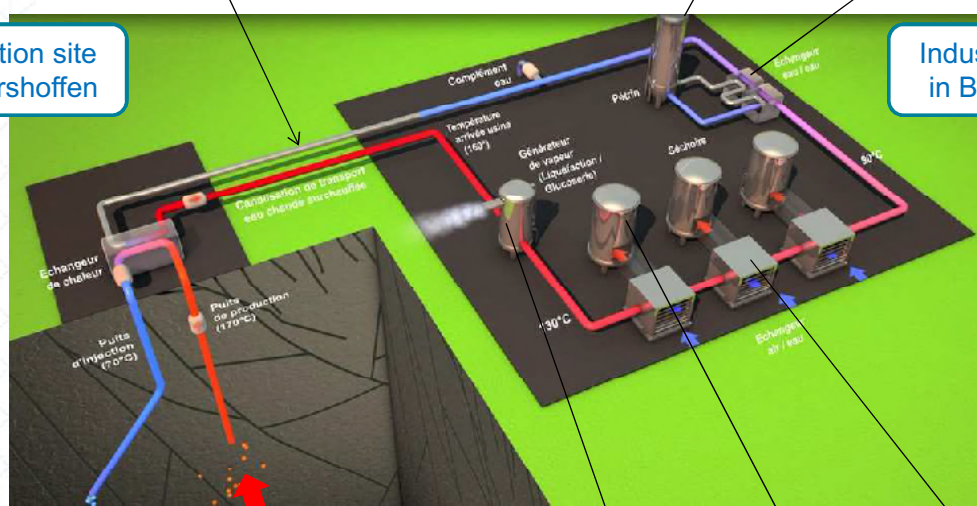
## The ECOGI concept

15 km transport of overheated hot water:  
double-envelope pipe to lower energy  
losses (maximum 3° C)

multiple applications in series:

Production site  
in Rittershoffen

Industrial site  
in Beinheim



24 MW<sub>th</sub>; 70l/s, 170° C

steam prod.

Starch dryer

Water/air HH

## Planning

2011	2012	2013	2014	2015	2016
------	------	------	------	------	------

ECOGI  
JV creation

Civil works  
Platform construction

GRT1  
Drilling and well development

Seismic  
Survey

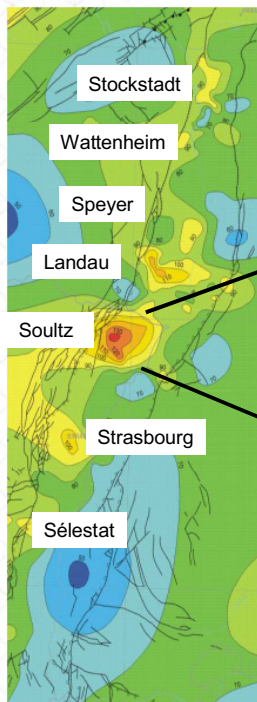
GRT2  
Drilling and tracer tests

Surface loop  
Thermal plant  
Thermal loop  
Bio-refinery

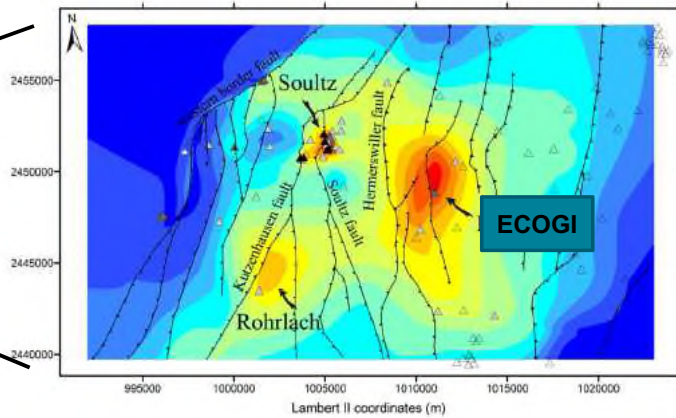


ECOGI  
Commissioning

## Background: a series of geothermal anomalies in the Upper Rhine Graben (URG)



Temperature distribution within the URG at 1500 m depth (LIAG)



Fault map and temperature field between Sultz and Rittershoffen

Baillieux, 2012

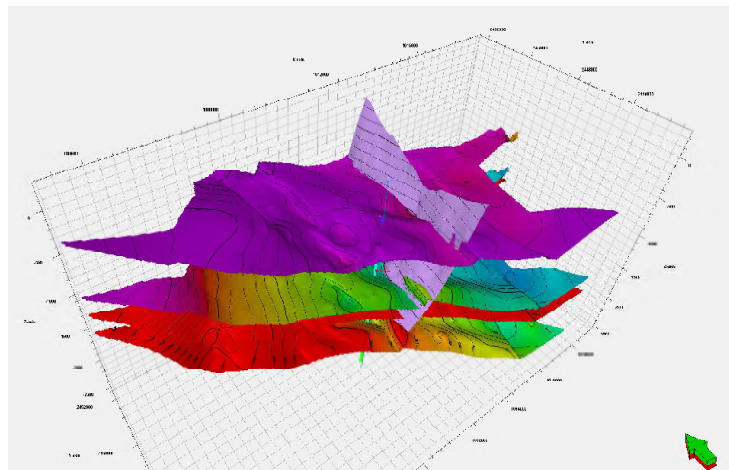
9

## Modelisation

- ✓ Seismic acquisition
  - ✓ Acoustic imaging
  - ✓ Elaboration of data from existing oil wells
  - ✓ ...
- New skills and expertise developed by ES-Group

esg  
és géothermie

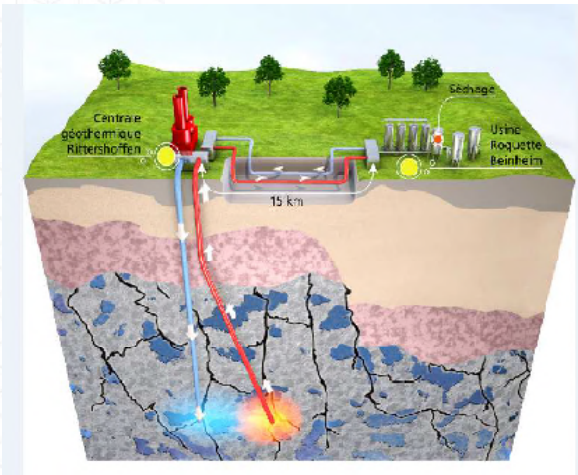
groupe ES



10

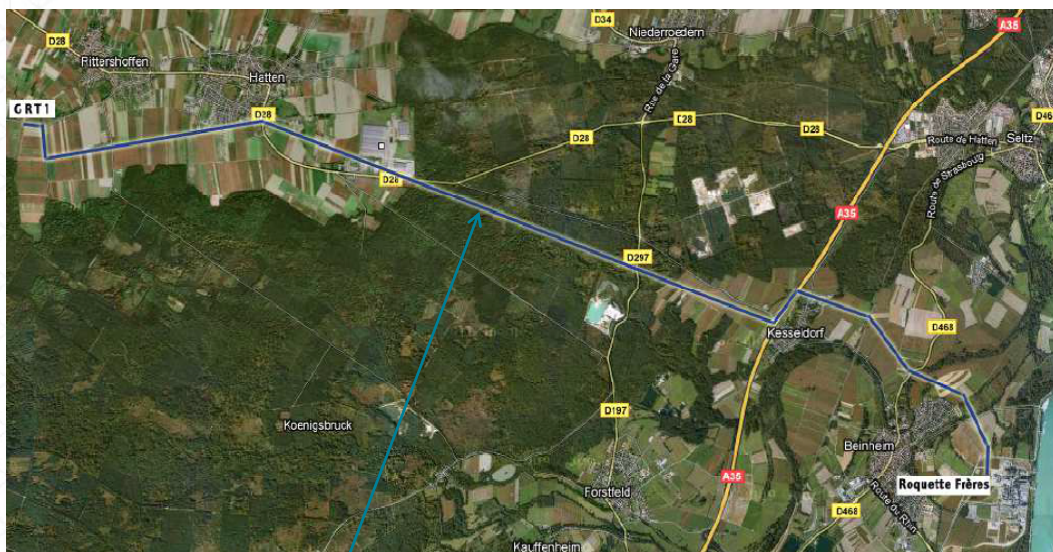


## Geothermal doublet : GRT-1 + GRT-2



- **GRT-1** : vertical well, 2600 m (600 m open section)
- **GRT-2** : deviated well, 3200 m (1000 m open section)
- Distance at the bottom: 1200 m
- Target: a faulted structure
- All wells achieved in 2014

## Over-heated pipeline from Rittershoffen and Beinheim



15 km transport loop between Rittershoffen and Beinheim

## Over-heated pipeline from Rittershoffen and Beinheim



**High temperature pipe :**  
 steel cased pipe-in-pipe  
 with vacuum, preloaded  
 ID : 250 mm  
 OD : 450 mm  
 thermal losses:  
 4° C/15km



**Return pipe :**  
 insulated pipe  
 ID : 250 mm  
 OD : 450 mm  
 Thermal losses:  
 3° C/15 km



## ECOGI: Well development and testing

### GRT-1 Well development

- Cold fluid reinjection (4200 m<sup>3</sup>, < 25 l/s, < 35 bars)
- Chemical cleaning with biodegradable products
- Hydraulic improvement of the well (3150 m<sup>3</sup>, < 80 l/s, < 35 bars)  
 ⇒ **Injectivity x 5**



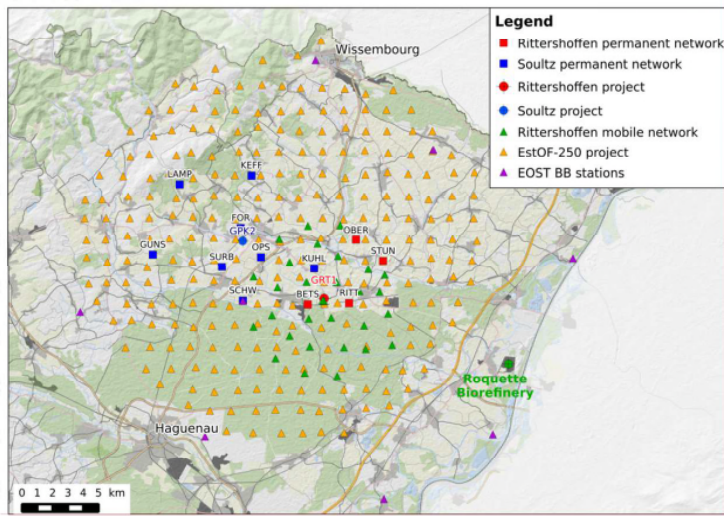
### GRT-2 Well testing

- Good production well
- No need for stimulation
- Tracer test between GRT-1 (injection well) and GRT-2 (production well)

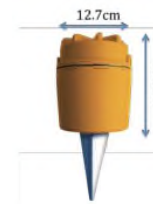




## Seismic monitoring



- More than 300 stations installed
- More than 500 micro-EQ automatically detected between 2012 and 2015
- $M_{lv}$  max : 1.5
- No micro-EQ felt by population



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## An example of collaboration: an Upper Rhine Valley alliance

- ÉCOGI benefits from the know-how of the German-French pilote project of Soultz-sous-Forêts
- ÉCOGI contributes to the development of industry in Northern Alsace
- For drilling activities, different French actors are involved: drilling operations, borehole supervision and prime contractor, well testing, cementing, geological & fluid data
- Project owner delegate: ÉS Géothermie, a daughter company from Groupe ÉS, is specialized in the technical supervision of geothermal energy project
- German expertise is involved through the reservoir development program
- Local support from academic research for seismic monitoring from Strasbourg university (EOST-LABEX in Deep Geothermal energy) and Karlsruhe with KIT



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## Conclusions

- ✓ First industrial EGS in France
- ✓ Valorization of the lessons learned from the pilot EGS in Soultz
- ✓ Development of expertise for stimulations, optimized well emplacement and hydraulic testing of deep fractured rocks
- ✓ Enhancement of the energy mix of the Beinheim site of RF
- ✓ Local energy for local industry
- ✓ Further developments: ongoing exploration phase in Illkirch...



17

## More information

Baujard et al., 2014, "The ECOGI EGS project in Rittershoffen, France", GRC, Portland, Oregon

Baujard et al., 2015, "ECOGI, a new deep EGS project in Alsace, Rhine Graben, France", WGC, Melbourne, Australia

Maurer et al., 2015, "Seismic monitoring of the Rittershoffen EGS project (Alsace, France)", WGC, Melbourne, Australia

Gaucher et al., 2015, "Migration based detection and location of the seismicity induced at Rittershoffen EGS (France)", WGC, Melbourne, Australia

## Contacts



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Clément ROBERT – clement.robert@roquette.com

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# Thank you



**Martino Lacirignola, M.Eng**

ADEME – French Environment and Energy Management Agency  
*Networks and Renewable Energy Department*

[martino.lacirignola@ademe.fr](mailto:martino.lacirignola@ademe.fr)

## Questions?



## **Session II Direct use applications (new concepts – built environment)**


### **Iceland – Kristin Vala Matthiasdottir (Resource Park/ HS Orka)**

**Title:** HS Orka Resource Park – Society without waste

**Presenter:** Ms. Kristín Vala Matthíasdóttir, VP Resource Park. Kristin Vala works for HS Orka and is the chairman of the Iceland Geothermal Association. She has an M.Sc. degree in Chemical Engineering from University of Lund, Sweden and wide experience within the geothermal industry. Prior joining HS Orka Kristín Vala worked for Magma Energy Iceland, Geysir Green Energy and Enex.

#### **Abstract:**

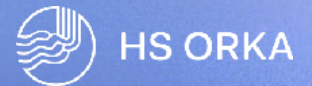
HS Orka operates two power plants at Svartsengi and in Reykjanes. Their core operations have been in the production of electricity and hot water. Excess resource streams have been used by an incredibly varied range of businesses, such as the Blue Lagoon, cosmetics manufacturers, biotechnology companies and aquaculture. More than 500 jobs can be directly attributed to HS Orka's Resource Park, in addition to other derived jobs. The Resource Park that has been developed in the neighbourhood of HS Orka's geothermal plants in the Suðurnes region is unique; it heralds the future, new ways of thinking and encourages even further development of increased and more efficient utilisation of what the geothermal plants produce. More information about the project <http://www.resourcepark.is/>

[Back to the program](#) 

# HS Orka Resource Park Society without waste

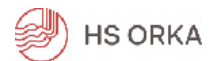
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Kristin Vala Matthiasdottir  
VP Resource Park



## HS Orka brief overview

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- Founded on the 31<sup>st</sup> of December 1974
  - As Hitaveita Suðurnesja
- HS Orka has over 40 years experience in the geothermal power industry
- HS Orka now has a capacity of 175 MW<sub>e</sub> and 190 MW<sub>t</sub>
  - Svartsengi: 75 MW<sub>e</sub> and 190 MW<sub>th</sub>
  - Reykjanes: 100 MW<sub>e</sub>
- Third largest power company in Iceland
  - The only one privately owned

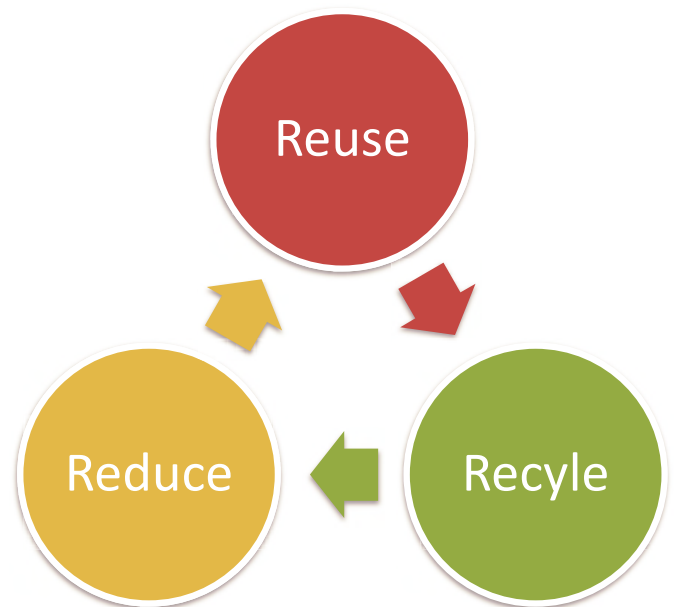


HS ORKA



## The Resource Park Goals

- Society without waste
- Goals
  - Ecological balance
  - Economic prosperity
  - Social progress
- Read the Nature—holistic approach to the project – be in the nature

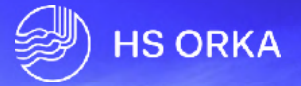


## HS Orka Physical Resource streams

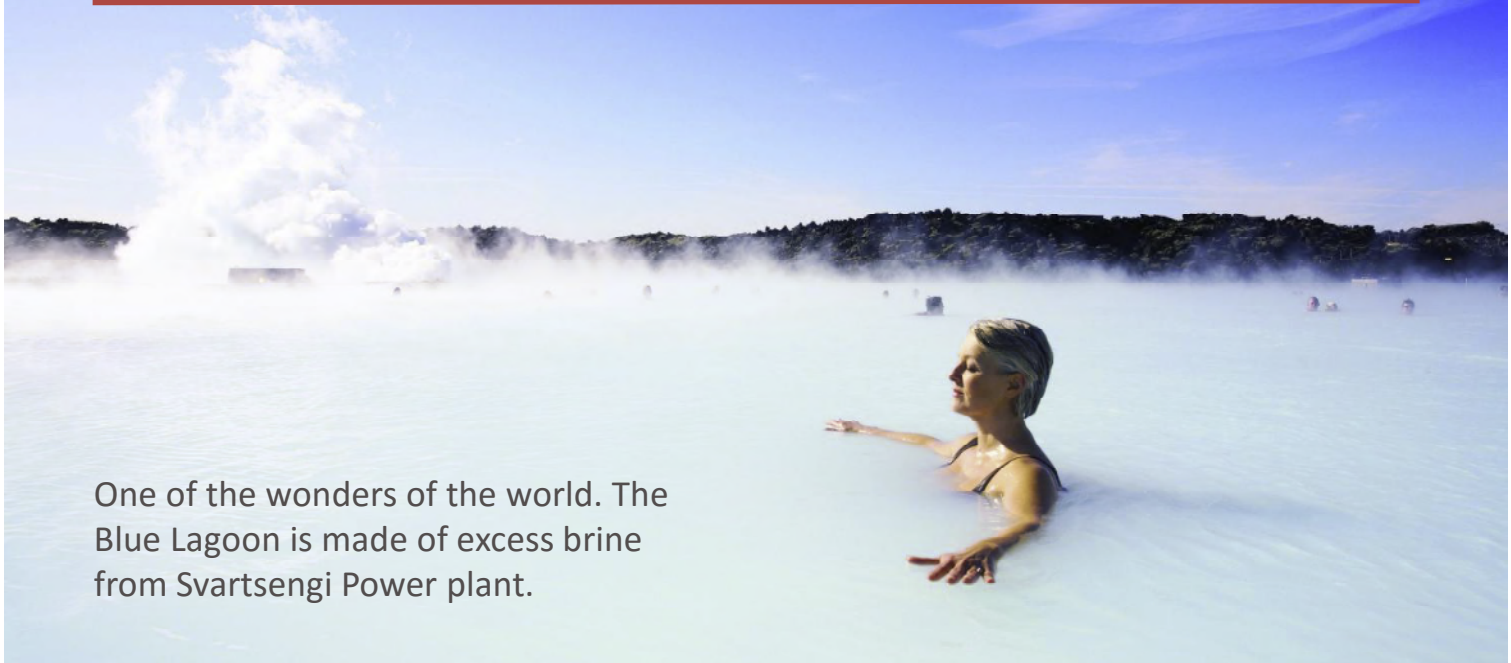


## The Blue Lagoon Geothermal gift of nature

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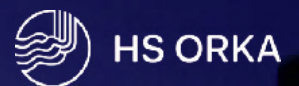


One of the wonders of the world. The Blue Lagoon is made of excess brine from Svartsengi Power plant.



## The Blue Lagoon Health clinic

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In the Blue Lagoon health clinic utilizes the beneficial effects of the mineral-rich geothermal seawater for its treatments



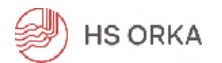


# The Blue Lagoon Research and Development



Researching the geothermal seawater, microbial community, Silica and Minerals

## Blue Lagoon Clinical Research –Healing Power



71 year old man from the Faeroe Islands. 2 years history of psoriasis.



4 weeks treatment at Blue Lagoon Medical Clinic.

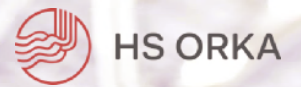


CRI



Produces renewable methanol from carbon dioxide, hydrogen, and electricity for energy storage, fuel applications, and efficiency enhancement.

ORF Genetics



Pioneer in the manufacturing of growth factors and other recombinant proteins in plants.



# Holistic Fish Processing Haustak & Háteigur



HS ORKA

Complete utilization of fish products using Steam from Reykjanes Power Plant



# Stolt Sea Farm Senegal Sol



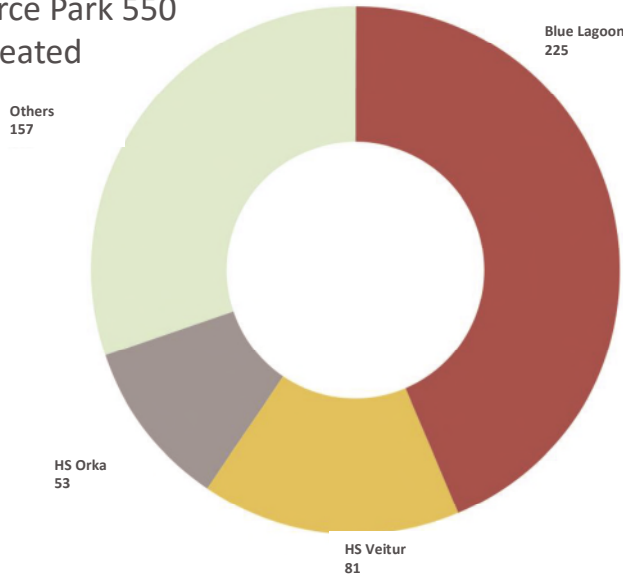
HS ORKA

The largest fish farm in Iceland. Excess cooling sea water from Reykjanes Power Plant is used to grow the product



# Resource Park impact in the area

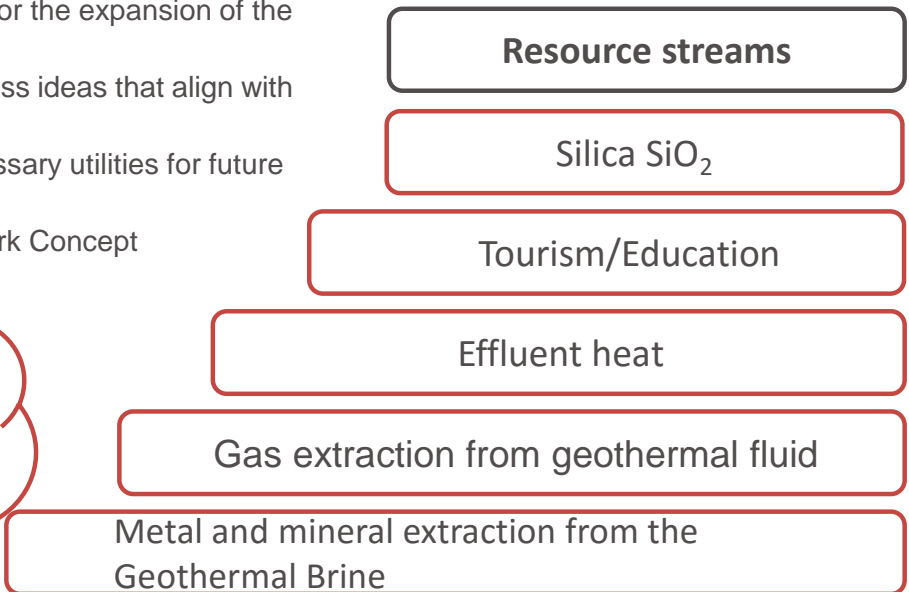
Within the Resource Park 550 jobs have been created



## HS Orka resource park– next steps

- Investigate further opportunities for the expansion of the Resource Park
- Approach companies with business ideas that align with the Resource Park concept
- Planning and installation of necessary utilities for future Resource Park projects
- Develop further the Resource Park Concept

**HS Orka's Mission statement**  
Harness renewable geo-resources in a sustainable way.  
The Resource Park concept is the tool to attain the goal





## Conclusion

- The Resource Park Concept has proved to be successful for treading the bumpy road of supporting sustainable development in the local society.
- It is unwise to look at the geothermal resource as a sole source of energy/enthalpy/power.
- Innovative thinking, research and development, interdisciplinary cooperation of different entities and entrepreneurial spirit are vital components of an active Resource Park.
- Commercially the multiple revenue streams generated in the Park and distributed financial risk is of great importance.

**Do what you can - with what you have - where you are.**

**Nothing ages faster than the future.**

**If you can dream it, you can do it.**



## Switzerland – Matthias Kolb (Amstein + Walthert AG)

**Title:** Smart thermal grids: operational experience with low temperature grids in Zurich

**Presenter:** Mr. Mathias Kolb studied environmental sciences at the Swiss Federal Institute of Technology in Zurich. He is currently working for Amstein + Walthert AG as an engineer in the building sector. In the last few years they started to consider whole areas and not 'only' distinct buildings to be served with energy. This leads to new energy concepts, such as the low temperature network with substantial potential to reduce primary energy demand and CO<sub>2</sub> emissions.

### **Abstract:**

“Smart thermal grids” is a concept which integrates all sources of heating and cooling either coming from thermal plants, industrial waste or residential. They can play important role in the future of Smart Cities by ensuring reliable and affordable heating and cooling supply to the customers. The concept of thermal networks aims at reduction of CO<sub>2</sub> emissions, sustainable energy supply, and higher security of energy supply, focus on life cycle cost and low usage of primary energy. The operational experience is greatly shown in the presentation on a case of Zurich grids.

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## Operational Experience with Low Temperature Networks in Zurich, Switzerland

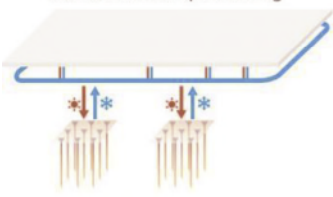
Matthias Kolb  
Geneva, 30.10.2015

### Aim of Thermal Networks

thermal connection



seasonal storage

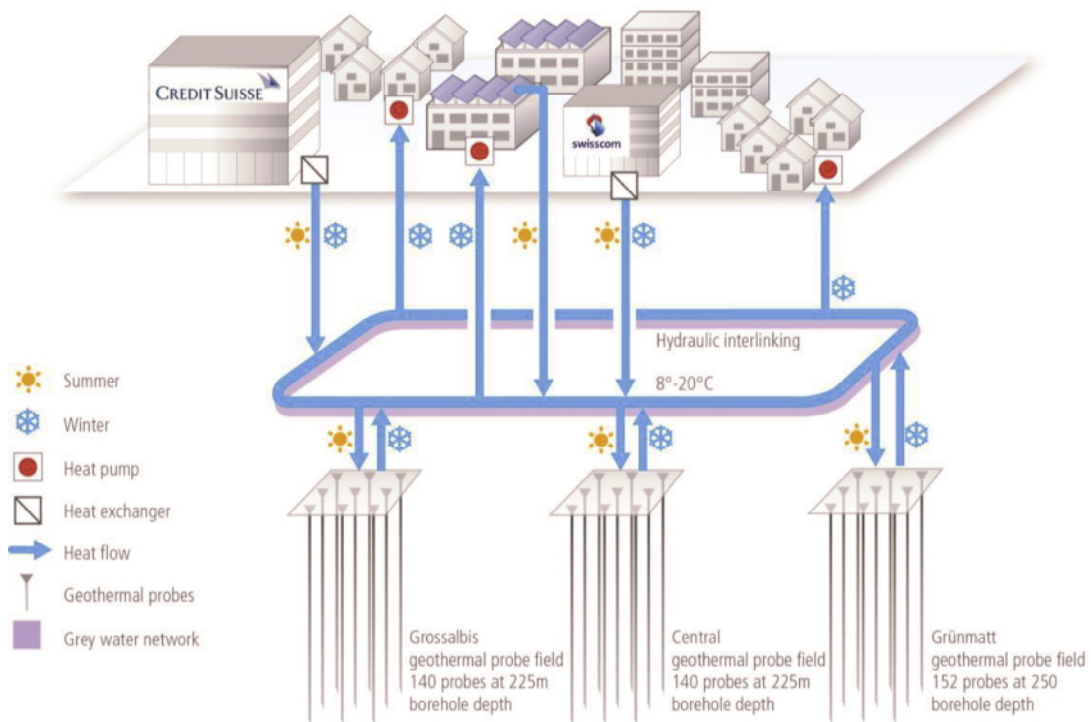


primary energy reduction



reduction of  
CO<sub>2</sub> emissions

## Principle of a Low Temperature Network



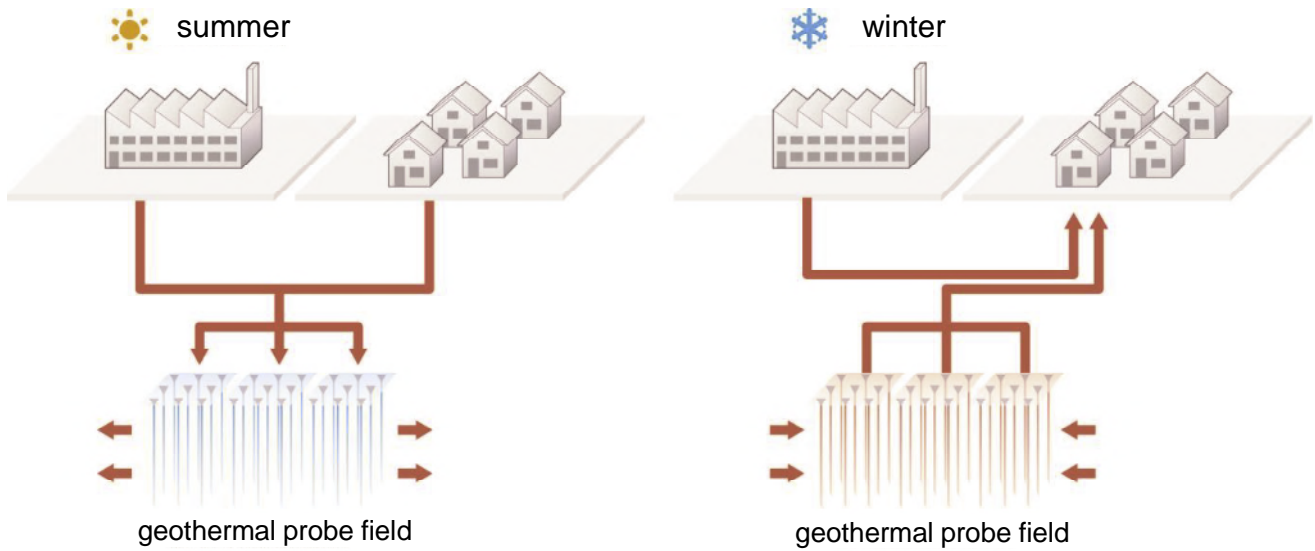
3

## Agenda

- 1) Aim of thermal networks
- 2) Principle of low temperature networks with seasonal heat storage
- 3) Implementation examples in Zurich
  - Network 'Campus Höggerberg' (Swiss Federal Institute of Technology)
  - Network 'Friesenberg'
  - Network 'Richti Areal'
- 4) Operational Experiences

4

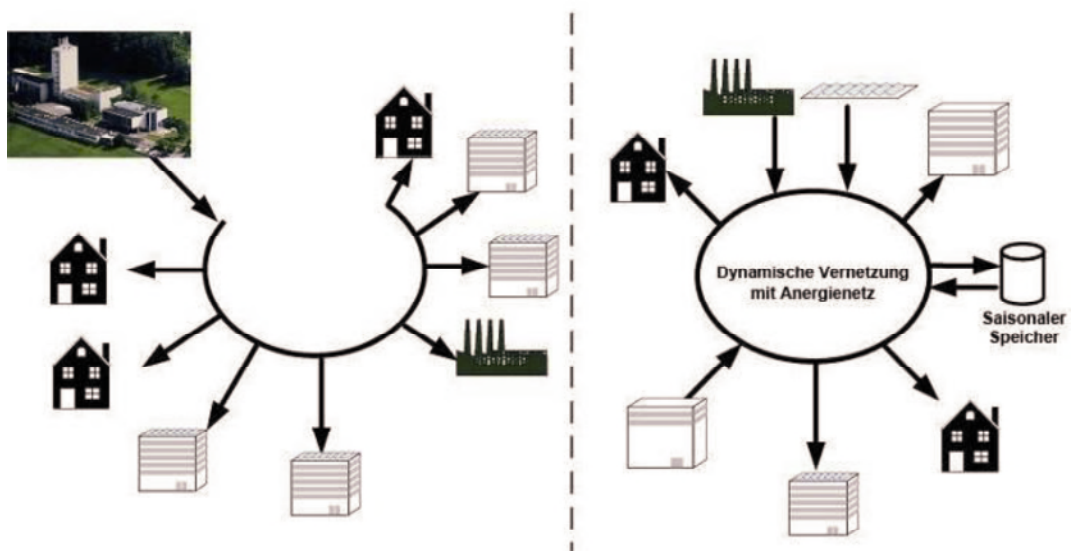
# Seasonal Balancing of Heating / Cooling Demand



5

# Bidirectional Network

Unidirectional → Bidirectional



'conventional District Heating → Energy Network

6



# ETH Hönggerberg



7

# Übersicht

Movie



## Energy Pipes in Media Channel



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## Plugging Station Bore Hole Field



10



## Heat Pump Station



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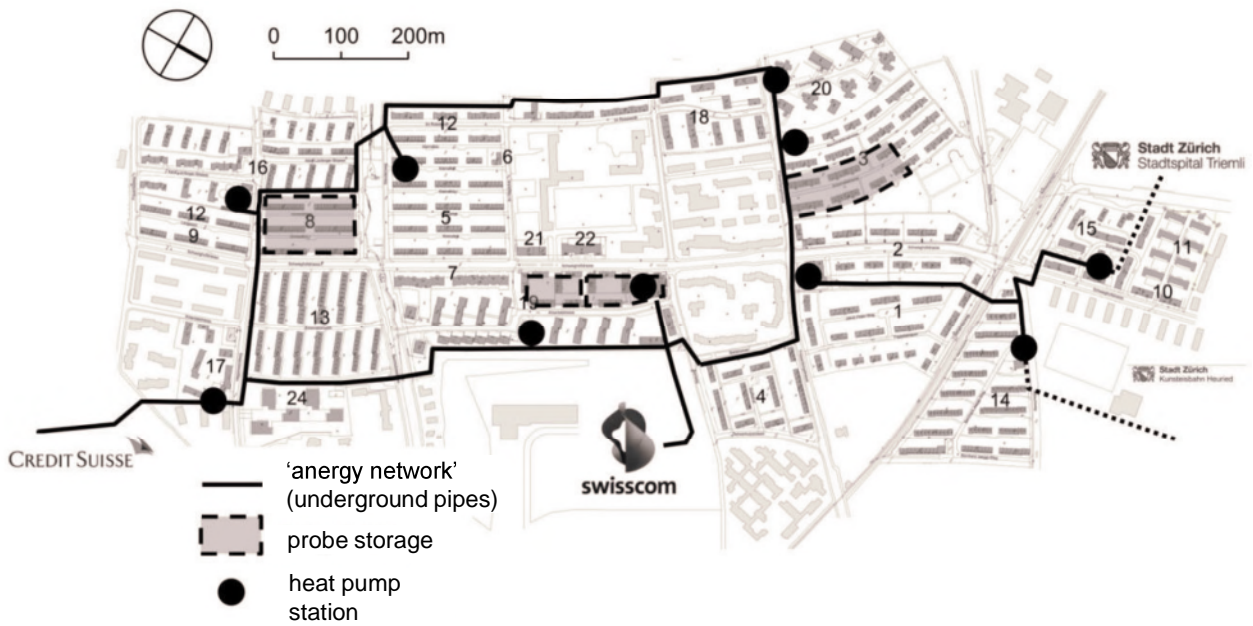
## Familienheim-Genossenschaft Zürich (FGZ)



12

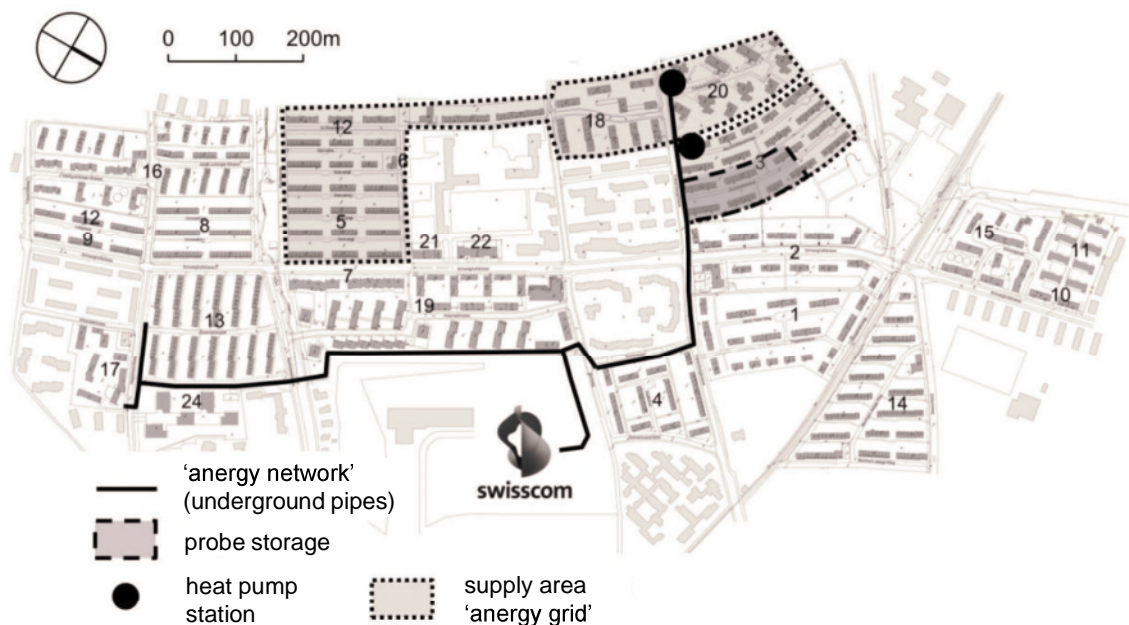


# Overview low temperature network FGZ



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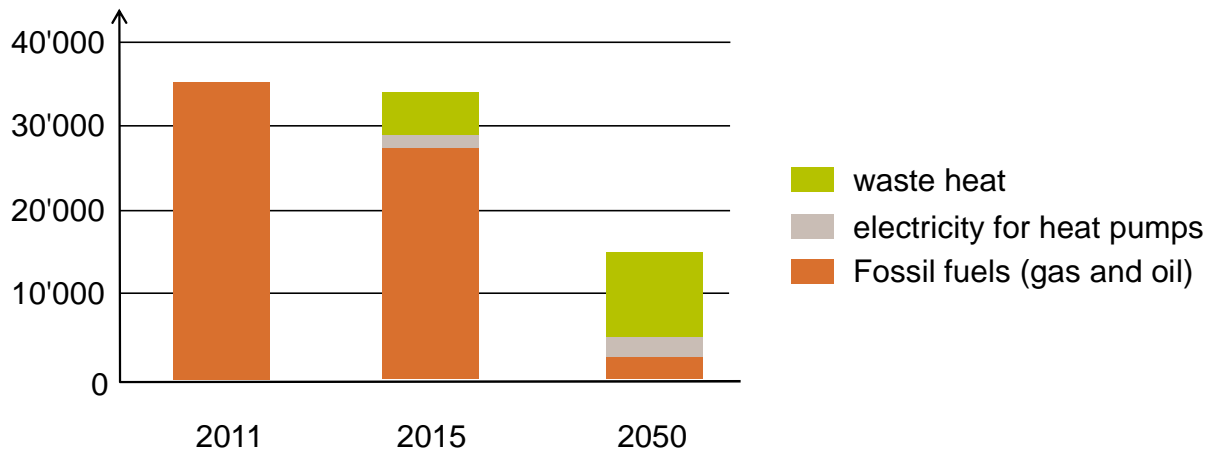
# Stage of Implementation (2015)



14

## Energy Mix

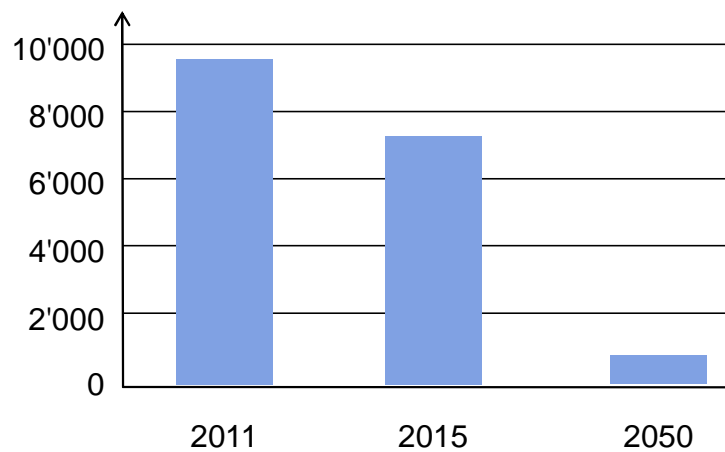
heat demand in MWh/a



15

## Greenhouse Gas Emissions

CO<sub>2</sub>-eq emissions in t/a



16



## Waste Heat from Data Center Swisscom



17

## Heat Exchange Station Swisscom



18



## Heat Exchange Station Swisscom



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## 'Anergy' Pipes



20



## 'Anergy' Pipes



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## Geothermal Storage



22



## Geothermal Storage



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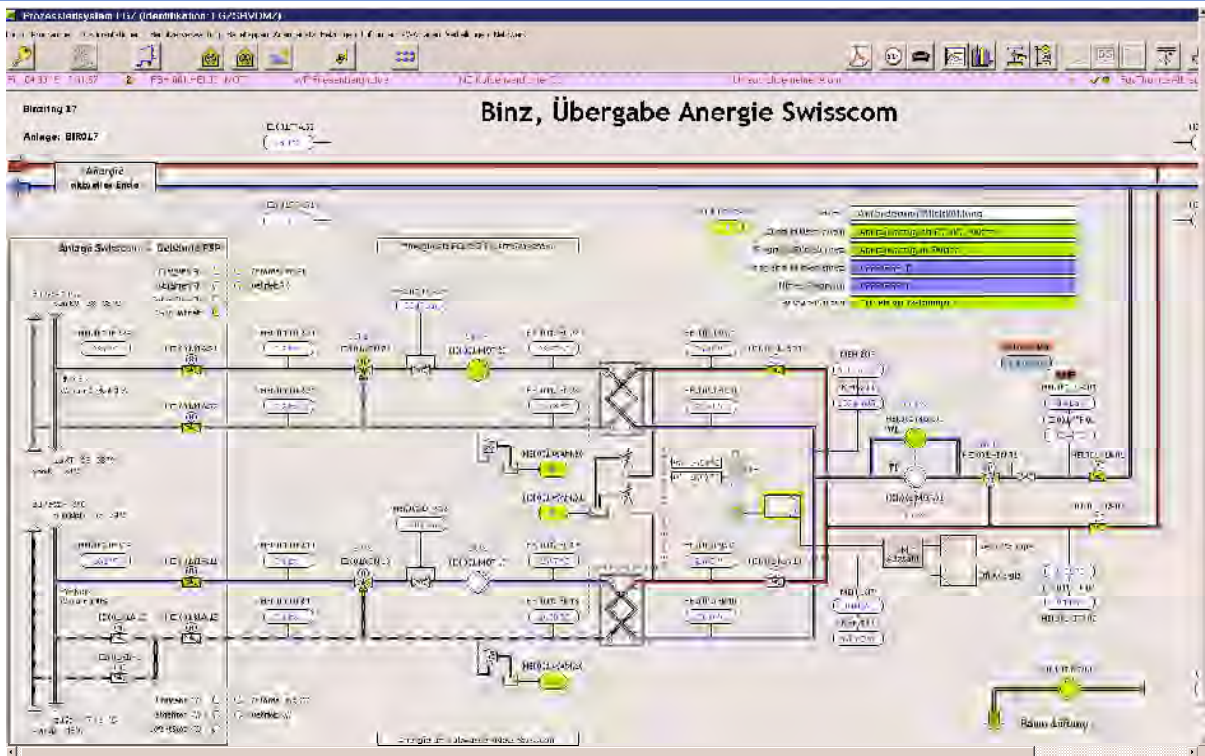
## Heat Pump Station



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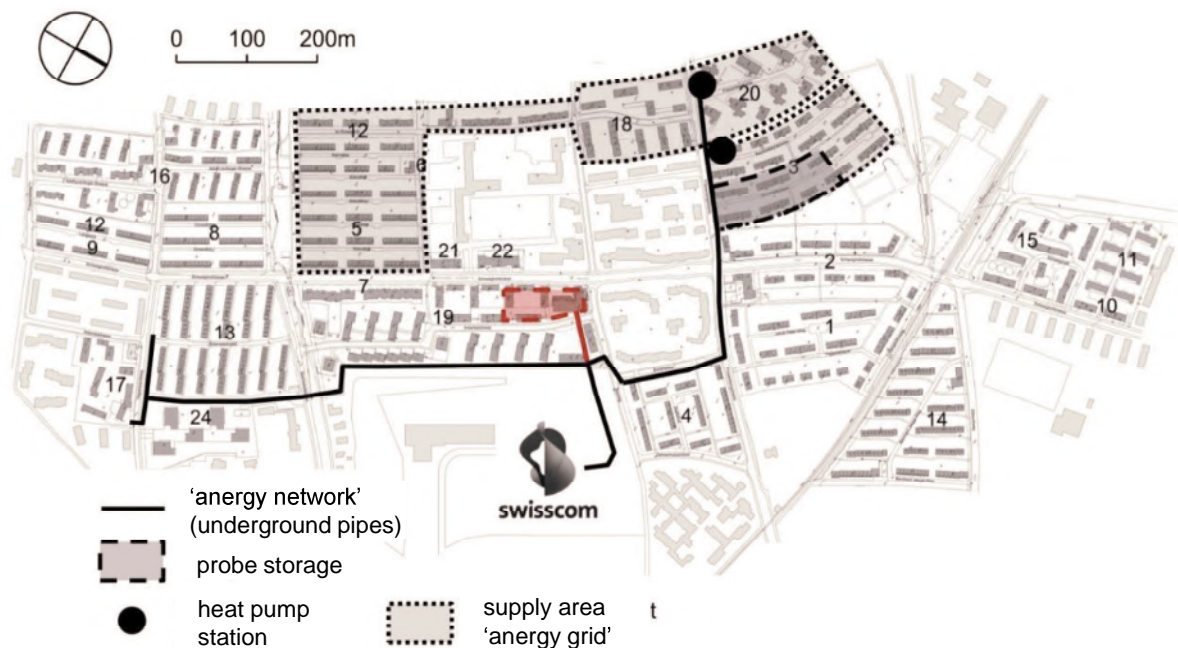


# Energy Management System



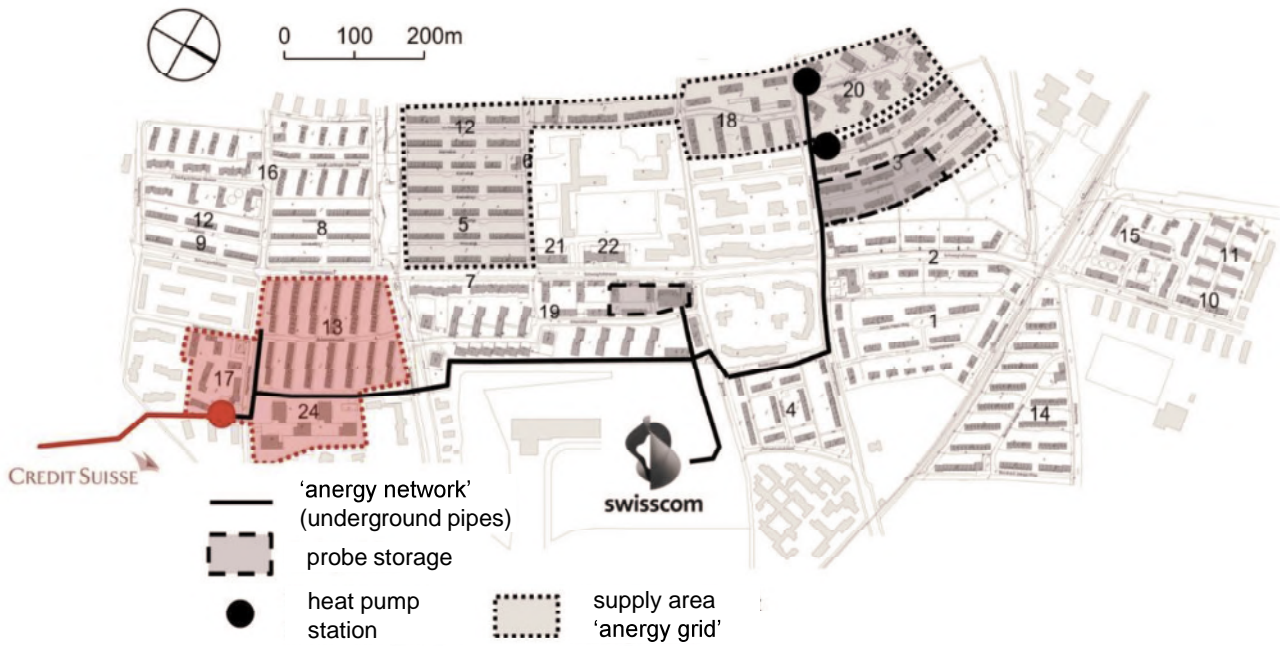
25

# Future Installation by Stages



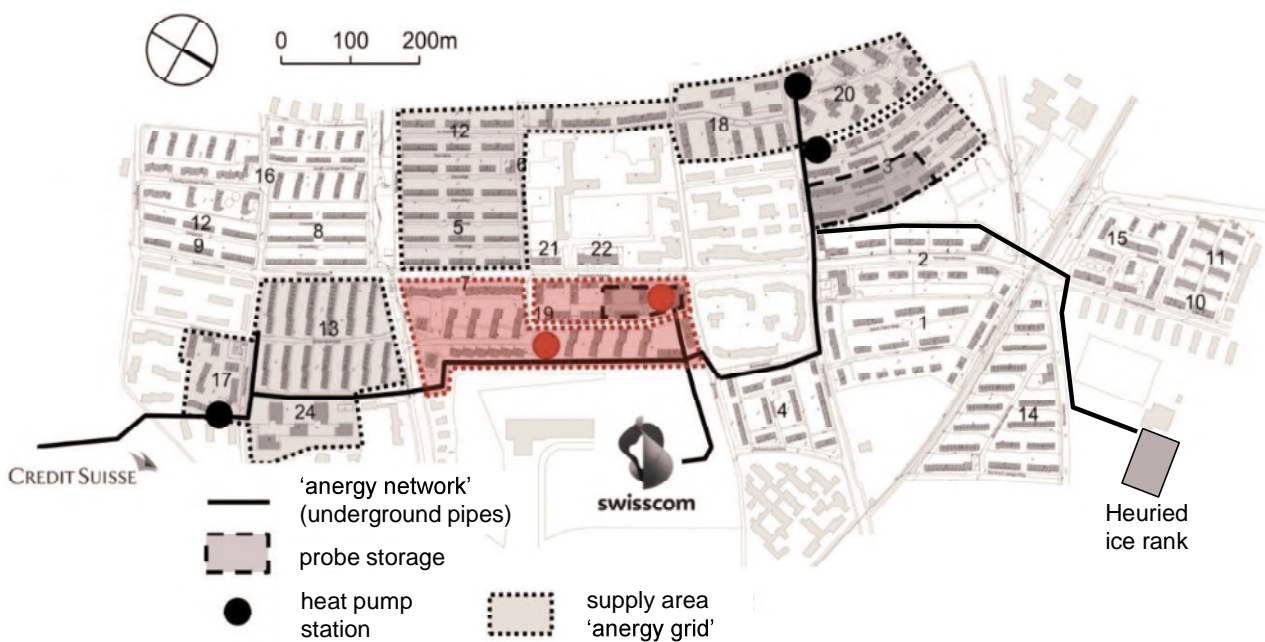
26

## Future Installation by Stages



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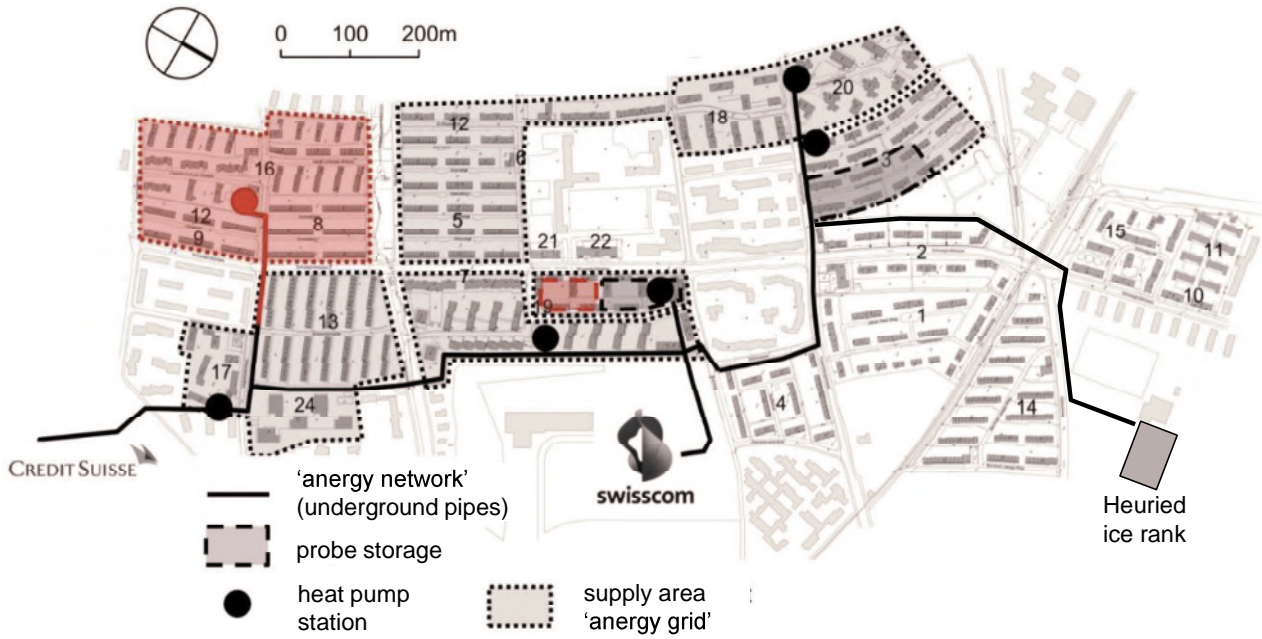
## Future Installations



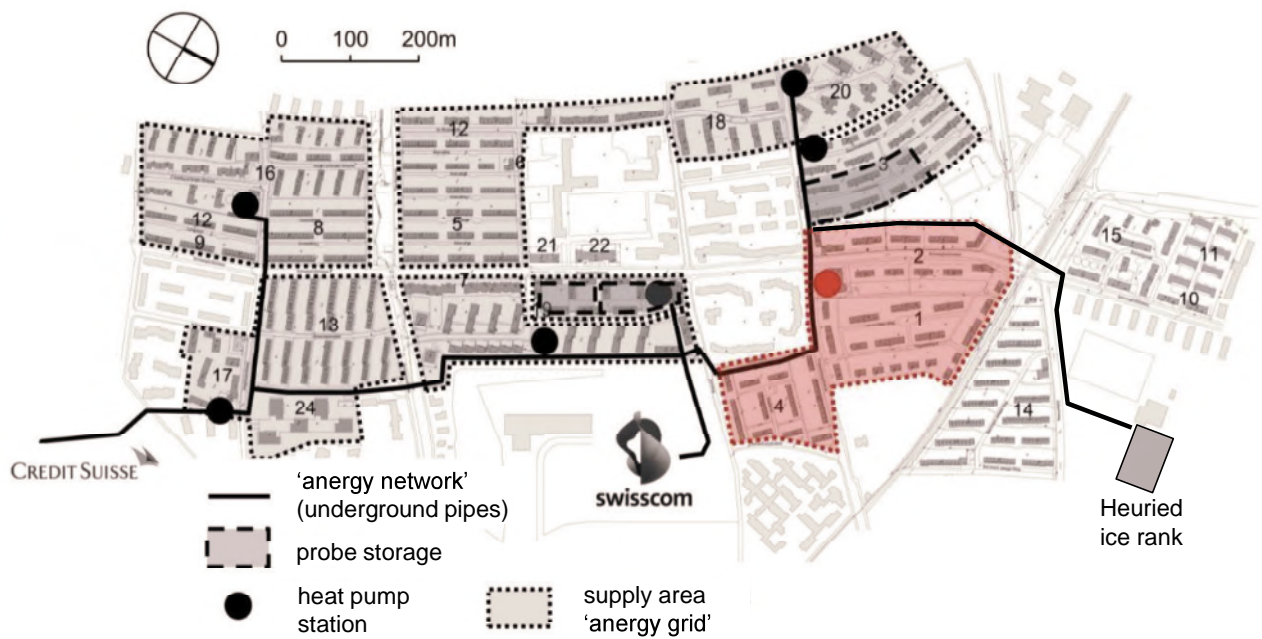
28



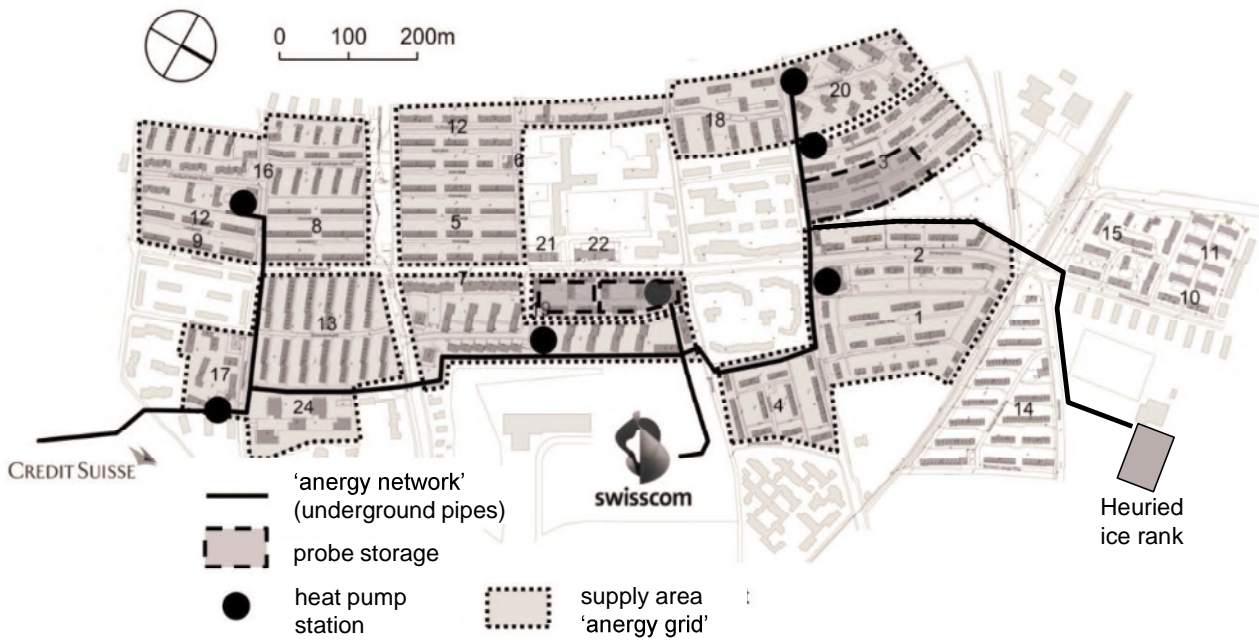
# Future Installations



# Future Installations

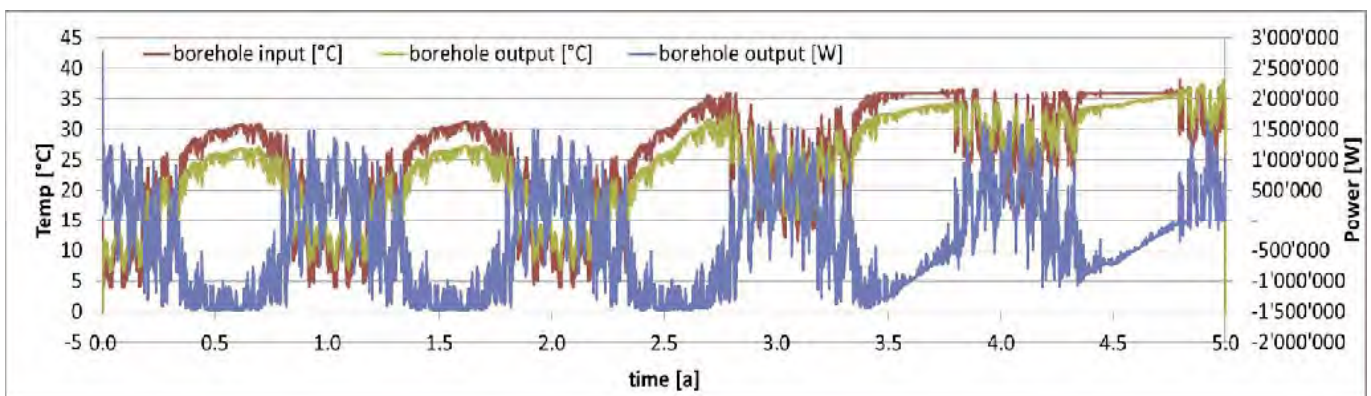


# Future Installations



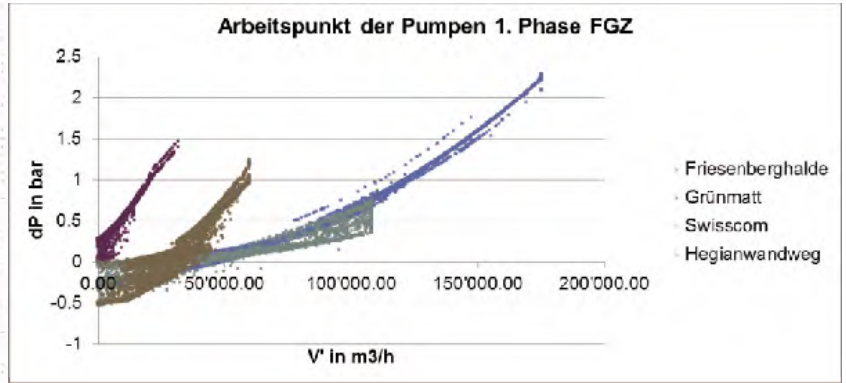
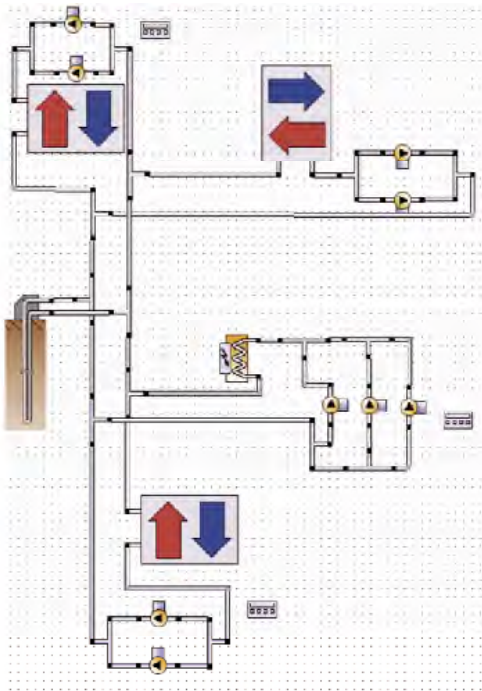
31

# Simulation – Network Temperature Development



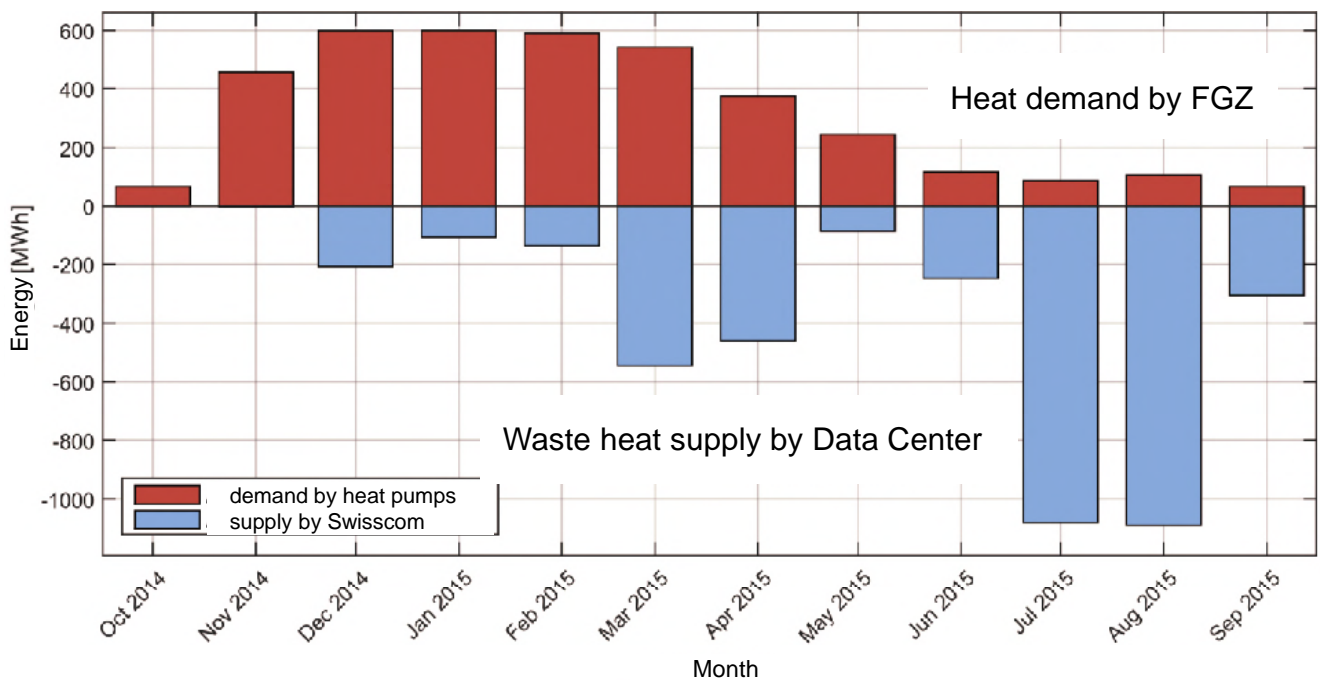
32

# Simulation – Hydraulics for Pump Dimensioning



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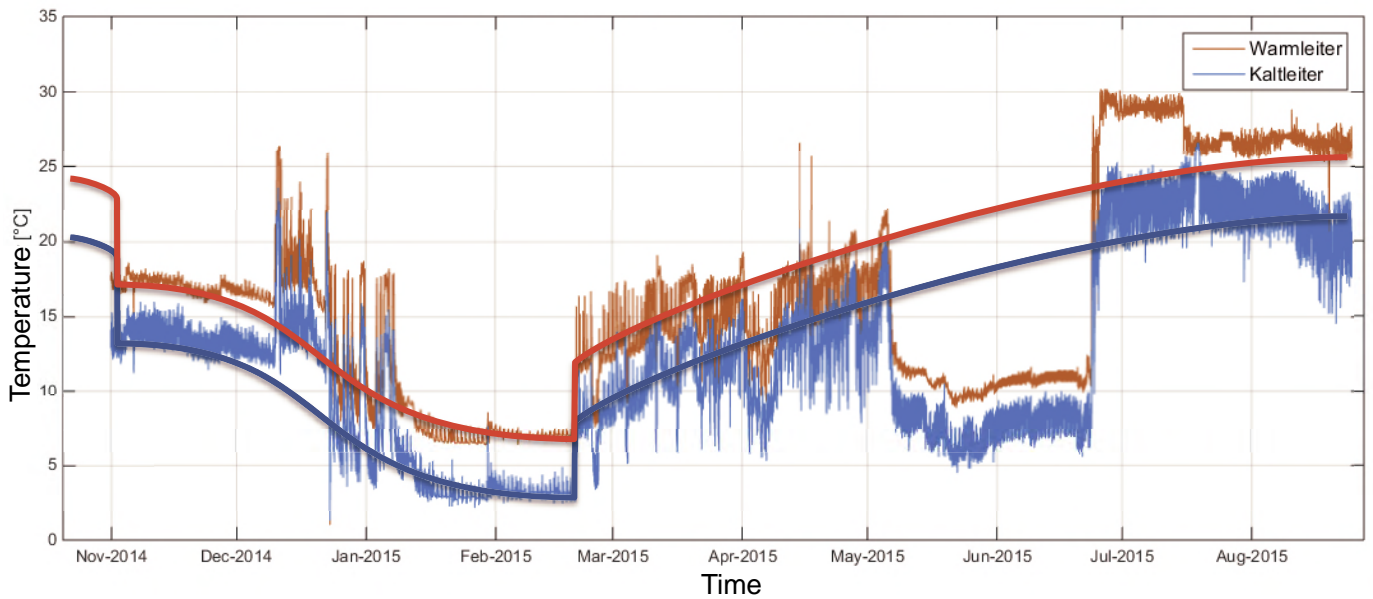
# Operating Figures – Waste heat demand and delivery



34

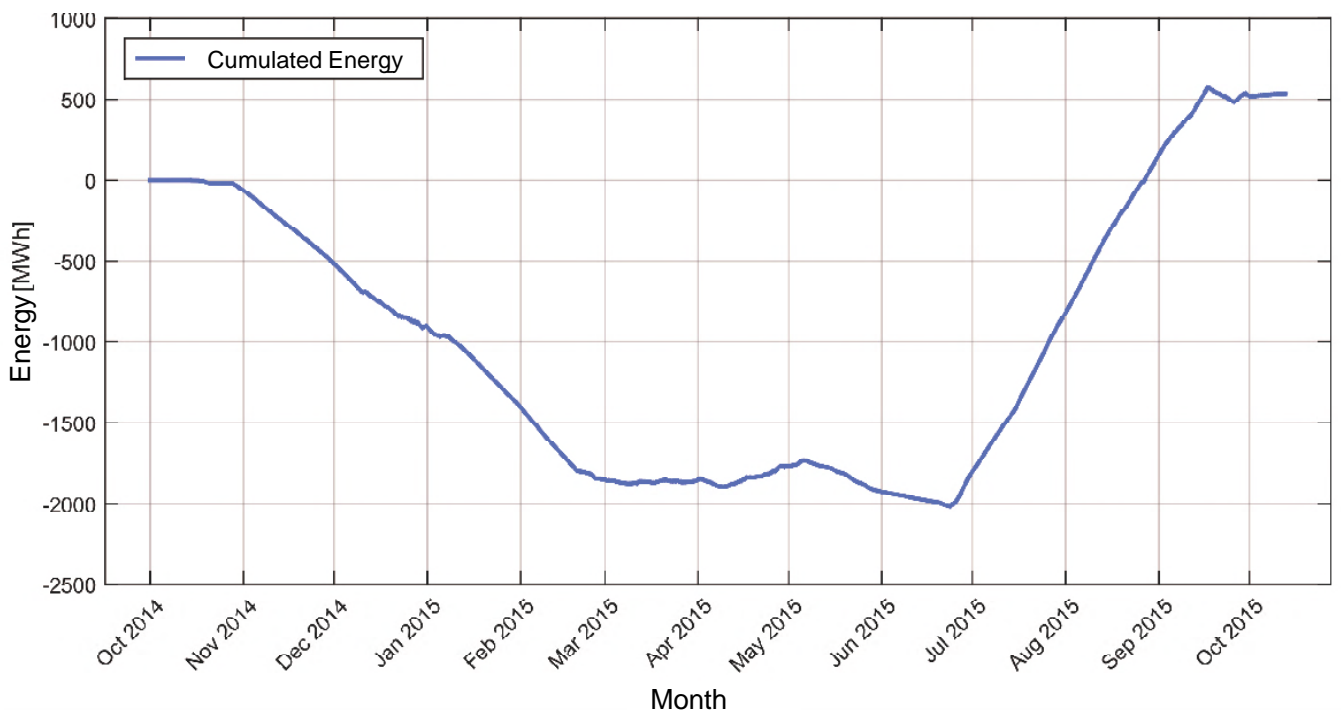


## Operating Figures– Temperature Profile of Network



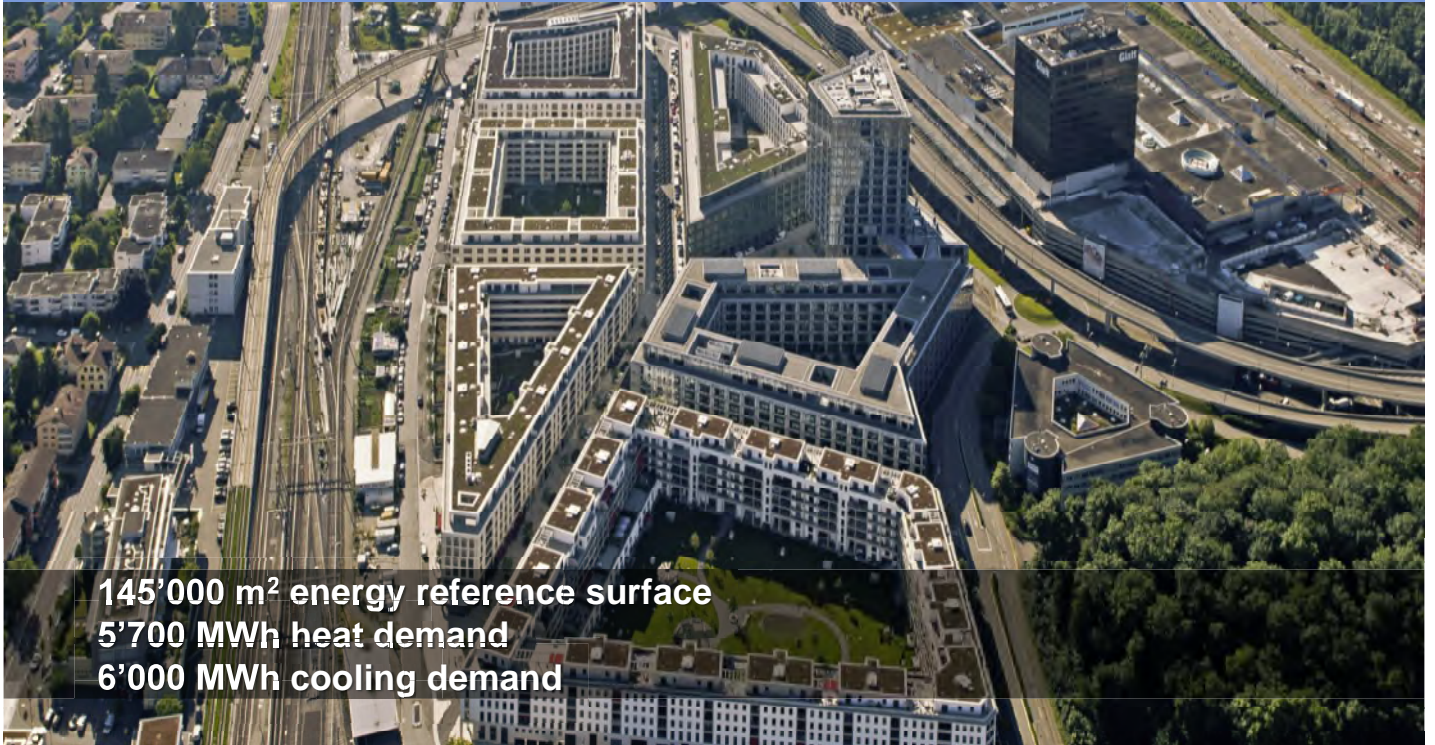
35

## Operating Figures – Load of Bore Hole Field



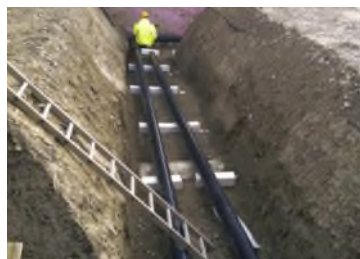
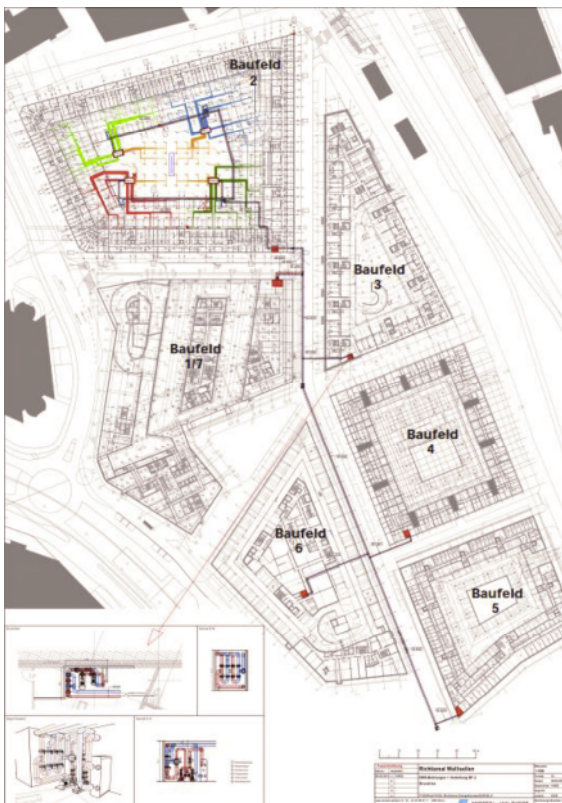
36

## Network 'Richti Area' in Wallisellen (Zurich)



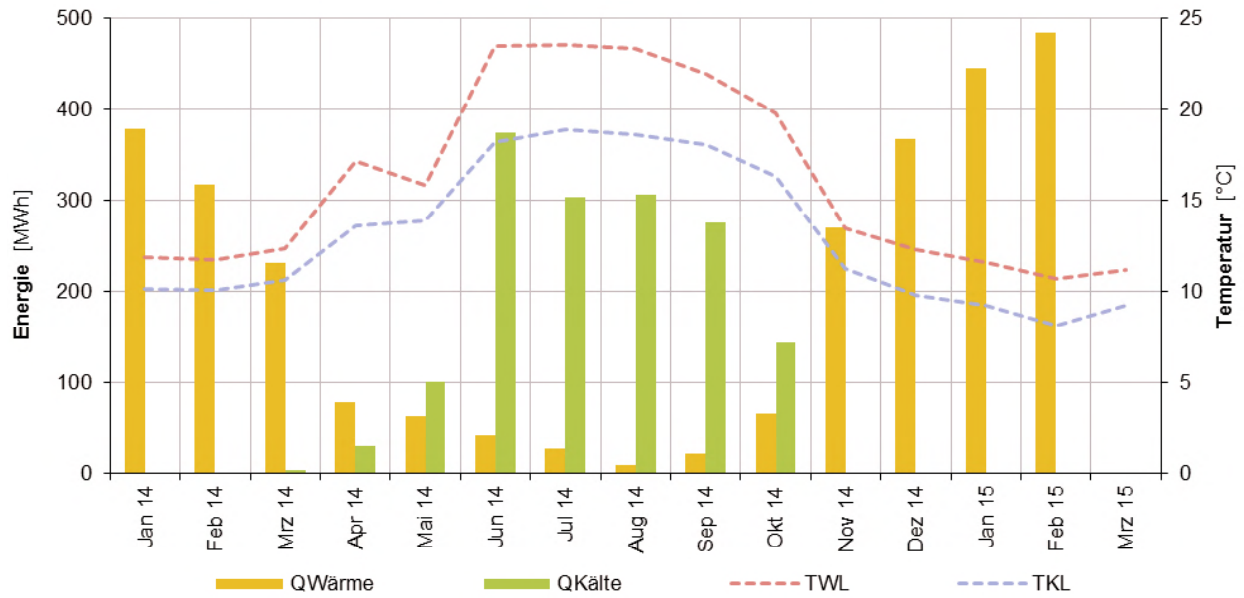
37

## Overview Anergy Network 'Richti' Area





## Operating Figures – Energy Balance, Temperatures



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## Outlook – Potential Areas for Energy Networks



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Thank you very much  
for your attention

Matthias Kolb  
Amstein+Walthert AG  
[matthias.kolb@amstein-walthert.ch](mailto:matthias.kolb@amstein-walthert.ch)  
phone: +41 44 305 94 62


**Germany – Christian Hecht (Stadtwerke München, SWM)**

**Title:** The Projekt GRAME - One Step towards our 2040 Vision of 100% Renewable District Heating in Munich

**Presenter:** Dr. rer. nat. habil. Christian Hecht is an Applied Geologist. Present position holds as Chief Geologist and Geothermal Expert Department for the Conception of Energy Generation Plants Stadtwerke München Service GmbH

**Abstract:**

The 3D seismic is a part of scientific project GRAME, which was funded by the Federal Ministry of Economics and Technology (BMWi). Partners of the SWM are the Leibniz Institute for Applied Geophysics LIAG, the planning office Erdwerk GmbH, the Institute of Energy Systems of the Technical University of Munich and the GGL geophysics, and geotechnical engineering Leipzig GmbH. The GRAME project focuses on the basics of optimization and sustainable exploration on the Bavarian Molasse Basin and beforehand identified geothermal sites in Munich area. As an outcome it is expected to receive technical, environmental and economic concept to integrate current geothermal production and distribution to the new SWM system.

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# The Projekt GRAME - One Step towards our 2040 Vision of 100% Renewable District Heating in Munich

Christian Hecht, Nadine Frank, Christian Pletl

M/Wasser M/Bäder M/Strom M/Fernwärme M/Erdgas M/net

## Contents

- ▶ SWM Energy
- ▶ 2040 Munich District Heat Vision
- ▶ The Project GRAME
- ▶ 3 D Seismic Munich South



## SWM Business Units



- ▶ Power (Production, Distribution, Sales)
- ▶ District Heating (Production, Distribution, Sales)
- ▶ Gas (Distribution, Sales, Exploration)
- ▶ Water (Production, Distribution, Sales)
- ▶ Public Swimming Pools (Indoor, Outdoor, Saunas, Ice Skating)
- ▶ Mobility (MVG: Metro, Tram, Bus)
- ▶ Telecommunication (Networks, Sales, M-Net)

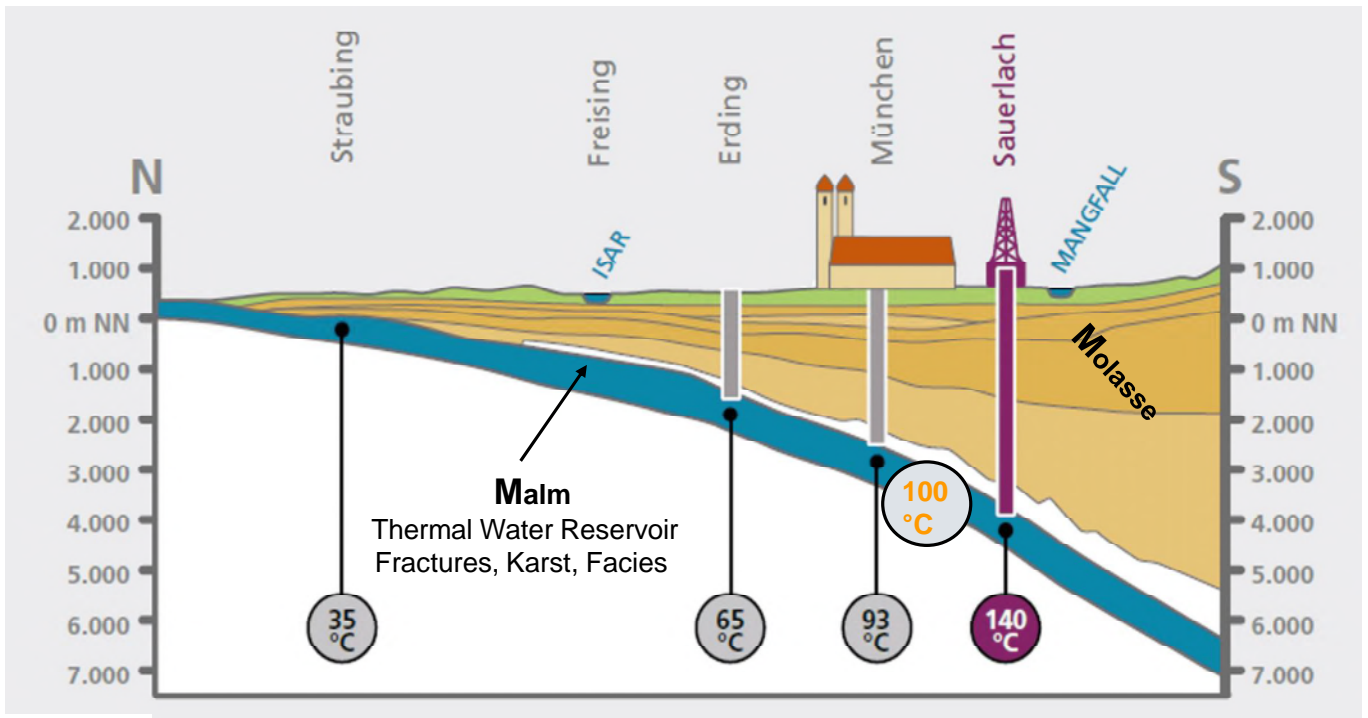
## SWM District Heating Vision

The vision for SWM's district heating system  
**fully renewable** from 2040



To achieve this vision, SWM aims at the continuous  
development of deep **geothermal** resources

# Geothermal – M-Energy Geological Conditions

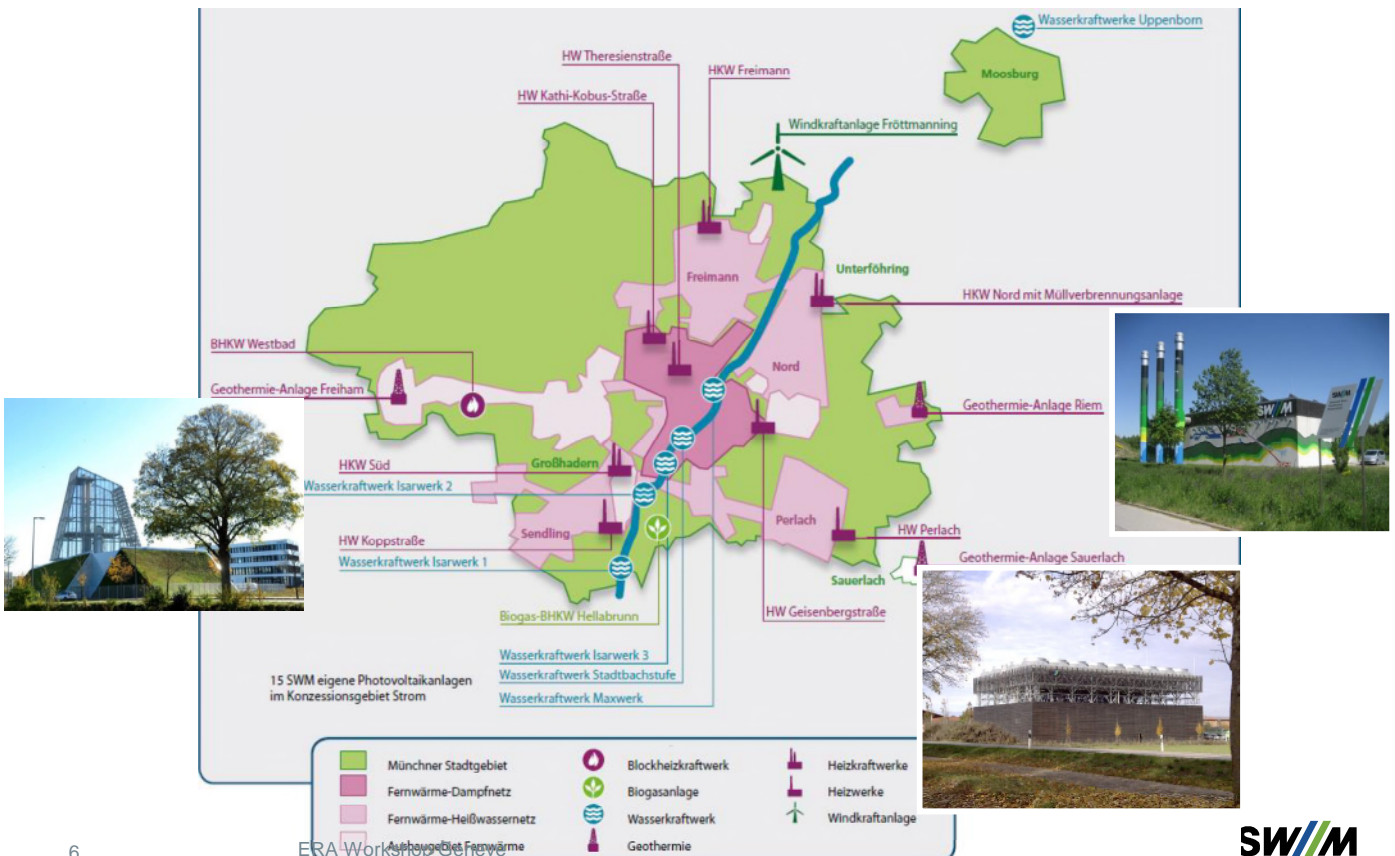


ERA Workshop Geneve

5



## Energy Supply SWM



6

ERA Workshop Geneve



# Project GRAME

„Ganzheitlich optimierte und nachhaltige Reservoirerschließung für tiefengeothermische Anlagen im bayerischen Molassebecken

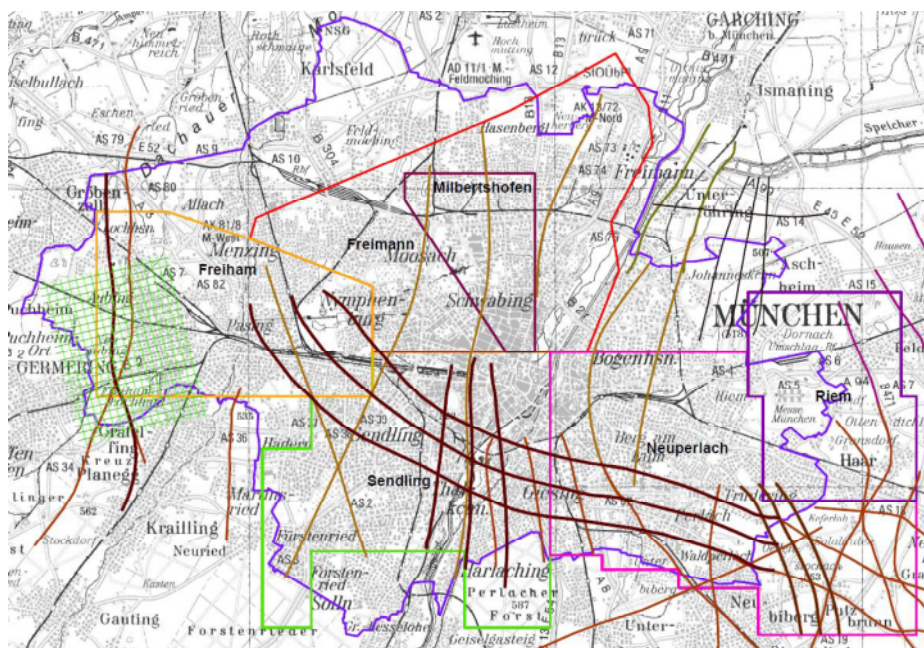
Entwicklung eines 50 MWel Kraftwerks und Erschließung von 400 MWth für die Fernwärme in München“

Optimized and Sustainable Reservoir Development for Deep Geothermal Plants in the Bavarian Molasse Basin

Design of a 50 MWe Powerplant and Development of 400 MWth for the Munich District Heating

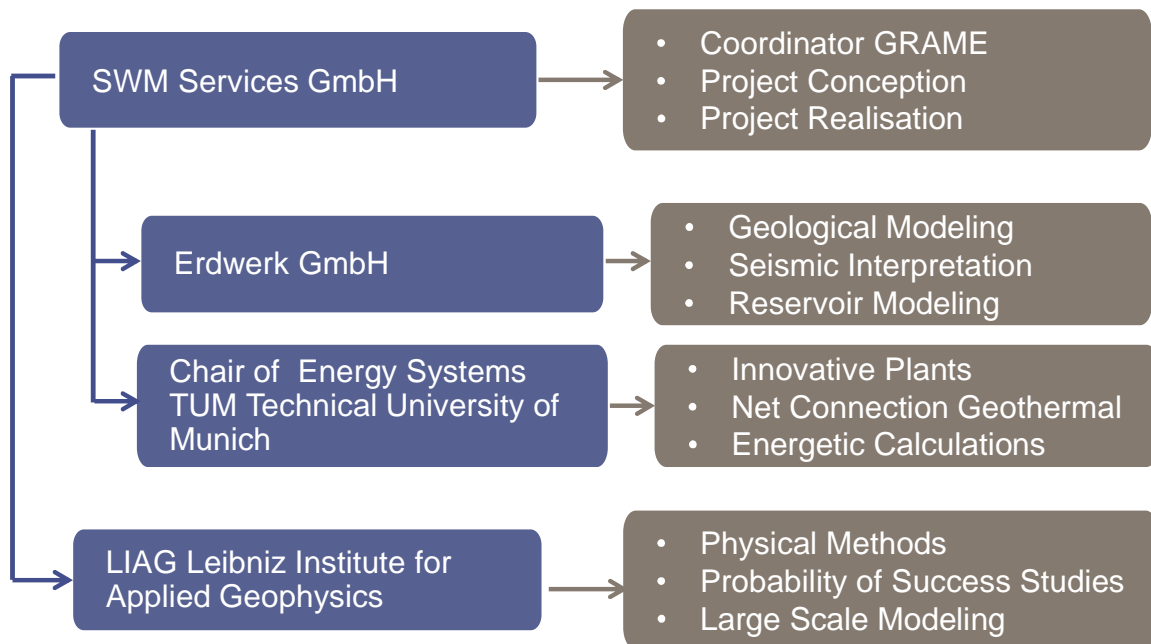
## GRAME Topics

- ▶ Development Concept of 400 MWth
- ▶ Reservoir Drilling and Engineering
- ▶ Standard Well Design
- ▶ 3 D Seismic Survey
- ▶ Geothermal District Heating Model

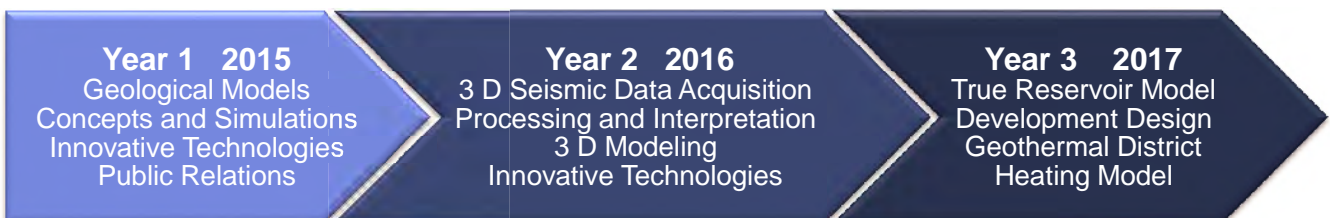




## Participants in GRAME



## Timetable



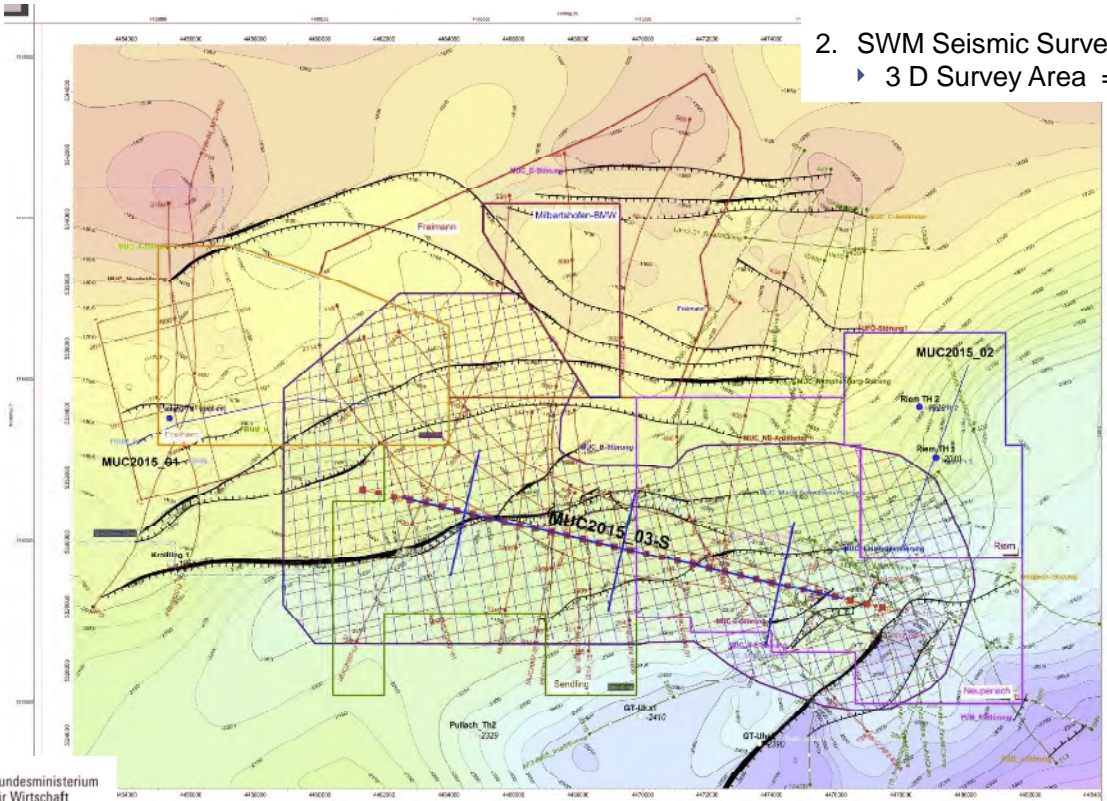
# SWM Seismic Surveys

1. SWM Seismic Surveys Munich

- ▶ 2 D Line Length = 200 km
- ▶ 3 D Survey Area = 20 km<sup>2</sup>

2. SWM Seismic Survey GRAME 2015

- ▶ 3 D Survey Area = 170 km<sup>2</sup>



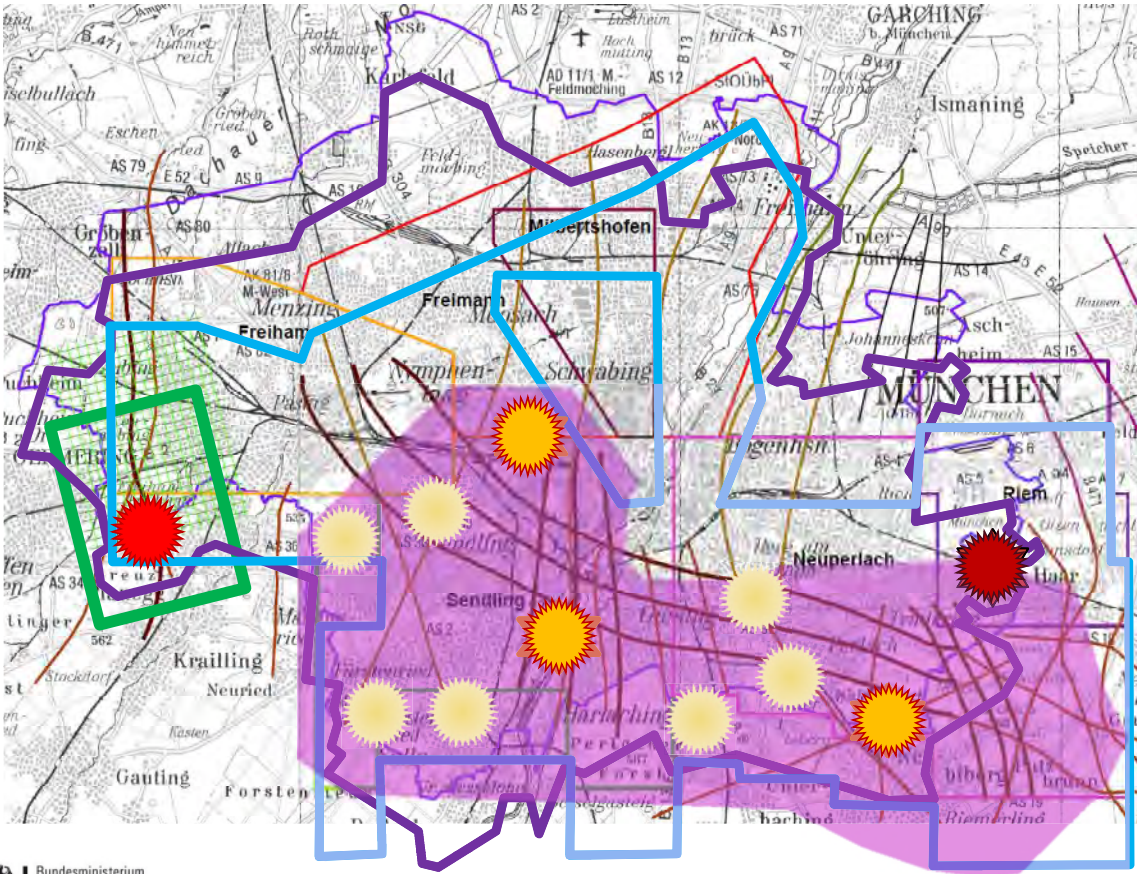
## Seismic Campaign 2015-2016

Surveys	Parameters
3 D Seismic	170 km <sup>2</sup> , 7587 Vibro Points, 35 Vibro Lines, Line Spacing 400 m in the Northwest, 500 m in the Southeast
2 D Seismic	4 Lines of 6 km, Distance of Vibro Points 50 m
Sheawave experiment	35 Vibro Points, 4 Vibro-Trucks, Distance of Vibro Points 500 m
Check-Shot-Surveys	In the Riem Th1 and Freiham Th1 Wells, Distance of Measurement Points 25 m, 130 Depth Levels, one external Vibro-Truck





# Project Development



ERA Workshop Geneve

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Stadtwerke  
München



Thanks for your attention!





## **Netherlands – René Verhoeven & Herman Eijdens (Mijnwater B.V)**

**Title:** Minewater Heerlen - Development of carbon neutral areas with thermal smart grids and geothermal

**Presenter:** Mr. René Verhoeven has a long experience in sustainable ESCO-projects and District heating networks. In Mijnwater in Heerlen he is a Cluster manager, designer of the new innovative Minewater 2.0 concept and responsible for the transformation and development of the Minewater project from a pilot system into a full-scale hybrid sustainable energy infrastructure. In this job his water energy experience come together which is highly satisfying.

**Presenter:** Mr. Herman Eijdens Researcher Bouwcentrum is technical consultant NCIV, technical consultant Damen consultancy, managing consultant Cauberg-Huygen Raadgevende Ingenieurs, head of building Physics Unit Rijksgebouwendienst, sr. consultant/knowledge manager Rijksgebouwendienst, teacher building-physics at Vitruvius opleidingen, Board Member Dutch Flemish building physics Association and member of the advisory board of Dutch Green Building Council. Herman acted as researcher in IEA Tasks 8 and 13 and in a broad range of energy saving and indoor environment projects in the Netherlands.

### **Abstract:**

Mijnwater BV's site in Heerlen (Netherlands) is a unique front runner within the Netherlands and the EU of a mine water heat recovery system that has become a true hydraulic thermal smart grid. Mijnwater BV is a modern utility company owned by the municipality Heerlen to realize the targets of the PArkstad Limburg Energy Transition (PALET) with the goal to become a carbon neutral region in 2040. Mijnwater BV takes care of innovation, development, realization and exploitation of the energy infrastructure and energy stations at the end-users. Integral, innovative and pragmatic thinking, own know-how (master of concept) and partnership are key in our approach. Mijnwater BV has an open mind for exchange of know-how and support of other parties with the development of mine water heat recovery systems and thermal smart grids in the EU and is looking for innovative European partners to join this development.

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Comfortably  
warm  
Pleasantly  
cool with  
Mine water



MINE WATER, A BASIS FOR SUSTAINABLE ENERGY

[WWW.MIJN WATER.COM](http://WWW.MIJN WATER.COM)



1

October 2015

European Geothermal Innovation Award  
Winner 2015



MINE WATER, A BASIS FOR SUSTAINABLE ENERGY

[WWW.MIJN WATER.COM](http://WWW.MIJN WATER.COM)

## Minewater Heerlen

Workshop New Concepts Geothermal EraNet

Development of carbon neutral areas  
with thermal smart grids and geothermal

Geneva, October 30th 2015

René Verhoeven ([r.verhoeven@mijnwater.com](mailto:r.verhoeven@mijnwater.com))

Herman Eijdens ([h.eijdens@mijnwater.com](mailto:h.eijdens@mijnwater.com))

Mijnwater B.V.

### 1. System development:

- Minewater 1.0 (past)
- Minewater 2.0 (present)
- Minewater 3.0 (next step)
- Summary

### 2. Roadmap to carbon neutral areas





# Minewater 1.0

Pilot (2008–2013)

- Traditional network (tree)
- Only heat and cold supply
- Simple change-over-system
- Minewater as source
- Bivalent energy stations (HP + Boilers + Chillers)
- Mijnwater owner and operator grid

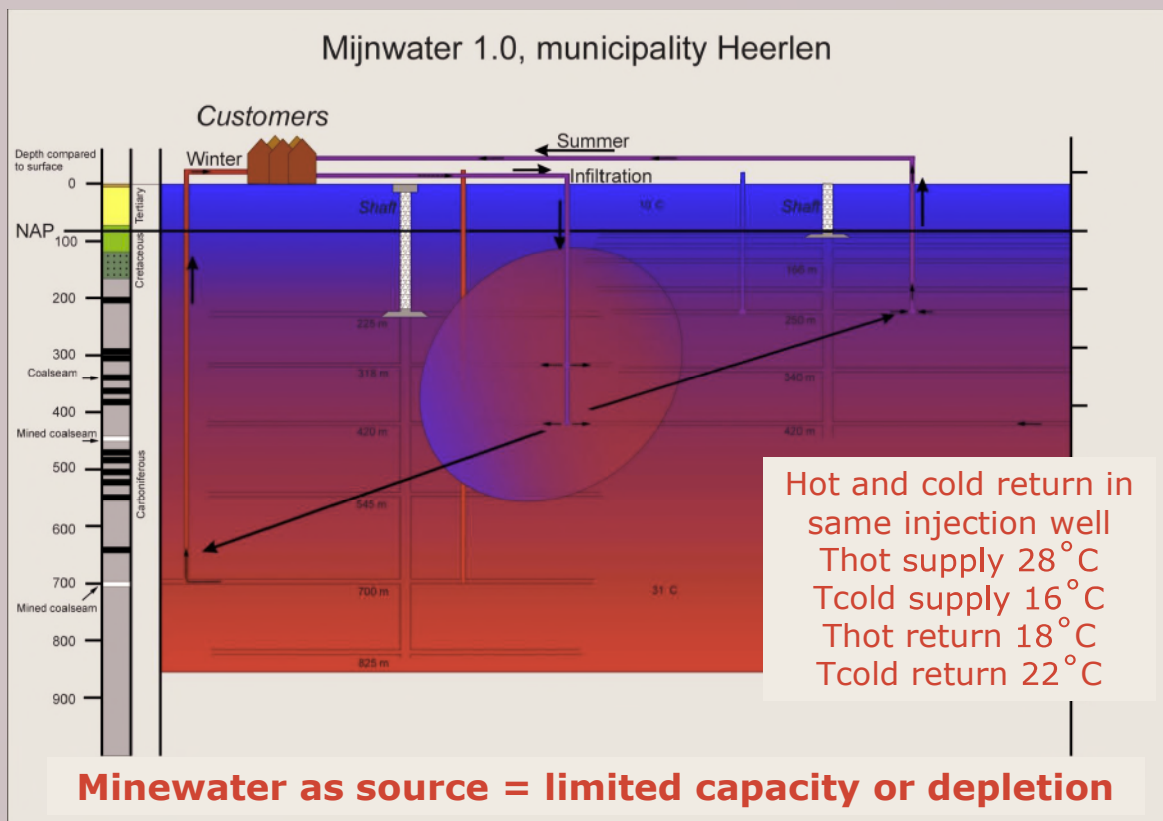


CO<sub>2</sub>-Reduction  
35 %

Comfortably warm  
Pleasantly cool  
with Mine water

# Minewater 1.0

Minewater as source



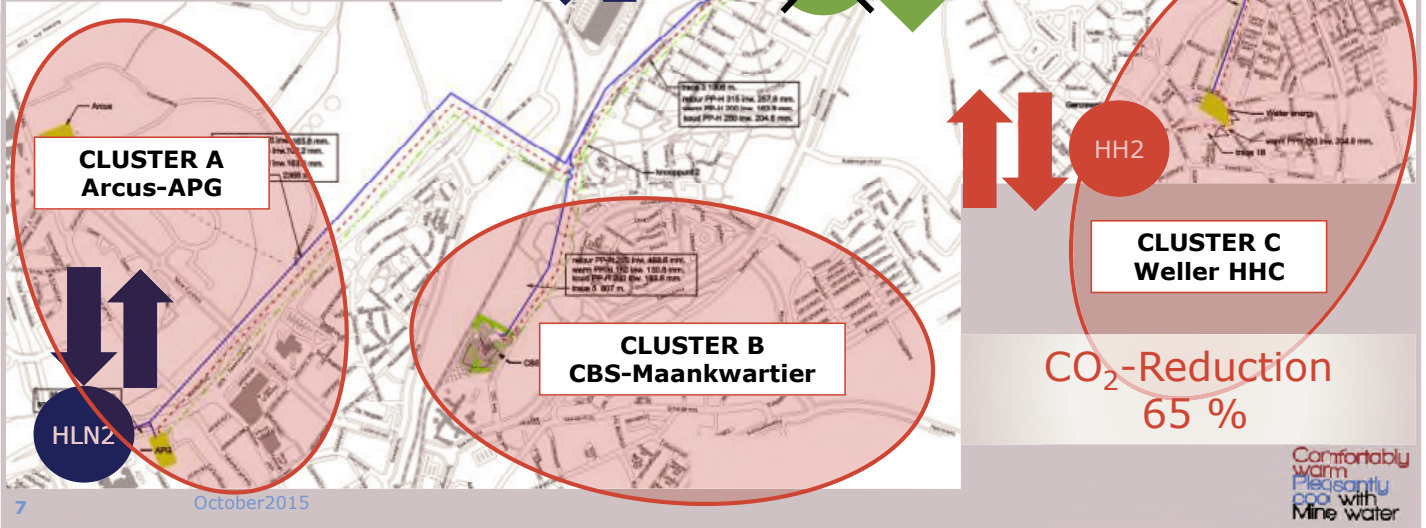
**Minewater as source = limited capacity or depletion**

Comfortably warm  
Pleasantly cool  
with Mine water

# Minewater 2.0

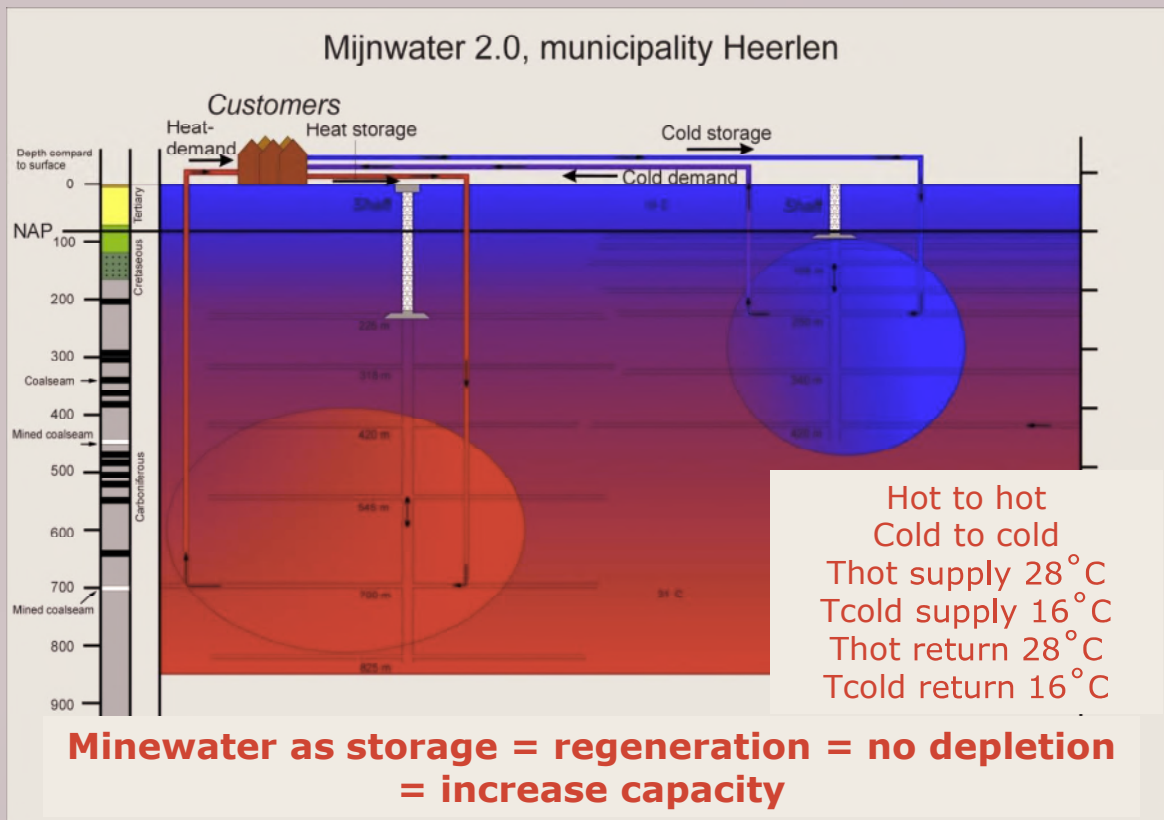
Clusters of buildings (since 2013)

- Hydraulic cloud network
- Instant heat/cold exchange
- Minewater as storage
- Fully demand driven
- Bidirectional wells
- Multiple sources
- All electric (100% HP)
- Mijnwater owner/operator network & energy stations



# Minewater 2.0

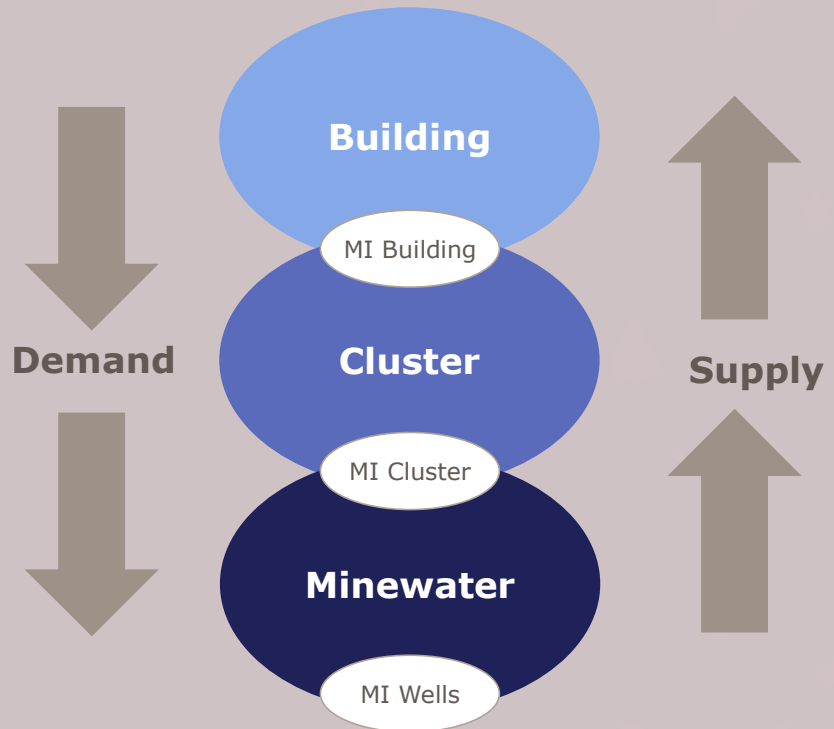
Minewater as storage



# Minewater 2.0

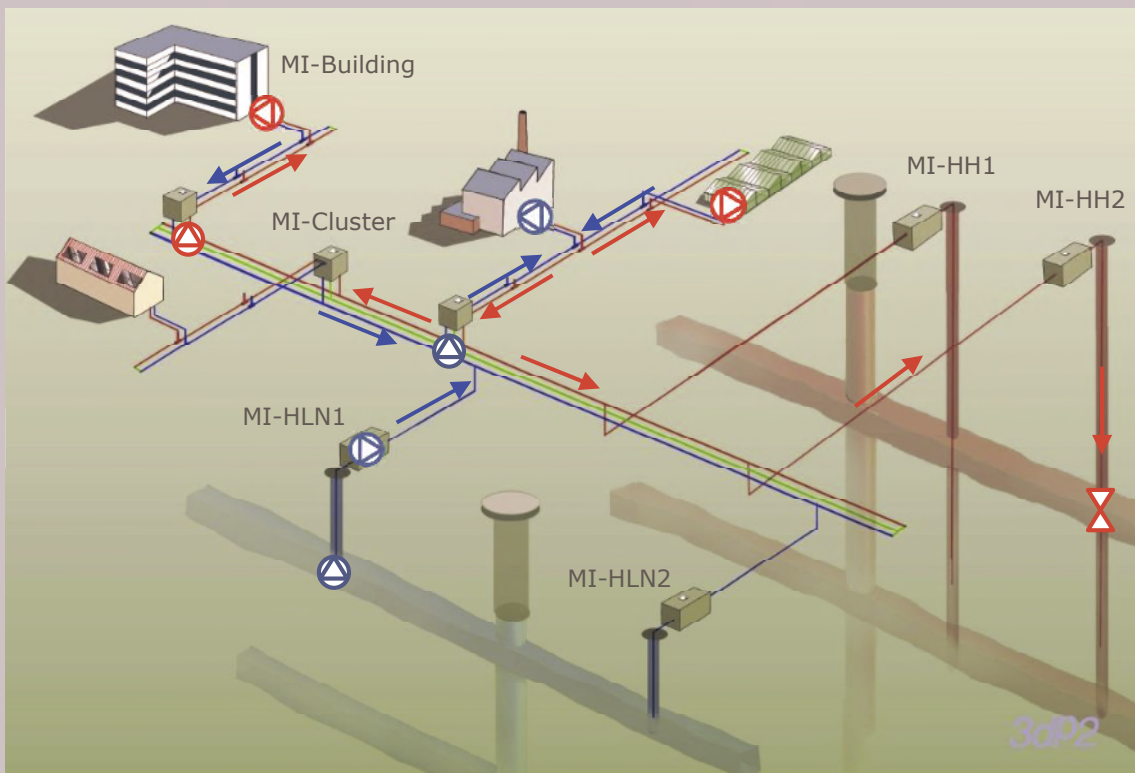
Smart grid: 3 levels of control

- Building  
*Temperature*
- Cluster  
*Flow*
- Minewater  
*Pressure*



# Minewater 2.0

Smart grid: Exchange!

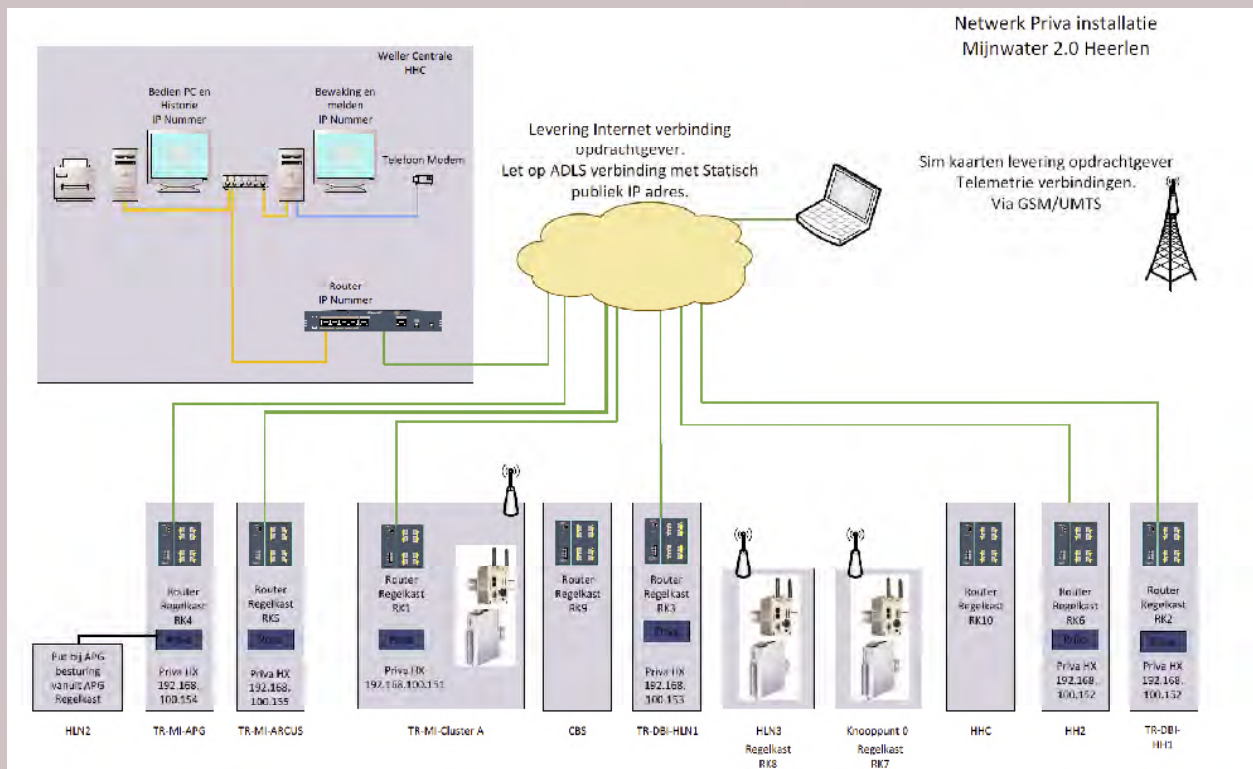


Artist impression Minewater 2.0 with geographically dispersed Minewater Installations (MI)



# Minewater 2.0

## Advanced process control



# Minewater 3.0

## The NEXT step!

Balancing with.....



Time

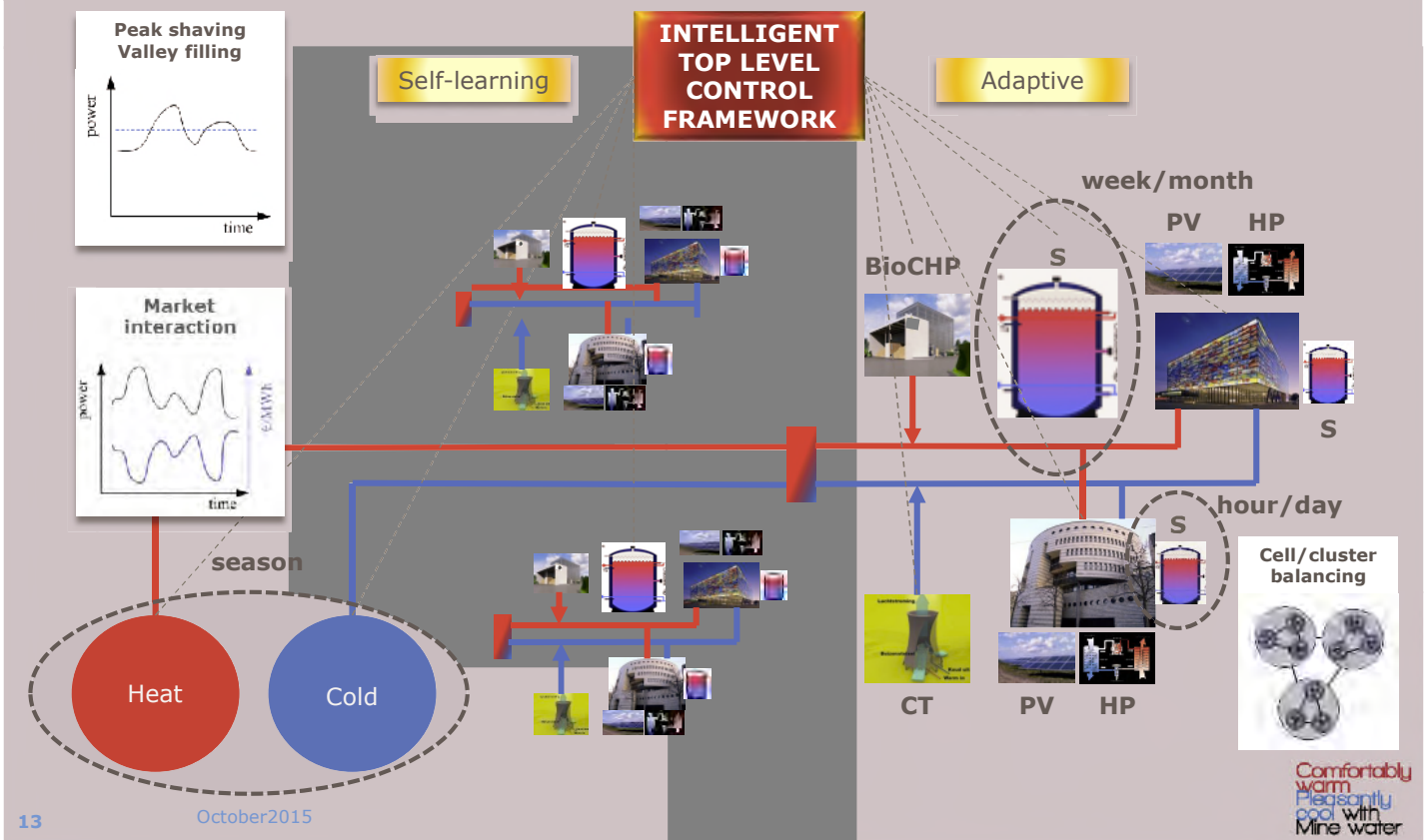


CO<sub>2</sub>-Reduction  
80-100 %

INTELLIGENCE

# Minewater 3.0

## STORM (Self-organizing Thermal Operational Resource Management)



13

October 2015

# Minewater Heerlen

## Summary

- Transition Minewater project Heerlen into a hybrid sustainable thermal smart grid:
  - ✓ Cloud structure (3 levels of control/decentralized)
  - ✓ Exchange (reuse; prosumers)
  - ✓ Storage (time)
  - ✓ Multiple sources (hybrid)
  - ✓ Intelligence (Demand & supply side management)
  - ✓ All-electric
  - ✓ Integratable with (smart) electricity grid
  - ✓ Low-exergy (LT-heating & HT-cooling)
- Increased CO<sub>2</sub>-emission reduction:
  - ✓ 1.0: 35%; 2.0: 65%; 3.0: 80–100%
- Concept replicable for future DHC-systems:
  - ✓ Not restricted to old mining areas
  - ✓ Blueprint for sustainable thermal smart grids

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# Geothermal fed low-exergy 4thG-DHC grid in Heerlen

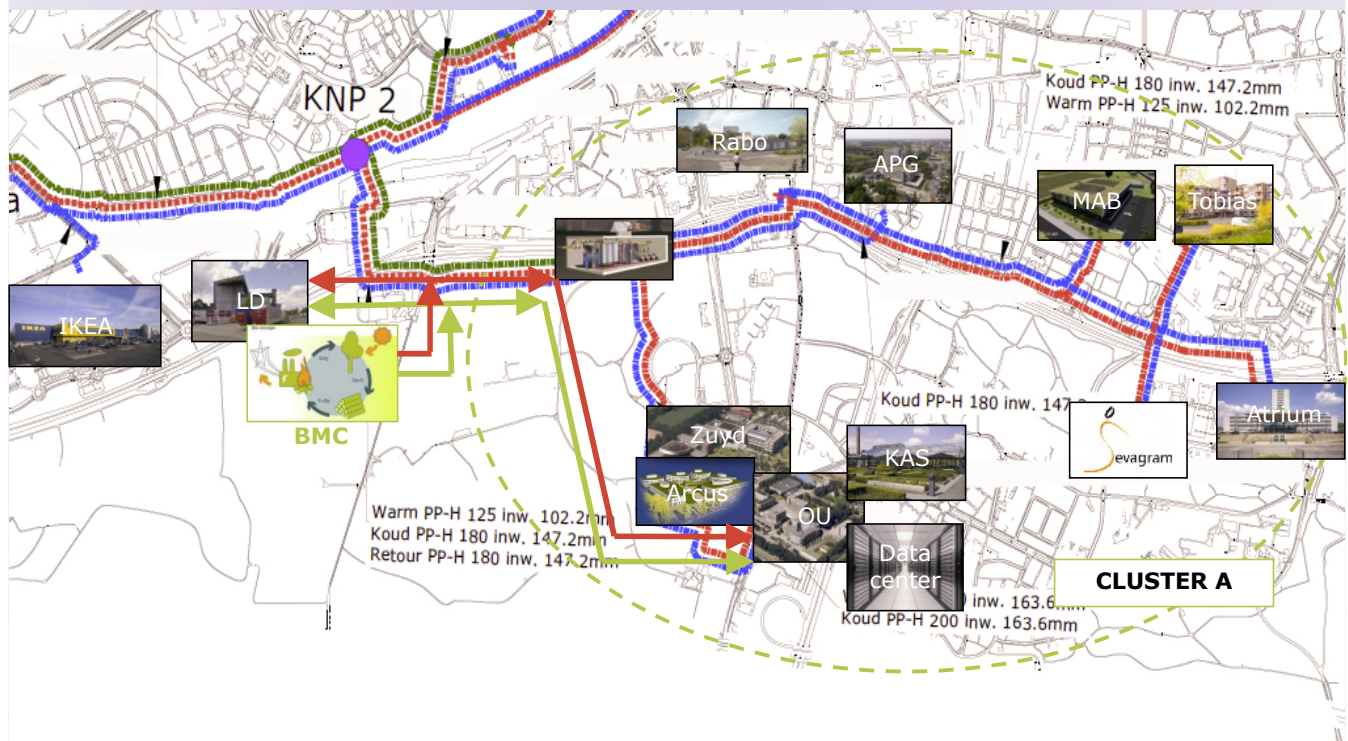
## Urban Energy Development



Herman Eijdem  
Mijnwater B.V.

## Mijnwater – grid Heerlen cluster A

Geneva  
30.10.2015  
- 2 -

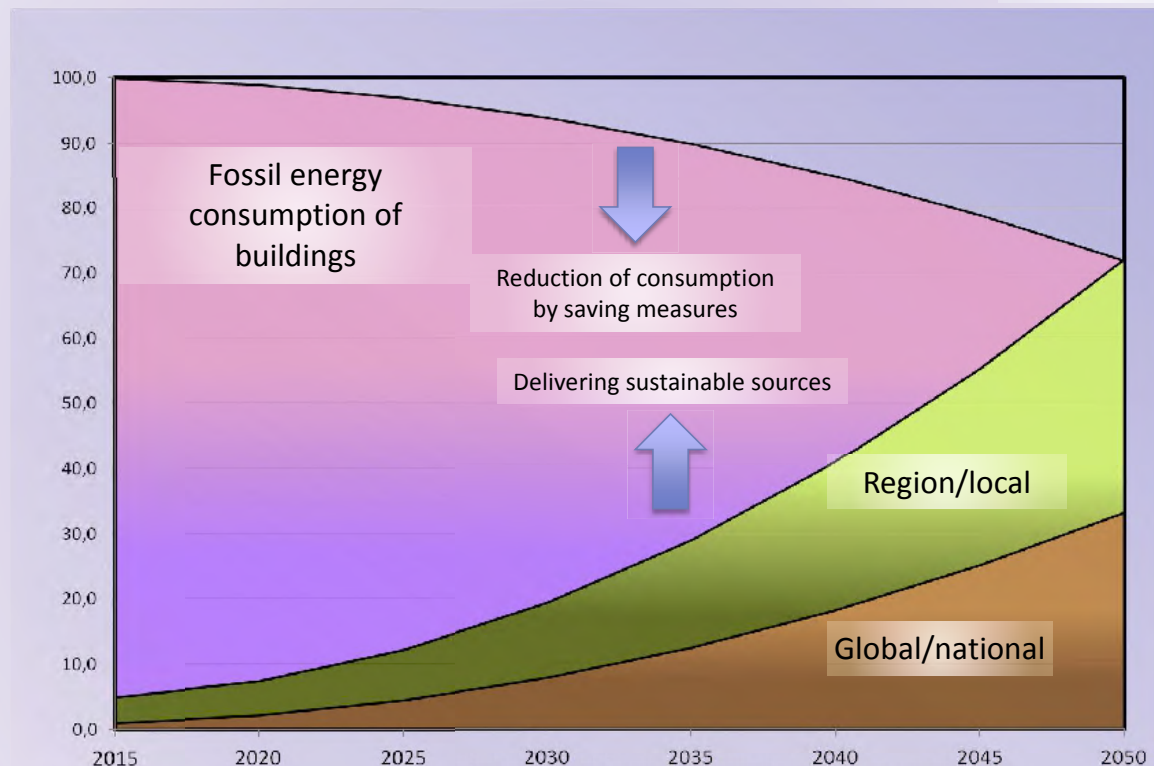


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Mijnwater B.V.



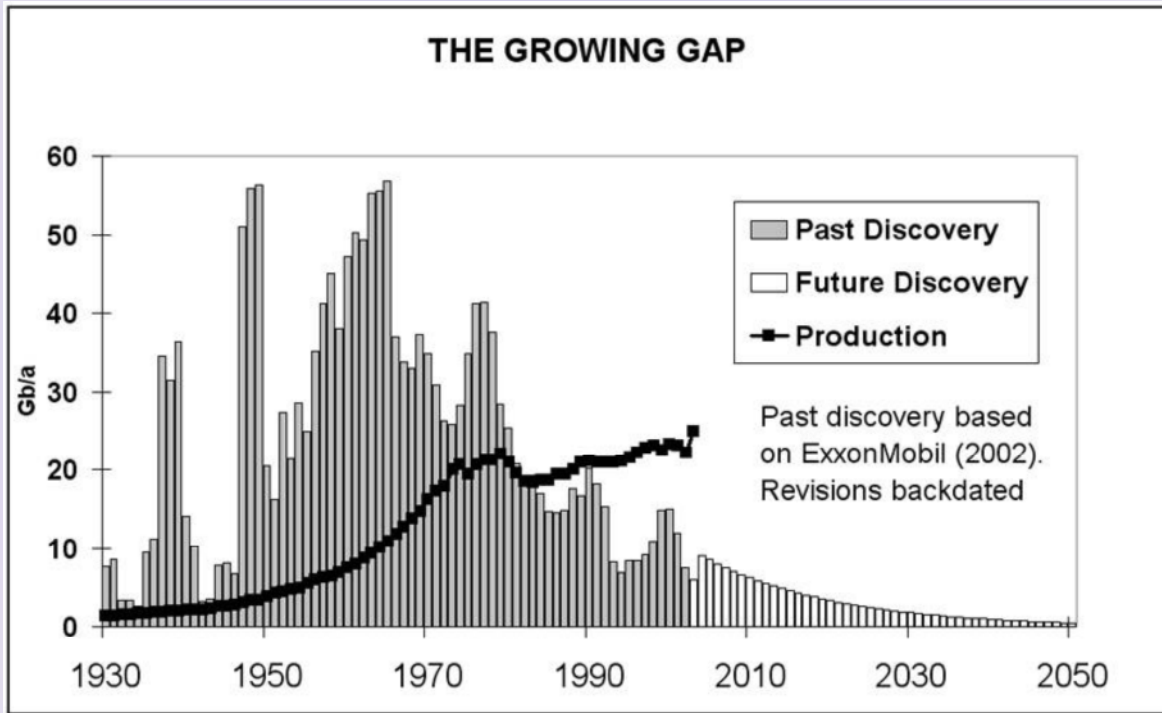
- *Everybody has the right to save, secure and continual access to energy;*
- *Energy should facilitate a healthy and comfortable life style and give opportunity for evolution and mobility;*
- *Everybody has the right to participate in, but also has a responsibility for the generation of our energy needs;*
- *Energy supply is based on infinite resources;*
- *A minimal impact on the environment is considered at the generation of energy;*
- *Revenues from energy benefit to the local community and are being fairly and evenly distributed (energy dependence may not lead to speculative or monopolistic profit for individuals or businesses);*
- *Energy is generated in the own region to prevent dependency on energy-producing countries or regimes and to save local money and employment;*
- *We strive -in a cycle of continuous improvement- to building knowledge and make this knowledge accessible to all stakeholders.*

## Road to Energy neutral



# Depletion of fossil resources

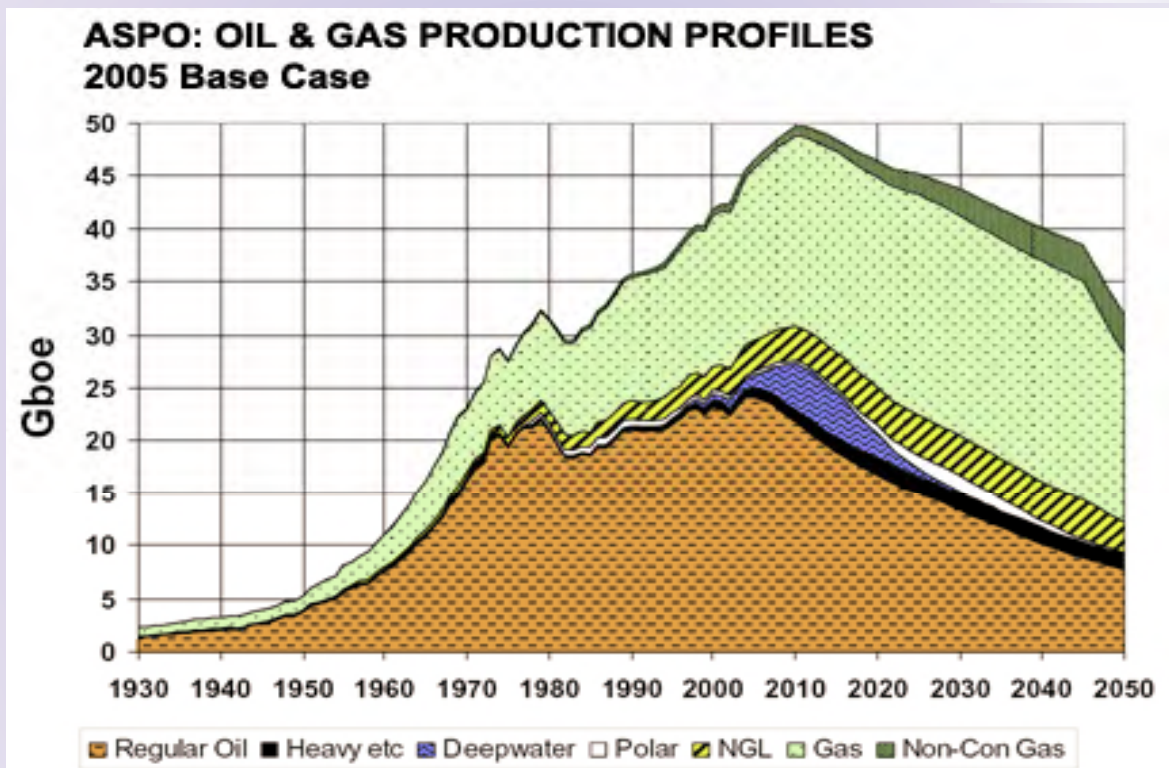
Geneva  
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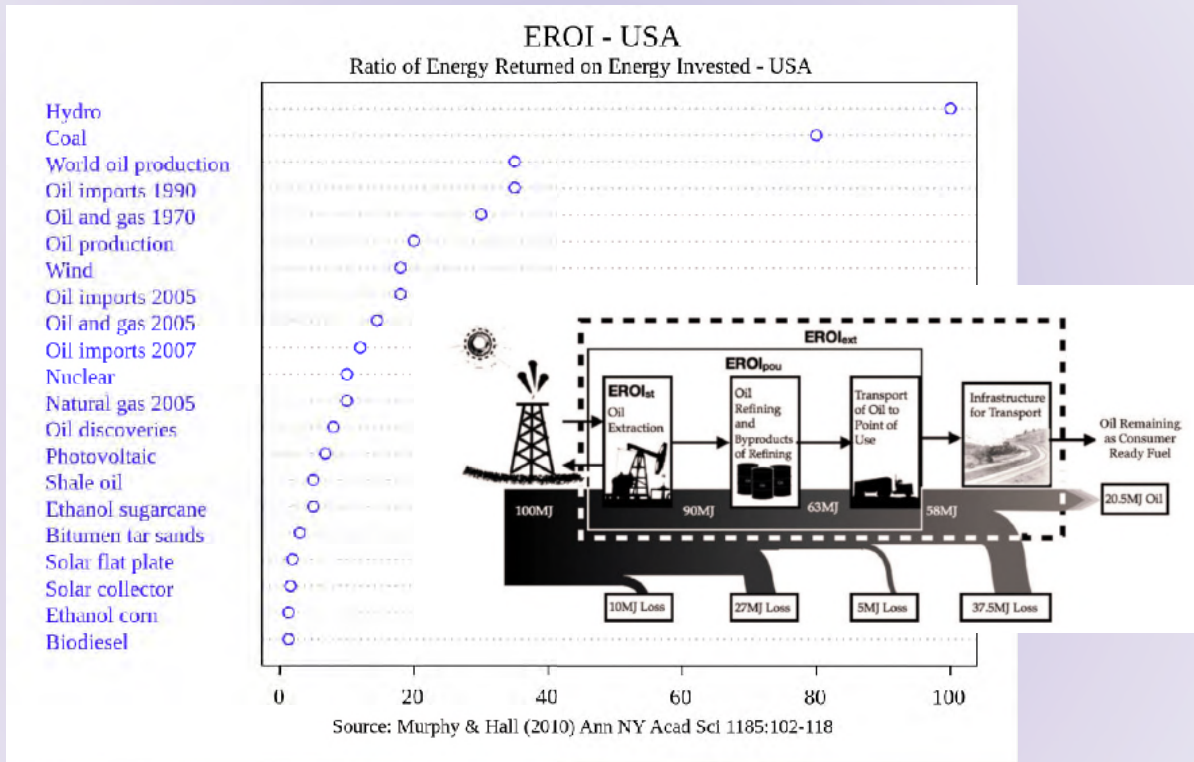
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# Depletion of fossil resources

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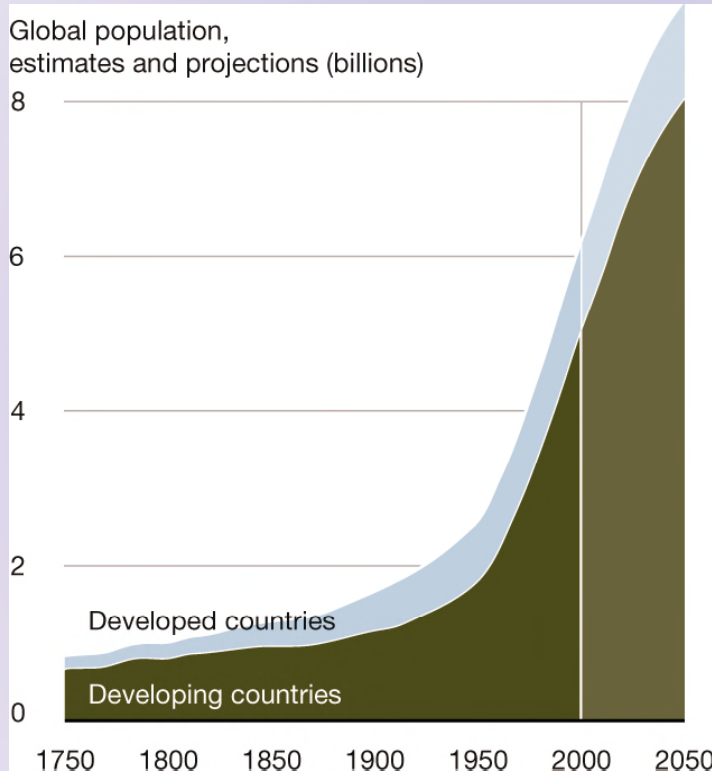


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# Population growth, urbanisation



*In 1950, 30 % of the world's population was urban, and by 2050, 66 % of the world's population is projected to be urban.*



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Mijnwater B.V.



# Security of support and welfare

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**DID YOU KNOW?**

**IN SCOTLAND**



**40%**

of households are in **Fuel Poverty**

This number has significantly risen, and will continue to rise, due to subsidising wind energy and associated infrastructure, by adding the costs onto household energy bills.

**What are the financial costs?**

- Feed-In-Tariffs
- Construction of National Grid Interconnectors
- Renewable Obligation Certificates
- New Transmission Lines
- Construction of backup Fossil Fuel Stations
- Constraint Payments
- Construction of Smart Grid
- Cost of installing Smart Meters
- Paying for Diesel Backup Generators

**Learn the FACTS**



www.ScotlandAgainstSpin.org

*People need energy*

*Therefore..*

*Long term energy support should be secured*

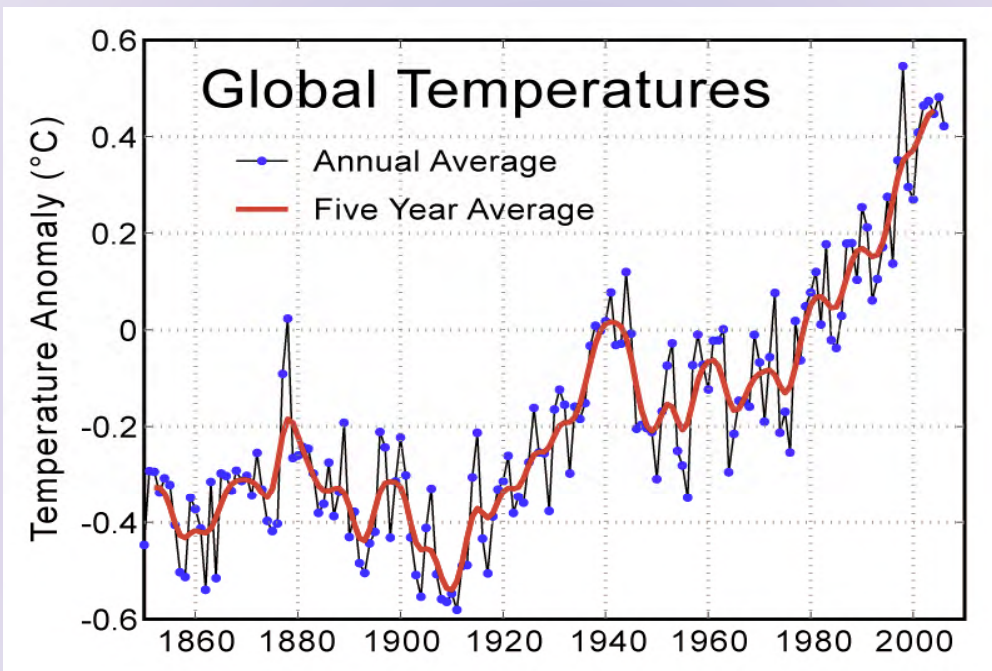
*We need strategies and concepts which will last*



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Mijnwater B.V.**

# CO2/global warming/sea level rise

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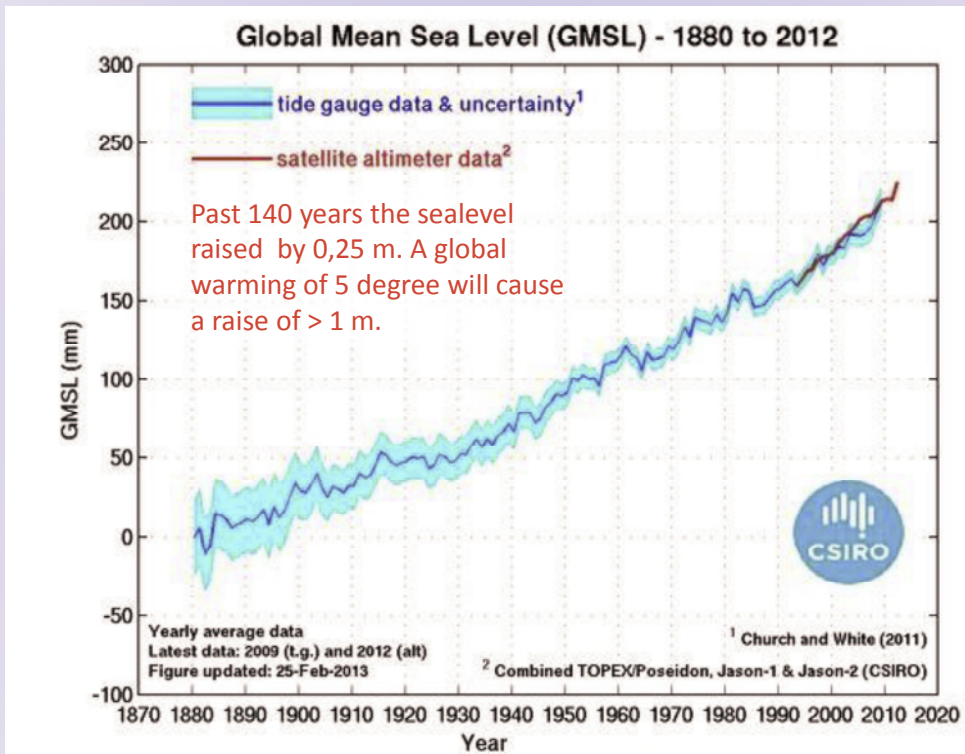


*Warming of 5 ° C could result in US\$7 trn in losses*

*Most Dutch cities experience a substantial impact of Urban Heat Islands*

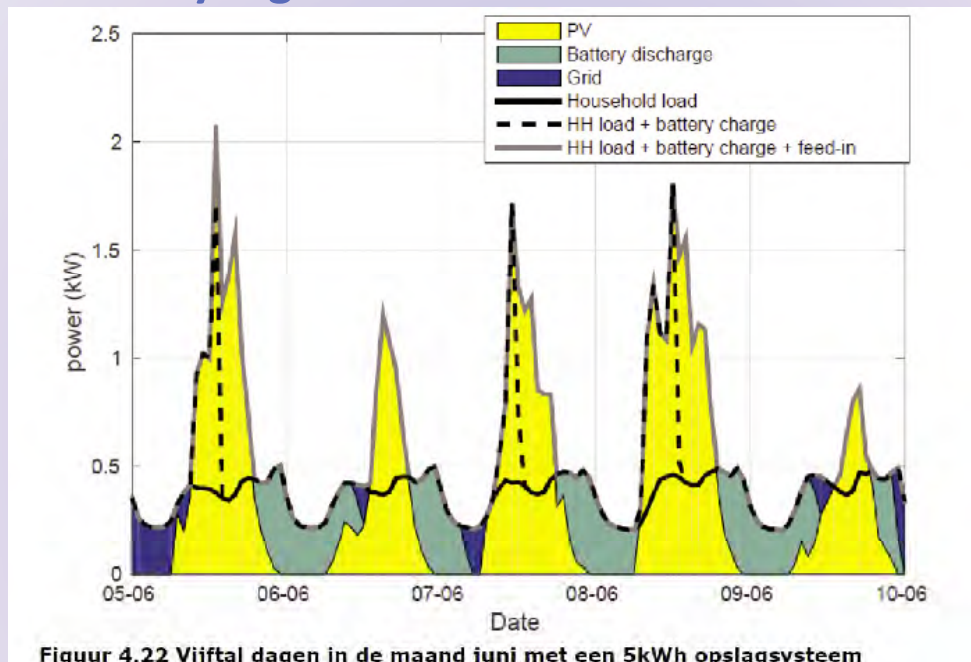


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Mijnwater B.V.**



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Mijnwater B.V.

## Instability E-grid



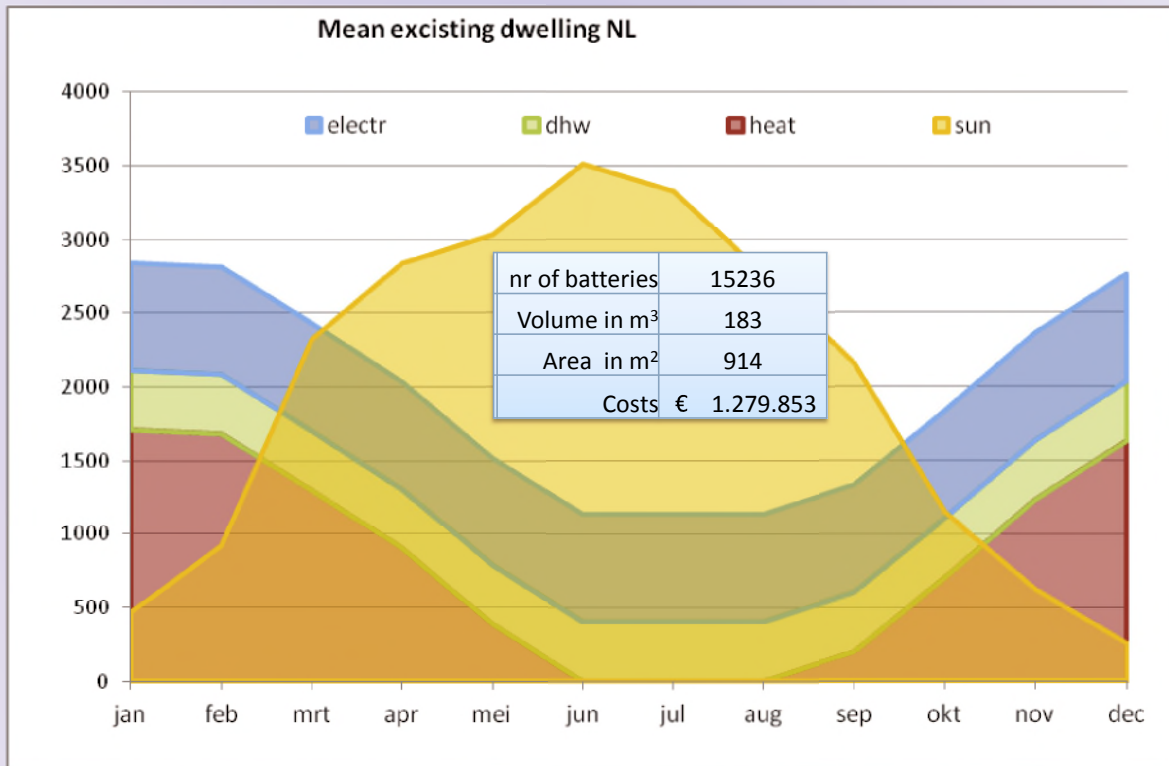
Figuur 4.22 Vijftal dagen in de maand juni met een 5kWh opslagsysteem

*Storage is one of a number of key technologies that can support decarbonisation. Thermal energy storage systems appear well-positioned to reduce the amount of heat that is currently wasted in the energy system (IEA) "*

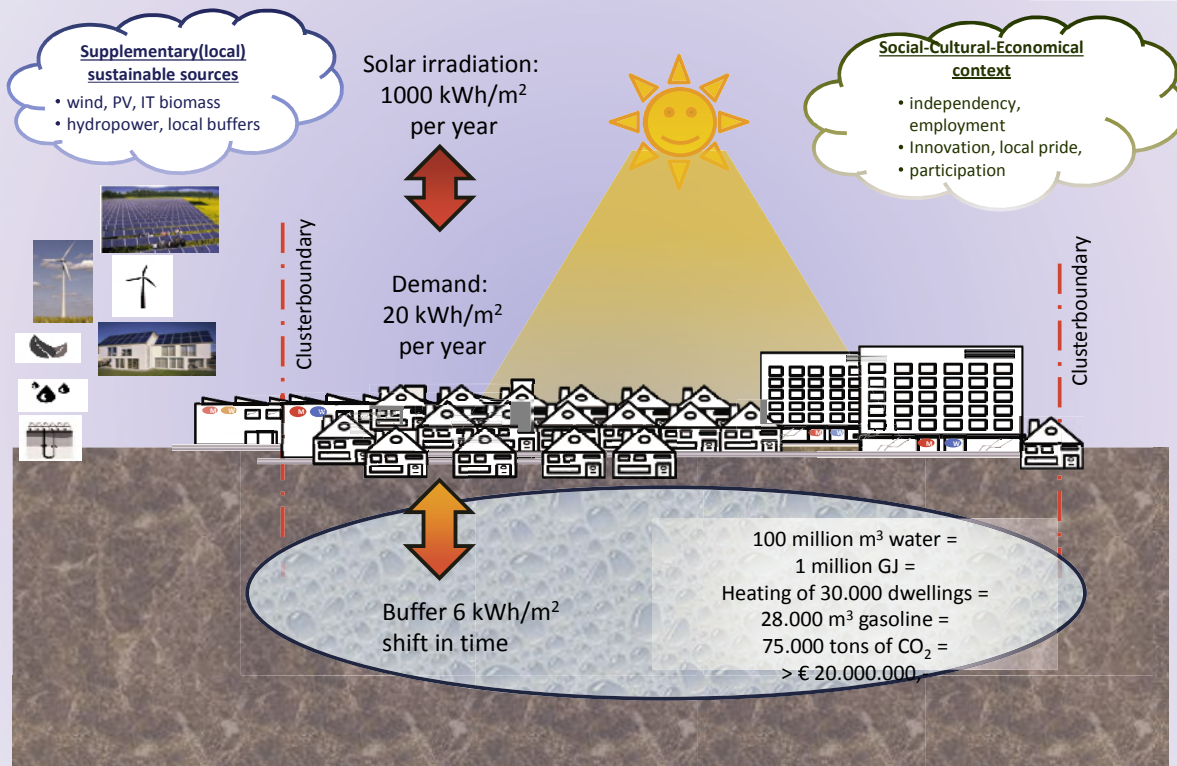


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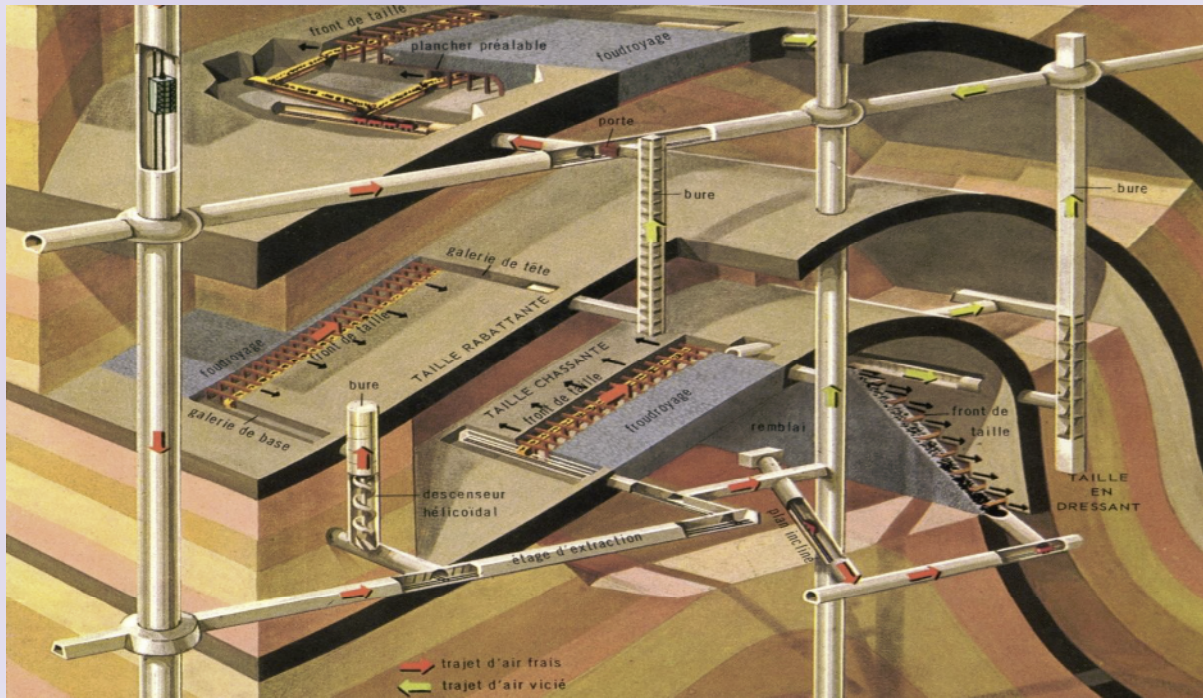
# Mijnwater Energy concept





# Mijnwater Underground voids

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MINE WATER, A BASIS FOR  
WWW.MIJN WATER.COM



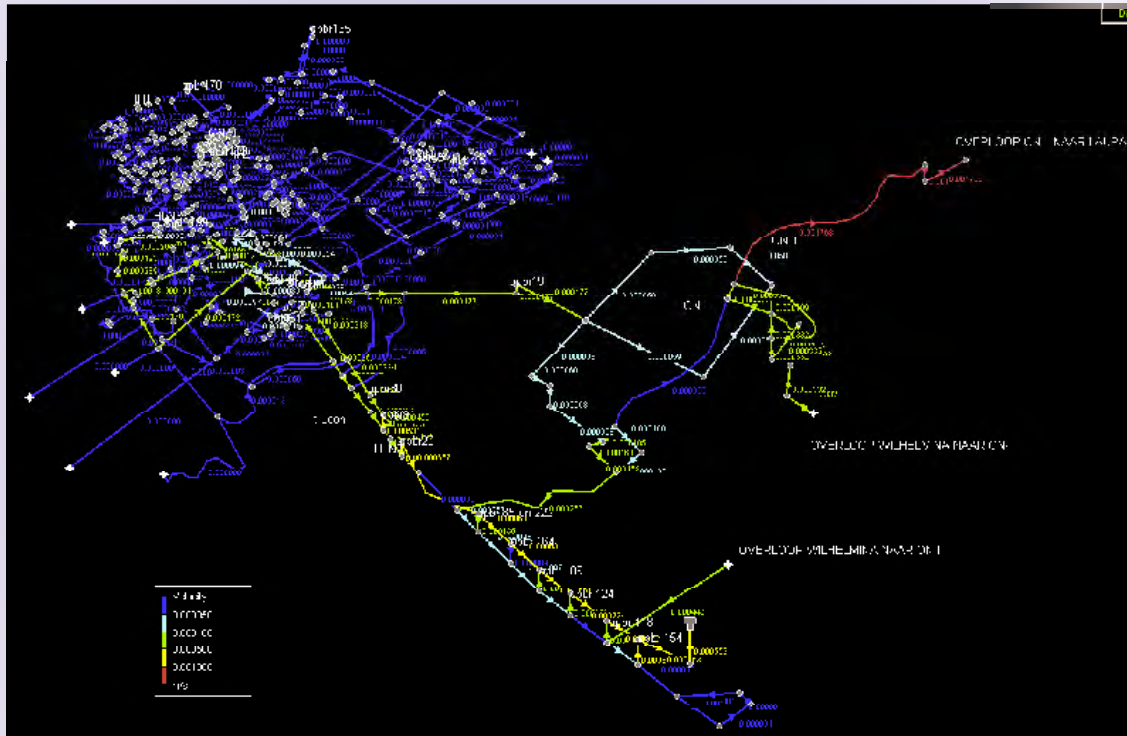
SUSTAINABLE  
PLACES



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# Mijnwater modeling the reservoir

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3D model of the underground mine water network (VITO)



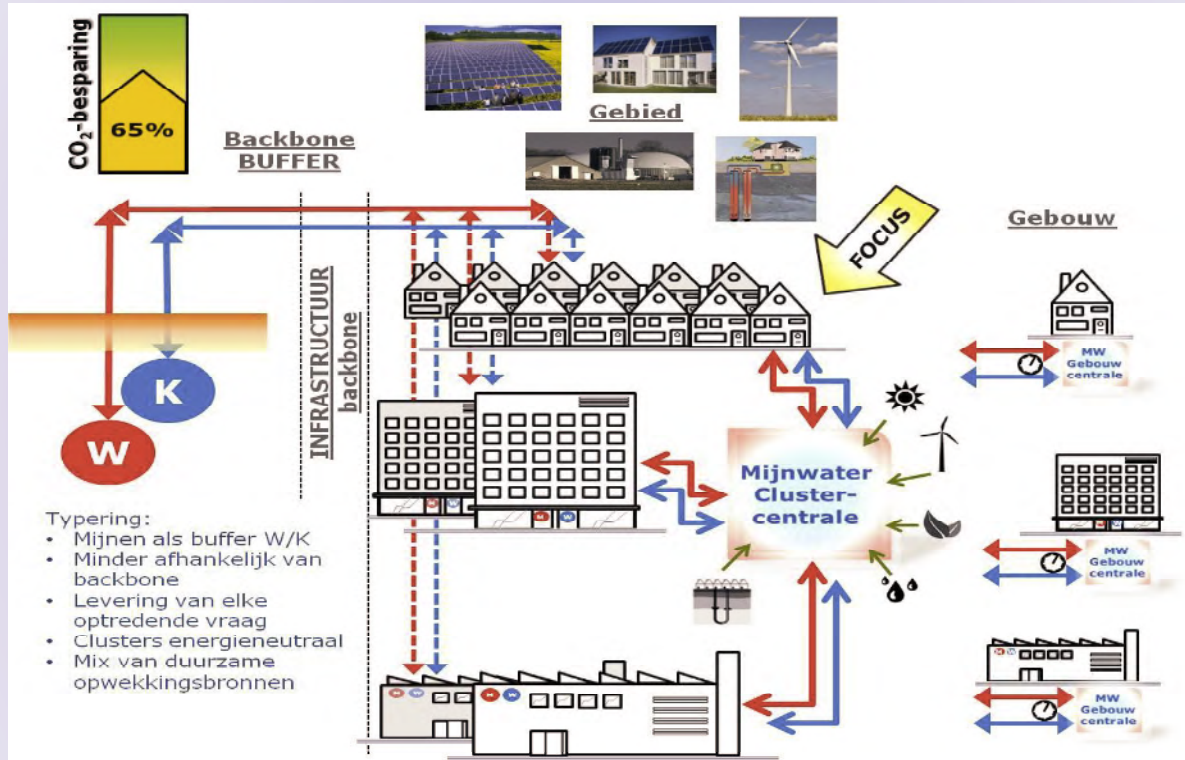
MINE WATER  
WWW.MIJN WATER.COM



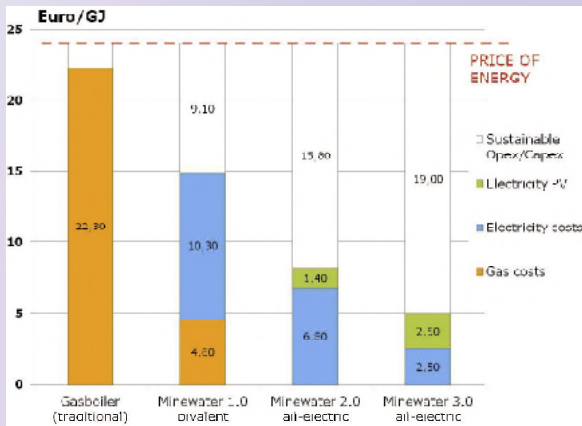
SUSTAINABLE  
PLACES



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# Mijnwater businesscase



National Gas Consumption for dwellings: 310 PJ (10<sup>15</sup> J) per year

Investment space is € 19,- per GJ

Investmentspace : € 5,9 Billion per year

Within 30 years: € 100 Billion

€ 14.500,- per dwelling + € 4.000,- of costs for CV boiler (7 million dwellings)

Total energyconsumption NL (divided to endconsumer group)					
Term	share	PJ	gas/coal	Electricity	DHC
Industry Electr	14,3%	570			
Industry Gas	16,8%	670			
Int. Transport	18,0%	720			
Offices	9,4%	375			
Other services	5,0%	200			
Energy plants	13,8%	550	870	-240	-80
Nat. Transport	12,0%	480			
Dwellings	10,9%	435	310	90	35
	100,0%	4.000			



		reference = basis 1550 m3 gas 3200 kWh E	Retrofit to label A CV HR+ & insulation	All Electric WP+PV + highly insulated	All Electric WP+PV + LTV/HTK + mijnwater	Notes
1	Running out of natural gas/oil	---	--	++	+++	Winning is 80 bln m3, stock < 1.100 bln m3, earth quakes, soil subsidence
2	EROI from 100 to 1	---	--	++	+++	The efficiency of production is declining
3	Population growth, urbanisation	0	0	+	++	Denser areas, spatial scarceness, air pollution
4	Security of support and welfare	--	-	0	++	Energij = basic, spreading of resources, exchange
5	CO2 / global warming/sea level rise	---	--	+	++	Reduction on fossil fuels
6	Dependency Arabia/Russia	---	--	+	++	National resources
7	Prosumentism (Uber, Airbnb, PV) / participation	--	--	0	+	Involvement and awareness, social support
8	Value of buildings / flexibility	-	-	+	++	Sustainability sells
9	Local economy	--	-	0	+	Dependent on development of local industry
10	From 'big sources' to 'clouds'	-	-	0	++	Better data, insight, critical population
11	Urban Heat Islands	-	--	---	++	More and more caused by cooling demand
12	Instability E-grid	+	+	---	++	PV limited to 7 %
13	Social costs	-	-	---	+	Varying from € 30.000,- to € 75.000,- per dwelling
14	Limited resources raw materials	0	0	-	+	Copper and other metals for infrastructure
15	Destruction of capital	-	-	+	++	Value during life cycle of 50 years



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Mijnwater B.V.

## Mijnwater a sustainable hybrid solution for urban areas



Thanks for your attention  
Questions?



Energy Water Circle

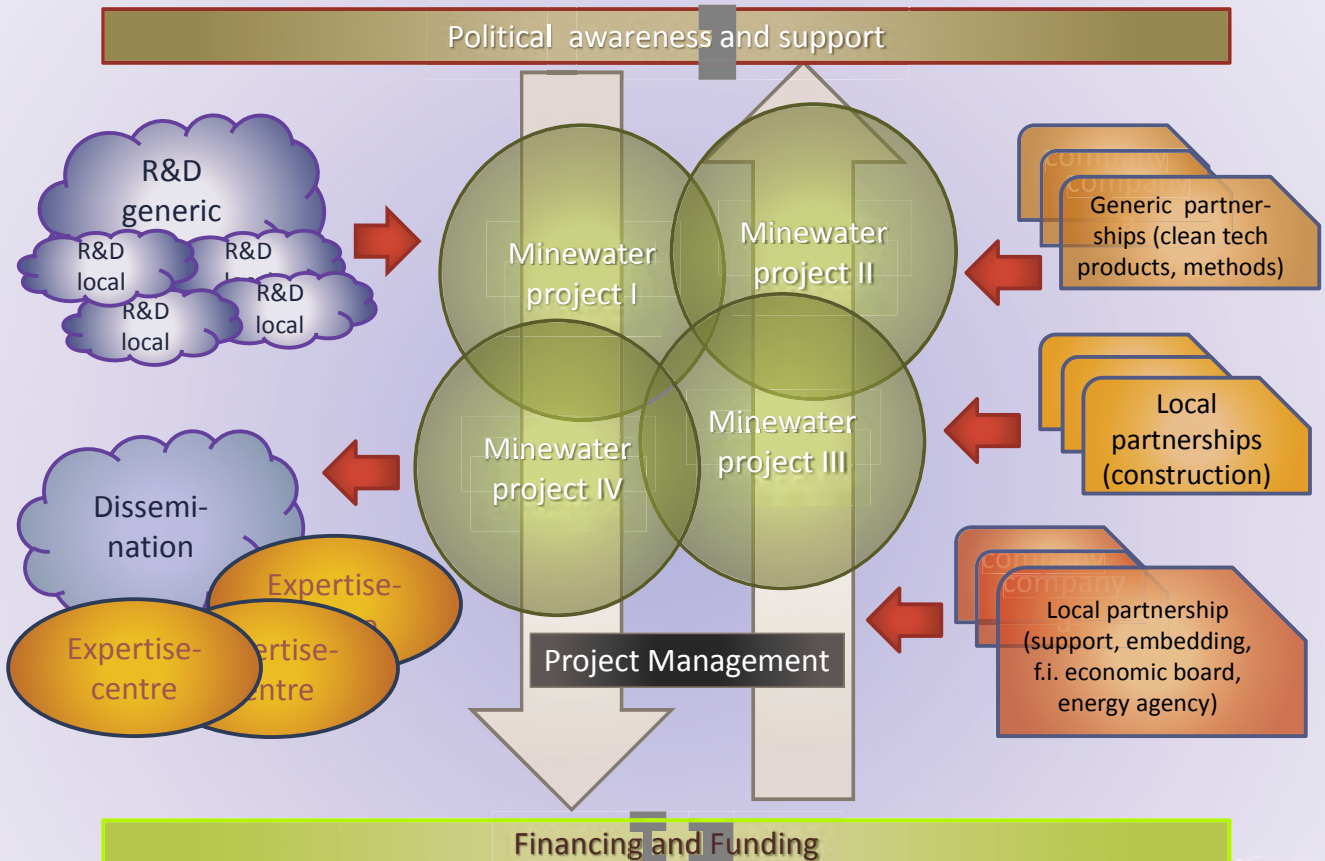
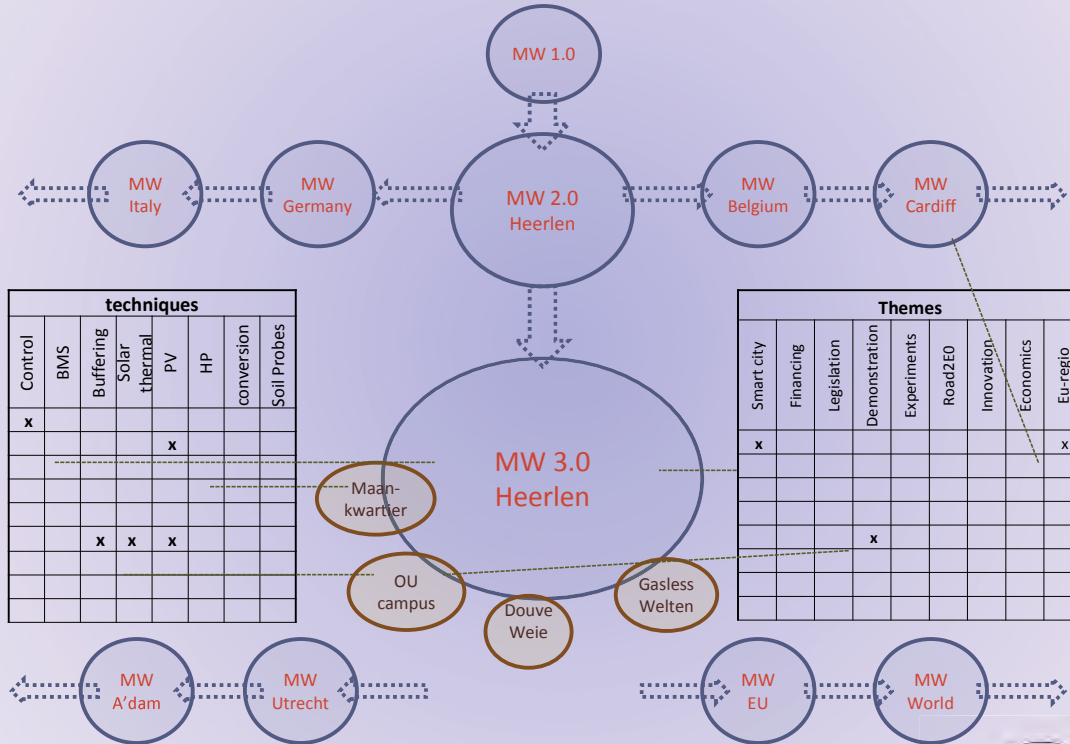


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Mijnwater B.V.



# Mijnwater R&D

## Innovation Agenda



## Session III Direct use applications (new concepts – other sectors)

### Italy – Adele Manzella, CNR

**Title:** Direct use of heat for industrial and civil processes

**Presenter:** Adele Manzella is a Senior Scientist working at the Italian National Research Council (CNR) as a geophysicist in geothermal exploration to conduct field and theoretical investigations of geothermal systems in Italy and abroad. She coordinates for CNR the national geothermal evaluation projects and participated in national ventures dedicated to crustal, volcanological and geothermal exploration. She has led the CNR participation in most of the EU funded projects of CNR in the geothermal sector I-GET, ENGINE, Development of the young researcher's competences at UE standards in the geothermal field and GEOELEC. Projects she is currently involved in, i.e.: IMAGE, Geothermal ERA-NET and DESCRAMBLE. Her activity nowadays tackles research, training, information and promotion of the geothermal energy.

#### **Abstract:**

The VIGOR project aims to propose applications for exploiting geothermal heat resources of southern of Italy, meet heat demands of local industrial/civil processes; and support economic and social growth of the south Italian regions. It is a number of 8 projects in the Convergence Regions (Campania, Calabria, Puglia and Sicily), which study natural potential and the possibilities of exploitation. Simulations of plants operation aims to assess the produced thermal/electrical energy and define if it meets the energy demand, environmental impact, energy saving and economic profitability. The project will bring the necessary elements of technical and socio economic study and will promote geothermal awareness in these regions.

[Back to the program](#) 

# *Direct use of geothermal heat as proposed in VIGOR project*

Adele Manzella, Giuseppe Lombardo

30 October 2015

Geothermal ERA-NET

New Concept Workshop

[www.vigor-geotermia.it](http://www.vigor-geotermia.it)



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## VIGOR aims

- To propose applications for :
  - exploiting geothermal heat resources of southern of Italy;
  - meet heat demands of local industrial/civil processes;
  - support economic and social growth of the south Italian regions



**n. 8 projects as examples of  
potential use of geothermal resources  
in the Convergence Regions**



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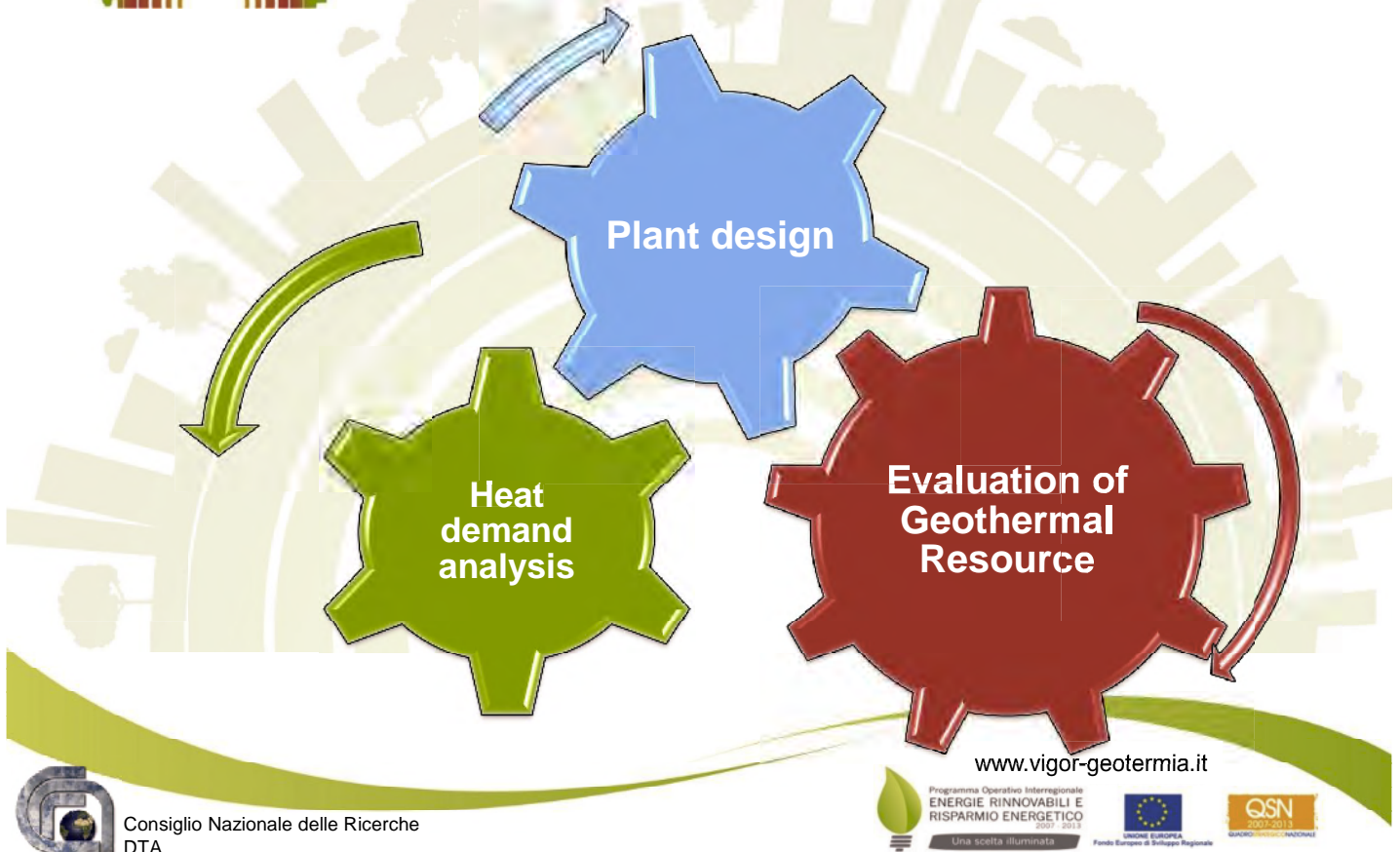
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[www.vigor-geotermia.it](http://www.vigor-geotermia.it)

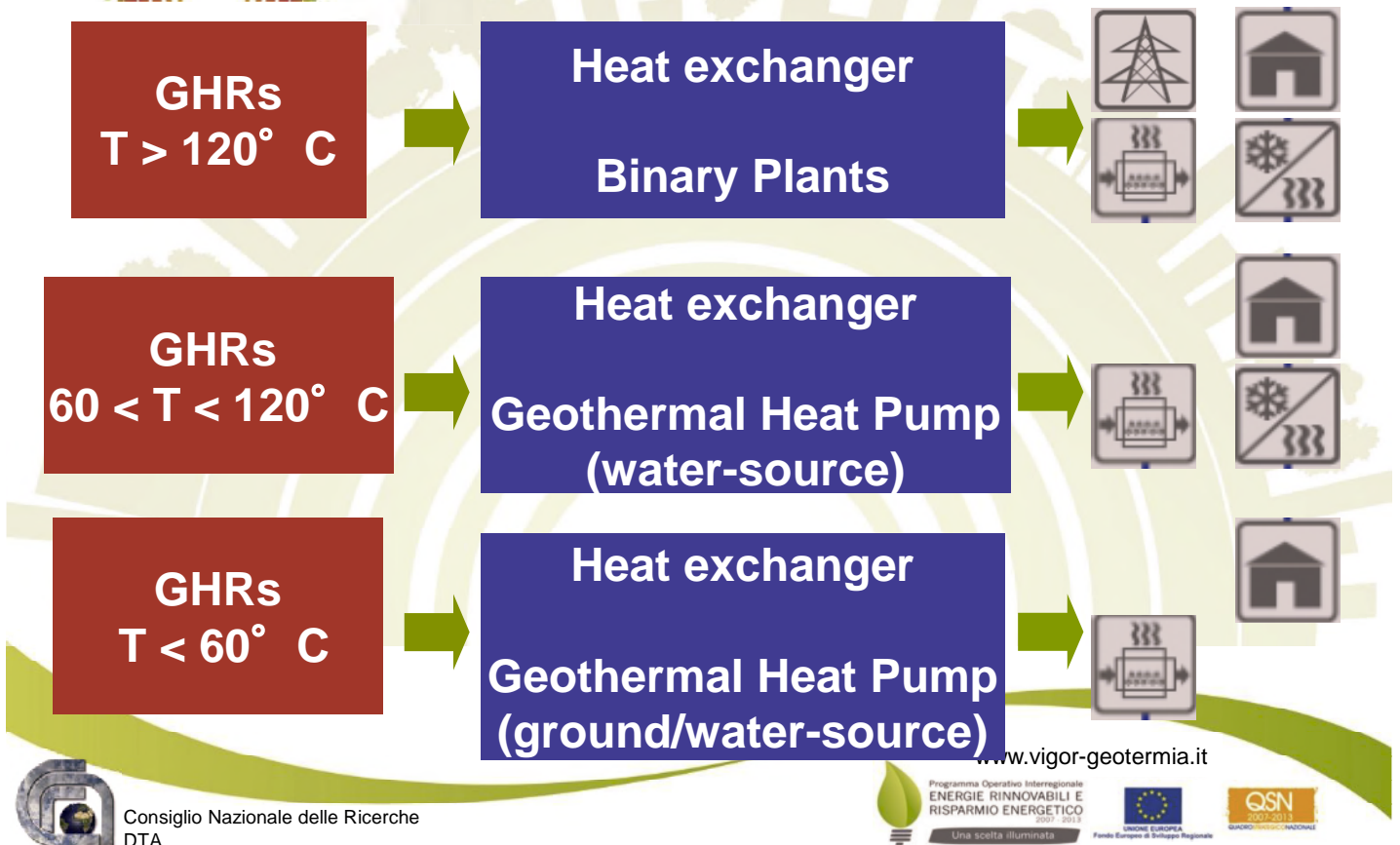




# Interdisciplinary approach with a common and systemic vision

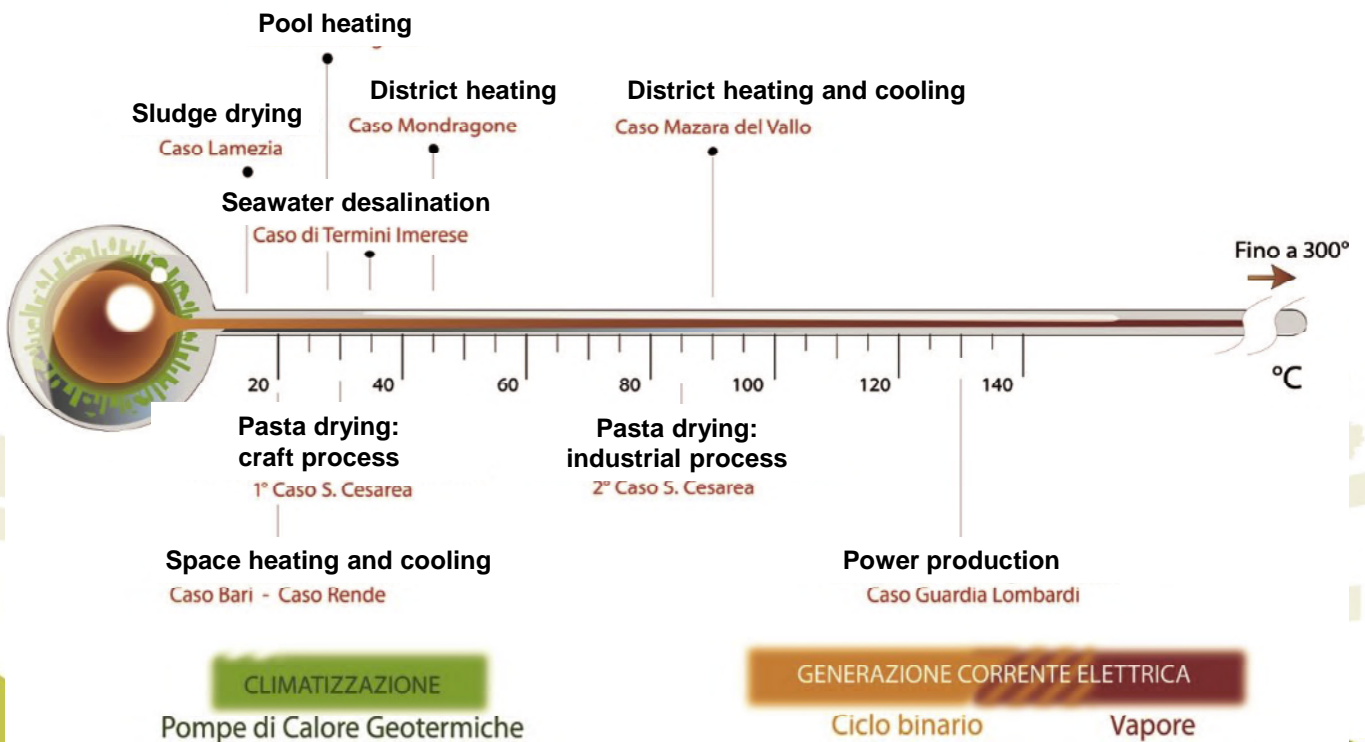


# Geothermal Heat Resources (GHRs) match heat demands





# Plant proposals in VIGOR



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## Geothermal plant for drying sewage sludge



### ➤ Plant proposal

- Geothermal plant for drying sludge from wastewater treatment;
- Location: Terme di Caronte (Calabria)

### ➤ Wastewater treatment plant:

- Controlled automatically by a PLC (Programmable Logic Controller)
- Water treatment: 1000 m<sup>3</sup>/h (8.760.000 m<sup>3</sup>/year)
- Treatment for water and sludges.



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[www.vigor-geotermia.it](http://www.vigor-geotermia.it)



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# Actual sludge disposal cost

- Disposal cost: **HIGH**

- 780 K€/year, since sludge is disposed in landfill with a cost of 130€/t (since it is considered high risk waste)

Is it possible to make the process of disposal sludge cheaper?



Use of geothermal heat for increasing the content of dried sludge

18%



80-90%

-30% €/t

Low environmental impact

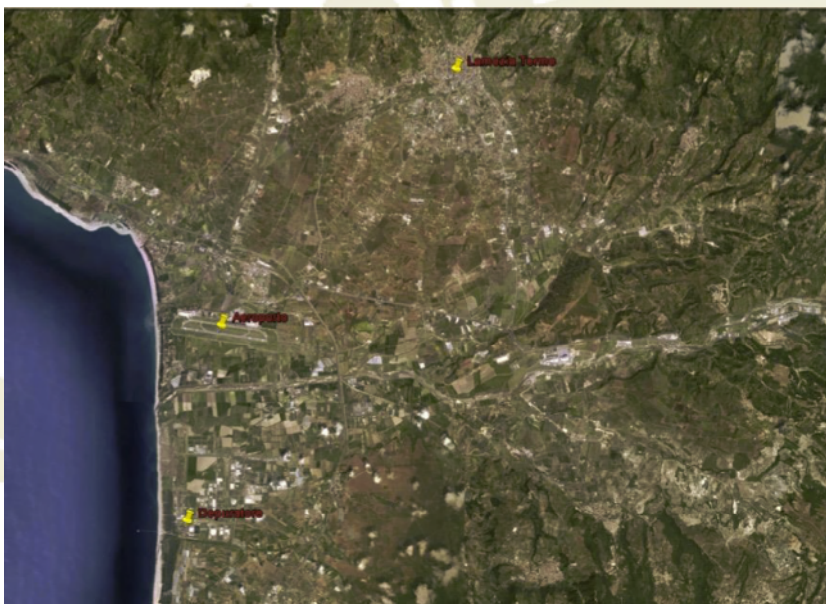


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# Geothermal resources



## Deep geothermal resource:

- T = 40° C

- Q = 10 l/s

- h = 1000 m

## Geothermal shallow resource:

- T = 17° C

- Q = 16 l/s

- h = 40 m

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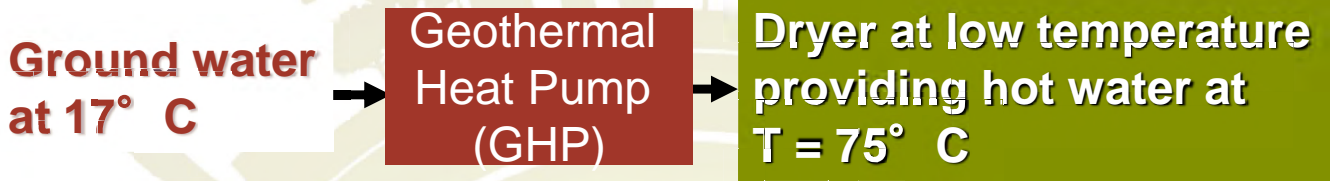
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# Sludge dryer powered by geothermal heat



- Two different plant proposals with GHP:
  1. drying with integral air recirculation;
  2. drying without air recirculation



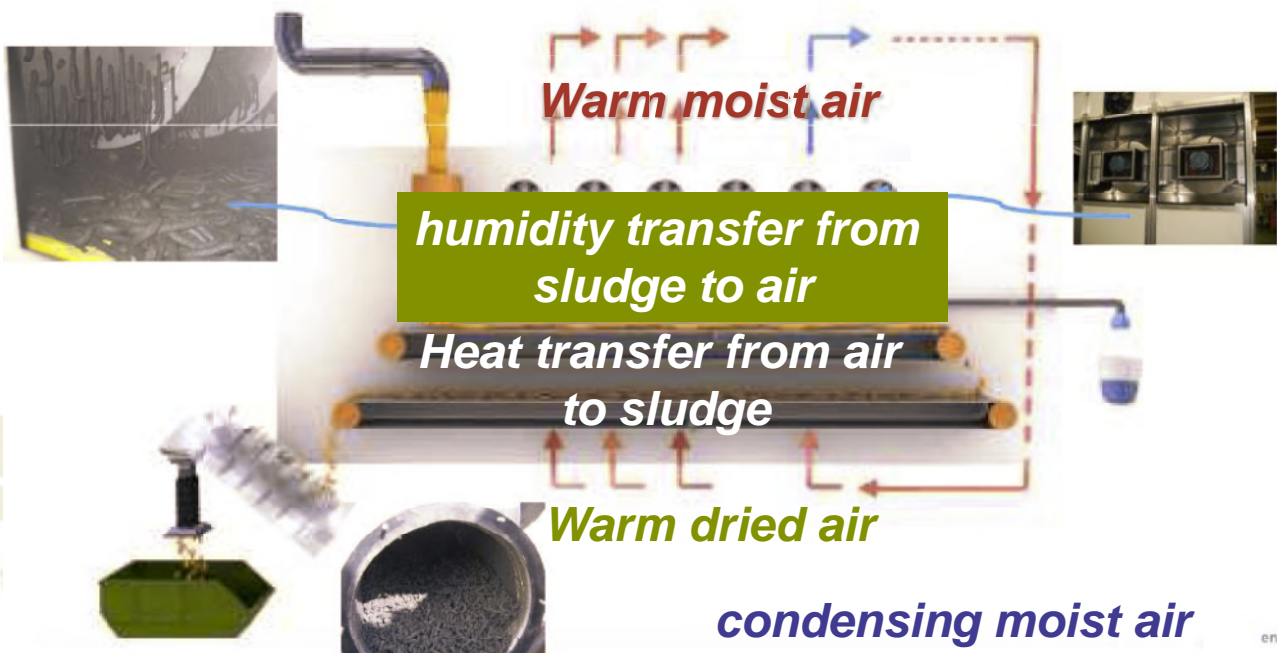
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**Sludge with 18% in dried weight**



**condensing moist air  
with recirculation (CASE 1)**

**Sludge with 80-90%  
in dried weight**



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# Thermal and Electrical dryers needs

- Case 1 (Dryer with air recirculation)
  - Thermal Power = 850 KW
  - Cooling Power = 420 KW
  - Electrical power = 70 KW
- Case 2 (Dryer without air recirculation)
  - Thermal Power = 1200 KW
  - Electrical Power = 35 KW



**Estimated operation hours: 7500 h/year**  
**Estimated dried sludge produced: 1500 t/year**



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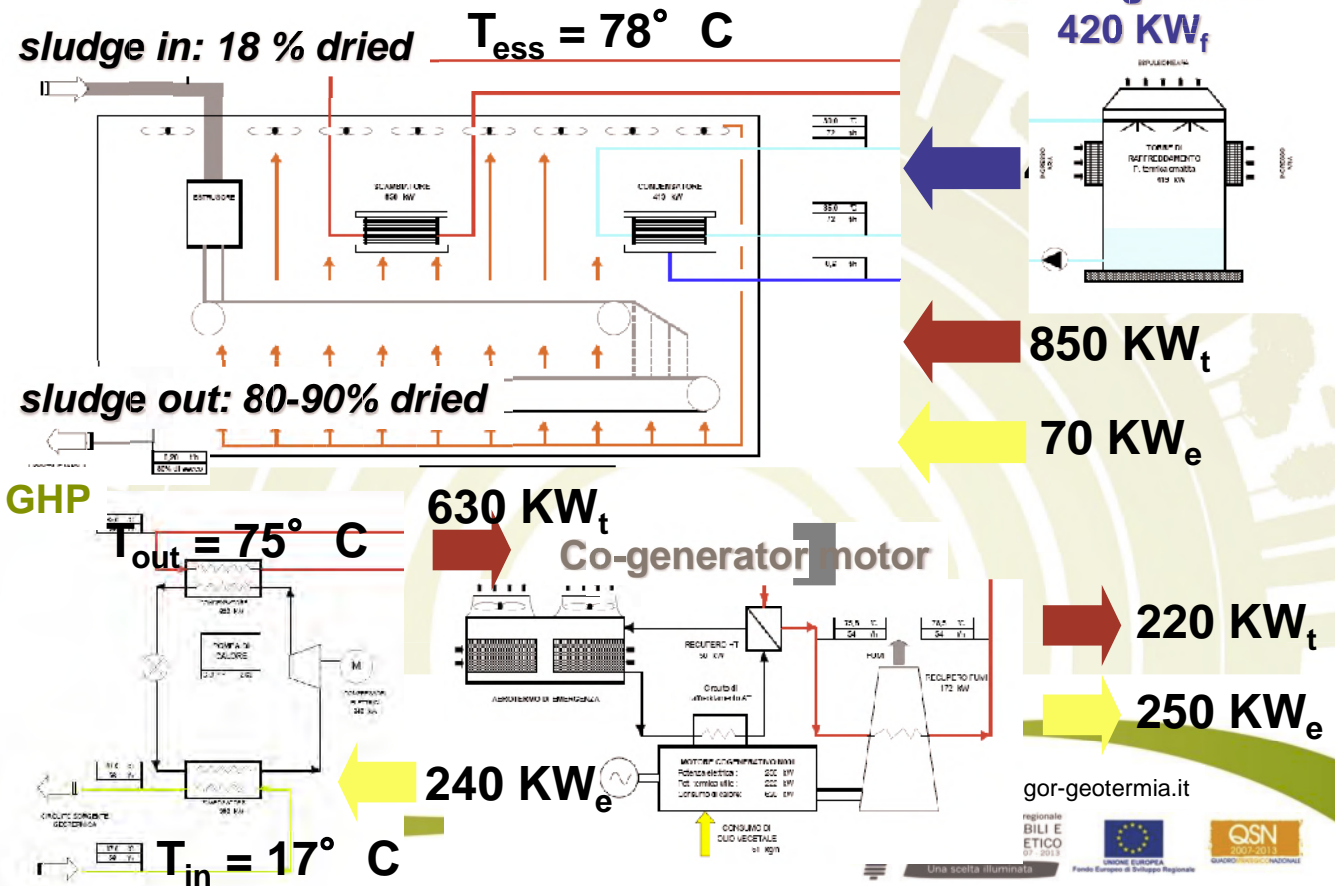
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## Schematic diagram – CASE 1

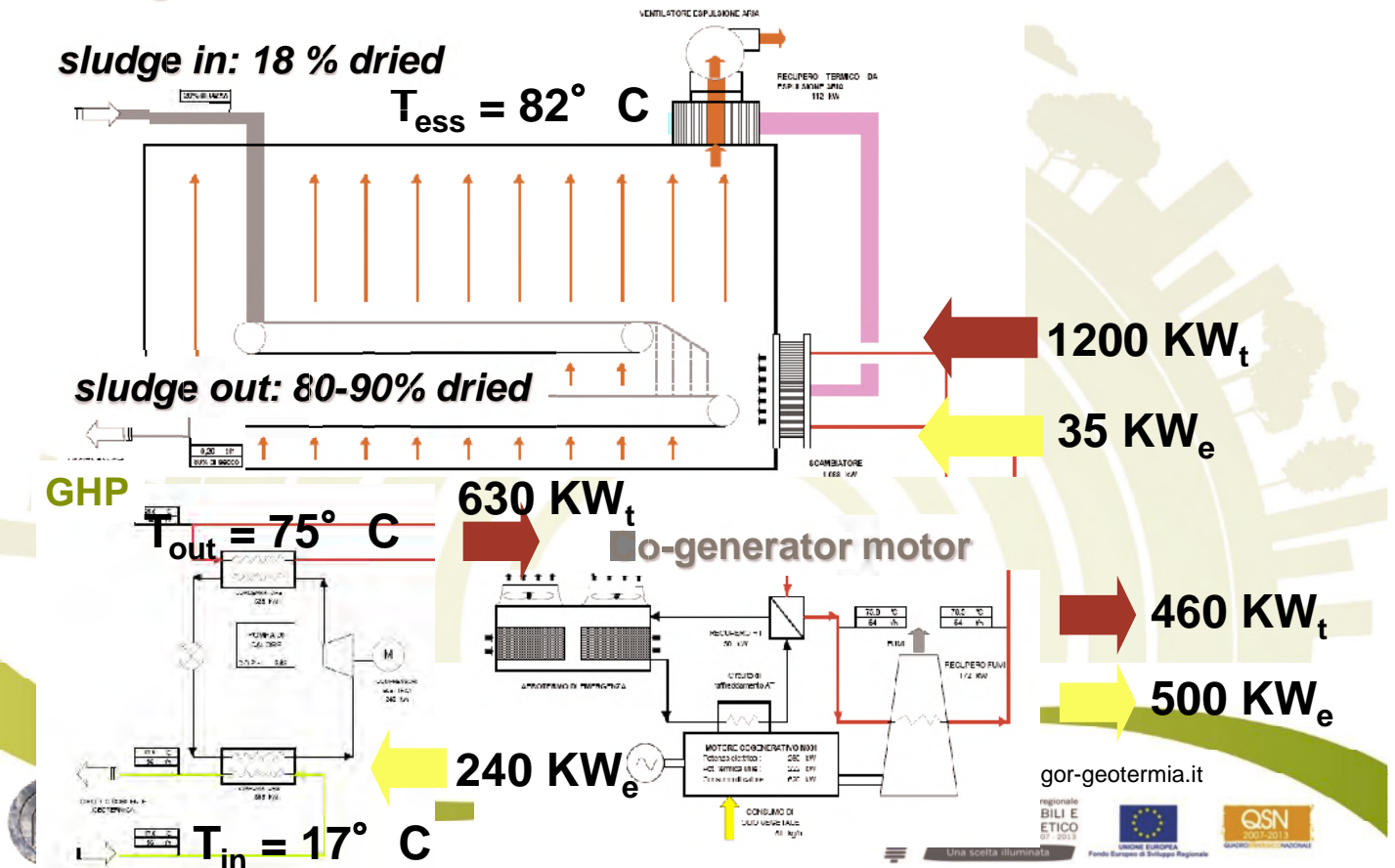
### Energy balance





# Schematic diagram – CASE 2

## Energetic balance



## Main plant characteristics

- The condenser of the heat pumps in series with one or two (only CASE 2) co-generative motors for heat recovery from the flue gases and from the cooling system at high temperature (only CASE 1);
- **Green system** and stand-alone with energy consumption produced by vegetable oil co-generators

Energy saving with respect  
 a conventional system

Case 1: 81 %

Case 2: 100 %







## Technical/Economical simulation

➤ Simulation of plants operation to assess



- the produced thermal/electrical energy and define if it meets the energy demand
- environmental impact
- energy saving
- economic profitability



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## Estimated cost – CASE 1

➤ Cost estimated for the investment **2.187 K€**

- Dryer: 930 K€
- GHP: 80 K€
- Co-generator motor: 450 K€
- Mechanical, Electrical and Electronic components: 420 K€
- Civil works: 150 K€
- Plant design and project management: 157 K€



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## Estimated cost – CASE 2

- Cost estimated for the investment **1.998 K€**
  - Dryer: 350 K€
  - GHP: 80 K€
  - N.2 co-generator motor: 900 K€
  - Mechanical, Electrical and Electronic components: 370 K€
  - Civil works: 150 K€
  - Plant design and project management: 148 K€



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## CASH FLOW

- Revenues:
  - cost saved from sludge weight reduced;
  - landfilling lower cost ;
  - green certificates;
- Costs:
  - purchases of fuel for co-generative motor ;
  - Maintenance and consumables;



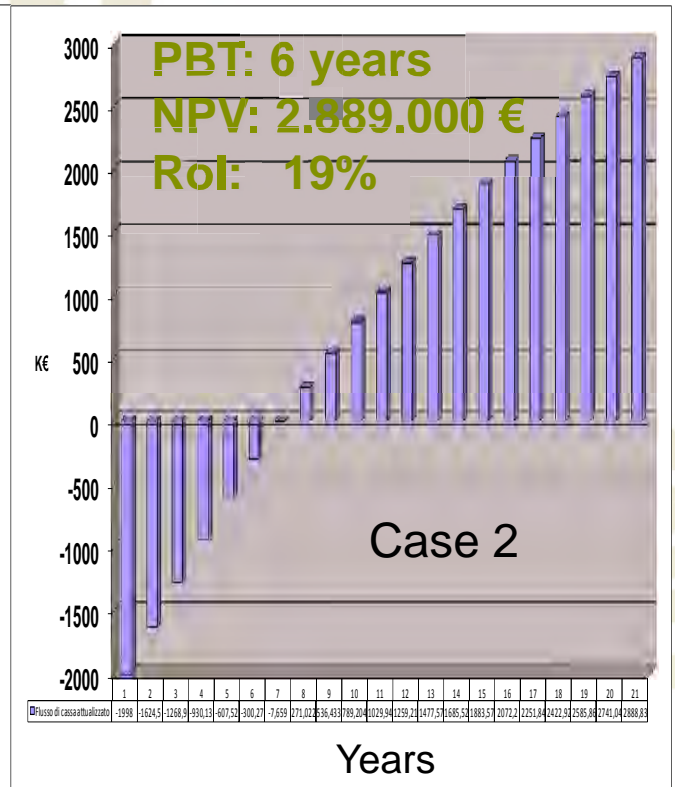
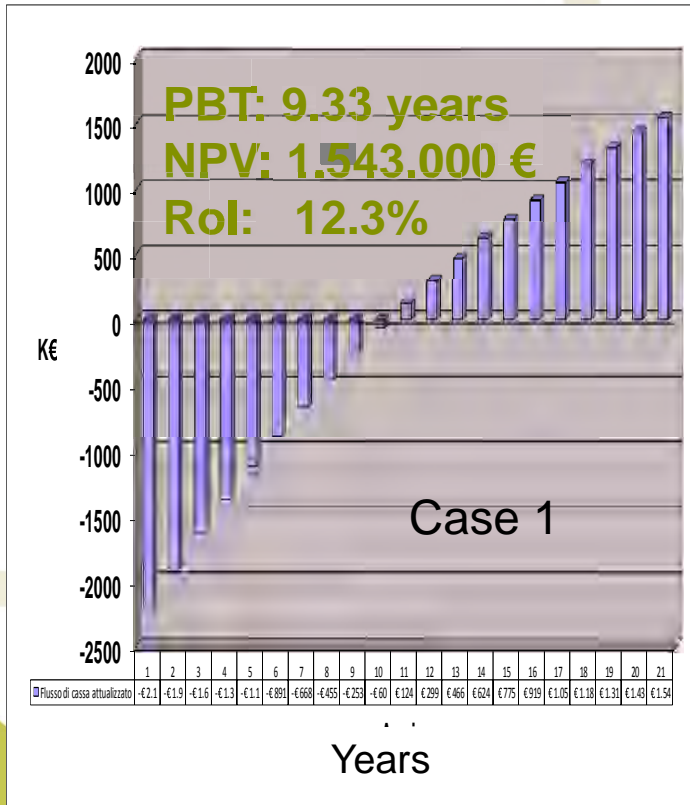
**EBITDA = 299 K€/year (Case 1)**  
**= 392 K€/year (Case 2)**



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# Profitability



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[www.vigor-geotermia.it](http://www.vigor-geotermia.it)



## Conclusions

- Plants proposals as complete feasibility studies are ready to be implemented in the Convergence Regions (and not only) as *Best Practices*:
  - *Some geothermal plants have already been implemented (Bari and Mondragone space heating and cooling systems, by Interventi innovativi di utilizzo della fonte geotermica decreto 14 July 2014 MISE)*
- All proposed plant are GREEN and ENERGETICALLY stand alone
  - *Development of SMART THERMAL GRID*



Geothermal heat use can be a driving force for socio-economic growth of the territory

[www.vigor-geotermia.it](http://www.vigor-geotermia.it)



Consiglio Nazionale delle Ricerche  
DTA



Programma Operativo Interregionale  
ENERGIE RINNOVABILI E  
RISPARMIO ENERGETICO  
2007-2013  
Una scelta illuminata

UNIONE EUROPEA  
Fondo Europeo di Sviluppo Regionale

QSN  
2007-2013  
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***SCIENCE***



***TECHNOLOGY***



***ENERGY***


## Netherlands – Henk de Beijer (SolabCool®)

**Title:** Cooling with Geothermal energy and local storage

**Presenter:** Henk de Beijer has been trained in the field of Mechanical/Construction Engineering, subsequent to which his focus was on thermodynamics, innovation and industrial marketing. He has worked extensively in the field of renewable energy. For the last thirty years he is the owner and director of several companies, e.g.: De Beijer RTB BV, Strategy, MKB Winstpunt, or SolabCool BV. He is involved in the Netherlands & International Energy Agency (IEA) and European Union (EU) Energy research programs. Production, product development and testing is one of the main areas of focus of De Beijer RTB, which works closely with all European Universities and institutes like TNO, ECN, Vito, WI and industrial companies Through his collaborations with the Universities, he has published works in the field of heat pumps, solar and solar cooling and energy storage.

### Abstract:

SolabCool is an environmental friendly cooling system with minimal CO<sub>2</sub> emission that uses residual heat that is normally lost to the environment. Key to the sustainability of SolabCool is the “sorption cooling” technology. This technology uses heat as a source of energy through which energy is saved. The SolabCool cooling system is an unique and ground-breaking sorption system by its compactness and range of power the ability is obtained to be used in both buildings as well as homes. Each room gets a pleasant temperature. Because of the use of water as a coolant, the system can easily be connected to the floor heating for example.

[Back to the program](#) 



# Cooling with “Geothermal, Waste or Solar” Heat



Henk de Beijer  
Genève 30-10-2015



## Introduction De Beijer RTB:

### Profile:

- Engineering company with 30 years of experience in renewable energy solutions and products.
- Many international cooperation's with institutes and universities.
- Various renewable energy products successfully launched to the market in the past.

### Main activity:

De Beijer RTB is mainly active in the field of Solar, thermo-chemical-energy storage and thermo-chemical conversion technology.

### Main projects:

Development, cost-effective pre-production method for SolabCool and ClimateBooster. Market introduction. Development and the pre-production SunRidge and thermo-chemical energy storage



SunRidge



ClimateBooster



SolabCool



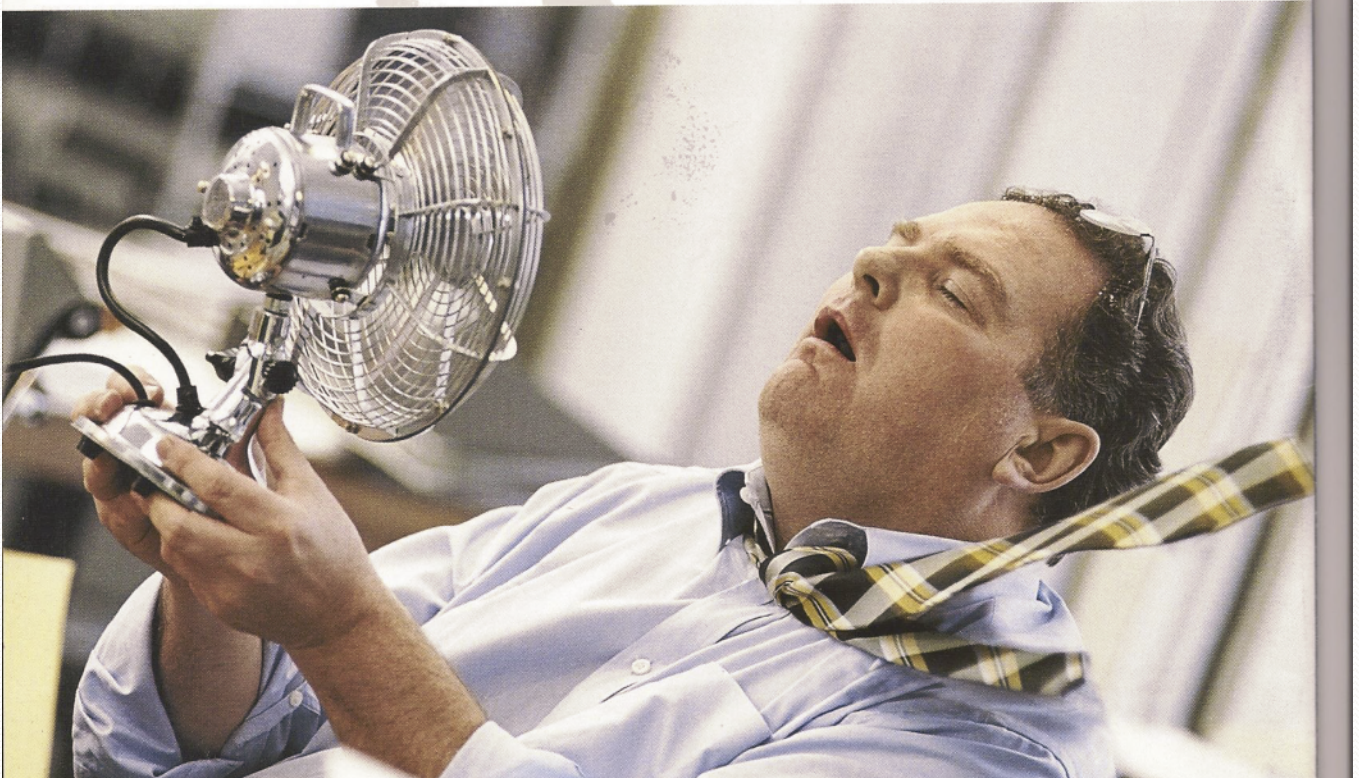
Thermo-chemical energy storage



De Beijer RTB B.V



## Problems with building cooling?



# Comfort spectrum

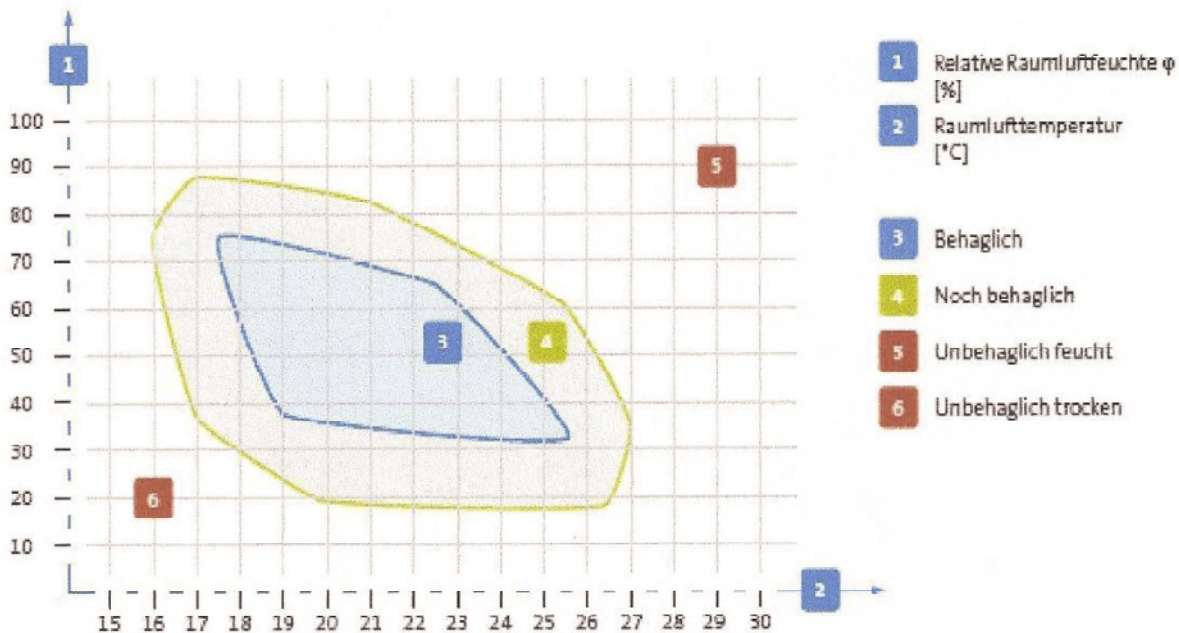
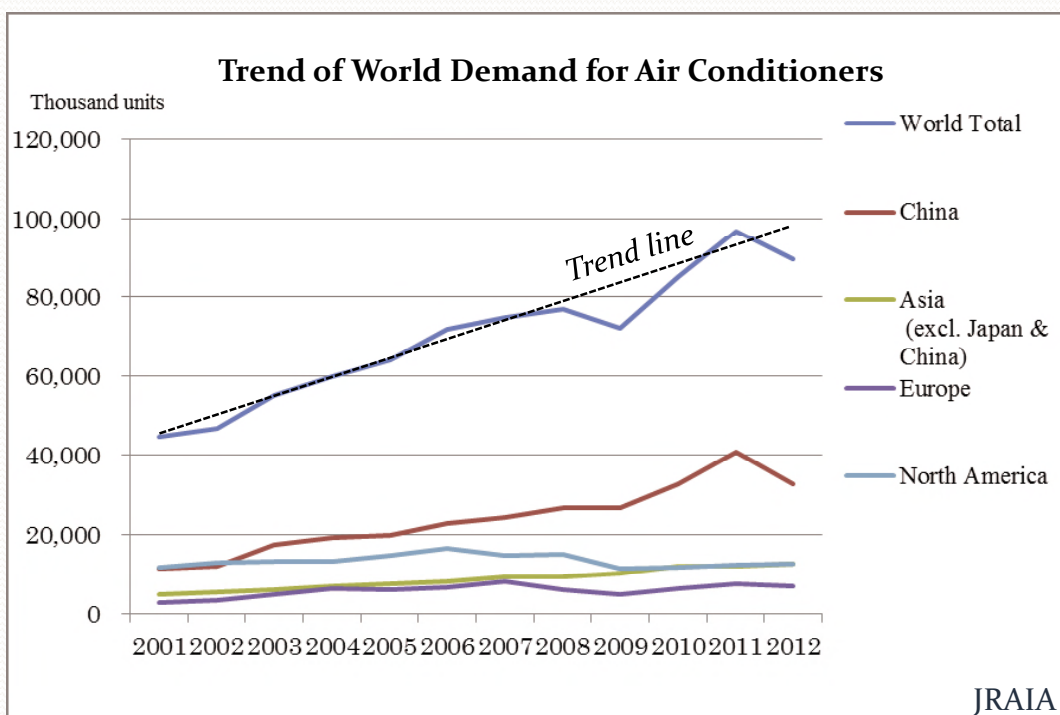


Abbildung 4:

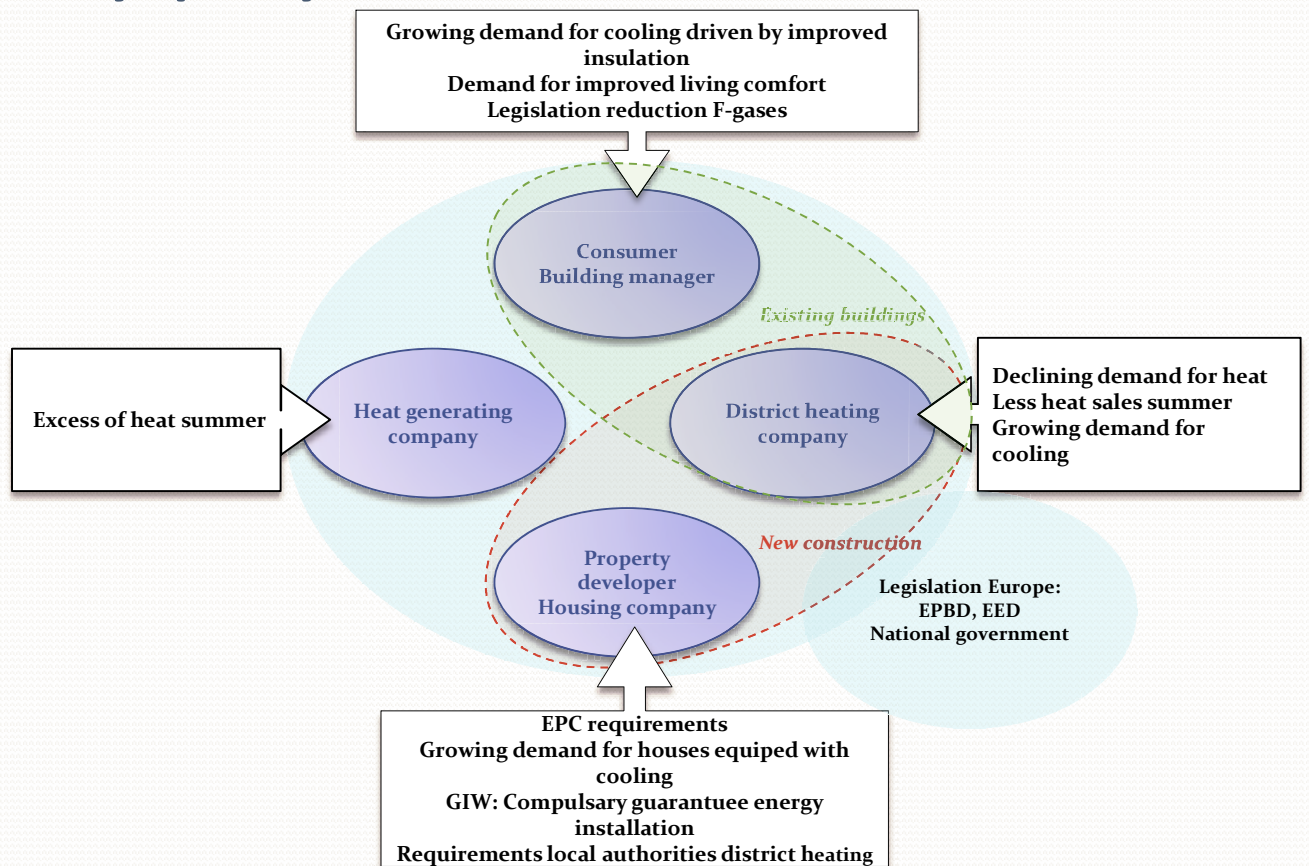
Eine bestmögliche thermische Behaglichkeit ergibt sich im inneren blauen Feld (3), also bei einer Raumtemperatur von etwa 20 bis 25 °C (Winter/Sommer) und einer relativen Raumluftfeuchte von 30 bis zirka 60 % (Winter/Sommer).

# Growing Demand for air conditioning





# Key players and marketdrivers



## Cooling is a must

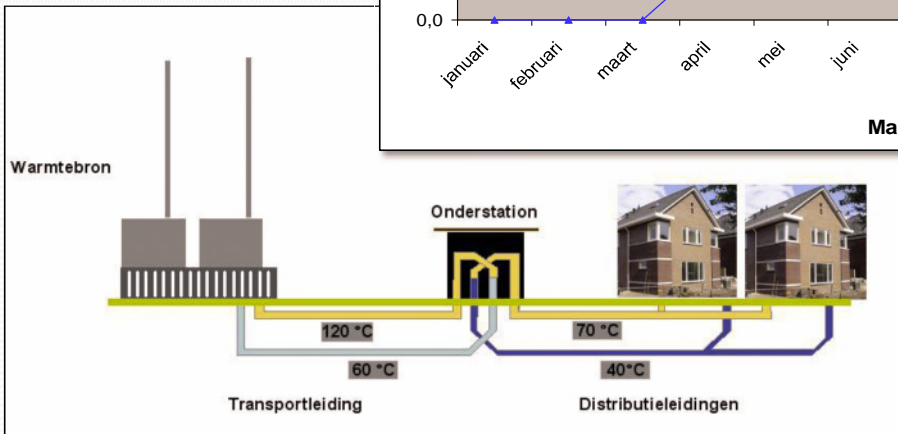
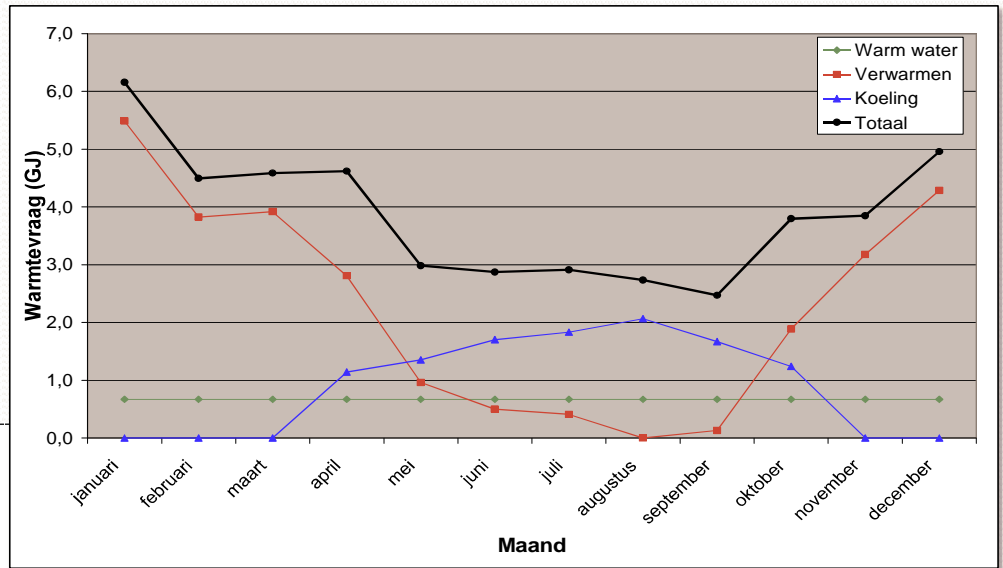
- Shifts in comfort culture, behavioural patterns, affordability and consumer expectation
- Perception that comfort cooling contributes to higher productivity
- Direct impact on rental value of commercial buildings
- Increase in internal loads (computers etc.)

## Cooling is also business

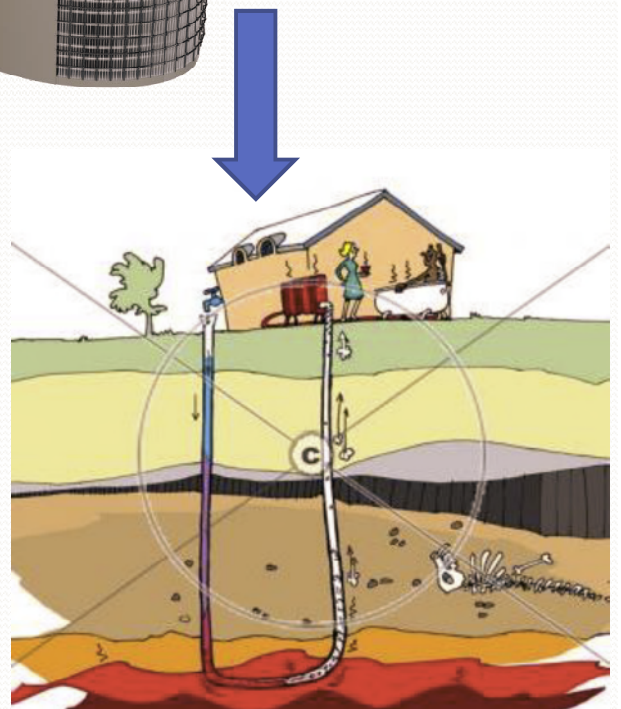
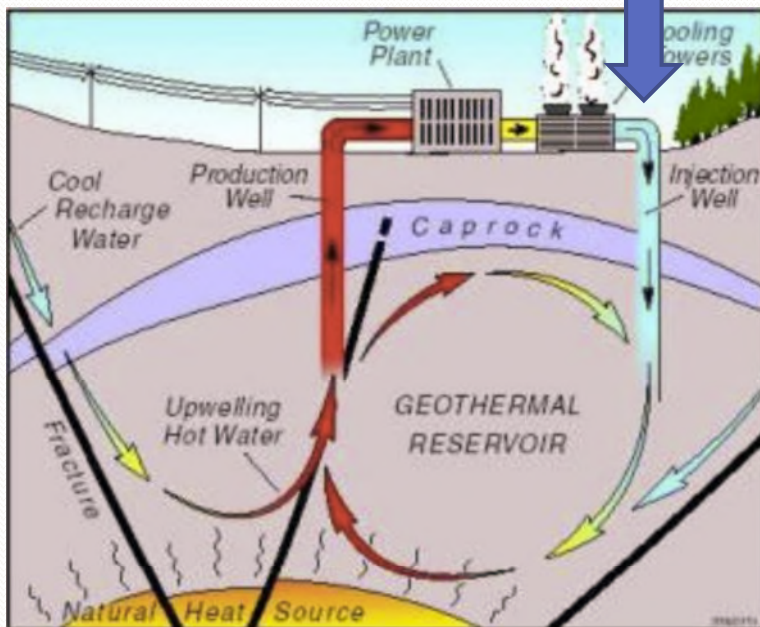
- 10% of electricity used for cooling (global) and 16% in US
- > 80% of commercial and institutional buildings in USA and Japan has air conditioning
- < 40% in EU, but expanding rapidly, 60% is expected by 2020



# District heating: excess heat in summer



# Geothermal & Cooling

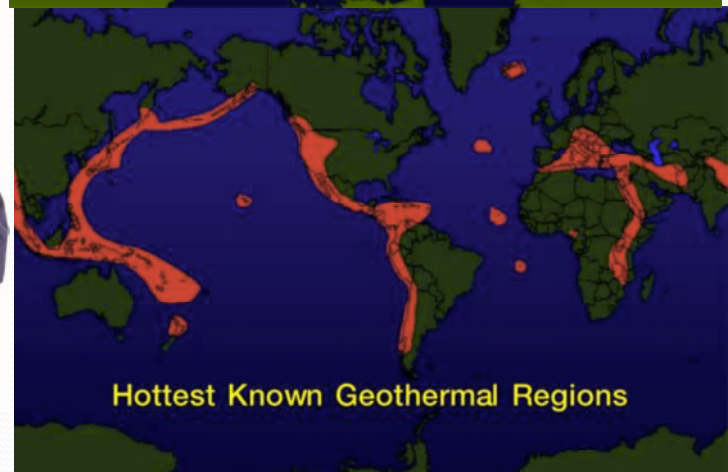


# Soultz, Alsace, Fr.



Production 5 km depth at 200°C & Organic Rankine Cycle (ORC) -> 2 MWe -> re-injected temp 70°C

## Geothermal in the world

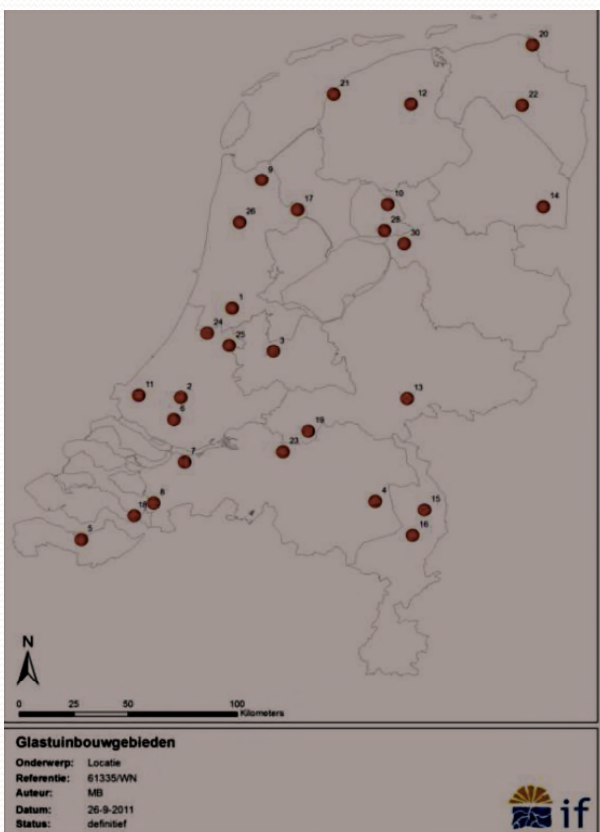




# Geothermal in Nevis



# Geothermal in the Netherlands



Nr	Locatie	Toevoeging
1	Aalsmeer e.o.	
2	Bleiswijk e.o.	"B-driehoek", Zuidplaspolder
3	Vleuten, Harmelen	
4	Deurne	
5	Terneuzen	
6	Zuidhollandse eilanden	Hoeksche Waard/Voorne Putten
7	Moerdijk	
7a	Dinteloord	nieuw te ontwikkelen
7b	Made	nabij Amer centrale
8	Bergen op Zoom	
9	Wieringermeer	"Agriport A7"
10	Luttelgeest	
11	Westland	
12	Berlikum	
13	Huissen/Bemmel	"Bergerden"
14	Klazienaveen	+ Erica
15	Horst a/d Maas	"Californie"
16	Maasbree	"Siberie"
17	Omgeving Enhuizen/Andijk	't Grootslag
18	Omgeving Rilland	
19	Zaltbommel e.o.	Bommelerwaard
20	Omgeving Eemshaven	
21	Sexbierum	
22	Hoogezand-Sappemeer	
23	Elshout	
24	Roelofarendsveen	
25	Nieuwkoop	
26	Heerhugowaard	
28	Ens	
30	Koekoekspolder	



# IEA Task 28 Arnhem Netherlands energy storage & geothermal



## Concentrating solar energy for electricity or heat



A power of tower near Seville



Bright Source Energy California



Electric Power Research based in Palo Alto

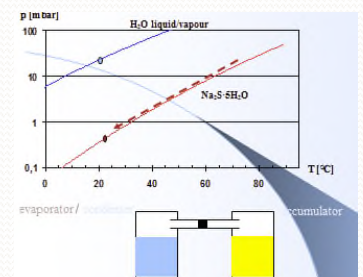
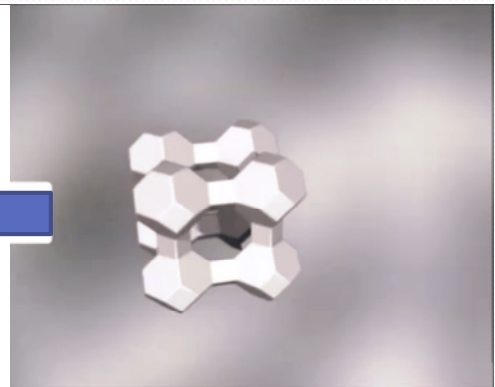
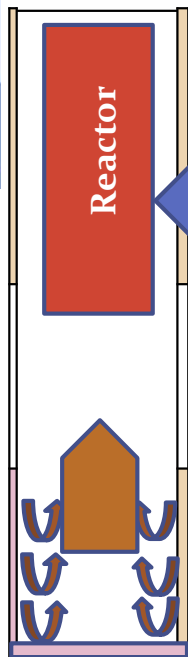
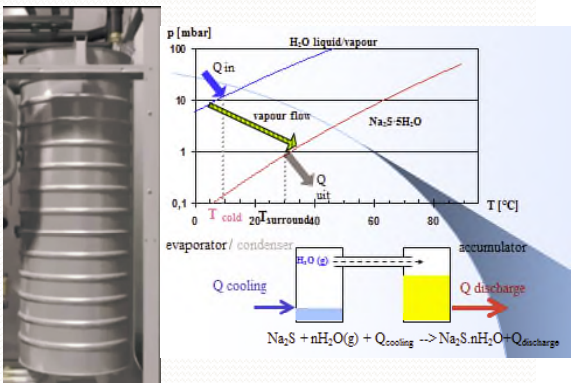
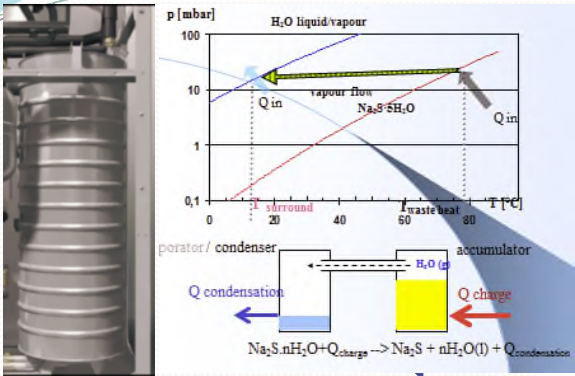


# Solar island District heating 'Almere'



Flat Plate Collectors 7000 m<sup>2</sup> Production 10,000 GJ/y at 75 C

## Energy storage and conversion





# Heat-driven cooling

Zonne-energie



Warmtenet

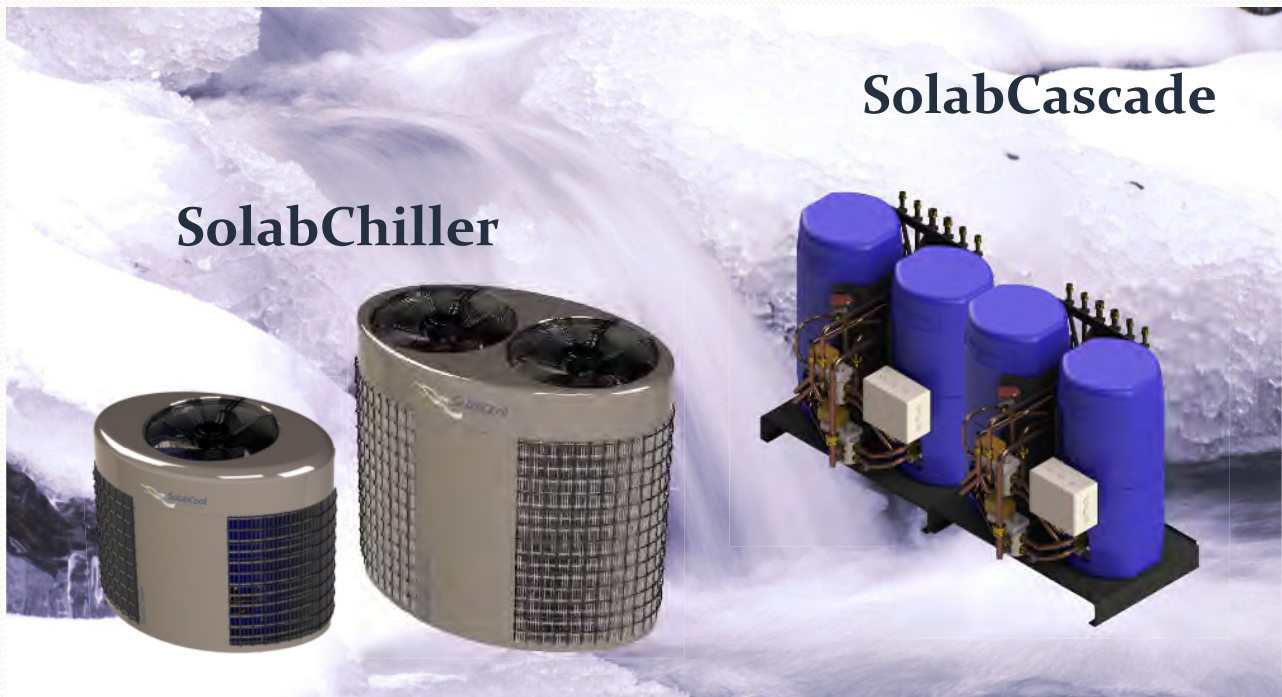


Warmtekrachtkoppeling



**SolabCool**  
The best comfort with pure energy

## SolabCool product range

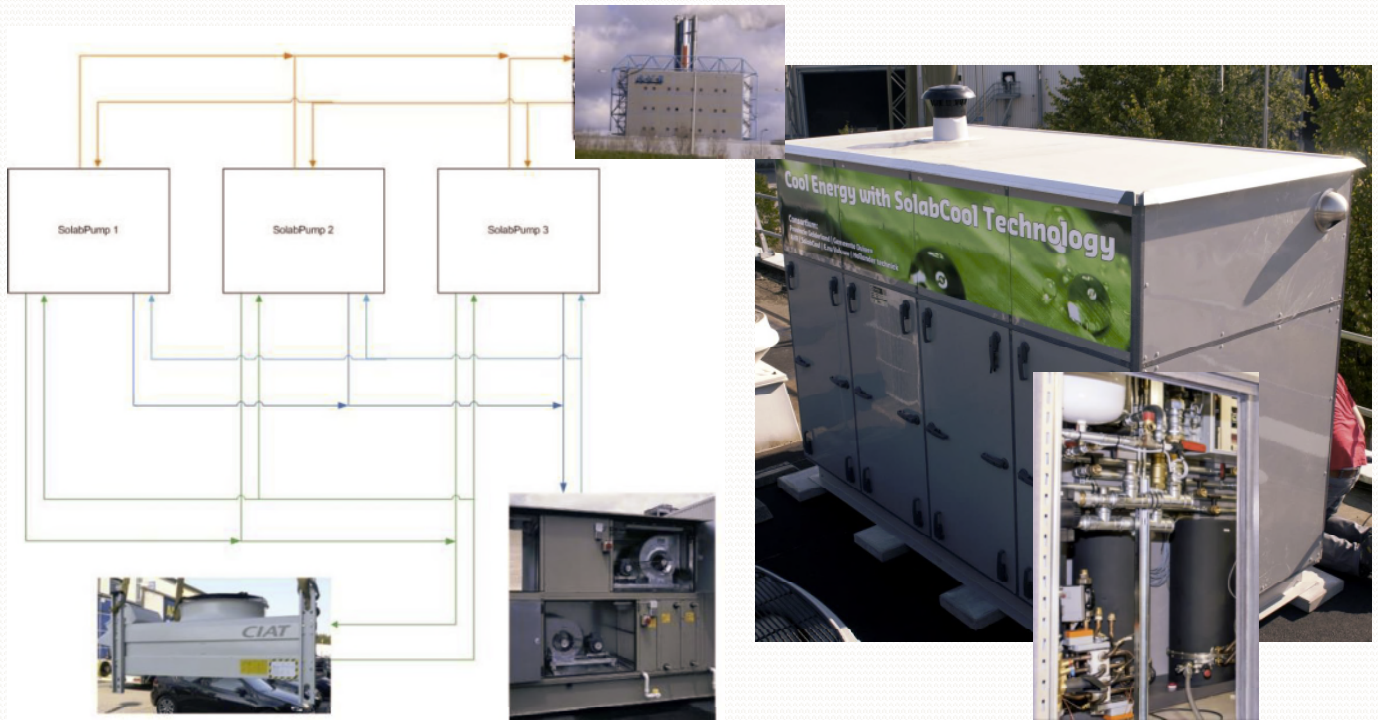


**SolabChiller**

**SolabCascade**



# Cooling office incineration plant AVR Duiven



Company presentation SolabCool BV



## Residential





# Absorption Chiller fed with heat from a district heating network

Two 3.5 MW absorption chillers for district cooling network making use of the heat delivered by the district heating system of the city of Helsinki.

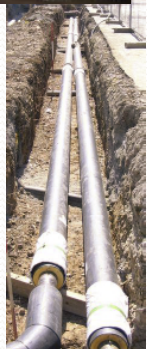
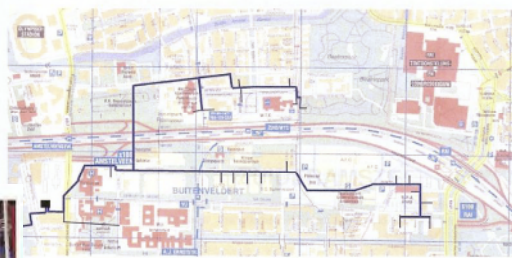
These units are installed in a rock cavern under the ground.

Chilling Capacity : 2 x 3 500 kW

Driving Heat : 80°C / 69°C

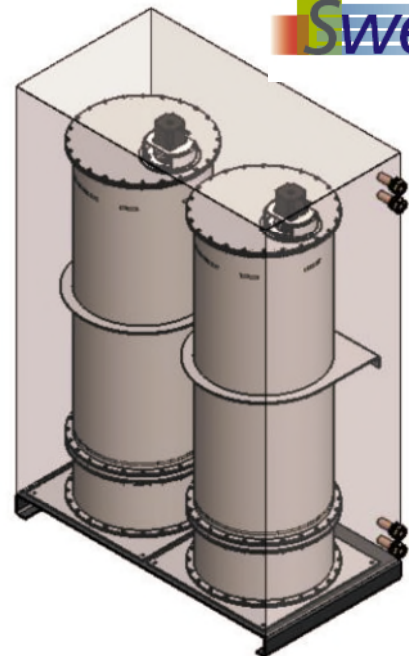
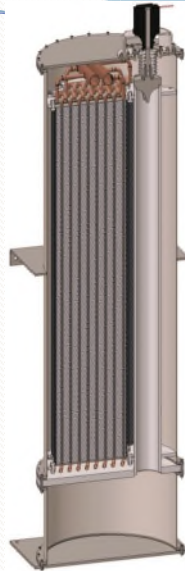
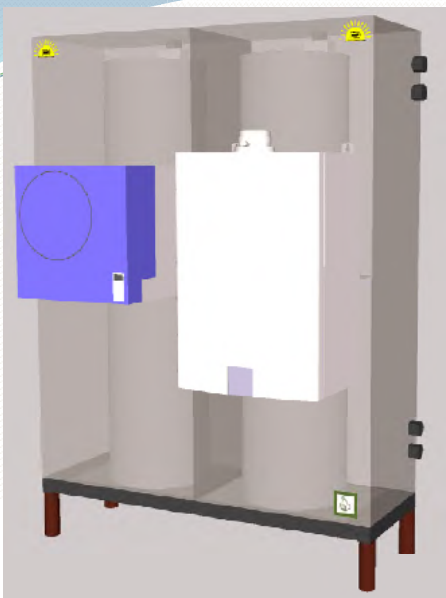


## District Cooling in Europe cities



Amsterdam 76 MW Freecooling/Absorption chillers  
Barcelona 66 MW  
Helsinki 60 MW  
Lisbon 40 MW  
Stockholm 188 MW  
Paris  
Berlin

# Cooling on District level

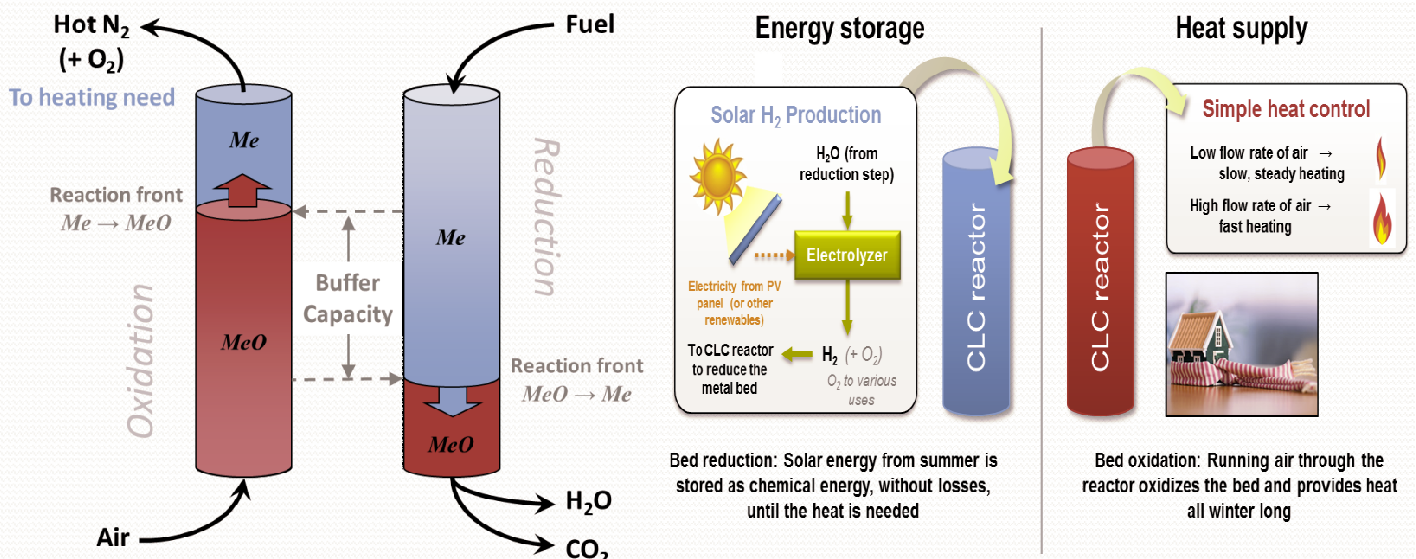




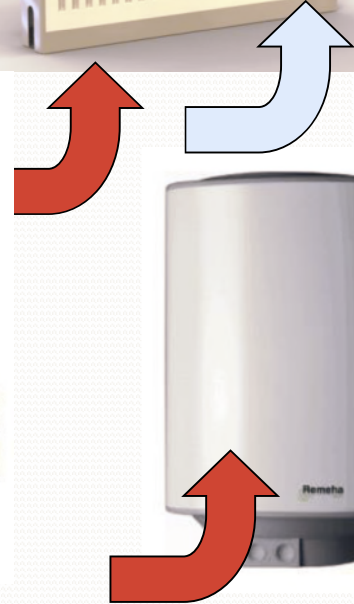
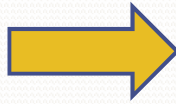
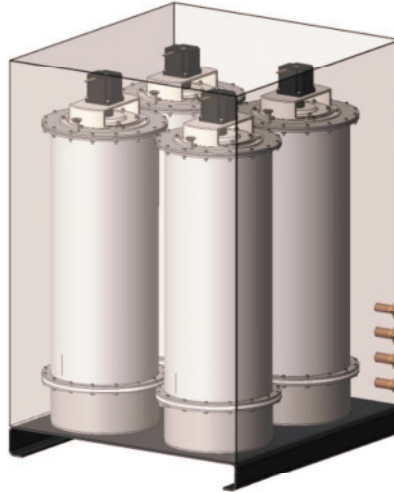
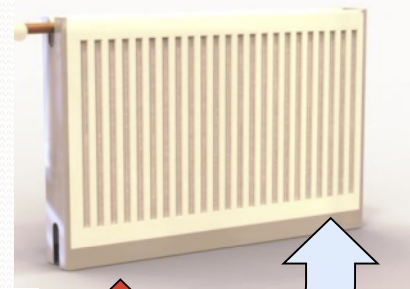
# Energy density of the materials

	Storage options				
	Hot water	Phase change materials	Thermochemical	Electical Batteries	Chemical Looping
Storage density	< 0.2 GJ/m <sup>3</sup> (dT= 50°C)	< 0.3 GJ/m <sup>3</sup>	~ 1 GJ/m <sup>3</sup>	~ 1 GJ/m <sup>3</sup>	~ 3 GJ/m <sup>3</sup>
Storage duration	Day	day-year	day-year	minites-months	day-year
Storage	Thermal	Thermal	Thermal	Electrical	Electrical > thermal
Cycling efficiency	~ 70%	~ 90%	~ 90%	75%	70%

# Chemical Looping Combustion for Energy Storage Applications



# Solar/Heat /Cold storage distribution system



De Beijer RTB B.V. 

Stenograaf 1  
6921 EX Duiven  
Tel: +31 26 3210289  
www.Ares-RTB.nl



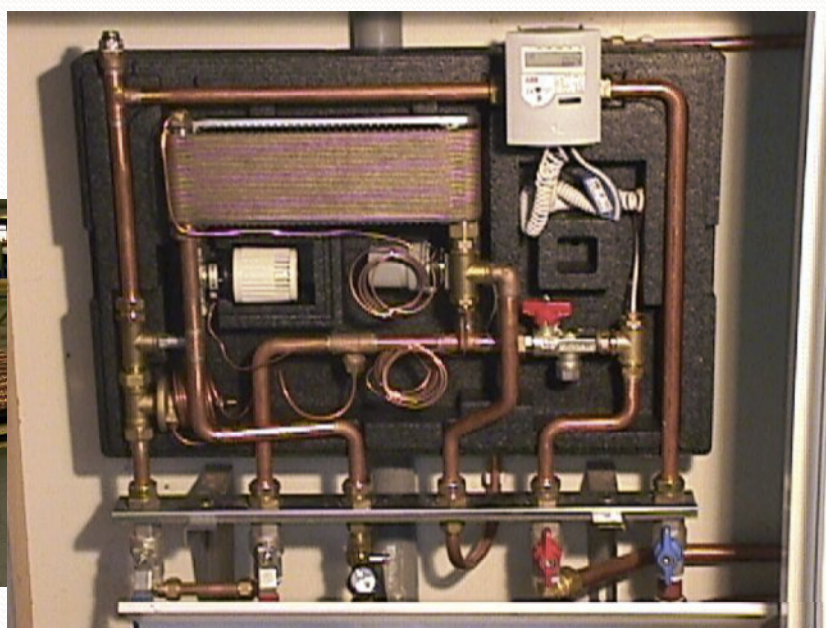
# Company 'Principles'

- Spirit
- Reliability
- Flexibility
- Innovation
- Fun



*It's our Competence that makes the difference*

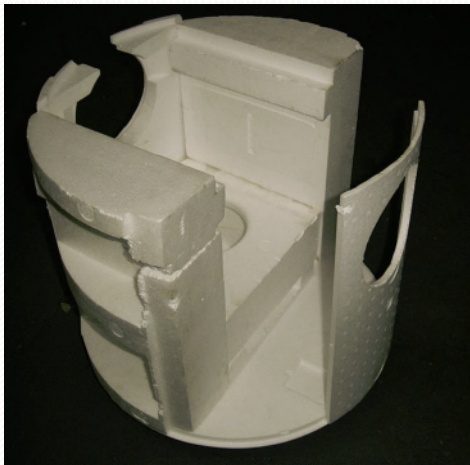
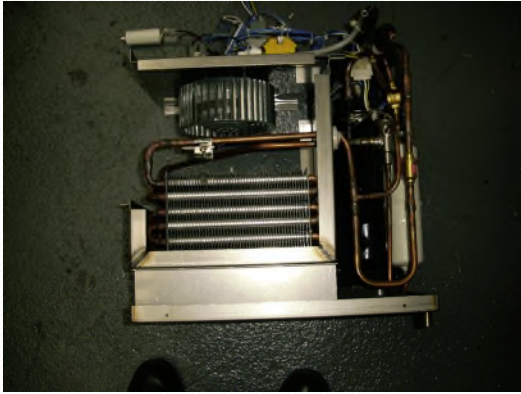
# District Heating Units



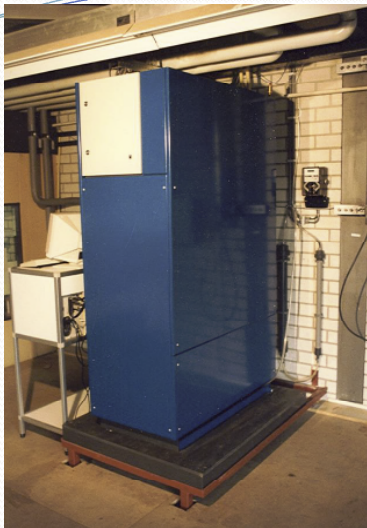


# Electrical Heatpumpboiler

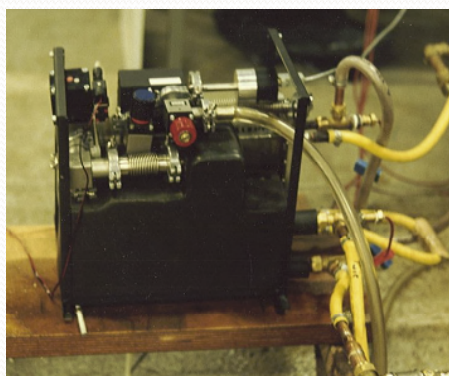
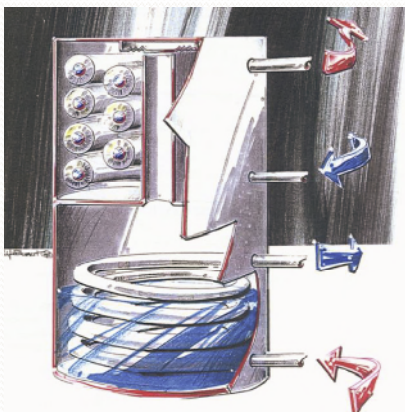
*Inclusie mechanische ventilatie*



## Storage and conversion 1<sup>e</sup> generation



**District heating**



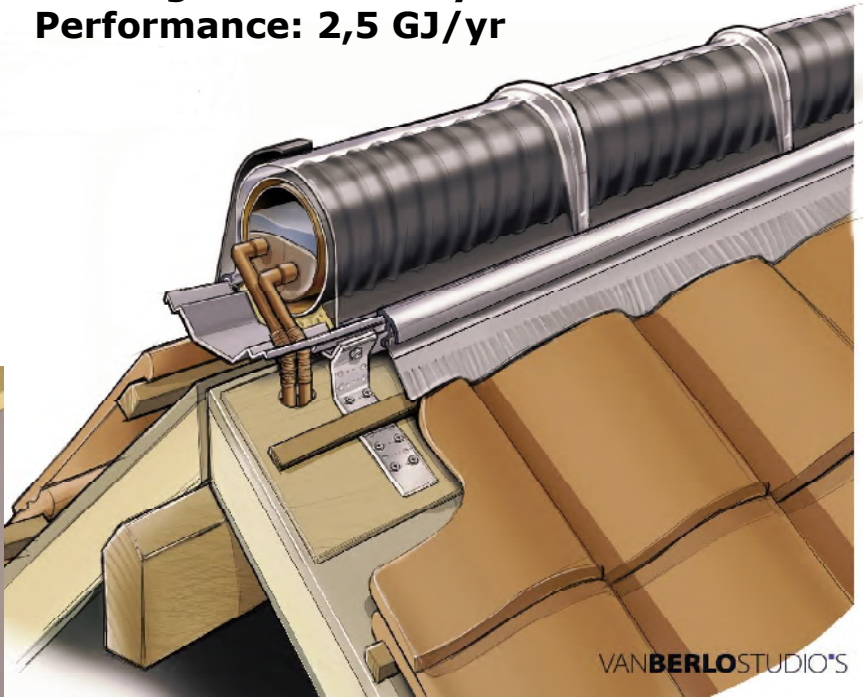
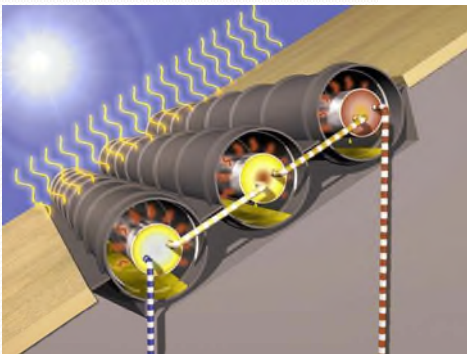
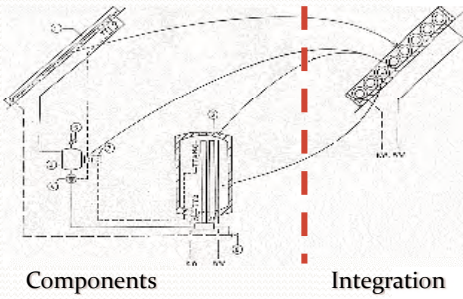
**Automotive airco**



# Product characteristics

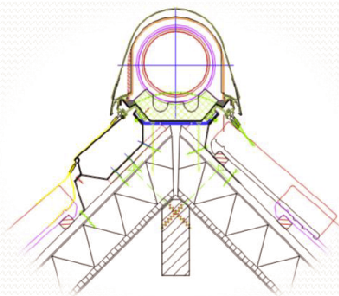


**Sunridge > 3 tubes system:**  
**Performance: 2,5 GJ/yr**



VANBERLOSTUDIO'S

35



**Ridge integrated solution**  
**No use of space indoors**  
**Optimal irradiation**  
**Independent of orientation**





## Electrical Heatpumps

Geotherm

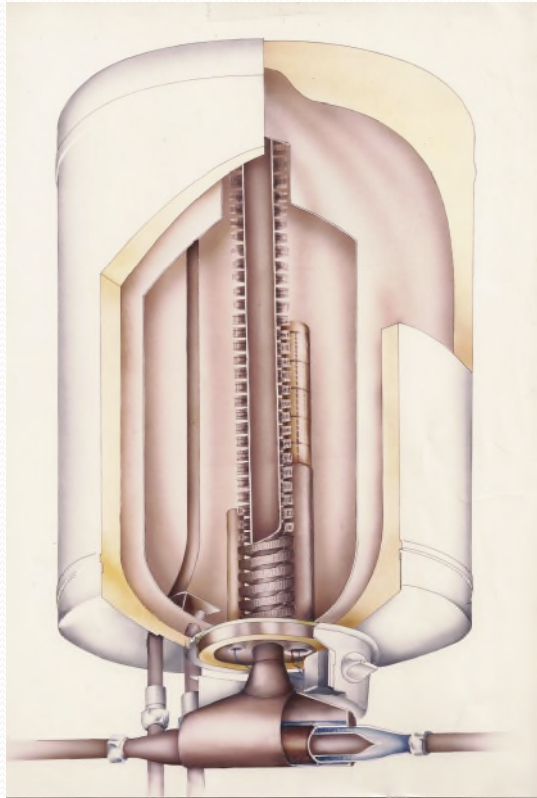


Energion®





# Heatpipe for renovating electrical boilers to Solarboiler




## Switzerland – Dirk Arndt & Philip Klingler (Gruner AG)

**Title:** District heating coupled with a seasonal heat storage in a deep aquifer (city of Oftringen)

**Presenter:** Philip Klingler is a geothermal consultant and project manager at the Gruner Group since 2012. As project manager Philip develops geothermal heat plants, geothermal heat storage systems and district heating schemes. Philip closely consults the only operating Swiss geothermal heat plant and district heating scheme in Riehen. His interest and commitment to the geothermal heating scheme of Riehen dates back to his master thesis in Hydrogeology and Geothermal Energy at the CHYN in 2010, where he analysed the reservoir properties with a 3D geological model, gravity analysis and tracer test.

### Abstract:

Geothermal heat storage in Oftringen city is a project of Gruner AG Company in Switzerland. It aims at creating synergies of incineration (erzo), geothermal energy (ewo) and district heating. Use of excess heat (erzo) in summer due to innovative heat storage system. Reduction of project risks. Site is geologically representative for other sites in Switzerland (and Europe) and has a high copy potential. Optimizing investment costs for geothermal energy and district heating. Building on existing structures. High Standard for supply guarantee with low costs through integration of "erzo.

[Back to the program](#) 

# GEO THERMAL HEAT STORAGE >

## OF TRINGEN



Philip Klingler

1

erdwärmefoftringen ■■■ gruner >

Designing our habitat

**gruner** >

COMPETENCES

- > ENERGY
- > BUILDING TECHNOLOGIES
- > GENERAL PLANNING
- > CIVIL ENGINEERING
- > CONSTRUCTION
- > SAFETY
- > ENVIRONMENT

22  
Companies

1057  
Employees

since 1862





# LOCATIONS IN SWITZERLAND



24  
LOCATIONS



3

erdwärmeoftringen gruner >

# LOCATIONS WORLDWIDE



10  
LOCATIONS

Gruner GmbH, Köln  
Gruner GmbH, Stuttgart  
Gruner GmbH, Leipzig  
Gruner GmbH, Wien



Gruner Peru S.A.C, Lima

Stucky Balkans d.o.o., Belgrad  
Stucky Caucasus Ltd, Tbilisi  
Stucky Teknik Ltd, Ankara

Stucky Asia, Bangkok

4

erdwärmeoftringen gruner >



- > Geothermal energy
- > District heating
- > Hydro power
- > Energy plants
- > Power transmission



Hydro dam Mutsee,  
Glarner Alps

for:  
Axpo Power AG

Geothermal district  
heating Riehen

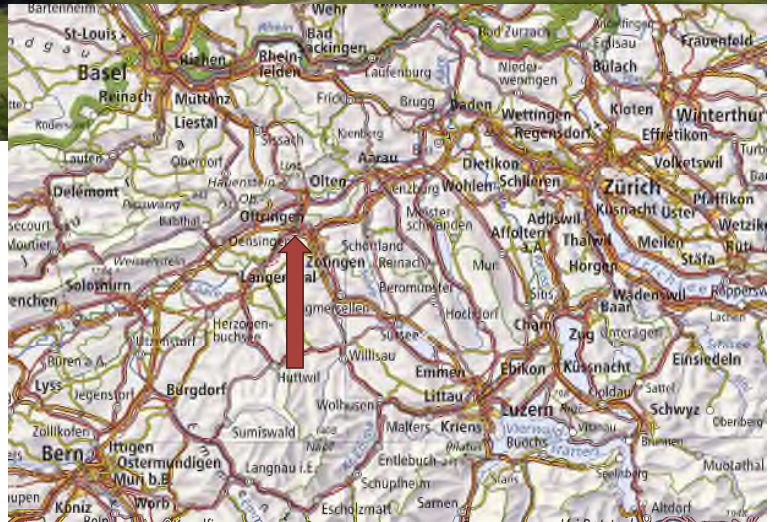
for:  
Erdwärmeriehen AG

ETDE, Mosambik

for:  
ETDE France

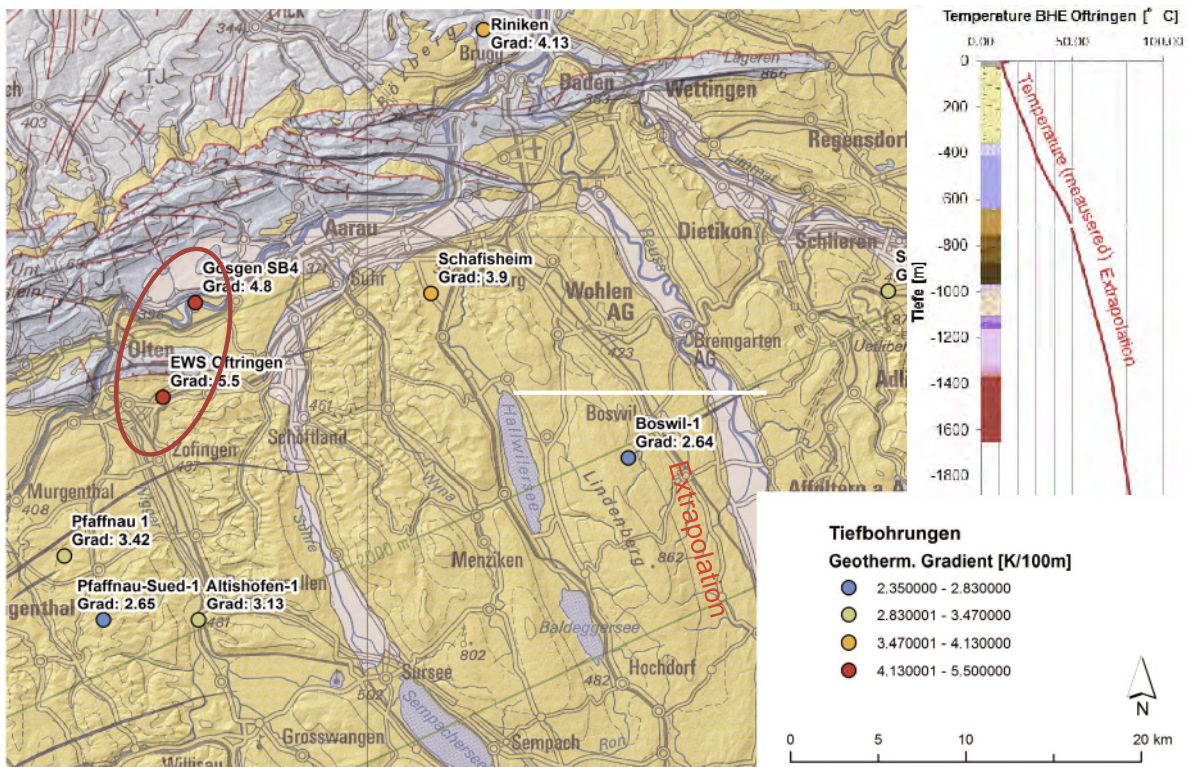


# Now back to Oftringen...



7

# Increased geothermal gradient



8



# Geothermal Timeline of Oftringen

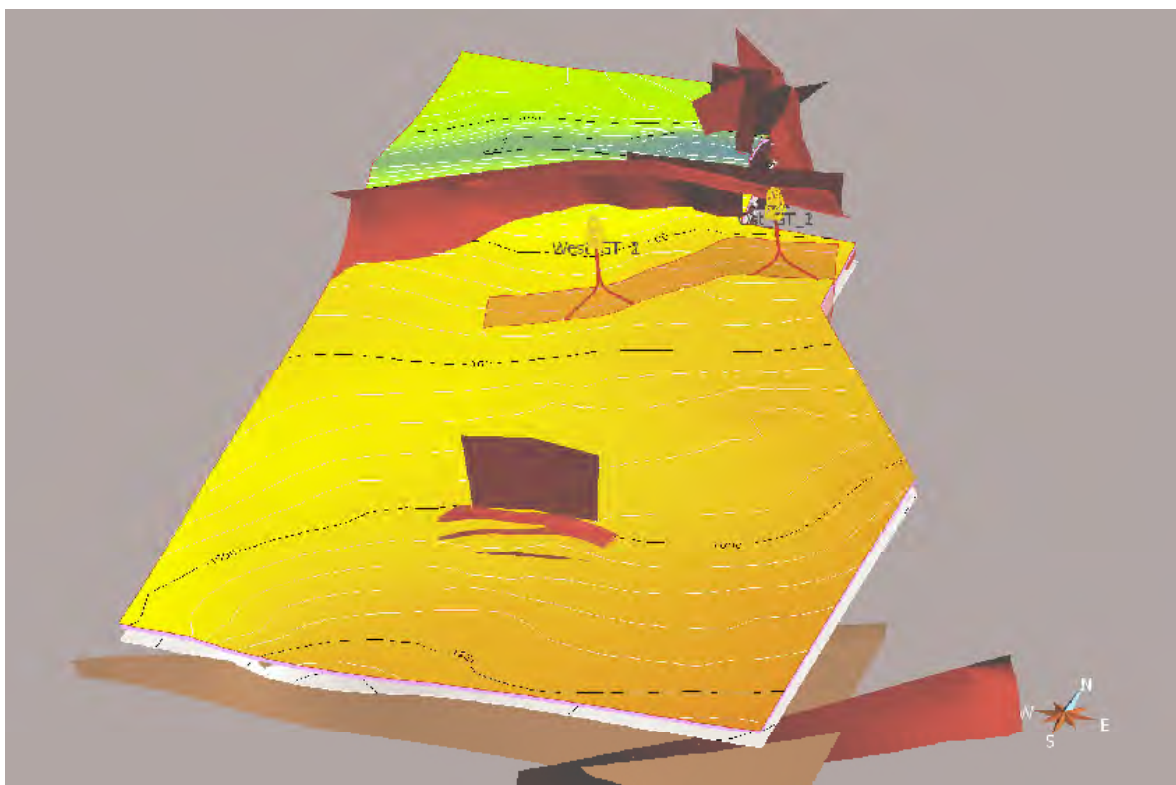


- > 2007 Deep BHE reveals a high geothermal gradient
- > 2012 Study on the potential of deep geothermal energy
- > 2013 Conclusion preliminary design study
- > Nov. 2013 Incorporation of Erdwärme Oftringen AG
- > 2014 Deep exploration well (swissnuclear) reveals high geothermal gradient too
- > 2014/2015 roundup of private and public investors
- > May 2015 Exploration licence approved
- > 2015 ... just a minute...

9

erdwärmeoftringen  gruner >

## Preliminary design study: Geological Model



10

erdwärmeoftringen  gruner >





# District heating sales potential study



## > Goals

- > Verification of expected district heating sales potential
- > Pathways for district heating network
- > Cost evaluation
- > Basis for economic evaluation

## > Results

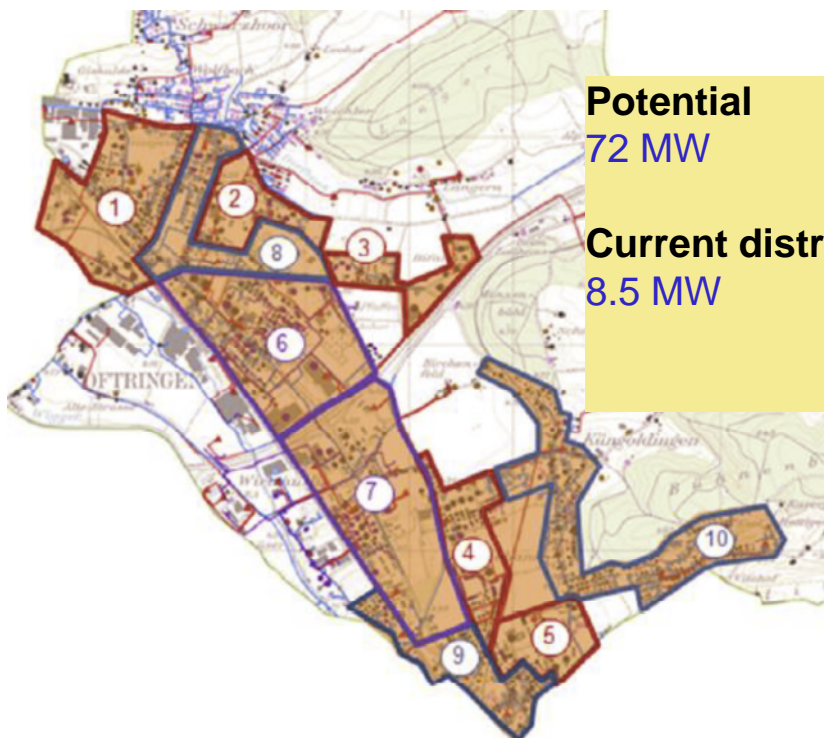
- > Connection Power: 21-40 MW (theoretical 71 MW)
- > Heat sales potential: 49-93 GWh (theoretical 166 GWh)

13

# District heating sales potential study



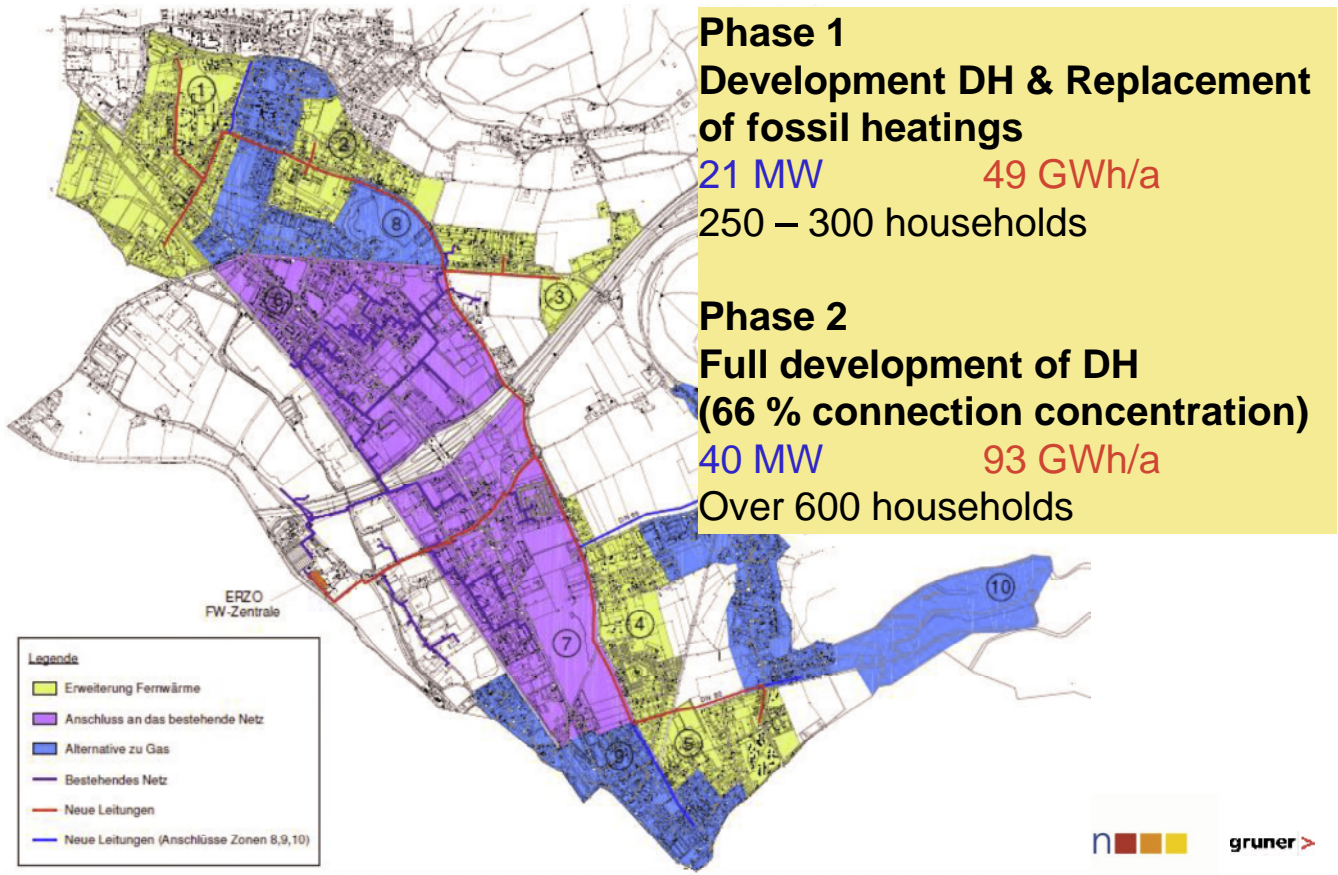
## Potential for district heating in Oftringen



14



# District heating development Oftringen



## Project idea



How can we optimize costs of peak load plant?

How can we reduce risks of not insufficient geothermal reservoir properties?

# Project idea



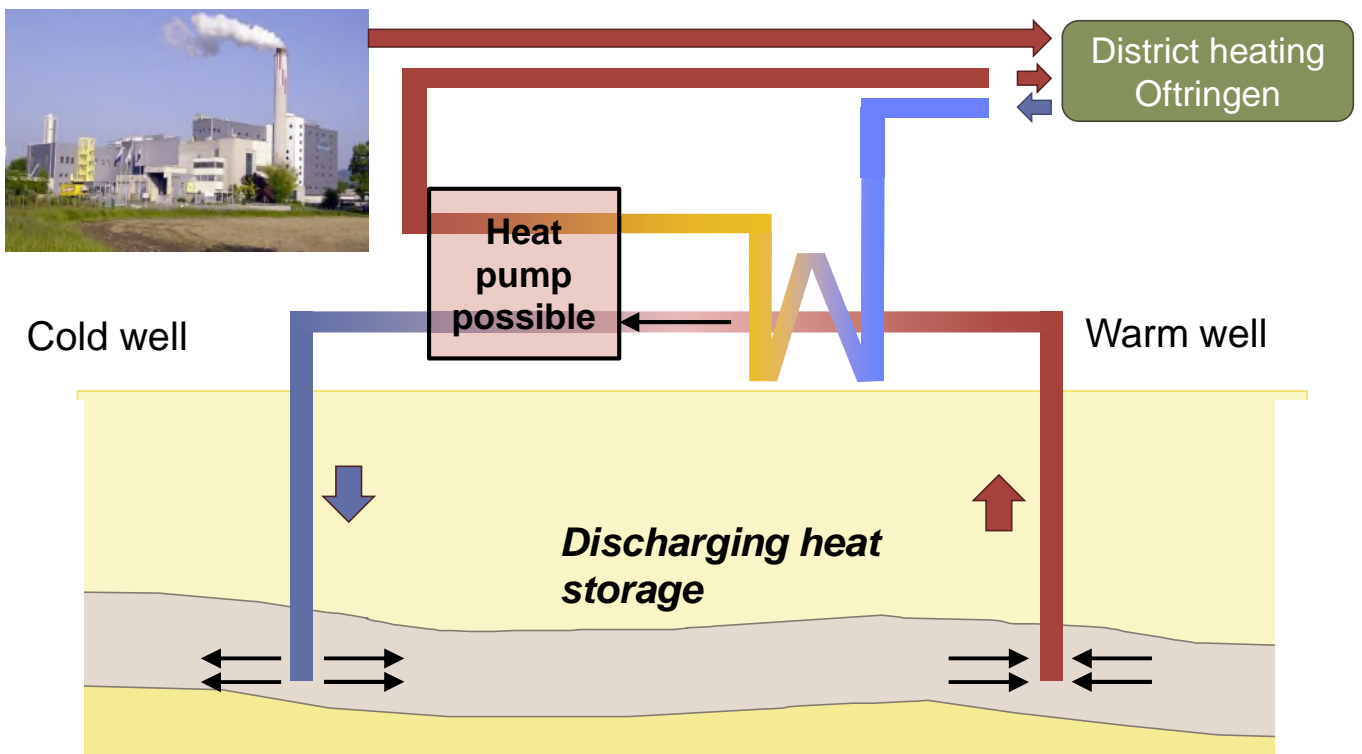
Geothermal energy - seasonal heat storage -  
incineration erzo



17

erdwärmeftringen gruner >

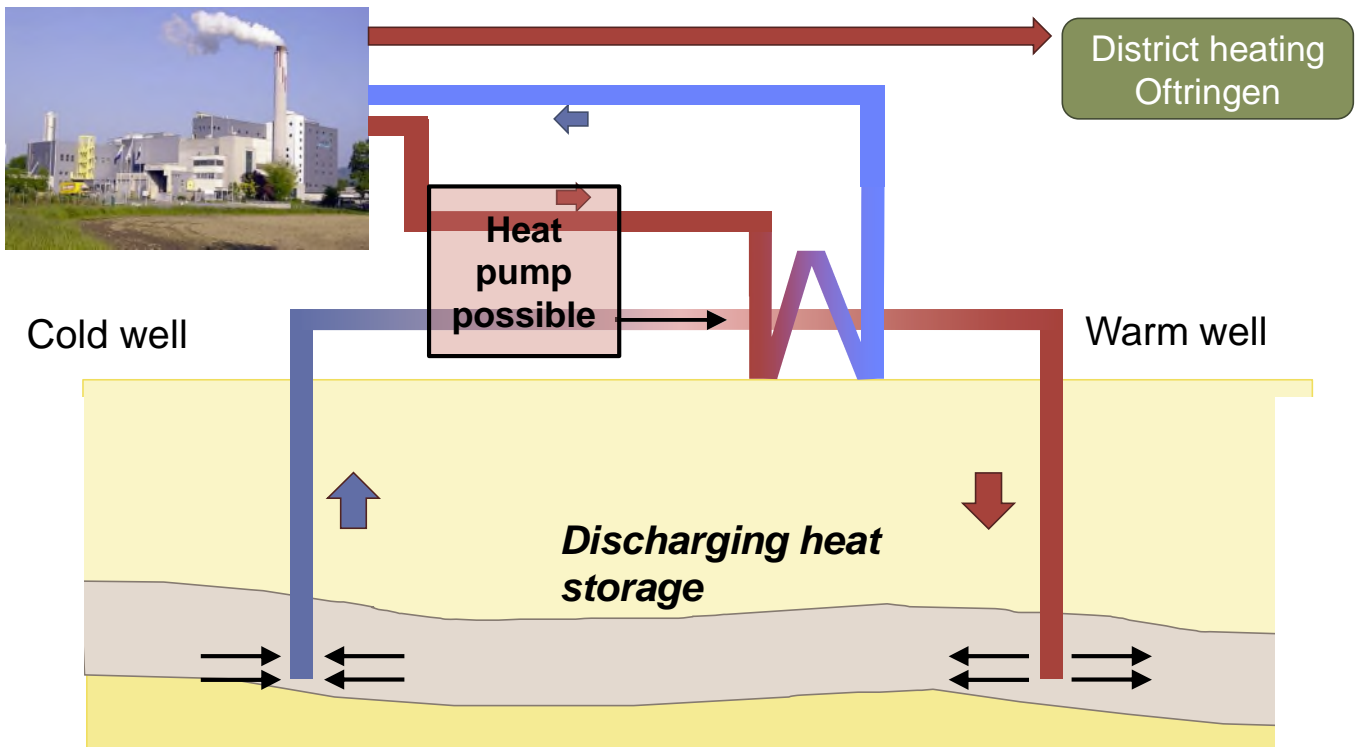
## Function in winter



18

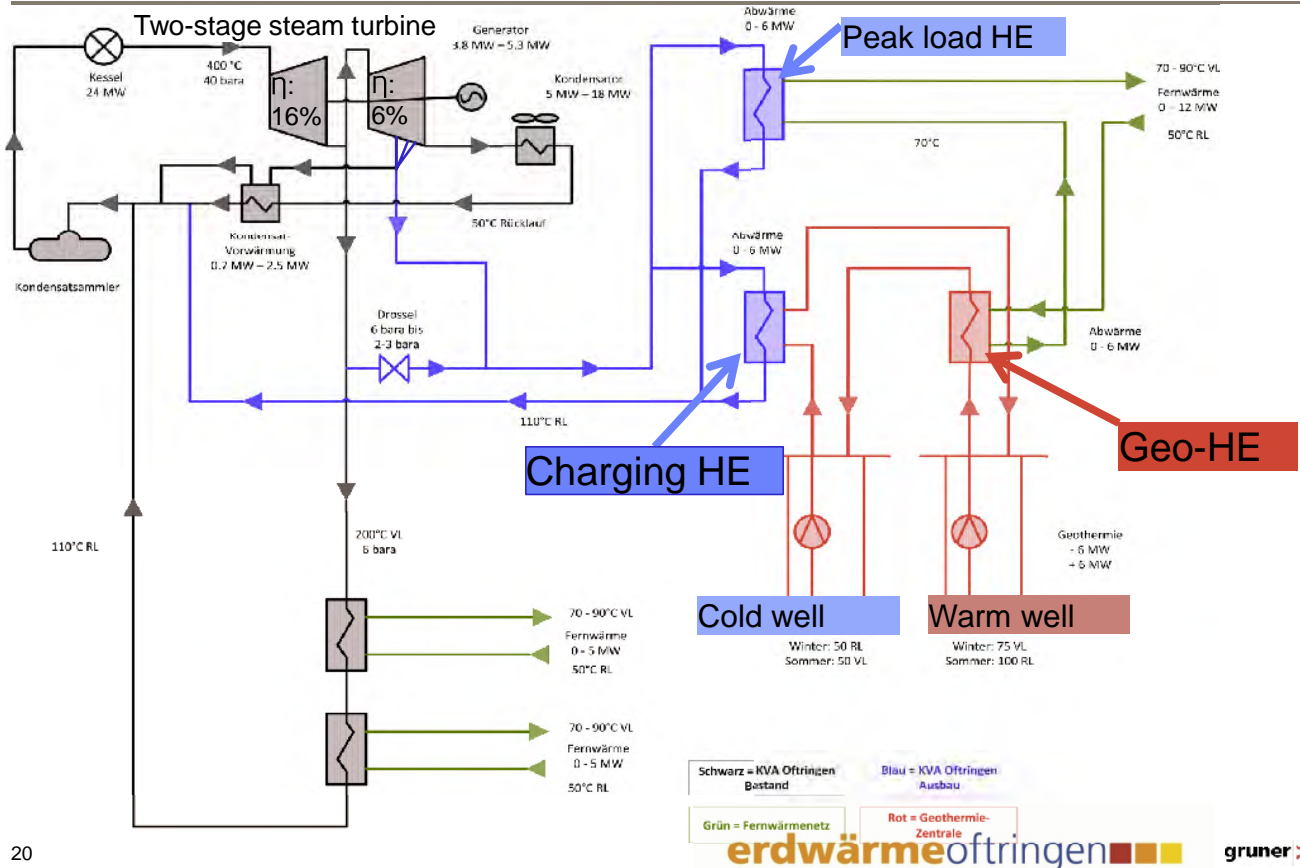
erdwärmeftringen gruner >

# Function in summer



19

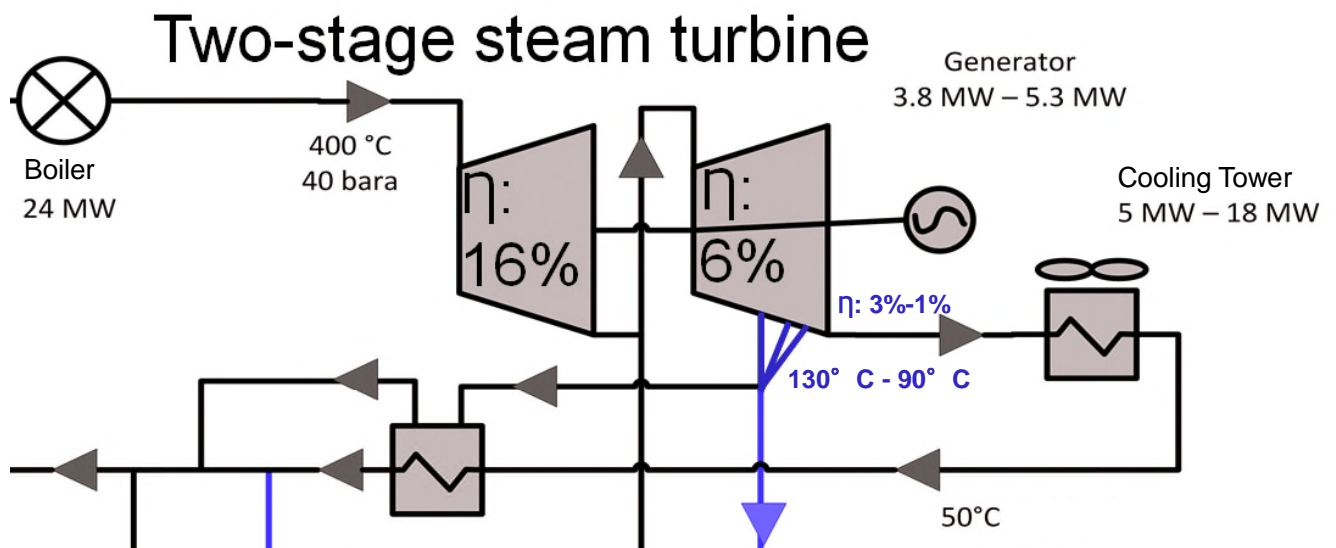
# Kopplung erzo / Geothermie Oftringen



20



# Steam extraction of low pressure steam >



21

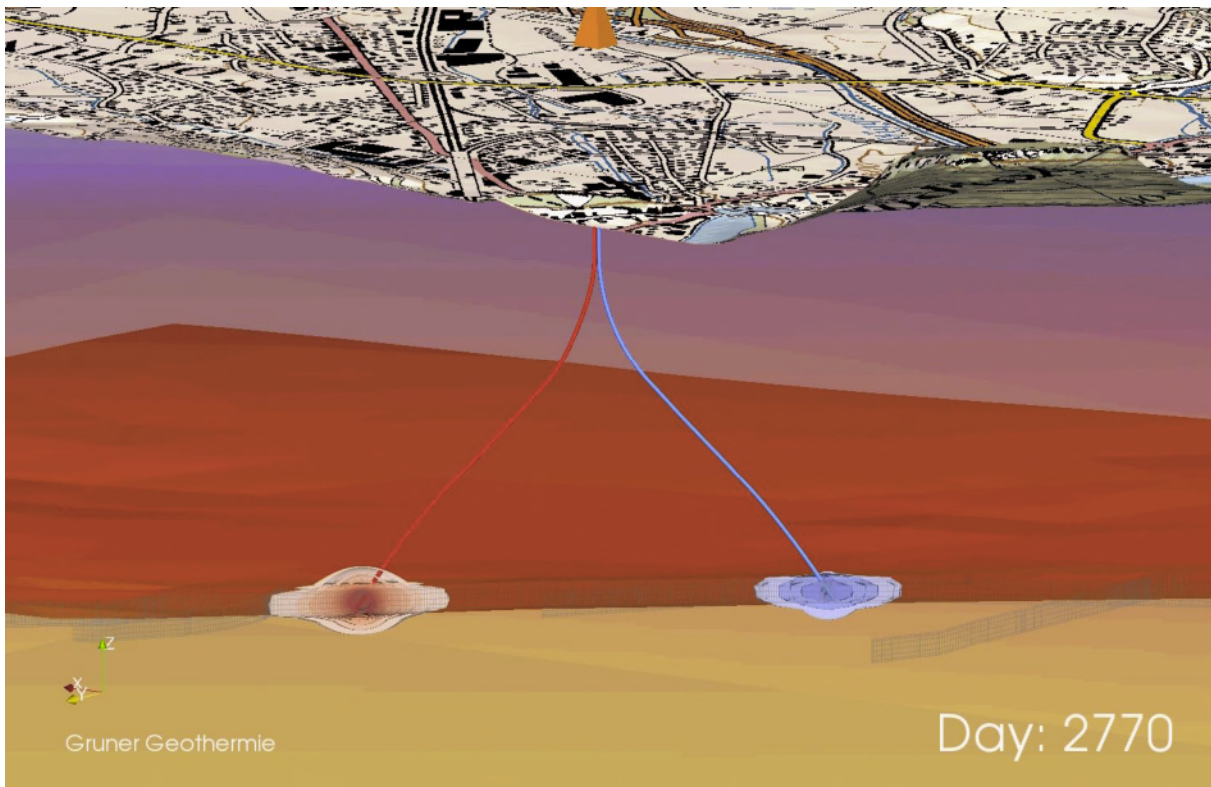
erdwärmeoftringen gruner >

## Modelling >

- > Validation of the idea
- > Determination of energetic parameters for an economic evaluation

22

erdwärmeoftringen gruner >



23

## Reducing Risks



### Temperature:

- > Increasing temperature for direct use through heat storage

### Hydraulic short cut:

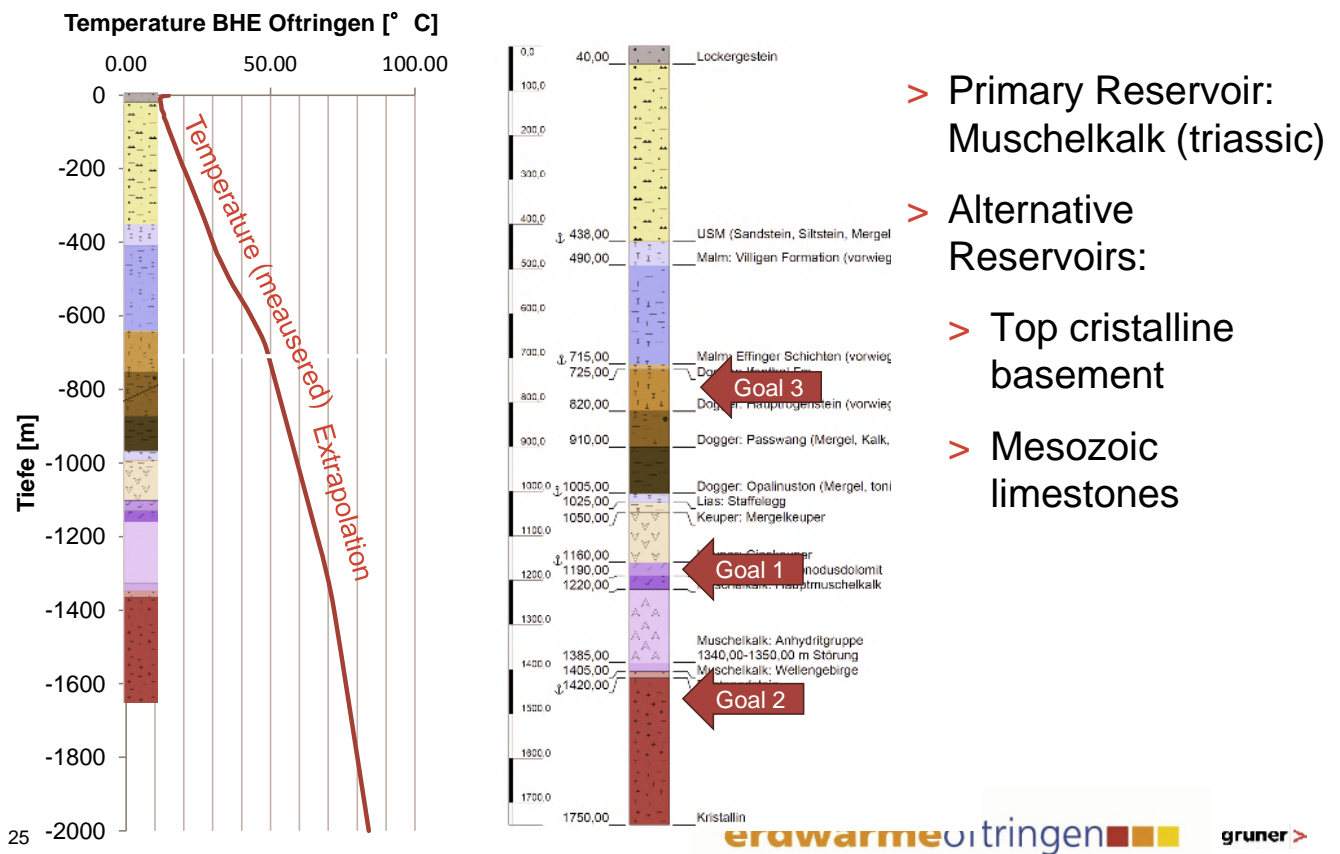
- > Reversing flow directions eliminate the risk of a hydraulic short cut.
- > No permanent reservoir cooling

### Multi-reservoir strategy

- > More independence of reservoir temperature

24

# Multi-Reservoir-Strategy



- > Primary Reservoir: Muschelkalk (triassic)
- > Alternative Reservoirs:
  - > Top cristalline basement
  - > Mesozoic limestones

# Projekt status



- > Preliminary design study concluded
- > Heat consumption potential study concluded
- > Licence for seismic exploration approved
- > Letters of intent of private investors
- > Government subsidies pending



## Next steps



2015

- > Concluding process for public subsidies
- > Incorporation of a supply and maintenance/running company

2016

- > Stakeholder orientated marketing and communication
- > Seismic exploration study
- > First investments for district heating extension

2017

- > Geological & technical planning for geothermal wells & reservoir management

27

erdwärmeoftringen ■■■ gruner >

## Conclusion

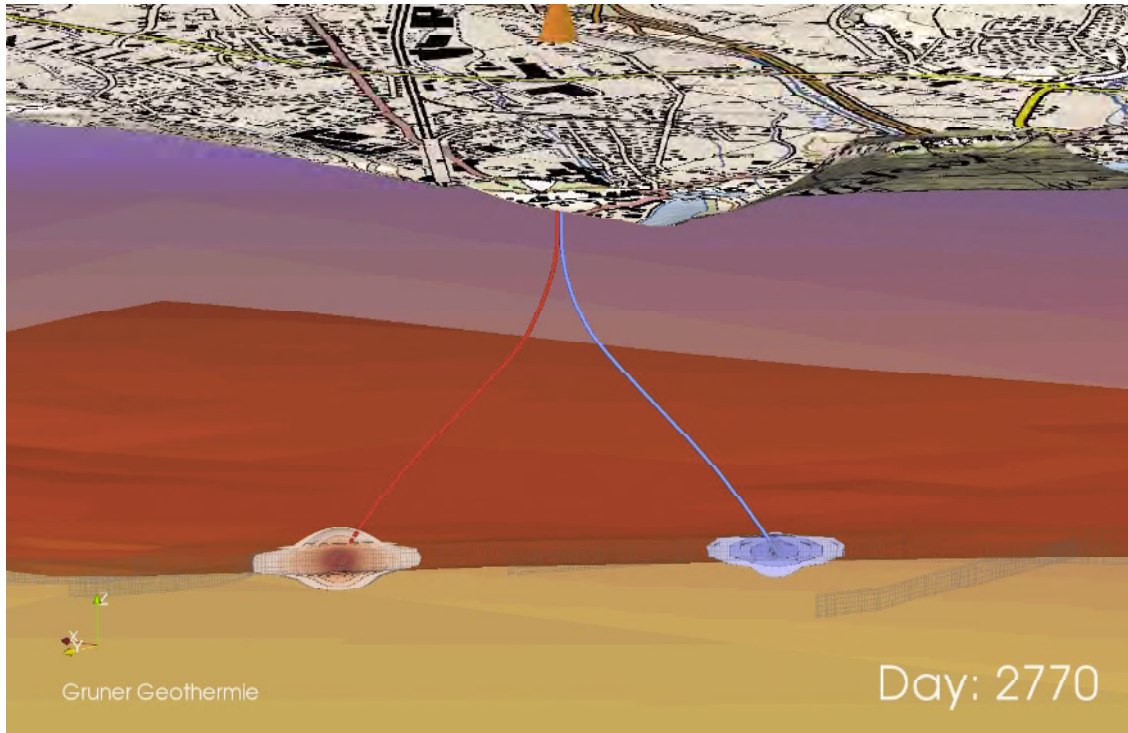


- > Synergies of incineration(erzo) – geothermal energy (ewo) and district heating
- > Use of excess heat (erzo) in summer due to innovative heat storage system
- > Reduction of project risks
- > Site is geologically representative for other sites in Switzerland (and Europe) and has a high copy potential
- > Optimizing investment costs for geothermal energy and district heating
- > Building on existing structures
- > High Standard for supply guarantee with low costs through integration of "erzo"

28

erdwärmeoftringen ■■■ gruner >

# Thank you for your attention!



## Italy – Ruggero Bertani (Enel Green Power)

**Title:** Geothermal for Agriculture and Food

**Presenter:** Mr. Ruggero Bertani is a Manager of innovation Geothermal Business Opportunities in Innovation and Sustainability Division of ENEL GREEN POWER S.p.A in Italy and also Vice President of the European Geothermal Council (EGEC). Ruggero Bertani holds a degree in physics from Pisa University. From 1979 to 1982 he worked for different Nuclear Physics Laboratories in Italy (INFN, Roma and Pisa) and abroad (CERN, Geneva and Fermilab, Chicago). In 1982 he started working for ENEL (since 1992 with geothermal energy). At ENEL he has been responsible for reservoir modelling activities, development projects in El Salvador and Turkey, for reservoir assessment in Italy and geothermal fields' acquisitions in USA. He participates actively in a range of different international activities and is author or co-author of about 70 papers, published in international journals as well as in official publications of International Bodies.

### Abstract

In Italy geothermal electricity generation is only in Tuscany, whereas direct uses are scattered throughout the country, mainly for bathing and district heating purposes. The Enel Green Power focuses also on geothermal for agriculture and food development. The potential development of new activities in the food and agriculture fields, using geothermal, is still high in Italy, especially in Tuscany. Perspective on the opportunities created by geothermal energy are based on good resource availability, incentive solutions, and availability of financing for start-ups located on geothermal territory. Main defined barriers are on locations, which are far from main roads, and lack of knowledge about the real opportunities. Enel Green Power efforts, together with local communities that host geothermal power plants, strongly committed to support start-ups supplying heat for their production process and find opportunities to lower the costs of electricity in the area.

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# Enel Green Power

## Geothermal for Agriculture and Food



Geneve, 30<sup>th</sup> October 2015



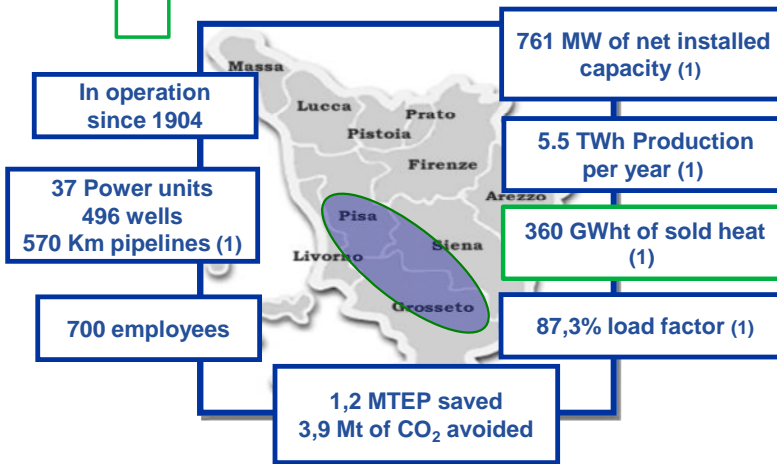
## Enel Green Power

### Geothermal for Agriculture and Food



- Enel Green Power – Geothermal leader in Italy
- The business of Heat supply
- Some examples for the use of geothermal heat for food and agriculture
- Opportunities and how to support them

# Enel Green Power Geothermal Leader in Italy



- The biggest fully integrated geothermal operator
- Pioneer in the exploitation of the resource – international player
- Culture of field “cultivation” – reinjection as main strategy to compensate the field decline
- Performance leadership: efficiency and availability of power plants.
- Proprietary Technologies
- Innovation.

700 EGP employees, more than 1000 contractor workers.

Source: Company information.  
(1) --- As of 2014

# Enel Green Power Heat Business



FY 2014

Supplied heat (GWht)      360 split ( **4% of Italian** district heating business and **17% from renewable resource** in the same business)

- 52,1% building heating
- 40,4% greenhouses**
- 7,2 % industrial uses
- 0,3 % food industry**

Contracts                      282

- 7 supplies to district heating systems including Ferrara (HERA)
- 6 supplies for greenhouses – 282.000sm**
- 4 supplies for food industry**
- 3 other industrial consumers
- 275 minor contracts

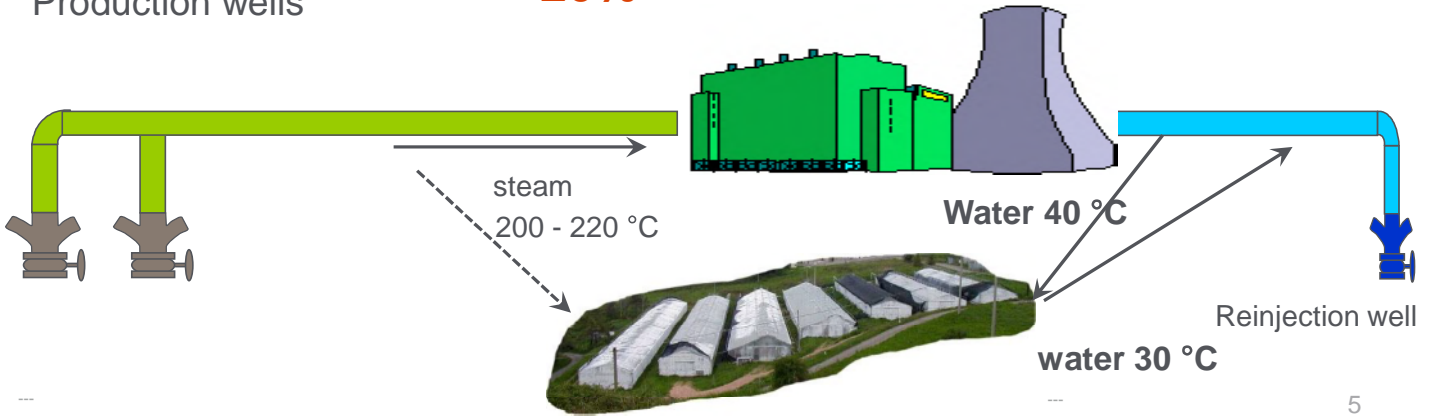
Heat Business



80%

Production wells

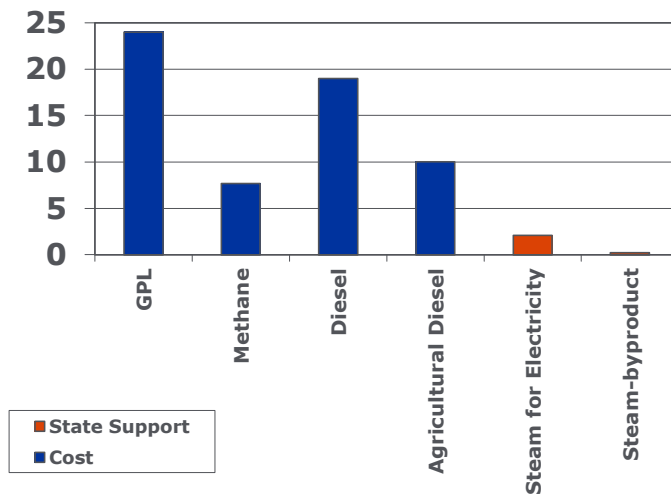
20%



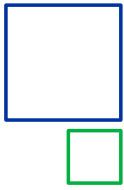
Heat Business



€ cent/Mcal







# Heat Business: Greenhouses

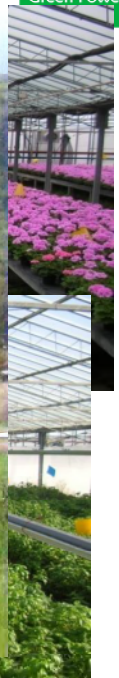


Up today there are more than 280.000 sm of greenhouses with 250 workers involved. Production characterized by the necessity to have constant high temperature during the entire year.

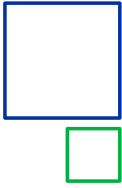
- Many types of flower
- Basil
- ect.



a)  e) 



40% of



# Heat business: food



Most of our customers are part of associations like “SlowFood” and “Comunità del Cibo”



Geothermal as the driver for adding value to traditional and high quality food productions

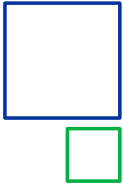


# Heat business: food



...1% of the total heat is used in cheese and salami production activities





Heat



...1% of the



Heat business: food



100% ene







## Future Development



The potential development of new activities in the food and agriculture fields, using geothermal, is still high in Italy, especially in **Tuscany**

### Opportunities

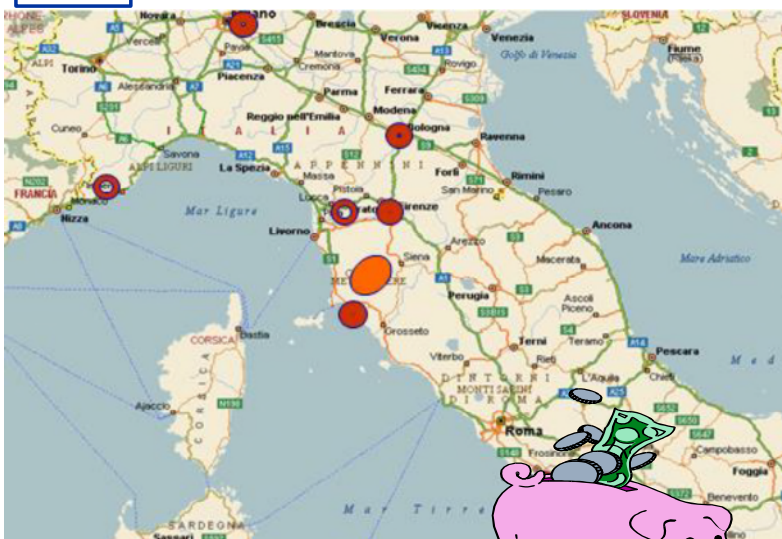
- Good resource availability
- Incentives
- EGP – Regione Toscana agreement on supply of heat to support new start-ups and local economy
- Availability of financing for start-ups located on geothermal territory

### Barriers

- Locations quite far from main roads
- Lack of knowledge about the real opportunities



## Future Development



General Market for

Food ●

Flower ○

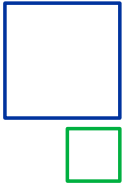
**Costs for Greenhouse near main communication roads**

Thermal Energy	=	22 %
Transportation	=	12 %

**Costs for Greenhouse at Radicondoli**

Thermal Energy	=	7%
Transportation	=	20 %

**Geothermal savings 34%-27%=7%**



# How to Incentivate Development

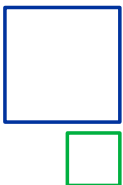


## Enel Green Power efforts

- Enel green Power, together with local communities that host geothermal power plants, is strongly committed to support start-ups supplying heat for their production process
- **Geothermal district heating** is an important element to mitigate logistical difficulties
- The opportunity to operate directly next to **geothermal power plants** makes access to the heat easier and cheaper than in other locations
- Lower cost of electricity inside “geothermal area”

## What's missing?

- **More information** about opportunities offered by the geothermal
- A systematic research focus on **discovering activities/productions** could maximize the benefits that geothermal can bring



Thanks for your kind attention

## Session IV Innovative Applications of Geothermal Direct Use worldwide

**USA- Arlene Anderson (US Department of Energy, USA)**

**Title:** Systems Analysis and Low Temperature Program Overview.

**Presenter:** Ms. Arlene Anderson is the Lead Technology Development Manager for Data Provision, Resource Assessment and Life Cycle Analysis in the Office of Energy Efficiency and Renewable Energy's Geothermal Technologies Program.

*[Presentation was held by Mr. Brian Carey](#)*

### **Abstract**

The mission of the Geothermal Technologies Program is to accelerate the deployment of domestic energy generation from geothermal resources by investing in transformative research, development, analysis and demonstration-scale projects that will catalyse commercial adoption. Successful efforts will promote a stronger, more productive economy; provide valuable, stable, and secure renewable energy to power the U.S.; and support a cleaner environment

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## Systems Analysis and Low Temperature Program Overview



U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

**Arlene Anderson, Technology Manager**  
**Geothermal Technologies Office (GTO)**

## Introduce you to

U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy

- **Geothermal Technologies Office – GTO**
  - Goals and Objectives
- **Technology Road Map**
- **Systems Analysis and Low Temperature Program - SALT**
  - Barriers to low temperature uptake
  - Research into additional value streams
- **Direct use Workshop – Pittsburgh – August 2015**
  - Key Messages
- **National Geothermal Data System - NGDS**

The mission of the Geothermal Technologies Program is to accelerate the deployment of domestic energy generation from geothermal resources by investing in transformative research, development, analysis and demonstration-scale projects that will catalyze commercial adoption. Successful efforts will promote a stronger, more productive economy; provide valuable, stable, and secure renewable energy to power the U.S.; and support a cleaner environment.

### Supported Administration Goals

- By 2035, generate 80% of electricity from a diverse set of clean energy resources
- Reduce GHG emissions by 17% by 2020 and 83% by 2050 from 2005 baseline

### GTO Program Goals and Objectives

GTO Goals	GTO Objectives
<ul style="list-style-type: none"> <li>• Develop advanced remote resource characterization tools to identify geothermal opportunities without surface expression</li> <li>• Purposeful control of subsurface fracturing and flow</li> <li>• Improve and lower \$/MW subsurface access technologies</li> <li>• Develop mineral recovery and hybrid systems to provide second stream of value</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate the capability to create and sustain a greenfield 5 MW Enhanced Geothermal Systems reservoir by 2020.</li> <li>• Reduce the LCOE of undiscovered hydrothermal to \$.10/kWh by 2020</li> <li>• Lower the levelized cost of electricity from newly developed geothermal systems to \$0.06/kWh by 2030.</li> <li>• Achieve \$1.70-\$2.60/m<sup>3</sup> for desalinated water from geothermal by 2018.</li> </ul>

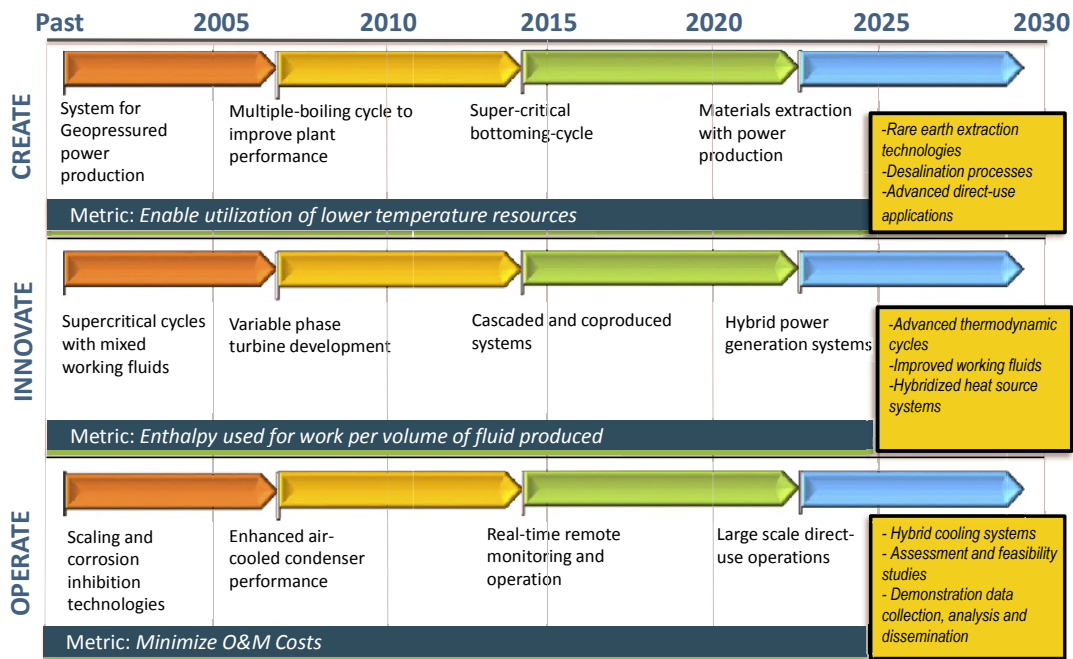
## GTO Technology Roadmaps

### 2016 Vision Study Activities:

- DOE will develop credible analysis jointly with the geothermal community that:
  - Articulates clear strategies across different sectors and has a cohesive plan to attain the goals
  - Discusses geothermal growth scenarios for 2020, 2030 and 2050 backed by robust data, modeling and analysis
  - Addresses all market segments: existing and potential hydrothermal, electrical **and non-electrical usages**, new EGS sector, and other value streams
  - Supported by objective and peer-reviewed industry data and available to decision-makers
  - Is aspirational and inspirational

### 2017 Vision Study Activities:

- Complete strategic planning based upon growth scenario modeling.
- Use completed analysis to feed into **technology roadmaps** that will cover all identified market segments.
- Utilize peer-reviewed data and analysis as the basis for developing various technology R&D pathways.



## Systems Analysis and Low-Temperature Program

Adding Value - Materials Extraction, Direct-Use, Hybrid Systems & Thermal Desalination

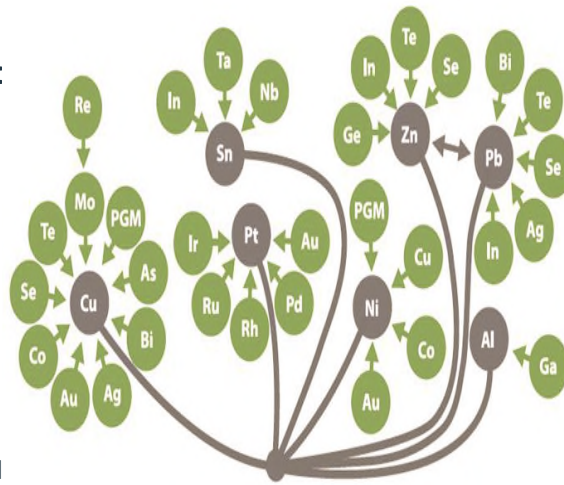


- **Low-Temperature Mineral Extraction** - Resource assessment and feasibility (ongoing)
- Large-scale **Direct Use**: where does it make technical and commercial sense?
- Use geothermal hot fluids for heating and cooling
- Potential displacement of traditional baseload generation on site-by-site basis
- Targeted RD&D on innovative energy conversion, additional **revenue-stream creation (e.g., hybrid systems & thermal desalination)**, and further development of power generation cycles



## Benefits of Coupling mineral/material extraction methods with geothermal power:

- Rare Earth (REE) and Near Rare Earth Elements may be relatively prevalent in the brines
- Chemical elements are critical for domestic industries
- Geothermal fluid can contain minerals that are a major source of corrosion and scaling

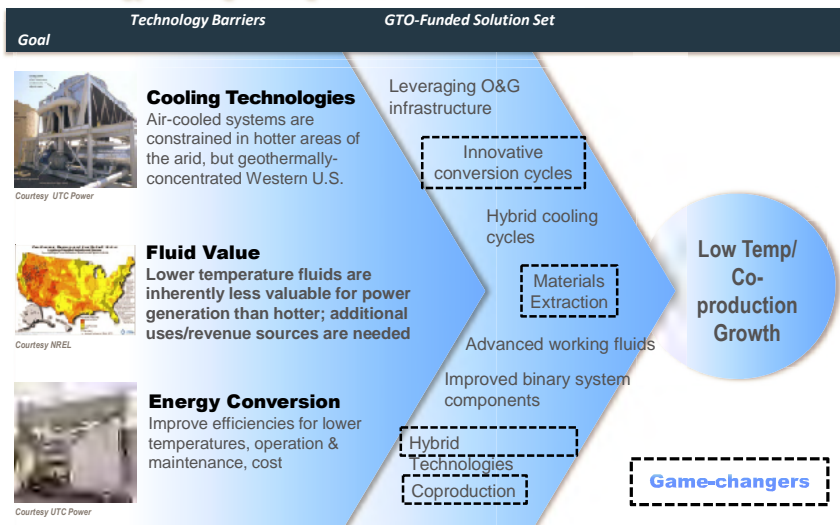


Technology metals produced as byproducts of base metals.

This matrix was used in the "Critical Materials for Sustainable Energy Applications" report by the Resnick Institute in 2011. (Original source: Hageluken, C., and Meskers, C.E.M.: Complex Life Cycles of Precious and Special Metals)

## Key Barriers to LT Expansion

### Technology and Engineering Needs





government/contractors

- Leverages DOE (NETL) 21<sup>st</sup> Century Infrastructure MOU with City of Pittsburgh by exposing energy and green buildings stakeholders to the potential for Geothermal Direct Use in key MOU localities within the Appalachian Basin
- City of Pittsburgh, Chief Resilience Officer presented emerging opportunities to develop **district energy** in cities like Pittsburgh that are experiencing growth and re-development.
- Icelandic consultant discussed geothermal district heating with an established geothermal resource, and provided insights into different heating and cooling needs and approaches that would be relevant to Pittsburgh.



NETL George Richards GTO



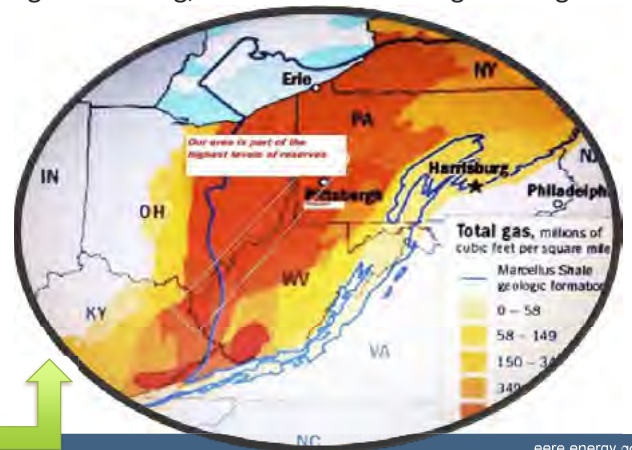
WVU Brain Anderson Geothermal Play Fairway

## Industry Engagement

- **NRG Energy District Energy** CEO and Plant Manager toured workshop participants through their Northside District Energy Plant discussing potential methods to integrate geothermal energy. Interested in EGS and cascaded Direct Use applications.
- **GRC** Executive Director and Incoming President attended interested in incorporating Direct Use and GSHP into membership base and working with International Ground Source Heat Pump members.
- **GEA** 2015 Update to include Direct Use – a first!
- **Frick Park Environmental Center**, through use of geothermal heating and cooling, slated to meet “Living Building Challenge” requiring stringent use of water and net zero energy

## Potential Partnerships

- **WV National Guard** (Camp Dawson)
  - City of Pittsburgh – 21st Century Infrastructure MOU
  - UAE Sustainable Fish Production
  - Bayer MaterialScience
  - CMU Center for Building Performance
  - Kasese Solar Power Ltd
  - Thar Energy
  - NETL, NREL, and ORNL resource assessment
  - Pittsburgh Southpointe Chamber of Commerce (Exhibitor)
- Map Courtesy of Marcellus Shale Chamber



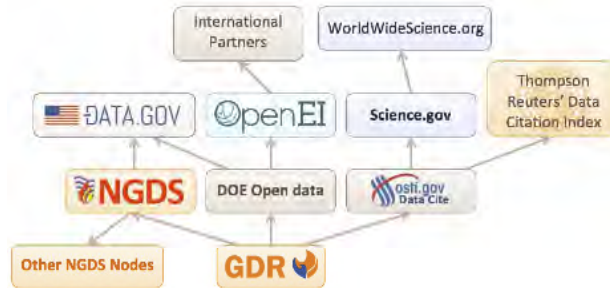
## Key Messages:

- Hot spots in NY, PA and WV can result in Deep Direct Use Applications. Cornell Case Study including EGS and Deep Direct Use of interest to others interested in pursuing sustainable development.
- Deep Direct Use applications lend themselves to large scale, commercially viable systems that optimize the value stream of lower temperature resources through a cascade of uses, from electricity generation to direct heating and cooling, industrial and commercial applications, and agricultural uses.
- District Heating Infrastructure in need of upgrading, opportunity to transition from natural gas to geothermal
- Documented audience opinions on potential impact for direct-use, technical challenges that require further research, and potential barriers for development, key information to present to Geothermal Vision Study Thermal Task Force.





DOE's node on the National Geothermal Data System (NGDS) is the DOE Geothermal Data Repository (GDR)



Over **500** geothermal projects data submissions from over **60** DOE GTO funds

Over **1,000** direct downloads with more than **11,000** downloads from users discovering GDR data



“reduce the inherent risk in early stages of development and encourage an independent investment market” - Deloitte LLP, *Geothermal Risk Mitigation Strategies* (2008)

## GDR Data Viewed through NGDS

- To connect with Arlene Anderson  
[Arlene.Anderson@ee.doe.gov](mailto:Arlene.Anderson@ee.doe.gov)

**Thank you**

## Asian region – Kasumi Yasukawa

(National Institute of Advanced Industrial Science and Technology (AIST), Japan)

**Title:** Innovative application Asia

**Presenter:** Ms. Kasumi Yasukawa is Principal Research Manager of Renewable Energy Research Center, AIST (National Institute of Advanced Industrial Science and Technology). Ever since joining to Geological Survey of Japan (GSJ: current AIST) in 1987, she has been working on geothermal studies. As a research associate in Lawrence Berkeley National Laboratory (USA), she combined a heat and mass flow simulation code with a geophysics (self-potential) code and got Master of Science in Mineral Engineering from University of California at Berkeley in 1993. Coming back to GSJ, she continued geothermal reservoir study and got Ph. D from Kyushu University in 2000. Then she has started hydrological study of non-geothermal areas for ground-source heat pump applications. She has been actively working with overseas institutes - USA, Italy, Indonesia, Korea, China, Thailand and Vietnam including field surveys - and served as a Board of Directors, International Geothermal Association from 2007-2013. She also served for environmental section (IPCC matters) of Ministry of Economy, Trade and Industry from 2009 to 2011.

### Abstract

ERIA geothermal project focused on technical and social challenges for geothermal utilization (power generation, direct use, GSHP and EGS) in each member countries. Report shows common technical problems on sustainable use of geothermal energy and publish a guideline for these problems with analysed collection of case studies from member countries. As a result of ERIA Geothermal Project, following matters emphasized for sustainable use of GSHP systems. Investigation, evaluation, and monitoring in China. Importance of monitoring and its data analysis in Korea. Suitability mapping for both closed and open systems in Japan. Lastly, comparison of groundwater and atmospheric temperatures in Thailand and Vietnam. The report of the whole project will be posted on [www.eria.org](http://www.eria.org)

[Back to the program](#) 



# Innovative Application of GSHP in the Asian Region - Lessons learnt from ERIA geothermal project -

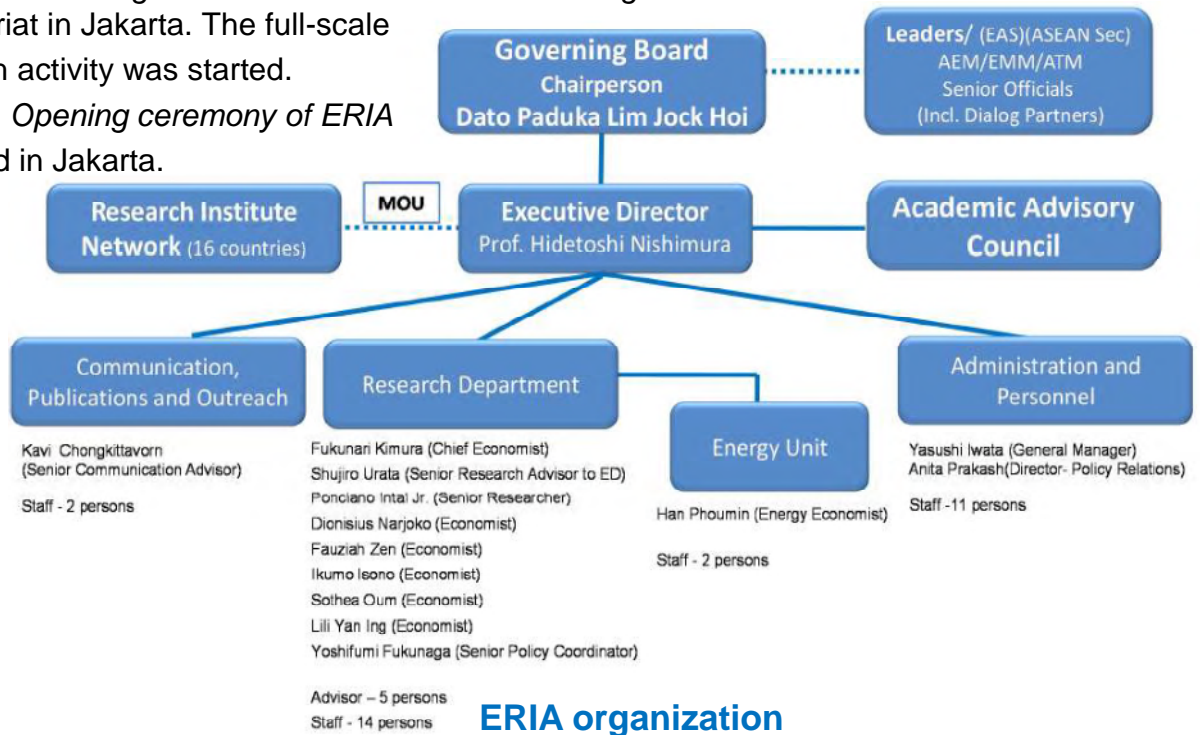
Kasumi Yasukawa, AIST  
Yoonho Song, KIGAM

## Contents

- Short introduction of ERIA Geothermal Project
- **China: Investigation, evaluation, and monitoring**
- **Korea: Importance of monitoring and its data analysis**
- **Japan: Suitability mapping for both closed & open systems**
- **Thailand and Vietnam: Comparison of groundwater and atmospheric temperatures**

## History of Economic Research Institute for ASEAN and East Asia (ERIA)

- 2006/04 *Global Economic Strategy* was announced.
- 2006/08 Japan proposed the *establishment of ERIA* at the 13<sup>th</sup> ASEAN-Japan Economic Ministers Meeting on August 23.
- 2008/06 *The inaugural ERIA Governor Board Meeting* was held at the ASEAN Secretariat in Jakarta. The full-scale research activity was started.
- 2008/09 *Opening ceremony of ERIA* was held in Jakarta.

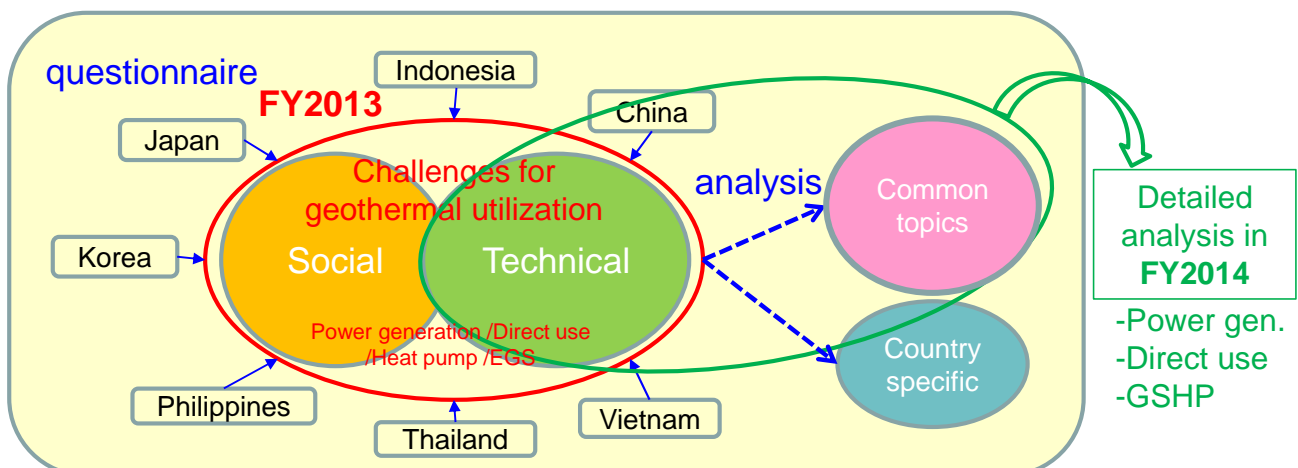


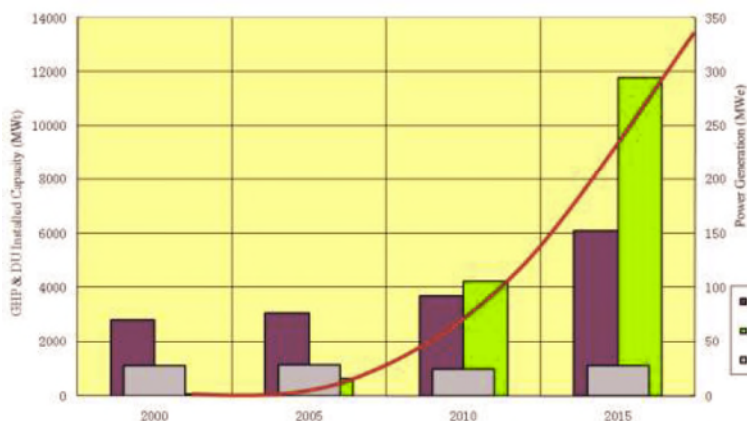
### “Sustainability Assessment of Utilizing Conventional and New-Type Geothermal Resources in East Asia”

**Sustainability** is the key to improve the reliability of geothermal energy.

#### Project Results

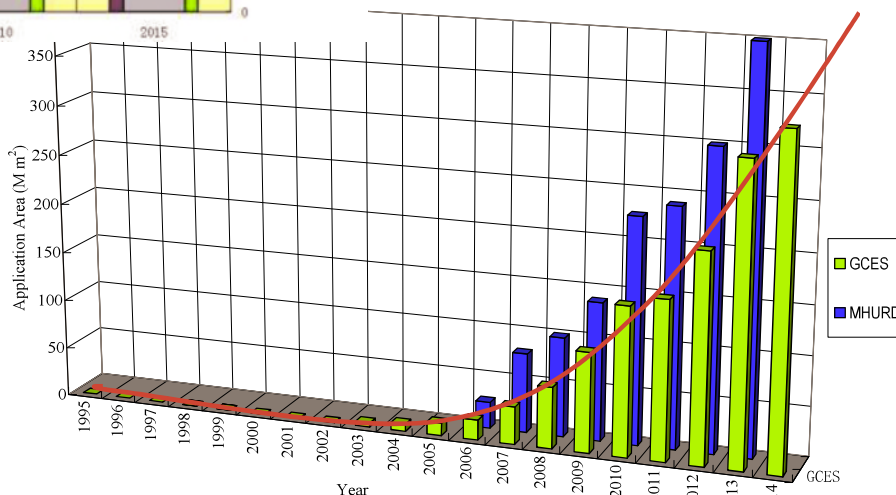
In FY2013, technical and social challenges for geothermal utilization (power generation, direct use, GSHP and EGS) in each member countries are summarized. In FY2014, common technical problems on sustainable use of geothermal energy are picked up and a guideline for these problems was made by analyzing collection of case studies from member countries.





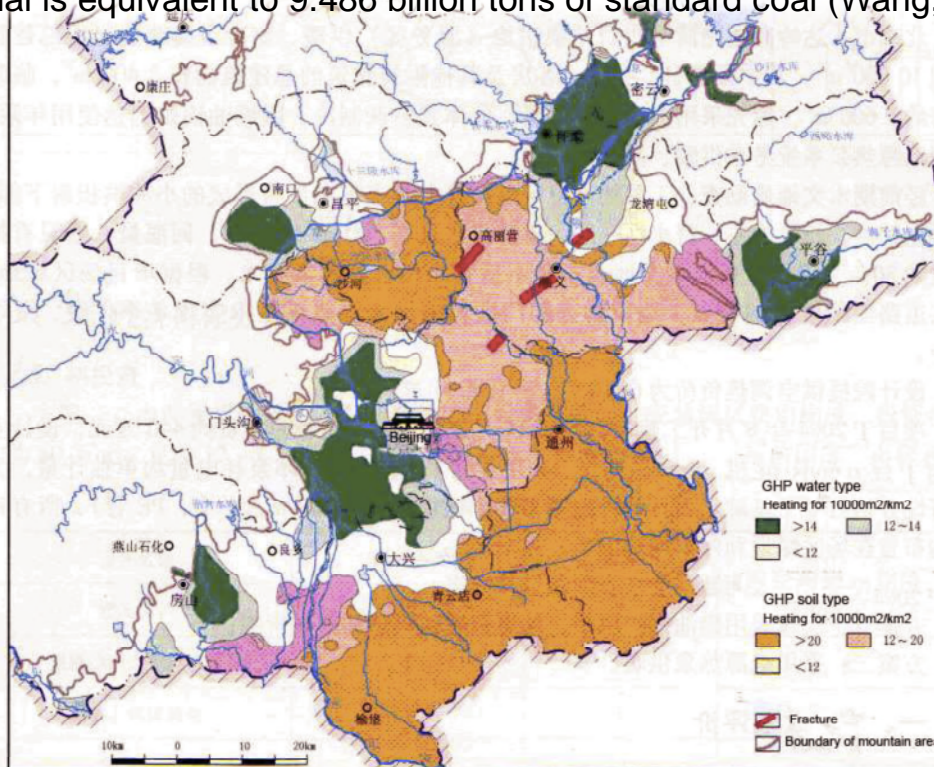
**Growth of Geothermal Utilisation in China**

Data source: Geothermal Council of China Energy Society (GCES), Ministry of Housing and Urban-Rural Development (MHURD)



**Growth of GSHP in China (Mm<sup>2</sup>)**

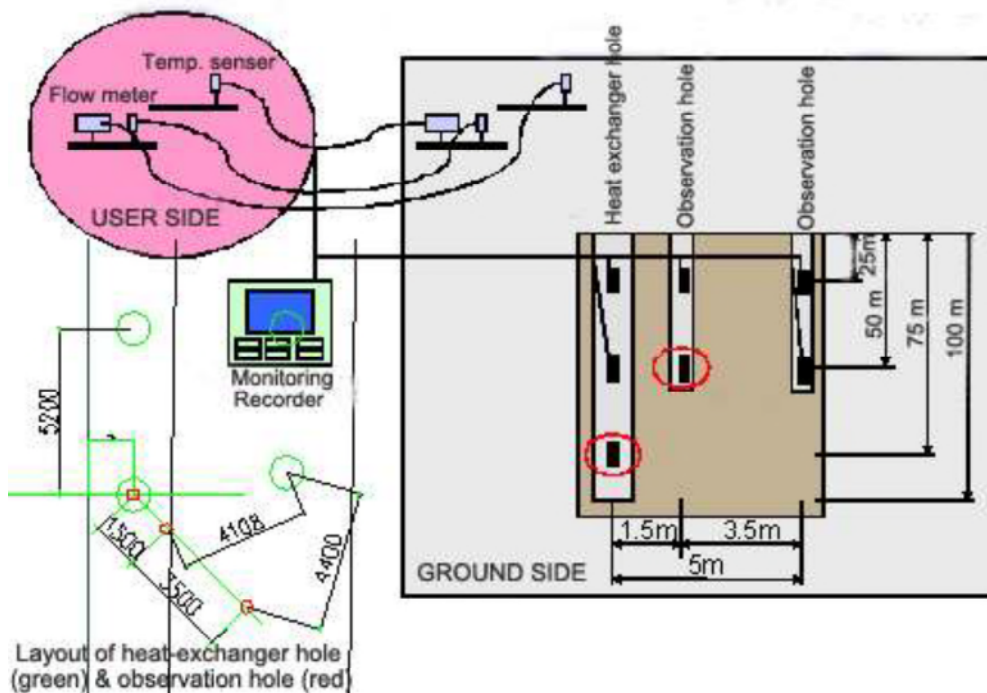
The national project of investigation and evaluation of shallow geothermal energy has shown great potential. It provides heat capacity for GSHP use. The total potential is equivalent to 9.486 billion tons of standard coal (Wang, et al., 2013).



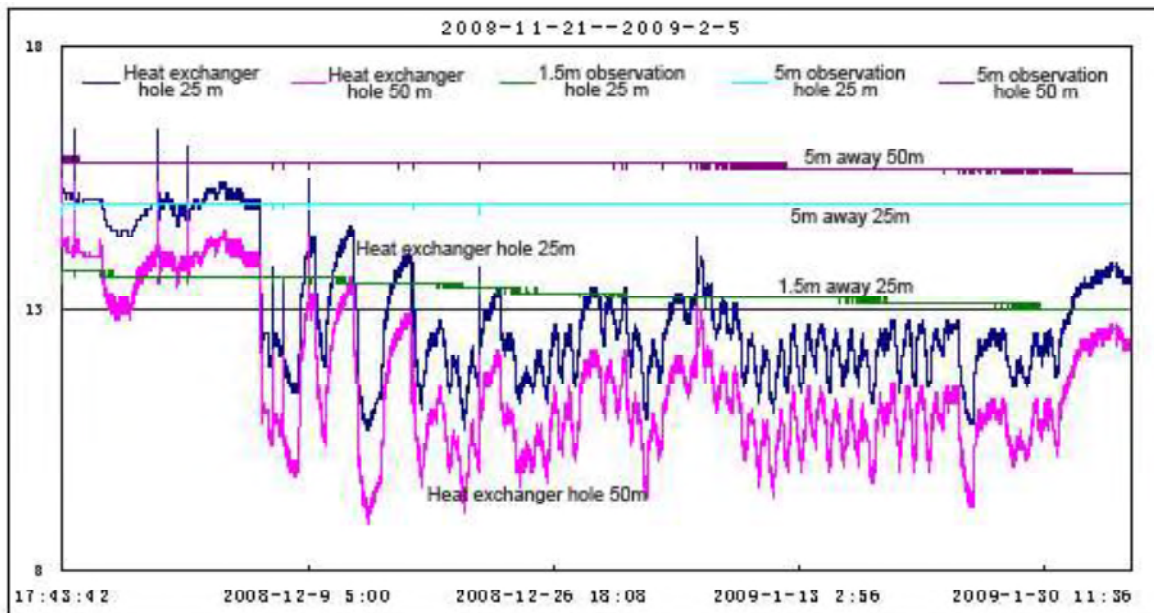
**Map Showing Shallow Geothermal Energy Conditions in Beijing**



Concerning the balance of heating and cooling, long-term monitoring has been conducted in typical projects for more than 10 years. Long-term monitoring of ground temperature and HP system has shown positive results for 20 or more projects in Beijing. (see next slide)



**Installation of Monitoring Tools for GSHP System**



**Temperature Curves Measured in Different Monitoring Holes**

### Lessons learned

- Mapping shallow geothermal energy conditions, such as water type and soil type, is important to perform proper design of GSHP systems.
- Monitoring of ground temperature is important to monitor thermal recovery of the ground and to assure the balance of heating and cooling.



## The government building complex of Sejong Metropolitan City

- The total building area: 607,555 m<sup>2</sup>.
- Total GSHP installed capacity >20 MW<sub>t</sub>, covering 38 % or more heating and cooling load.
- 70 % of heat is from borehole heat exchangers (BHEs) through 1,190 boreholes of 200 m deep (total length of holes: 238 km).
- 30 % of heat is from ground water wells of around 400 m deep.
- Zone 1 of the building complex started operation in 2012,
- Zone 2 in 2013, and Zone 3 was completed in 2014.
- GSHP for other public buildings including City Hall and the Educational District Buildings are continuously being installed.

**Bird's-eye View of Zones 1 and 2 of the Government Building Complex, Sejong Metropolitan City**

## Monitoring

The GSHP system in Sejong City is readily equipped with automated monitoring systems and the monitored data are automatically collected at each site.

But there is no systematic regulation or organisation for checking and analysing the monitoring data. It is very important not only to monitor the geothermal system, but to analyse the data.

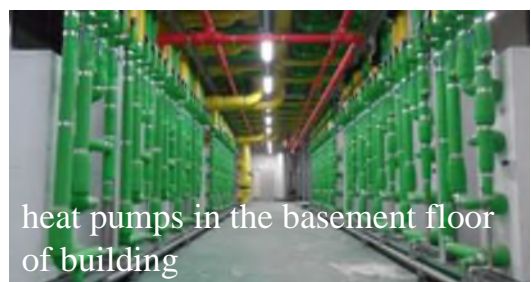
Regulations or organisations are needed for making advice on the sustainable use of GSHP systems based on the analysis of results.



drilling of borehole for BHE



trench line of heat exchanger pipes into building



heat pumps in the basement floor of building

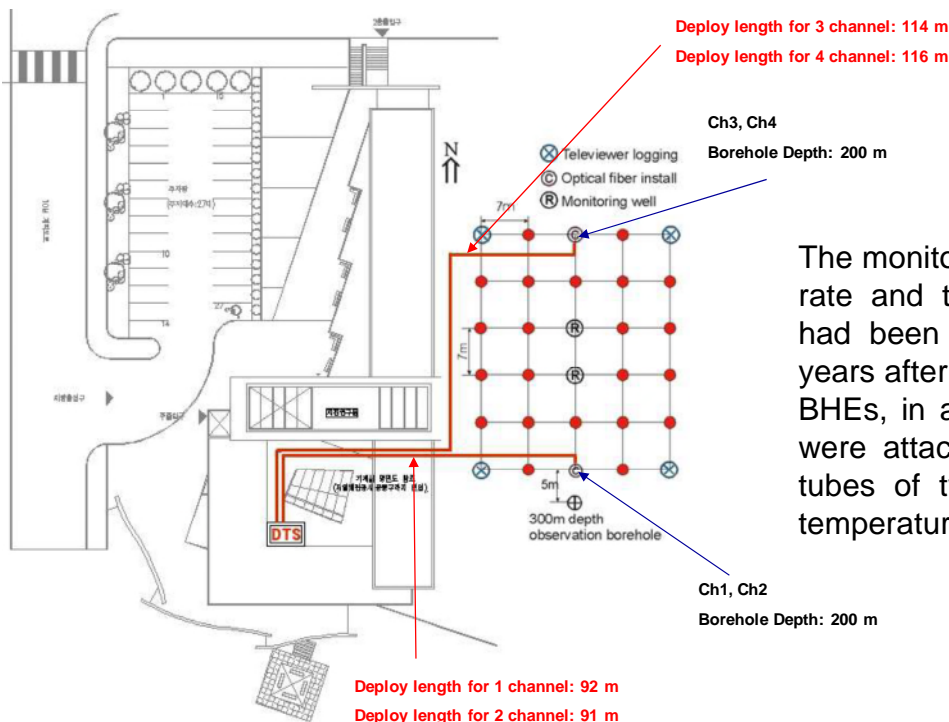
## Long-term temperature monitoring in Earthquake Research Center, KIGAM

- A long-term monitoring case of ground temperature variation according to GSHP operation can be found at the Earthquake Research Center (ERC) building in KIGAM.
- The building is three storeys high with an area of 700–900 m<sup>2</sup> each, 2,435.4 m<sup>2</sup> in total, constructed in 2005.
- The heating and cooling load is 400 kW.
- 28 boreholes with a diameter of 165 mm, a depth of 200 m, and 7 m apart were drilled to be installed with double U-tube type borehole heat exchangers (BHE).



ERC building in KIGAM during the Installation of BHEs (left) and after Covering BHEs with Green Grasses (right)

## Long-term temperature monitoring in Earthquake Research Center, KIGAM

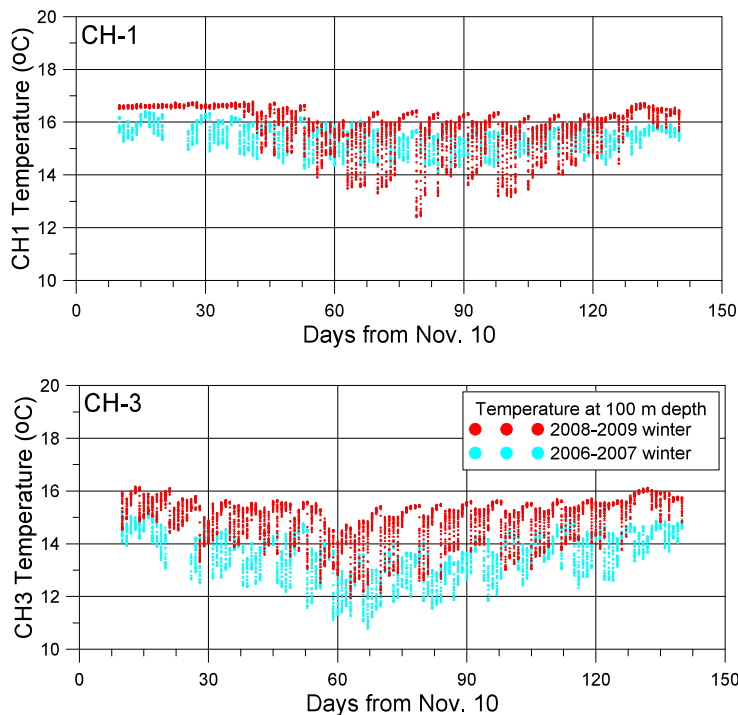


The monitoring of the inlet/outlet flow rate and temperature of the BHEs had been performed for about 3.5 years after the installation. Among 28 BHEs, in addition, fibre optic cables were attached to the outside of U-tubes of two BHEs to monitor the temperature variation with depth.

Layout of BHEs and the Monitoring System for the ERC Building at KIGAM



## Long-term temperature monitoring in Earthquake Research Center, KIGAM



The subsurface temperature beneath the borehole field was getting higher with the GSHP operations and we can see 0.5–1°C of temperature increase per year at 100 m depth.

The increase of subsurface temperature was caused by unbalanced seasonal variation of load (cooling load is bigger than heating in the building), which may lead to performance degradation as GSHP operation continues year after year.

This result is a good example showing that accurate monitoring of the subsurface is important for sustainable use of geothermal energy in heating and cooling applications.

- **Comparison of Temperature Variations at 100 metre Depth between the Winter Seasons of 2006–2007 and 2008–2009**

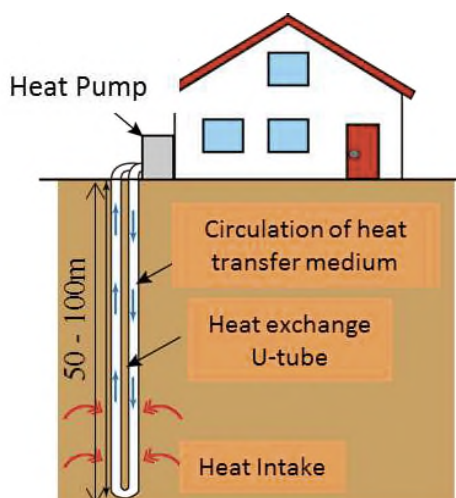
### Problem

In South Korea, by law, all GSHP systems are subject to be monitored in terms of inlet and outlet temperature and flow rates during operation. All these data are collected by the authorised ministry. However, no analysis has been made for these data so that the actual coefficient of performance (COP) has not been calculated, although the COP is the key to understand the effectiveness of GSHP in terms of saving energy, heat extraction, and sustainability.

#### Lessons learned

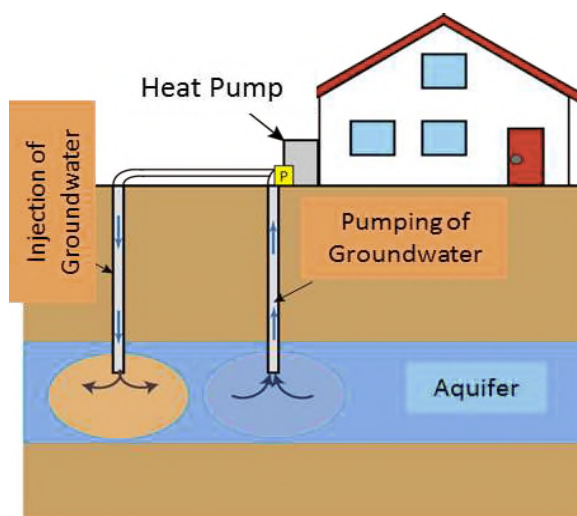
- For long-term sustainability, monitoring of the system is important. The monitoring is mandated by law in case of South Korea, but the problem is that the monitoring data has not been properly analysed in many cases.
- Ideally, the subsurface temperature down to the depth of subsurface heat exchanger will be monitored.
- The flow rate and temperature of the primary and secondary fluids and electricity consumption of the heat pump and circulation pump should be monitored to calculate actual COP and long-term performance including extracted heat, amongst others.

In sedimentary basins and plains in monsoon Asia, sustainable heat exchange rate and preferred drilling depth of a closed loop system varies with local hydrogeological settings due to the **variation of effective heat conductivity caused by groundwater flow**. Therefore, suitability mapping for closed loop system is important in such regions.



Suitability index parameters for closed loop system

- Effective heat conductivity (or equivalent overlaid parameters: see the following page)

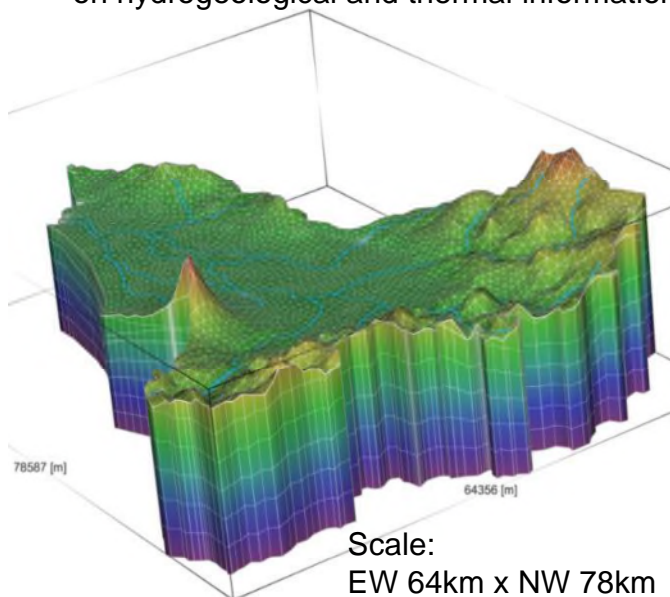


Suitability index parameters for open loop system:

- Economical availability (accessibility) of aquifer
- Injectivity of the aquifer
- Productivity of the aquifer

**Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain**

The objective of this study is to assess the installation suitability of a closed-loop GSHP system by developing ‘suitability’ maps. The term suitability is mainly related to heat exchange with the subsurface, which depends on geology, groundwater flow system, and subsurface temperature distribution. Hence, suitability assessment should be done based on hydrogeological and thermal information.



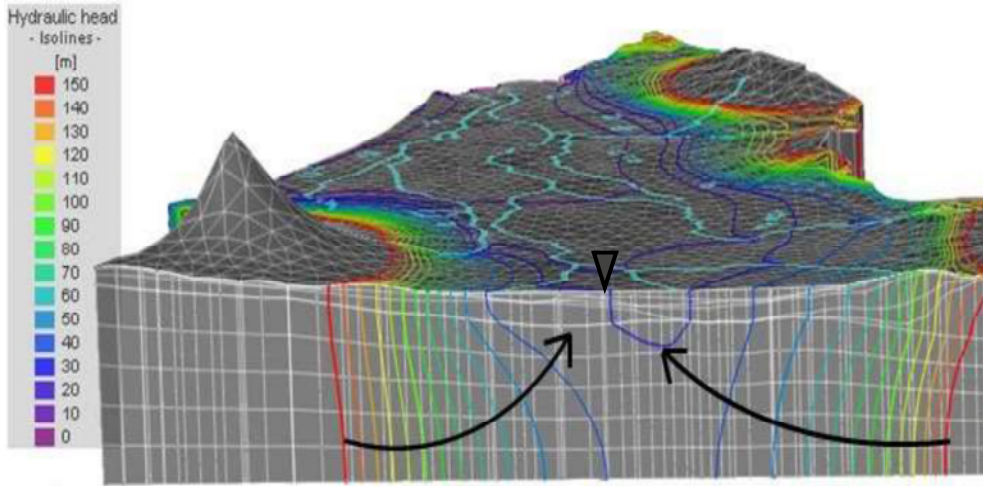
	Quaternary System	Tertiary System	
		Neogene	Paleogene
Hydraulic Conductivity (m/s)	$5 \times 10^{-5}$	$3.4 \times 10^{-6}$	$2.4 \times 10^{-7}$
Porosity (-)	0.4	0.1	0.1
Heat Capacity (J/m <sup>3</sup> K)	$2.6 \times 10^6$	$2.6 \times 10^6$	$2.6 \times 10^6$
Thermal Conductivity (W/mK)	1.2	1.5	1.5

**Regional scale analysis model and its input parameters** (Shrestha, et al., 2015).

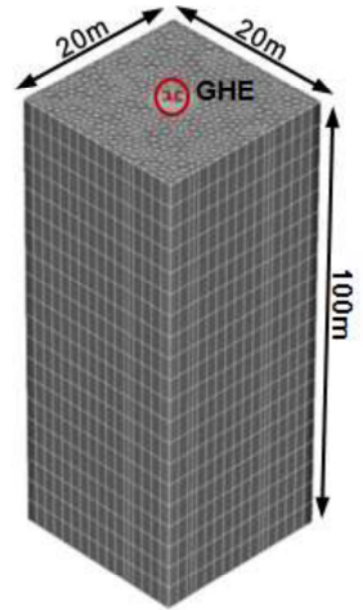
**Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain**

Normally simulation results of the regional model is compared with observed temperature profiles in observation wells. But since there is no observation wells in this plain, results of TRT at several sites are compared with calculation results of single GHE model using boundary conditions obtained by regional model.

Thus the model parameters are adjusted.



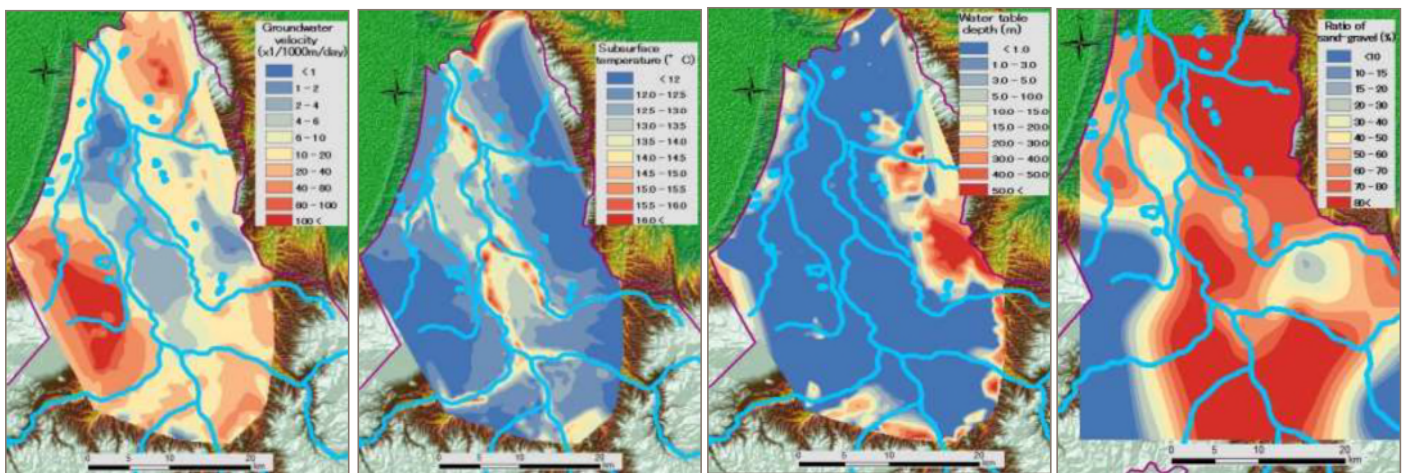
Groundwater Upflow at Tomita Spring (Shrestha, et al., 2015).



Single Ground Heat Exchanger Model

**Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain**

Then “Thematic Maps,” to be overlaid into a suitability map, are made using simulation results of regional model.



(a)Groundwater velocity (b)Subsurface temperature (c)Water table depth (d)Sand-gravel ratio (Shrestha, et al., 2015).



**Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain**

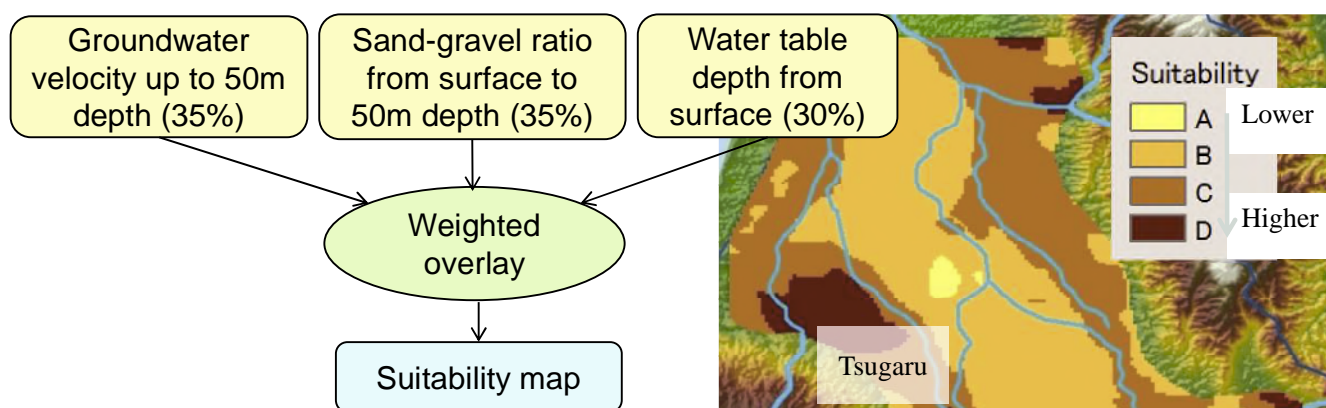
Then “Thematic Maps” are reclassified to be overlaid into a suitability map.

Groundwater velocity Index class ( $\times 10^{-3}m/day$ )	Sand-gravel ratio Index class (%)	Water table depth from surface Index class (m)	Grade
< 1	<10	50 <	1
1 – 2	10 – 15	40 - 50	2
2 – 4	15 – 20	30 - 40	3
4 – 6	20 – 30	20 - 30	4
6 – 10	30 – 40	15 - 20	5
10 – 20	40 – 50	10 - 15	6
20 – 40	50 – 60	5 - 10	7
40 – 80	60 – 70	3 - 5	8
80 – 100	70 – 80	1 - 3	9
100 <	80 <	< 1	10

Reclassification of Thematic Maps(Shrestha, et al., 2015).

**Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain**

Then “Thematic Maps” are overlaid into a suitability map.



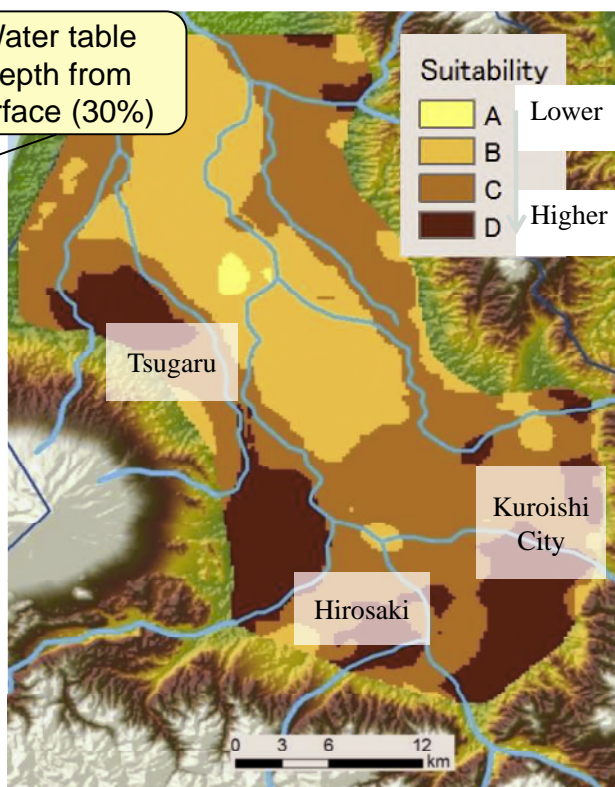
**Weighted Overlay Model for Space Heating and Cooling**

(Shrestha, et al., 2015).

For the case of heating purpose only, Subsurface temperature is also overlaid.

**Suitability Map**

(Shrestha, et al., 2014)



## Lessons learned

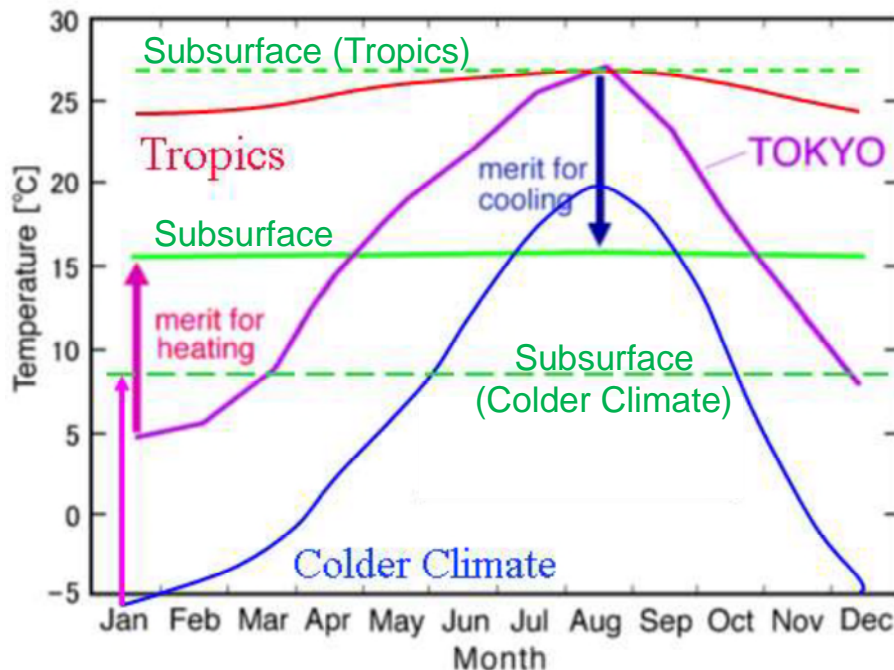
- For sustainable use of GSHP systems, system design suitable for the subsurface condition of the location as well as GSHP application purpose is needed.
- Heat exchange rate and preferred drilling depth of a GSHP system varies with local subsurface conditions.
- In this context, a hydrogeological survey is very important for places in sedimentary basins and plains, while only rock properties are important for places with near surface hard rocks.
- To compile suitability maps of GSHP systems for sedimentary regions, groundwater and geological surveys are needed to perform numerical simulations on groundwater flow and local heat exchange rate.
- The design of a GSHP system can be improved by utilising the suitability map, such that high system performance and cost reduction may be achieved.

## Lessons learned (continued)

- A suitability map can be made in the following order of procedures:
  1. Groundwater and geological survey
  2. Regional groundwater flow simulation
  3. Heat exchange simulation of the site
  4. Making suitability map
    - Weighted overlay method may be used for making suitability map.
    - For closed-loop system, groundwater velocity, sand-gravel ratio, and water table are used. For open-loop system, horizontal and vertical groundwater flow rate and permeability of geological layers are used.
    - Space heating suitability map needs subsurface temperature data additionally.

Choice of overlaid parameters and their weight

Is GSHP applicable everywhere? Not really in tropics...



Monthly mean atmospheric and subsurface temperature

(Yasukawa et al., 2009)

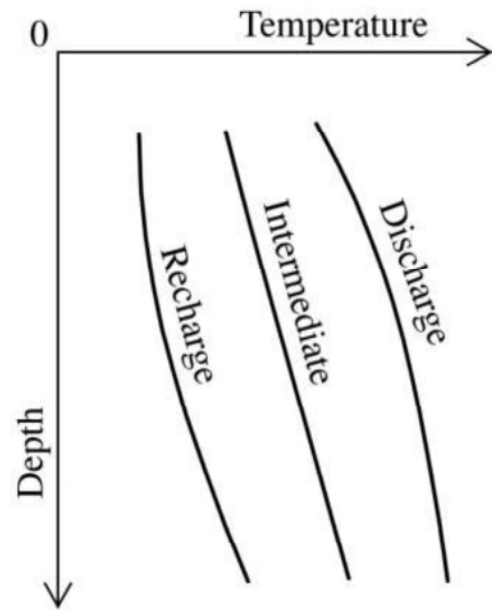
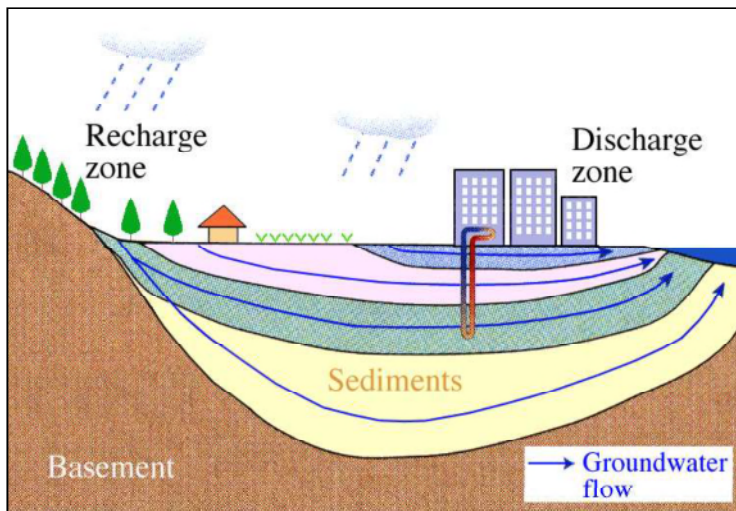
## Can we use GSHP System in tropics?

- In East-Asia, where significant economical growth in this century is expected, **energy saving and environmental protection** are major matters of importance
- Promotion of GSHP may contribute to energy (electricity) savings and protection of the environment
- However, in tropics where space-cooling is needed, subsurface temperature is generally higher throughout a year and the underground is not suitable for heat exchange
- Nevertheless in tropical regions, underground may be used as a cold source, **if there exist seasonal and areal variation in atmospheric temperature, and subsurface temperature is rather low**



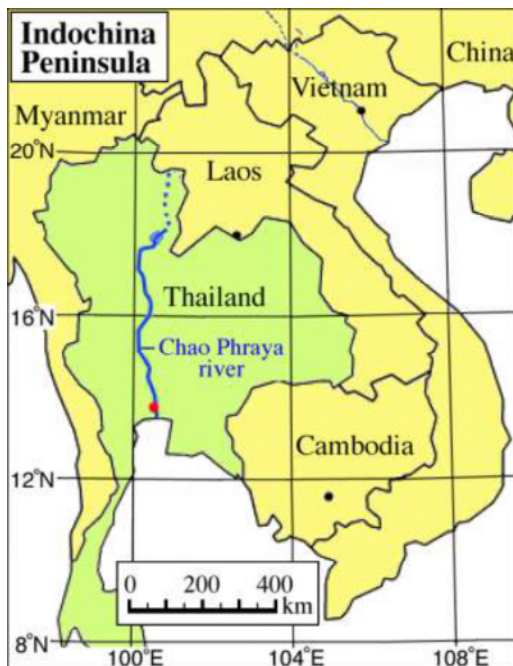
## Shallow subsurface temperature affected by groundwater flow

- At recharge zones (high elevation), shallow temperature is lower, while it is higher at discharge zones
- At recharge zones, underground may be used as cold source in tropics

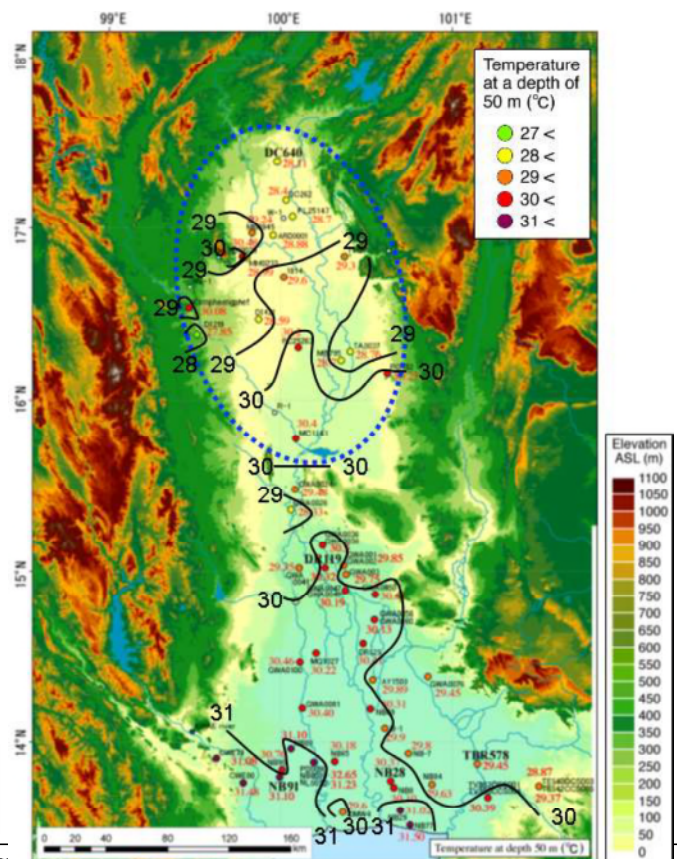


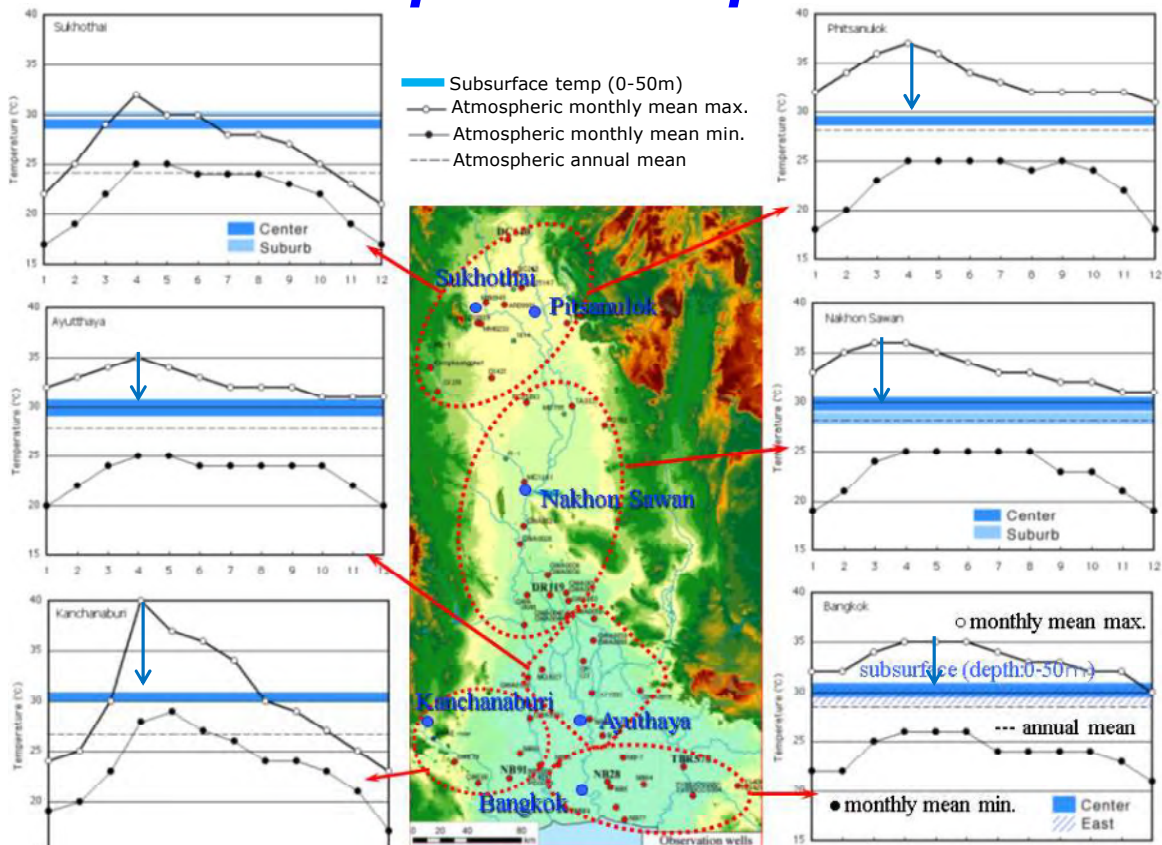
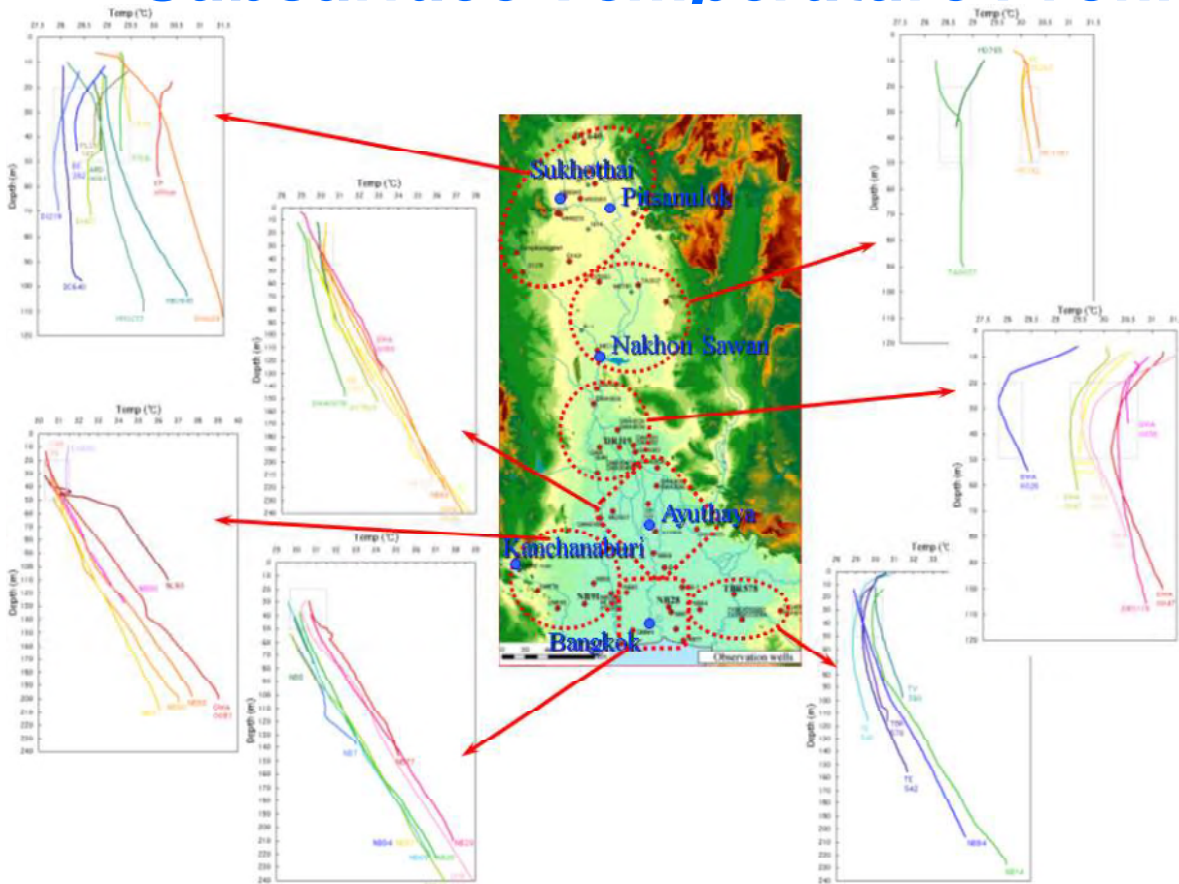
Subsurface temperature profile with groundwater flow

## Temperature measurements in Thailand



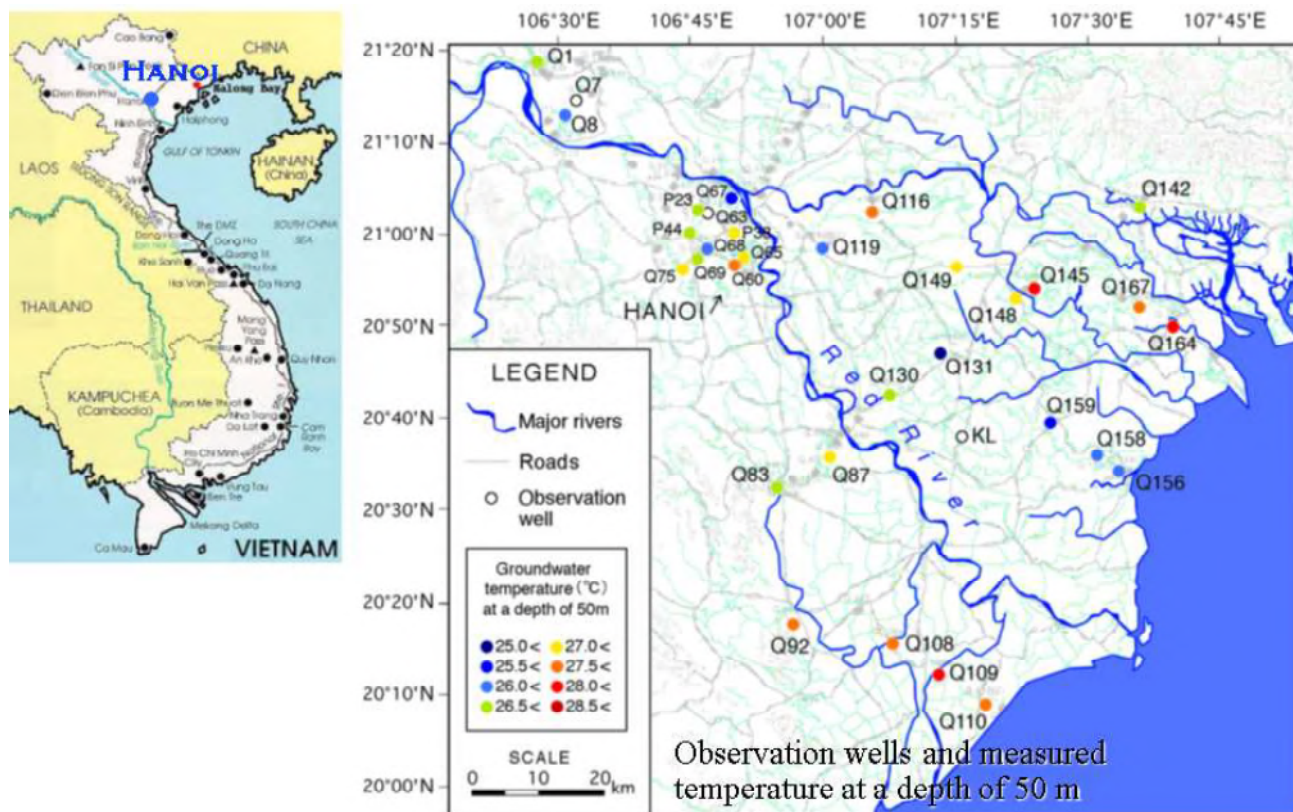
DGR: Department of Groundwater Resources of Thailand



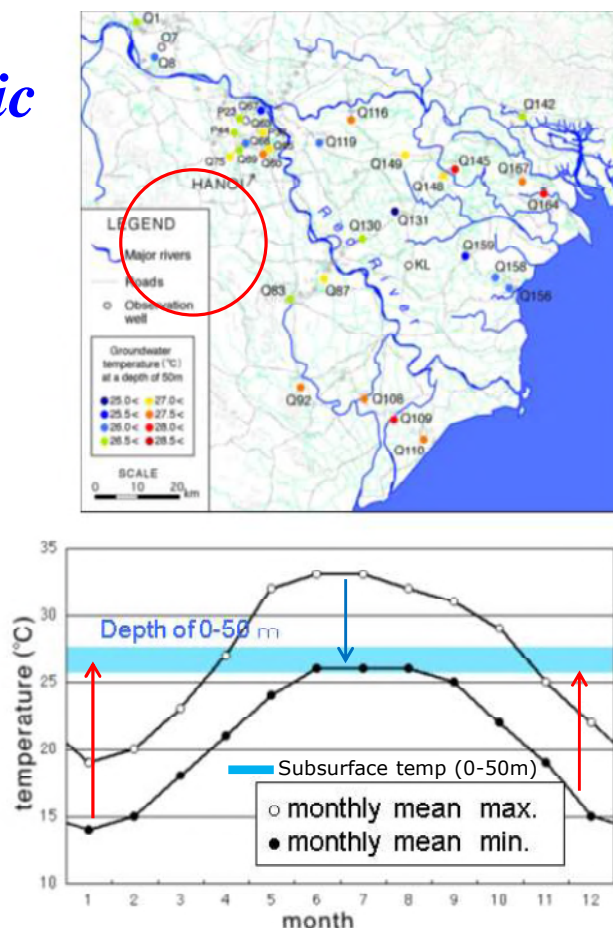
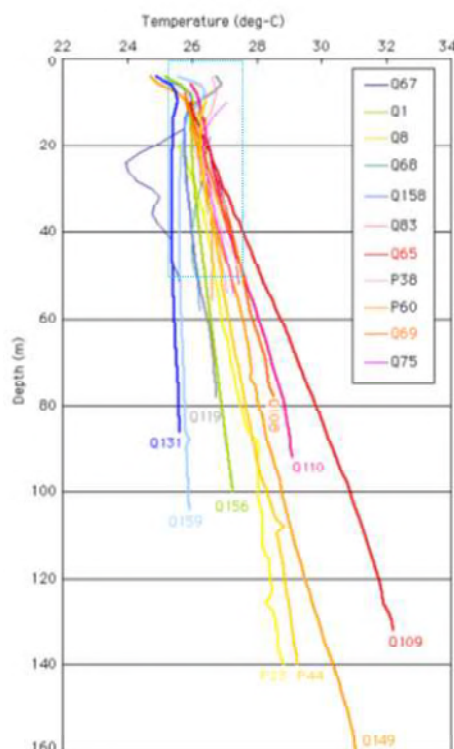




## Temperature measurements in the Red River Plain (Hanoi region)

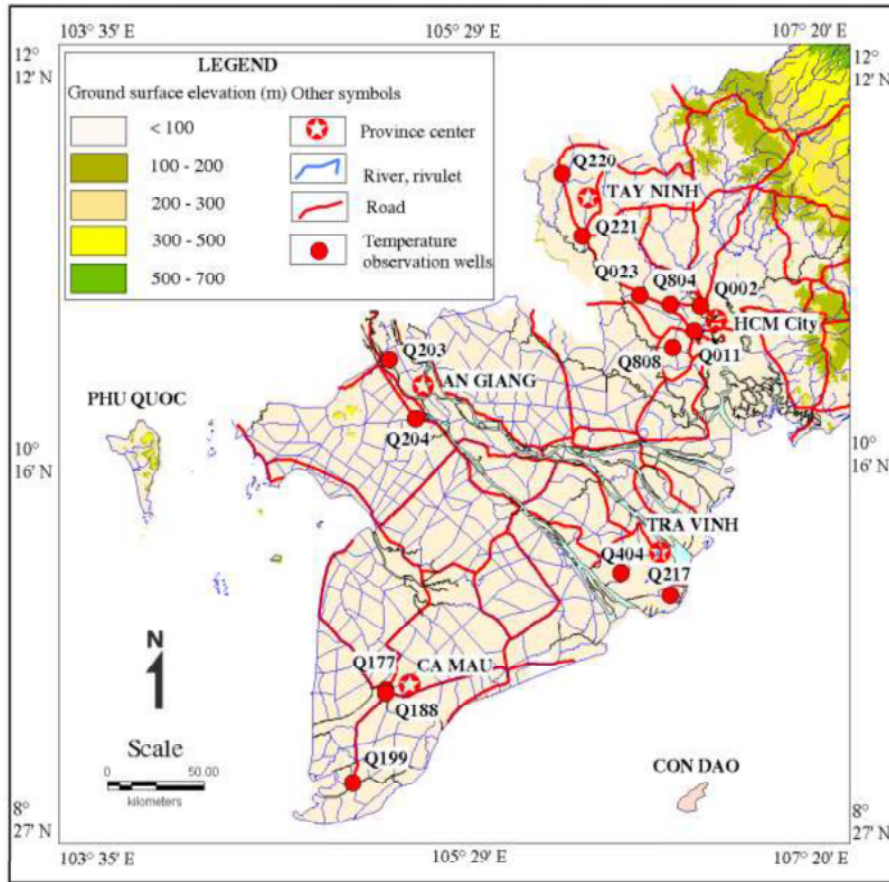


## Comparison between subsurface and atmospheric temperature in Hanoi



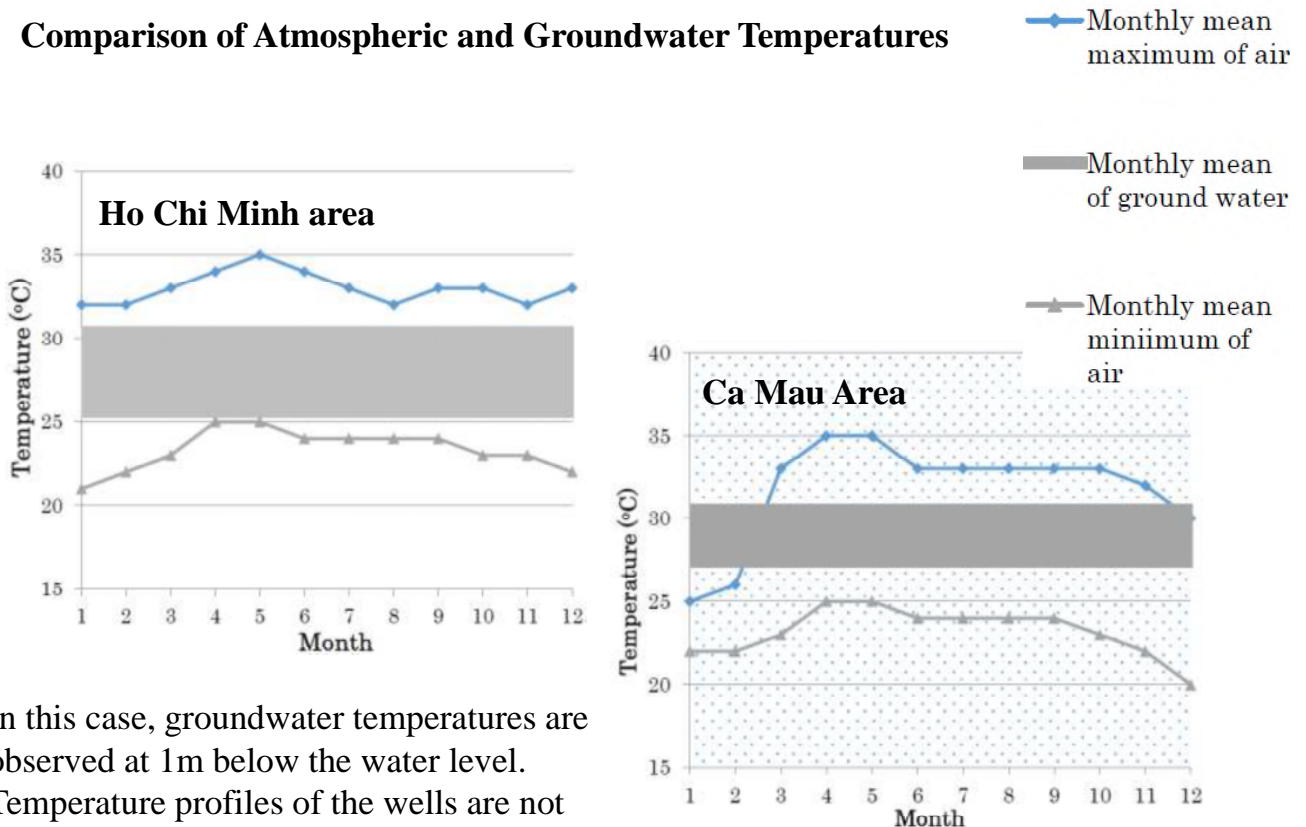


## Temperature measurements in the South Plain (Ho Chi Minh region)



NDWRPI (2011).

## Comparison of Atmospheric and Groundwater Temperatures



In this case, groundwater temperatures are observed at 1m below the water level. Temperature profiles of the wells are not obtained in this region.

Edited by ERIA project authors

## Lessons learned and recommendation

- For GSHP application in tropical regions where only space cooling is needed, the underground temperature should be measured first to ensure the applicability of the GSHP system.
- If the underground temperature is lower than the atmosphere at least in daytime, GSHP may be effective. Thus temperature survey results shows the applicability of a GSHP system in many cities in Thailand and Vietnam.
- The observation wells can be used to evaluate the subsurface temperatures so that the possibility of GSHP may be evaluated.
- To extract the suitable areas for GSHP systems, more detailed investigations including suitability mapping based on hydrogeological data should be conducted.
- As for areas where the GSHP can be applied, a pilot system installation and operation including subsurface temperature monitoring is recommended before distribution of the systems.

## Conclusions

- As a result of ERIA Geothermal Project, following matters are emphasized for sustainable use of GSHP systems:
  - **Investigation, evaluation, and monitoring (China)**
  - **Importance of monitoring and its data analysis (Korea)**
  - **Suitability mapping for both closed & open systems (Japan)**
  - **Comparison of groundwater and atmospheric temperatures: Thailand and Vietnam**
- The report of the whole project will be posted on;  
<http://www.eria.org>

## **New Zealand and Australia – Brian Carey (GNS, New Zealand)**

**Title:** Innovative applications in New Zealand and Australia

**Presenter:** Brian Carey (BE, ME) has over 25 years' involvement in geothermal energy developments at a commercial and project level. Prior to joining GNS Science as the Geothermal Manager in 2007, he was the geothermal resource manager at Contact Energy's Wairakei Power Station. This work has included an environmental planning focus over the last 20 years, most recently working on the resource consenting for Wairakei Power Station, and coordinating the technical input, science and engineering for field development programmes. He has a strong, established network of geothermal contacts both in New Zealand and overseas, supported by membership of a number of professional organisations, including IPENZ and the NZ Geothermal Association. Brian's professional interests include geothermal resource utilisation specialising in reservoir utilisation, steam field engineering, steam field energy management, electric power generation and environmental planning.

[Back to the program](#) 



# New Zealand and Australia



Brian Carey  
New Concepts Workshop  
Penthes Geneva  
30<sup>th</sup> October 2015



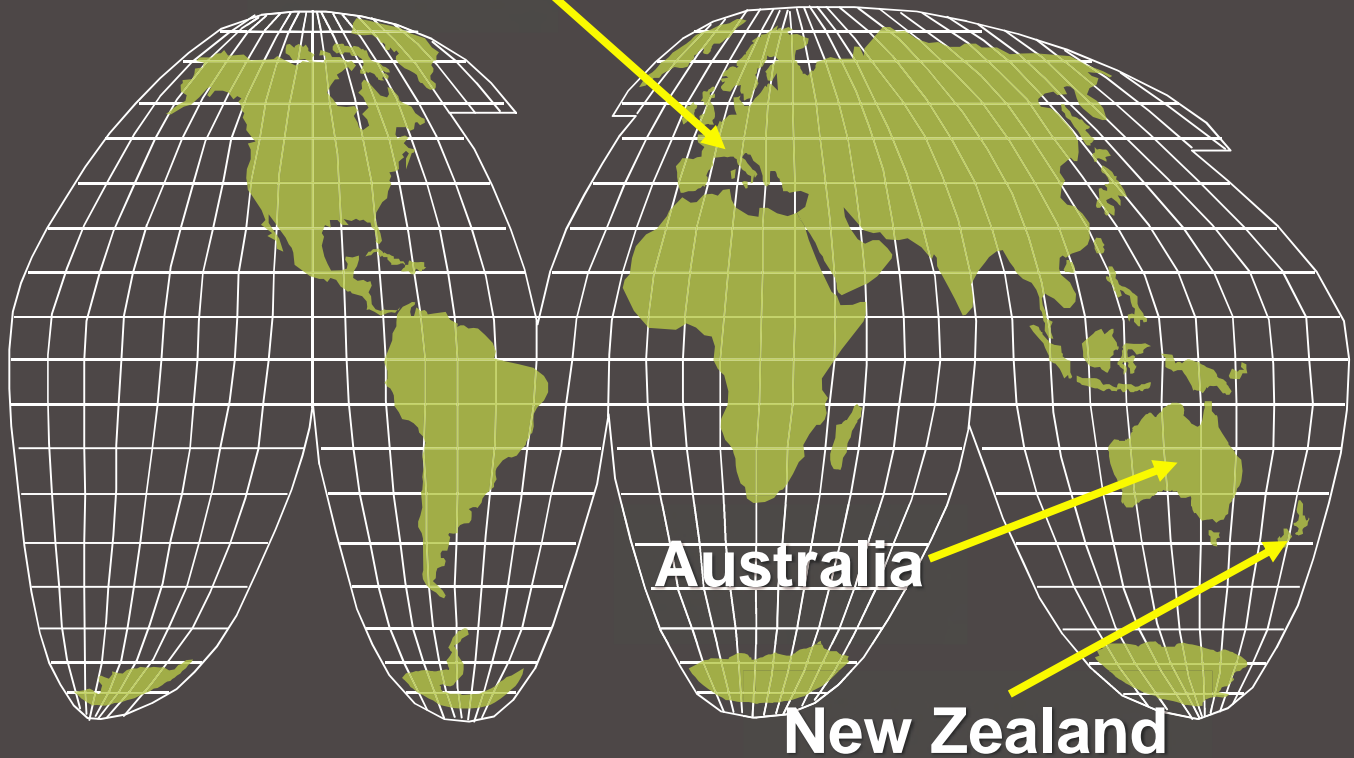
## Where are Australia and New Zealand ?

- Giant Jump



# Giant Jump

Geneva



3

GNS Science

## Quite Different

- **New Zealand**
  - High temperature geothermal resources
  - Amongst the world leaders
  - Much more opportunity
    - Direct Use
    - Lower temperature use
- **Australia**
  - Create higher temperature reservoirs
  - Sedimentary aquifers
  - Using lower temperature
  - More can be done

4

GNS Science

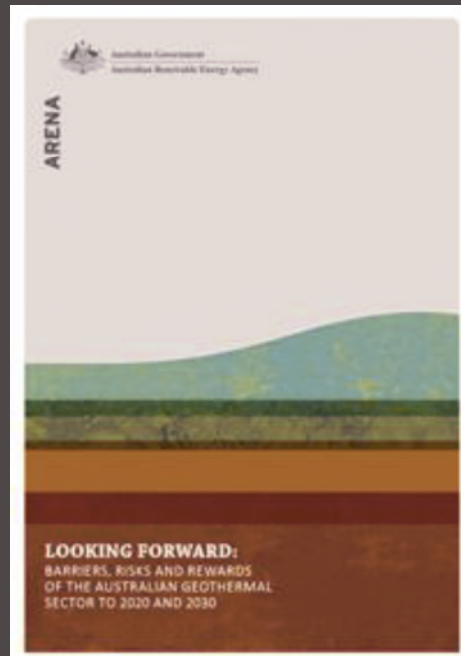
# Australia

- **Australian Renewable Energy Agency (ARENA)**
- **Expert group commissioned 2014**
  - Options to realise the potential of geothermal
- **Time frame**
  - Over coming decades



# Expert Report

- **Structured approach**



<http://arena.gov.au/files/2014/07/ARENA-IGEG-main-report.pdf>



# Readiness Matrix

## 5.2.1 Commercial Readiness Index – Shallow Direct Use (Type A)

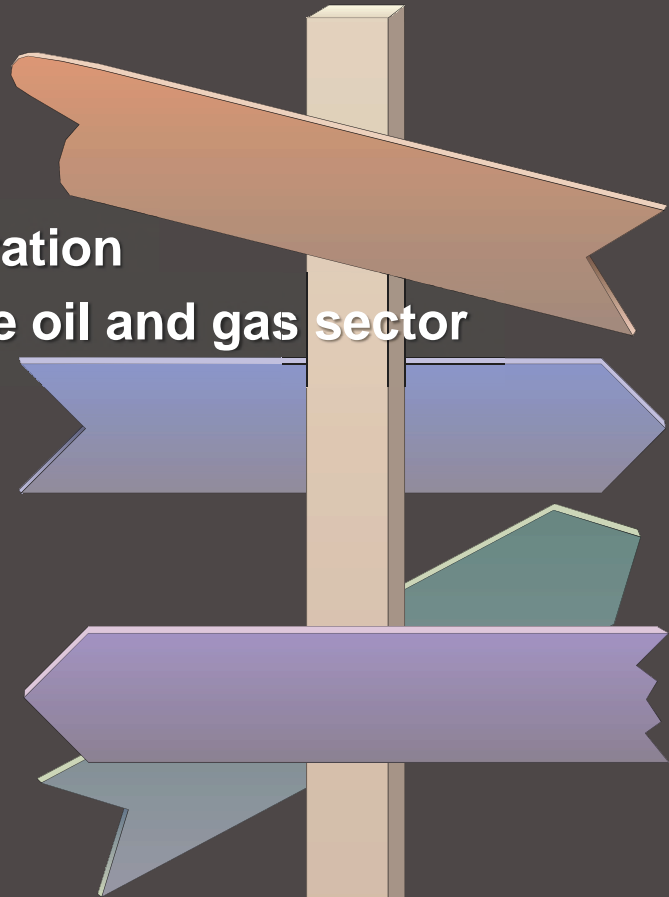
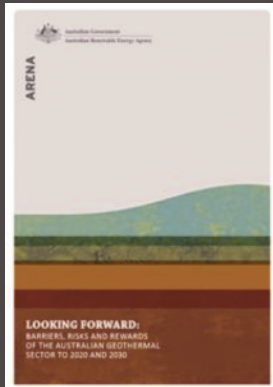


## Report

- Findings
  - Shallow – ready
  - Deep natural – commercial trial / hypothetical
  - EGS – hypothetical / commercial trial
- Roadmap
  - for developing the potential of geothermal energy in Australia
  - 2030 and beyond

## Roadmap

- Data collection
- International collaboration
- Collaboration with the oil and gas sector



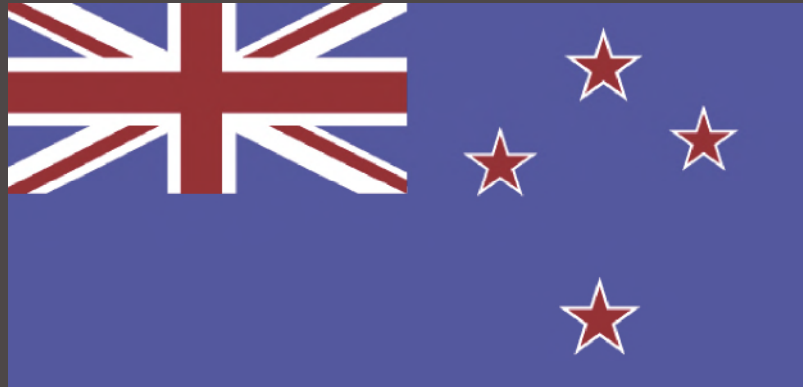
## Australian Innovation

- Geothermal for heating and cooling in Victoria
- Melbourne University
- Professor Ian Johnston and Guillermo Narsilio



## New Zealand

- Direct geothermal use is well established
- Raising Awareness
- Being purposeful to develop further



## Kawerau

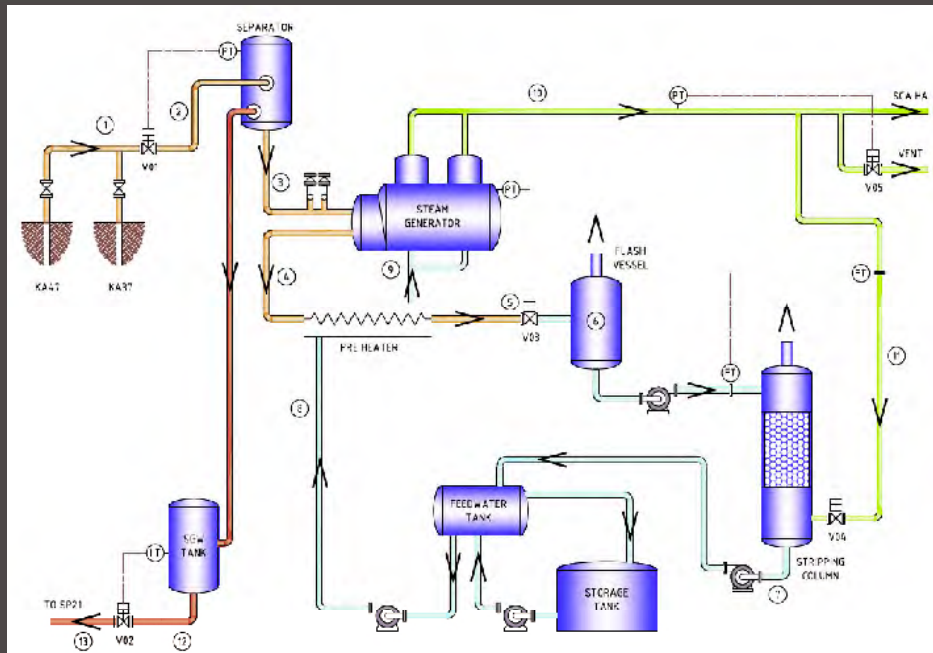
- Largest direct geothermal use site in world
- Timber, pulp, paper, tissue processing
- > 4 PJ per annum



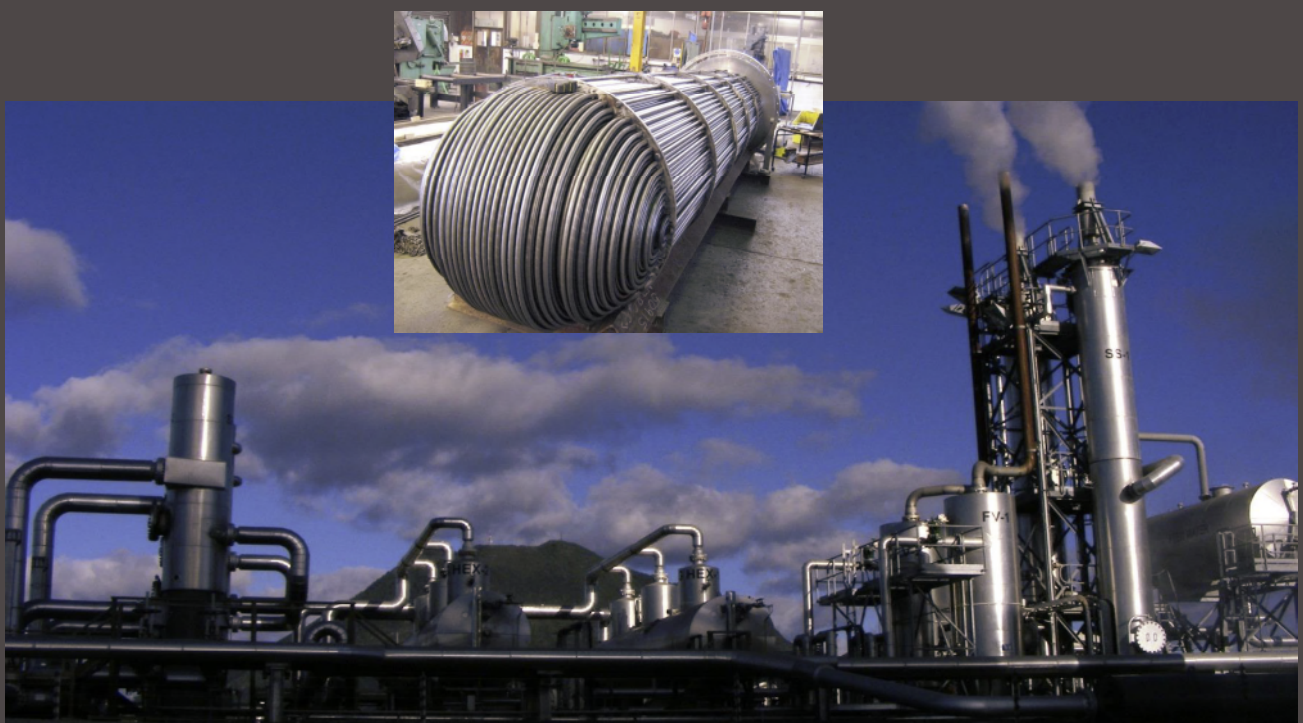


# Innovative

- Clean Steam from Geothermal Steam



# Clean Steam Plant Kawerau



# Integrating Geothermal Activities

- Tuaropaki at Mokai
- Farms
- Power Plant
  - 110 MWe
- Green houses
- Milk Processing facility
- Worm farm



[www.tuaropaki.com](http://www.tuaropaki.com)

# Geothermal Heat Pumps

- New Zealand is a technology adopter
- Unaware
- Raising Awareness
  - Heat Pump Association





# Geothermal Heat Pumps in Christchurch

- Post 2011 earthquake
- City energy nodes being established



## Christchurch Central City GHP Locations



At least 10 systems



# Direct Geothermal Case studies

earth energy: accessible; reliable; renewable

**case study 1**

## Tenon's Earth Energy Solution

By Lisa Lind (GNS Science), Lily O'Brien and Jo Bell



**Key Benefits:**

- Reduced running costs
- Increased productivity
- Renewable and eco-friendly
- Easy to operate
- Reliable

**Key Features:**

- Geothermal heat plant with an installed capacity of 27 MW to heat 6 timber drying kilns
- Commissioned in 2006

**GNS Science**

earth energy: accessible; reliable; renewable

**case study 4**

## Geothermal Energy Helps to Grow Prawns

By Lisa Lind (GNS Science), Lily O'Brien and Jo Bell



**Key Benefits:**

- Easy to meet required temperatures
- Controlled optimal growth temperature
- Economically viable

**Key Features:**

- Founded in 1987
- Aquaculture location receives geothermal water from an adjacent geothermal power station
- Supplies an estimated 2.5 tonnes of prawns to the park restaurant

**GNS Science**

earth energy: accessible; reliable; renewable

**case study 8**

## Geothermal Hot House for Gerberas

By Lisa Lind (GNS Science), Diane Bradshaw (GNS Science) and Jo Bell



**Key Benefits:**

- Geothermal energy provides heat to keep the temperature above the minimum essential temperature of 10°C
- Reduced cost for heating requirements

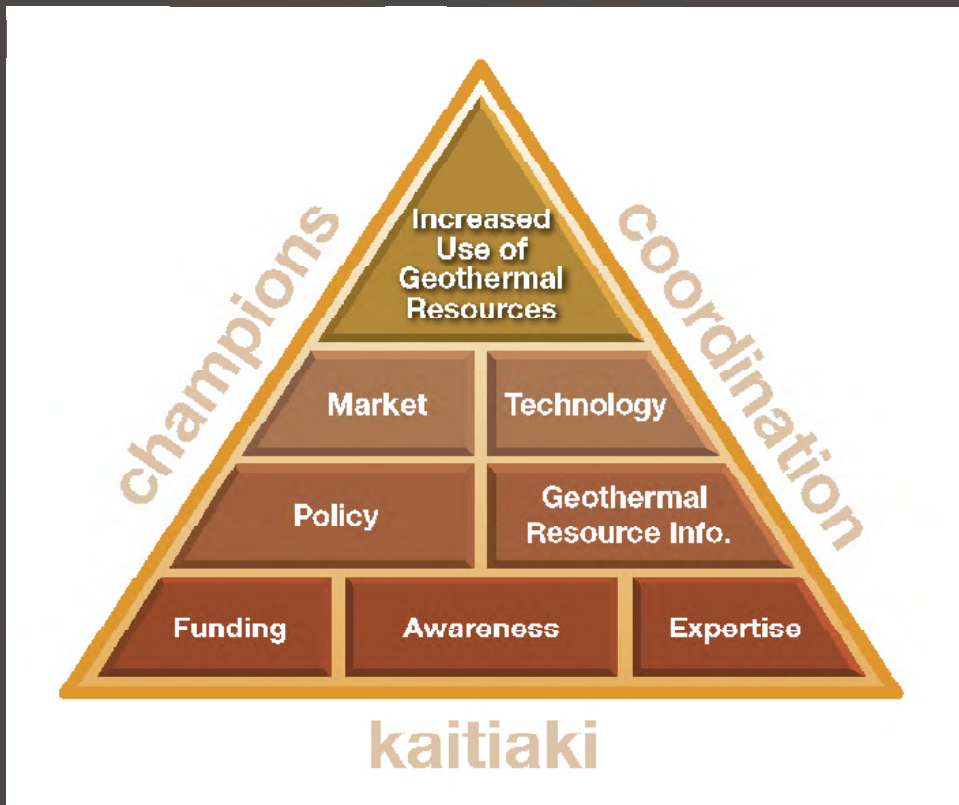
**Key Features:**

- More than 600,000 gerbera grown annually at PineryFlora
- Two geothermal bores are the main heat source for gerberas all year round

**GNS Science**

[www.gns.cri.nz/Home/Learning/Science-Topics/Earth-Energy/Case-Studies](http://www.gns.cri.nz/Home/Learning/Science-Topics/Earth-Energy/Case-Studies)

# Direct Use - GeoHeat Strategy



## Direct Use Strategy



- **Sponsor - New Zealand Geothermal Association**
  - Overarching National Strategy
  - Developed consultatively
  - 25 year plus horizon
  - Draft expected to be released end Qtr 1 2016
- **Being purposeful**

## Growing Direct Geothermal



# Kia Ora





Guillermo A. Narsilio, CGD & AI  
The University of Melbourne  
[narsilio@unimelb.edu.au](mailto:narsilio@unimelb.edu.au)

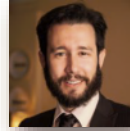
+61 3 8344 4659

Ian W. Johnston, CGD & AI  
[ianwj@unimelb.edu.au](mailto:ianwj@unimelb.edu.au)

+61 3 9035 8034

## Geothermal / GSHP systems for heating and cooling in Victoria

Ian Johnston & Guillermo Narsilio



### Melbourne - State of Victoria



#### Melbourne:

~4 M inhabitants

Latitude 37 South

Temperate

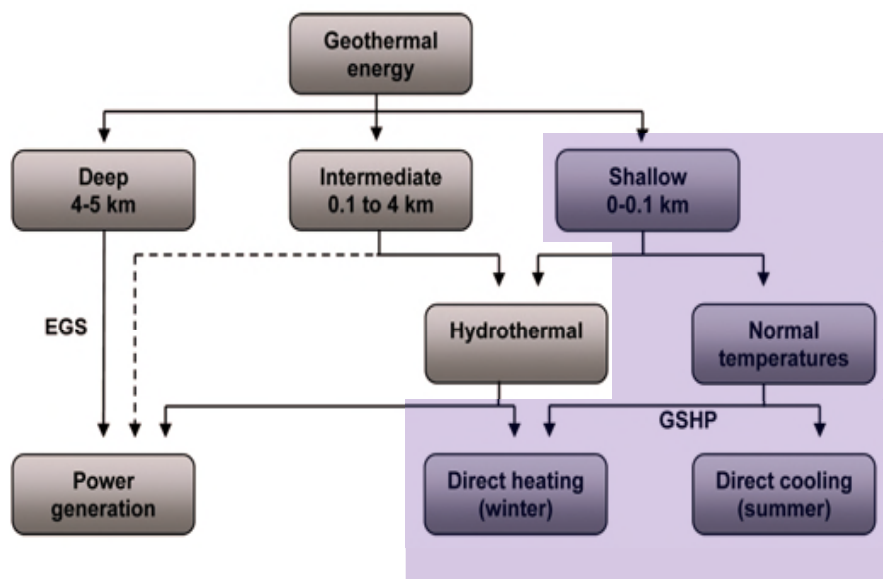


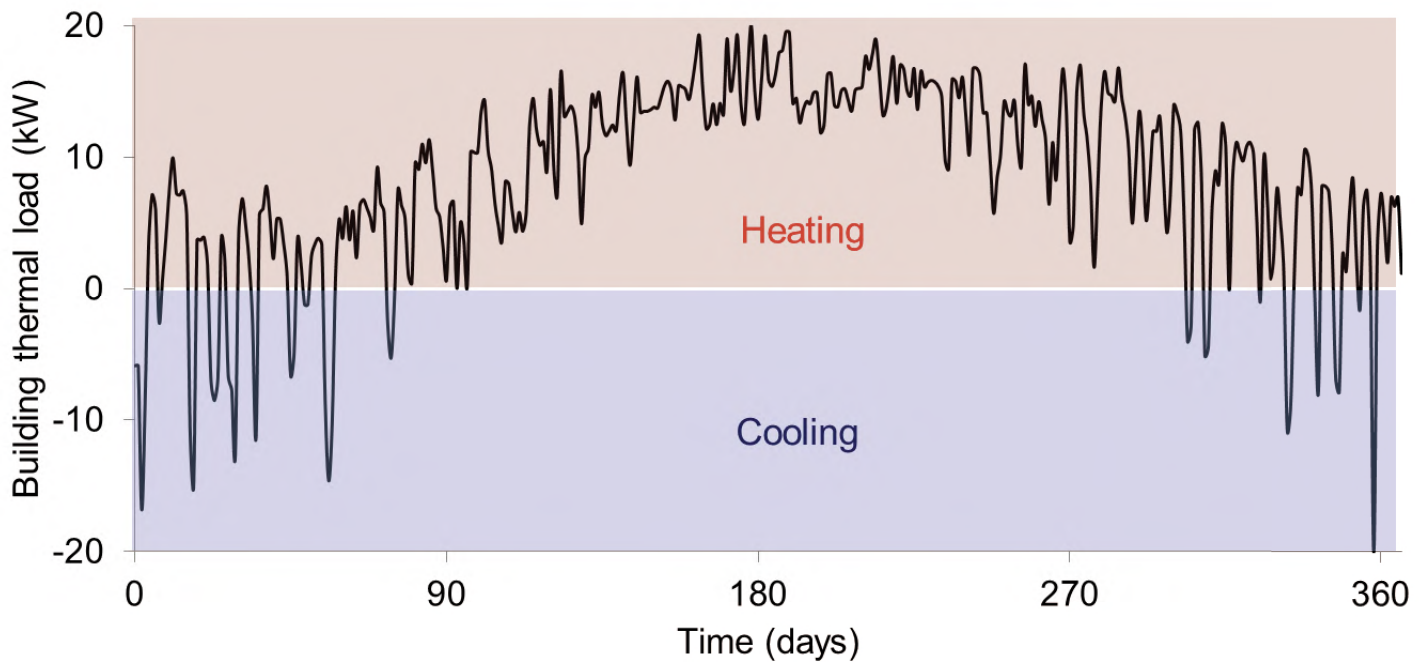
- Establishing the technology in Victoria
- Showing Casing
- Detailed Performance Monitoring of the Ground Heat Exchangers
- Analysis and modeling

Using the data to calibrate mathematical models

Reduce cost of GHE's

- Team of ten researchers at University of Melbourne
- Well connected with the industry





### Full Scale Pilot Projects

- Borehole heat exchangers at University and elsewhere
- Horizontal heat exchangers – other locations in Victoria

### Energy Pilot Demonstration Program – Government support

- Elizabeth Blackburn School of Sciences at University
- 20 to 40 residential-equivalent buildings

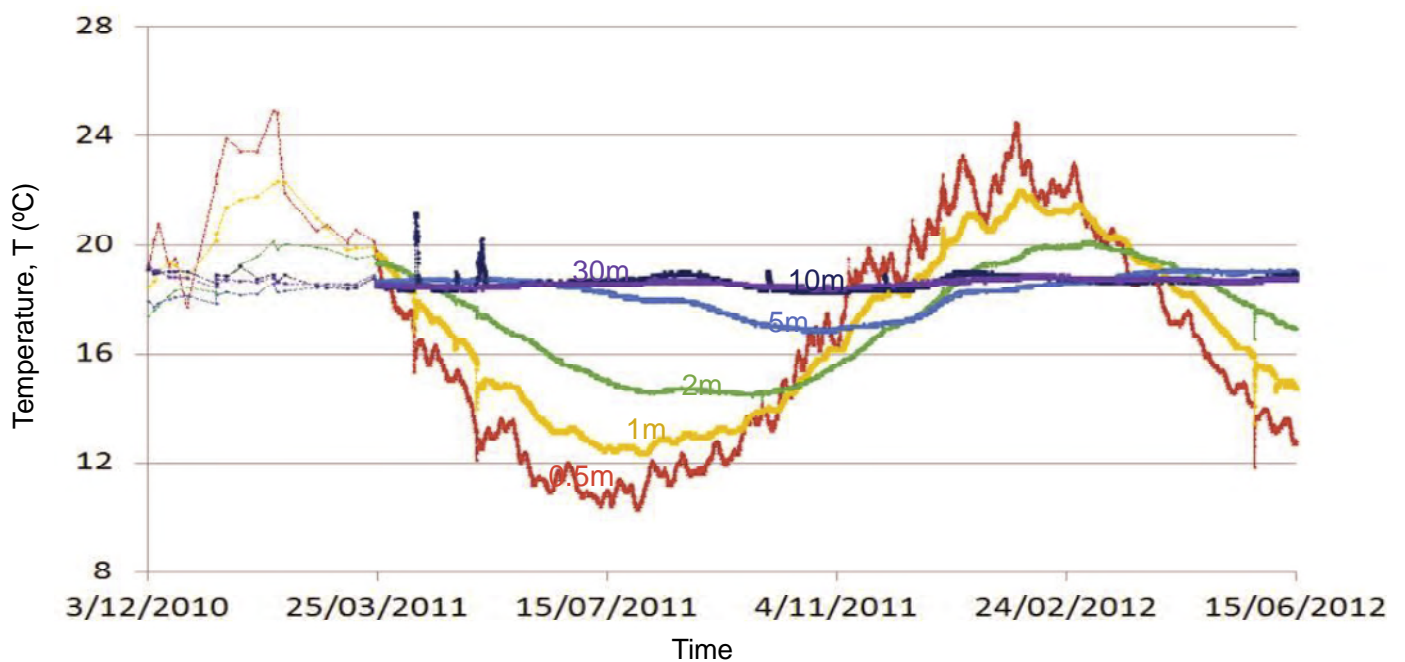
### Detailed 3D Numerical Models



Around Melbourne  $\approx$  25 systems  
in place

Ground temperature below 10 m  
typically 18 C

## Far field temperature with depth at UoM

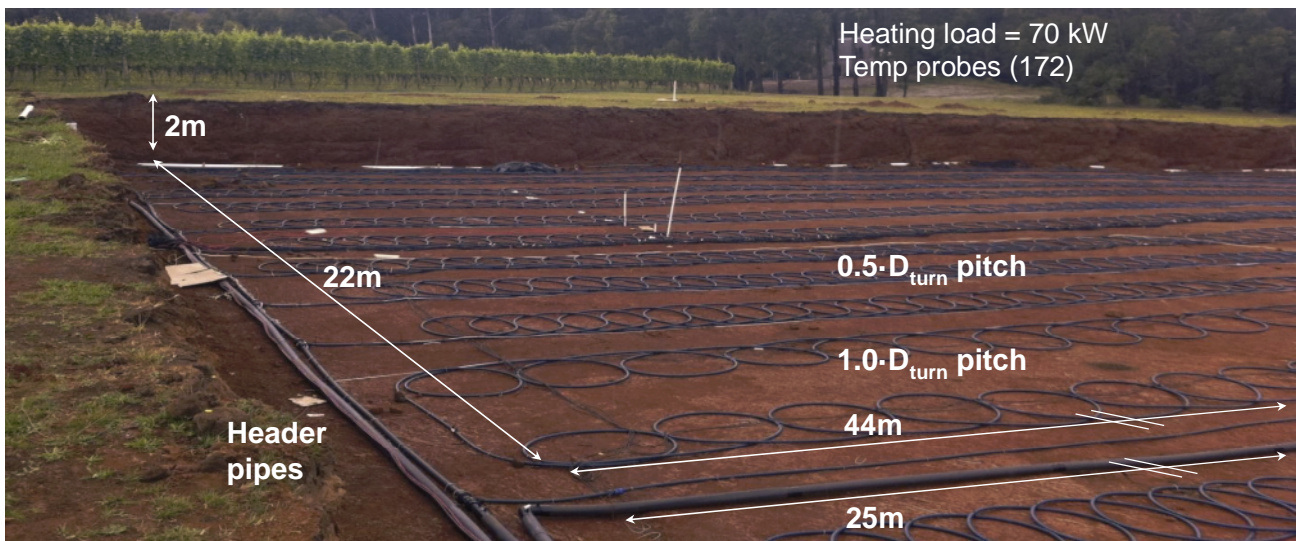




## Walter Boaz Building – UoM – 50m Vertical



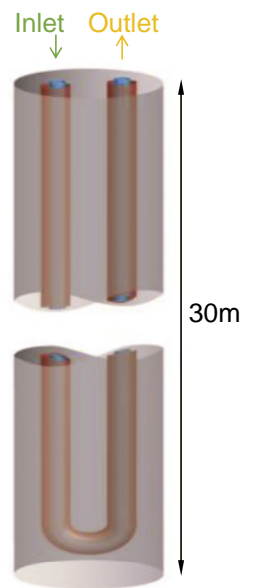
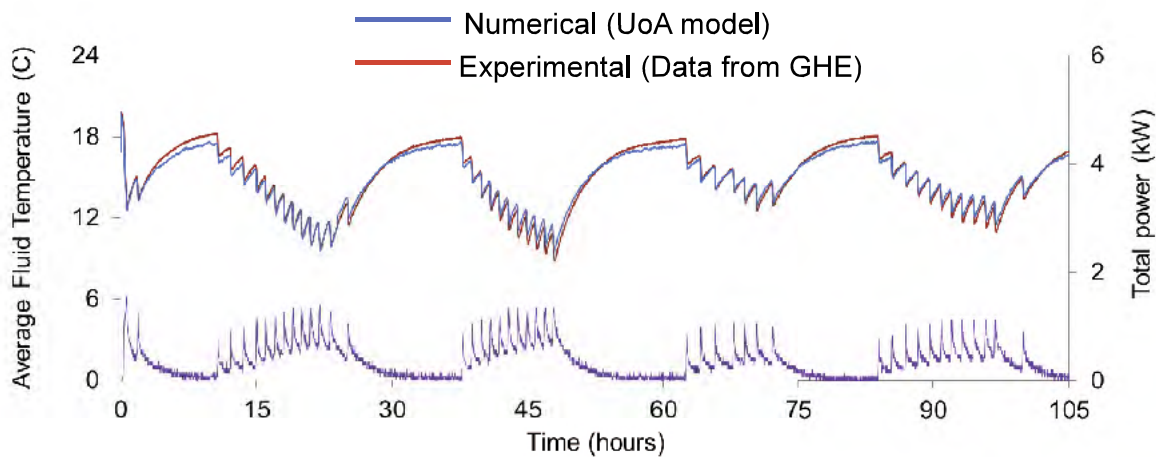
## Main Ridge – Mornington Peninsula



30m Energy Piles



Data from: Colls, S., Johnston, I., and Narsilio, G., 2015(?), "Observations from an experimental ground-source heat pump system", *Geothermics* (Under review).



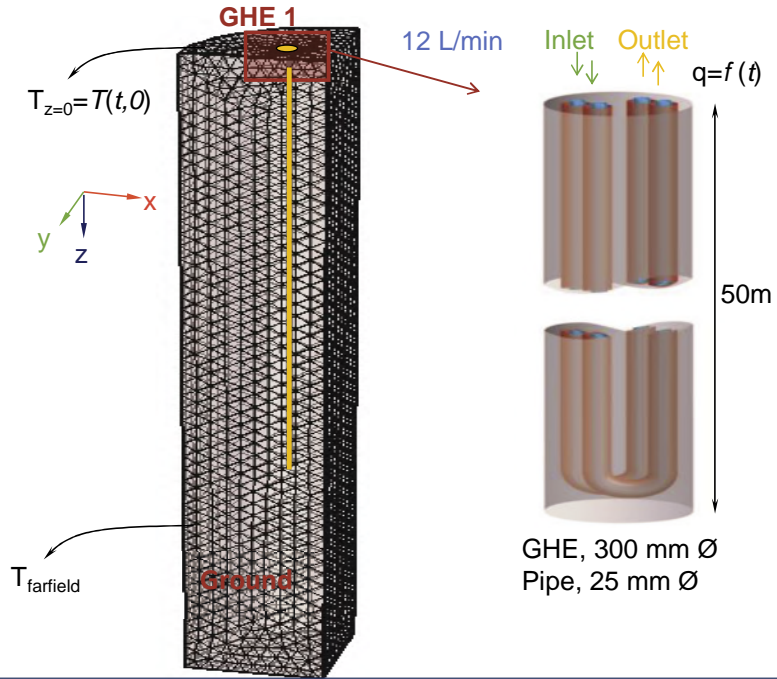
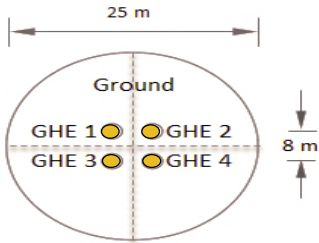
GHE, 125 mm Ø  
Pipe, 20 mm Ø





# Numerical Models

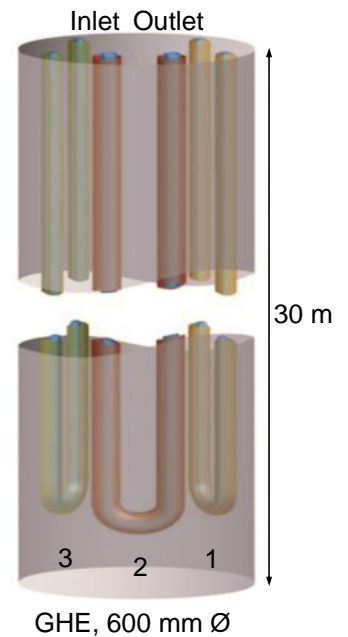
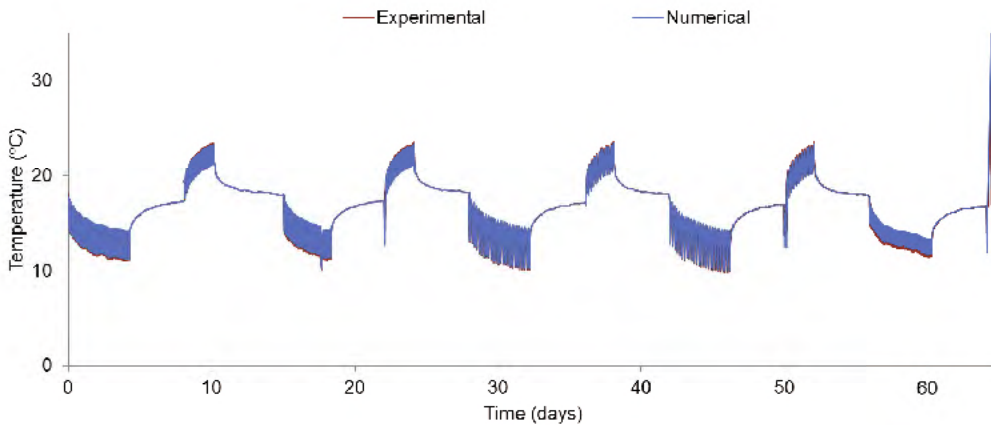
## Borefield with 4 GHEs x 50m



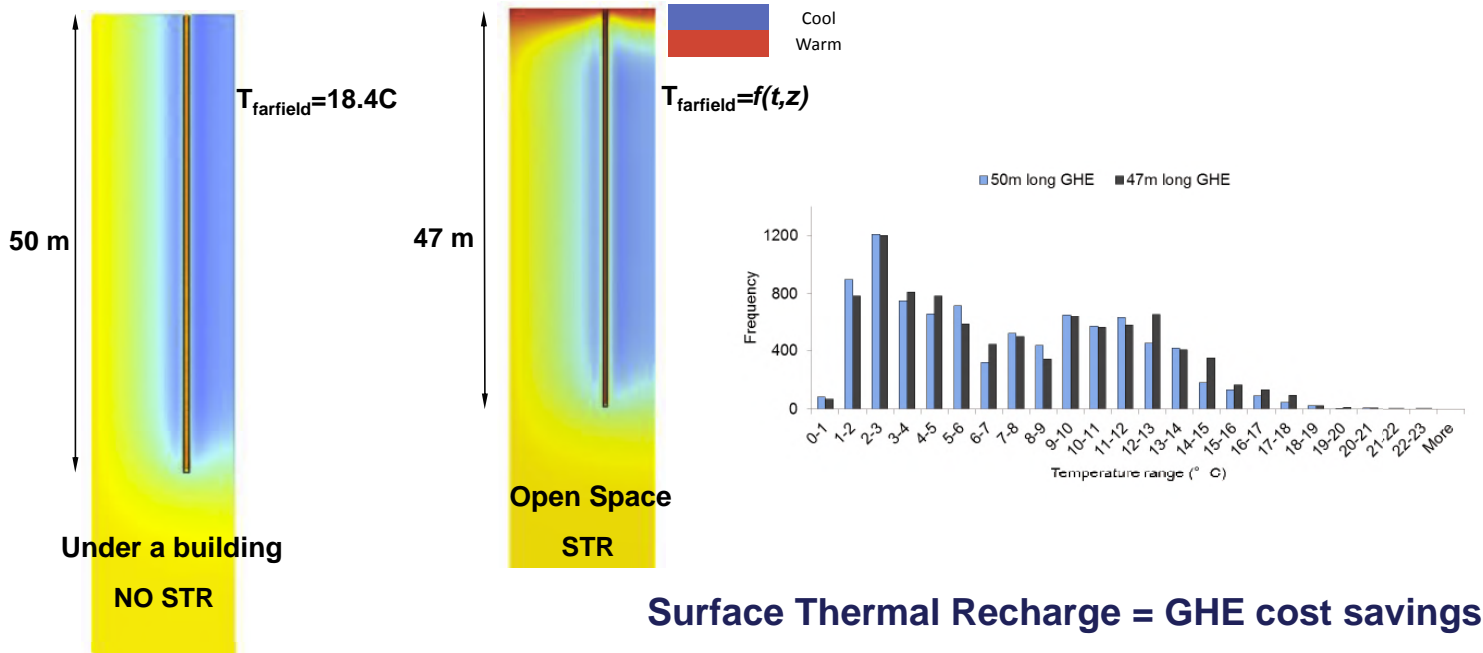
# Numerical Model Validation – 30m Pile Cage

$L_{GHE} = 30\text{ m}$   
 Flow rate = 6.9 L/min  
 $T_{farfield} = T(t,z)$   
 Pipe, 20 mm  $\varnothing$

Material	$k_m$ W/(mK)	$C_{p,m}$ J/(kgK)	$\rho_m$ kg/m <sup>3</sup>	Diameter m	Spacing m	Wall thickness mm
Soil	2.7	850	2,350	-	-	-
Pile (3 loops)	2.5	1,190	2,100	0.6	-	-
Pipe	0.4	-	-	0.02 ( $d_p$ )	0.105-0.23	1.84
Carrier fluid	0.582	4,180	1,000	-	-	-







10 Students written output will come

Theses are public

Two theses completed

Stuart Colls

Ground Heat Exchanger Design for Direct Geothermal Systems

Asal Bidarmaghz

Numerical Modelling

Papers are being produced



THE UNIVERSITY OF  
MELBOURNE

## Visionary Panel Discussion, Conclusions and Next Steps

### Iceland, Startup Energy Reykjavik - Alicja Wiktorja Stokłosa (GEORG)

**Title:** Business Success Story?

**Presenter:** Alicja Wiktorja Stokłosa is working for Orkustofnun National Energy Authority and GEORG Geothermal Research Group in Iceland. Past five years she has been involved in innovation and entrepreneurship development projects where she gained interested and experience in startup communities within renewable energy ideas. Her work interest relates to the new concept of financial possibilities in accelerating the geothermal energy technology projects.

#### Abstract

Startup Energy Reykjavik is a mentorship-driven seed stage investment program with focus on energy related business projects. Startup Energy Reykjavik was founded by [Landsvirkjun](#), [Arion Bank](#), [GEORG](#) and [Innovation Center Iceland](#) in December 2013. The program is facilitated by [Icelandic Startups](#) and [Iceland Geothermal](#). SER run a 10-week long program in Reykjavik, Iceland once each year and select the energy business ideas. Nominated companies or ideas get USD 40,000 in seed funding. Startup Energy Reykjavik participants also get great place to work, ten weeks of intensive top-notch mentorship, and the chance to pitch to angel investors and venture capitalists at the end of the program. There is immeasurable value in the mentorship-driven connections and advice that attendees receive with Startup Energy Reykjavik. The opportunity to pitch to angel investors and venture capitalists at the end of the program is provided during Investor and Demo Day.

[Back to the program](#) ↑



# Business Success Story?



**Startup Energy**  
Reykjavik

Alicja Wiktorja Stoklosa

## Outline



**Startup Energy**  
Reykjavik

- Startup Energy Story
  - Idea
  - Concept
  - Program
- Startup Energy Companies
  - Ideas
  - Work
  - Achievements
  - Fears
  - Benefits
- Startup Energy Innovation

# How the idea began?

Research  
Institution

Financial  
Institution

University

Power  
Company

Public  
authority

Innovation  
Center



# Startup Energy Reykjavik Concept

- Open to any energy startup ideas
  - 10 weeks mentorship & coaching
  - Network
  - Community
  - 60+ Mentors availability
  - Workspace
  - Powerful investors
  - Pitching to angel investors and venture capitalists
  - \$ 40,000 seed funding
- IN RETURN**  
10% equity to SER

# How we make it happen?

Begin cooperation between



*Icelandic Geothermal Research Group*



*Iceland's largest Power Company*



*Iceland's largest Bank*



*Icelandic Innovation Center*



*Facilitators: non-profit organizations*

# How we make it happen?

## Creating

The holding company  
**Startup Energy Reykjavik**

## Investing

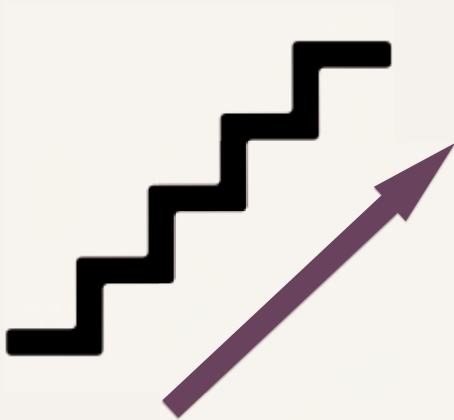
In new innovative ideas

## Proceeding

With mentorship and funding



# Stages



FORMING COMPANY

PROTOTYPE

RESEARCH PROJECT

IDEA

# What do we look at?



Does the product/service have the chance to compete on an **international level**?



Is the business model **scalable**?



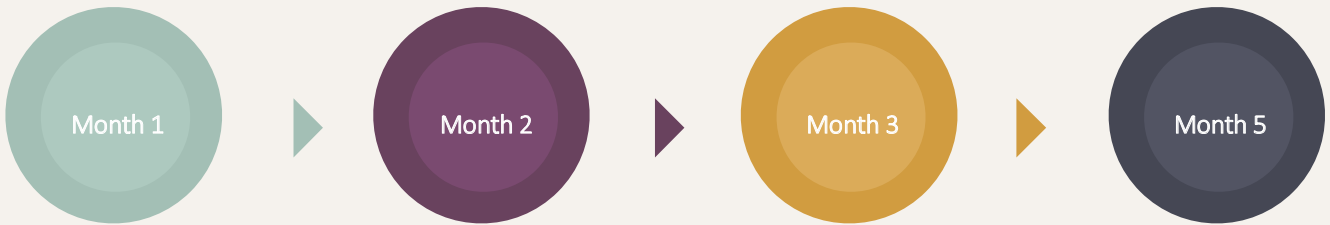
Is the business idea within the **energy sector** or related industries?



How well does the product/service **serve the needs or solve a problem** for a selected target group?

# How we make it happen?

The year of Startup Energy Reykjavik



1. Open for applications

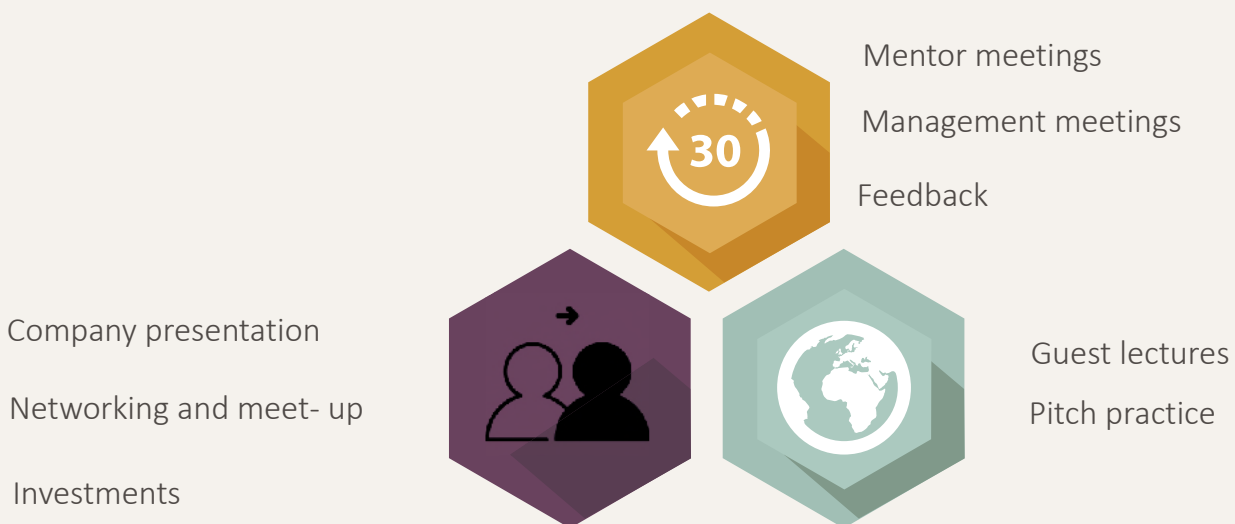
1. Close for applications
2. Choosing TOP finalists
3. Presentation of top teams
4. Feedback from Mentors

1. Kick off meeting 7 winning teams
2. Program starts 10 weeks

1. Investor Day

# How we make it happen?

The program gives opportunity:



# Geo Tech Companies



Landsvarmi



Eta-nýtni



Loki Geothermal



# Startups



- 1. Gerosion-** Casing materials for super- critical conditions in geothermal industry  
<http://gerosion.com/>
- 2. Landsvarmi-** Consultation in finance, sets up and operation of heat pumps for central heating of houses
- 3. GeoDrone-** Drones (UAVs) and remote sensing technology for geothermal industry  
[www.geodrone.is](http://www.geodrone.is)
- 4. Eta Nytni-** Small scale Sodium Chlorate production for export and more efficient use of energy.

- 1. Loki Geothermal-** Expanding gate valves for super-critical conditions in geothermal  
[www.lokigeothermal.is](http://www.lokigeothermal.is)
- 2. XRG Power-** Electricity generator from non- boiling geothermal water  
[www.xrg.com](http://www.xrg.com)
- 3. Keynatura-** Production of food, nutraceutical & pharmaceutical products from algae using Icelandic energy.  
[www.keynatura.is](http://www.keynatura.is)



# What do we look for

- Energy and Technology
- International possibilities
- Scalability
- Building knowledge & Business



Startup Energy Reykjavik Batch 2014



Startup Energy Reykjavik Batch 2015

# Contact



Startup Energy Reykjavik

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## **Conclusions and Next Steps -Paul Ramsak (RVO), Hjalti Pall Ingolfsson (OS) & Brian Carey (GNS)**

Paul Ramsak and Hjalti Páll Ingólfsson concluded the presentation sessions with an inspiring talk about the next steps of Geothermal ERA NET cooperation and through ERA NET Co-fund action called Geothermica, before moving to the closing, we had a discussion on the innovative thinking on the Future of Geothermal, which participants worked during the workshop.

Results of thoughts on the Future of Geothermal can be visible in [Appendix II](#)

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*Geothermal ERA NET - New Concepts  
Summary and Follow up*

Source: <http://www.geneve-tourisme.ch/>

*The window of opportunity is up on us...*

*Geothermal competitiveness*

*Emphasis on Energy Security*

*Paris Climate Change Conference*

Source: <http://www.geneve-tourisme.ch/>

# Geothermal ERA NET - New Concepts

## The Follow up

Publication – Proceedings

Geothermal ERA NET -Cofund



Geothermal EraNet Cofund Action

## Geothermica

continued cooperation

Creating a European research & innovation framework

- organize and pool national financial and human resources as well as national research infrastructures, **to accelerate research and innovation.**
- Building on relationships with industry and researchers and bridge the gap between research and the market with **innovative solutions.**
- Focus on what is often called “deep” geothermal energy.  
The scope includes the **integration of geothermal reservoirs into novel energy system concepts** (e.g. use of reservoirs for energy storage, CO<sub>2</sub> storage, integration with near-surface geothermal applications).





To be good at football you need a lot of practice from young age



## Iceland vs the Netherlands



Iceland won both matches



# Iceland vs the Netherlands

## What is the reason for this?



**But the main reason!!**



## Geothermal – of course !!!

**Geothermally heated** outdoor and indoor  
**football fields** are the key to success



## Appendix IV Meeting Minutes

Appendix IV presents meeting minutes from New Concepts joint workshop hold on November 30, 2015 by Geothermal ERA-NET partners and IEA Geothermal. The joint workshop on “New Concepts – the new and innovative applications of geothermal energy”. Document prepared by Ms. Gerdi Breembroek from RVO in the Netherlands.

### Welcome

On behalf of the organisers, Paul Ramsak (RVO), Katherina Link (Dr Roland Wyss GmbH), Gunter Siddiqi (SFOE) and Brian Carey (GNS Science) welcomed everybody to the meeting. The work of IEA Geothermal and Annex VIII on direct use, and the background of the workshop were briefly explained by Brian Carey. After that, Paul Ramsak explained the work of Geothermal ERANET and the aims for the workshop. It is about bringing together new ideas, inspiring each other with what is happening in geothermal throughout the world.

And as it is a workshop, there was a challenging task for all participants: drawing the future of geothermal, with the famous “vaxlitir” of the 100 year old Geneva-based firm “Caran d’Ache”.

Paul then introduced the moderator of the day, Þora Þorgeirsdóttir, living in Switzerland but with Icelandic and also geothermal roots.

### Session I: EGS projects + direct use applications

Peter Meier presented “EGS Projects of the Geo-Energie Suisse AG – the new concept”. The company is founded by 7 power providers with the aim of realising geothermal electricity generation in Switzerland. The company is looking for low-risk areas, and aims for small stimulated areas, as this most probably limits induced seismicity. The plans are now for a horizontal borehole with multiple stages, in project site Haute Sorne (Jura). Permits are in place, current planning is drilling in 2017/18.

Lászlo Adám of Mannvit presented the “South Hungarian EGS demonstration project”. This project was awarded NER 300 in December 2012. Besides administrative issues the project has looked into a suitable location and drilling methods. Alta Rocks TZIM technology is in focus. The project location will be full South-east Hungary; the project is now in the process of securing the land.

Martino Lacirignola of ADEME presented “ECOIGI – an EGS project for the industry in the Upper Rhine Graben”. This project that is in operation, supplies heat from Rittershofen to a starch processing industry. With 24 MWth, geothermal energy supplies about 25% of the total heat demand. There is 15 km transport pipeline. Induced seismicity is very intensively monitored.

During the discussion, Roy Baria of EGS Energy commented that he is sceptical about multiple stage stimulation. His experience is that in the end “one crack takes it all”. He complimented the work done in Rittershofen; especially how the experiences from (nearby) Soultz have really been used to advantage. Others commented that it is great that an industrial user has taken the initiative here. Then, a brief discussion on guarantee schemes evolved. A question to Peter, which packers he is planning to use? - There are many on the market, swelling packers might be selected, and “cement and shoot

through” is considered a last resort. How about the traffic light approach for induced seismicity?  
Comment from Peter: we used it in our risk studies.

### **Session II: Direct use applications (new concepts – built environment)**

The “Resource Park Reykjanes” was presented by Kristin Vala Matthíasdóttir. The philosophy of HS ORKA is to create a society without waste – instead of focusing on electricity only, the company recognises 7 resource streams, and is looking for more. As examples, warm seawater from cooling is used for fish farming; steam goes to fish drying companies; and CO<sub>2</sub> to renewable methanol and algae.

Matthias Kolb presented “Smart thermal grids”, in particular in Zürich, Switzerland. Utilising waste heat from industry – data centre cooling - to domestic heating, or waste heat from summer for heating in winter. Through thermal storage with earth probes, and heat pumps. The distribution temperatures in their networks are about 20-30°C.

Christian Hecht then showed the ambitions of München and Stadtwerke München, for “München 2040”. The city should operate on renewables, and for heating this means geothermal. München has district heating networks at three temperature levels. Changes to the old steam DH network will be necessary. There will be a 2D and 3D seismic campaign to better characterise the area. Drilling is already ongoing, as the next step in the right direction (Freiham, München).

René Verhoeven and Herman Eijndems presented “Minewater Heerlen – development of carbon neutral areas with thermal smart grids and geothermal”. They described the improvements to system control, from “Minewater 1.0” to “Minewater 3.0”. And the potential of seasonal (heat) storage.

The discussion first zoomed in on the resource park. The interdependency is high; how do they handle that? The system has been designed to address this issue. For example, the fish farm has a two-hour operating buffer. Kristin also mentioned that there will be a field trip to the resource park at the Conference next year. Then the discussion considered district heating in about 30-50 years. What will be the heat demand, will waste incineration still play a role then, what is the certainty that heat sources in the systems will still be there? Advanced thermal grids, multiple-source, multiple sink can be considered a risk mitigation in themselves.

### **Session III: Direct use applications (new concepts – other sectors)**

Adele Manzella reported on the VIGOR project, aiming to explore viable business cases for Southern Italy, solving local problems and creating jobs. Sludge drying with geothermal heat is an option. A process configuration with venting the warm air instead of recirculation is more cost effective. The idea is, that VIGOR makes the region ready for geothermal projects – a new round of operational funds is upcoming.

Henk de Beyer introduced a different perspective. He took the meeting into a discussion of the growing need for cooling; better insulation and increasing temperatures challenge the profitability of district heating. A growing number of European cities supplies district cooling. De Beyer developed the SOLABCOOL, which is modular (5 kW) and adapted to low temperature heat sources.



Philip Klingler presented the district heating system of the city of Oftringen. This is a system with seasonal storage – the hot well is charged during summer with heat from the waste incinerator. There will be a hot (between 60-90°C) and a cold well – the flow direction is reversed depending on the operating mode.

As the last speaker in the session, Ruggero Bertani made an inspiring presentation of the various uses of geothermal energy in Tuscany, for example in greenhouses and in food production. When it concerns waste heat from power plants, very small-scale applications such as a single cheese-making farm can successfully be supplied with geothermal heat.

The discussion considered the matching of resource and demand – geothermal is everywhere, but not in equal qualities; one could turn it around and locate heat-intensive industry where there is the resource. How about bringing tourists in Tuscany to those nice locations with flowers and great Italian food, and a Laguna Azura?

#### **Session IV: Innovative Applications of Geothermal Direct Use Worldwide**

Brian Carey presented the contribution of Arlene Anderson, in the absence of an internet connection to Arlene herself. Her presentation showed highlights of the development going on in the USA, both on low temperature applications (SALT – system analysis low temperature), but also about EGS systems.

Kasumi Yasukawa presented the ERIA project, on geothermal heating and cooling in Asia. China has become number 2 in the world for GSHPs; Korea boasts large (> 20 MW) district heating systems; for Japan, subsurface suitability is mapped – but in the tropical regions in Asia, for example Thailand, there is only a cooling demand. One should be looking for cool ground. In many areas, indeed the daily average temperature of the ground is lower than that of the air. This offers opportunities.

Brian Carey then presented highlights from New Zealand and Australia. New Zealand has high temperature geothermal resources, and Australia does not. Brian presented ongoing work, existing and new projects, and nearly-forgotten technologies to produce clean steam from geothermal.

The discussion very much went into cooling and balancing. A balanced system is desirable and easier operable. Another aspect is that cities become hotter because of air conditioning. So bring out the air conditioning and distribute the cool water. Absorption cooling can operate on heat instead of electricity. Also hot water supply can balance heating and cooling demand.

#### **Visionary panel discussion**

Alicja Wiktorja Stoklosa kicked off the visionary panel discussion, by showing how “Startup Energy Reykjavik” inspires young entrepreneurs to develop their businesses. And many of their ideas are related to geothermal.

So, how did the participants see the future of geothermal? Their drawn visions showed amongst others heat transport by chemicals; and simple, easy to use, away-from-tailor-made systems. Also, the visions showed a bright and loving future, with geothermal families, the warm heart of mother earth, and peace to the world from using indigenous resources.

The organisers/Paul Ramsak and Brian Carey wrapped up the meeting and thanked everybody for their input. Integration, use of indigenous resources, job creation, an open mind and a broad approach, those are some keywords that will help us realise that bright future.

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