Geothermal ERA-NET

New Concepts – New and Innovative Applications of Geothermal Energy

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

August, 2016

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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Table of Contents

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 Wiktoria 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 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.

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 vax 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, 30th 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 Eijdems (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 ***Þóra Margrét Þorgeirsdóttir***

Appendix I - List of participants

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

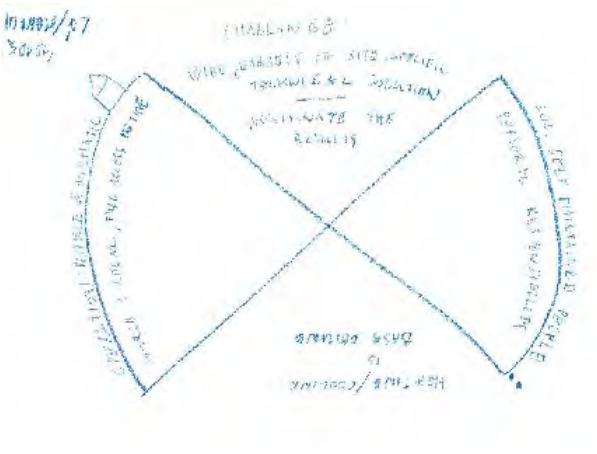
Surname	First name	Organisation / company	Country
Arndt	Dirk	Gruner AG	Switzerland
Baria	Roy	EGS Energy	United Kingdom
Bendall	Betina	Department Manufacturing Innovation Trade Resource and Energy (DMITRE), State Government of South Australia	Australia
Bertani	Ruggero	Enel Green Power	Italy
Breembroek	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
Eijdems	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

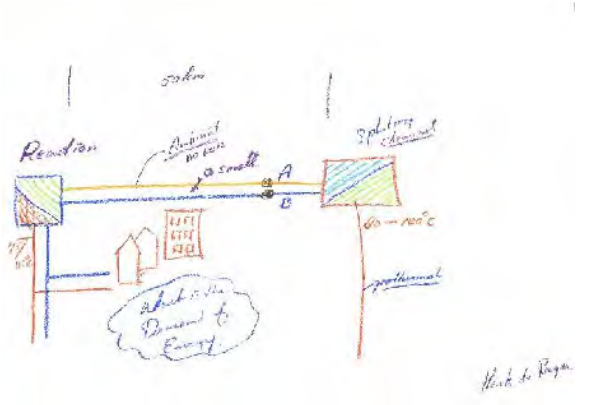
Kolb	Matthias	Amstein + Walthert AG	Switzerland
Lacirignola	Martino	French Environment and Energy Management Agency (ADEME)	France
Lapanje	Andrej	Geological Survey of Slovenia	Slovenia
László	Ádám	Mannvit	Hungary
Link	Katharina	Dr. Roland Wyss GmbH	Switzerland
Manzella	Adele	National Research Council (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	**L**eibniz **I**nstitute for **A**pplied **G**eophysics	Germany
Wissing	Lothar	Project Management Jülich (PTJ)	Germany
Yasukawa	Kasumi	National Institute of Advanced Industrial Science and Technology (AIST)	Japan

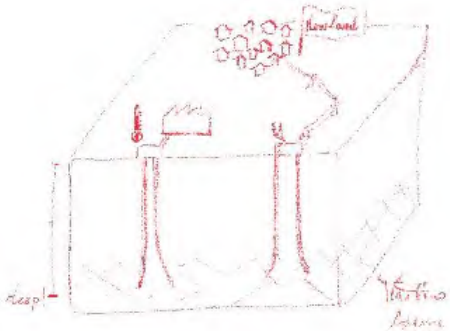
Appendix II- Drawings initiative /Innovative thinking

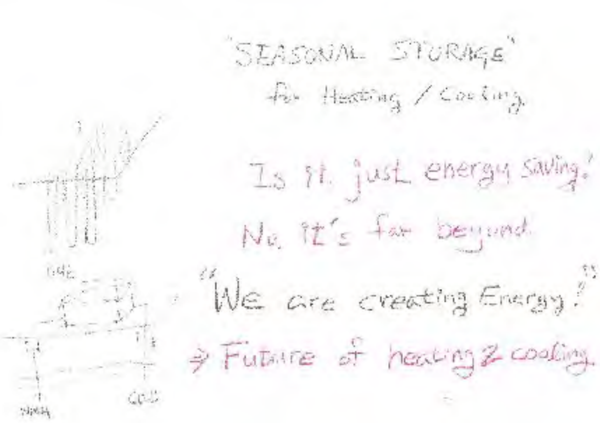
The Future of Geothermal Energy- how do you see it? It is time to present results of participants work during the workshop. Their drawn visions are spread among different solutions connected to the geothermal energy. It goes from peace and love to the world using indigenous resources, warm heart of mother 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





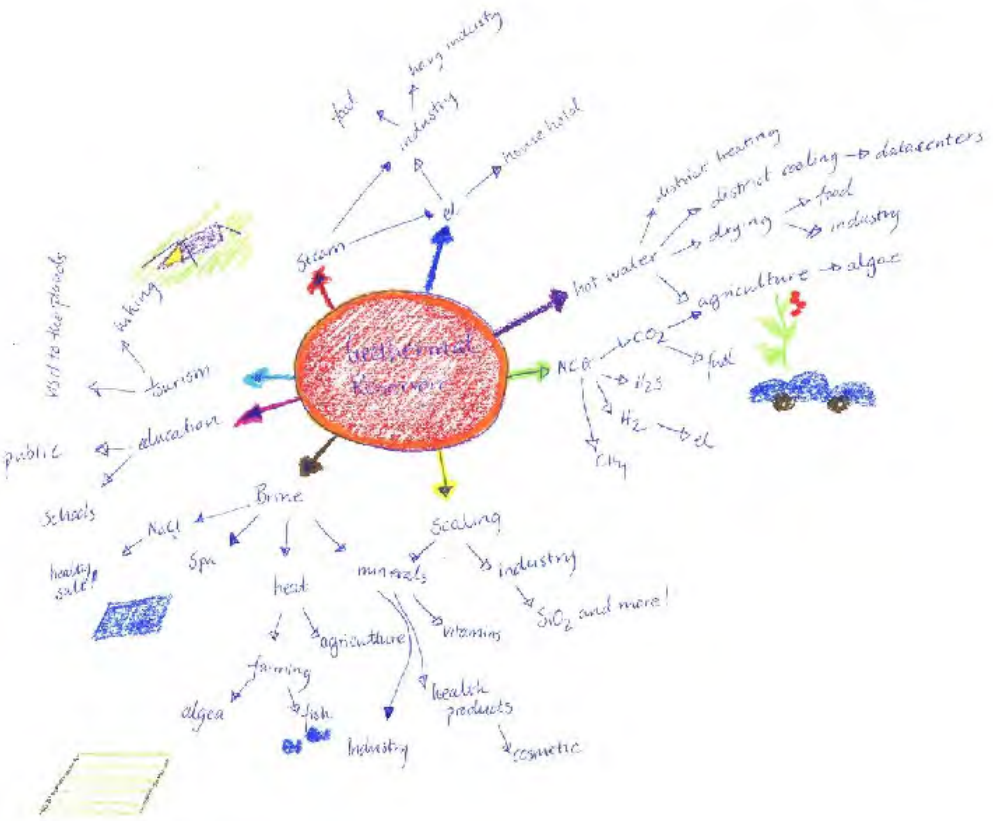


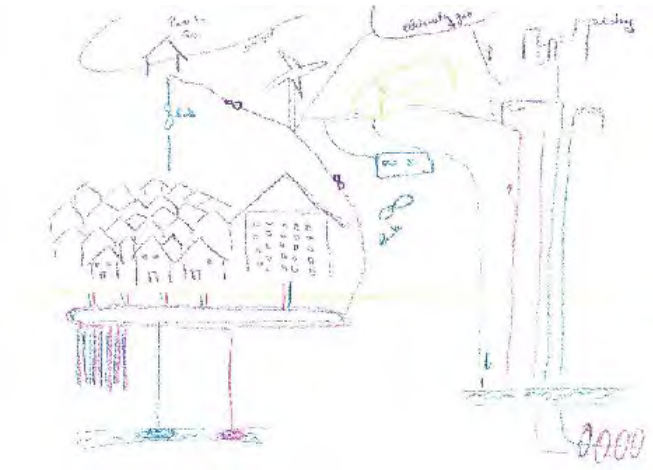

"SEASONAL STORAGE"
for Heating / Cooling
Is it just energy saving?
No, it's far beyond
"We are creating Energy!"
⇒ Future of heating & cooling

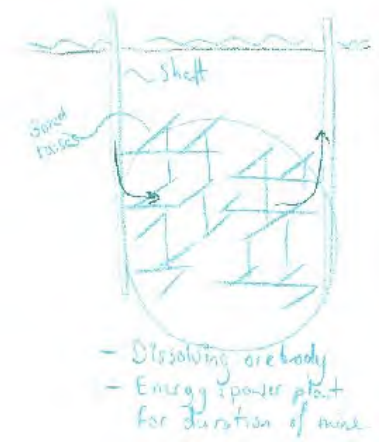

HEATING
SPA
HYBRID


World Peace
by geothermal
Liberte
Key: EGS & Direct Use
Imagine: if each nation can self-supply energy 100%....
No fight for energy resources!
Donna Nobis Pacem
Kasumi Y.

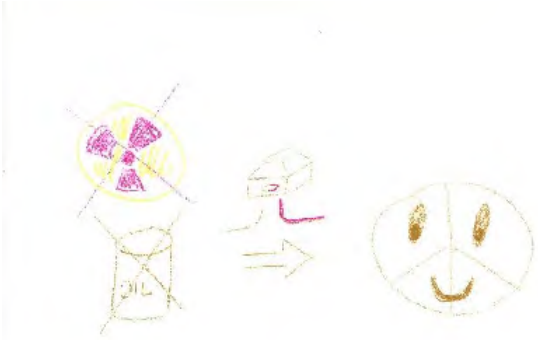
Kristin Vala Matthíasd
Iceland

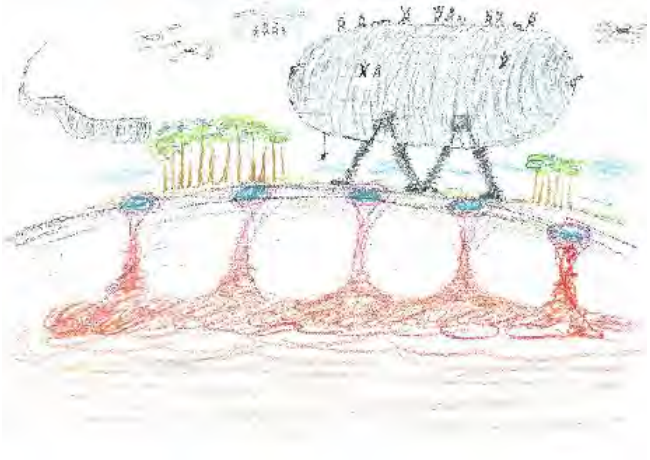


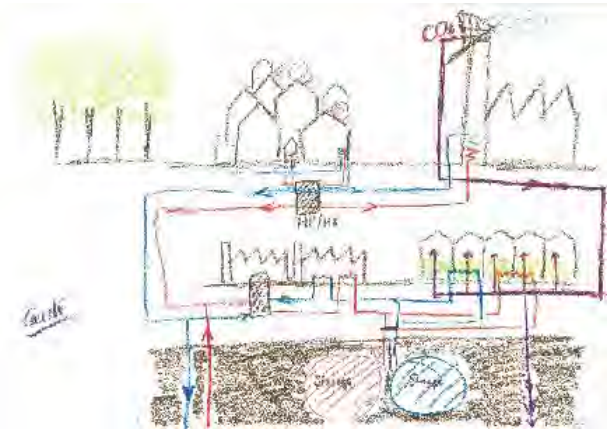


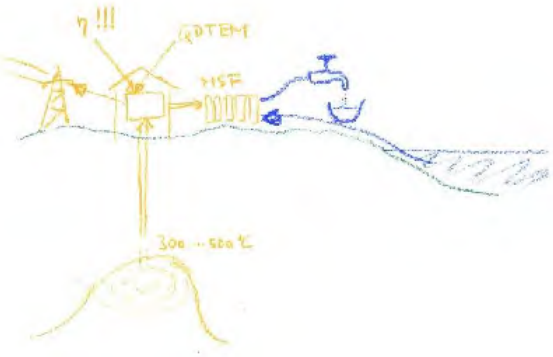


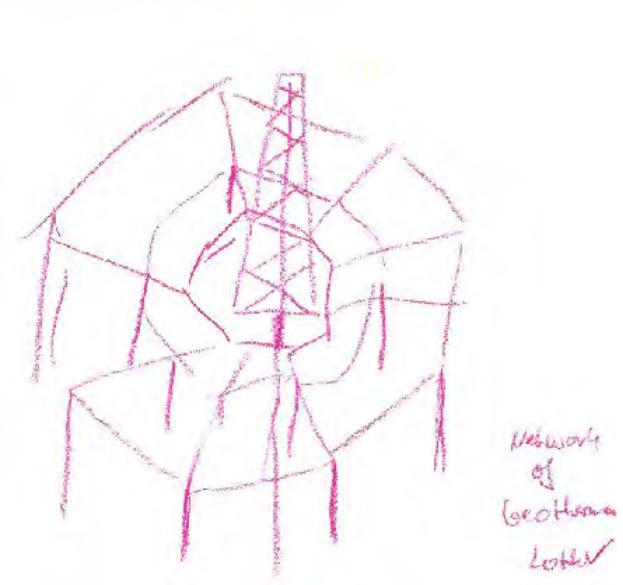

Brian Carey

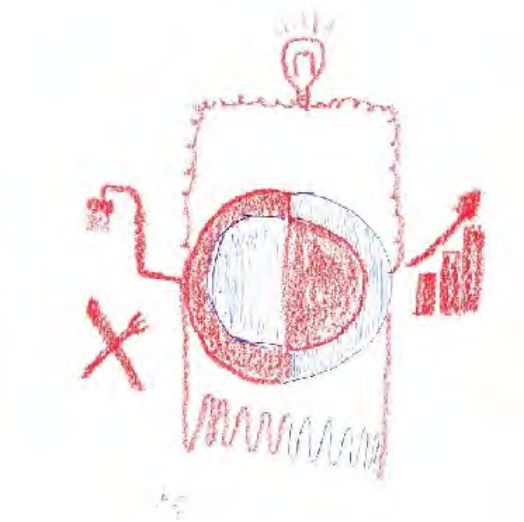


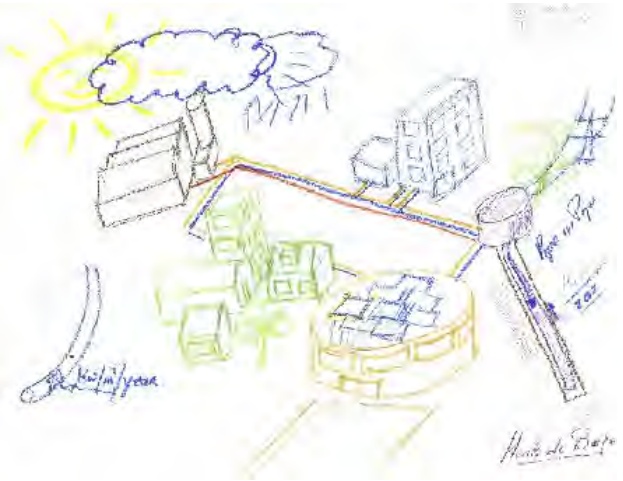


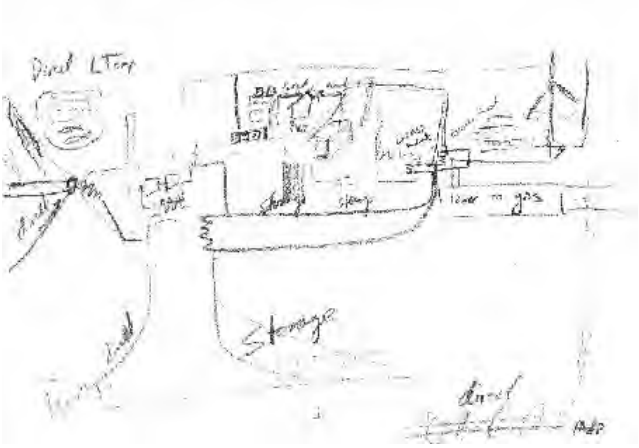



GOTEM









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 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.

Back to the program ↑

Netherlands Enterprise Agency

Geothermal ERA-NET

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

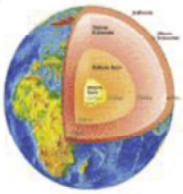
European Network Cooperation

Geothermal ERA-NET

Geothermal Energy

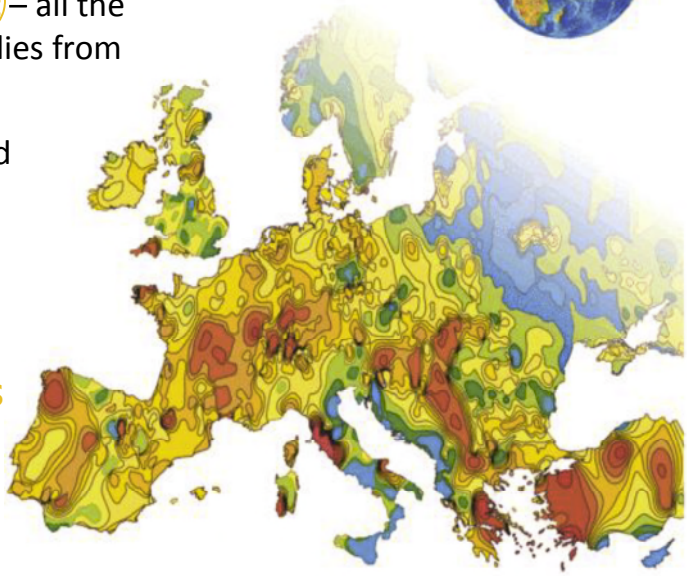
Geothermal Energy contributes to the Energy Union

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

The Geothermal ERA NET is supported by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 291866

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	Electicidade dos Acores

Cooperation between European (member) states

Geothermal ERA-NET

Ministries and National Agencies
programme owners & managers

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

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

Geothermal ERA NET

VISION

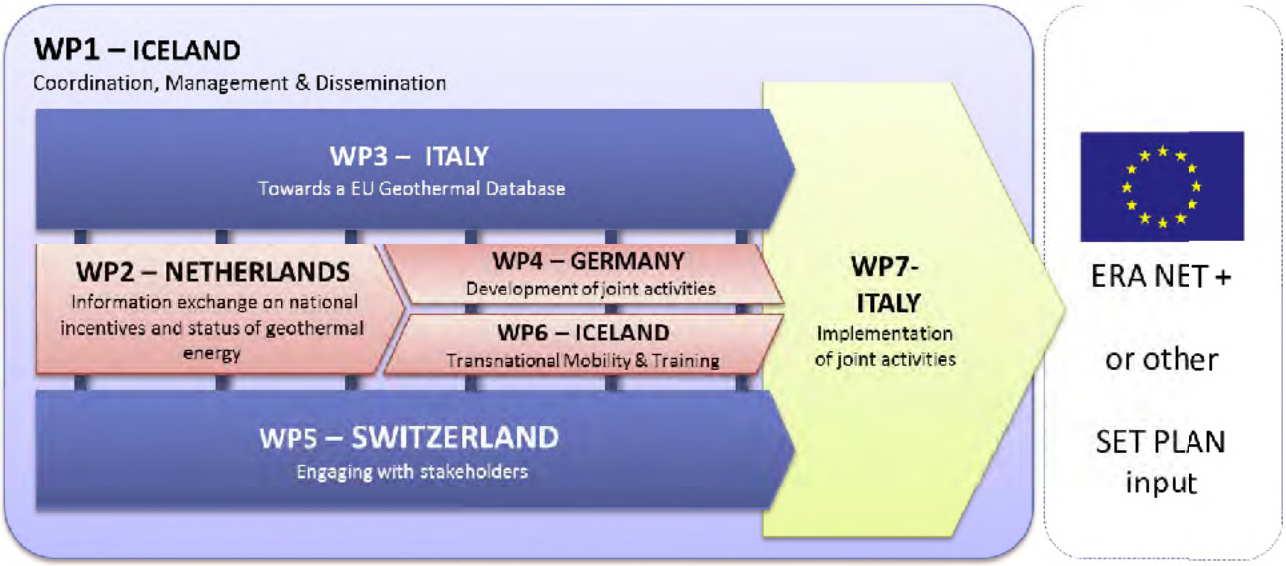
- *Minimize the fragmentation of geothermal research in Europe*
- *Build on European know-how and know-who to utilize geothermal energy*
- *Contribute to a framework to realise large opportunities in the utilization of geothermal energy through joint activities*

Three important EU pillars to strengthen the geothermal sector in Europe

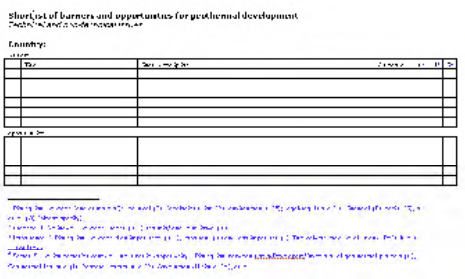
Industry | Public authority | Research

Geothermal ERA NET
Coordination Office
Orkustofnun, Iceland

Organisational structure / work packages

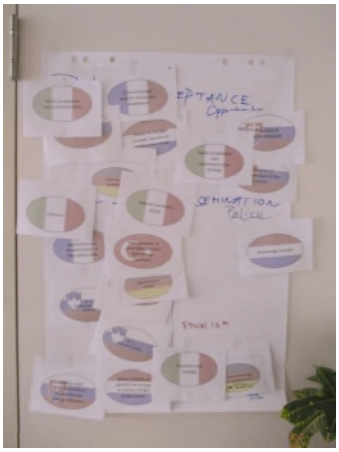


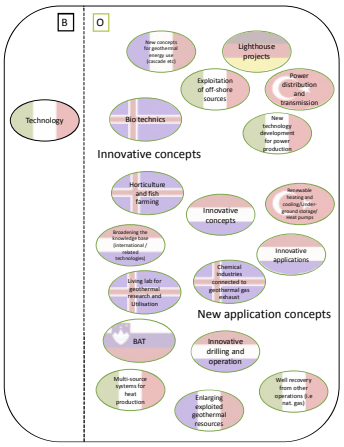
Technical & non-technical barriers & opportunities (task 2.2a CNR/RVO)



10-bullet lists
(per country)

clustering workshop





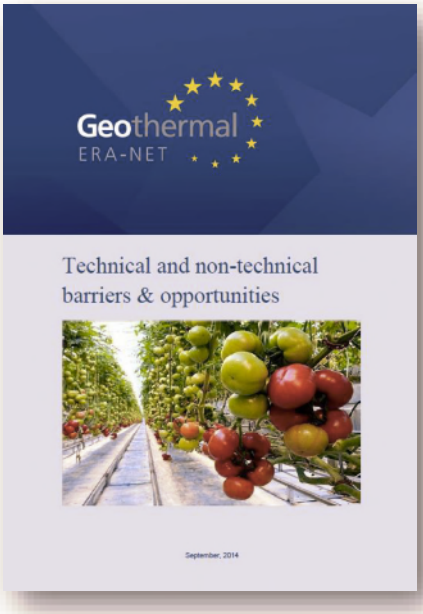
Report
(barriers & opportunities)

Technical/non-tech. barriers & opportunities

7 B&O clusters

A1 Regulations	
A2 Economics & risk-mitigation	a investment
	b operational support
	c 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	a public acceptance
	b visibility & dissemination
	c education and training

report
> ready
sep`14



RD&D needs

RD&D clusters

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

report
> ready
sep'14

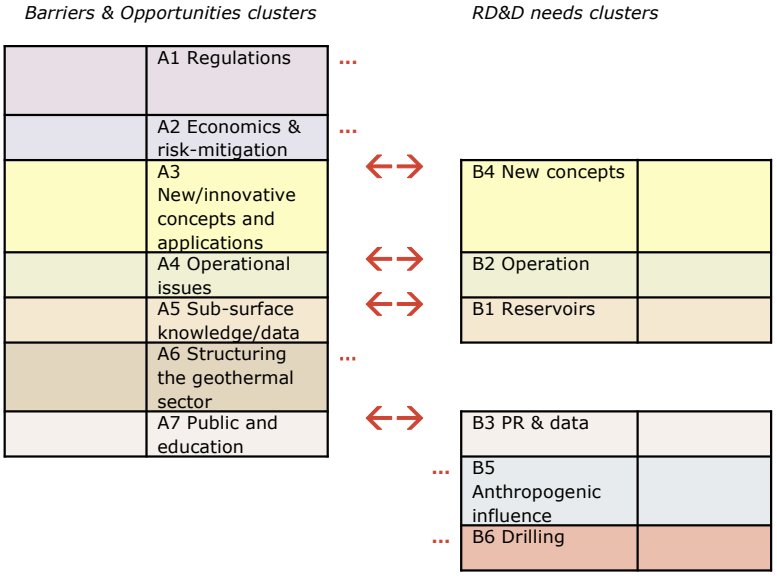
Propose (joint) actions
to bridge gaps, overcome barriers and promote the use of geothermal energy in Europe (task 2.2c RVO)

> ready nov '14

> basis for wp4:
development of joint activities

> All reports available on:
www.geothermaleranet.eu

Common Challenges in Geothermal EraNet countries



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?

JA1 Information exchange (groups)

regular meetings, workshops, visits, idea factories, etc.:

JA2 Joint work

Joint assignment: detailed study on specific issue

JA3 Joint call

Jointly developing new insights, new systems

- 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

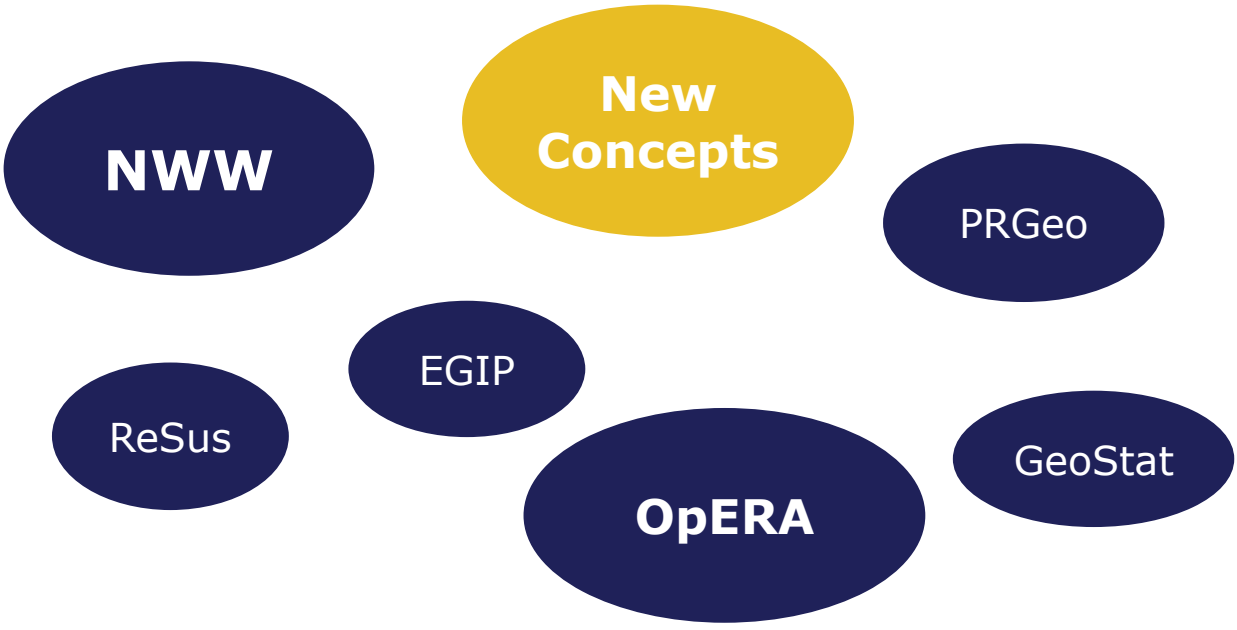
How to start/organise joint activities ?

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

At least two countries to take the initiative

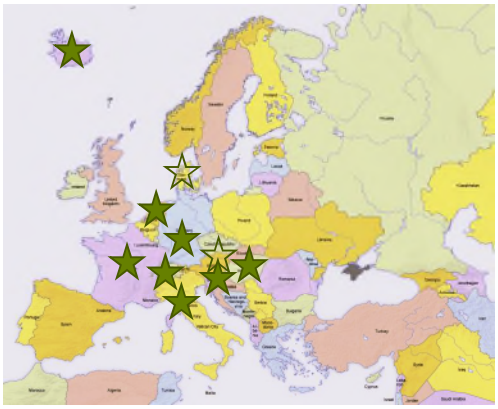
The Geothermal Era Network as a continuing vehicle to launch JA's !

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)
  - …

Common Challenges in Geothermal EraNet countries

Barriers & Opportunities clusters *RD&D needs clusters*

	A1 Regulations	...		
	A2 Economics & risk-mitigation	...		
	A3 New/innovative concepts and applications	↔	B4 New concepts	
	A4 Operational issues	↔	**B2 Operation**	
	A5 Sub-surface knowledge/data	↔	B1 Reservoirs	
	A6 Structuring the geothermal sector	...		
	A7 Public and education	↔	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)

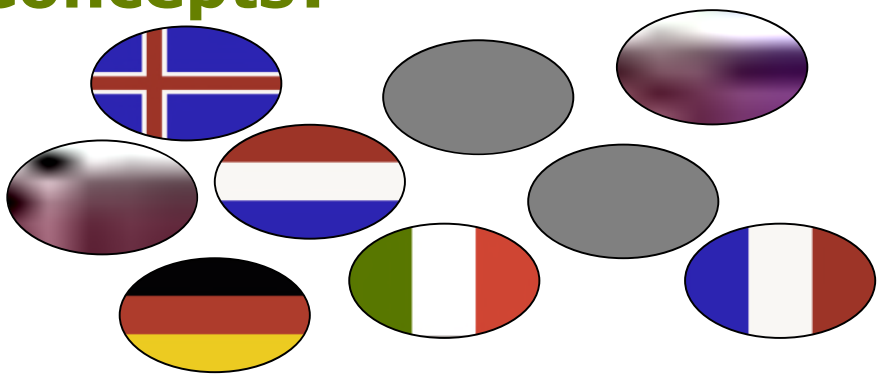
All clusters are relevant for the progression of geothermal energy in Europe

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

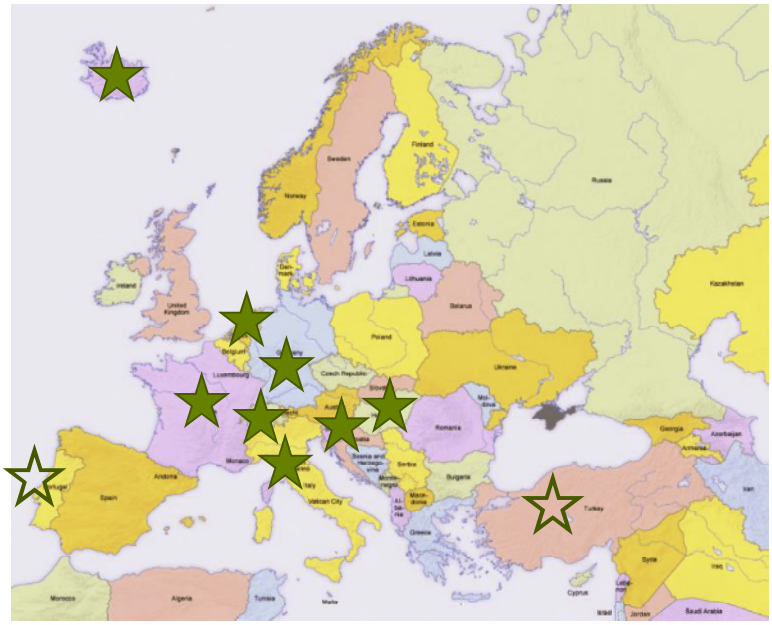
Coordination

IS + NL

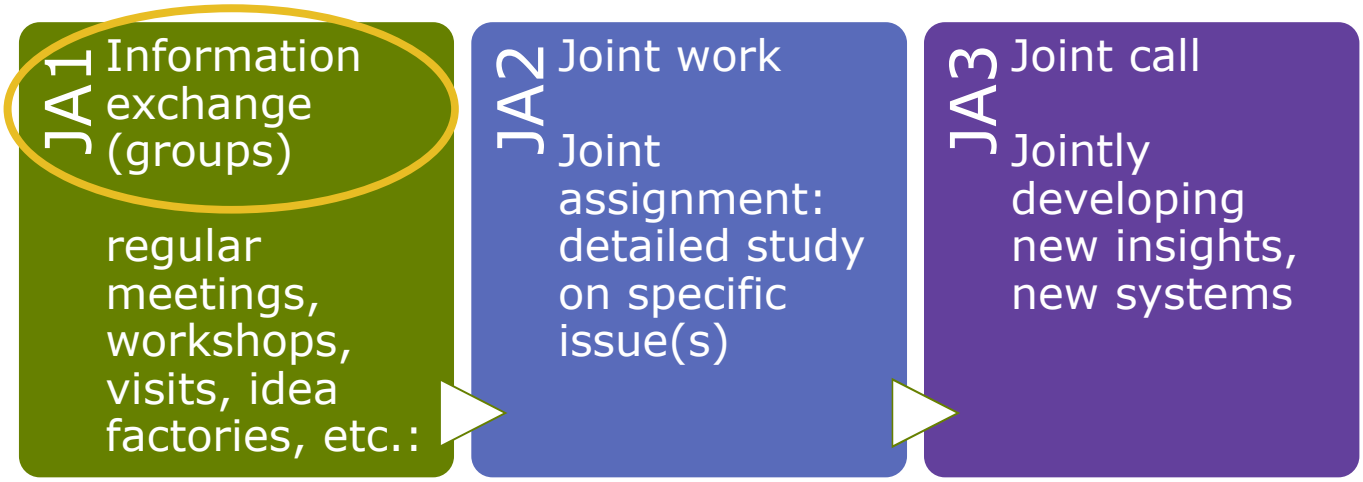
EraNet Partners

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, CO2 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 ?

Your tools

vaxlitir

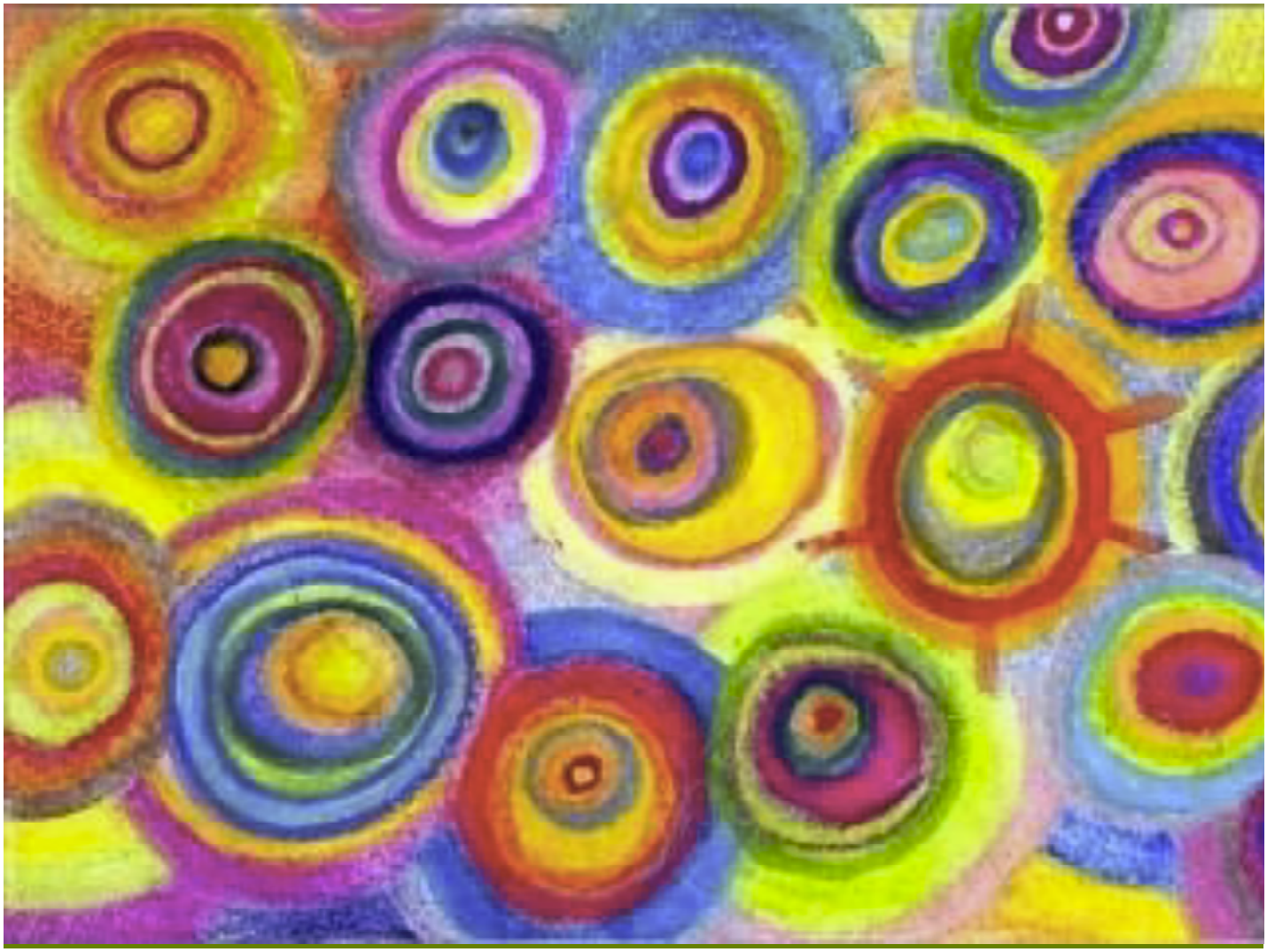
Your instructions

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

Welcome & Introduction

I EGS + Direct Use

Break

II Built Environment NewCon

Lunch

afternoon 13:45-19:00

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, 30th 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	*IEA Geothermal + Annex VIII – Brian Carey*
		(Secretary and Annex VIII Task Leader, IEA Geothermal)
	8:55 - 9:10	*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**	
	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 Ádám (Mannvit)* **What are the challenges and new concepts in South Hungarian Enhanced Geothermal System (EGS) Demonstration Project?**
	9:50 - 10:10	*France – Martine Lacroignois (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/ 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 Eijdems (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/civil processes (title TBC)**
	14:05 - 14:25	*Netherlands – Henk de Beijer (SolarCoolM)* **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 Ottringen)**
	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, 30th of October 2015:

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 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

Geothermal ERA-Net project is supported by the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 291866

Geothermal ERA-NET

Your New Concepts Moderator

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Þorgeirsdóttir

Contact Geothermal Energy
leader WP2 Information Exchange

NL Enterprise Agency
Geothermal ERA-NET

www.rvo.nl/aardwarmte
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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**

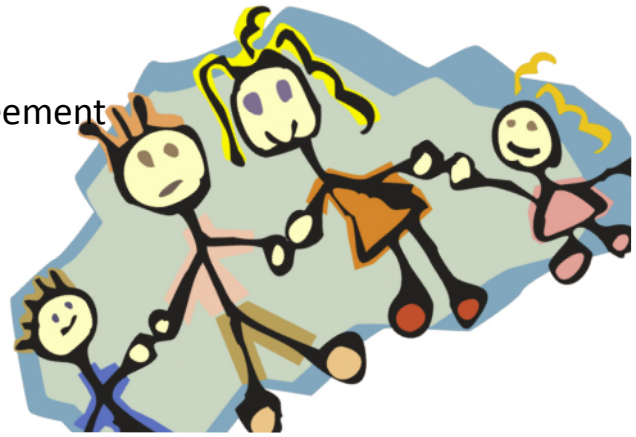
Geothermal at Heart

- 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

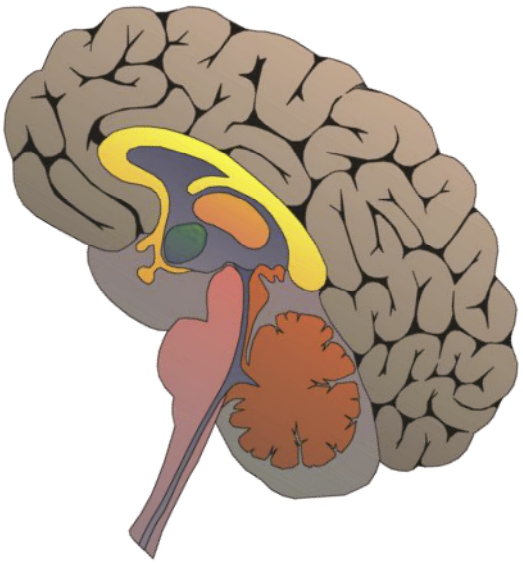
Technical Activity

- **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

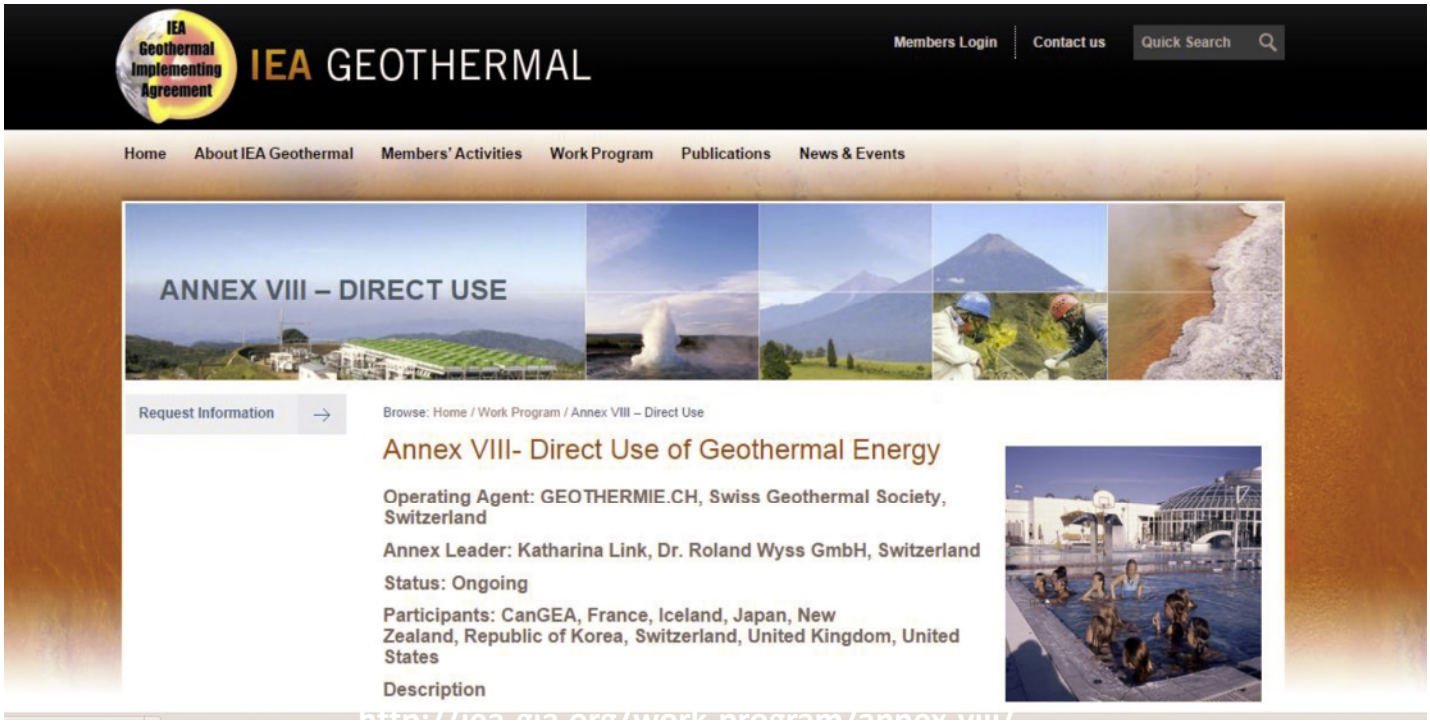
Great Information

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



Direct Use - Annex VIII

Includes Geothermal Heat Pumps



Direct Use

Lead by Katharina Link

Dr. Roland Wyss GmbH, Switzerland

Email: 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

Todays 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 trough 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: 1st Phase: 2016-2018, 2nd Phase: 2018-2019, 3rd Phase: 2019-2020.

Back to the program ↑

Swiss centre of competence for deep geothermal energy for power and heat production

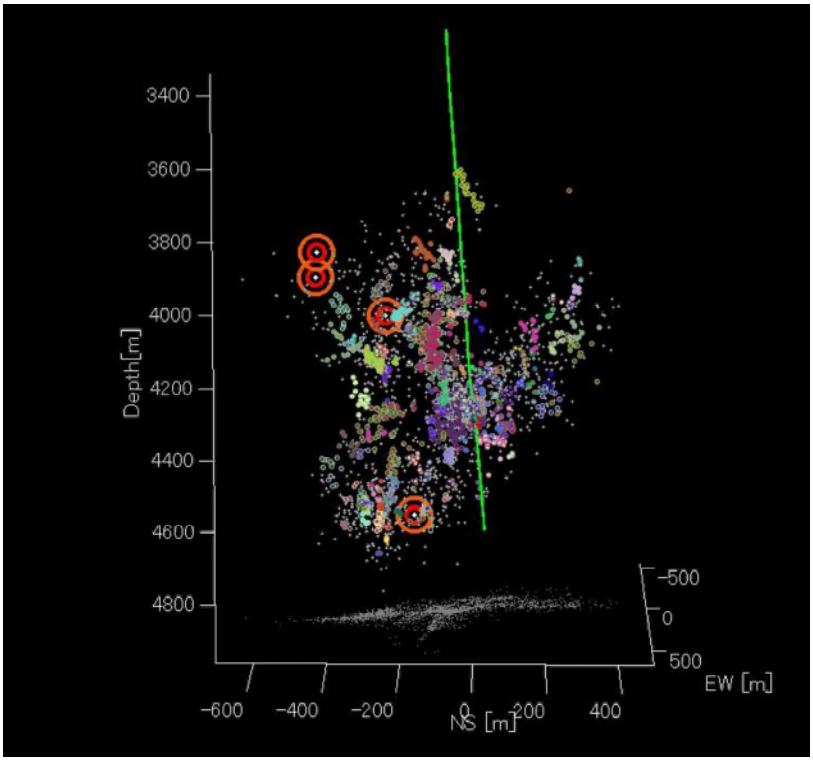
GEO ENERGIE SUISSE

MULTI-STAGE EGS HAUTE-SORNE PROJECT

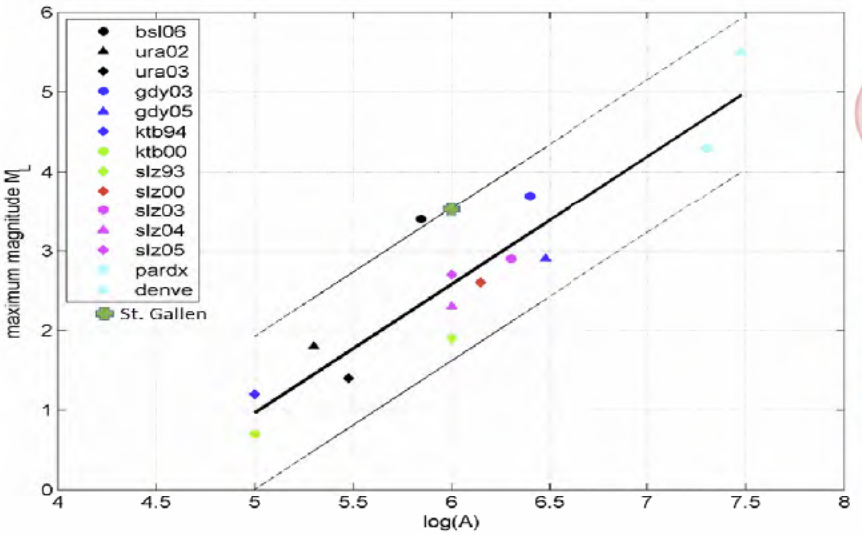
DR. PETER MEIER, CEO

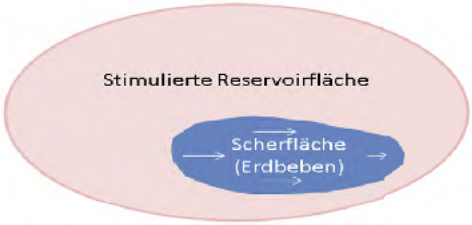
GEOTHERMAL ERA-NET NEW CONCEPTS PROGRAM, GENEVA 30.10.2015

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



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

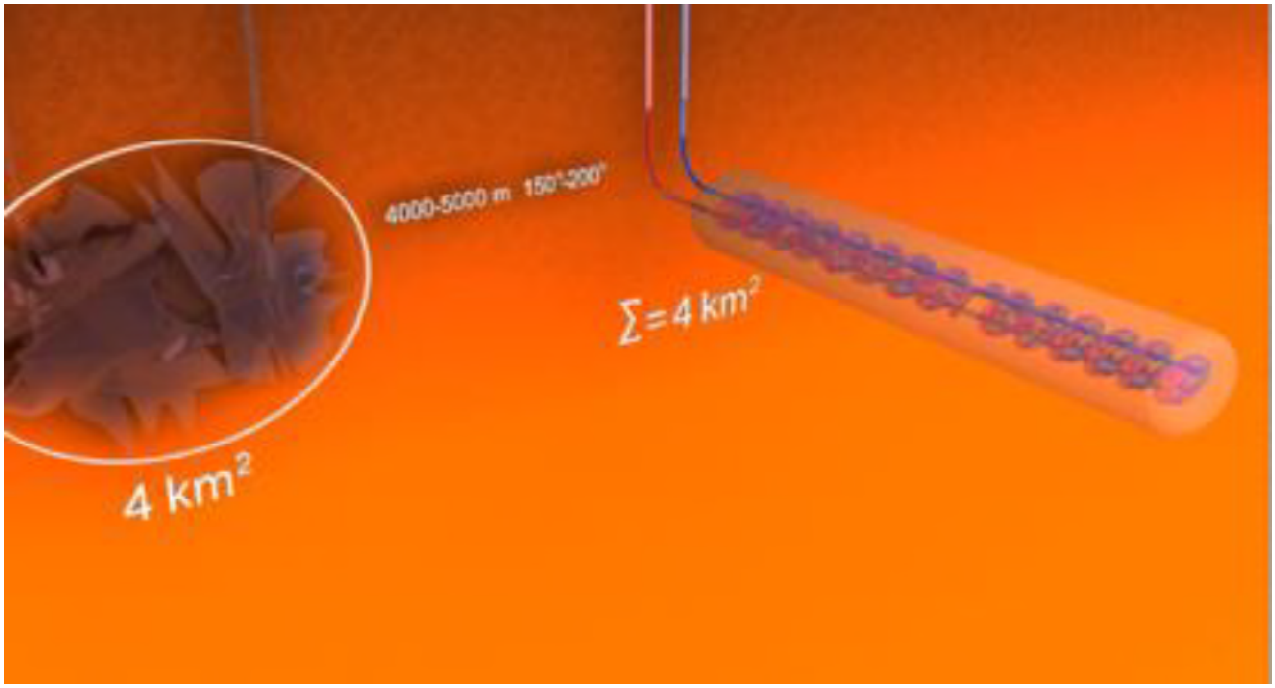




Nach St.Gallen: Stimmt unser Konzept?

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.

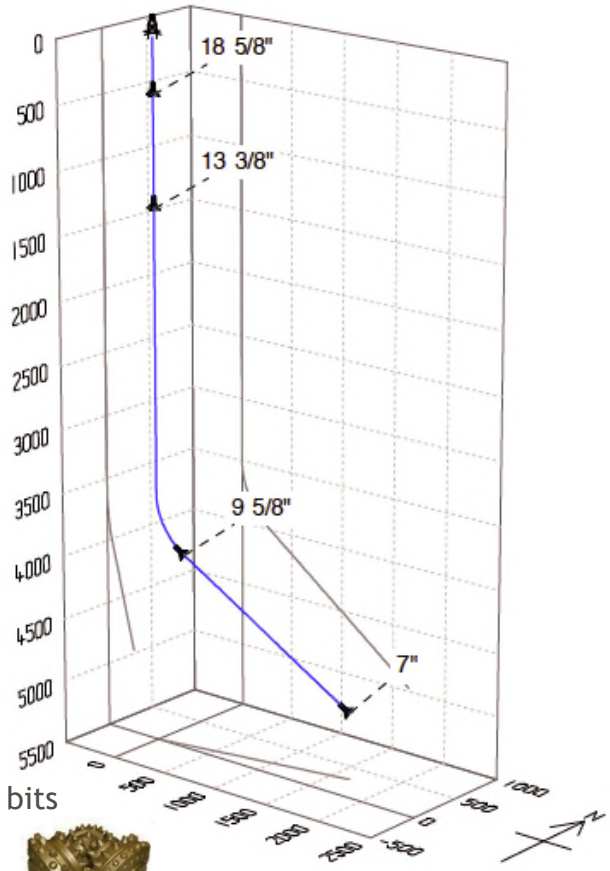
Concept DHM Basel vs. „new“ horizontal multi-frac system



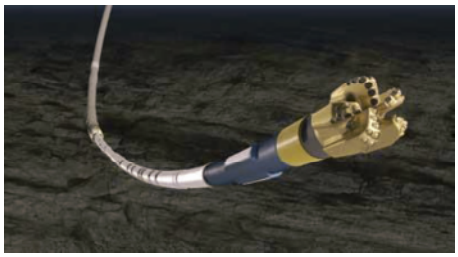
Drilling

Weight on Bit

PDC bit

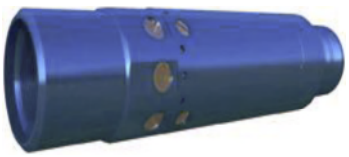


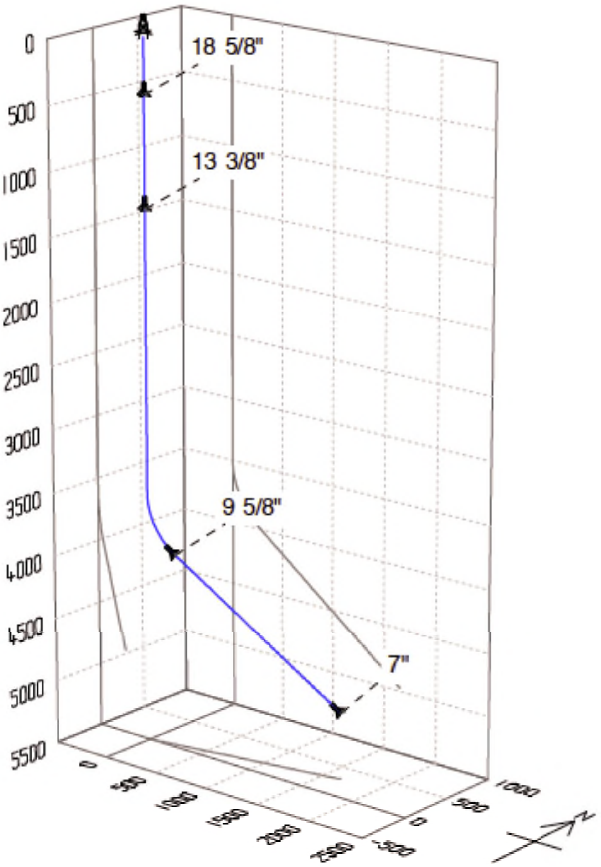
Rotary steerable



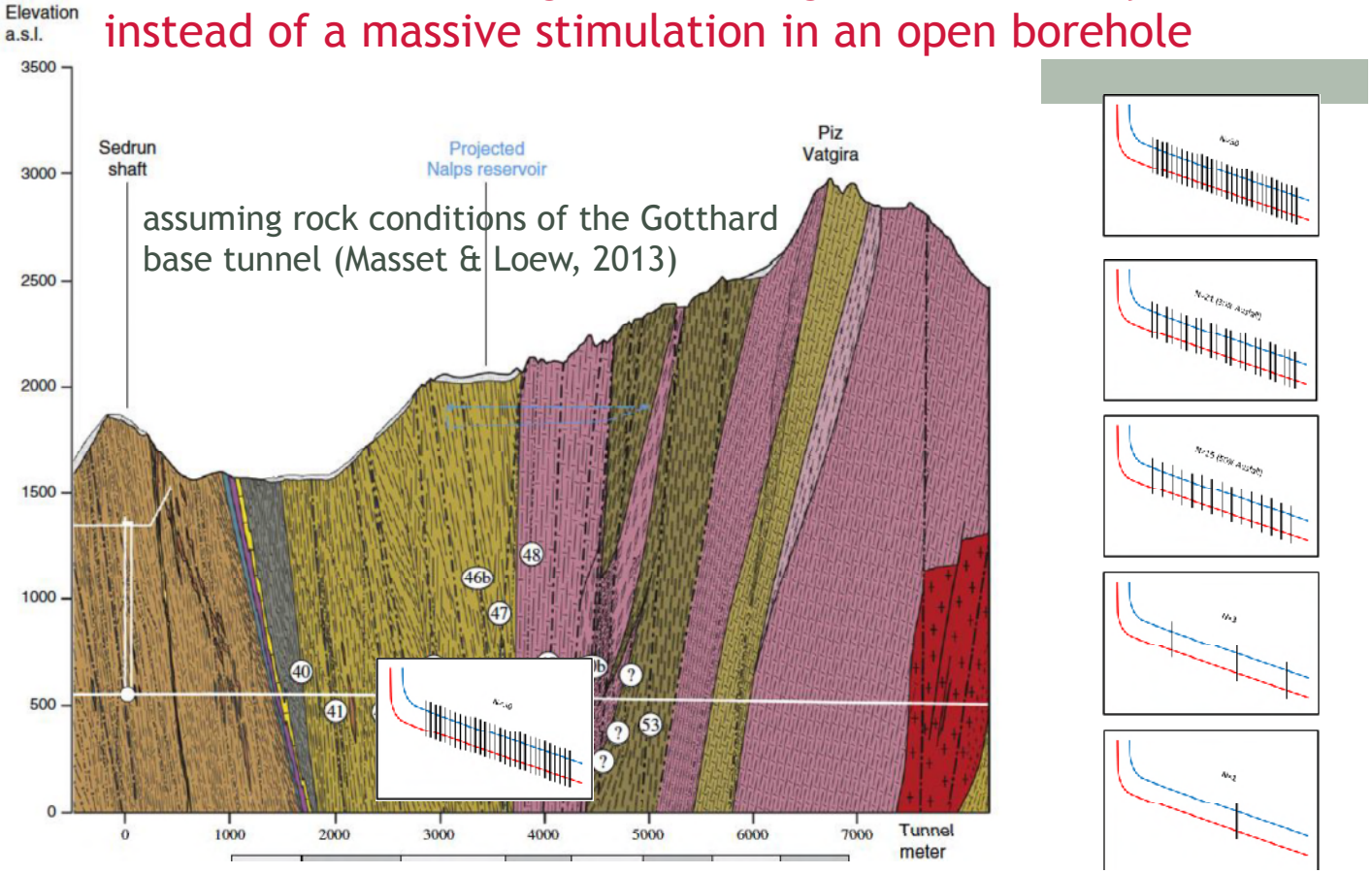
Tricone drill bits

Multi-zonal isolation

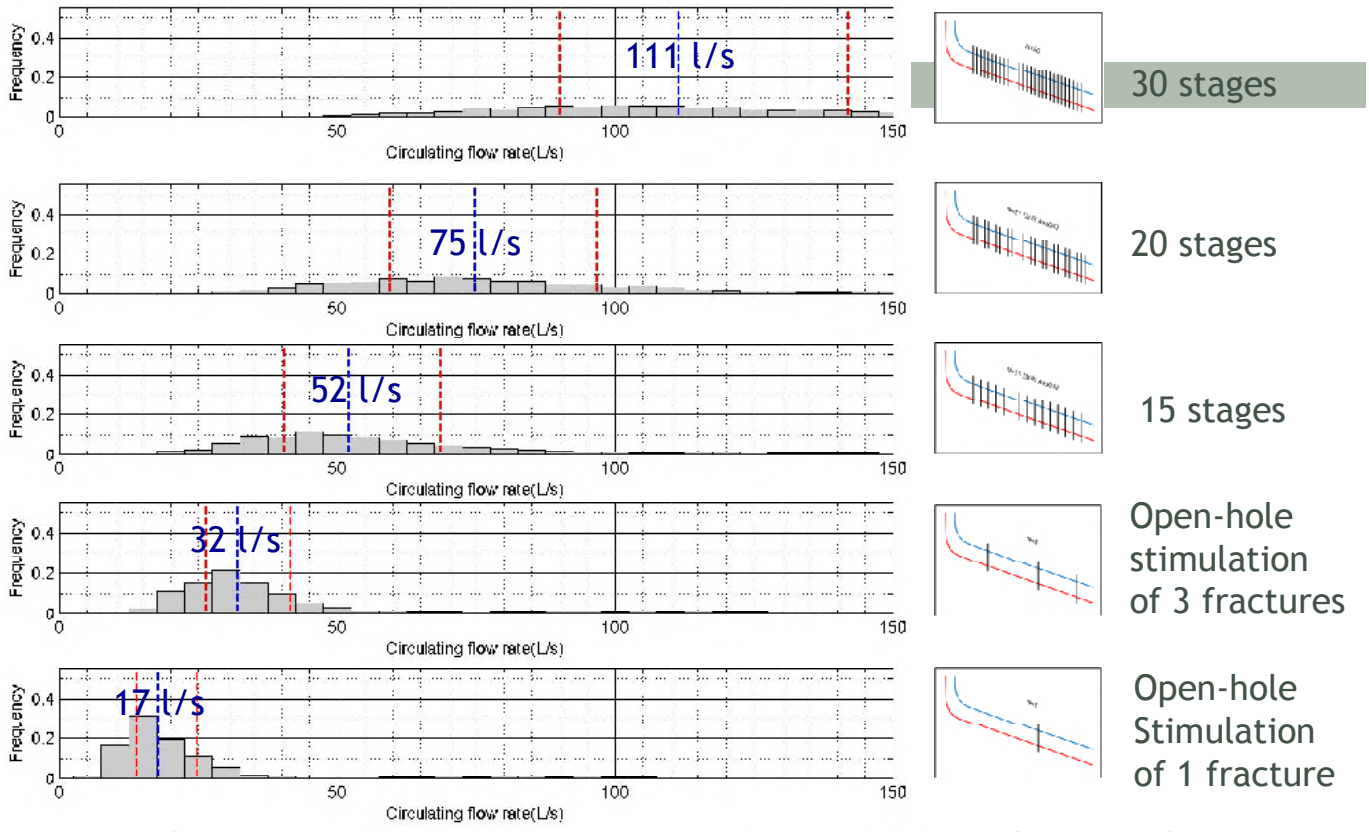




Monte Carlo simulations demonstrate the improvement of circulation rates using a multi-stage stimulation system instead of a massive stimulation in an open borehole

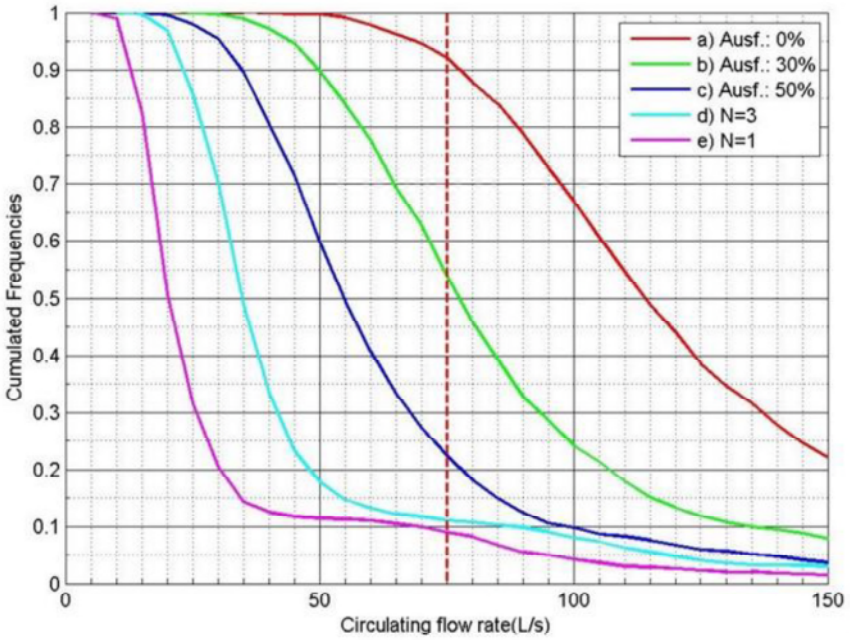


Flow rates from MC calculations for different numbers of successful stages versus open-hole stimulation

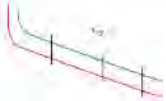


Medium Transmissivity (Gneiss, Masset & Loew 2013, Higher Bound K)

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

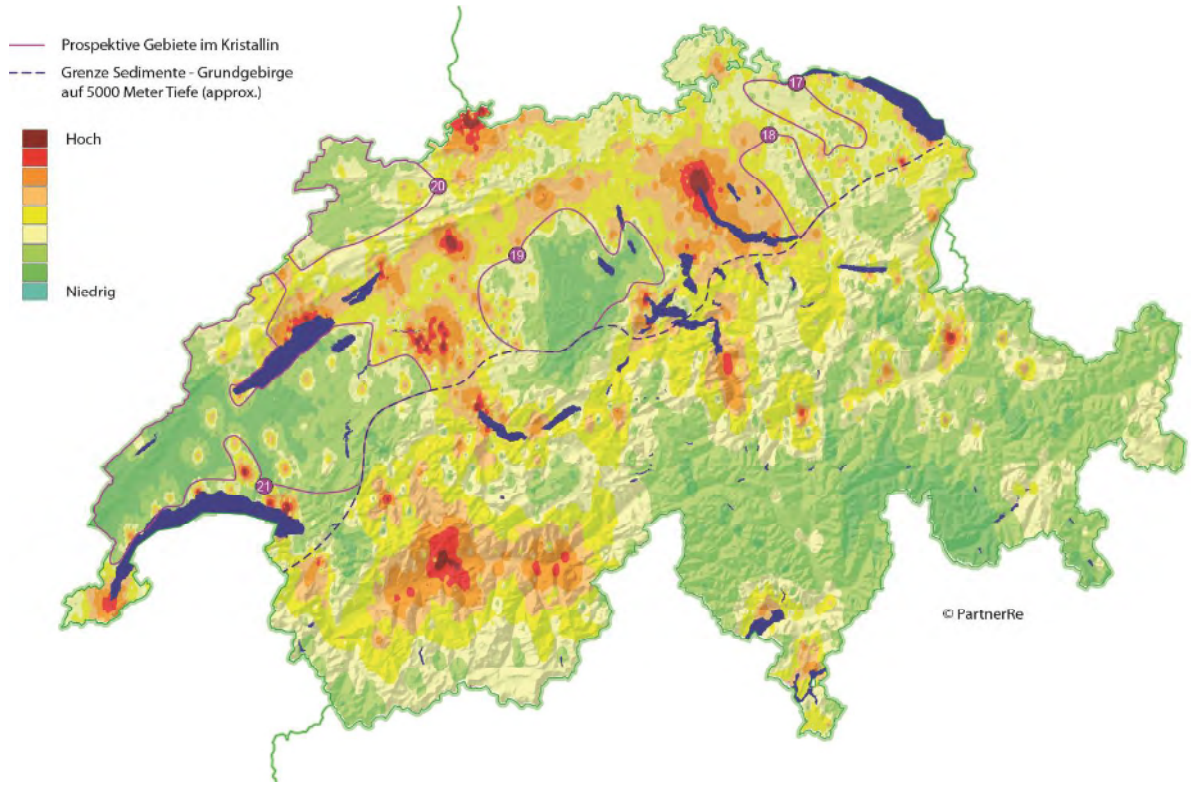


Efficiency of the multi-stage vs. single open-hole systems

	Utilisation System	Increase Factor of: El. Power	Increase Factor of: 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

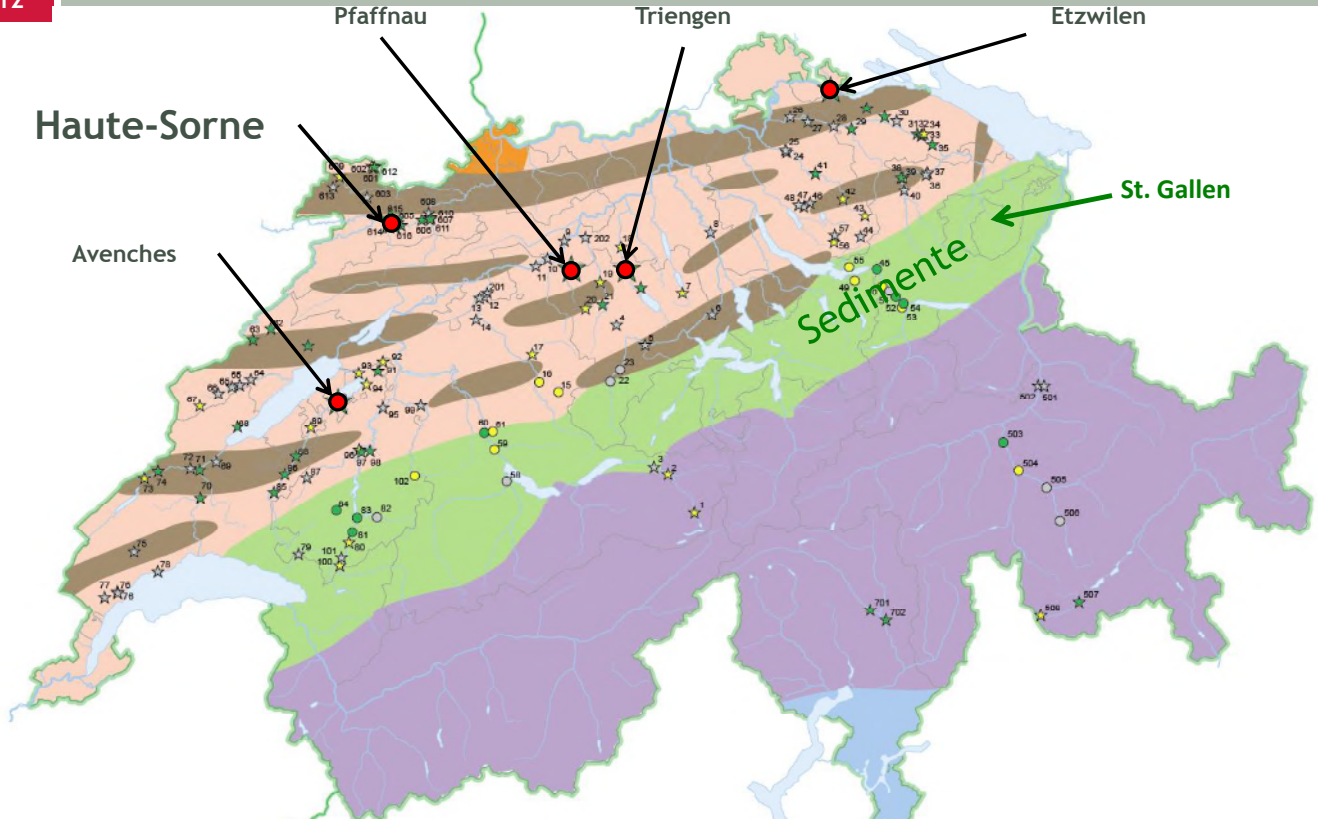
Low risk areas for first pilot projects and safety distance to large fault zones

11



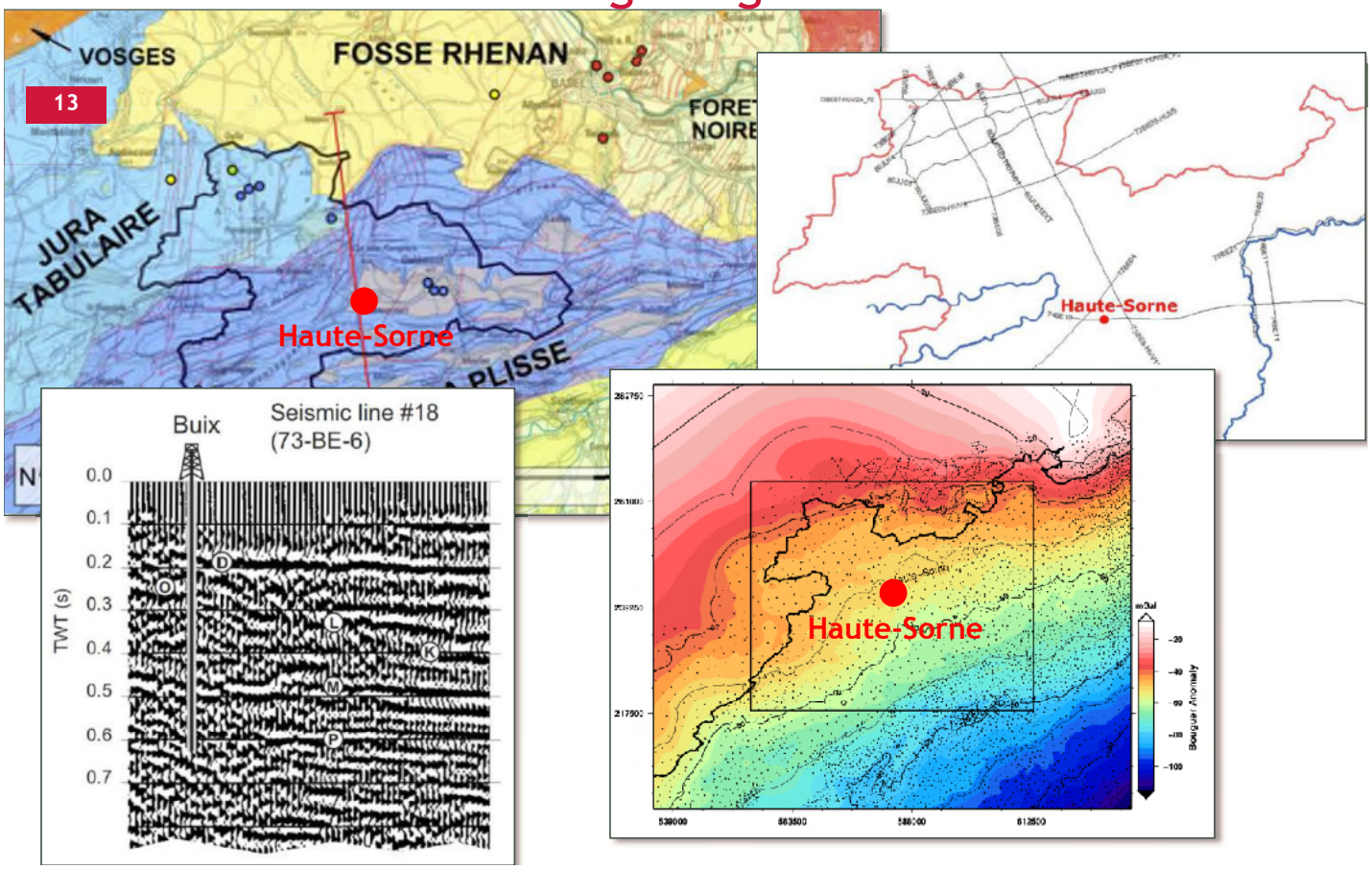
130 potential sites for pilot projects were evaluated within different plays within crystalline basement and sediments

12



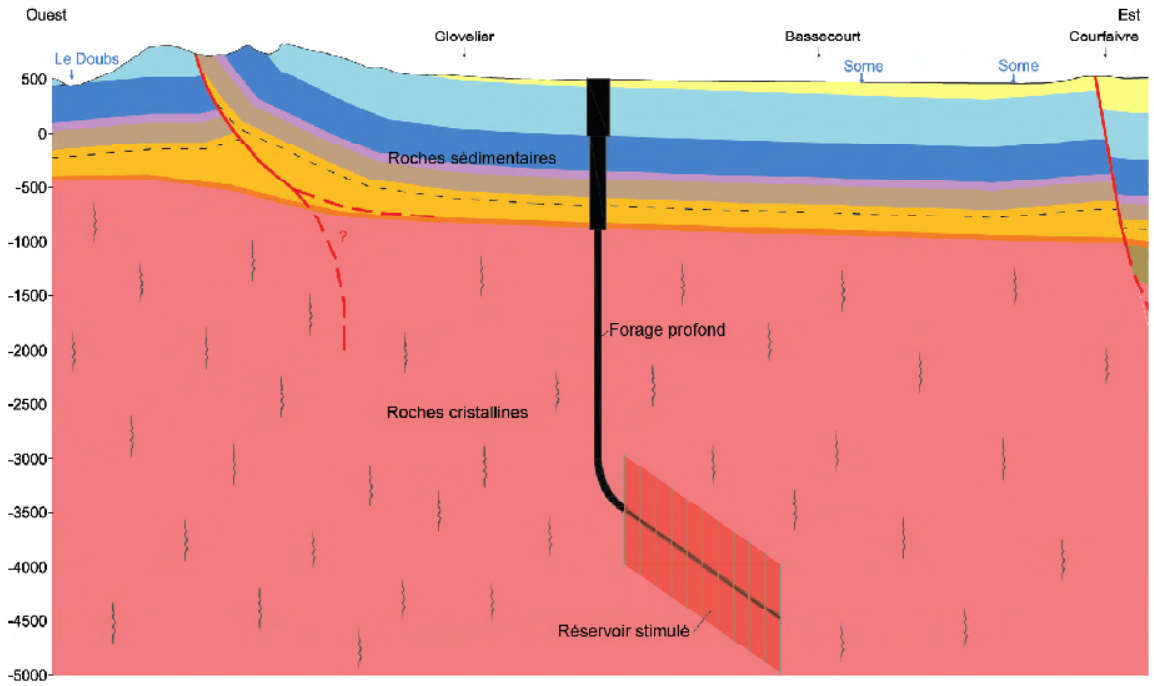
Regional geology
Construction of the geological model

13

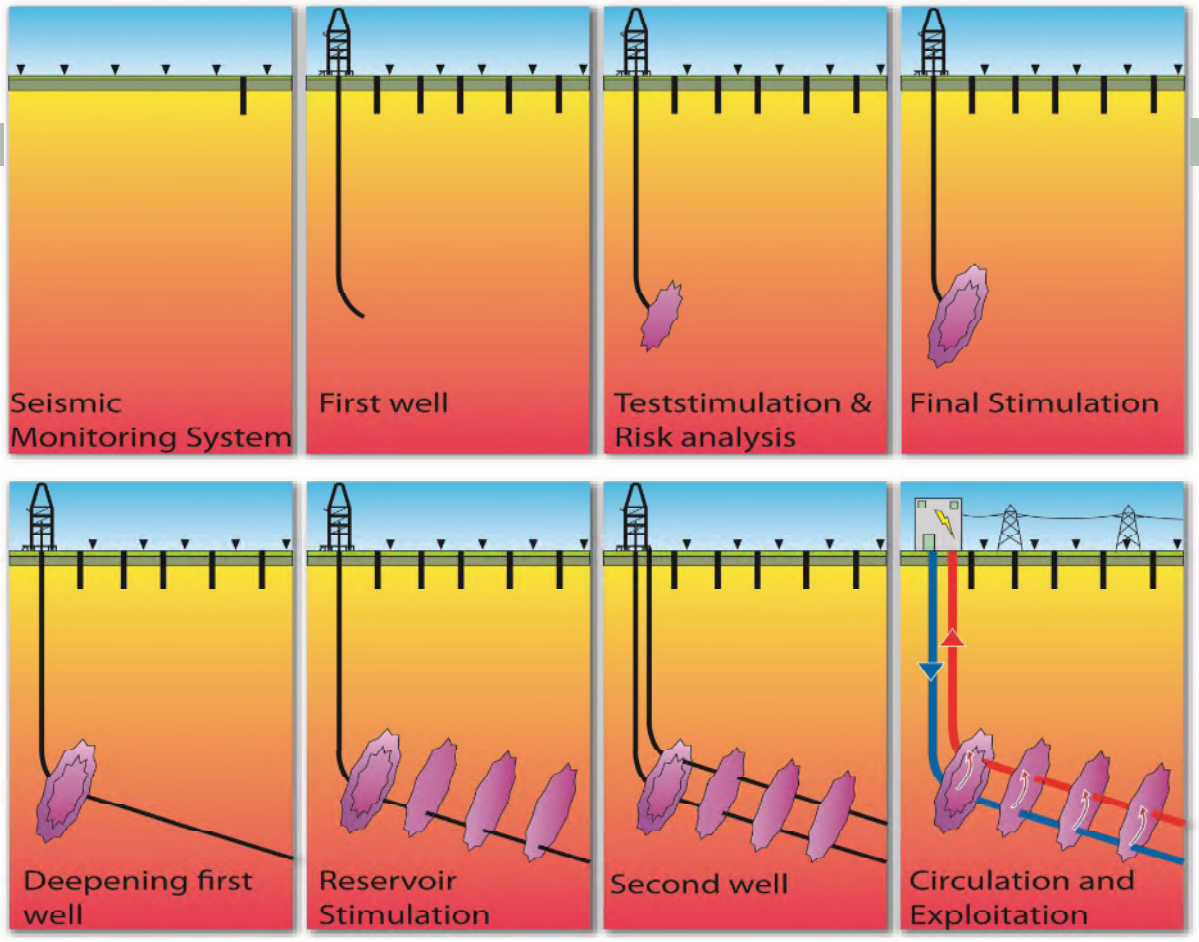


Geological cross-section with well and reservoir sketch

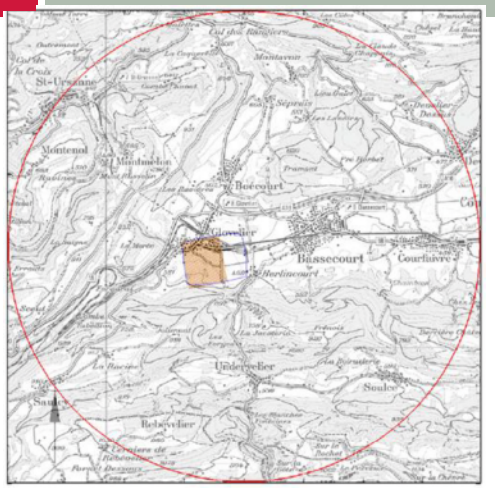
14



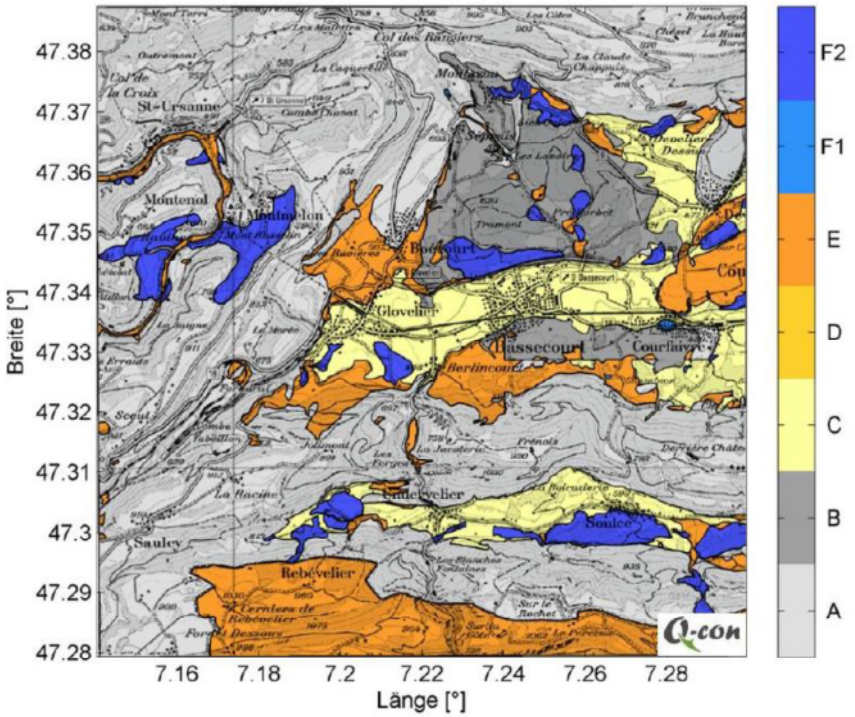
Conceptual design



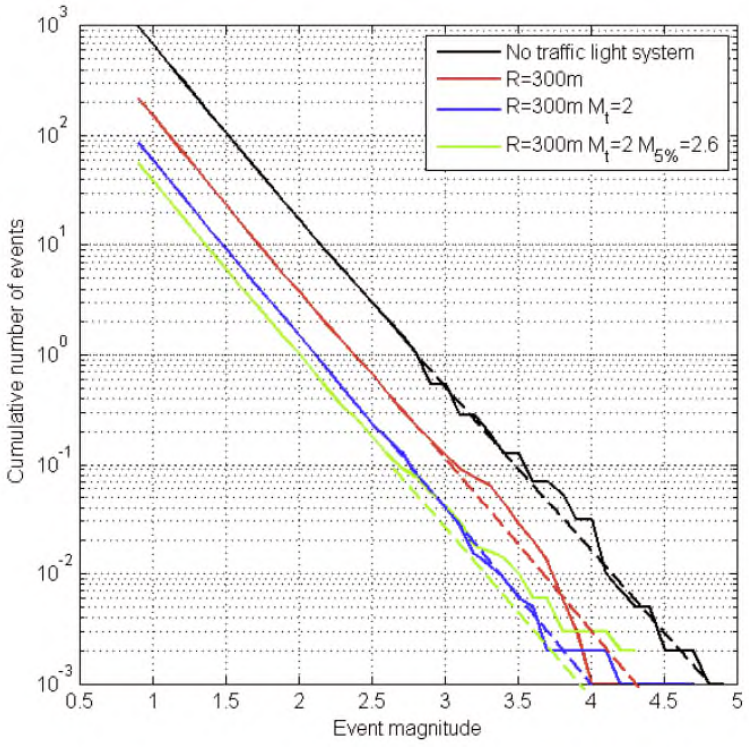
Deterministic study (Q-con)
Numerical modeling of ground motions

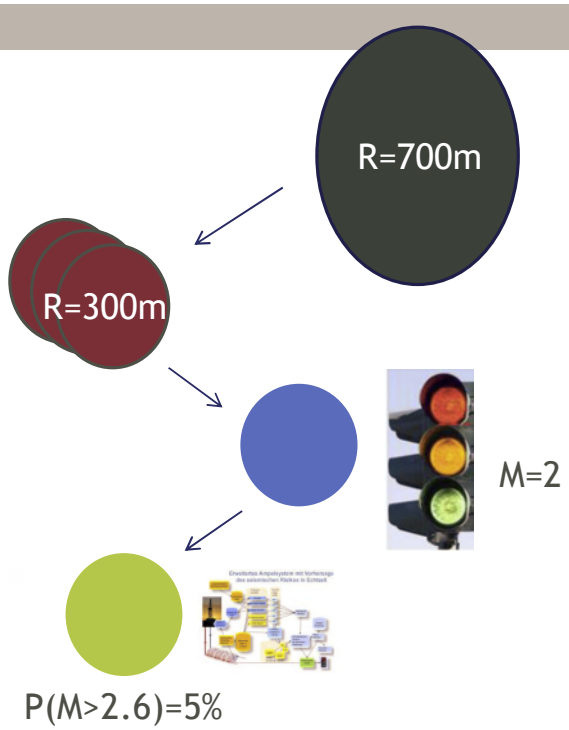


- Mw=2.6
- Damage < 5000 CHF



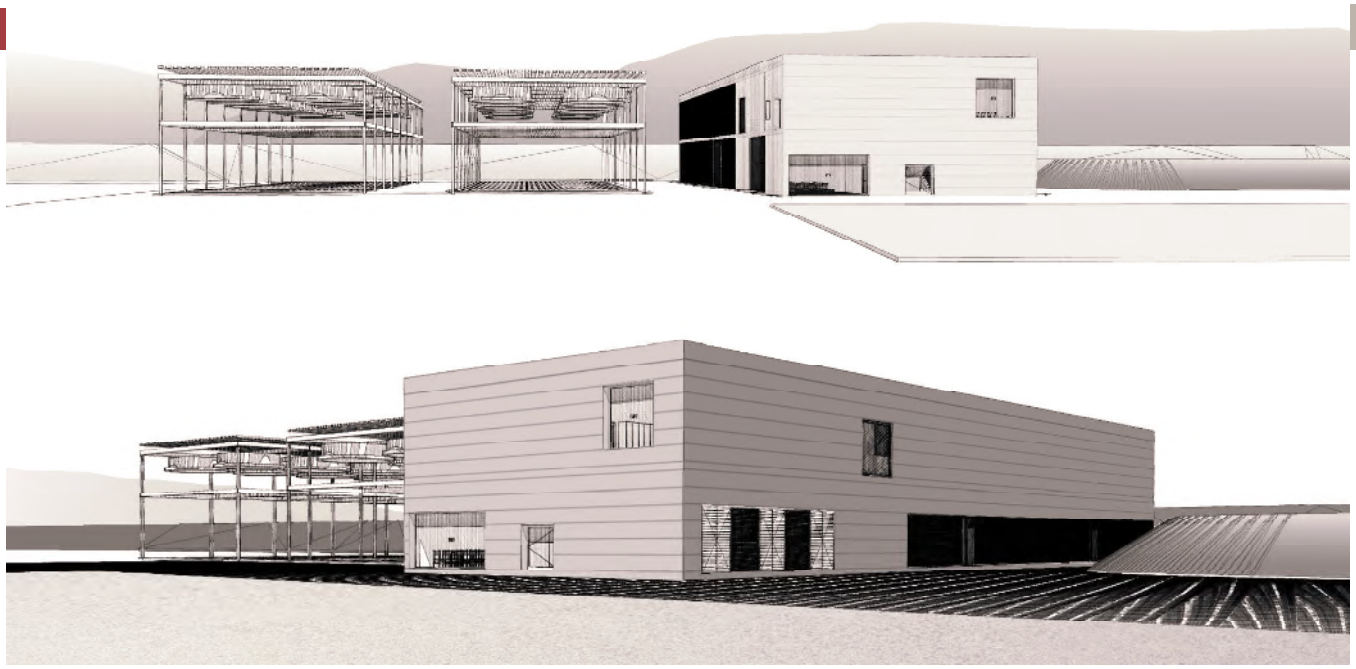
Probabilistic risk study according to SED philosophy & ATLS





Project site in Haute-Sorne

Power plant contruction permit: Pmax = 5 MW_{el}
Electrical Power will be sold to Swissgrid (KEV-waiting list)



plans: Kury&Staehelin

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

January 2014

Accompanying Group

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


GÉOTHERMIE PROFONDE EN HAUTE-SORNE

Bulletin d'information du groupe d'accompagnement du projet

No 1 octobre 2013

Aux habitants des communes de Haute-Sorne et de Boécourt

GEO ENERGIE SUISSE

Sommaire

Le groupe d'accompagnement

Le groupe est composé de

geothermie@haute-sorne.ch

Présentation du projet

Press

un chaud voyage au centre de la Terre

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

Boécourt
Bassecourt
Courfaivre
Glovelier
A16

commune de Haute-
ne a été sélectionnée
mi 130 en Suisse pour
cueillir une centrale pilote
géothermie profonde.
Le sous-sol du Jura recèle
n haut potentiel
le cette énergie propre,
népuisable et continue.
Ayant profité de cin-
quante ans d'expérience,
les techniques de forage ont
beaucoup évolué, devenant
plus sûres et efficaces.
Associations et population

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

jet géothermiq

trou à Glovelier

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 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, recueille d'ores et déjà ques-

Un trou scruté à la loupe

Ces trois sujets préoccupent naturellement le groupe CS•POP/Verts. 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

Glovelier
Bassecourt
Ligne CFF
Site géothermique
LA SORNE
Berlincourt

Une tête de perçage utilisée pour creuser le forage à grande profondeur, avec en arrière-plan la tour du projet géothermique de Saint-Gall. En médaillon, la carte de l'implantation du site, à la croisée des trois villages.

«Un faisceau de critères a conduit au choix de ce groupe de trois parcelles

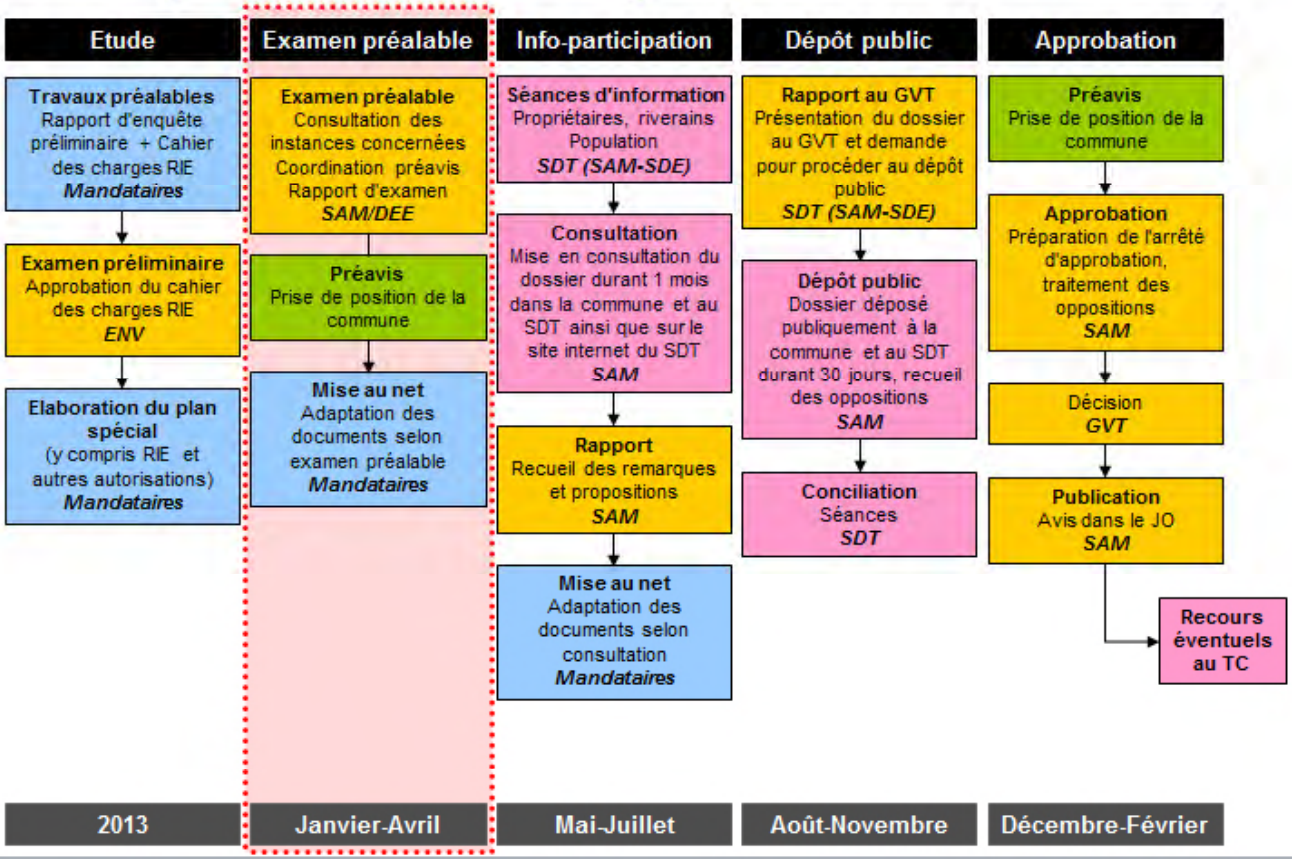
tés en terres agricoles et proches de zones humides

communes de Haute-Sorne

particulier à la surveillance des risques sismiques, la nuisance sonore et la sauvegarde des eaux souterraines et de surface.

tement avec l'EPFZ.
que retenue, dite pét
le, est sensiblement
de celle employée
malheureux de Sain
type hydrothermal. L'
pourvue d'additifs chi
est ici injectée froide
cueillie chaude après
sit à 4000 m de profo
non seulement pompé
sous-sol. Les aléas si
ainsi que les risques
tion des eaux sout
sont donc fortement
Reste que le chanti
me toute installatio
trielle, produira queiq
sances sonores, d'abo
réalisation des forage
l'horizon 2016, puis p
ronnement des aéro

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

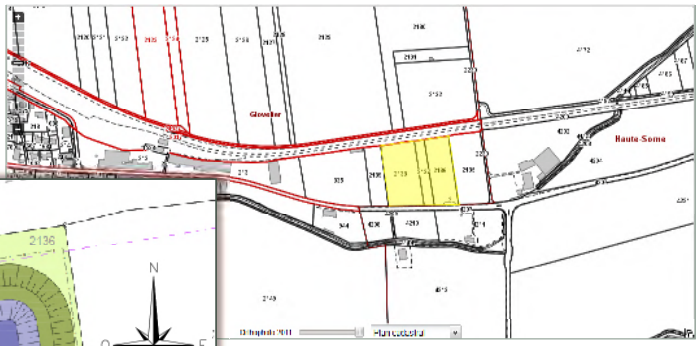
25

2012		Preliminary impact and risk studies
2013		- Accompanying groups - Application for construction permit and main environmental impact and risk studies
2014 2015		Examination by authorities Risk guarantee BFE/Swissgrid
2017/2018		Drilling (if financing successful)
2020+		Power plant working

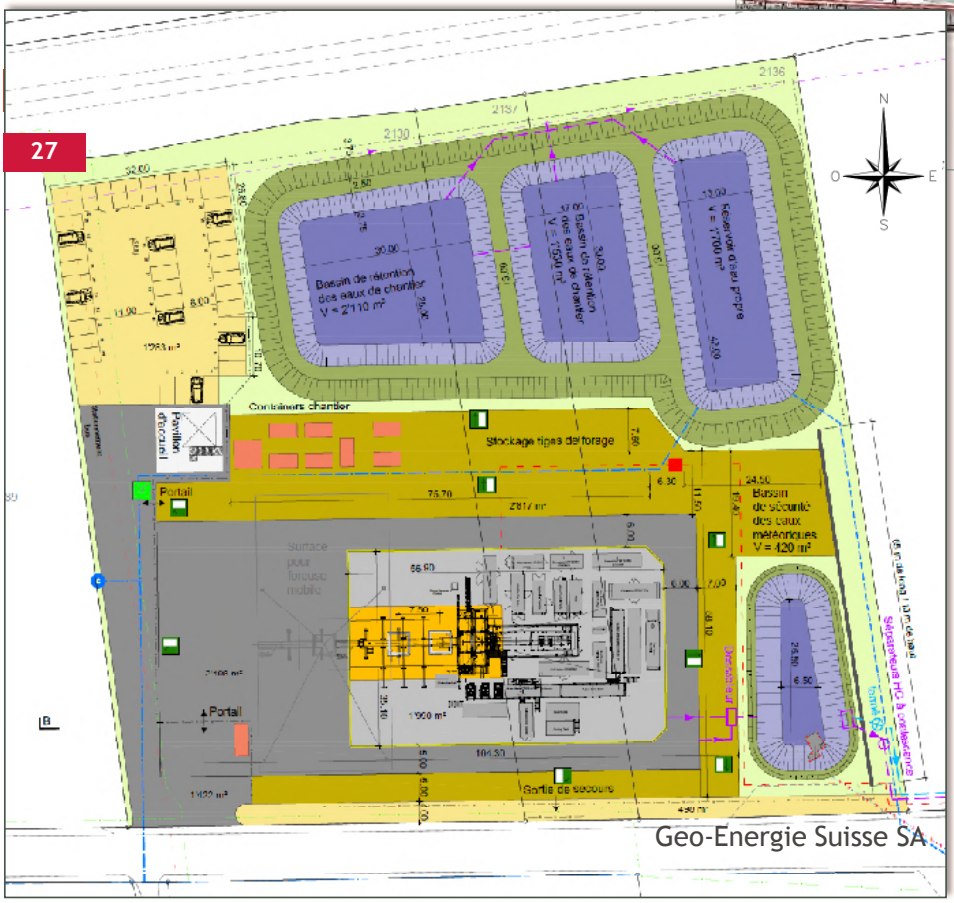
Two visits of geothermal power plants in Germany organised for the accompanying group and representatives of the communal and cantonal authorities

26

Drillpad



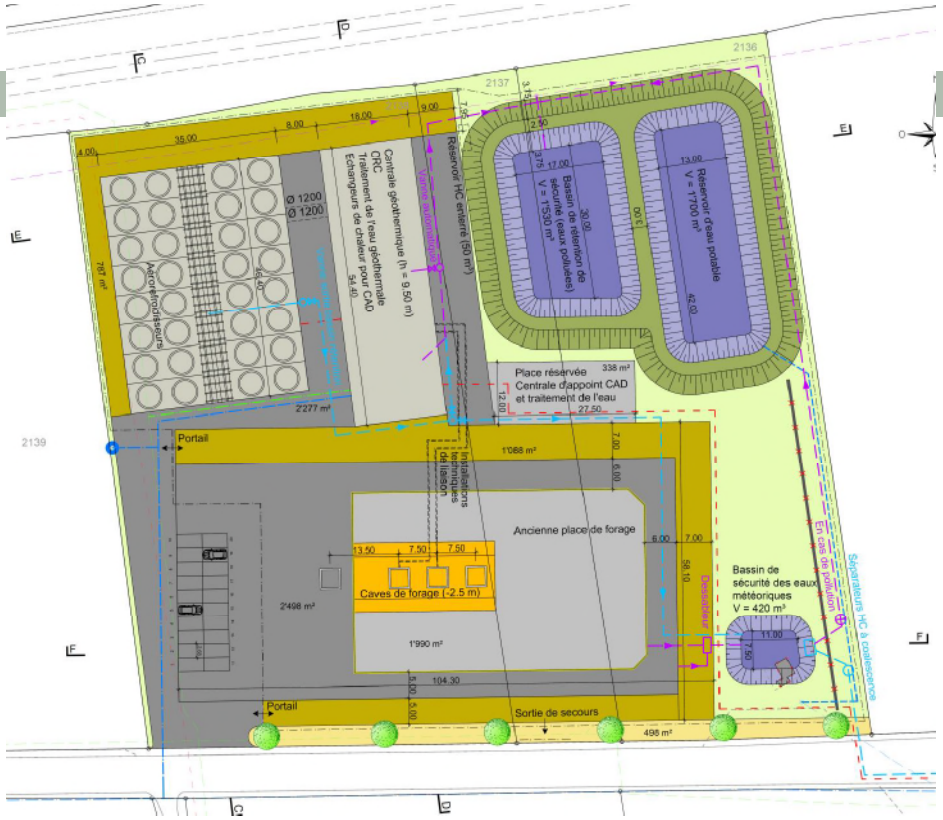
27



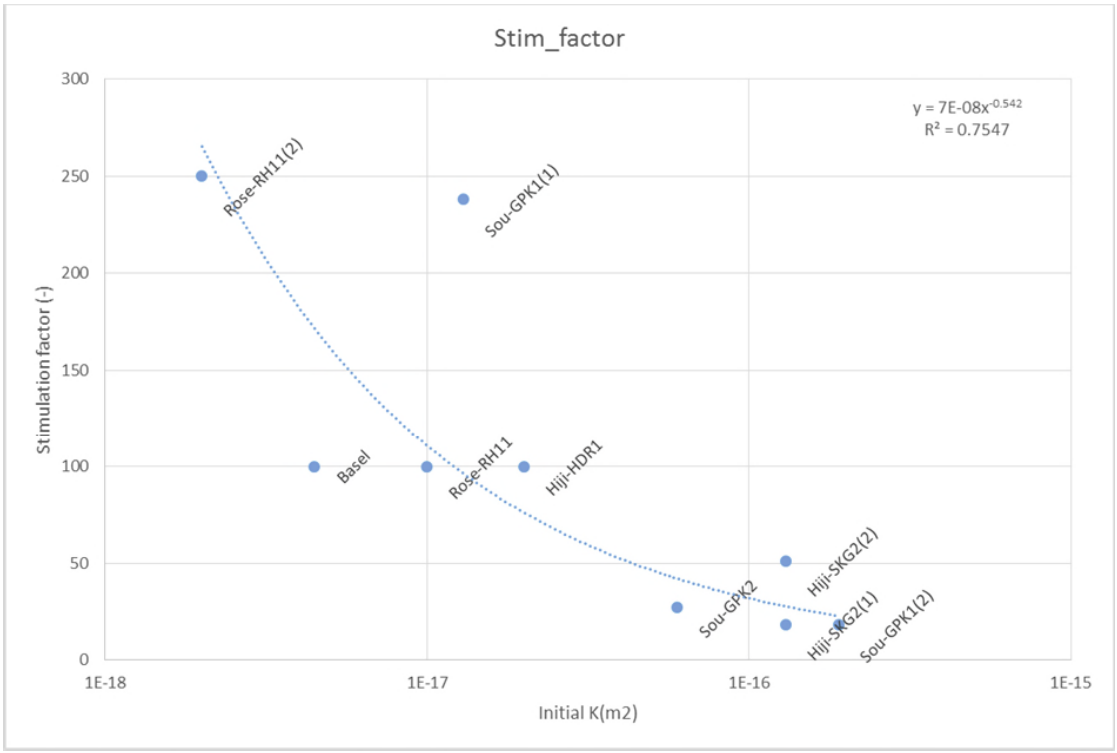
Geo-Energie Suisse SA

GEO ENERGIE SUISSE

Power plant

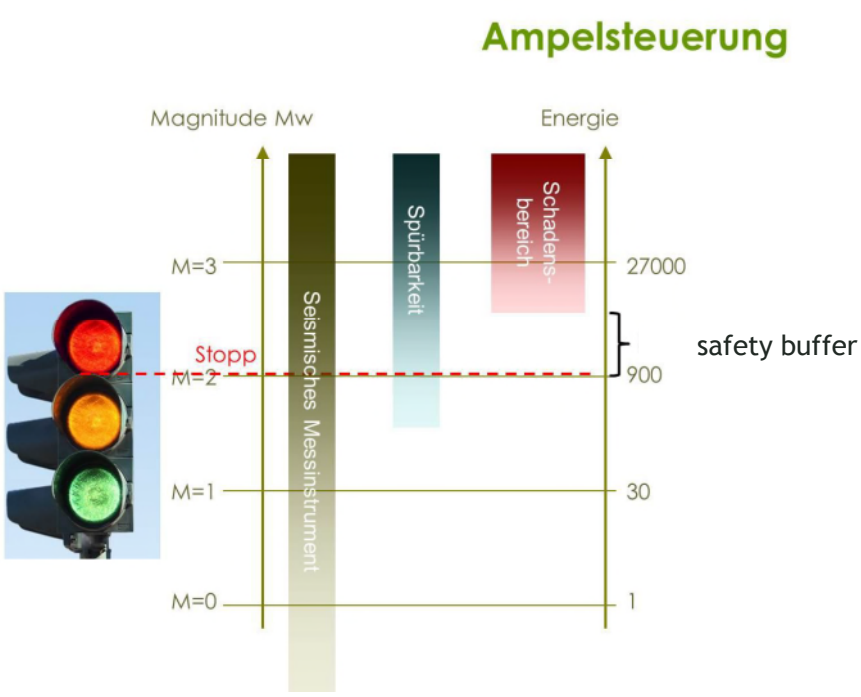


Stimulation factor (Evans, 2013)



Traffic light system with lower thresholds

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



Convention Tripartite
Fondation de Geo-Energie Jura SA

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

Convention Tripartite
Rémunérations

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

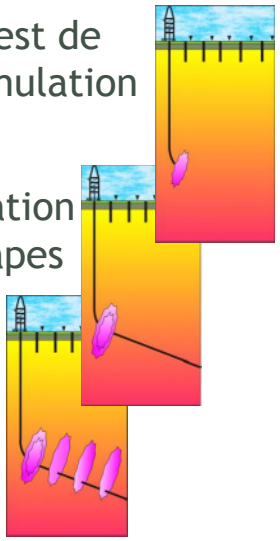
Risque sismique

SED
Schweizerischer Erdbebendienst
Swiss Seismological Service

Expertise du Service sismologique suisse

Etude de risque très poussée

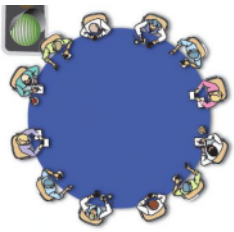
Test de stimulation



Réalisation en étapes

Maîtrise du risque

Groupe d'experts neutres



Seuils d'arrêts plus bas

Surveillance en temps réel

Etablissement des preuves et assurances

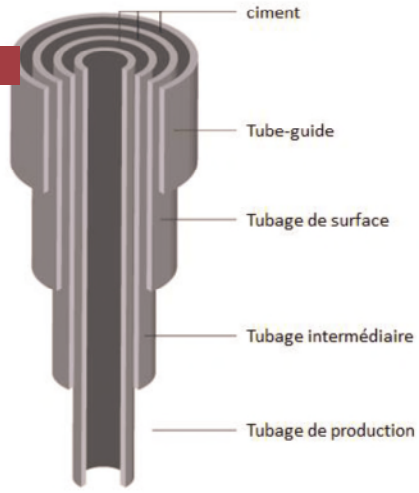
Etablissement des preuves

- 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



Protection des eaux souterraines

Contrôle des émissions sonores

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.

Expertise
Success
Value

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

MANNVIT

EU-FIRE
Finance, Investment and Renewable Energy

NEMZETGAZDASÁGI MINISZTÉRIUM

DANUBE REGION strategy
Energy

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.

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Finance, Investment and Renewable Energy

NEMZETGAZDASÁGI MINISZTÉRIUM

DANUBE REGION strategy
Energy

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

EU-FIRE
Finance, Investment and Renewable Energy

Nemzetgazdasági Minisztérium

DANUBE REGION strategy
Energy

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 is to deliver a power of 25 MWth 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 Soultz-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”

Back to the program ↑

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**

ECOGI:

Exploitation de la **C**haleur d'**O**rigine **G**éothermale pour l'**I**ndustrie
(***Exploitation of geothermal heat for industrial applications)***

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

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: ~ 100MWth
  → Geothermal project: 25% of the energy demand

- Global strategy: reduction of the gas consumption by 70%: geothermal energy, biomass, reduction of the demand

ROQUETTE

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*

Technical data

2 Wells	2500-3000 m
Operating Hours	8.000 h/year
Temperature	170° C
Transport Loop	15 km
Thermal Power	24 MW_{th}
Reduction of GHG emissions	40 kt/y

The ECOGI concept

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

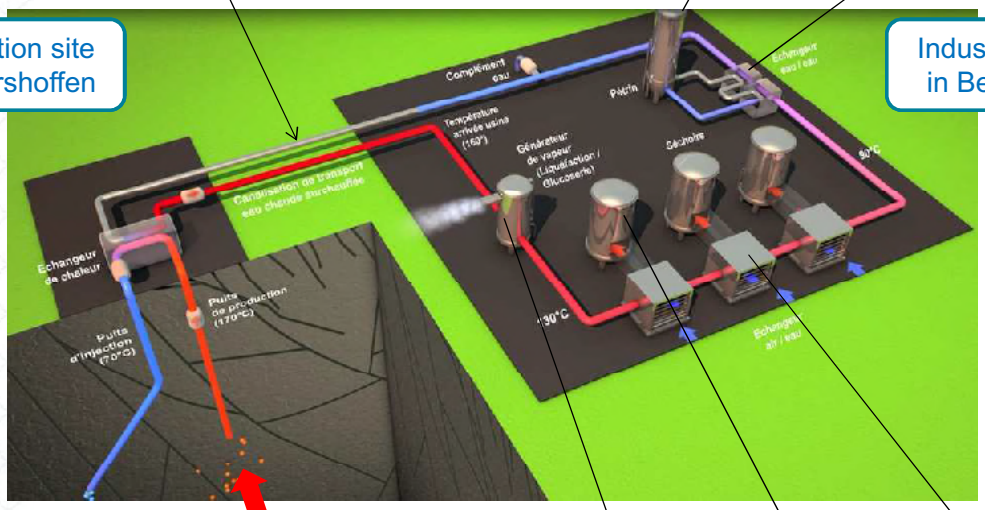
multiple applications in series:

kneading machine

Water/water HH

Production site in Rittershoffen

Industrial site in Beinheim



24 MW_{th}: 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

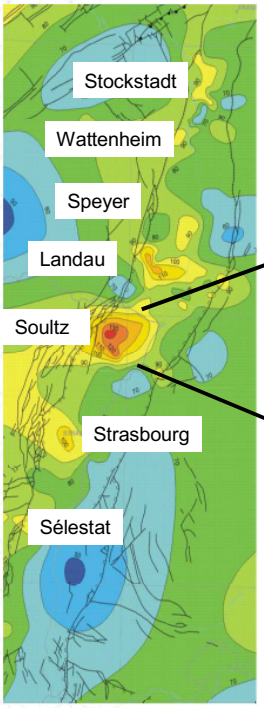
Seismic
Survey

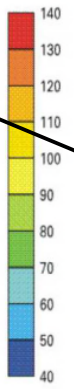
GRT2
Drilling and tracer tests

Surface loop
Thermal plant
Thermal loop
Bio-refinery

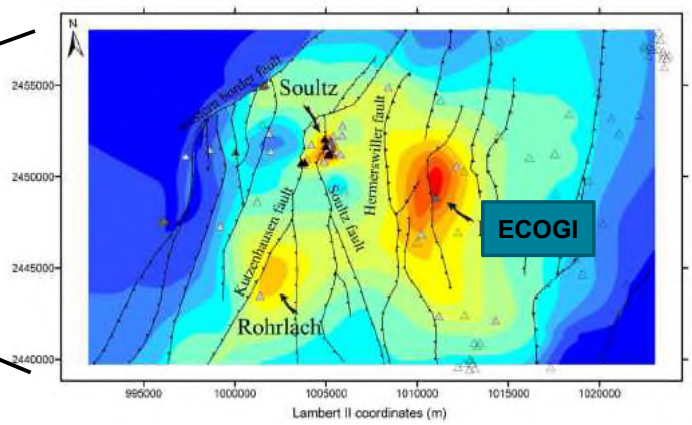
ECOGI
Commissioning

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





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



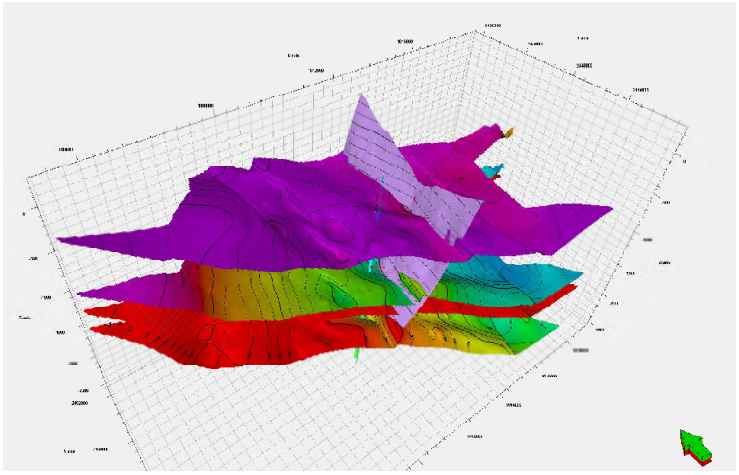
Fault map and temperature field between Soultz and Rittershoffen

Baillieux, 2012

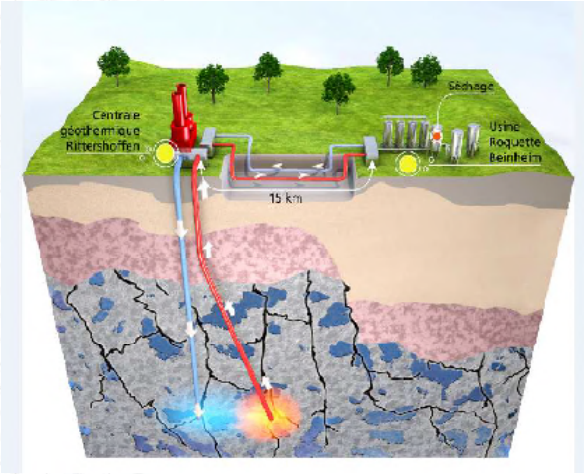
Modelisation

- ✓ Seismic acquisition
- ✓ Acoustic imaging
- ✓ Elaboration of data from existing oil wells
- ✓ …

→ New skills and expertise developed by ES-Group

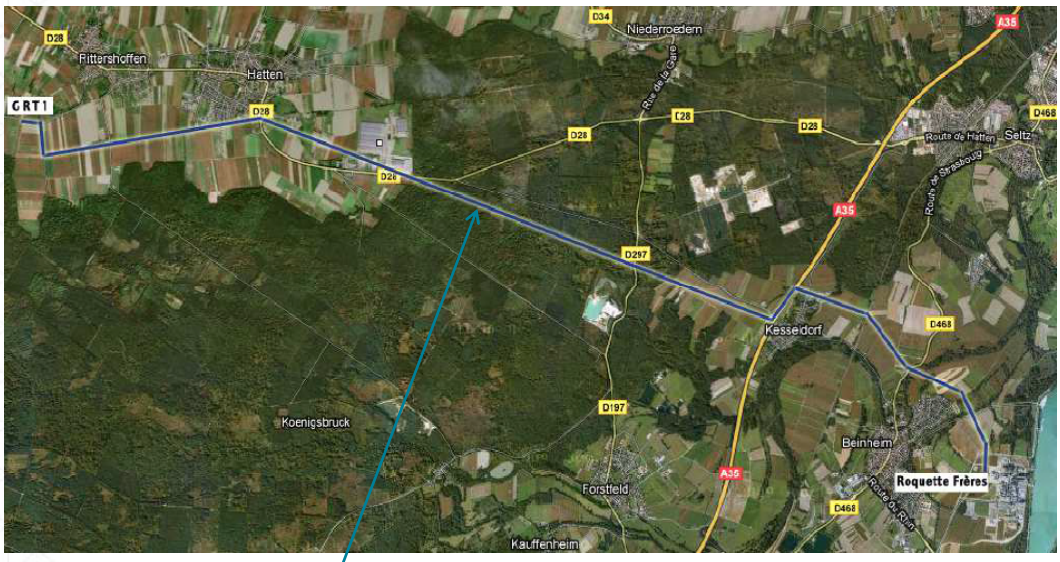


Geothermal doublet : GRT-1 + GRT-2



- **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, preloded
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

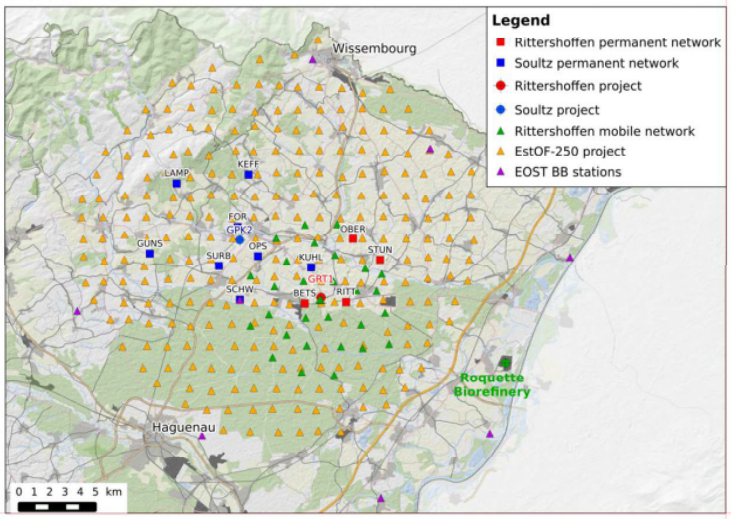
GRT-1 Well development

- Cold fluid reinjection (4200 m3, < 25 l/s, < 35 bars)
- Chemical cleaning with biodegradable products
- Hydraulic improvement of the well (3150 m3, < 80 l/s, < 35 bars)
  ⇨ **Injectivity x 5**

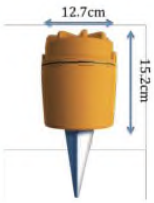
GRT-2 Well testing

- 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
- Mlv max : 1.5
- No micro-EQ felt by population



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 Karlsruhle with KIT

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...

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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ROQUETTE Clément ROBERT – clement.robert@roquette.com

Thank you

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ADEME – French Environment and Energy Management Agency
Networks and Renewable Energy Department
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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. Moore 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 brief overview

HS ORKA

- Founded on the 31st 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_e and 190 MW_t
  - Svartsengi: 75 MW_e and 190 MW_{th}
  - Reykjanes: 100 MW_e
- Third largest power company in Iceland
  - The only one privately owned

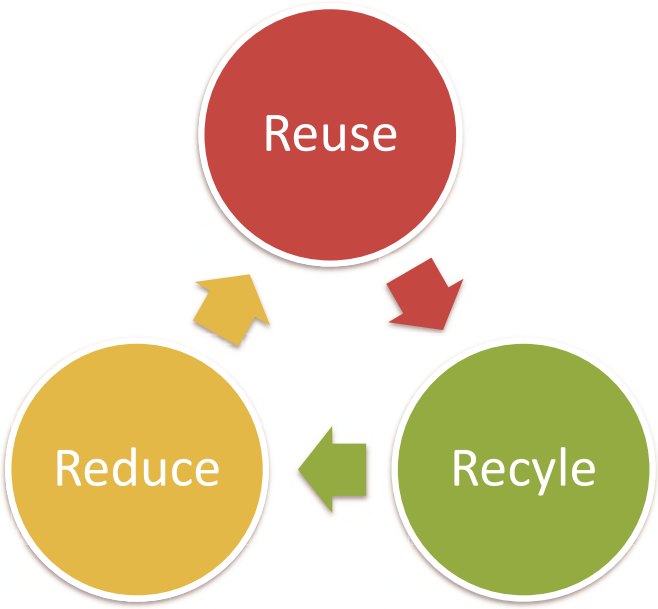
HS ORKA

The Resource Park Goals

HS ORKA

- Society without waste
- Goals
  - Ecological balance
  - Economic prosperity
  - Social progress

- Read the Nature–holistic approach to the project – be in the nature

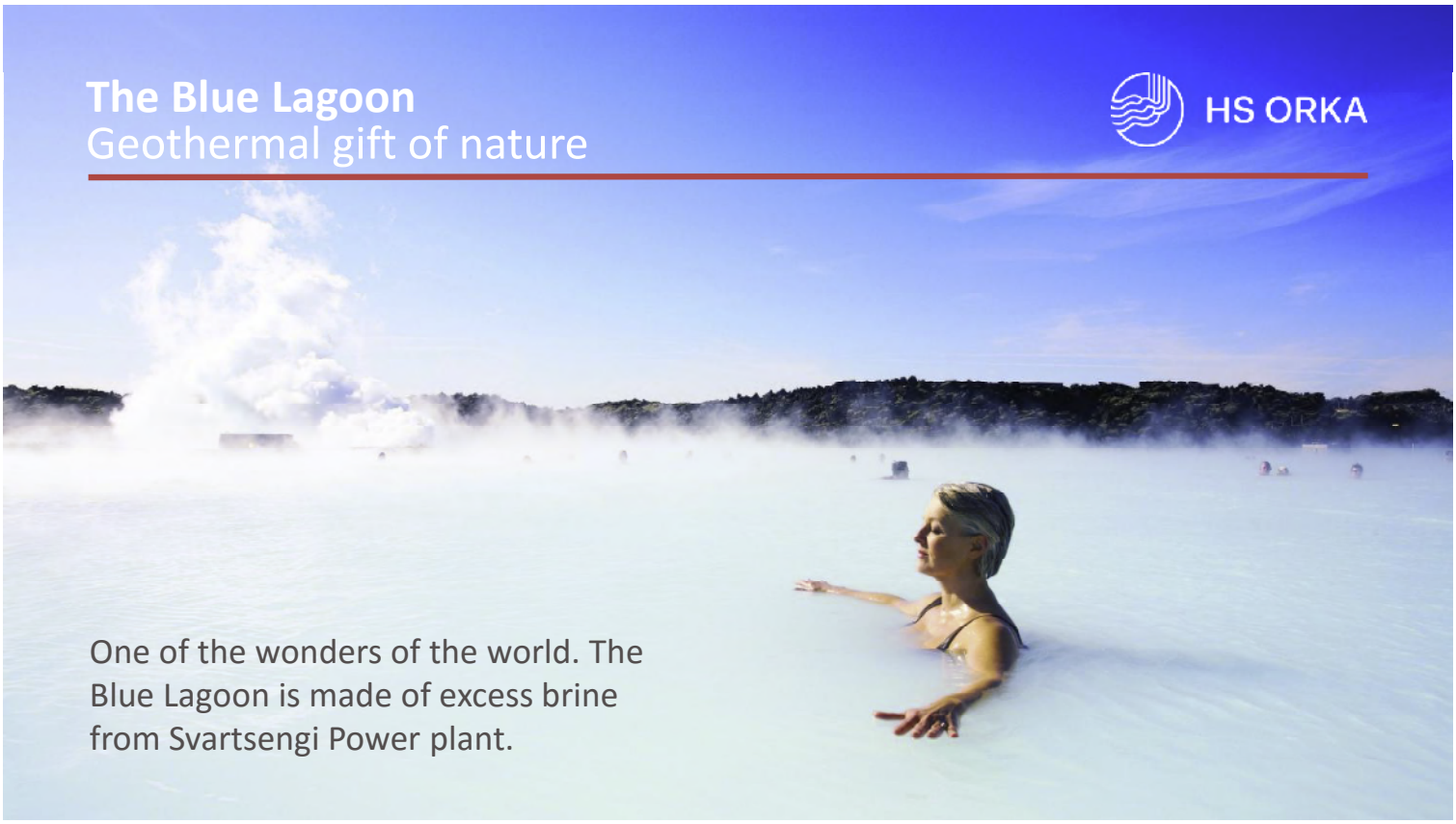


HS Orka Physical Resource streams

HS ORKA

The Blue Lagoon
Geothermal gift of nature

HS ORKA



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

The Blue Lagoon Health clinic

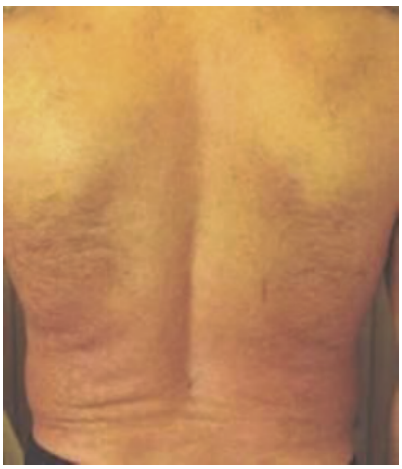
HS ORKA

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

Blue Lagoon Clinical Research –Healing Power

HS ORKA

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



4 weeks treatment at Blue Lagoon Medical Clinic.

CRI

HS ORKA

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

ORF Genetics

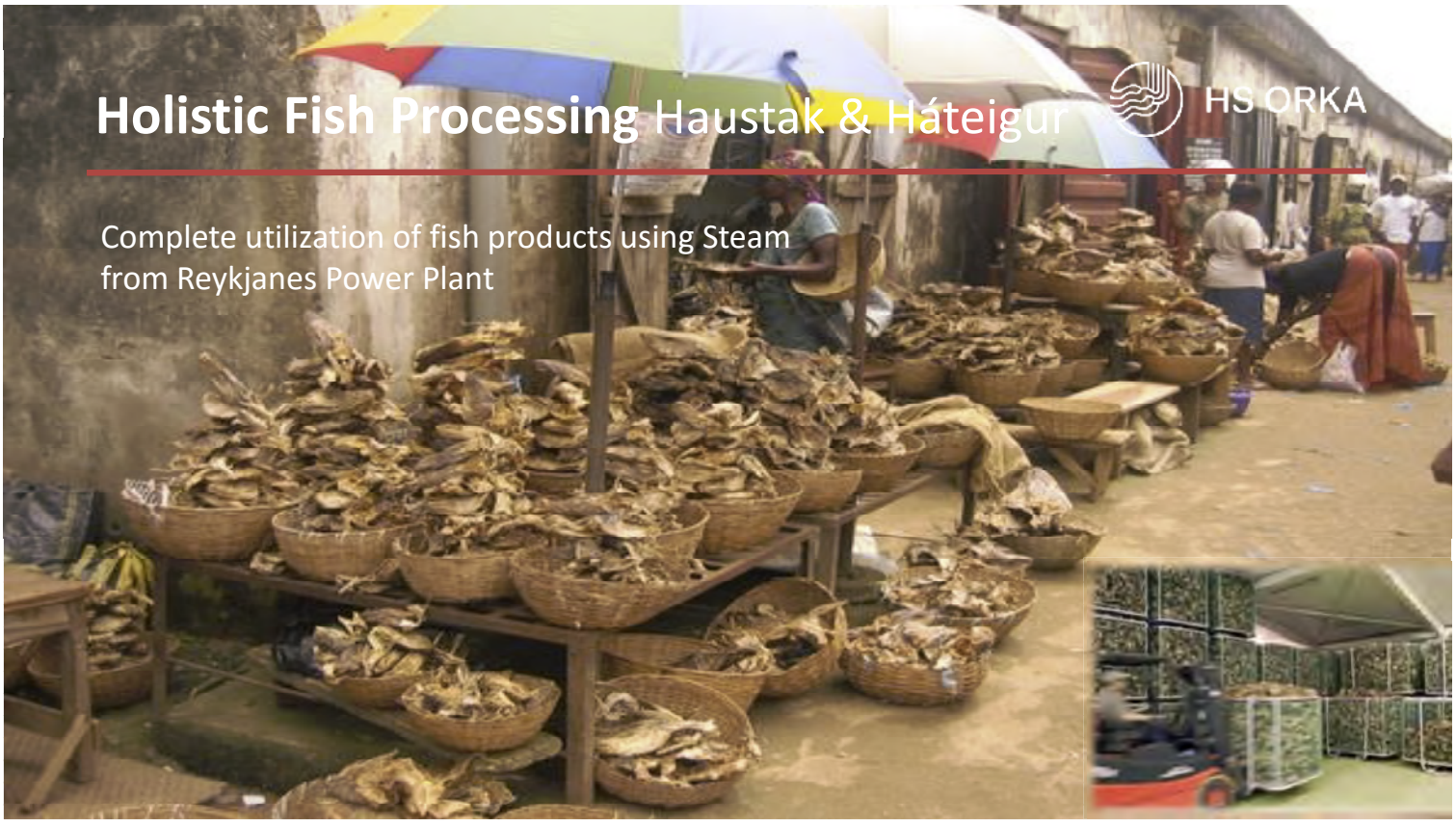
HS ORKA

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

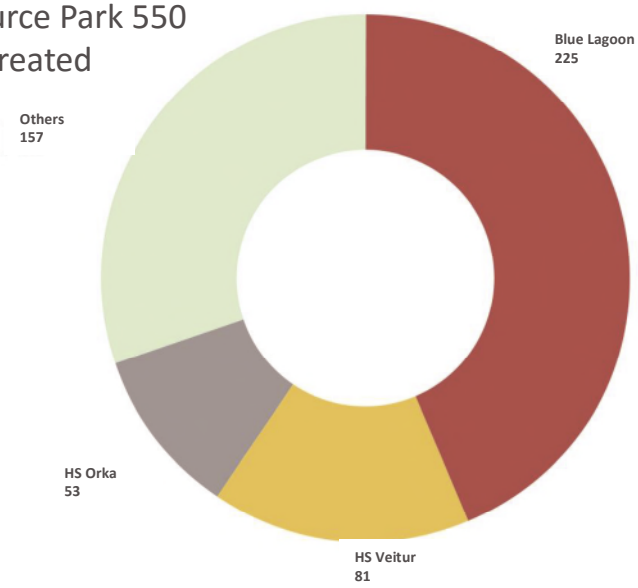
HS ORKA

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

HS ORKA

Within the Resource Park 550 jobs have been created



HS Orka resource park– next steps

HS ORKA

- 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

Resource streams

Silica SiO_2

Tourism/Education

Effluent heat

Gas extraction from geothermal fluid

Metal and mineral extraction from the Geothermal Brine

Conclusion

HS ORKA

- The Resource Park Concept has proofed 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_2 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_2 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.

Back to the program ↑

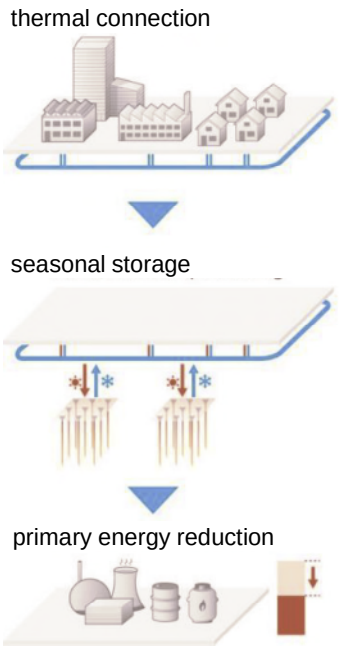
AMSTEIN + WALTHERT

Operational Experience with Low Temperature Networks in Zurich, Switzerland

Matthias Kolb
Geneva, 30.10.2015

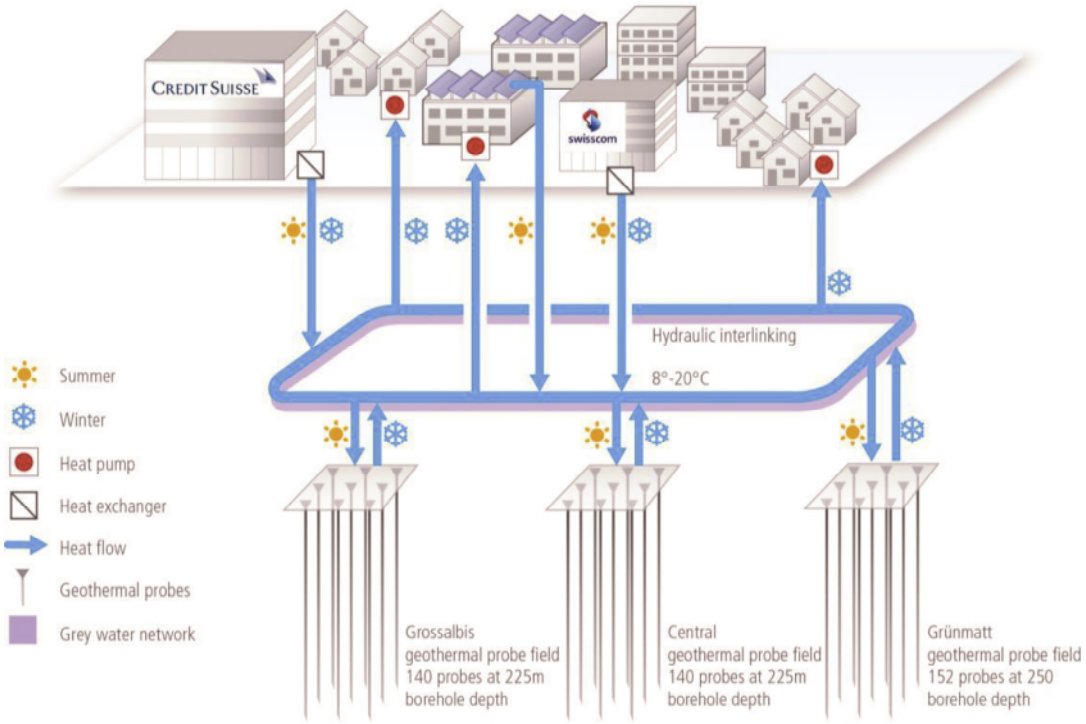
AMSTEIN + WALTHERT

Aim of Thermal Networks



reduction of CO_2 emissions

Principle of a Low Temperature Network



AMSTEIN+WALTHERT

Agenda

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

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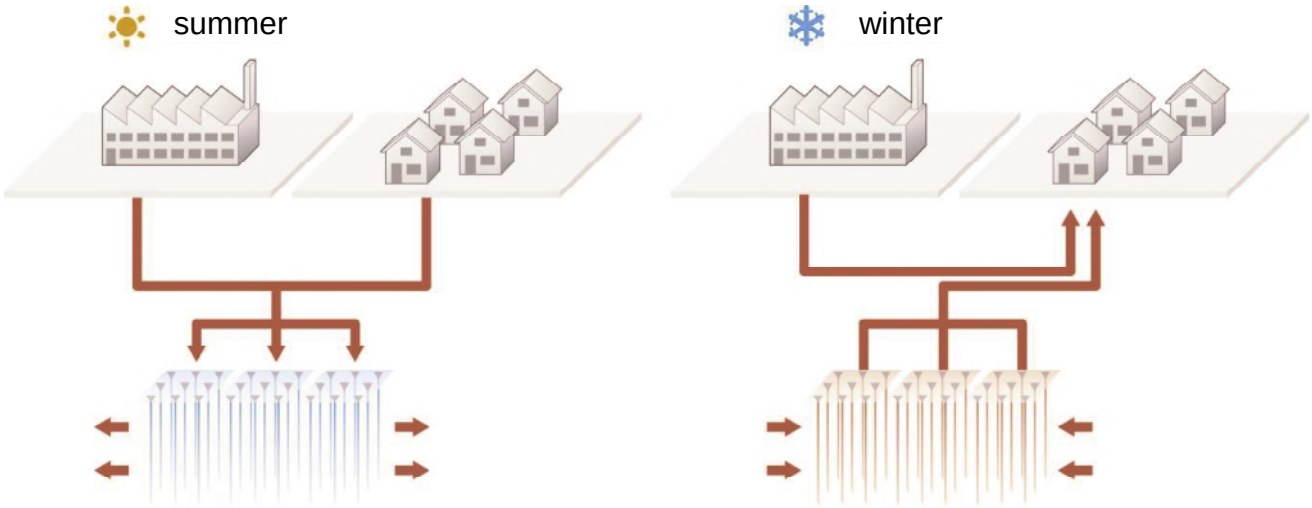
Seasonal Balancing of Heating / Cooling Demand



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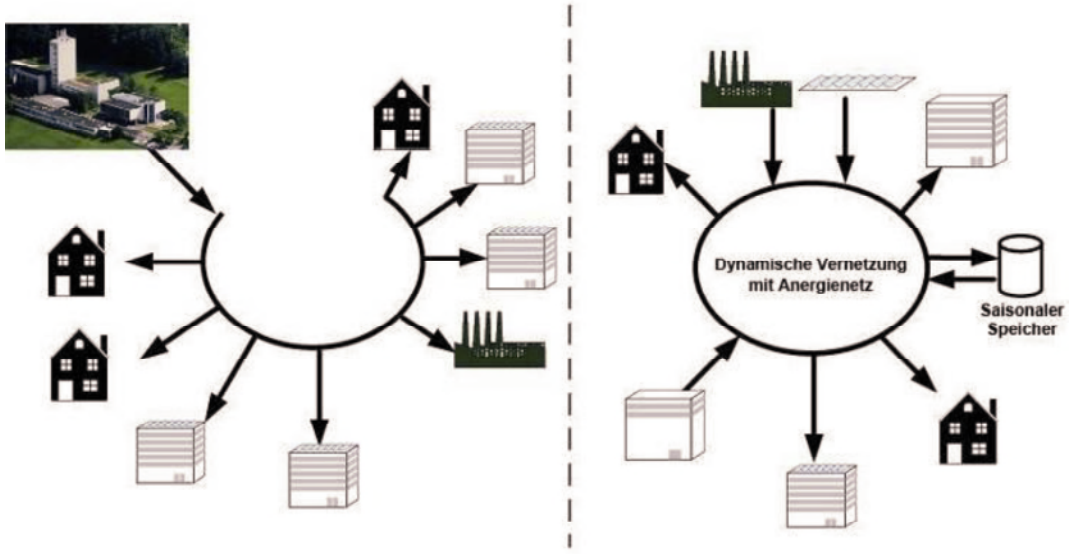
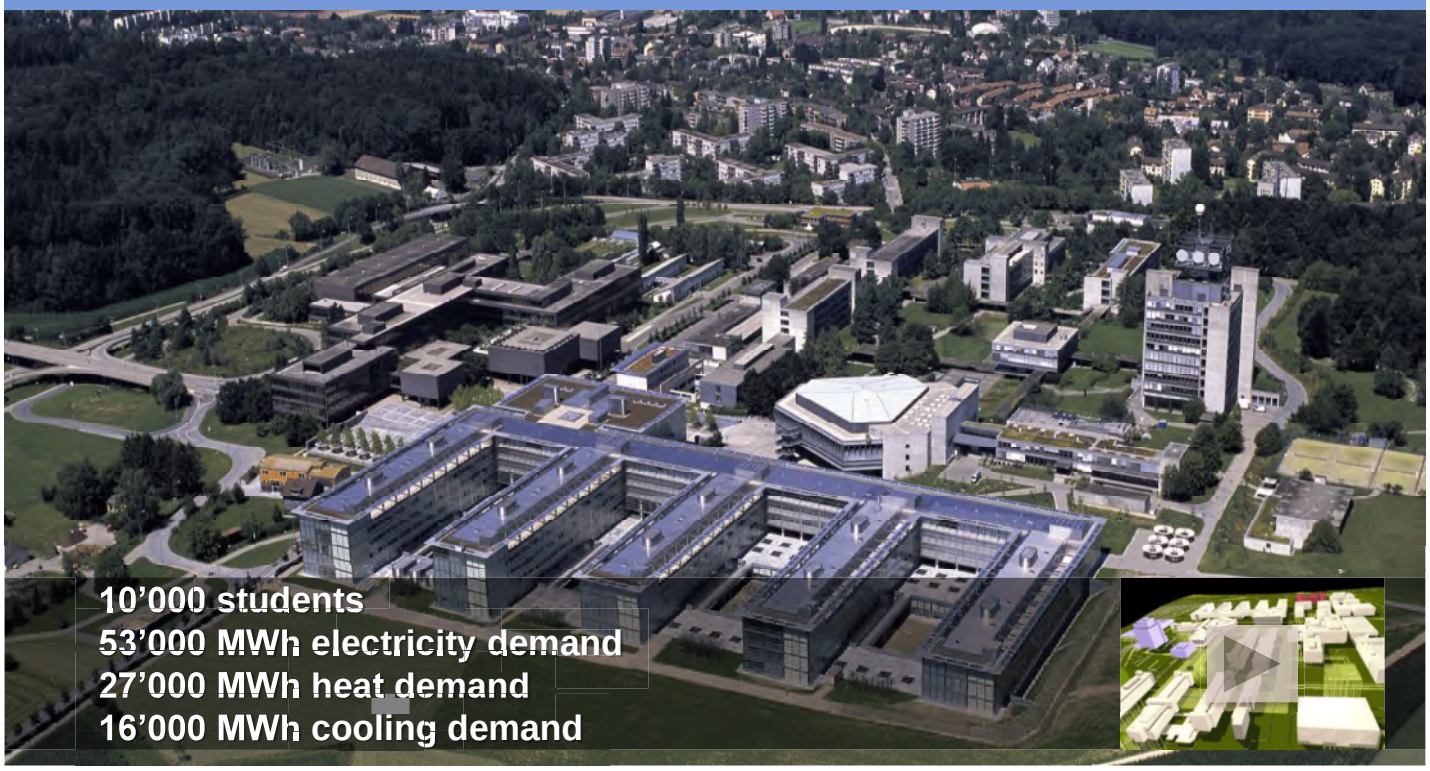
Bidirectional Network

Unidirectional ⟶ Bidirectional



‘conventionalDestrict Heating ⟶ Anergy Network

ETH Hönggerberg

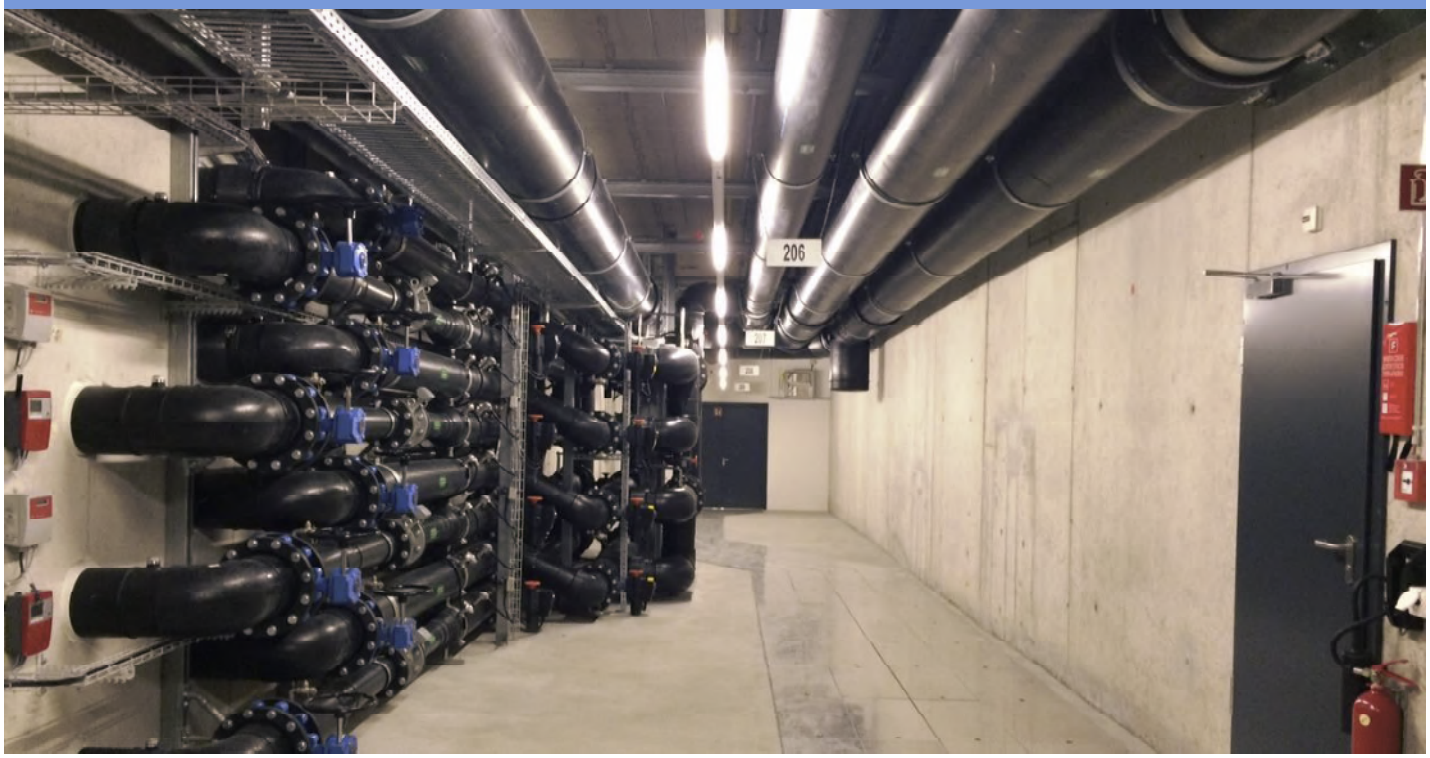


Übersicht

Movie

Anergy Pipes in Media Channel

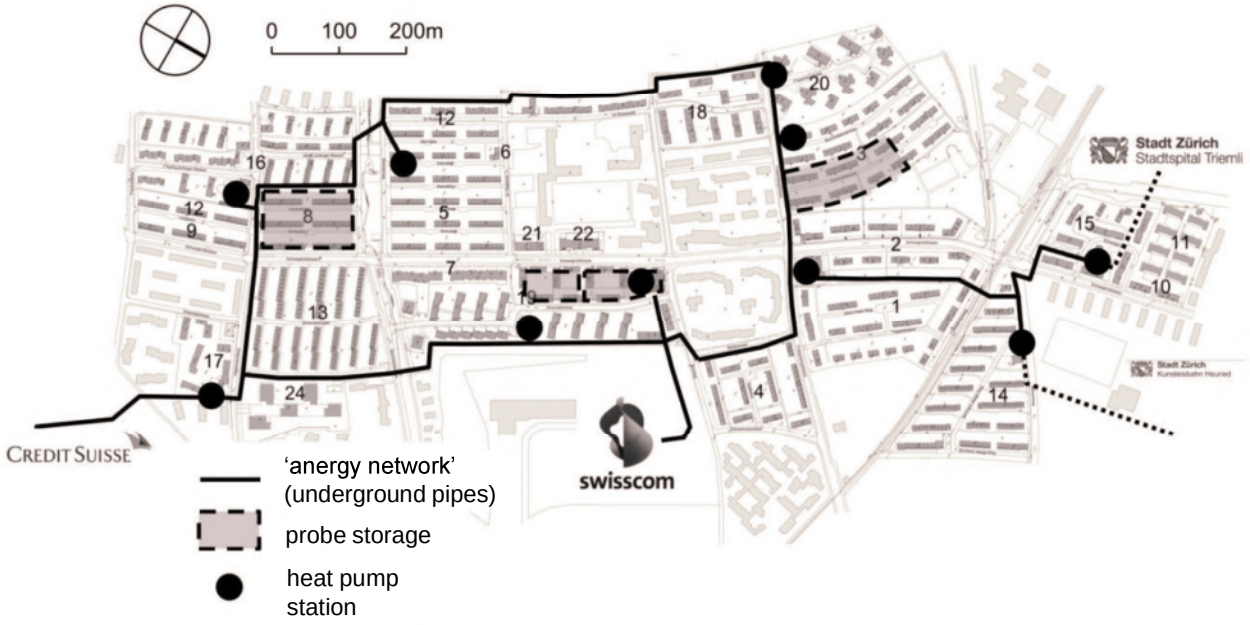
Plugging Station Bore Hole Field



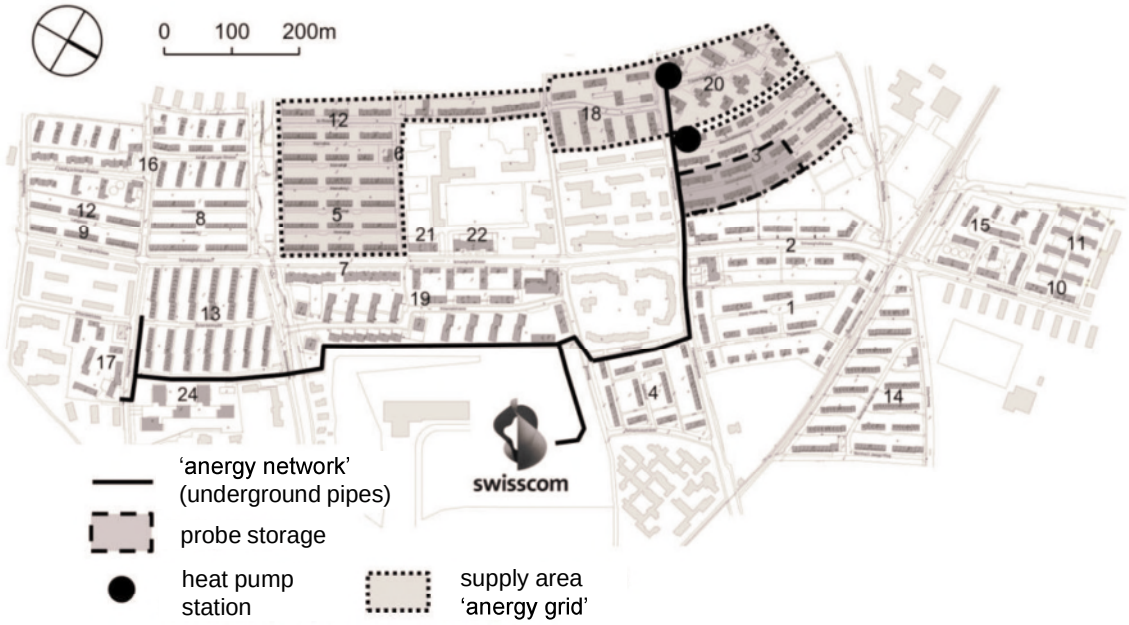
Heat Pump Station

Familienheim-Genossenschaft Zürich (FGZ)

Overview low temperature network FGZ

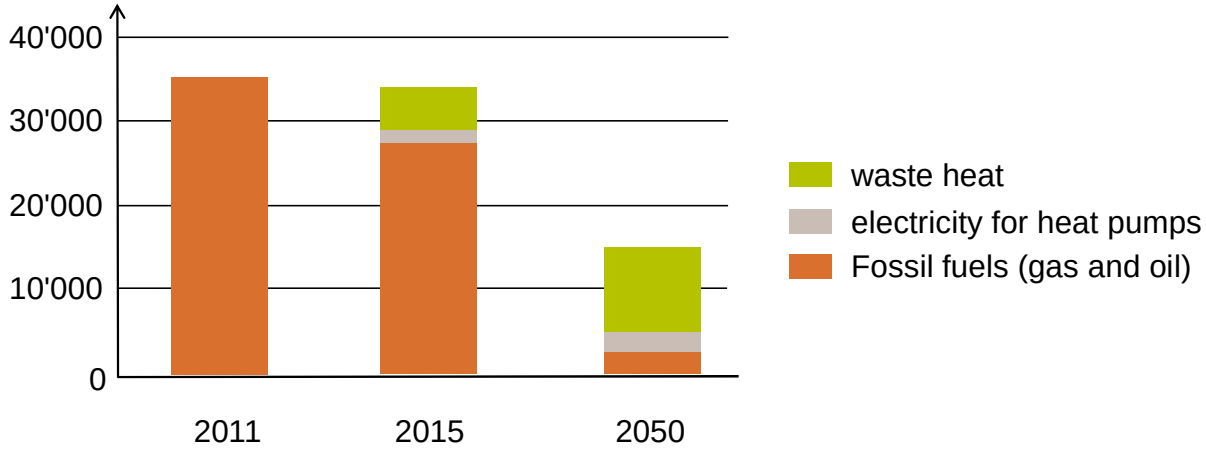


Stage of Implementation (2015)



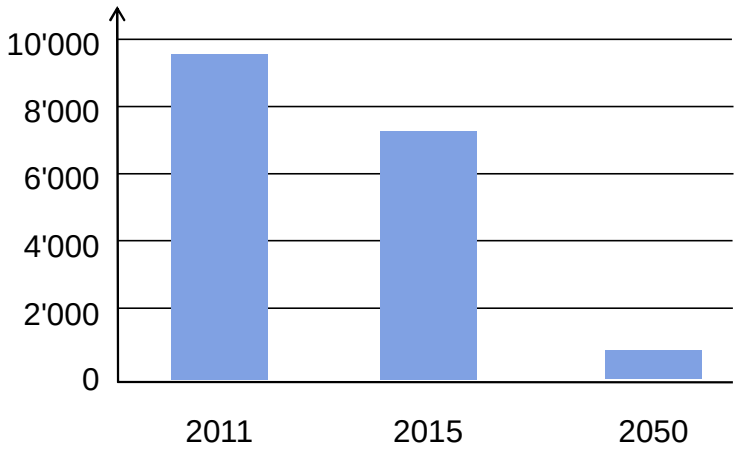
Energy Mix

heat demand in MWh/a



Greenhouse Gas Emissions

CO_2-eq emissions in t/a



Waste Heat from Data Center Swisscom

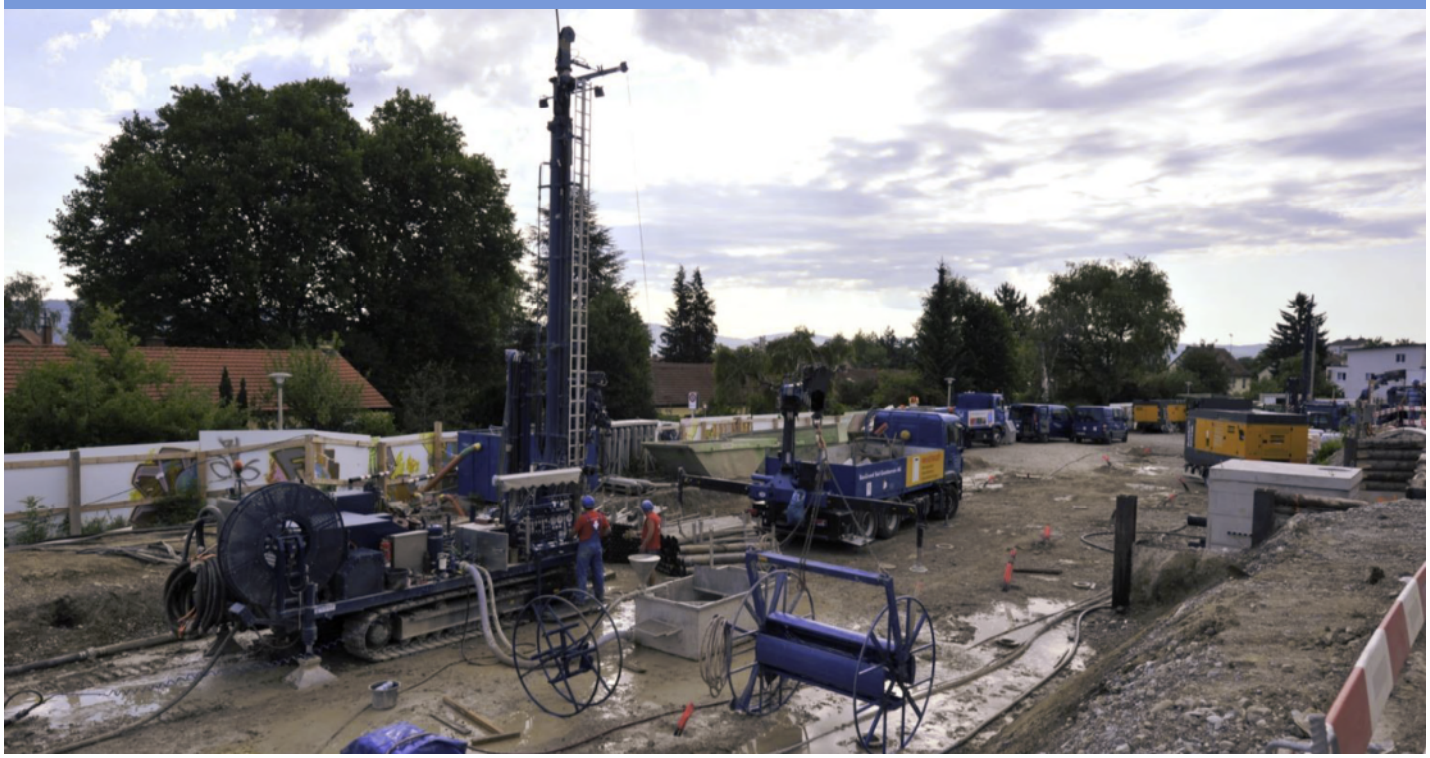
Heat Exchange Station Swisscom

Heat Exchange Station Swisscom

‘Anergy’ Pipes

‘Anergy’ Pipes

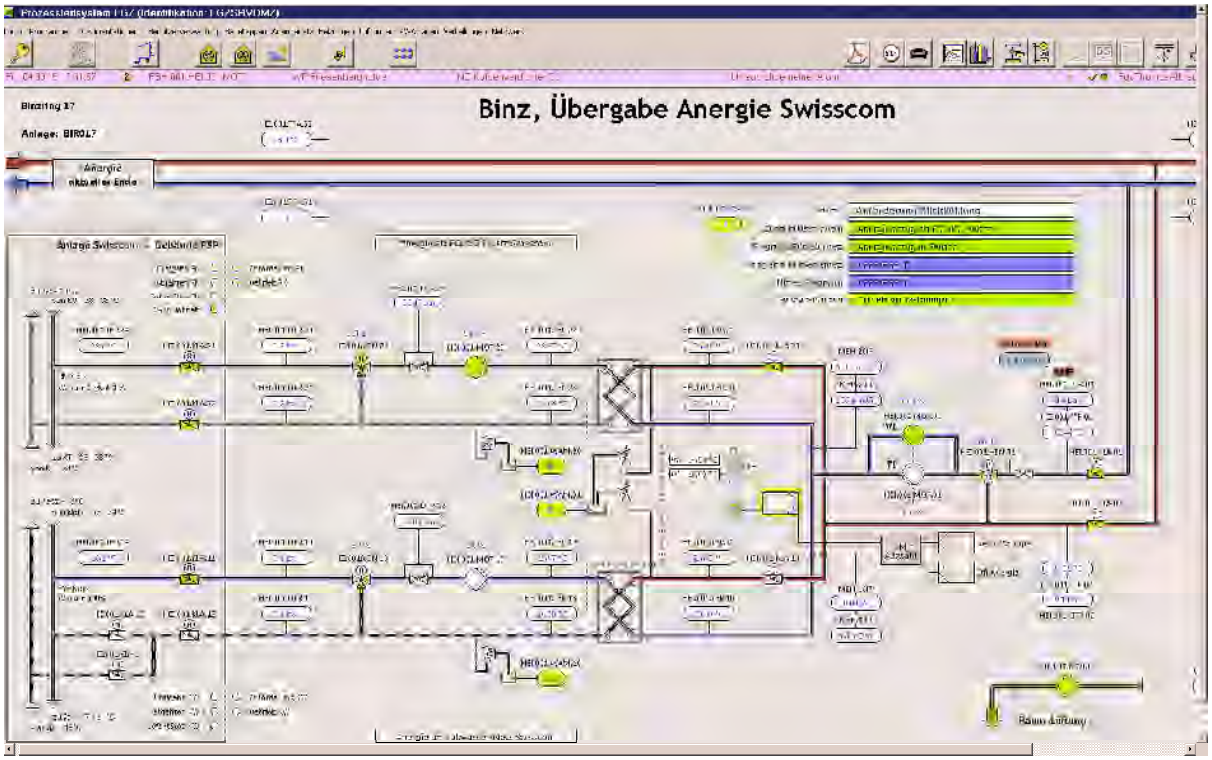
Geothermal Storage



Geothermal Storage

Heat Pump Station

Energy Management System



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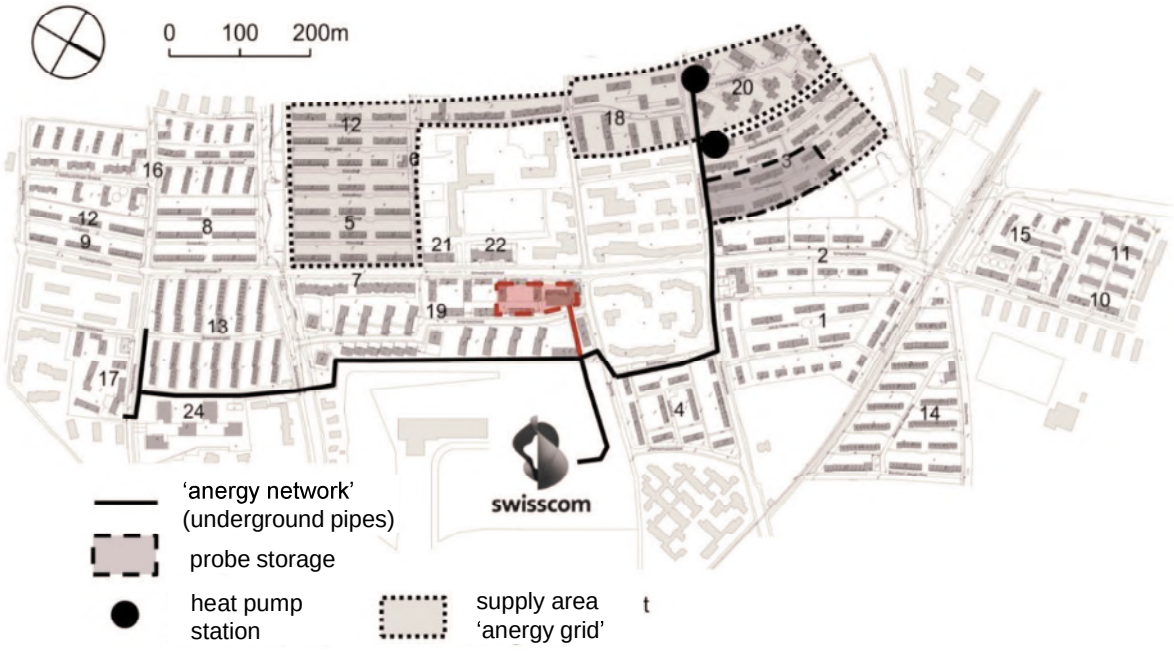
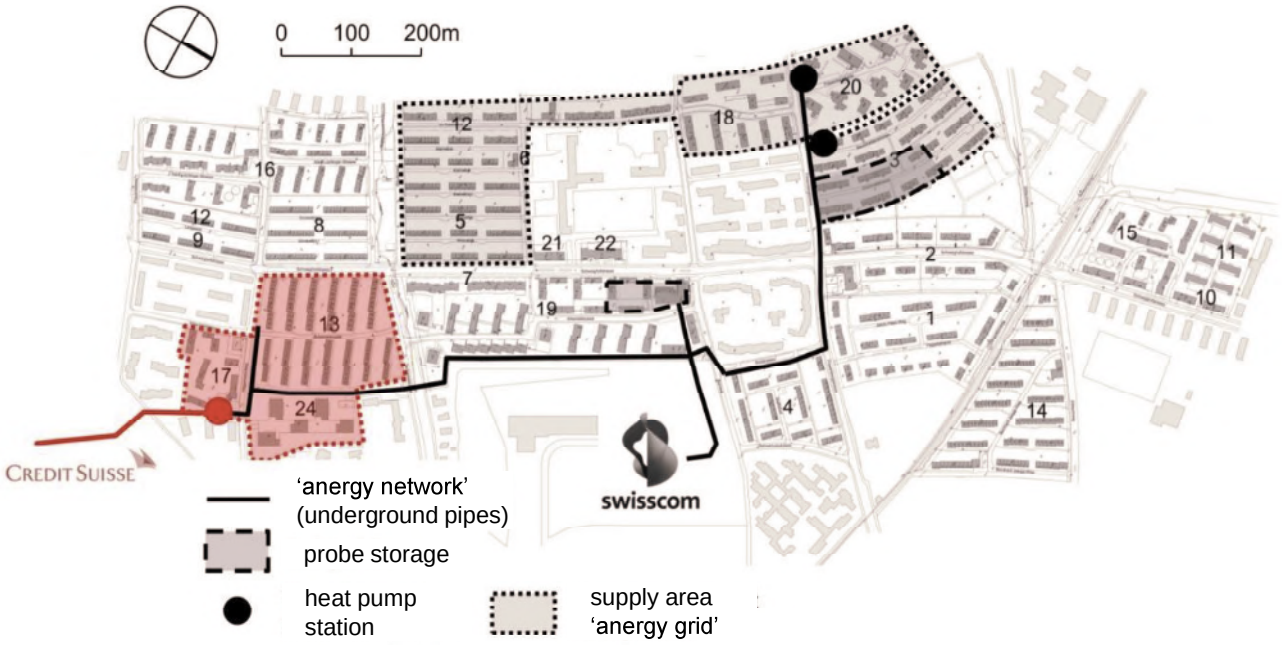
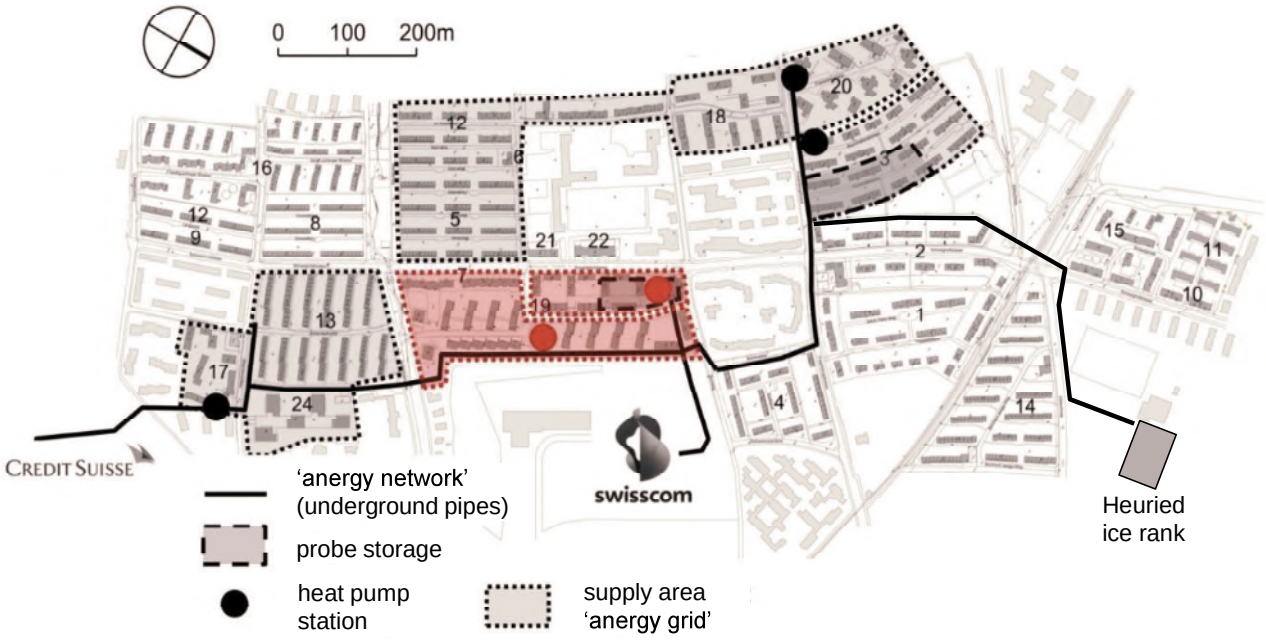
Future Installation by Stages



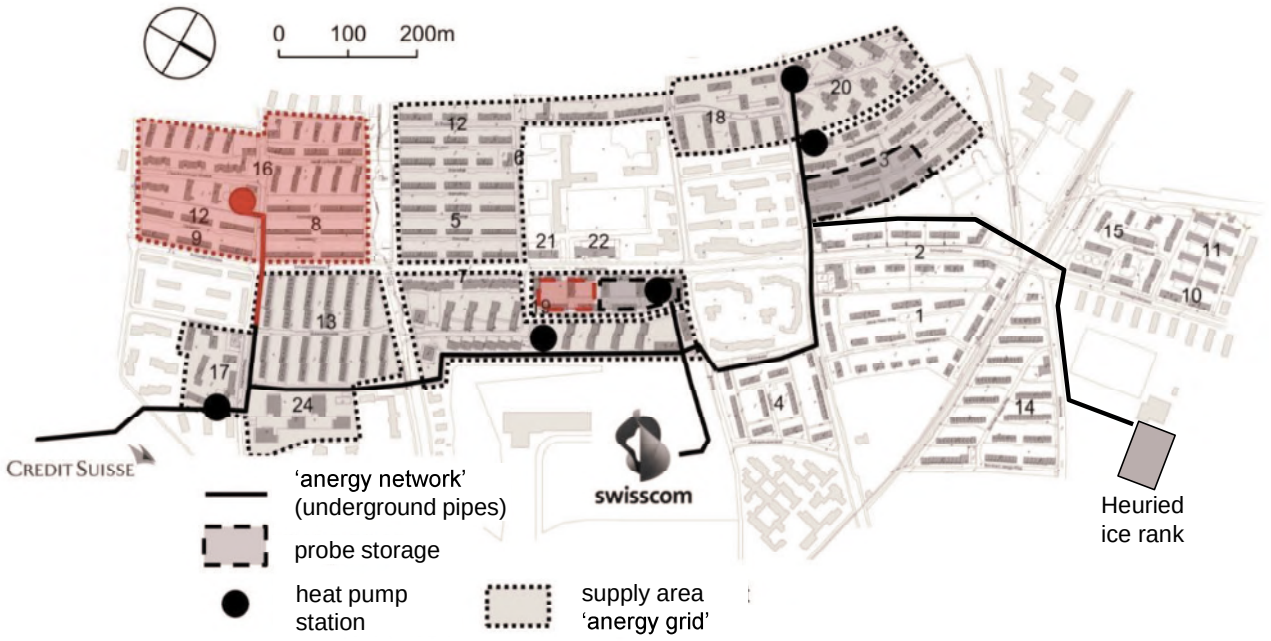
Future Installation by Stages



Future Installations



Future Installations



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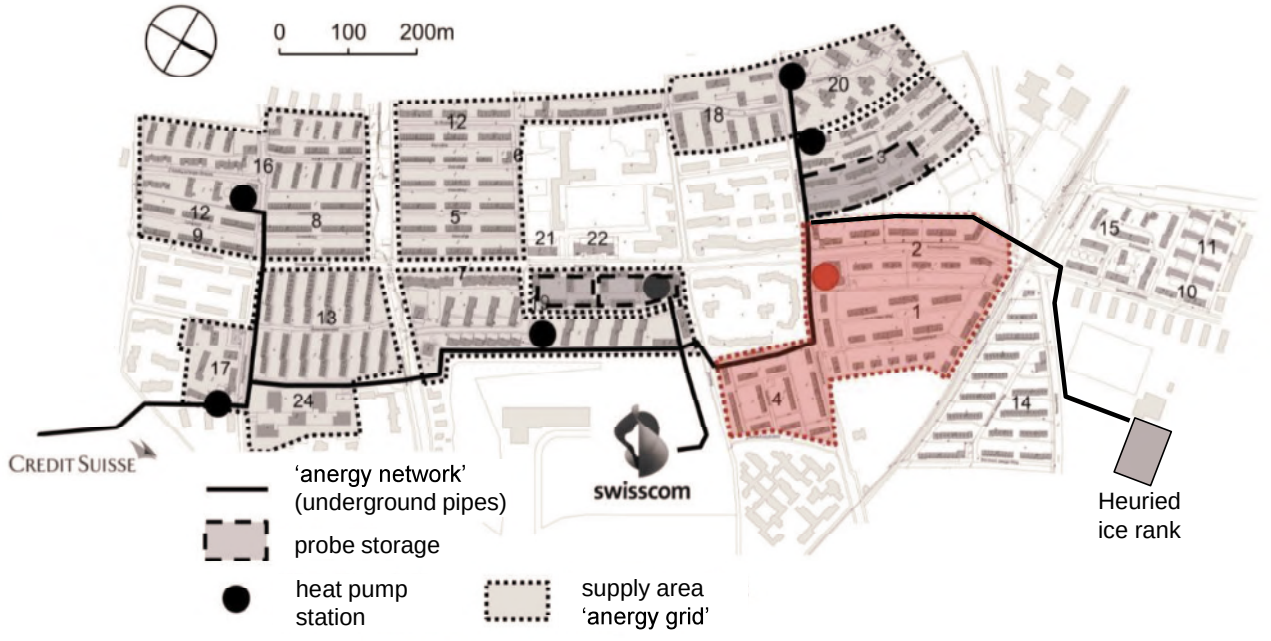
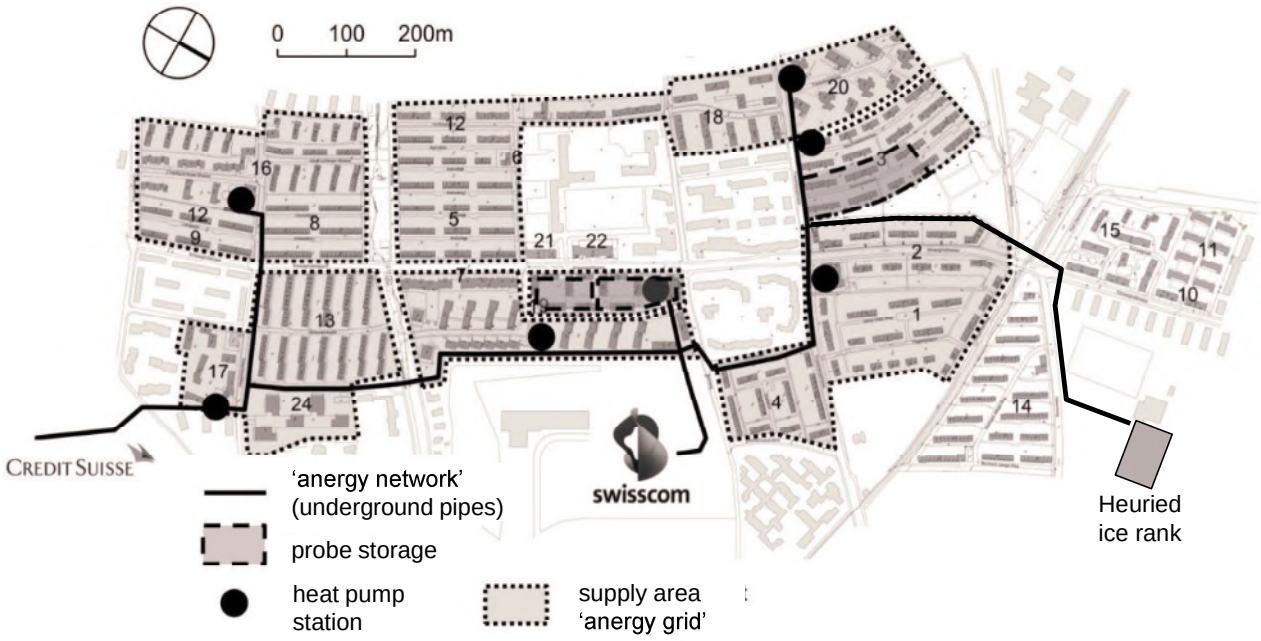
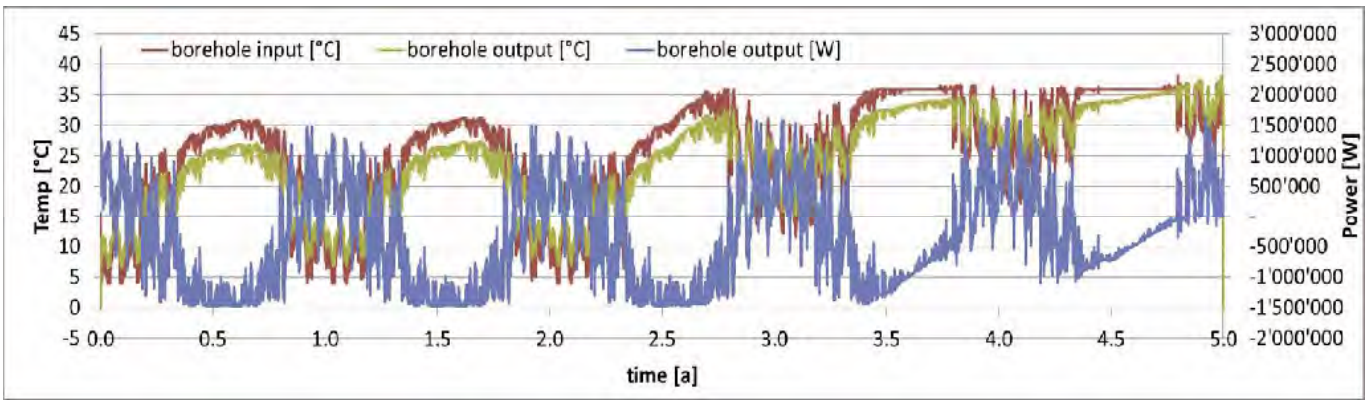
Future Installations



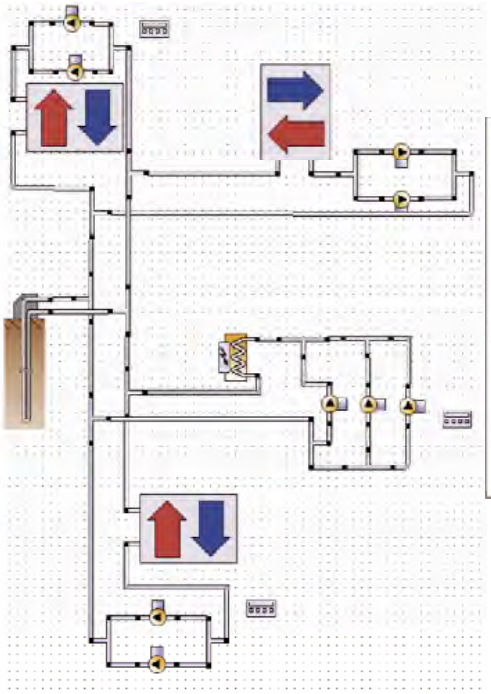
Future Installations

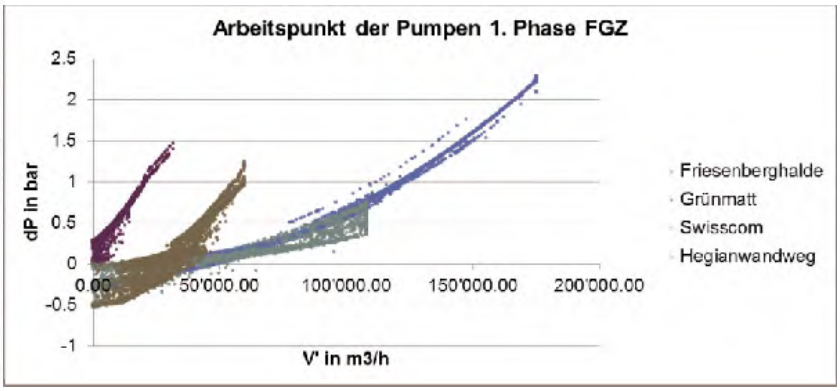


Simulation – Network Temperature Development

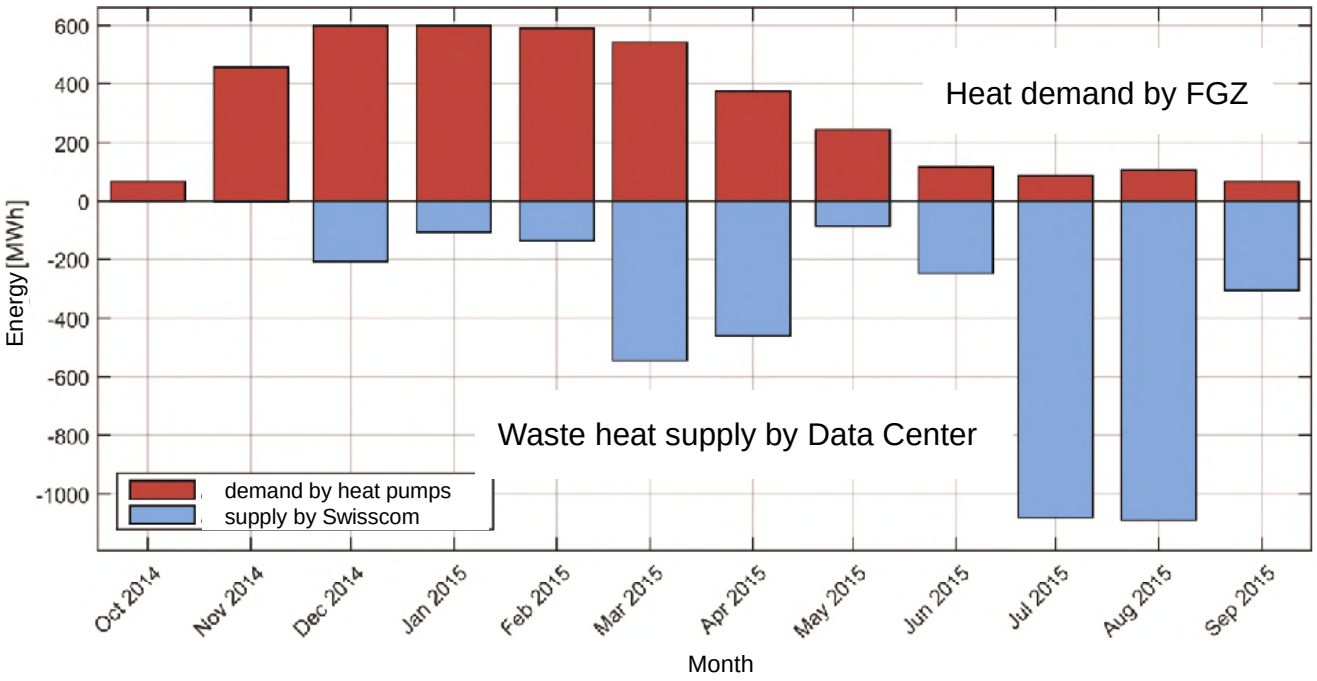


Simulation – Hydraulics for Pump Dimensioning





Operating Figures – Waste heat demand and delivery



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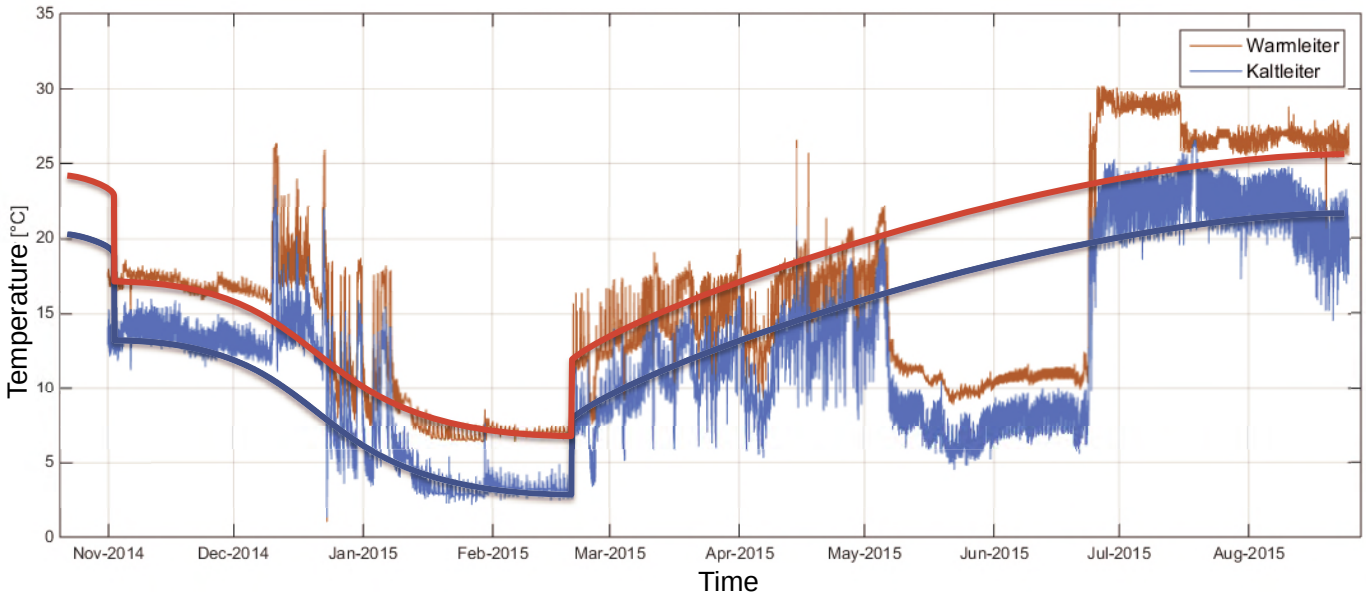
Operating Figures– Temperature Profile of Network



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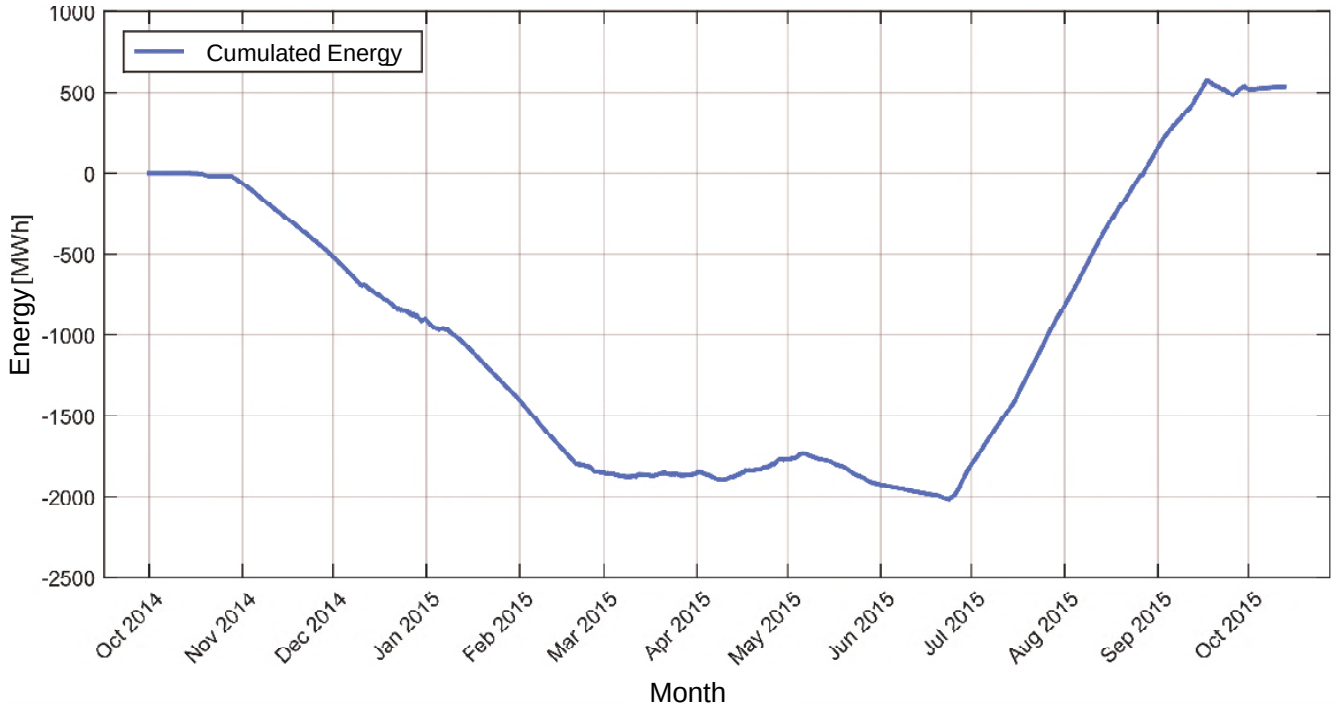
Operating Figures – Load of Bore Hole Field



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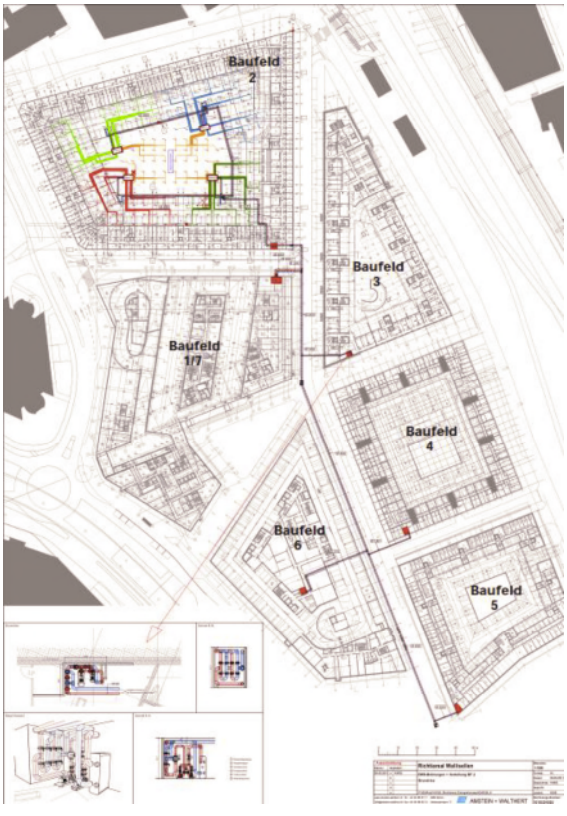
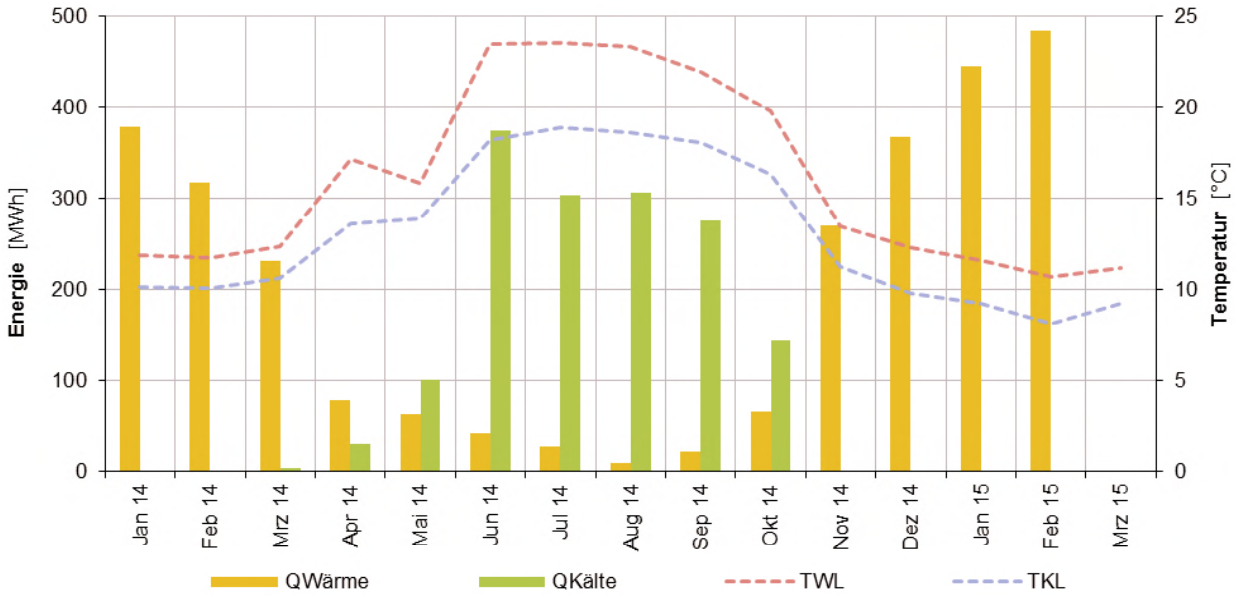
Network ‘Richti Areal’ in Wallisellen (Zurich)

AMSTEIN+WALTHERT

Overview Anergy Network ‘Richti’ Area



Operating Figures – Energy Balance, Temperatures



Outlook – Potential Areas for Anergy Networks

AMSTEIN + WALTHERT

Thank you very much for your attention

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Amstein+Walthert AG
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 helds 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.

Back to the program ↑

Contents

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

SWM Business Units

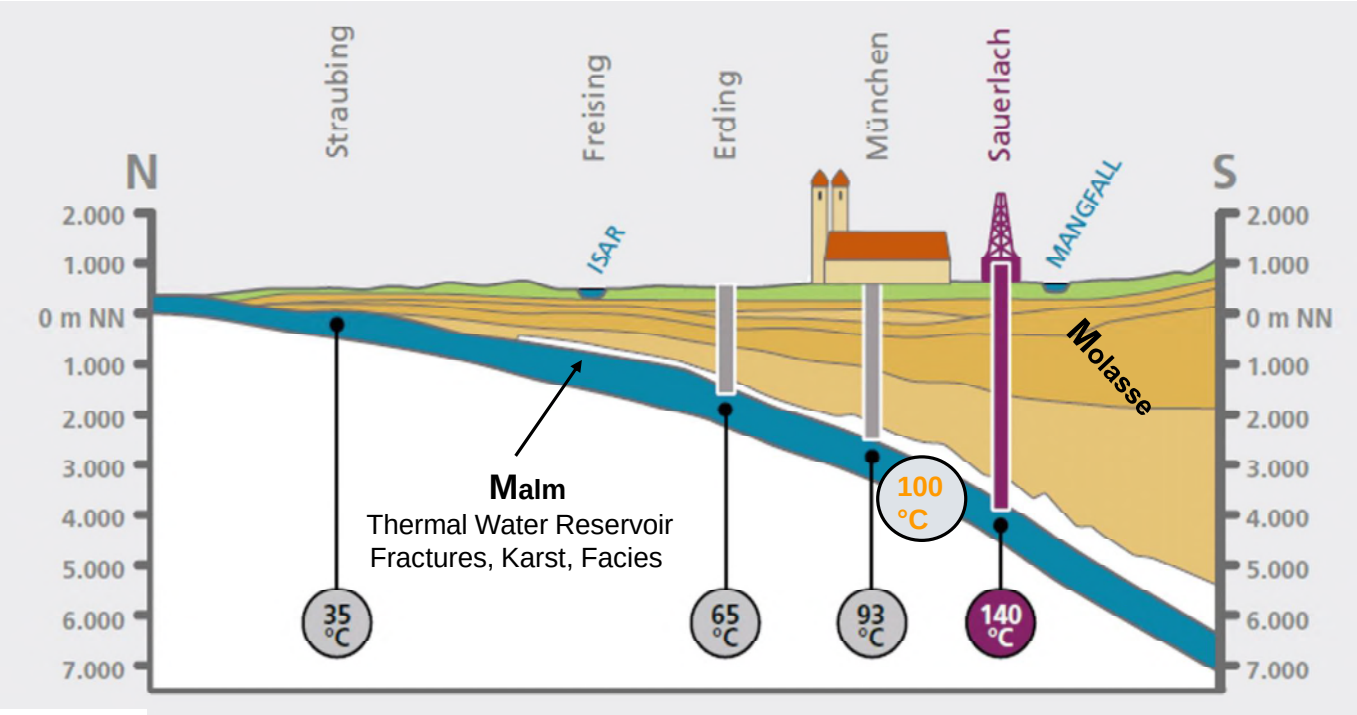
- Power (Production, Distribution, Sales)
- District Heating (Production, Distribution, Sales)
- Gas (Distribution, Sales, Exploration)
- Water (Production, Distribution, Sales)
- Public Swimming Pools (Indoor, Outdoor, Saunas, Ice Skating)
- Mobility (MVG: Metro, Tram, Bus)
- Telecommunication (Networks,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

SWM District Heating Vision

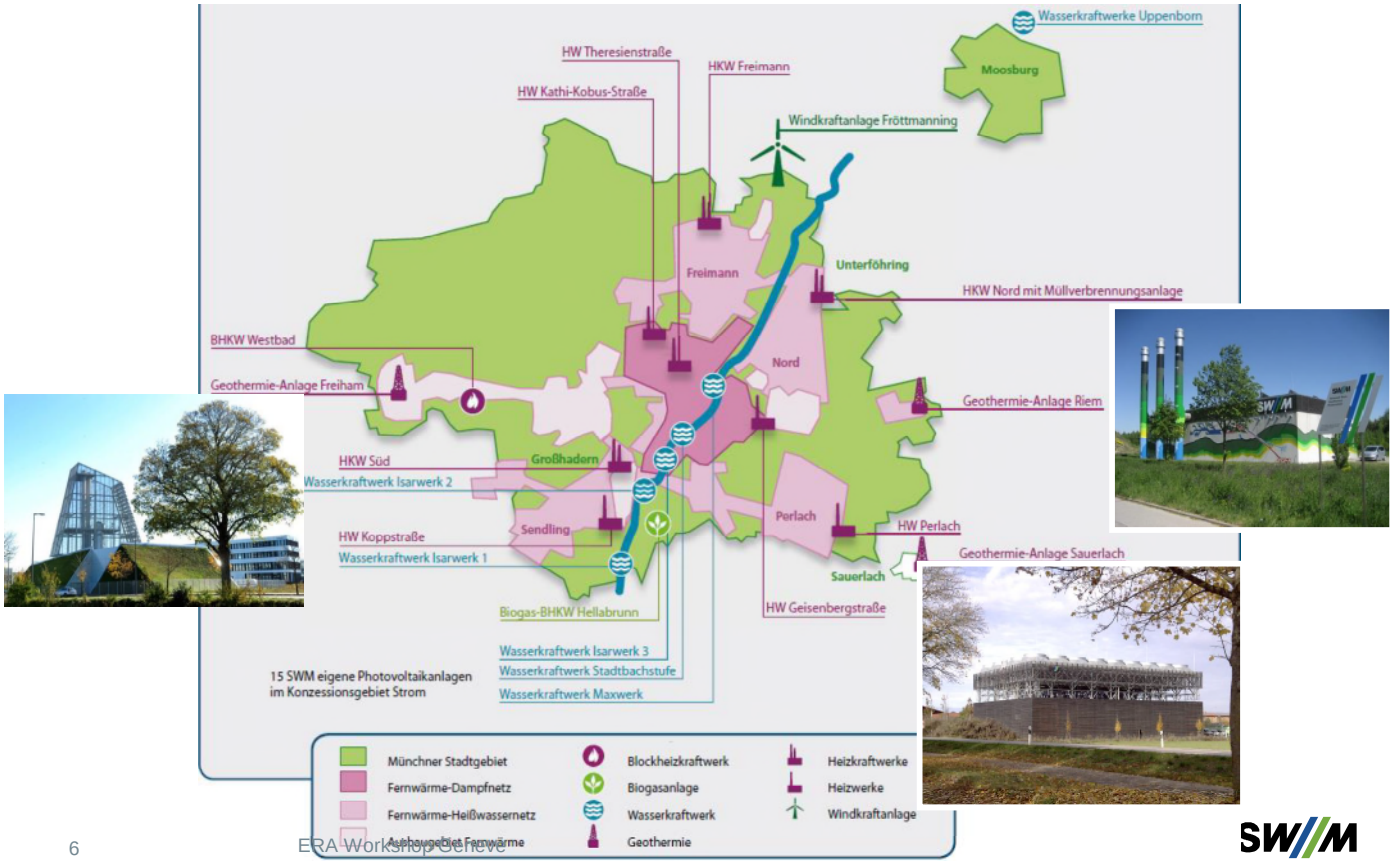
The vision for SWM´s district heating system
fully renewable from 2040

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

Geothermal – **M**-Energy Geological Conditions



Energy Supply SWM



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“

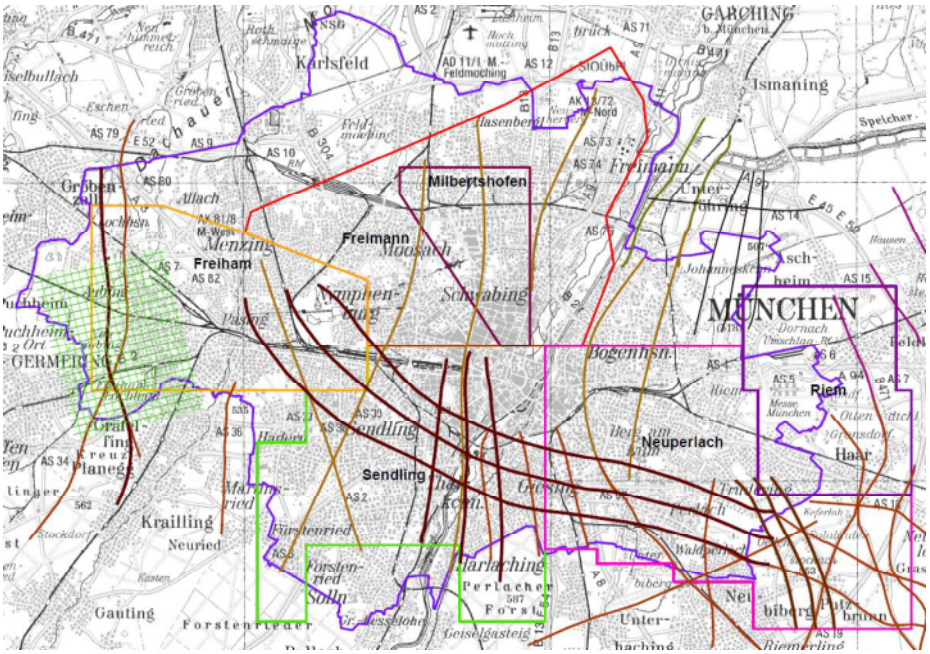
Optimized and Sustainable Reservoir Development for Deep Geothermal Plants in the Bavarian Molasse Basin

-

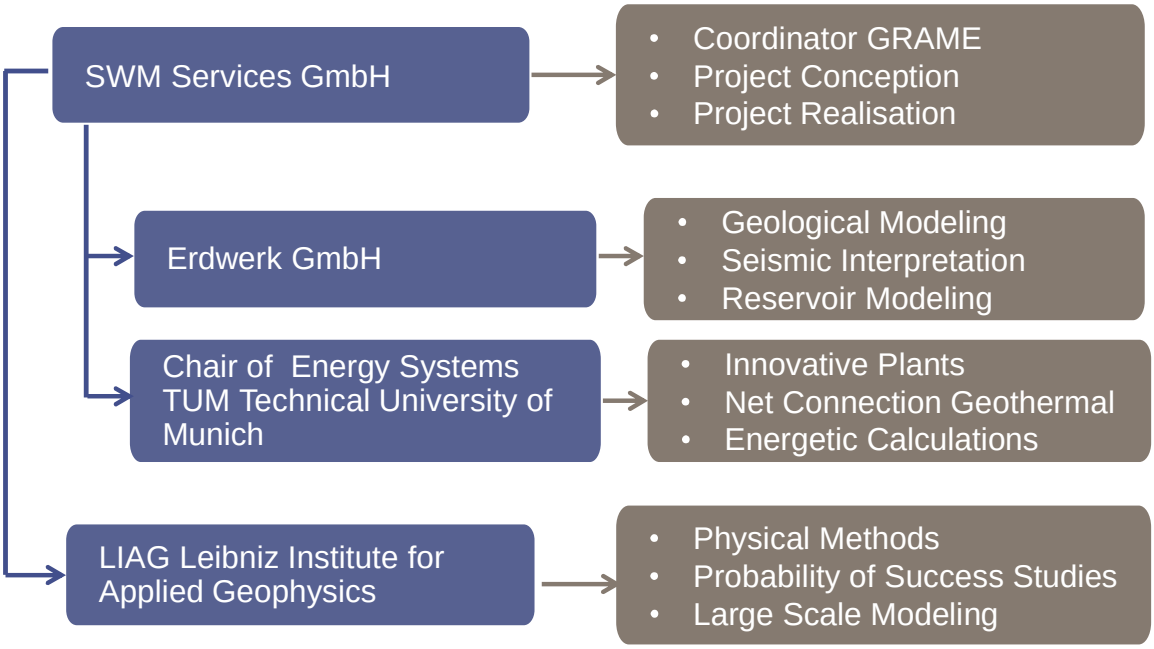
Design of a 50 MWe Powerplant and Development of 400 MWth for the Munich District Heating

GRAME Topics

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



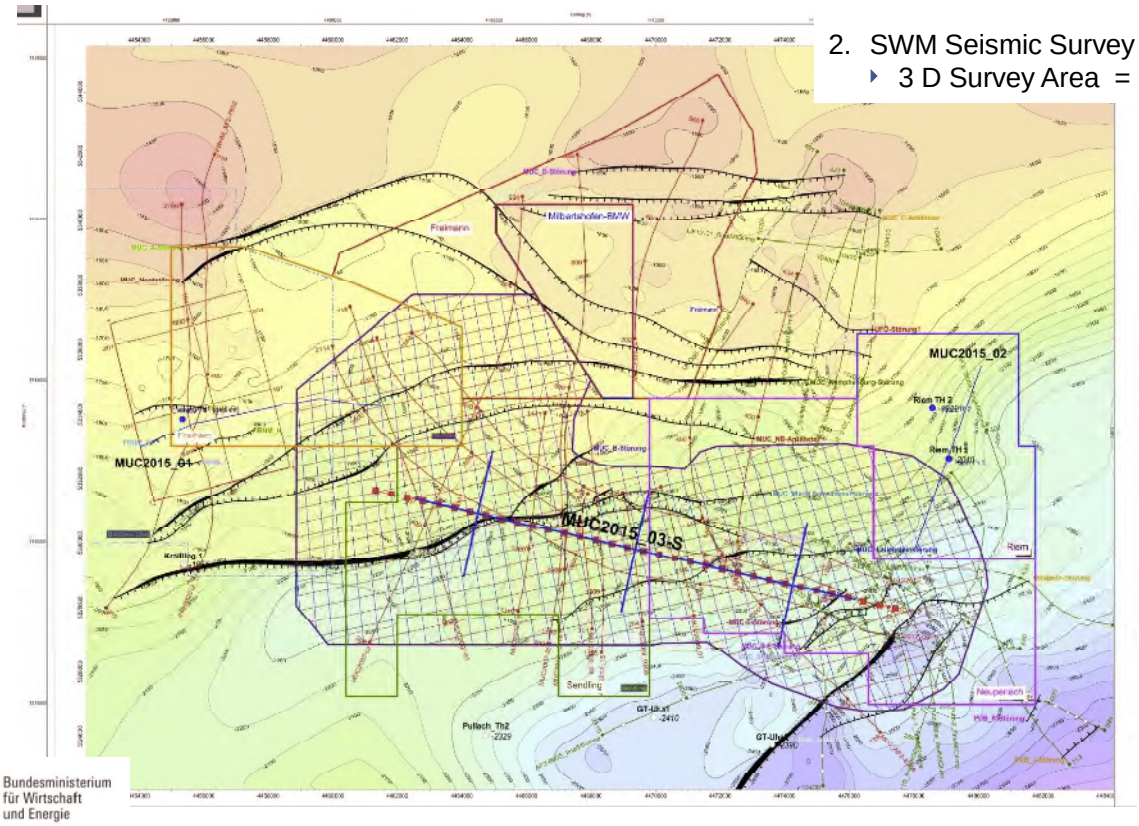
Participants in GRAME



Timetable

SWM Seismic Surveys

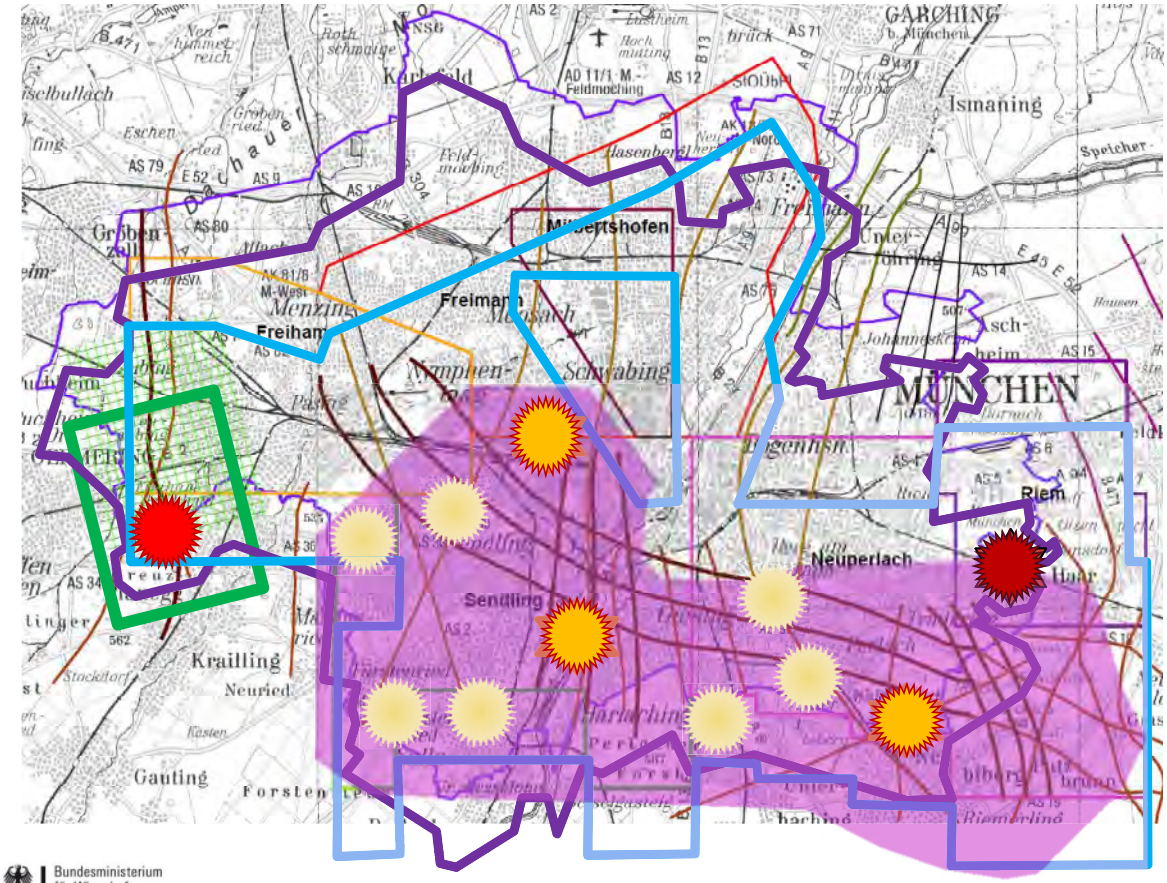
1. SWM Seismic Surveys Munich
   - 2 D Line Length = 200 km
   - 3 D Survey Area = 20 km²
2. SWM Seismic Survey GRAME 2015
   - 3 D Survey Area = 170 km²



Seismic Campaign 2015-2016

Surveys	Parameters
3 D Seismic	170 km², 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



Bundesministerium für Wirtschaft und Energie

SW//M

Stadtwerke München SW//M

Thanks for your attention!

Netherlands – René Verhoeven & Herman Eijdems (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 Eijdems 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 Vitrivius 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.

Back to the program ↑

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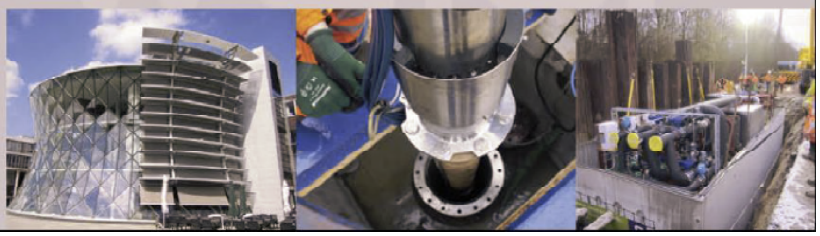

European Geothermal Innovation Award
Winner 2015

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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)
Herman Eijdems (h.eijdems@mijnwater.com)
Mijnwater B.V.

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Content

1. System development:
   - Minewater 1.0 (past)
   - Minewater 2.0 (present)
   - Minewater 3.0 (next step)
   - Summary

2. Roadmap to carbon neutral areas

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Location Minewater Project

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Minewater 1.0

Pilot (2008–2013)

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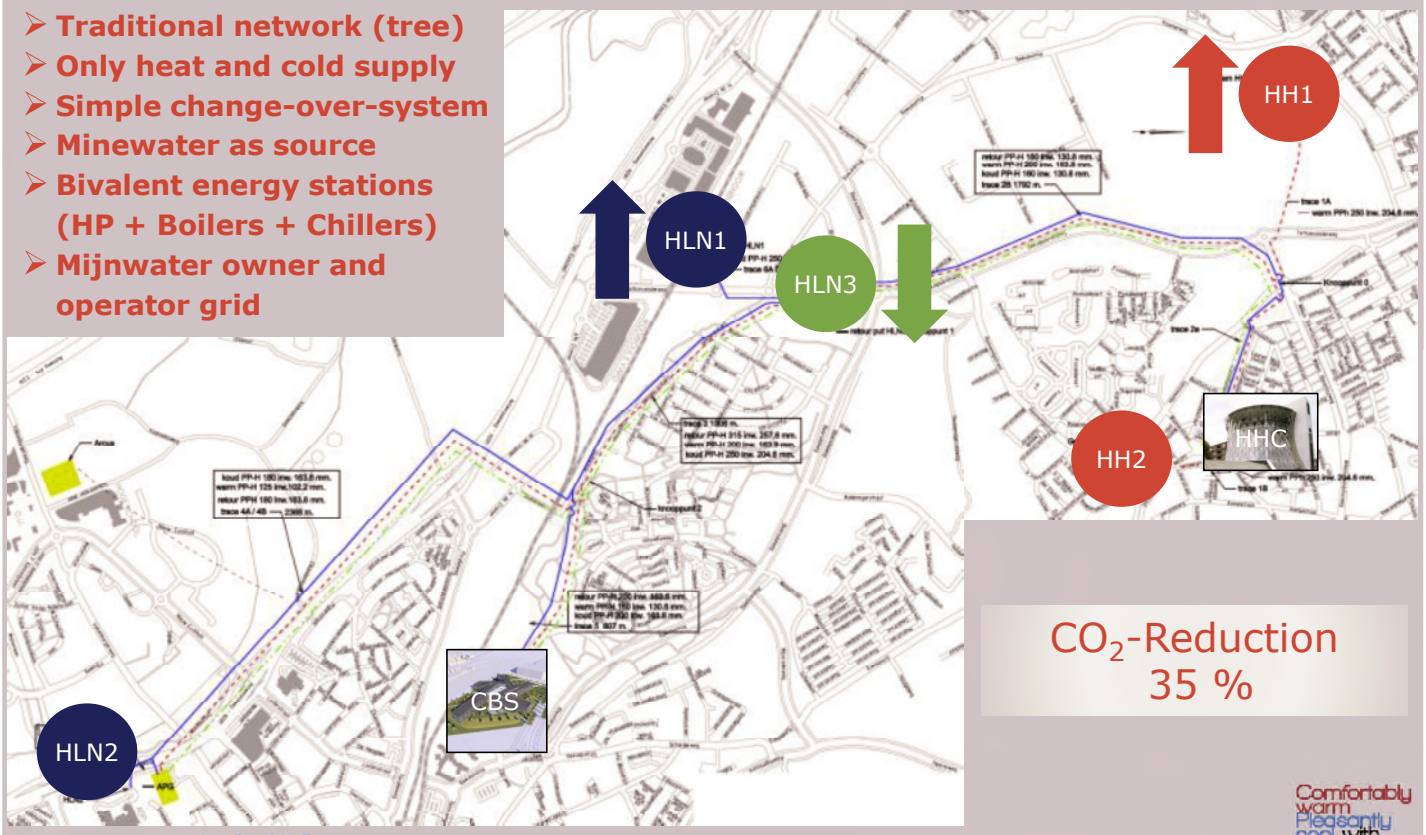
- Traditional network (tree)
- Only heat and cold supply
- Simple change-over-system
- Minewater as source
- Bivalent energy stations (HP + Boilers + Chillers)
- Mijnwater owner and operator grid



CO_2-Reduction
35 %

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Minewater 1.0

Minewater as source

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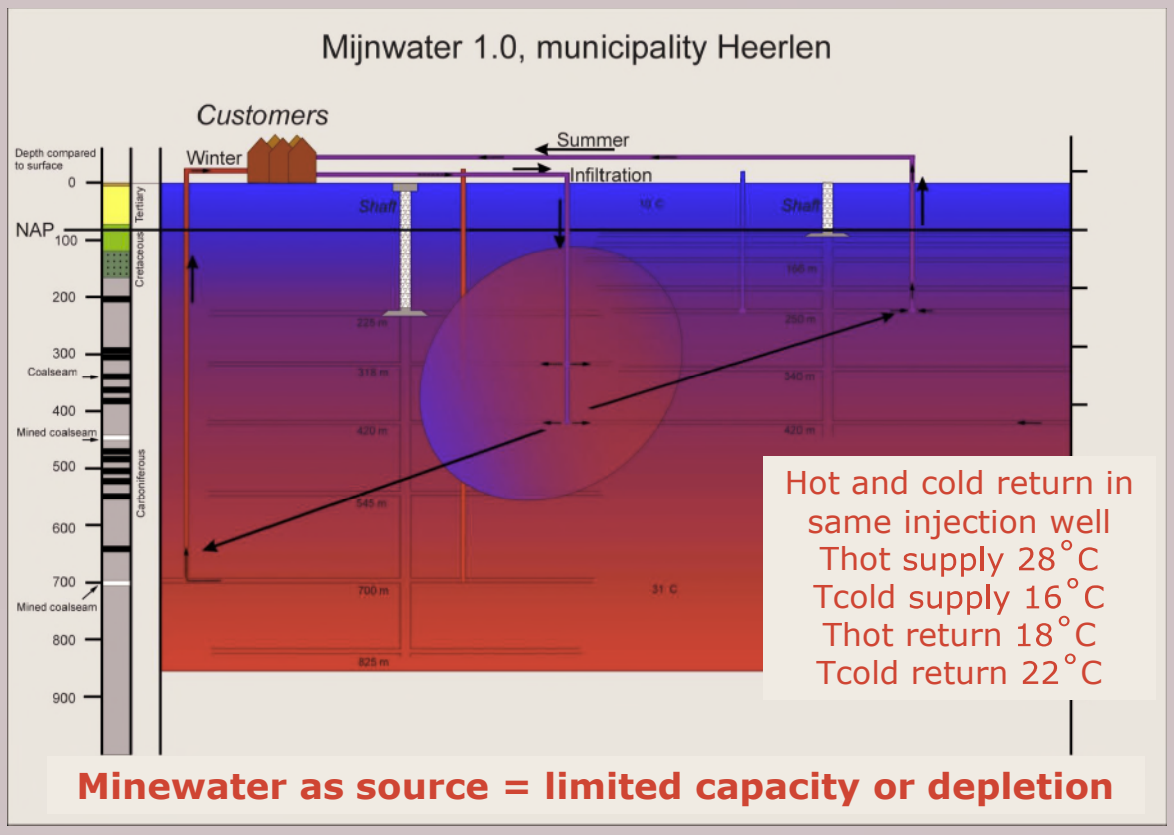

Minewater as source = limited capacity or depletion

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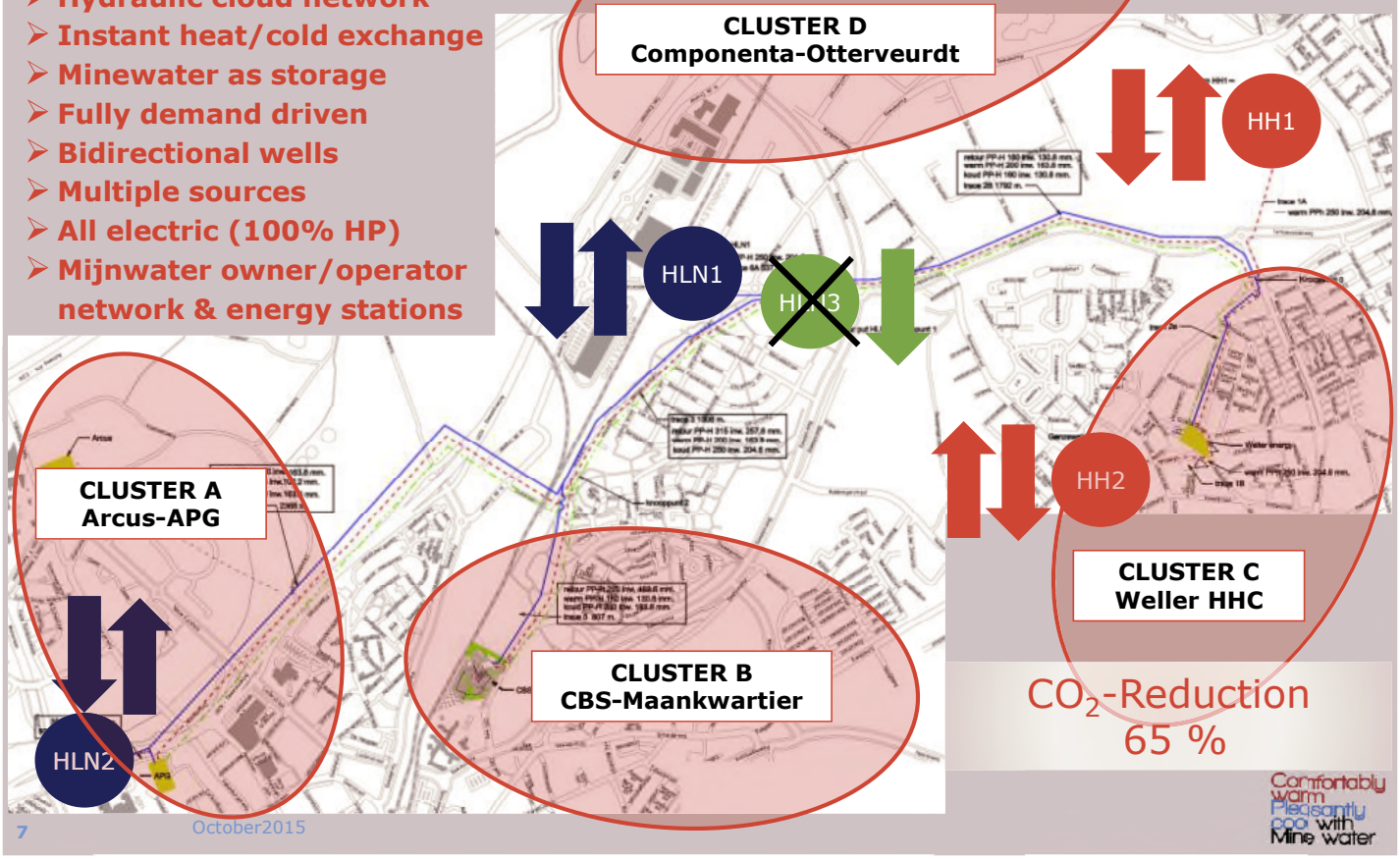
Minewater 2.0

Clusters of buildings (since 2013)

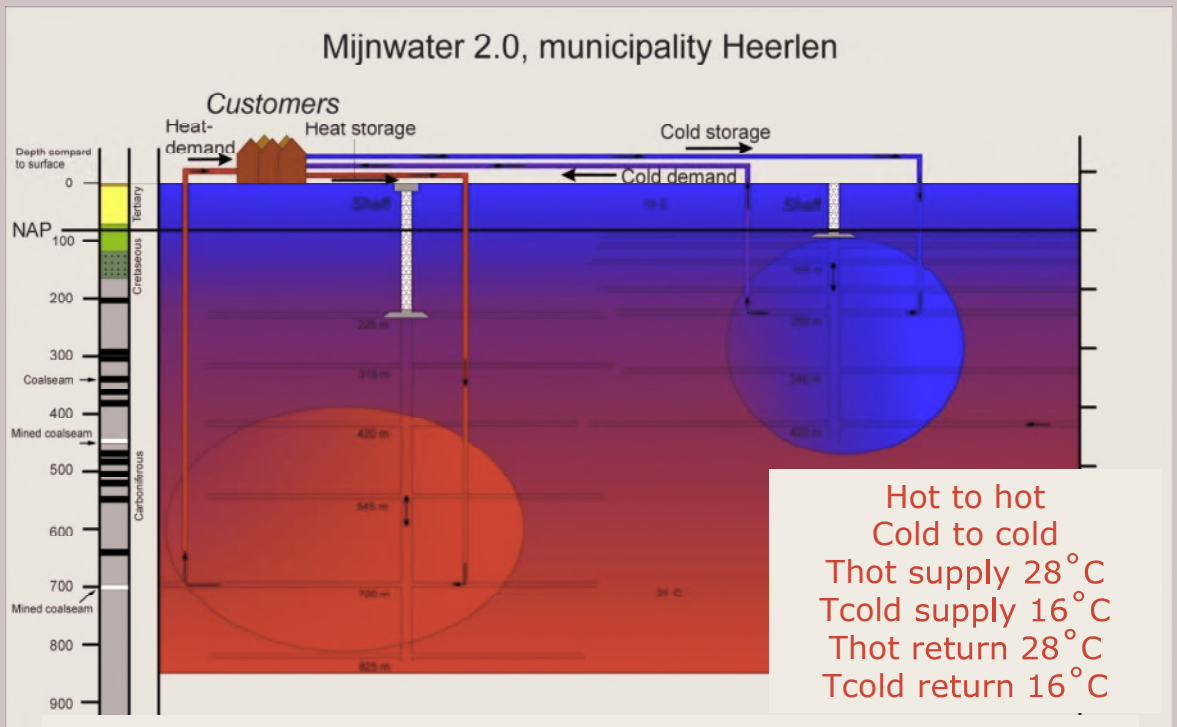
- Hydraulic cloud network
- Instant heat/cold exchange
- Minewater as storage
- Fully demand driven
- Bidirectional wells
- Multiple sources
- All electric (100% HP)
- Mijnwater owner/operator network & energy stations



CO_2-Reduction
65 %

Minewater 2.0

Minewater as storage



Hot to hot
Cold to cold
Thot supply 28°C
Tcold supply 16°C
Thot return 28°C
Tcold return 16°C

Minewater as storage = regeneration = no depletion = increase capacity

Minewater 2.0

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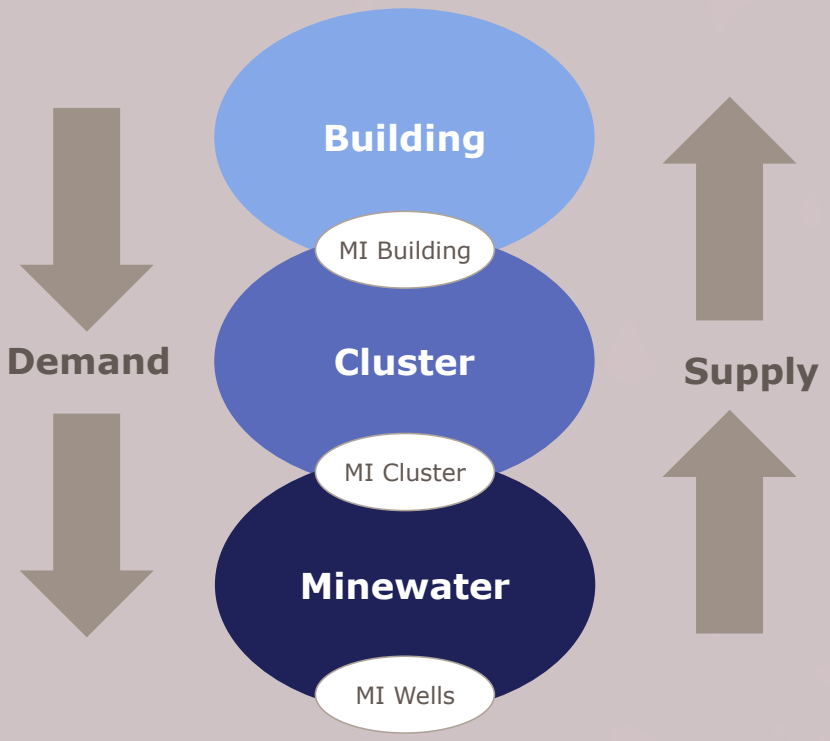
Smart grid: 3 levels of control

- Building
  Temperature
- Cluster
  Flow
- Minewater
  Pressure



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Minewater 2.0

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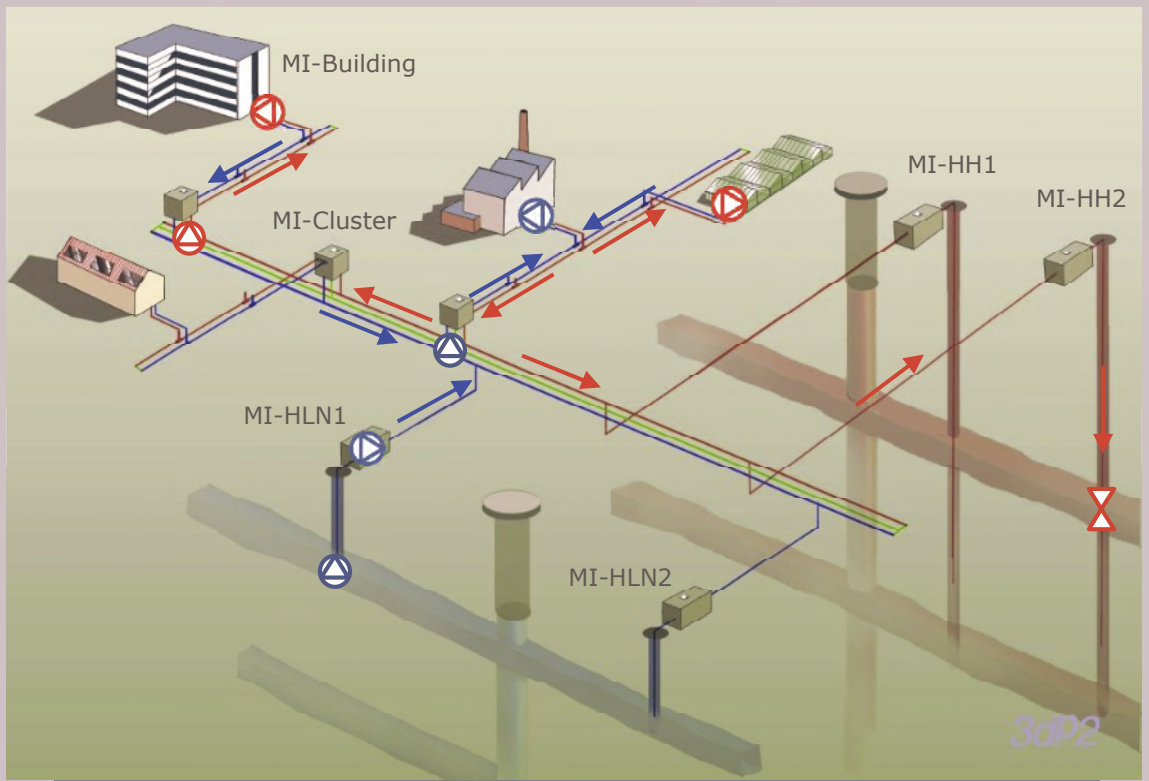
Smart grid: Exchange!



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

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Minewater 2.0

Advanced process control

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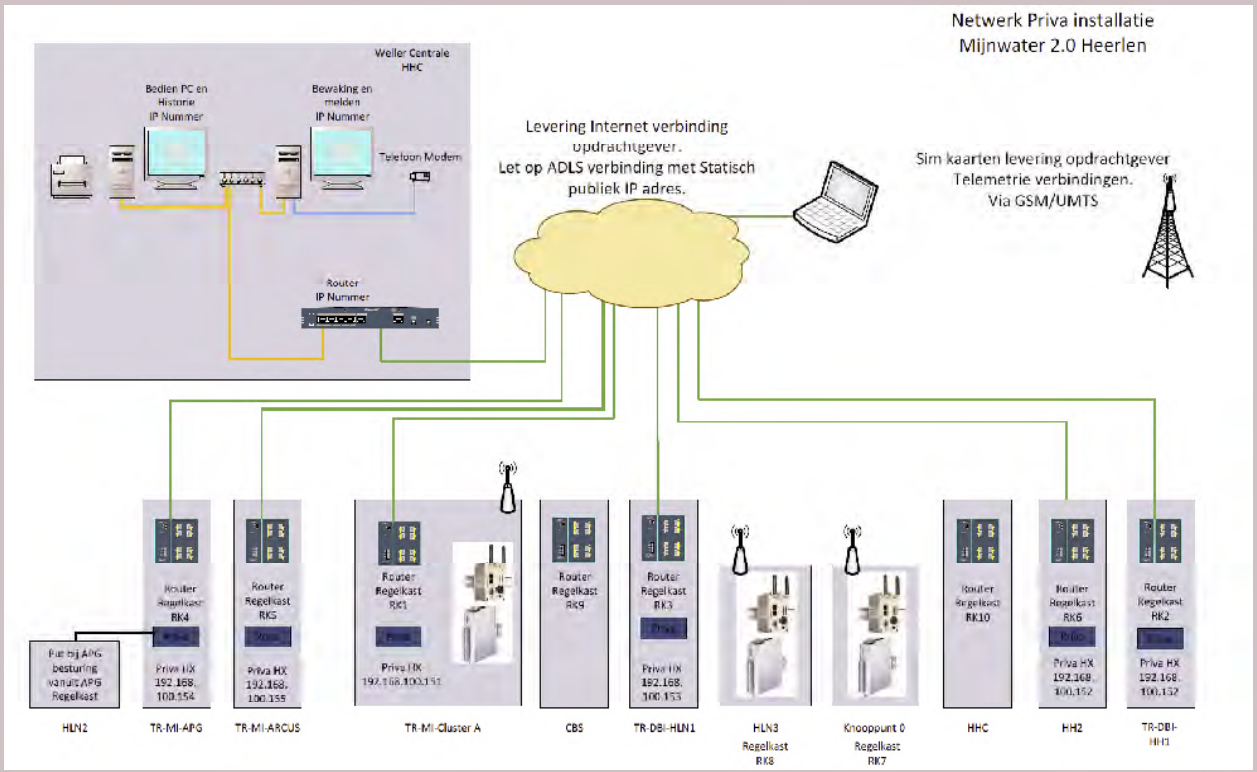

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Minewater 3.0

The NEXT step!

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Balancing with.....

Time

CO_2-Reduction
80-100 %

INTELLIGENCE

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Minewater 3.0

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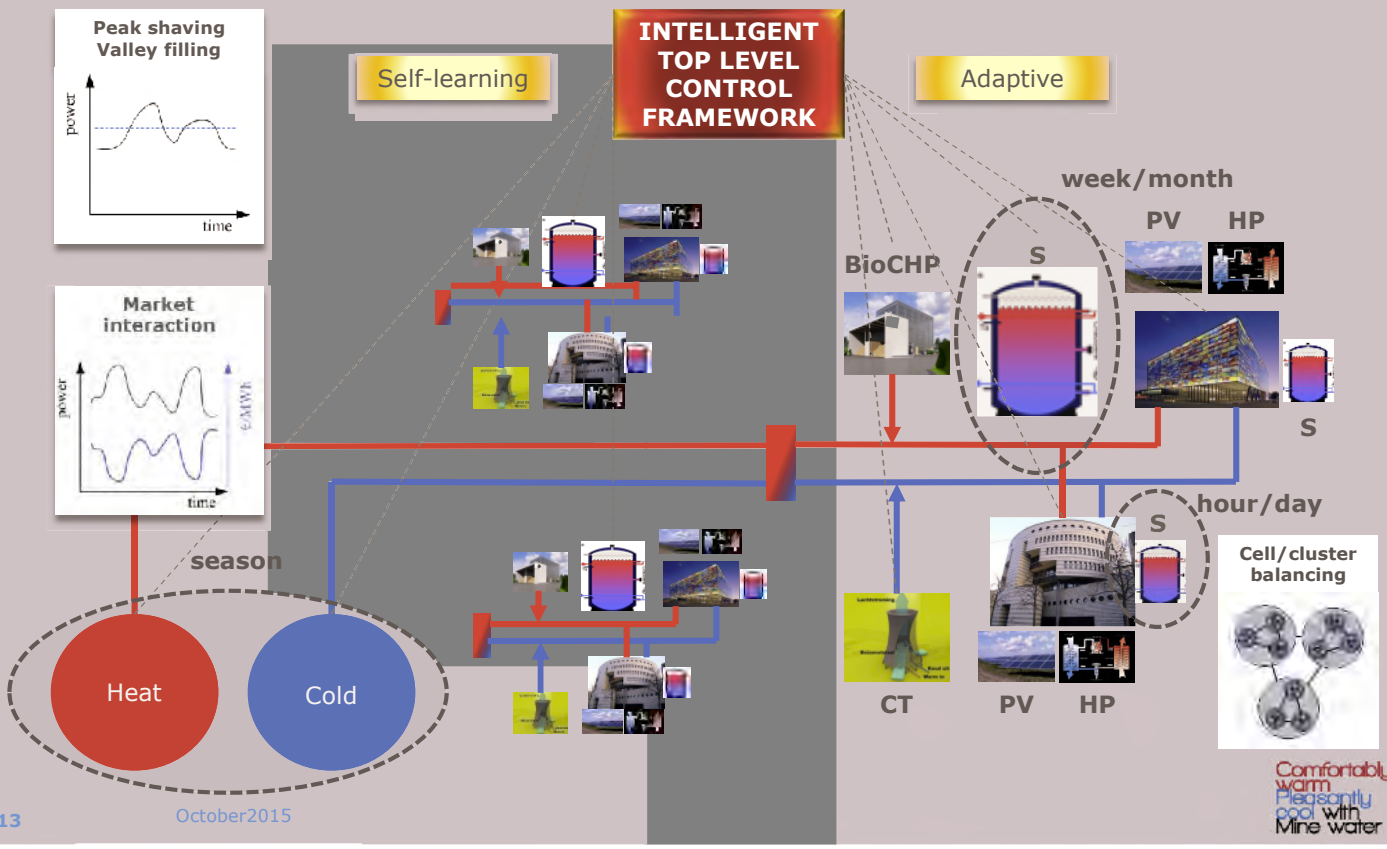
STORM (Self-organizing Thermal Operational Resource Management)



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Minewater Heerlen

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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_2-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

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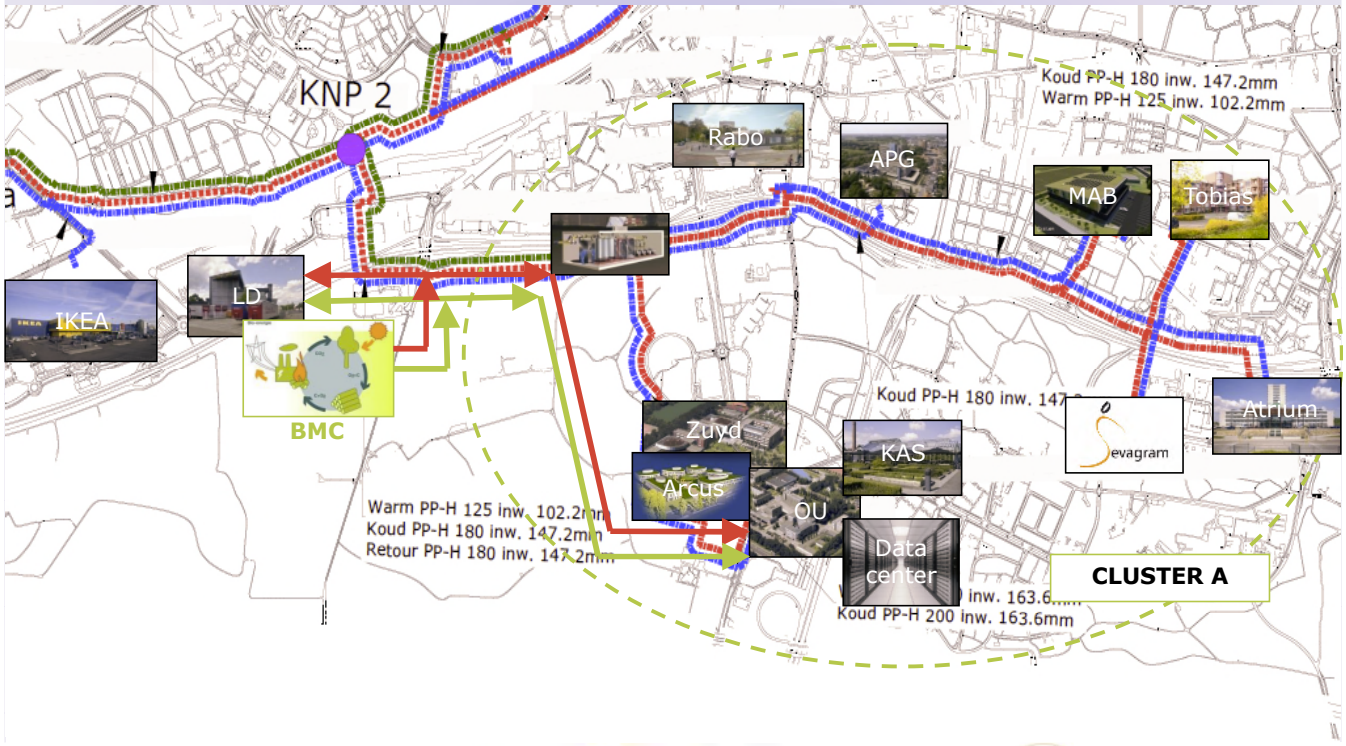
Geothermal ERA-NET

SUSTAINABLE PLACES

European Geothermal Innovation Award Winner 2015

Herman Eijdems
Mijnwater B.V.

Mijnwater – grid Heerlen cluster A



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Geothermal ERA-NET

SUSTAINABLE PLACES

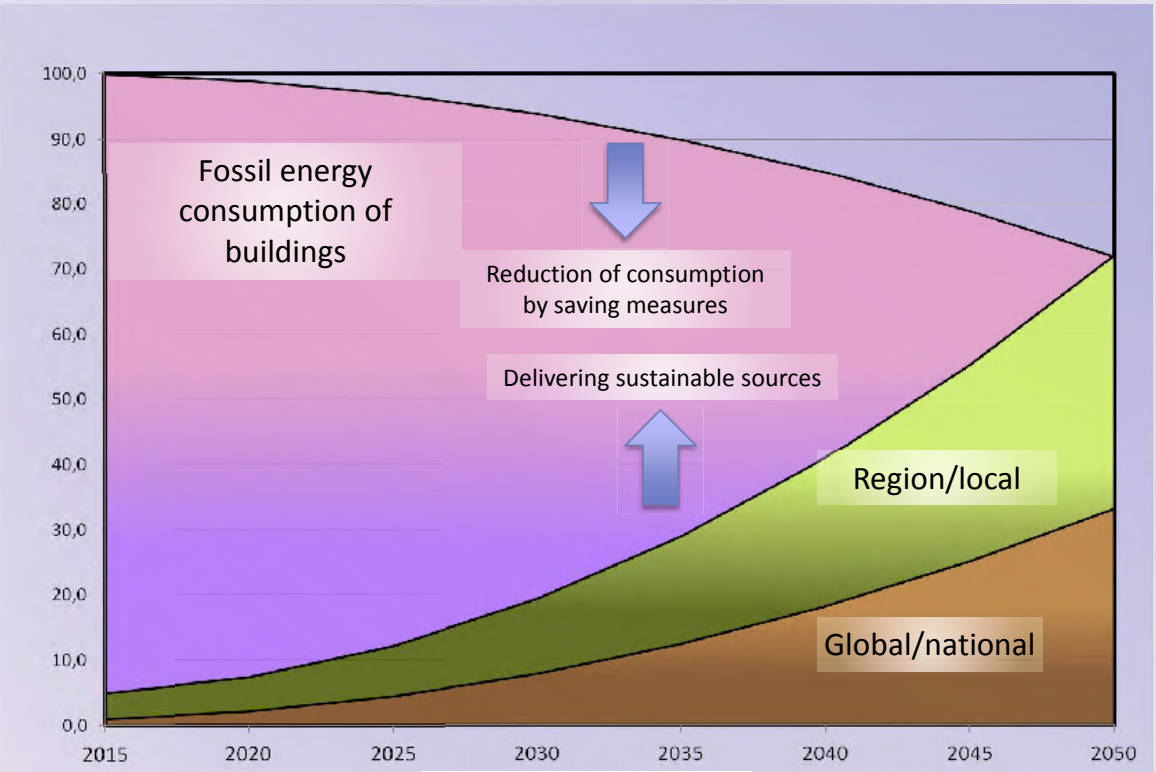
European Geothermal Innovation Award Winner 2015

Herman Eijdems
Mijnwater B.V.

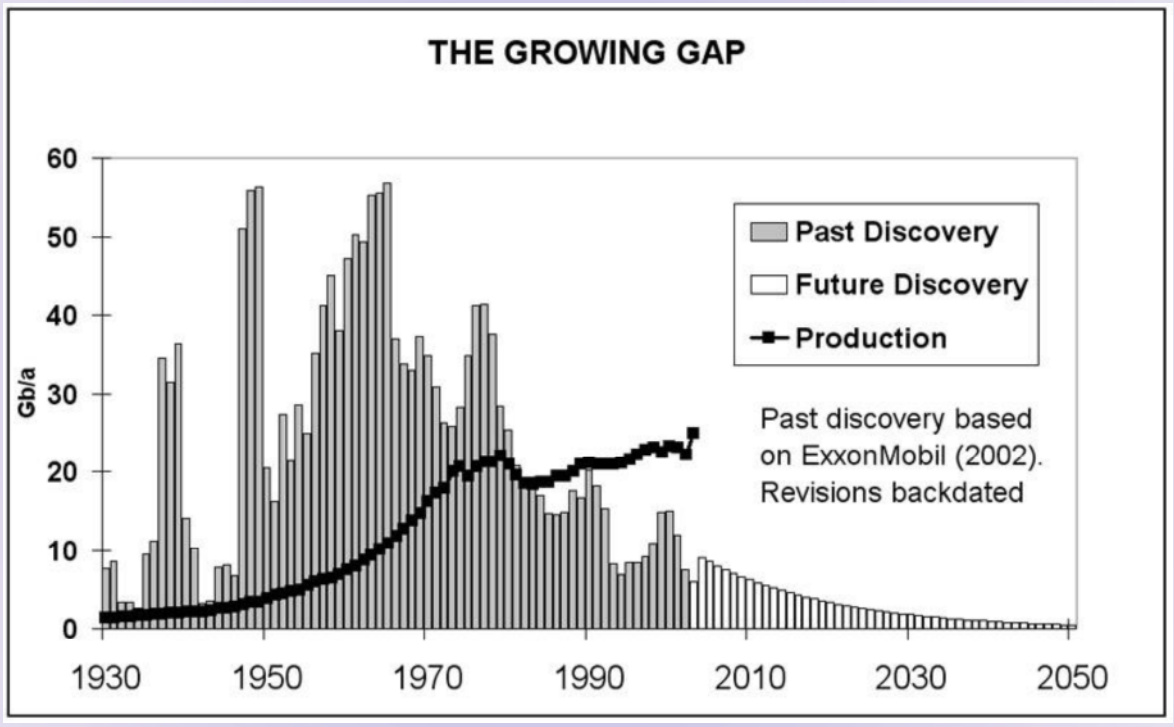
Energy Values

- *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.*

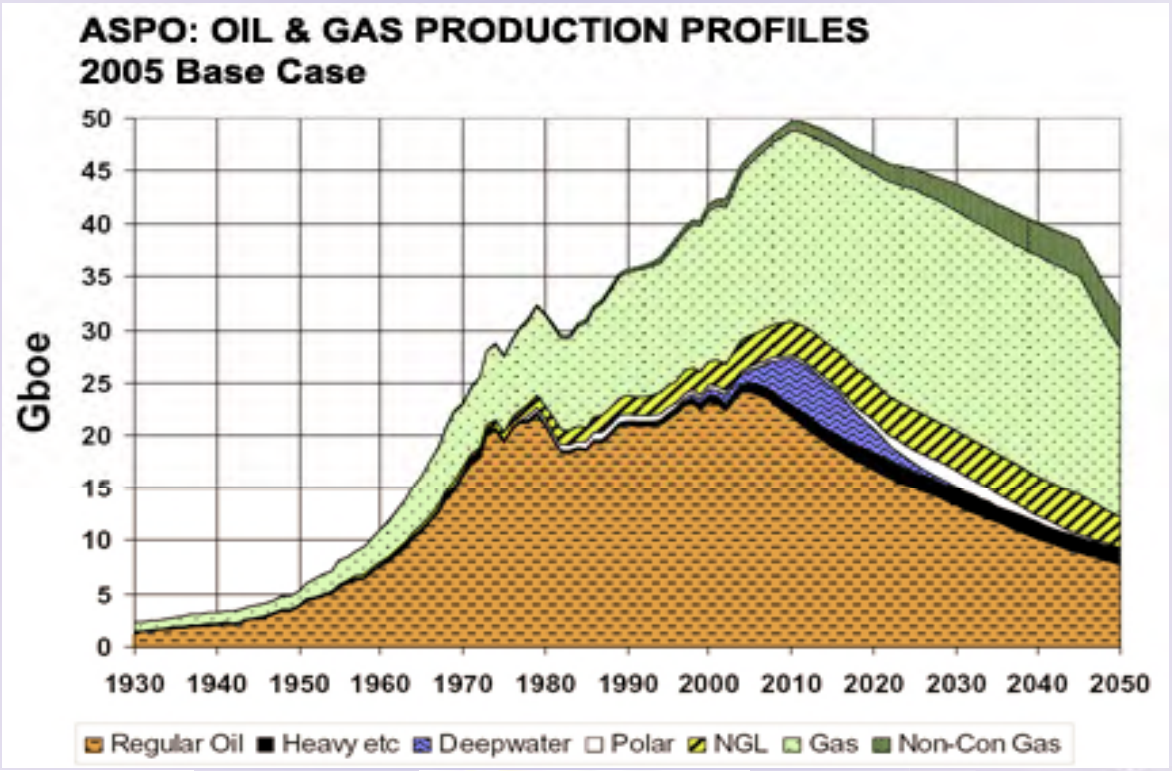
Road to Energy neutral



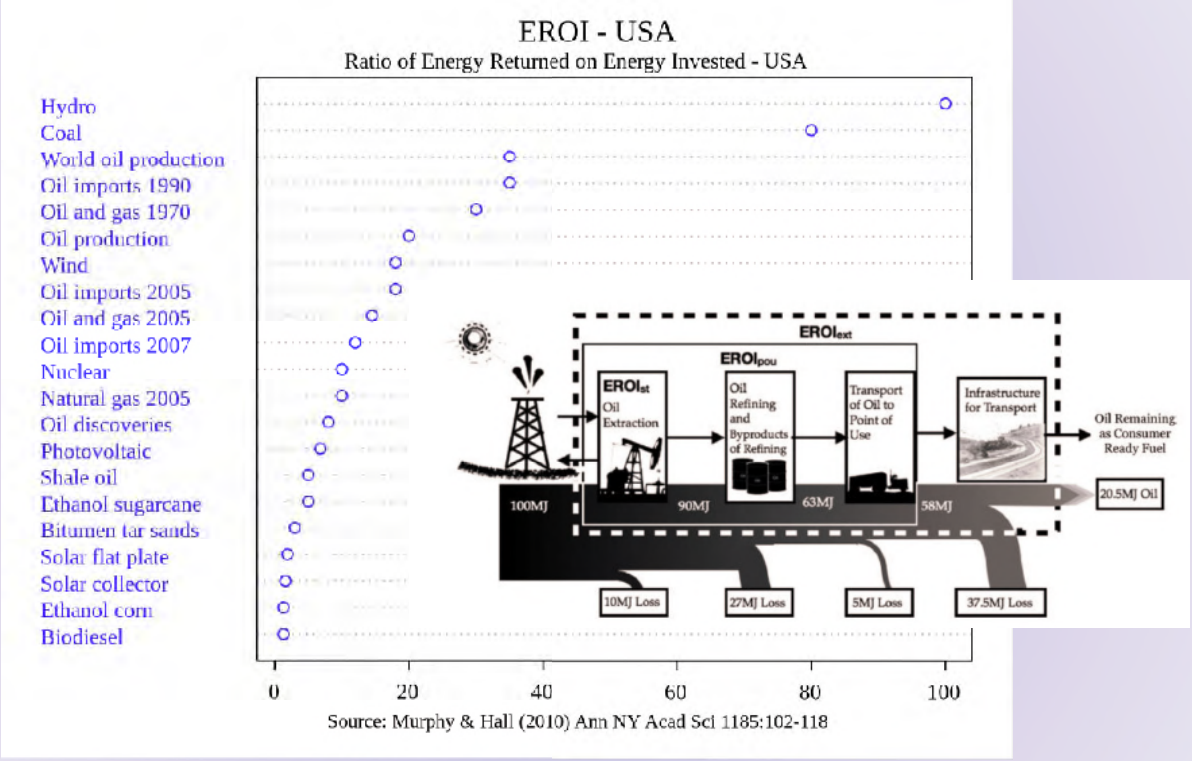
Depletion of fossil resources



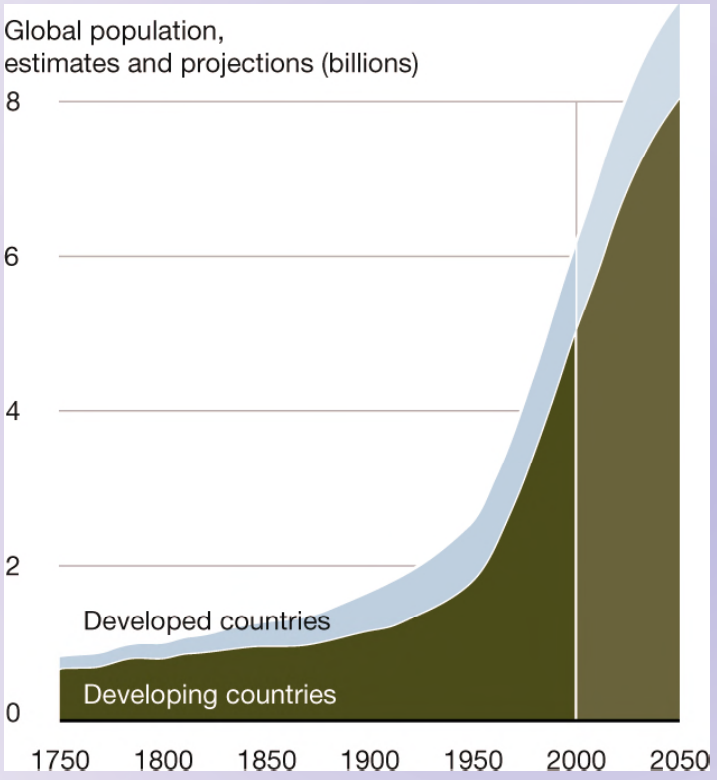
Depletion of fossil resources



Energy return on investment (EROI)



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.

Security of support and welfare

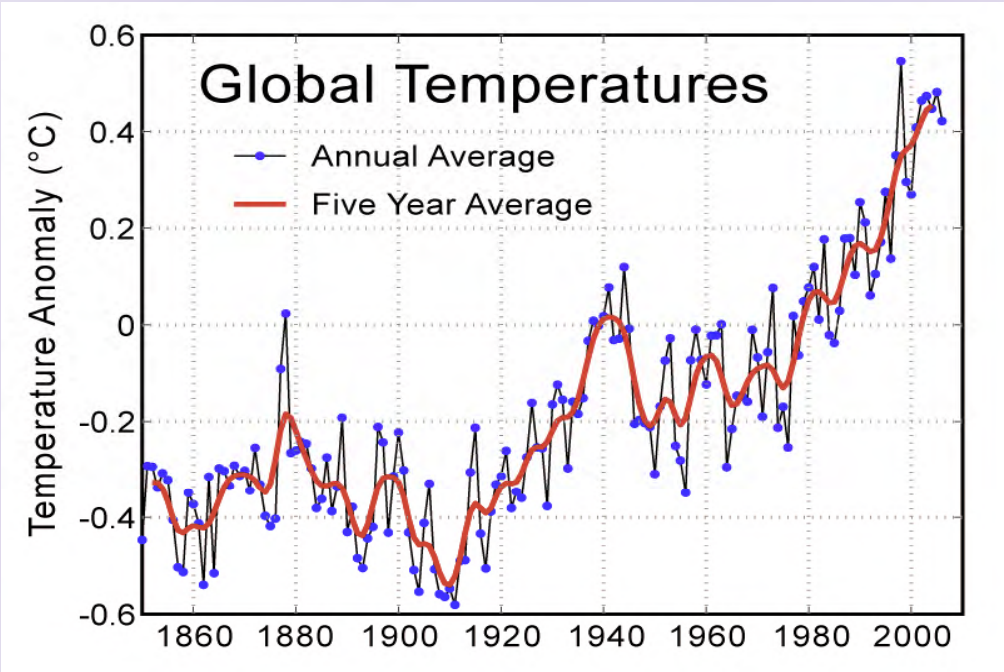
People need energy

Therefore..

Long term energy support should be secured

We need strategies and concepts which will last

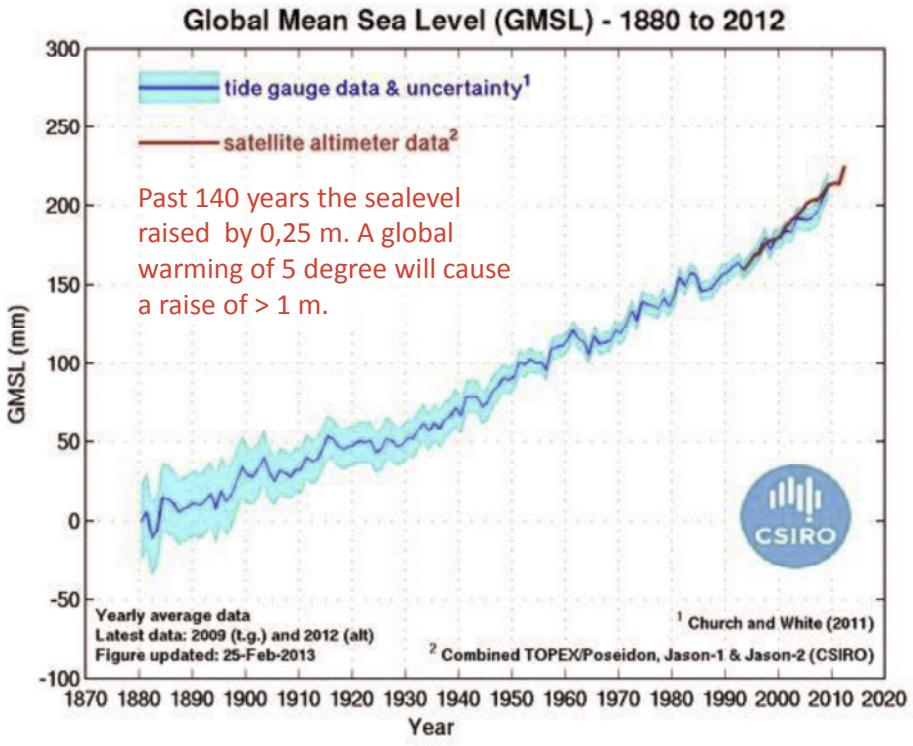
CO2/global warming/sea level rise



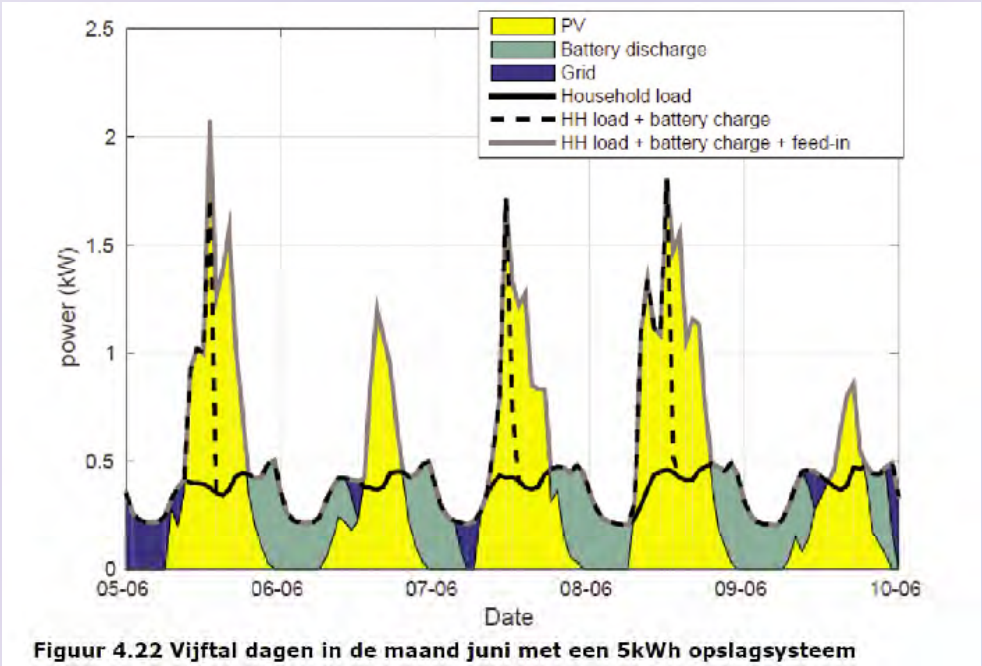
Warming of 5 ° C could result in US$7 trn in losses

Most Dutch cities experience a substantial impact of Urban Heat Islands

CO2/global warming/sea level rise



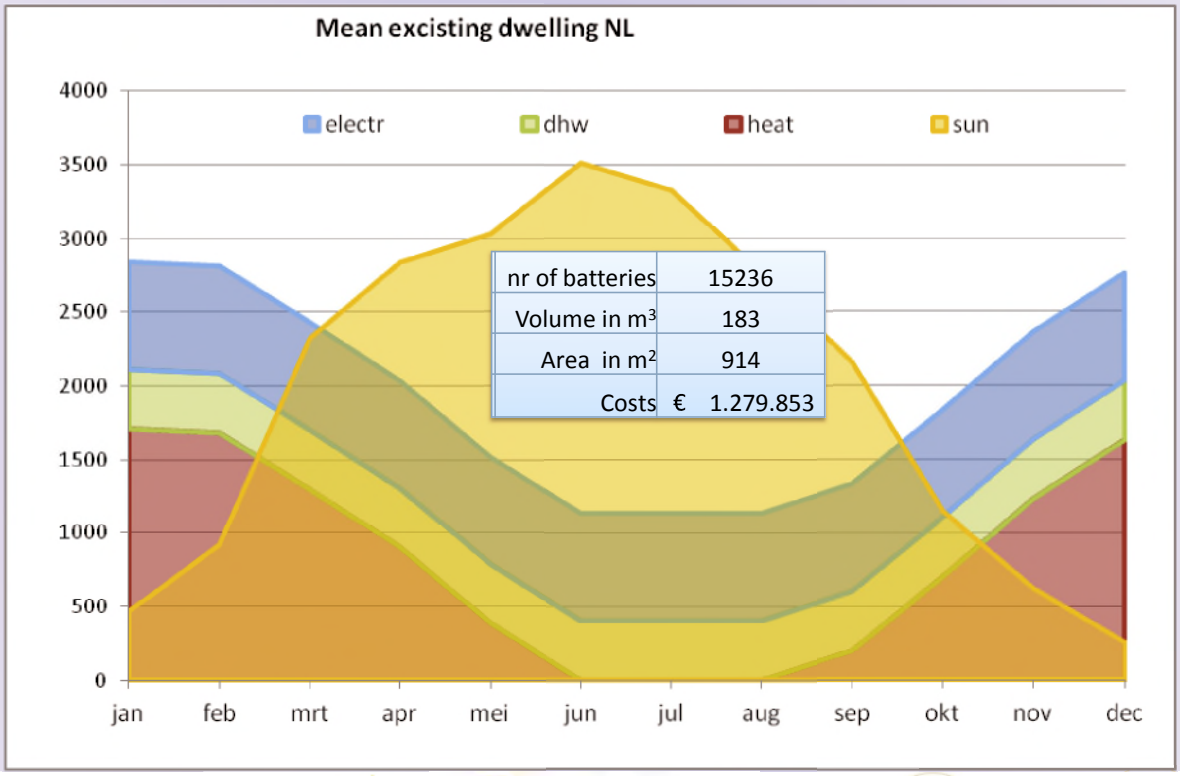
Instability E-grid



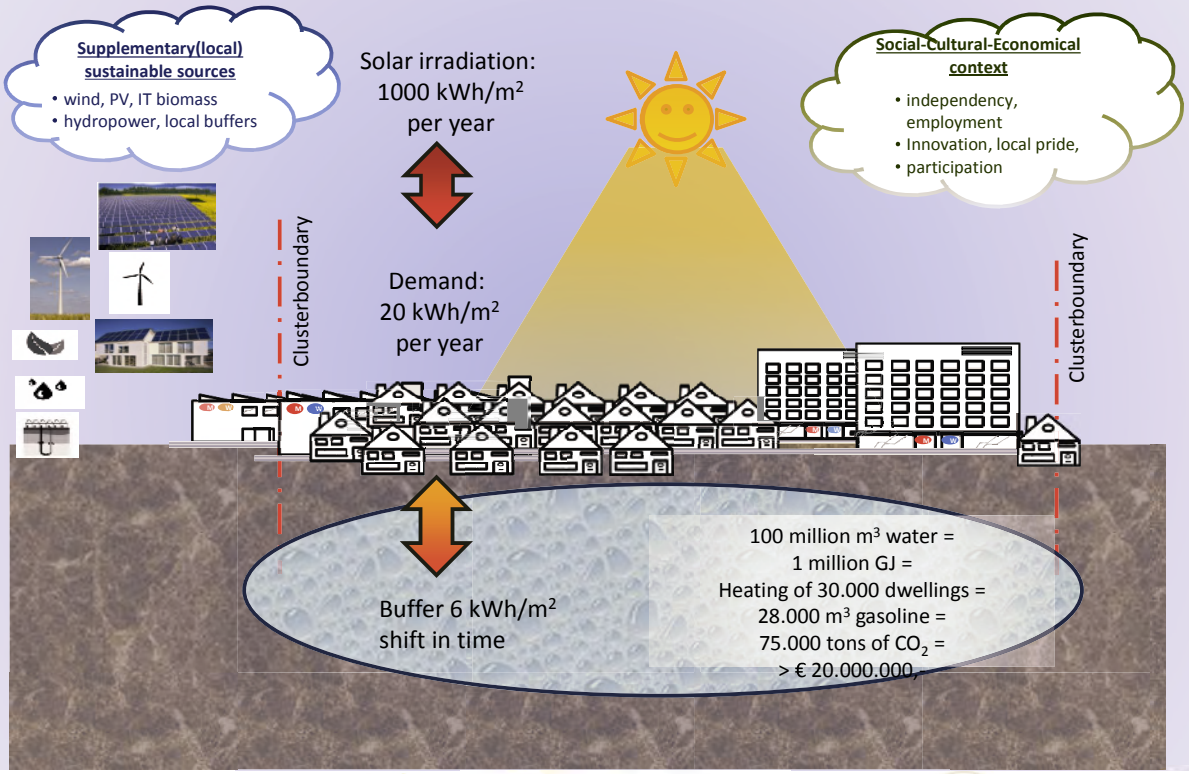
Figuur 4.22 Vijftal dagen in de maand juni met een 5kWh opslagsysteem

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) "

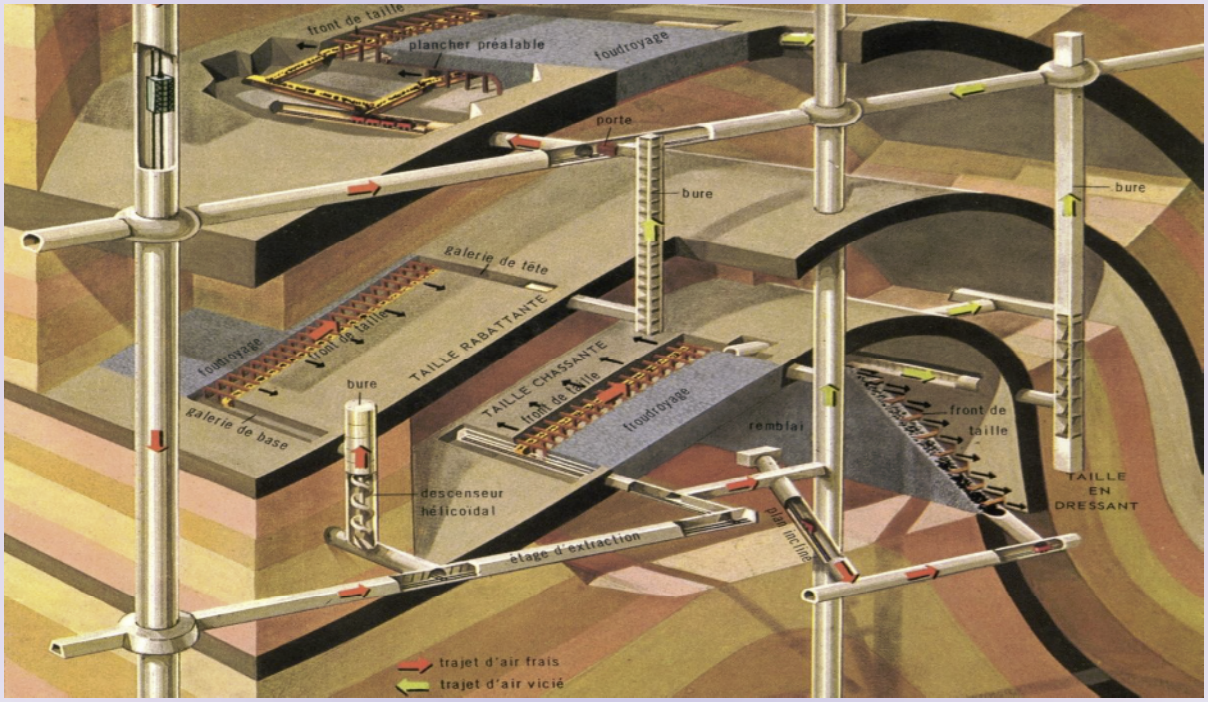
Instability E-grid



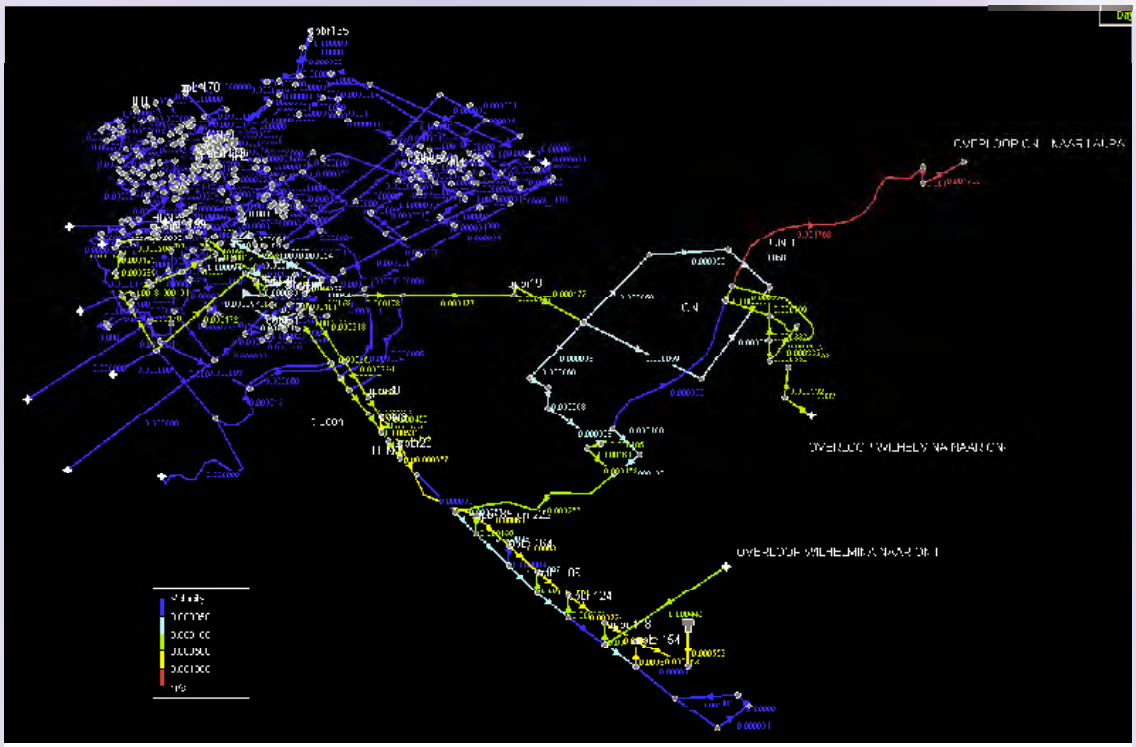
Mijnwater Energy concept



Mijnwater Underground voids

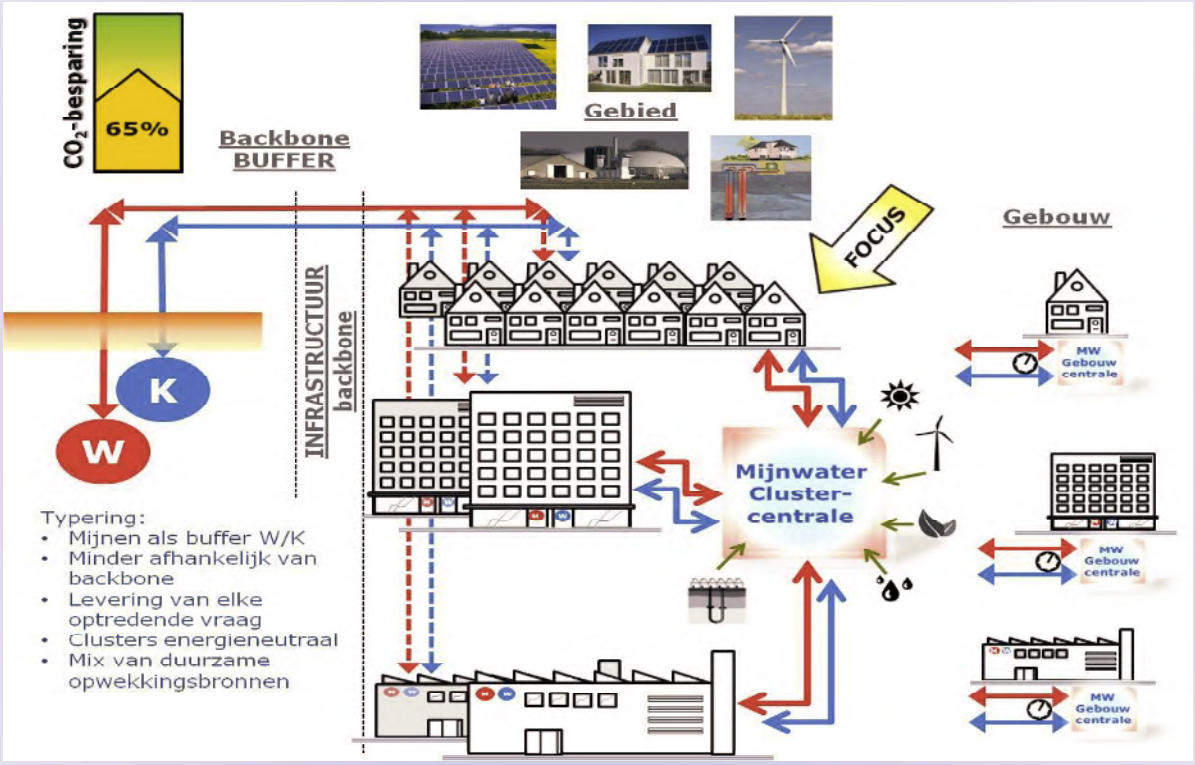


Mijnwater modeling the reservoir

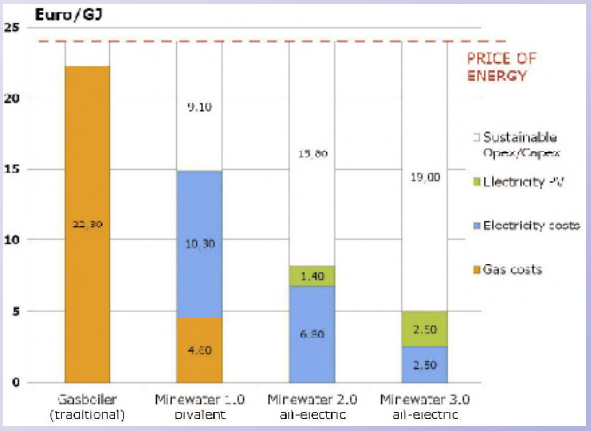


3D model of the underground mine water network (VITO)

Mijnwater Energy concept



Mijnwater businesscase



Investment space is € 19,- per GJ

National Gas Consumption for dwellings: 310 PJ (10^15 J) per year

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			

Mijnwater performance on trends

		reference = basis 1550 m3 gas 3200 kWh E	Retrofit to label A CV HR+ & isulation	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 quackes, 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	++	Energiy = 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 / flexibillity	-	-	+	++	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	-	-	---	+	Variying 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

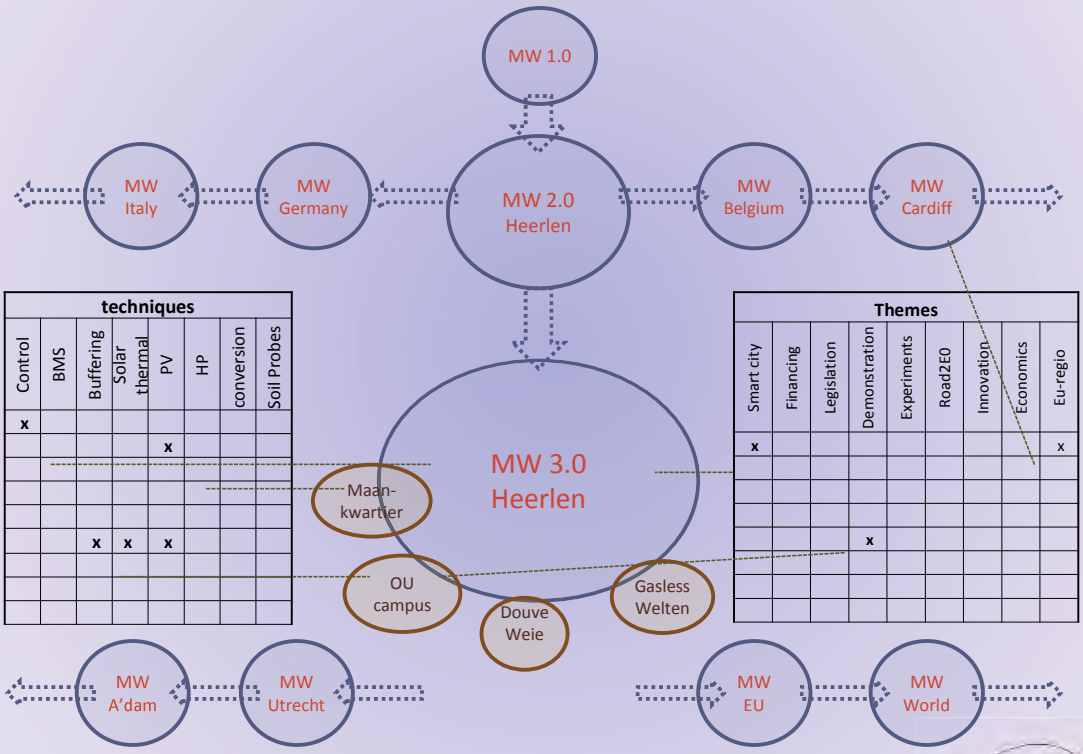
Mijnwater
a sustainable hybrid solution for urban areas

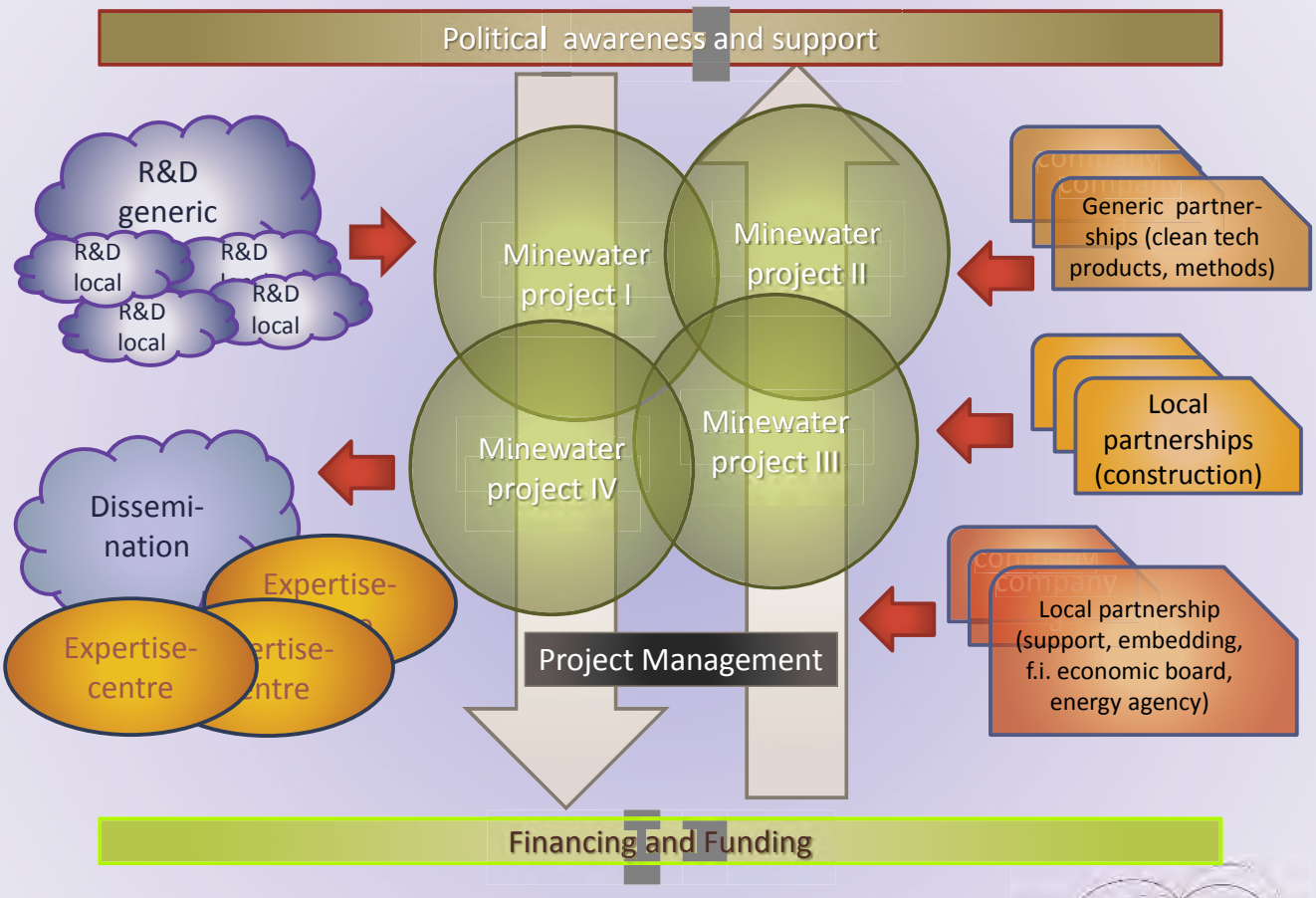
Thanks for your attention
Questions?

Energy Water Circle

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

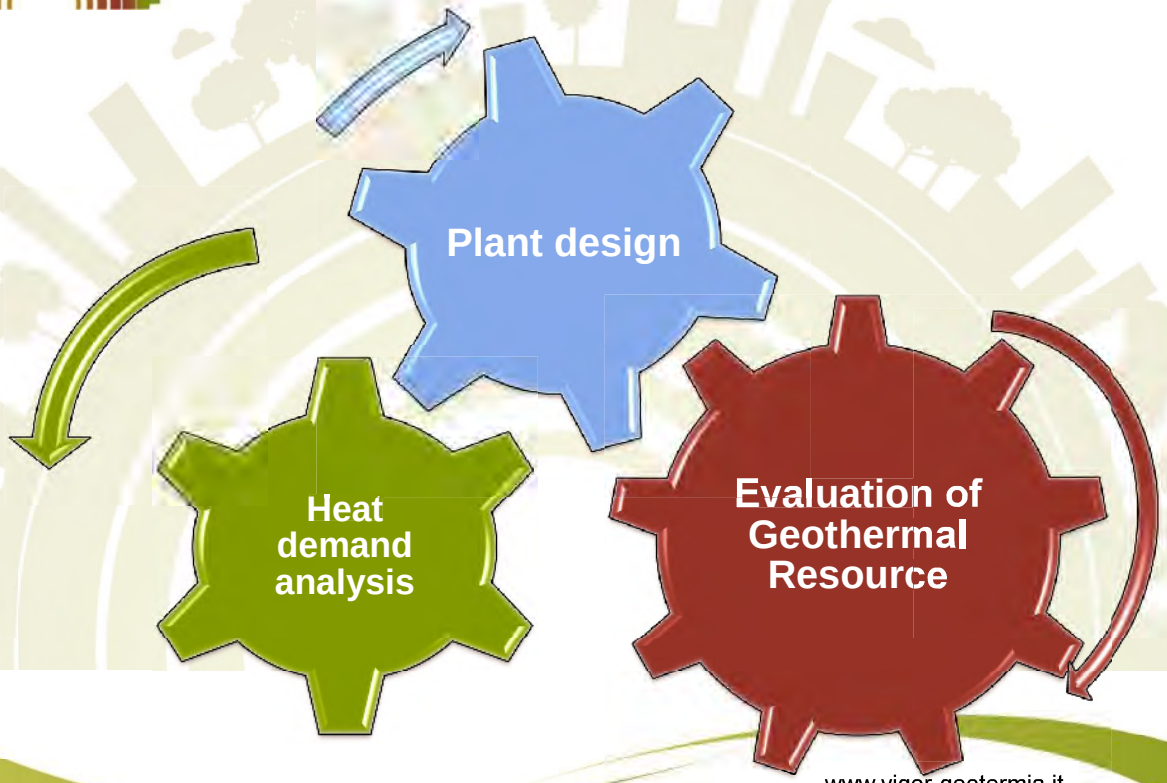
VIGOR aims

- 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

www.vigor-geotermia.it
Consiglio Nazionale delle Ricerche
DTA

Interdisciplinary approach with a common and systemic vision



www.vigor-geotermia.it

Consiglio Nazionale delle Ricerche
DTA

Geothermal Heat Resources (GHRs) match heat demands

GHRs
T > 120° C
→ **Heat exchanger**
Binary Plants

GHRs
60 < T < 120° C
→ **Heat exchanger**
Geothermal Heat Pump (water-source)

GHRs
T < 60° C
→ **Heat exchanger**
Geothermal Heat Pump (ground/water-source)

www.vigor-geotermia.it

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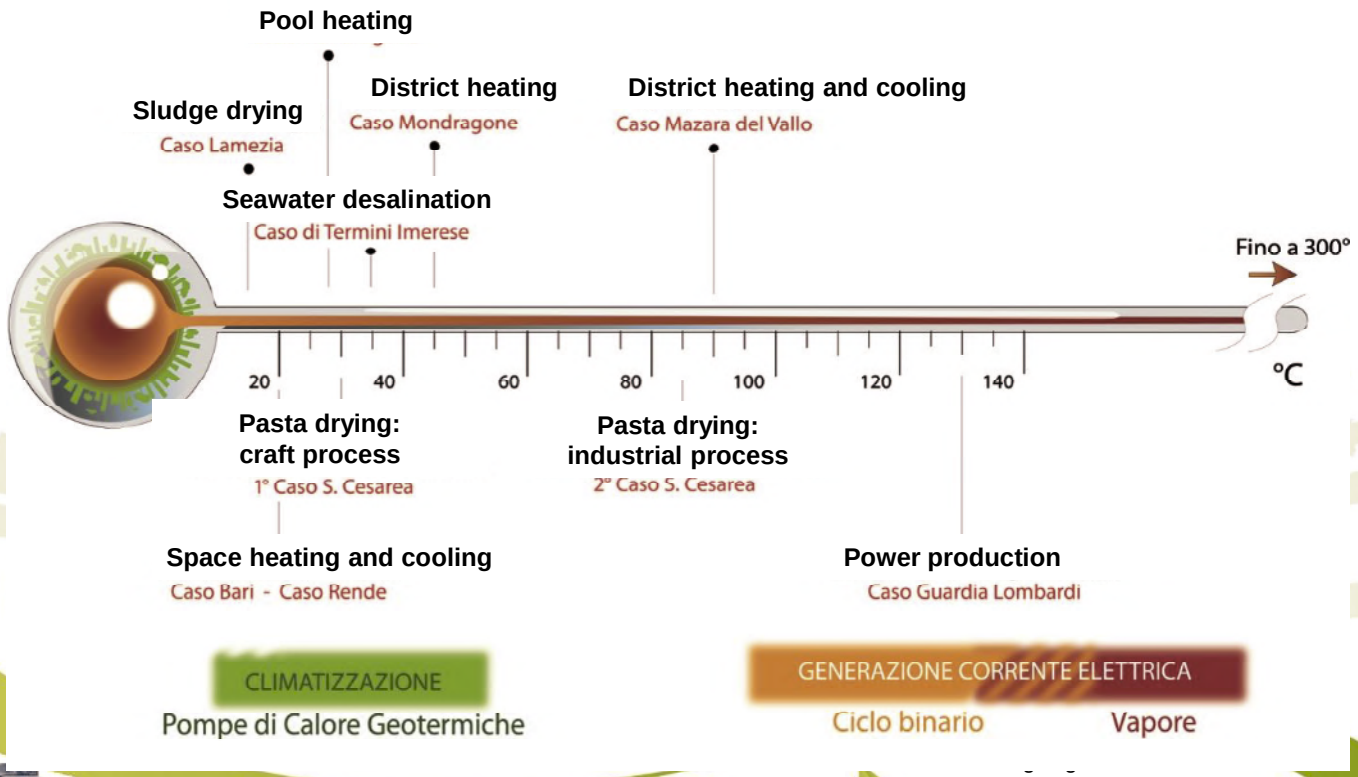
Plant proposals in VIGOR



Geothermal plant for drying sewage sludge

- Plant proposal
  - Geothermal plant for drying sludge from wastewater treatment;
  - Location: Terme di Caronte (Calabria)
- Wastewater treament plant:
  - Controlled automatically by a PLC (Programmable Logic Controller)
  - Water treatment: 1000 m^3/h (8.760.000 m^3/year)
  - Treatment for water and sludges.

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Actual sludge disposal cost

- Disposal cost: **HIGH**
  - 780 K€/year, since sludge is disposed in landifill 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**

Geothermal resources

Deep geothermal resource:

- T = 40° C
- Q = 10 l/s
- h = 1000 m

Geothermal shallow resource:

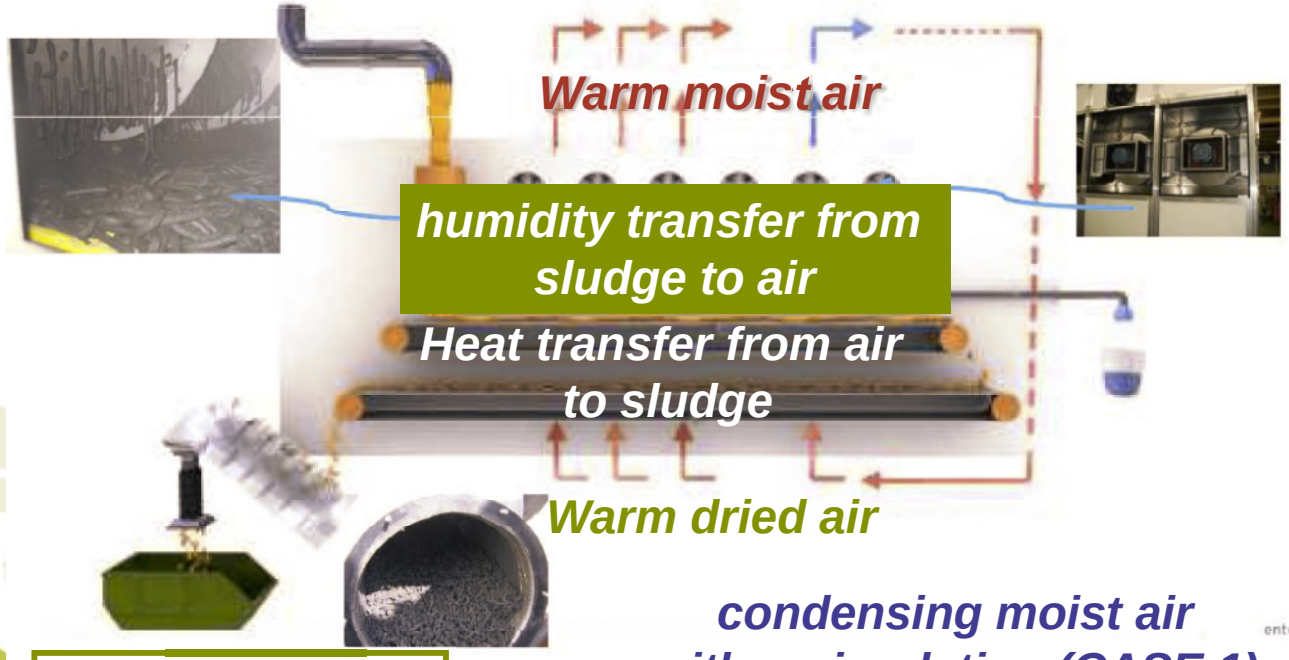
- T = 17° C
- Q = 16 l/s
- h = 40 m

Sludge dryer powered by geothermal heat

Ground water at 17° C → Geothermal Heat Pump (GHP) → **Dryer at low temperature providing hot water at T = 75° C**

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

Sludge with 18% in dried weight



condensing moist air with recirculation (CASE 1)

Sludge with 80-90% in dried weight

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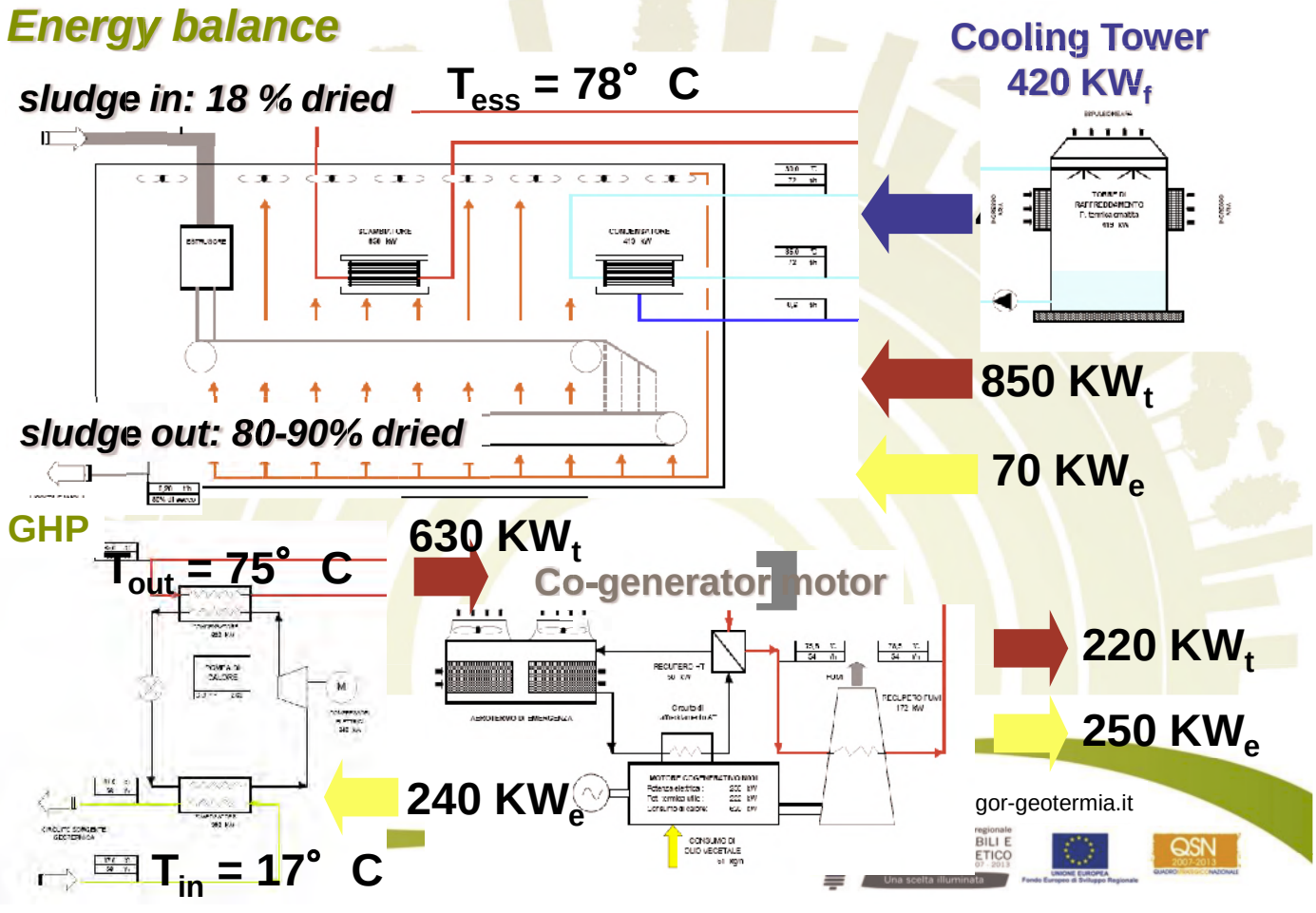
Thermal and Electrical dryers needs

- 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

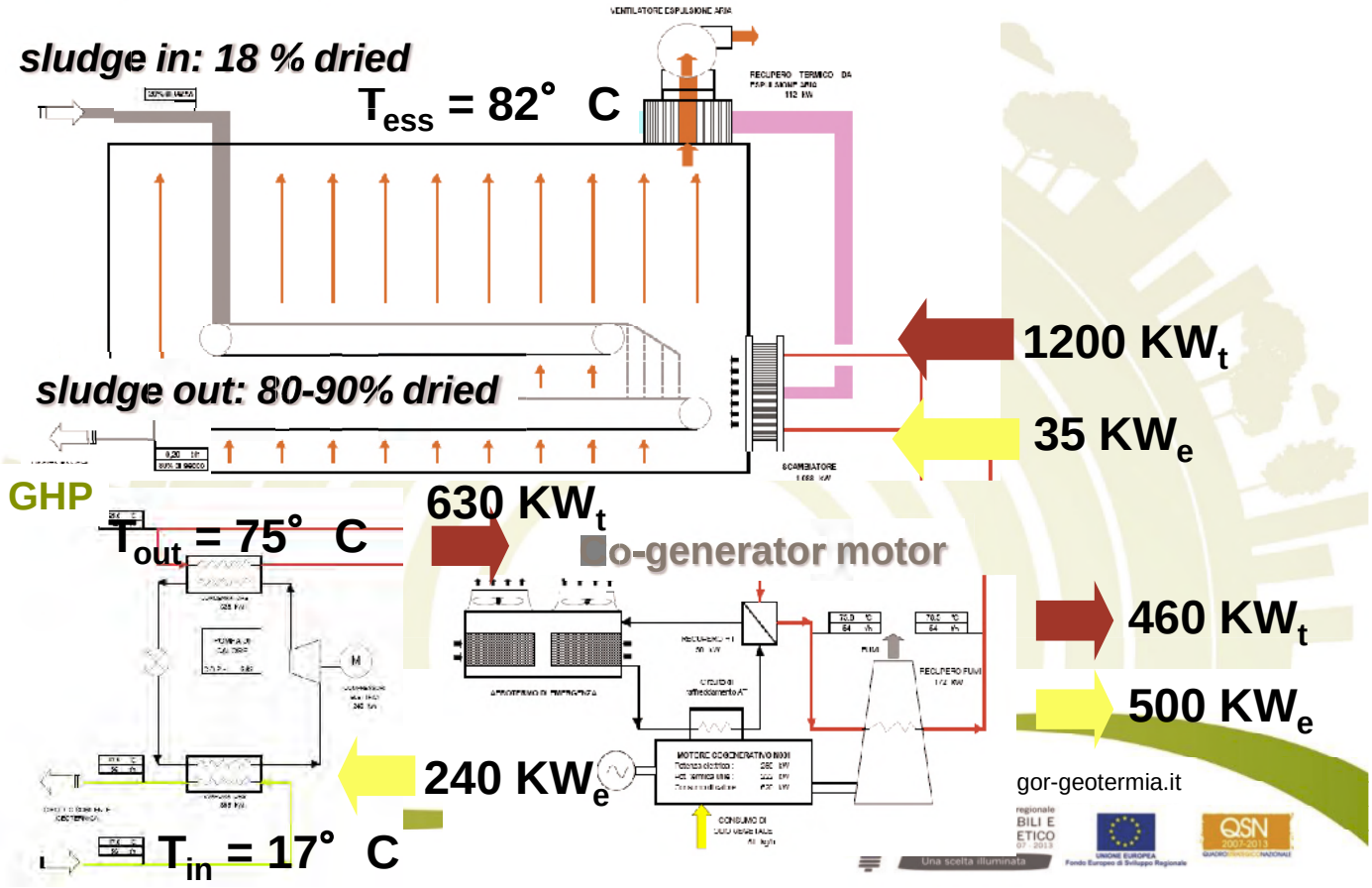
www.vigor-geotermia.it

Schematic diagram – CASE 1



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**

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

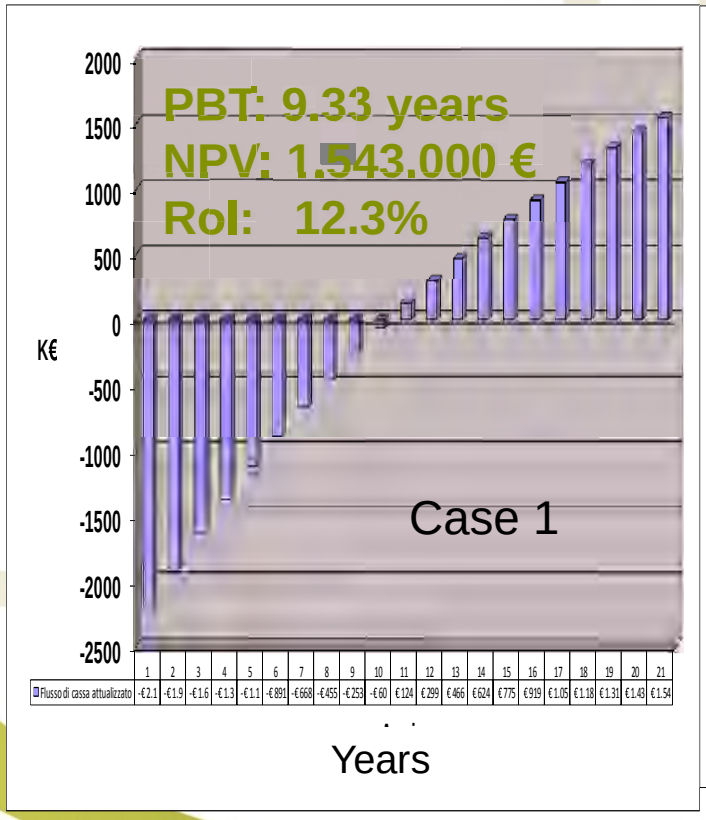
- Cost estimated for the investment ***1.998 K€***
  - Dryer: 350 K€
  - GHP: 80 K€
  - N.2 co-generator motor: 900 K€
  - Mechanical, Electrical and Electronic components: 370 K€
  - Civil works: 150 K€
  - Plant design and project management: 148 K€

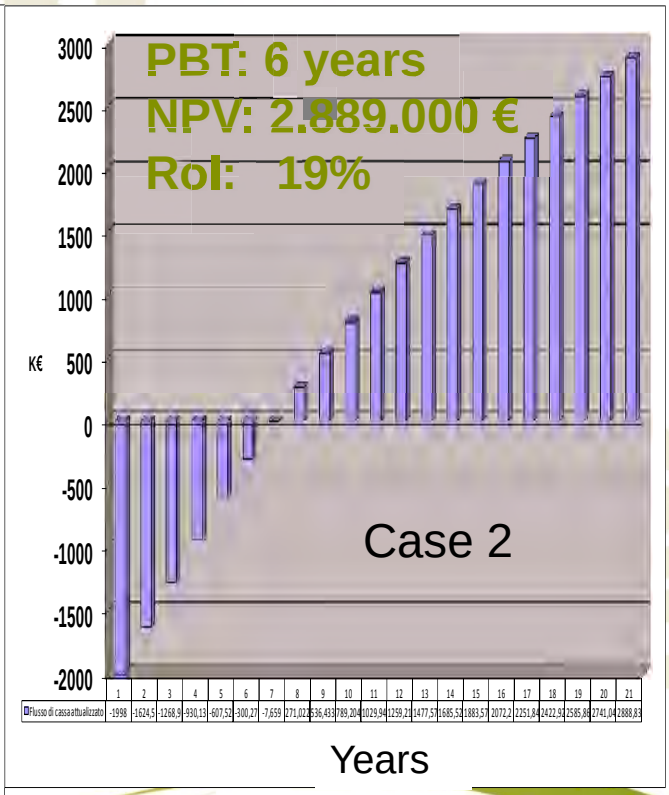
CASH FLOW

- 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)

Profitability





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

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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_2 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 ↑

De Beijer RTB B.V

Cooling with "Geothermal , Waste or Solar" Heat

Henk de Beijer
Genève 30-10-2015

SolabCool
The best comfort with pure energy

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.

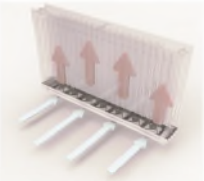
Main activity:

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



CimateBooster

SolabCool

Thermo –chemical energy storage

De Beijer RTB B.V

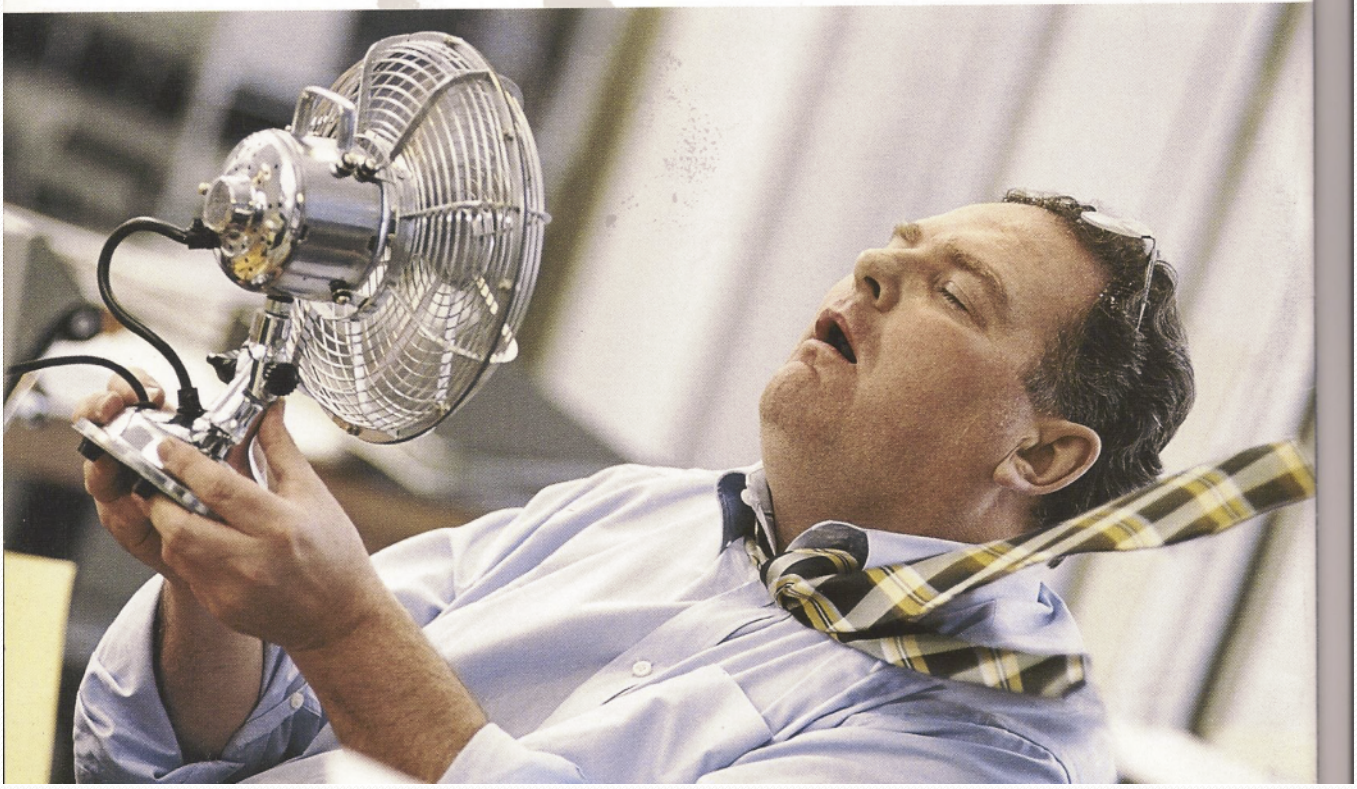
ClimateBooster

Sunridge

SolabCool

Sweat

Problems with building cooling?



Comfort spectrum

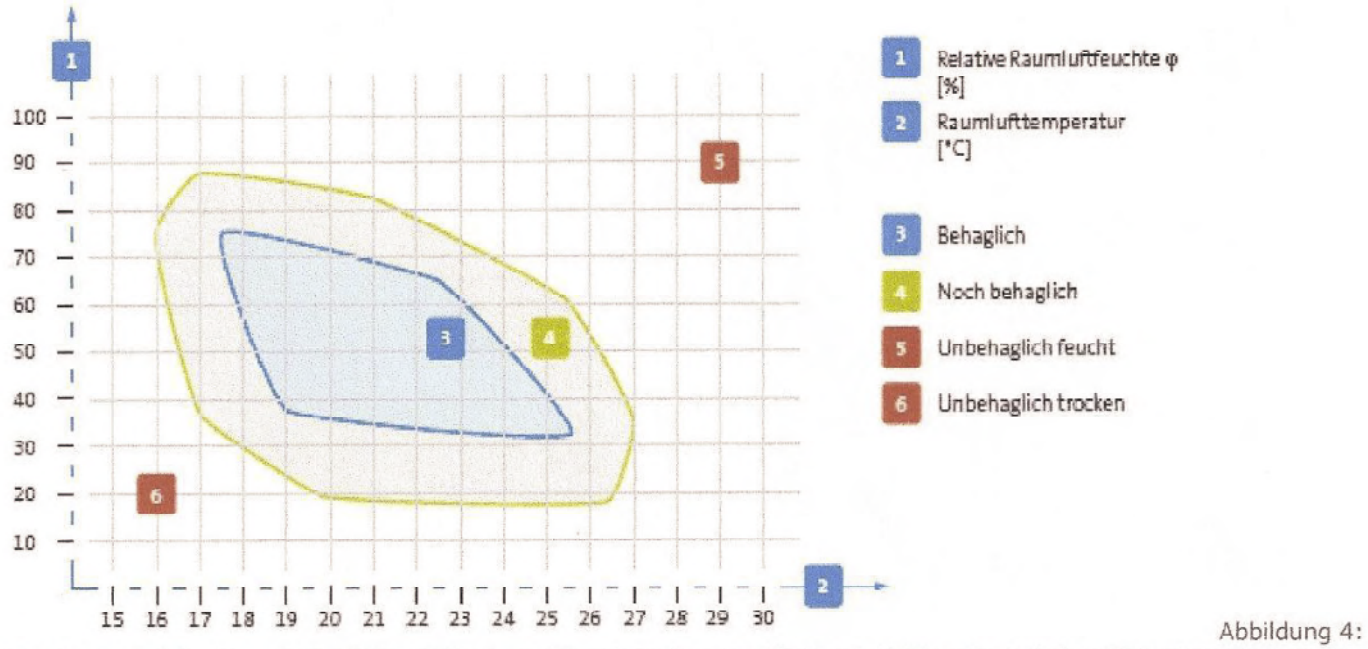
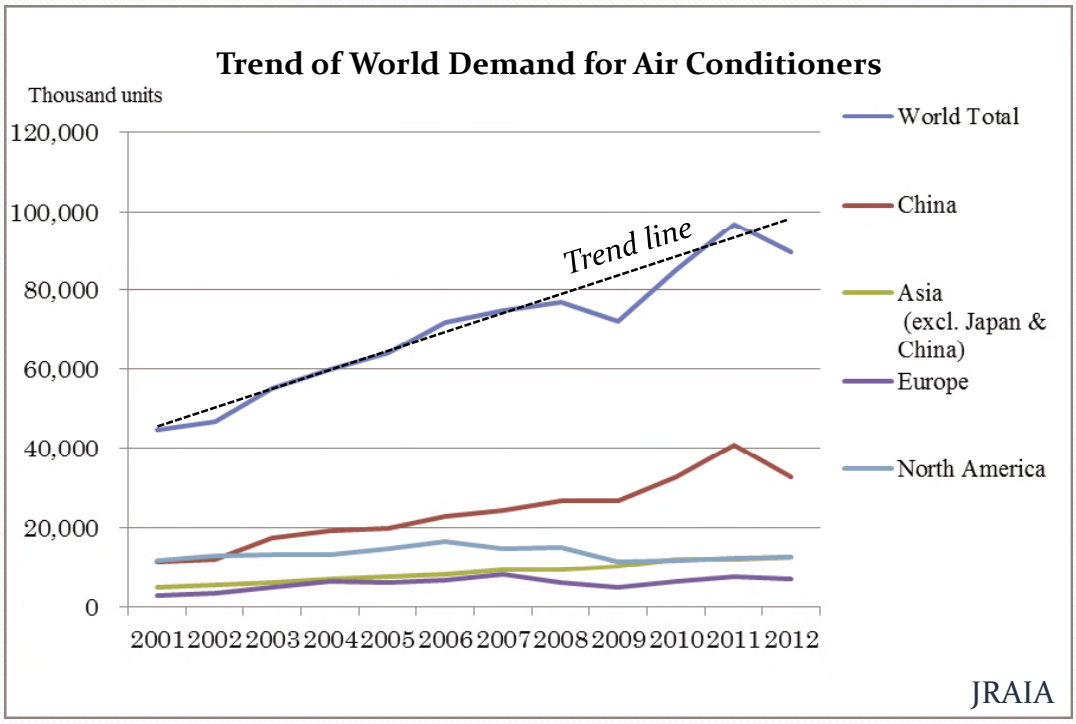
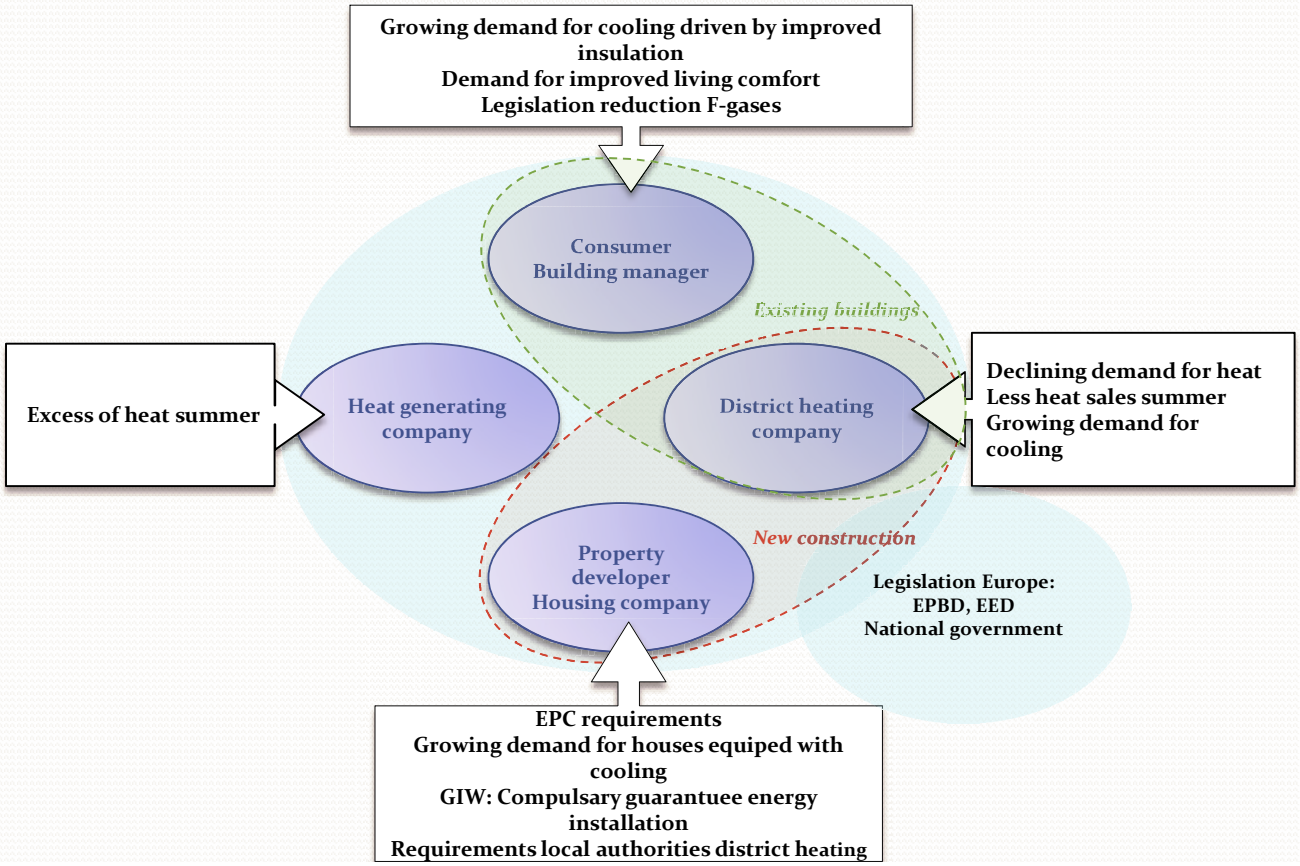


Abbildung 4:
Eine bestmögliche thermische Behaglichkeit ergibt sich im inneren blauen Feld (3), also bei einer Raumtemperatur von etwa 20 bis 25 °C (Winter/Sommer) und einer relativen Raumluftfeuchte von 30 bis zirka 60 % (Winter/Sommer).

Growing Demand for air conditioning



Key players and marketdrivers



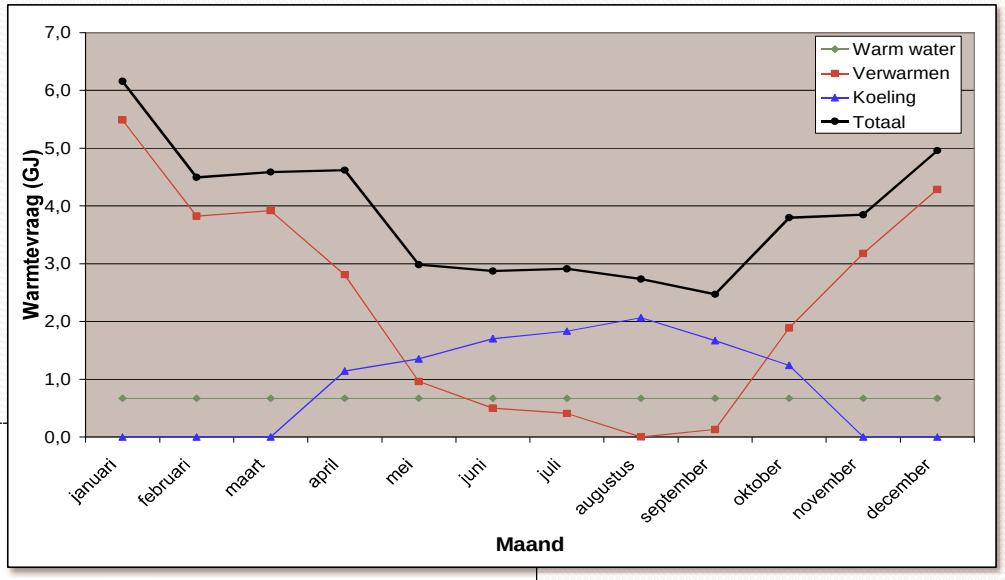
Cooling is a must

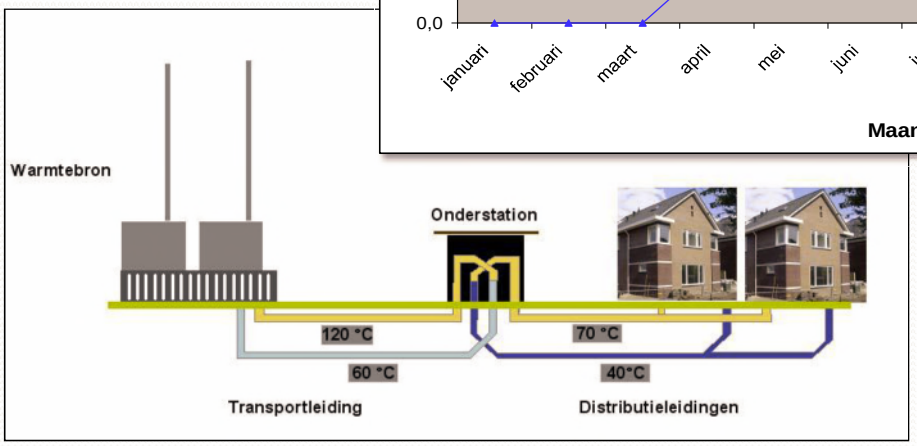
- Shifts in comfort culture, behavioural patterns, affordability and consumer expectation
- Perception that comfort cooling contributes to higher productivity
- Direct impact on rental value of commercial buildings
- Increase in internal loads (computers etc.)

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

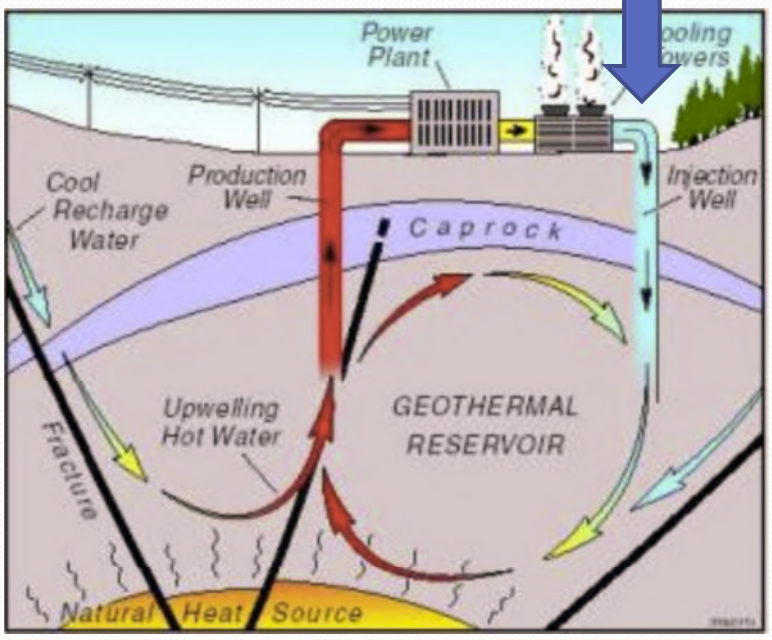
District heating: excess heat in summer

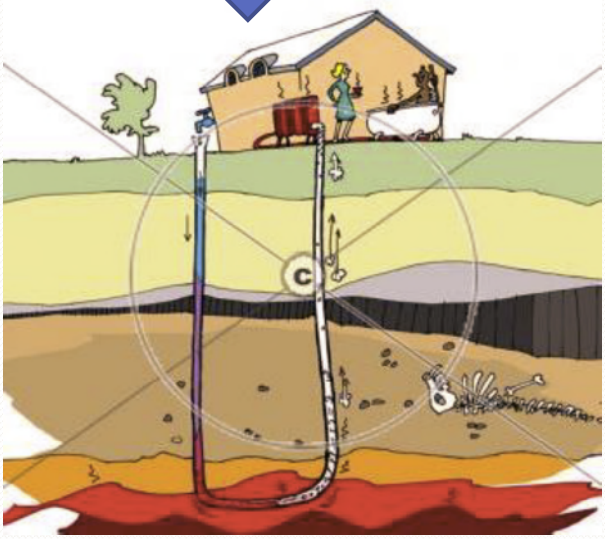




Geothermal & Cooling

SolabCool

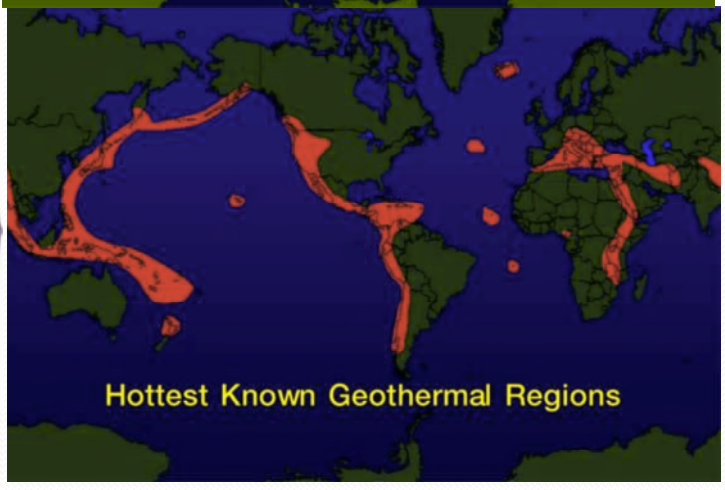




Soultz, Alsace, Fr.

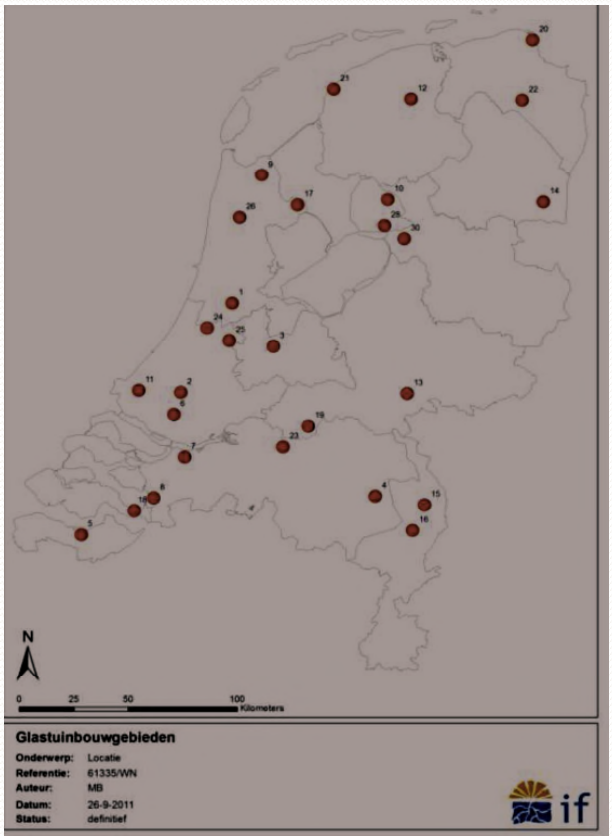
Production 5 km depth at 200°C & Organic Rankine Cycle (ORC) -> 2 MWe -> re-injected temp 70°C

Geothermal in the world



Geothermal in Nevis

Geothermal in the Netherlands

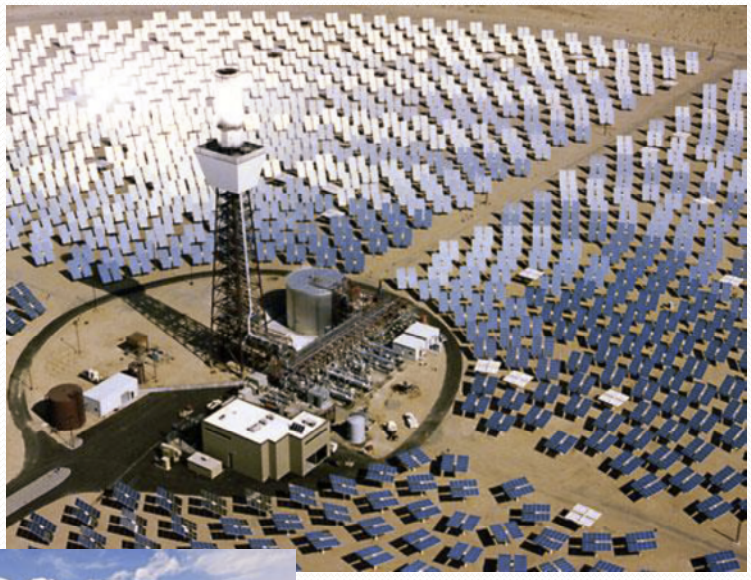


Nr	Locatie	Toevoeging
1	Aalsmeer e.o.	
2	Bleiswijk e.o.	"B-driehoek", Zuidplaspolder
3	Vleuten, Harmelen	
4	Deurne	
5	Terneuzen	
6	Zuidhollandse eilanden	Hoeksche Waard/Voorne Putten
7	Moerdijk	
7a	Dinteloord	nieuw te ontwikkelen
7b	Made	nabij Amer centrale
8	Bergen op Zoom	
9	Wieringermeer	"Agriport A7"
10	Luttelgeest	
11	Westland	
12	Berlikum	
13 14	Huissen/Bemmel Klazienaveen	"Bergerden" + 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



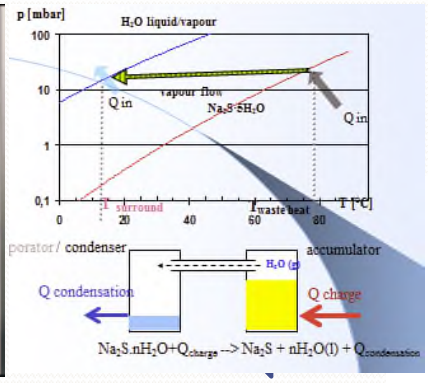
Bright Source EnergyCalifornia

Electric Power Research based in Palo Alto

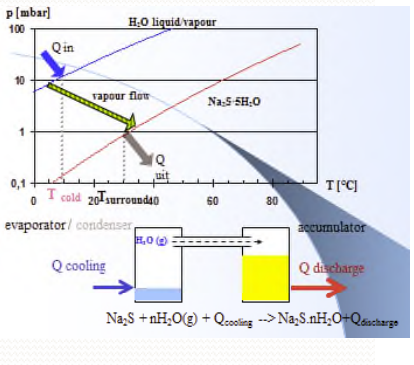
Solar island District heating 'Almere'

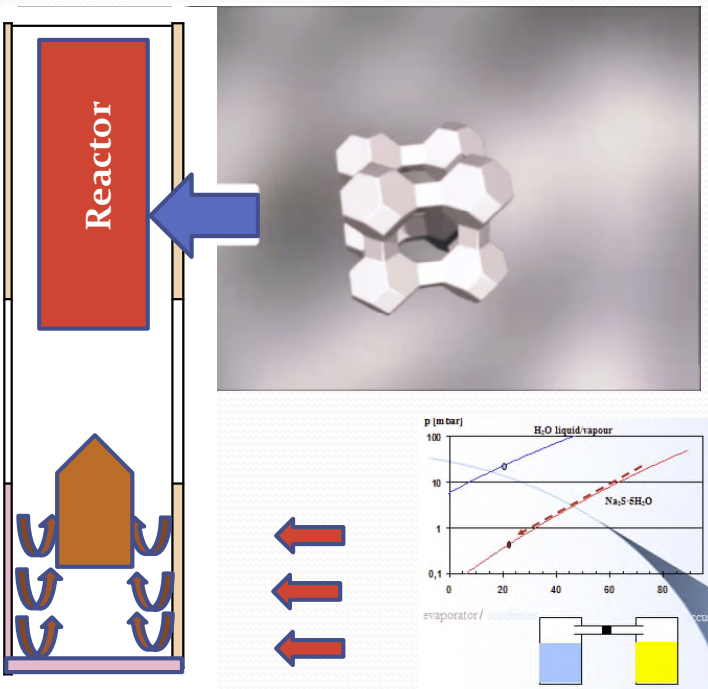
Flat Plate Collectors 7000 m² Production 10,000 GJ/y at 75 C

Energy storage and conversion



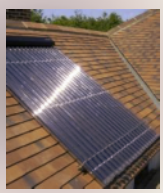
Sweat





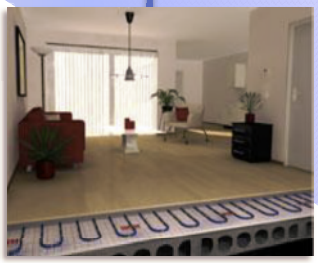
Heat- driven cooling

Zonne-energie



Warmtenet

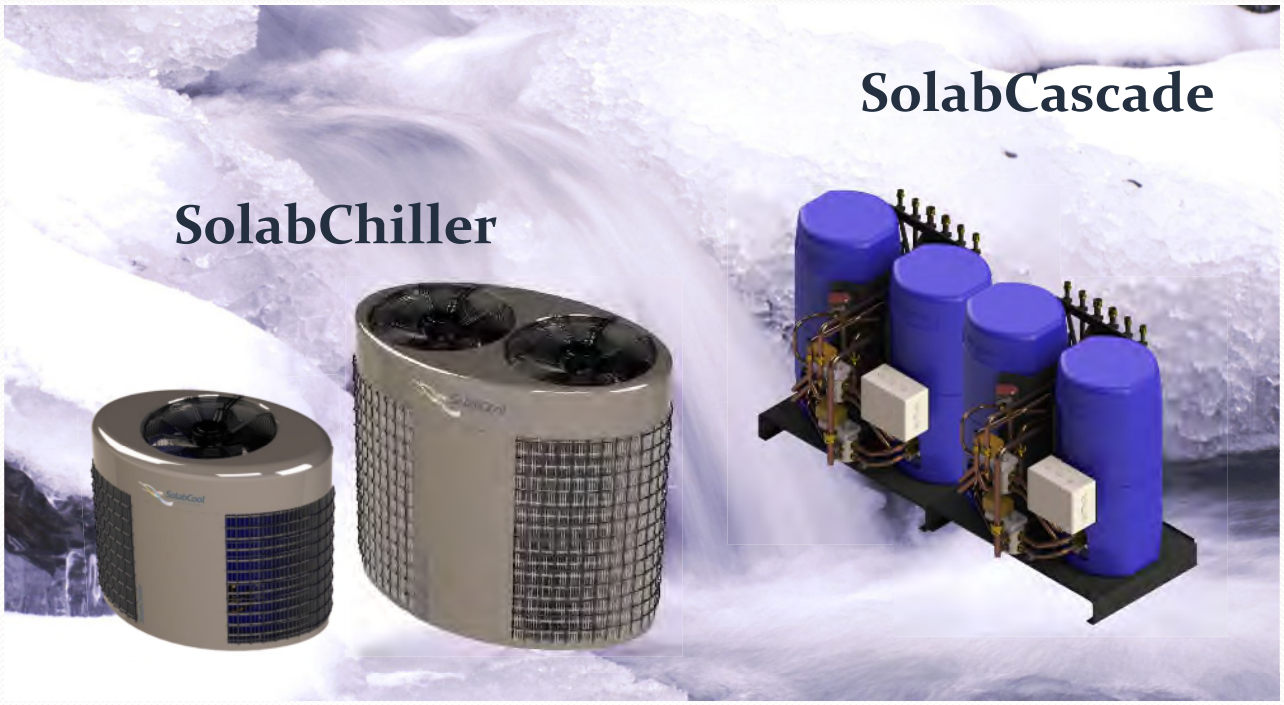
Warmtekracht-koppeling



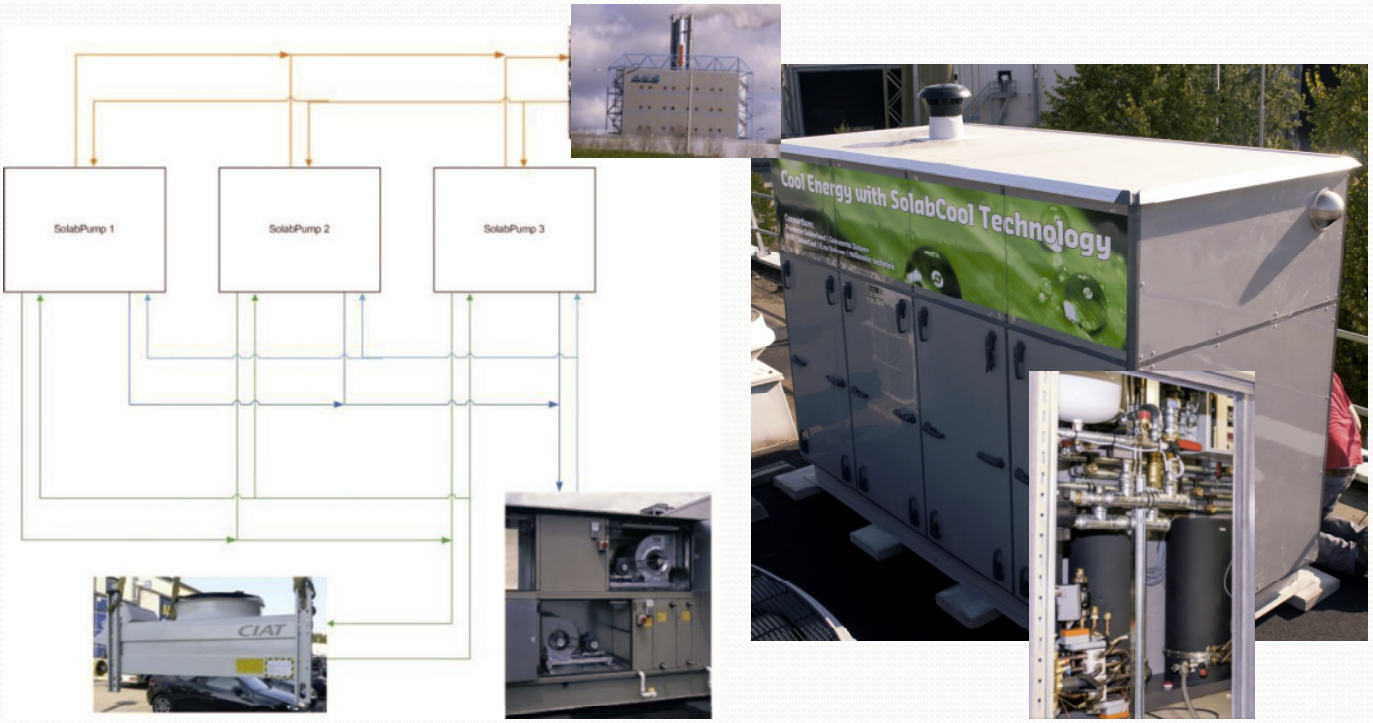
SolabCool

The best comfort with pure energy

SolabCool product range



Cooling office incineration plant AVR Duiven



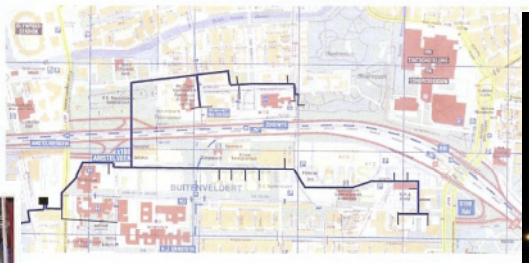
SolabCool
Sorption technology

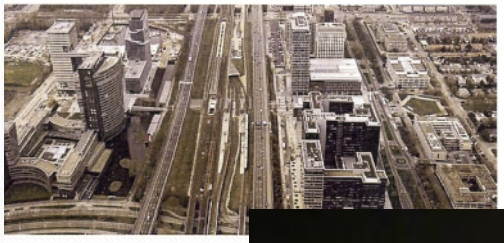
Residential

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

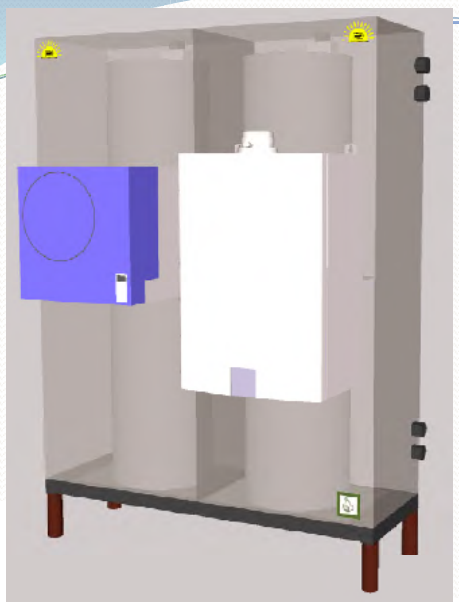
District Cooling in Europe cities



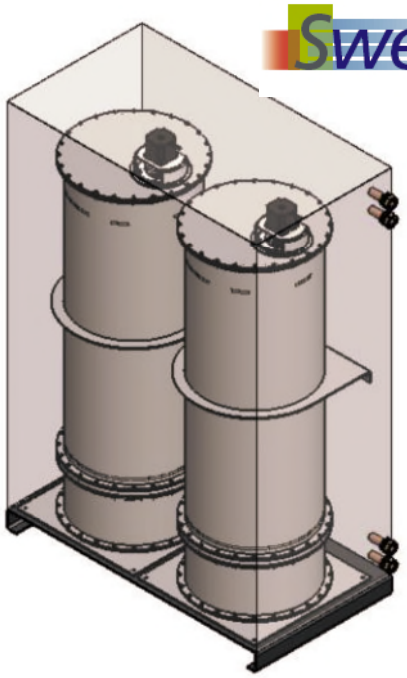


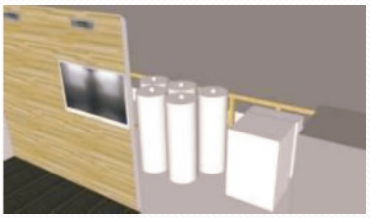
Amsterdam 76 MW Freecooling/Absorption chillers
Barcelona 66 MW
Helsinki 60 MW
Lisbon 40 MW
Stockholm 188 MW
Paris
Berlin

Cooling on District level



Sweat

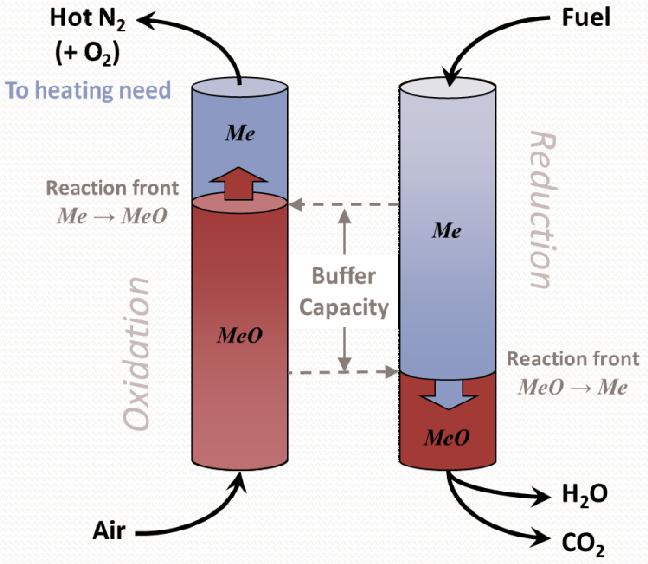


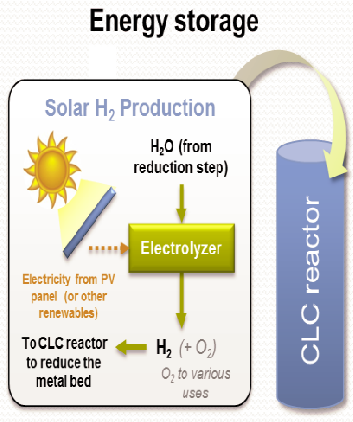


Energy density of the materials

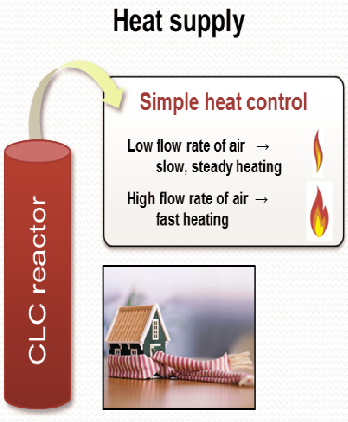
	Storage options				
	Hot water	Phase change materials	Thermochemical	Electical Batteries	Chemical Looping
Storage density	< 0.2 GJ/m³ (dT= 50°C)	< 0.3 GJ/m³	~ 1 GJ/m³	~ 1 GJ/m³	~ 3 GJ/m³
Storage duration	Day	day-year	day-year	minites-months	day-year
Storage	Thermal	Thermal	Thermal	Electrical	Electrical > thermal
Cycling efficiency	~ 70%	~ 90%	~ 90%	75%	70%

Chemical Looping Combustion for Energy Storage Applications



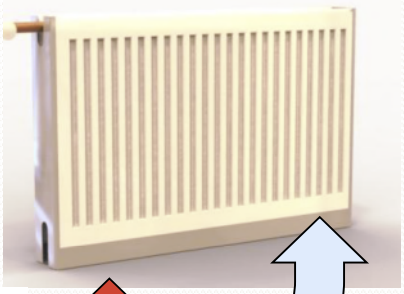


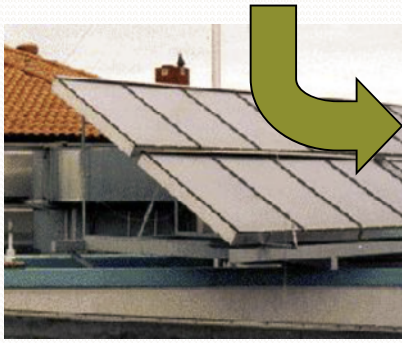
Bed reduction: Solar energy from summer is stored as chemical energy, without losses, until the heat is needed

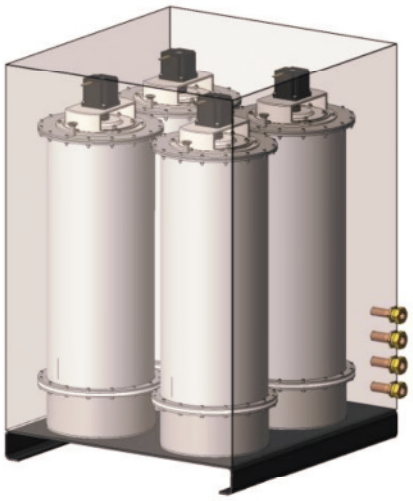


Bed oxidation: Running air through the reactor oxidizes the bed and provides heat all winter long

Solar/Heat /Cold storage distribution system







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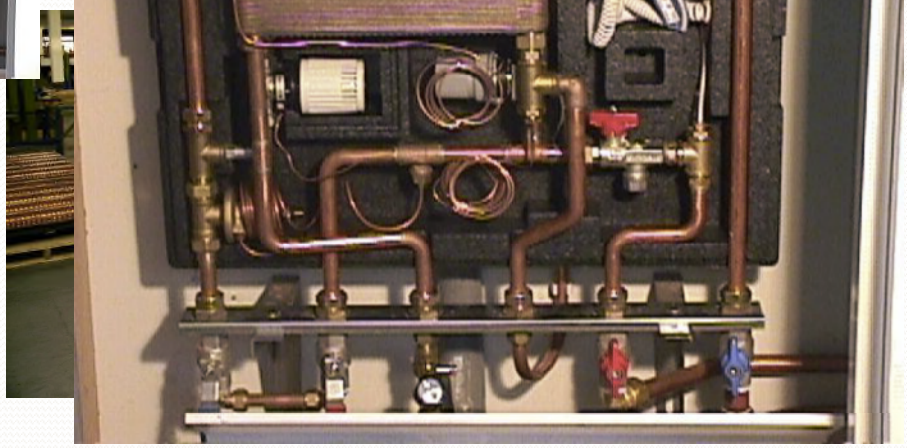
Company ‘Principles’

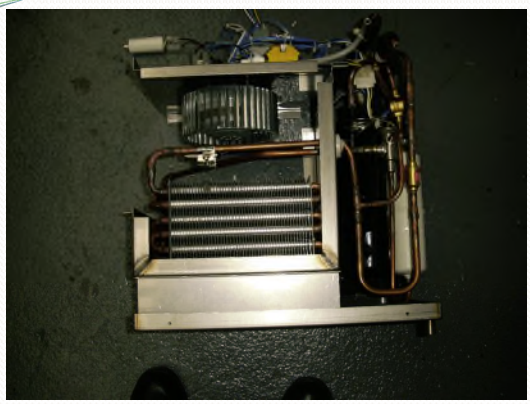
- Spirit
- Reliability
- Flexibility
- Innovation
- Fun

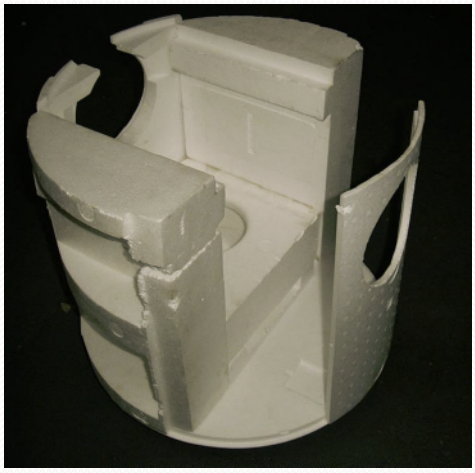
It’s our Competence that makes the difference

District Heating Units



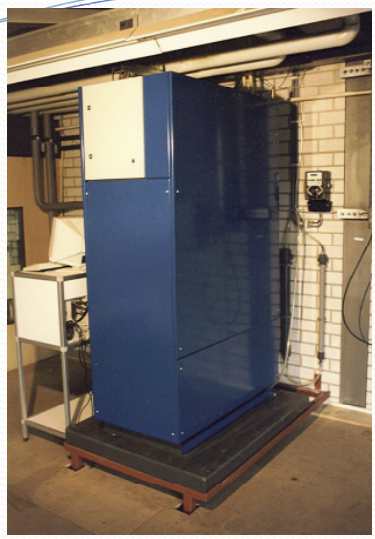
Electrical Heatpumpboiler

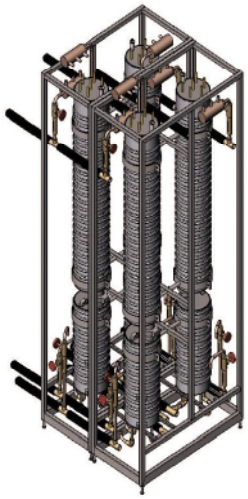




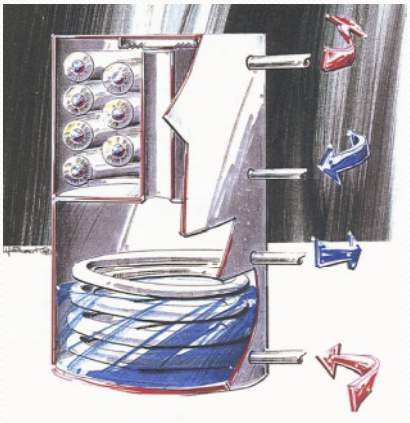
Inclusie mechanische ventilatie

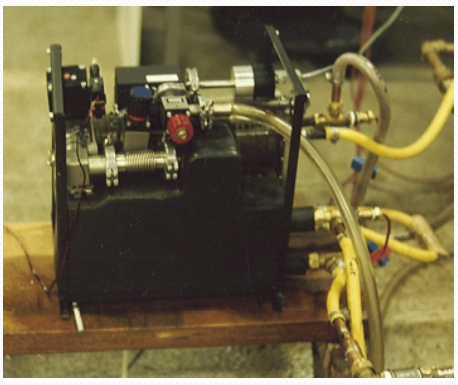
Storage and conversion 1e genaration





District heating

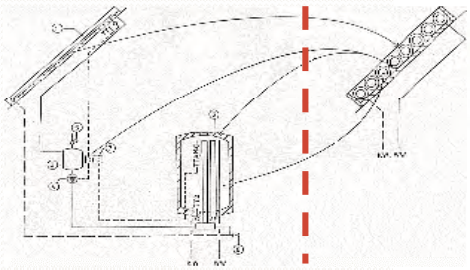




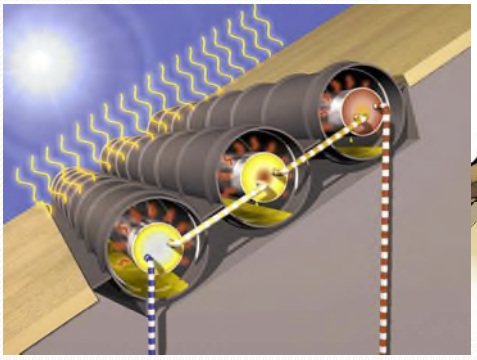
Automotive airco

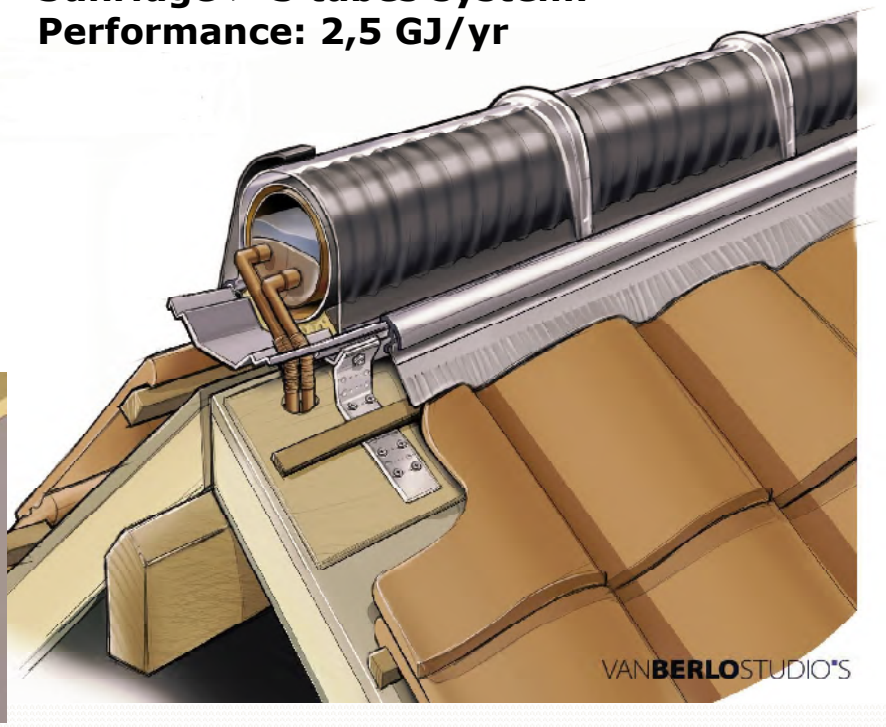
Product characteristics

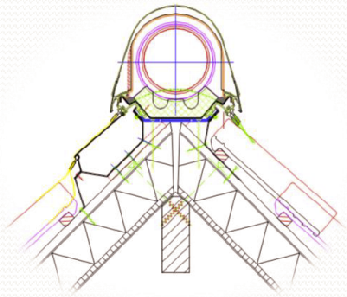
Sunridge > 3 tubes system
Performance: 2,5 GJ/yr



Components Integration

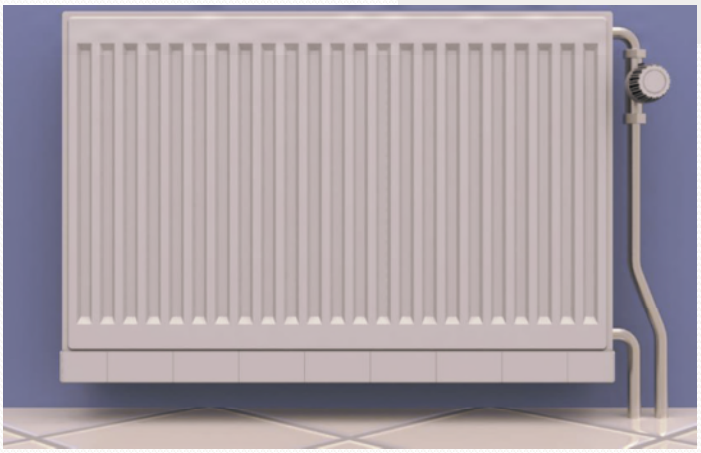






Ridge integrated solution
No use of space indoors
Optimal irridation
Independent of orientation

ClimateBooster

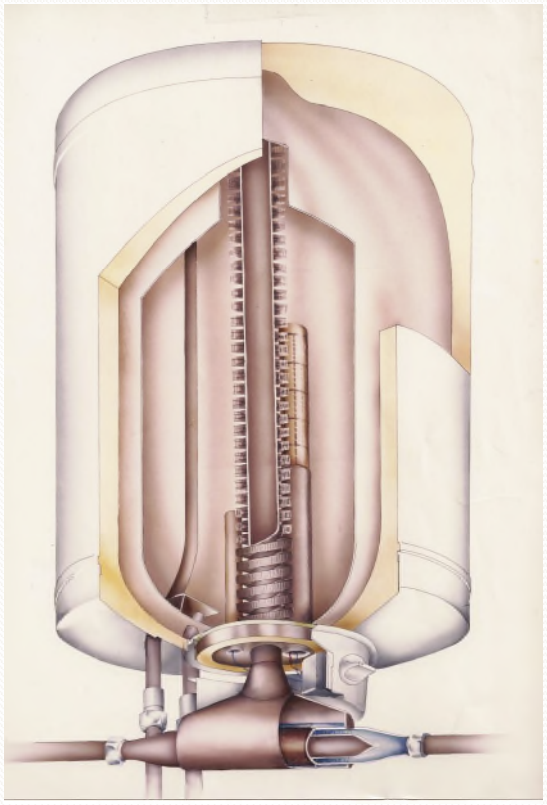


Electrical Heatpumps

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 ↑

GEOTHERMAL HEAT STORAGE >

OFTRINGEN

Philip Klingler

erdwärmeoftringen gruner >

Designing our habitat

gruner >

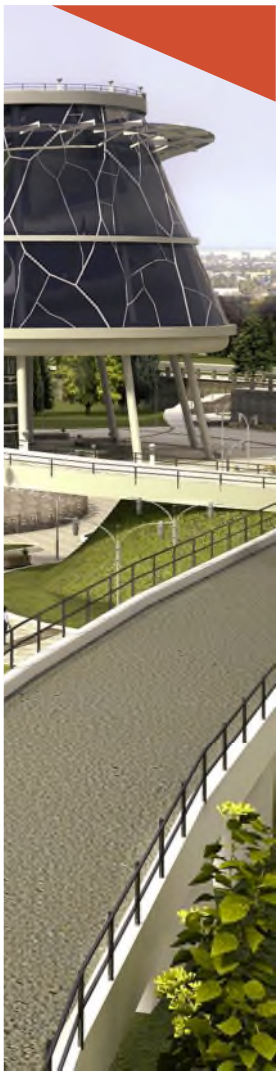
COMPETENCES

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

22 Companies

1057 Employees

since 1862



LOCATIONS IN SWITZERLAND

24
LOCATIONS

erdwärmeoftringen gruner

LOCATIONS WORLDWIDE

10
LOCATIONS

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

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

Stucky Asia, Bangkok

Gruner Peru S.A.C, Lima

erdwärmeoftringen gruner

ENERGY FOCUS

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

ENERGY REFERENCES

Hydro dam Muttsee, Glarner Alps

for:
Axpo Power AG

Geothermal district heating Riehen

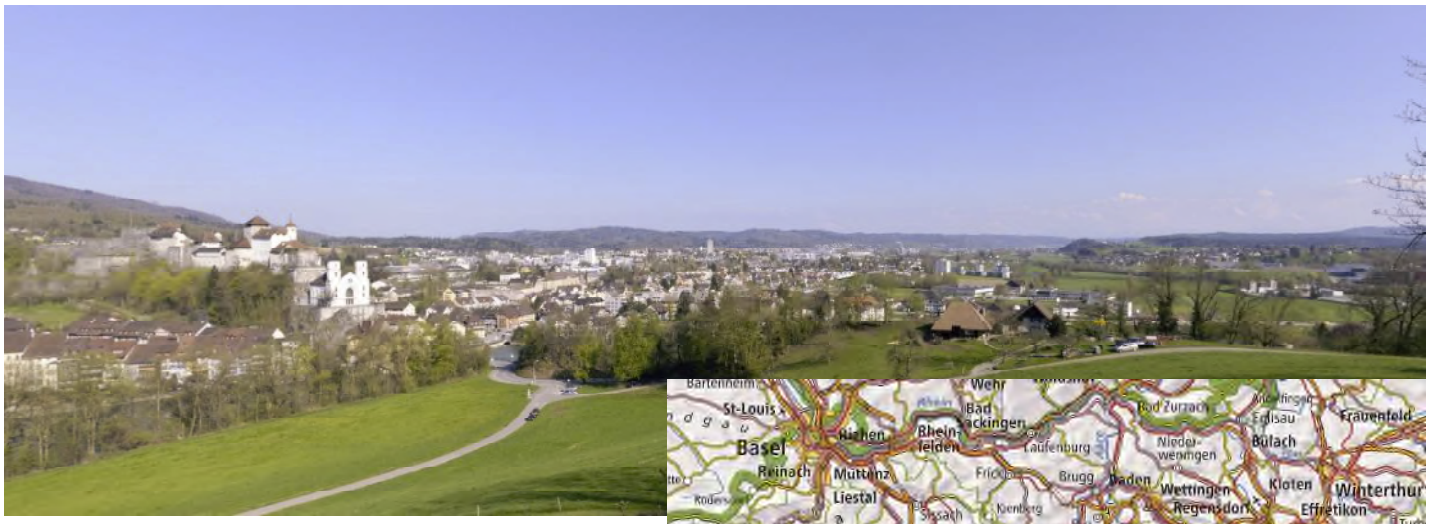
for:
Erdwärmeriehen AG

ETDE, Mosambik

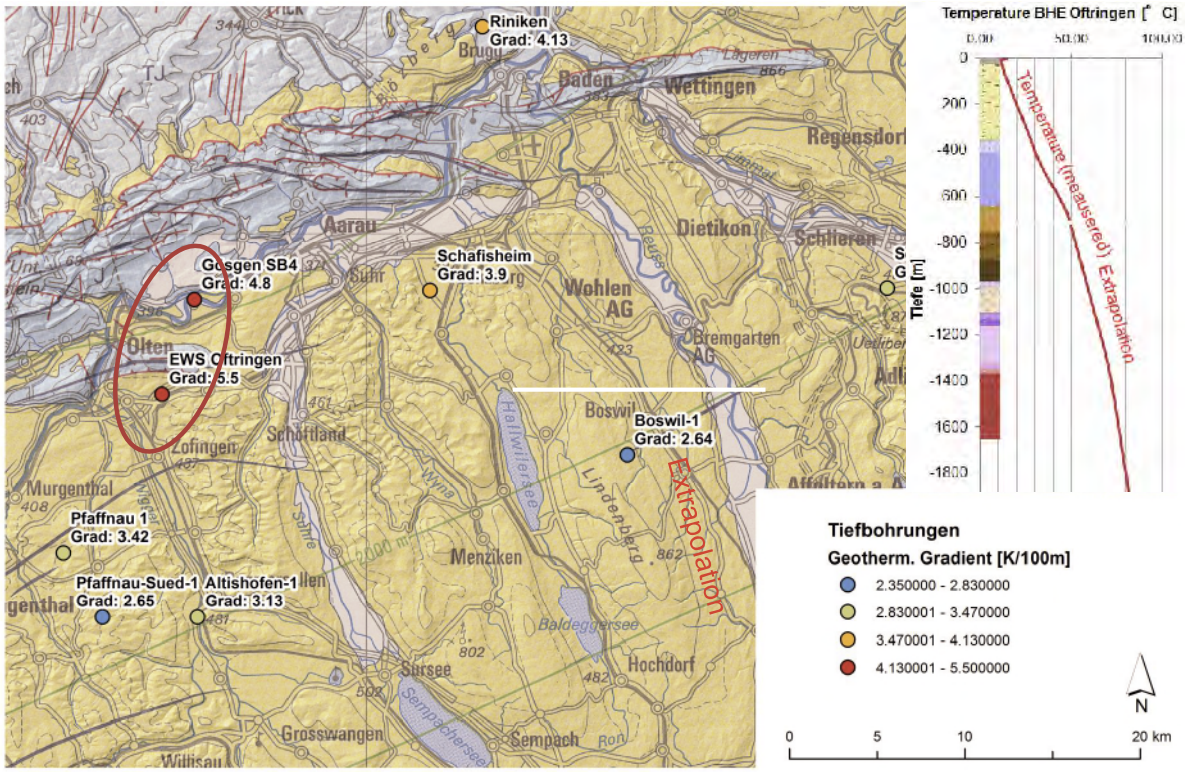
for:
ETDE France

erdwärmeoftringen gruner

Now back to Oftringen…



Increased geothermal gradient



erdwärmeoftringen

gruner

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

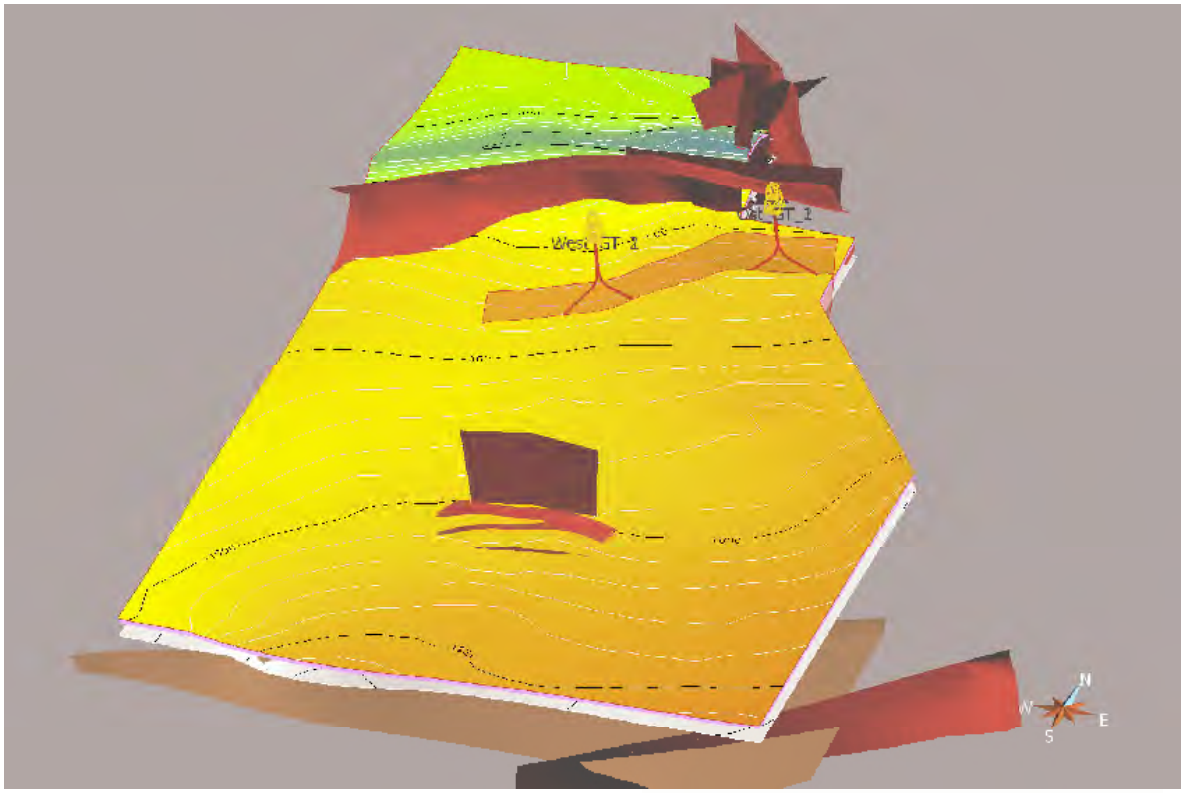
> 2014 Deep exploration well (swissnuclear) reveals high geothermal gradient too

> 2014/2015 roundup of of private and public investors

> May 2015 Exploration licence approved

> 2015 … just a minute…

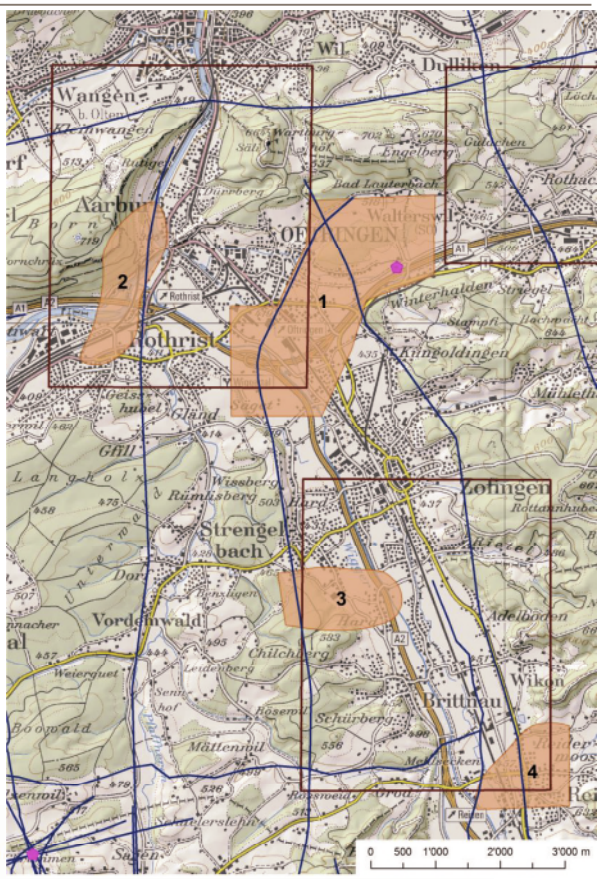
Preliminary design study: Geological Model



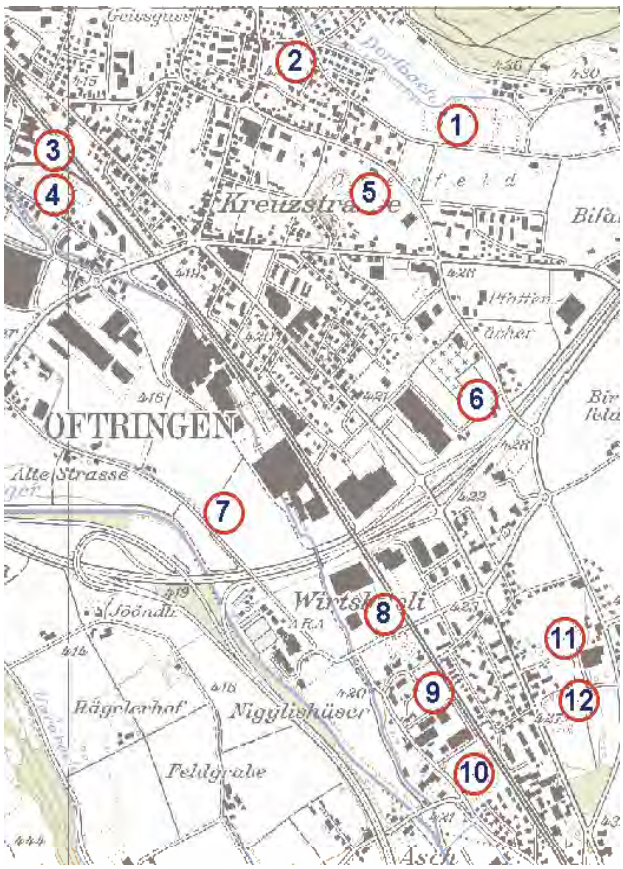
Preliminary design study

On the basis of a thorough geological analysis four potential areas of interest were defined

→ Section1 was chosen



Preliminary design study: site evaluation



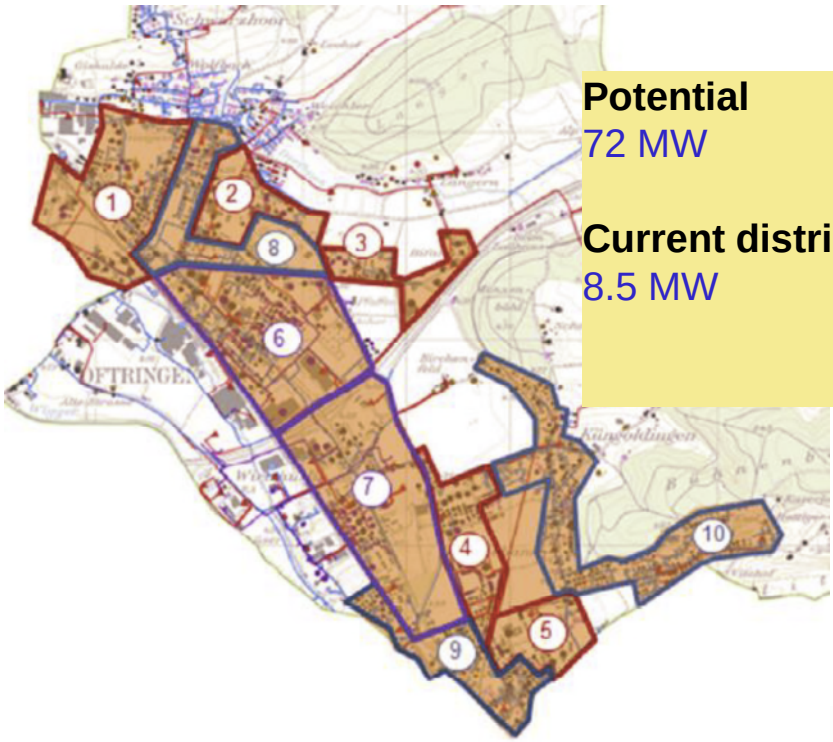
	Geology	Building stability	Noise	Access	Polluted site	Natural hazards	Gas	District heating	TOTAL
1									**
2									
3									
4									
5									
6									*
7									***
8									*
9									
10									
11									
12									

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)

District heating sales potential study

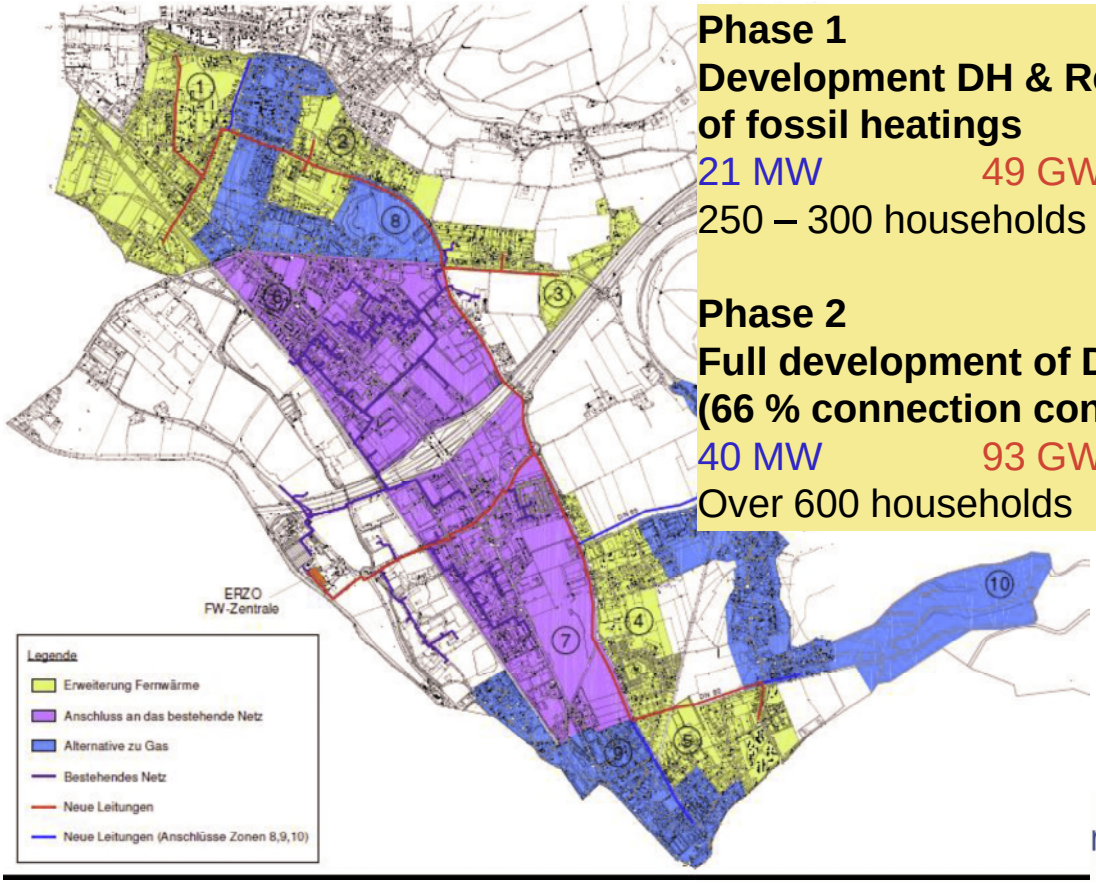
Potential for district heating in Oftringen



Potential (Study "nova")
72 MW 166 GWh/a

Current district heating (ebm)
8.5 MW 20 GWh/a

District heating development Oftringen



Phase 1
Development DH & Replacement of fossil heatings
21 MW 49 GWh/a
250 – 300 households

Phase 2
Full development of DH (66 % connection concentration)
40 MW 93 GWh/a
Over 600 households

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

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Function in winter

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Function in summer

District heating Oftringen

Heat pump possible

Cold well

Warm well

Discharging heat storage

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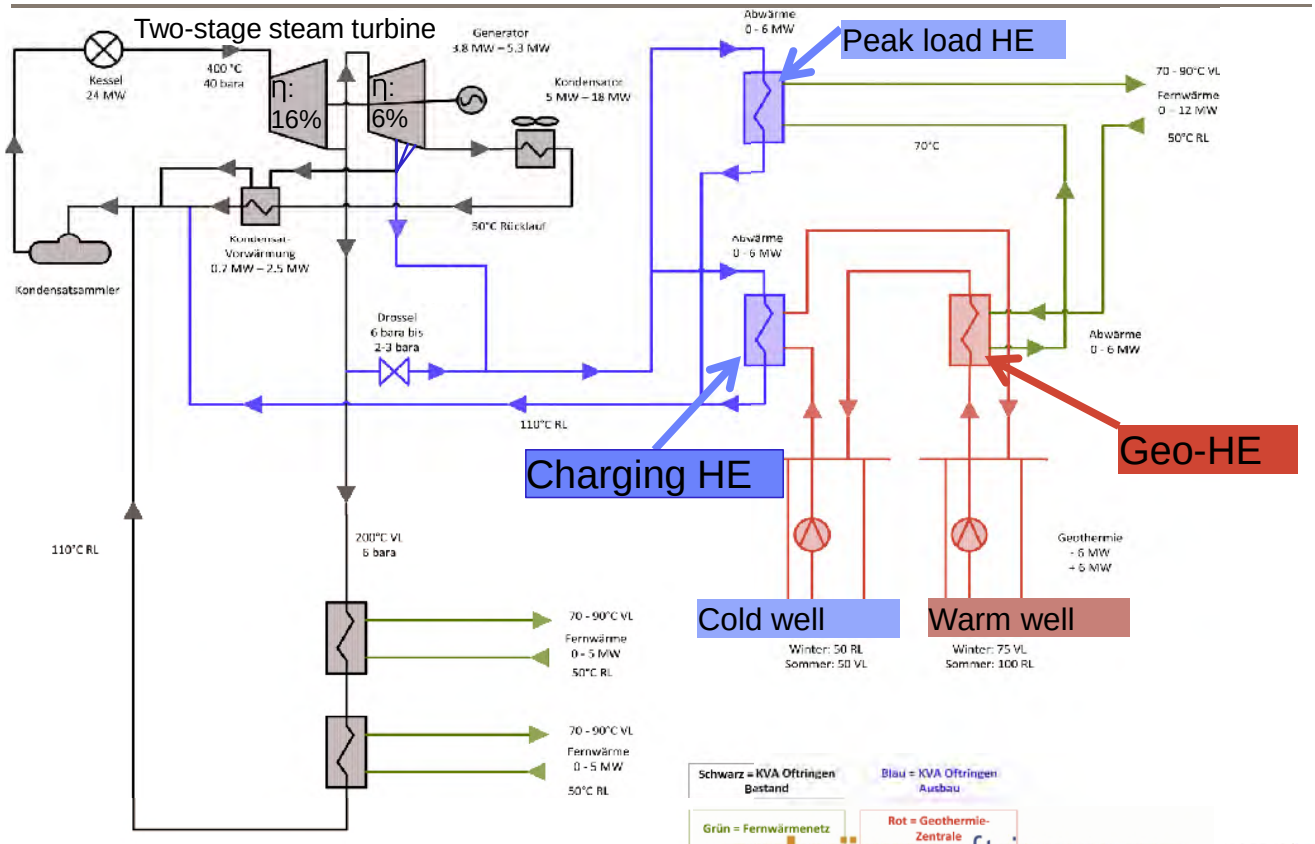
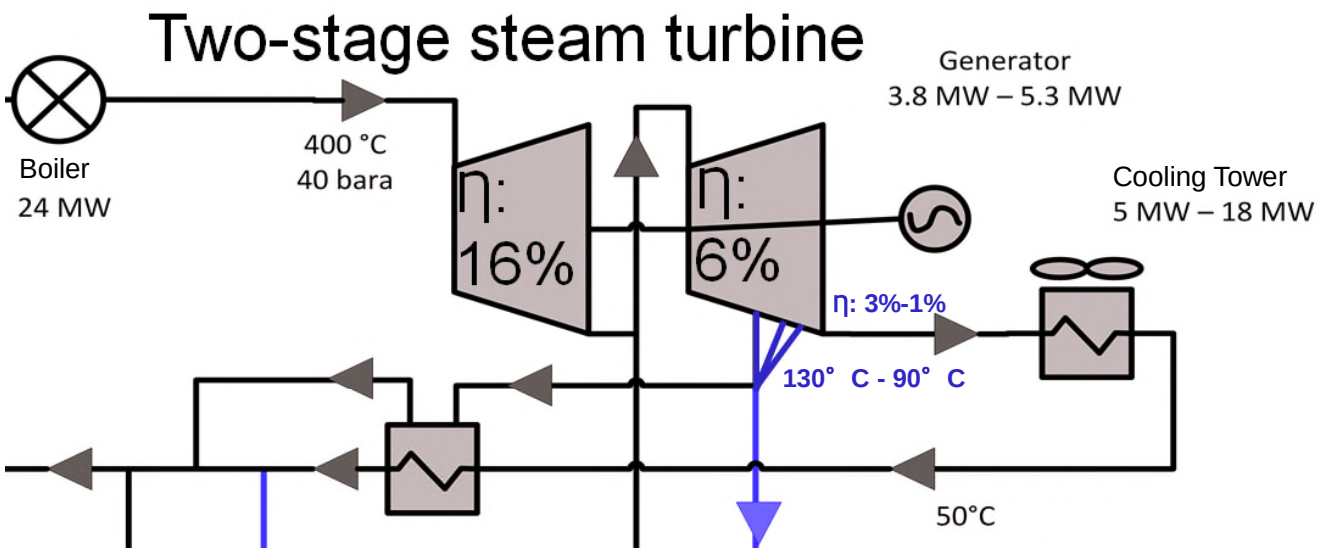
Kopplung erzo / Geothermie Oftringen



erdwärmeoftringen gruner

Steam extraction of low pressure steam

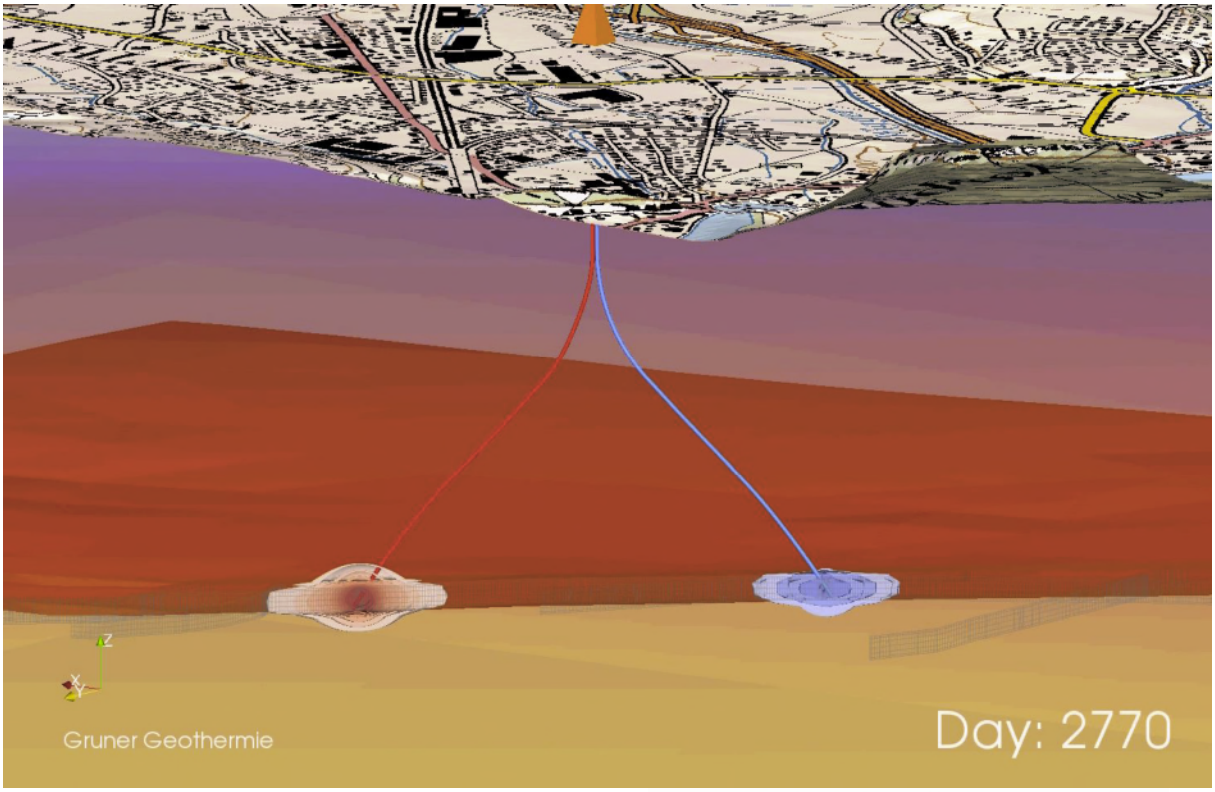


Modelling

> Validation of the idea

> Determination of energetic parameters for an economic evaluation

Hydrogeological reservoir model



Reducing Risks

Temperature:

> Increasing temperature for direct use through heat storage

Hydraulic short cut:

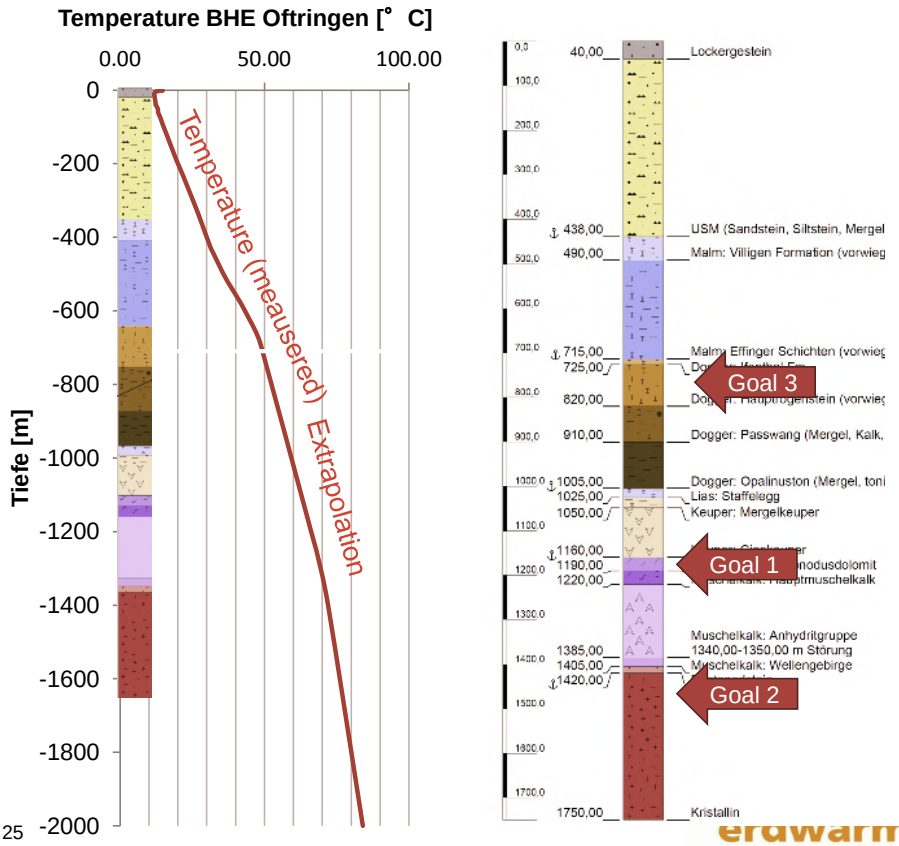
> Reversing flow directions eliminate the risk of a hydraulic short cut.

> No permanent reservoir cooling

Multi-reservoir strategy

> More independence of reservoir temperature

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

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

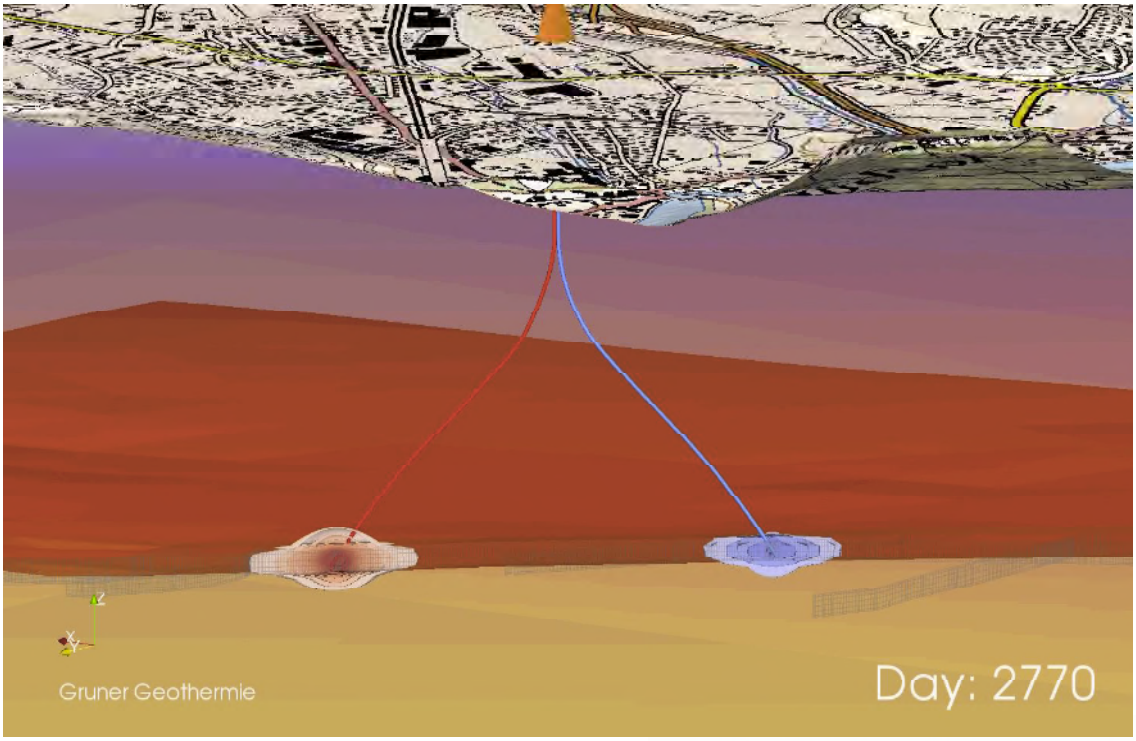
> Site is geologically representative for other sites in Switzerland (and Europe) and has a high copy potential

> 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"

Thank you for your attention!



erdwärmeoftringen

gruner

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 committee to support start-ups supplying heat for their production process and find opportunities to lower the costs of electricity in the area.

Back to the program ↑

Enel Green Power

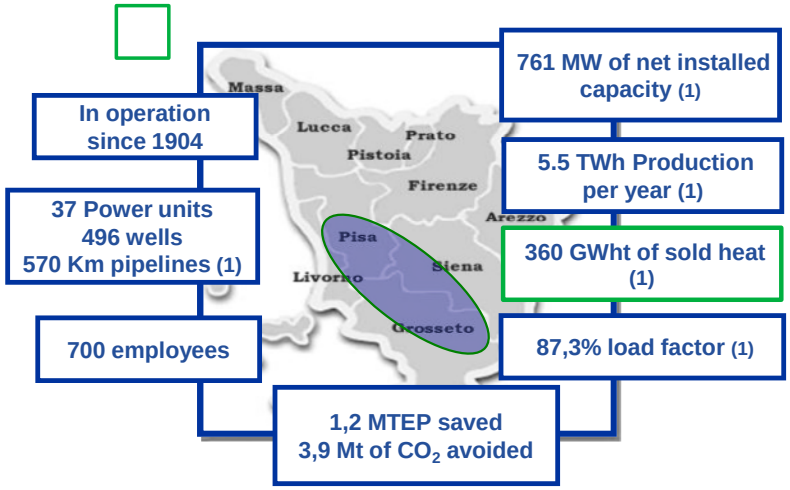
Geothermal for Agriculture and Food

Geneve, 30th 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



In operation since 1904

37 Power units
496 wells
570 Km pipelines (1)

700 employees

761 MW of net installed capacity (1)

5.5 TWh Production per year (1)

360 GWht of sold heat (1)

87,3% load factor (1)

1,2 MTEP saved
3,9 Mt of CO_2 avoided

- 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%

20%

Production wells

steam
200 - 220 °C

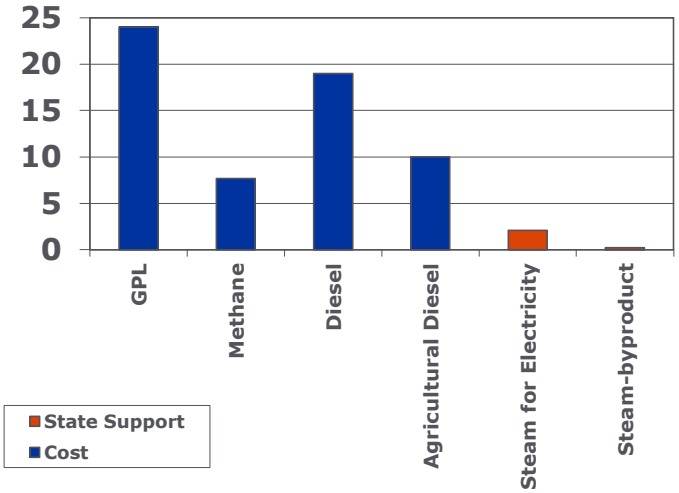
Water 40 °C

Reinjection well

water 30 °C

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.

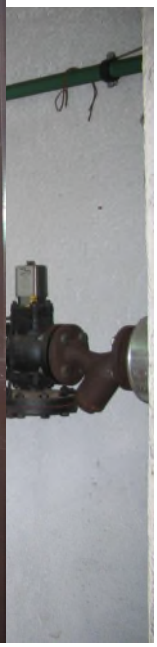
40% o

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

He

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**

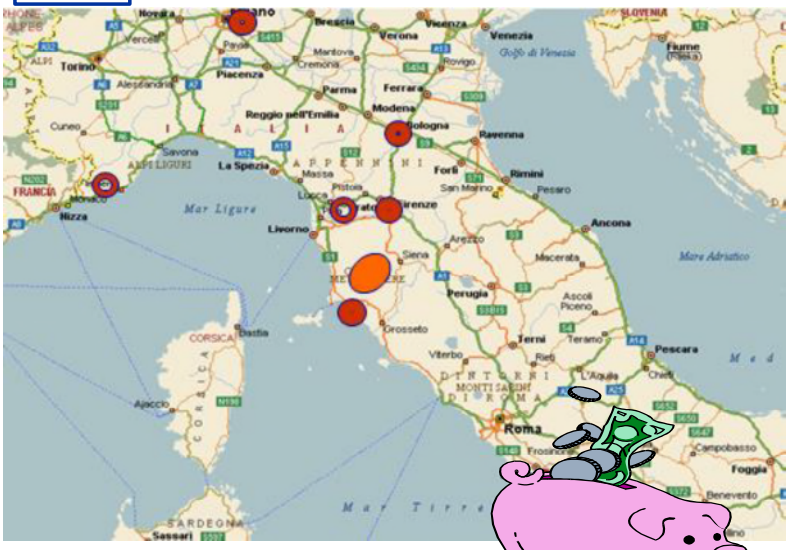
Opportunities

- 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



Geothermal savings 34%-27%=7%

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 %

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

Back to the program ↑

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

Geothermal Technologies Office Performance Metrics Overview

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
• Develop advanced remote resource characterization tools to identify geothermal opportunities without surface expression • Purposeful control of subsurface fracturing and flow • Improve and lower $/MW subsurface access technologies • Develop mineral recovery and hybrid systems to provide second stream of value	• Demonstrate the capability to create and sustain a greenfield 5 MW Enhanced Geothermal Systems reservoir by 2020. • Reduce the LCOE of undiscovered hydrothermal to $.10/kWh by 2020 • Lower the levelized cost of electricity from newly developed geothermal systems to $0.06/kWh by 2030. • Achieve $1.70-$2.60/m³ for desalinated water from geothermal by 2018.

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

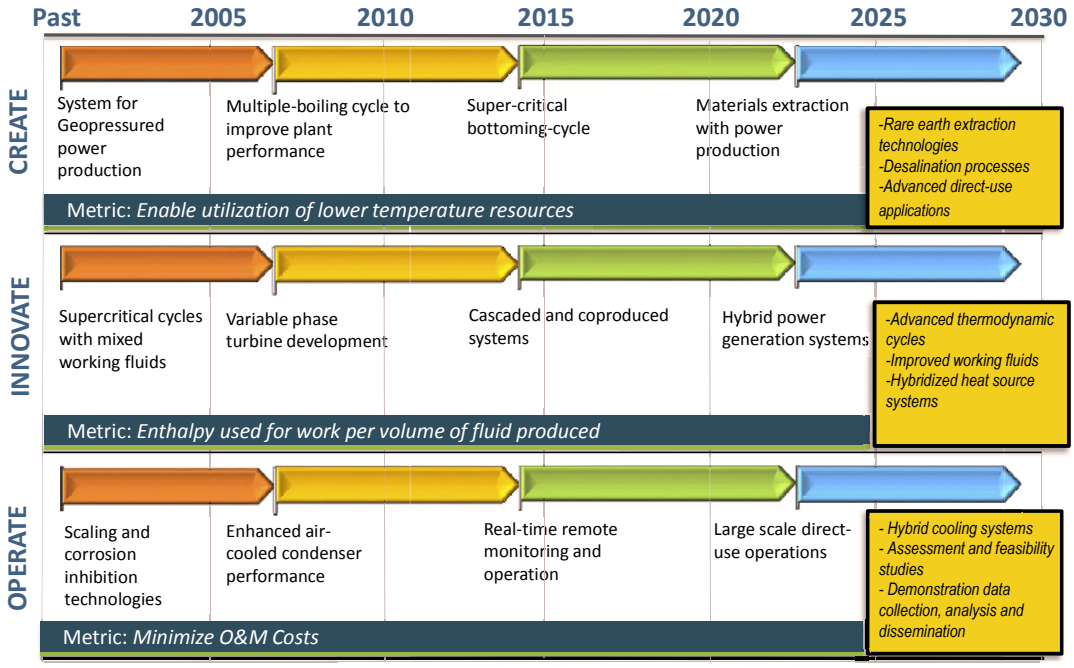
2017 Vision Study Activities:

- 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.

LT Technology Roadmap

Pathways: Create, Innovate and Operate

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



Systems Analysis and Low-Temperature Program

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

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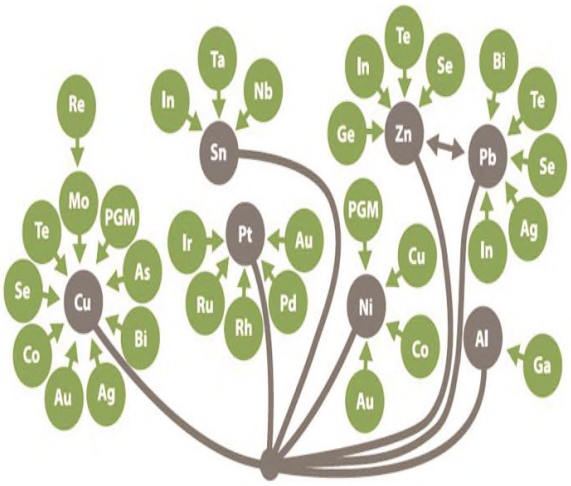
- **Low-Temperature Mineral Extraction** - Resource assessment and feasibility (ongoing)
- Large-scale **Direct Use**: where does it make technical and commercial sense?
- Use geothermal hot fluids for heating and cooling
- Potential displacement of traditional baseload generation on site-by-site basis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

GTO Mineral Recovery Program's Rationale

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.

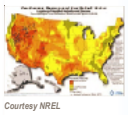
This matrix was used in the "Critical Materials for Sustainable Energy Applications" report by the Resnick Institute in 2011. (Original source: Hageluken, C., and Meskers, C.E.M.: Complex Life Cycles of Precious and Special Metals)

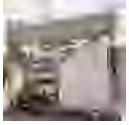
Key Barriers to LT Expansion

Technology and Engineering Needs

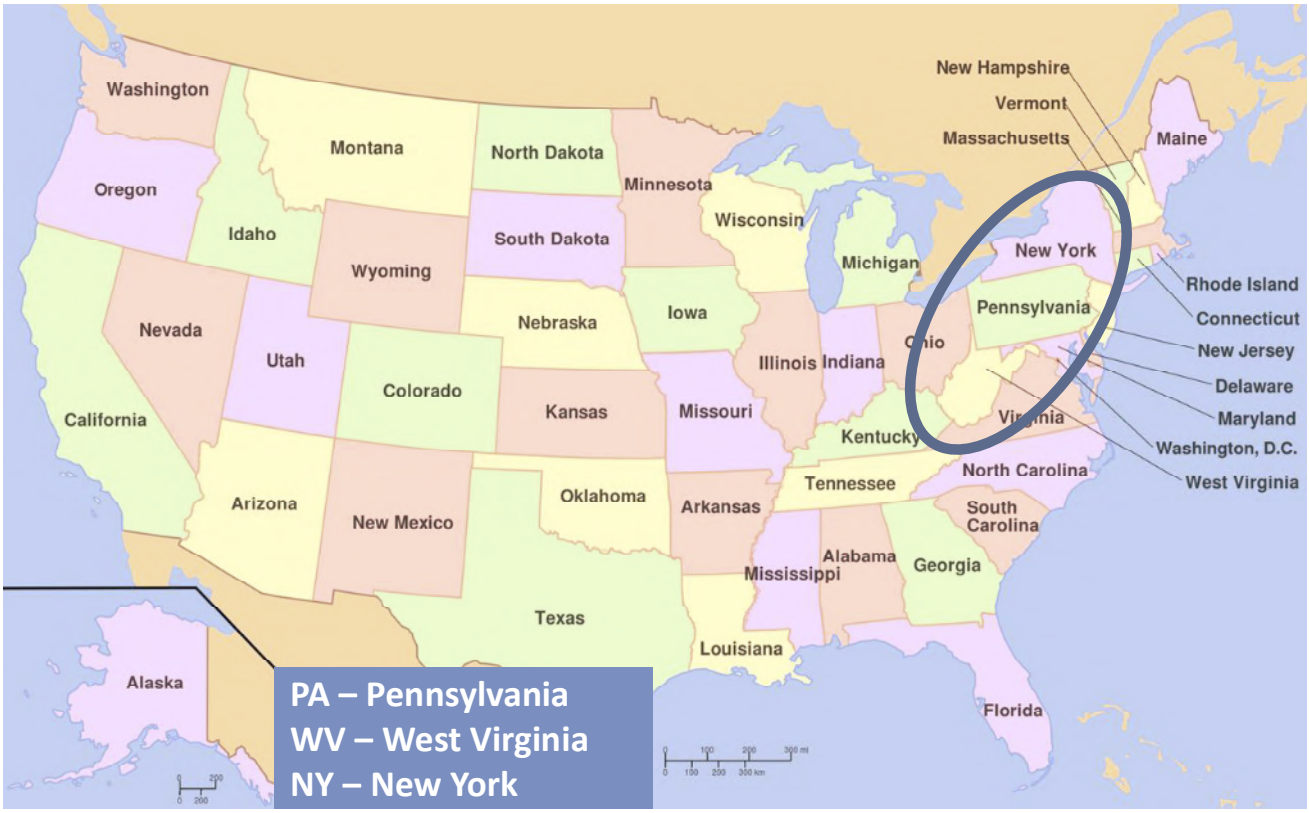
Goal	Technology Barriers	GTO-Funded Solution Set
Low Temp/ Co-production Growth	**Cooling Technologies** Air-cooled systems are constrained in hotter areas of the arid, but geothermally-concentrated Western U.S.	Leveraging O&G infrastructure; Innovative conversion cycles
	Fluid Value Lower temperature fluids are inherently less valuable for power generation than hotter; additional uses/revenue sources are needed	Hybrid cooling cycles; Materials Extraction; Advanced working fluids
	Energy Conversion Improve efficiencies for lower temperatures, operation & maintenance, cost	Improved binary system components; Hybrid Technologies; Coproduction


Courtesy UTC Power


Courtesy NREL


Courtesy UTC Power

Game-changers



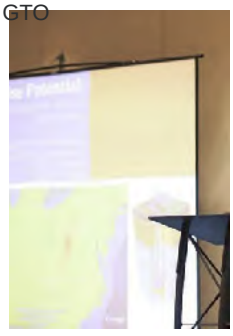
government/contractors

- Leverages DOE (NETL) 21st 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

NETL George Richards GTO

- 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.



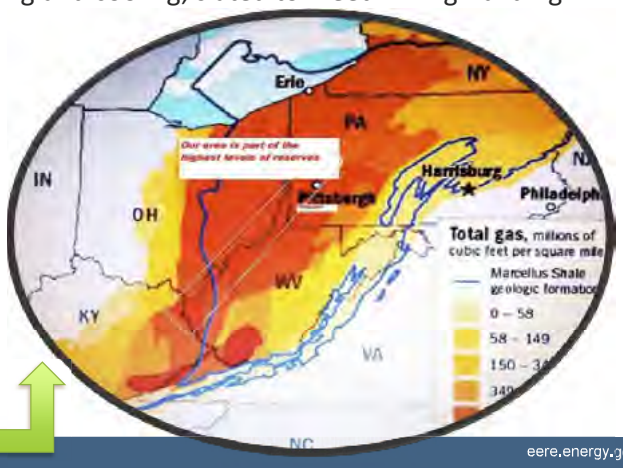
WVU Brain Anderson Geothermal Play Fairway

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.

U.S. DOE Geothermal Data Repository Node on the NGDS

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GDR

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

OpenEI

"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

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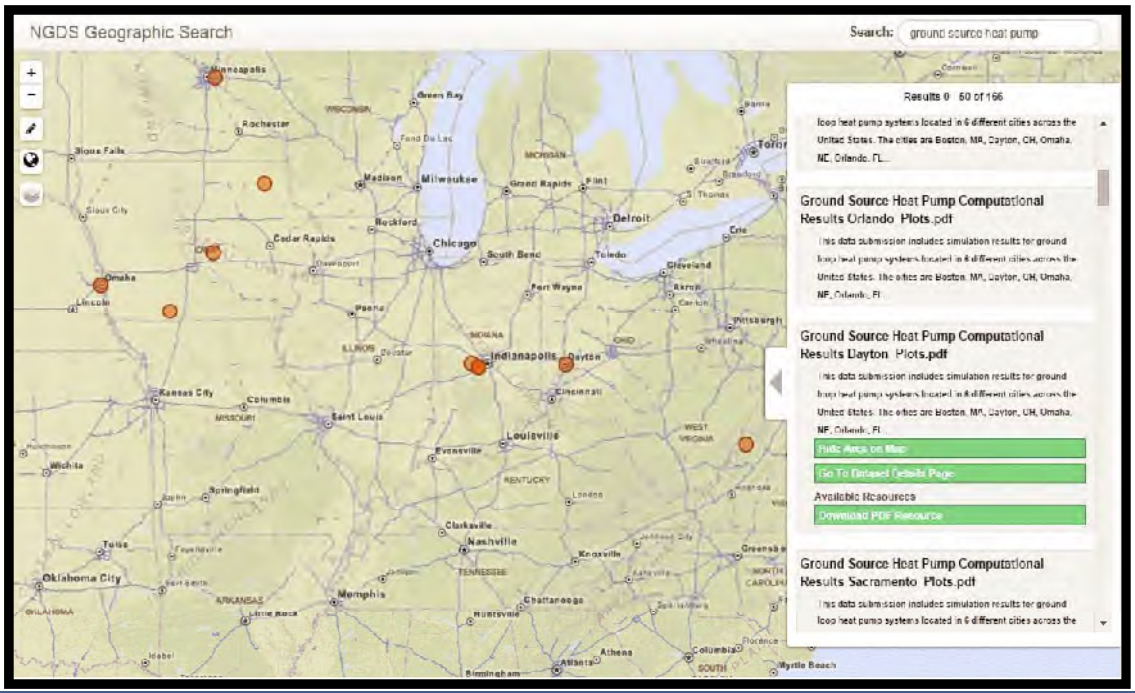


- **To connect with Arlene Anderson**

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

Back to the program ↑

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

Kasumi Yasukawa, AIST
Yoonho Song, KIGAM

AIST

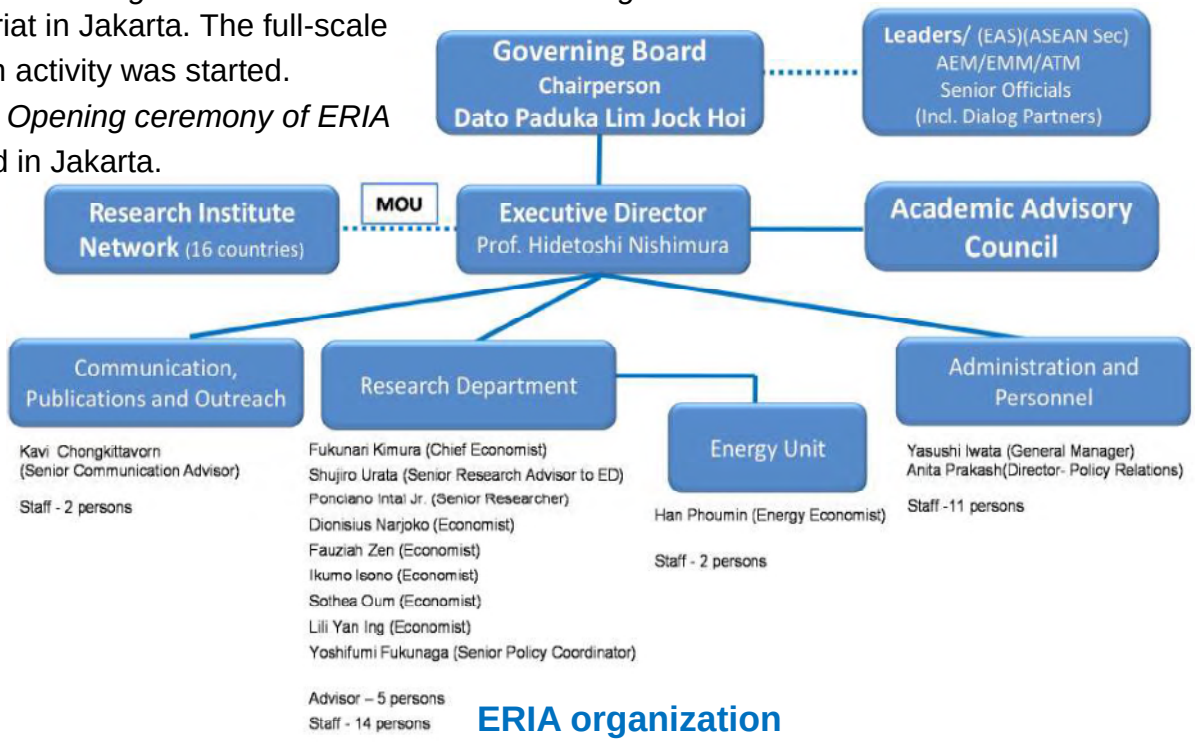
Contents

- 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**

Short introduction of ERIA

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 *13th 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.



ERIA organization

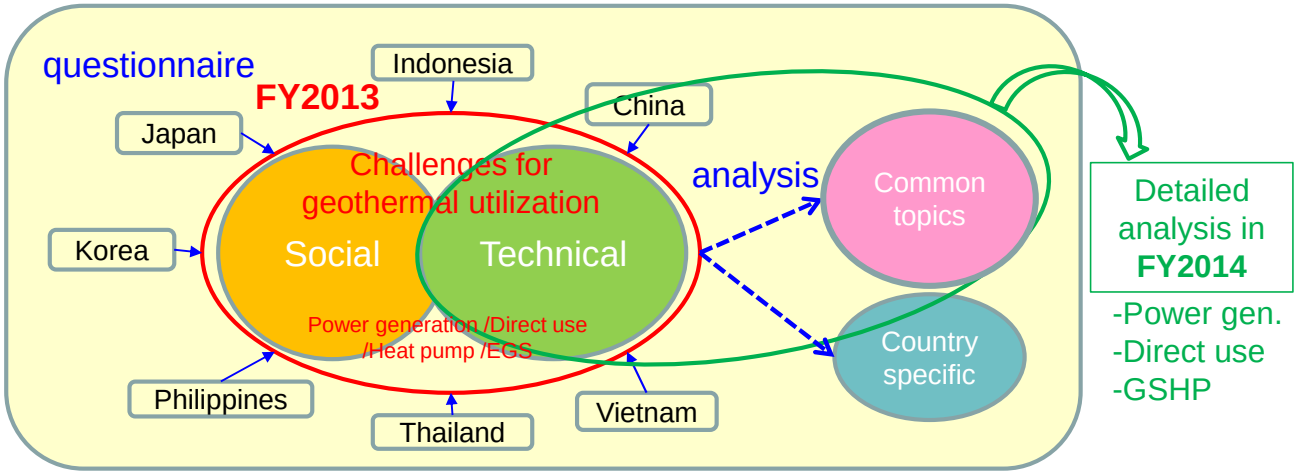
ERIA Geothermal Project (September 2013- June 2015)

"Sustainability Assessment of Utilizing Conventional and New-Type Geothermal Resources in East Asia"

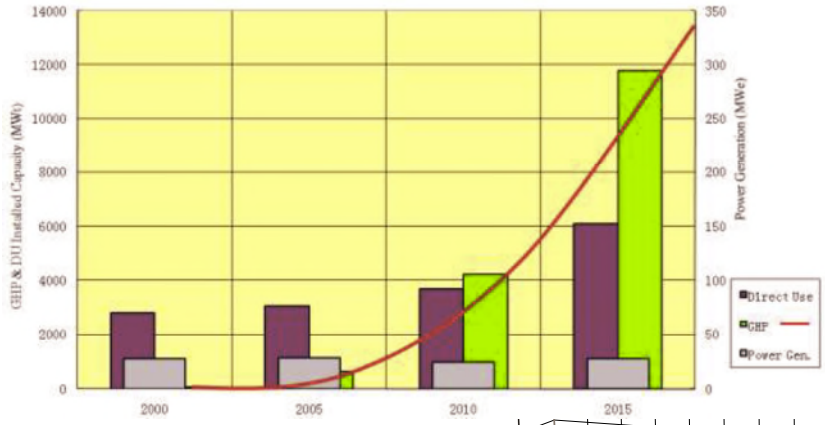
Sustainability is the key to improve the reliability of geothermal energy.

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.

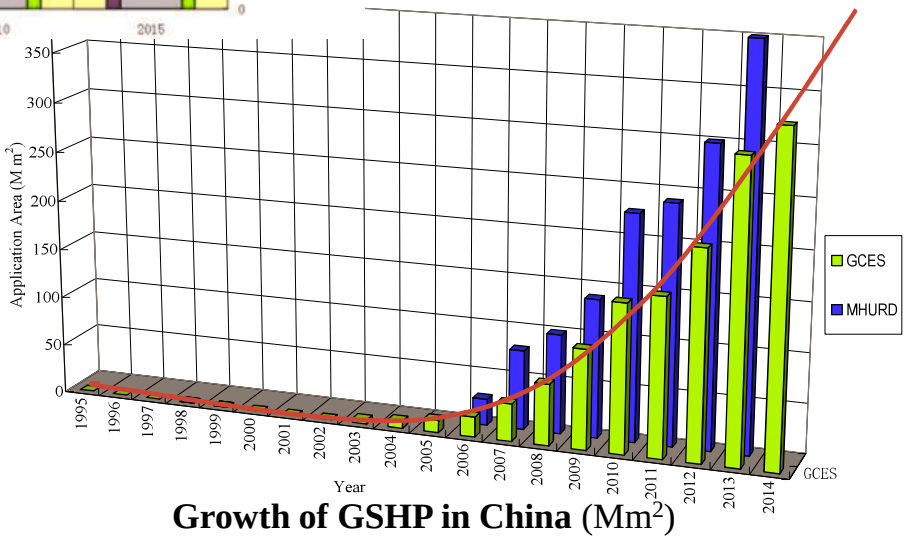


China: Investigation, evaluation, and monitoring



Growth of Geothermal Utilisation in China

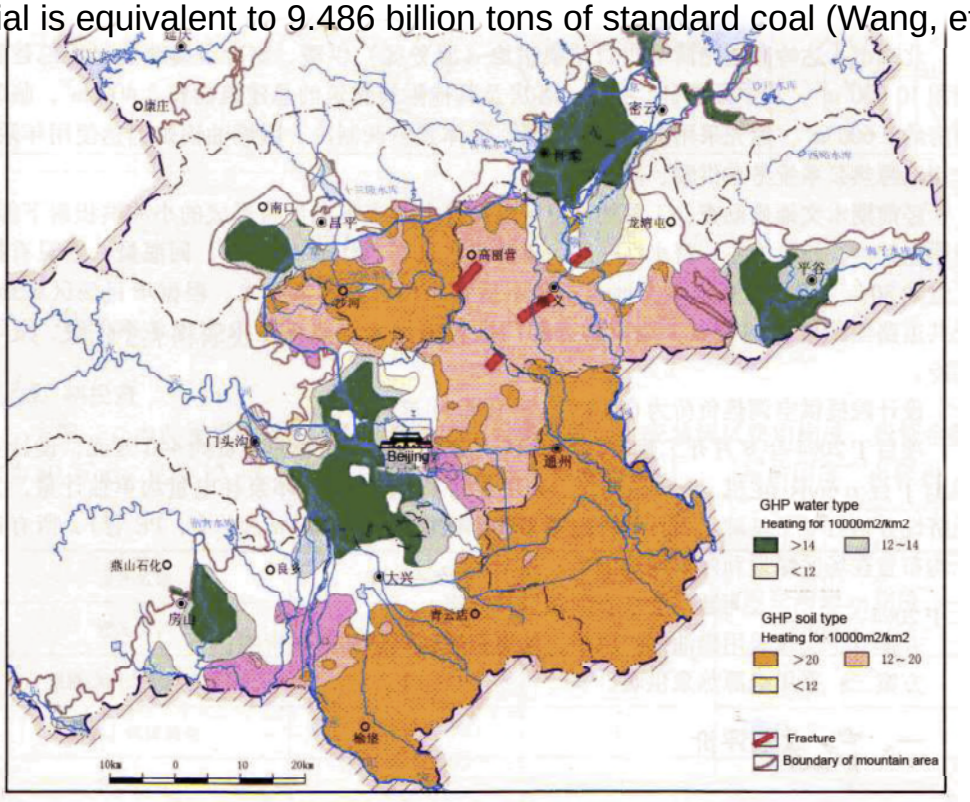
Data source: Geothermal Council of China Energy Society (GCES), Ministry of Housing and Urban-Rural Development (MHURD)



Growth of GSHP in China (Mm^2)

China: Investigation, evaluation, and monitoring

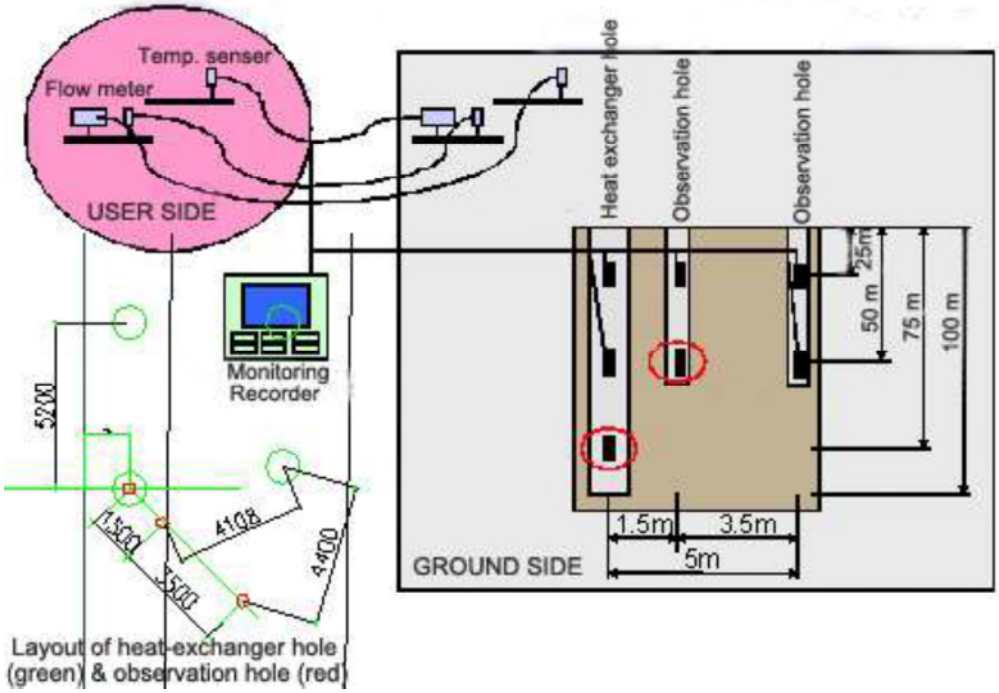
The national project of investigation and evaluation of shallow geothermal energy has shown great potential. It provides heat capacity for GSHP use. The total potential is equivalent to 9.486 billion tons of standard coal (Wang, et al., 2013).



Map Showing Shallow Geothermal Energy Conditions in Beijing

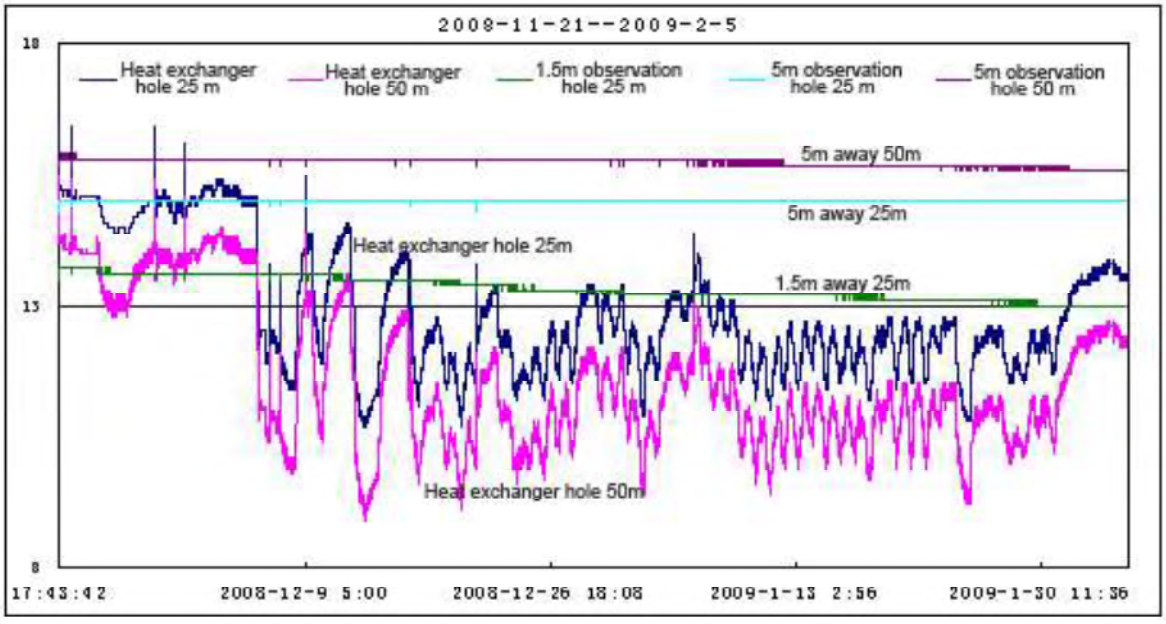
China: Investigation, evaluation, and monitoring

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

China: Investigation, evaluation, and monitoring



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.

Korea: Importance of monitoring and its data analysis

The government building complex of Sejong Metropolitan City

- The total building area: 607,555 m^2.
- Total GSHP installed capacity >20 MW_t, 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

Korea: Importance of monitoring and its data analysis

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.

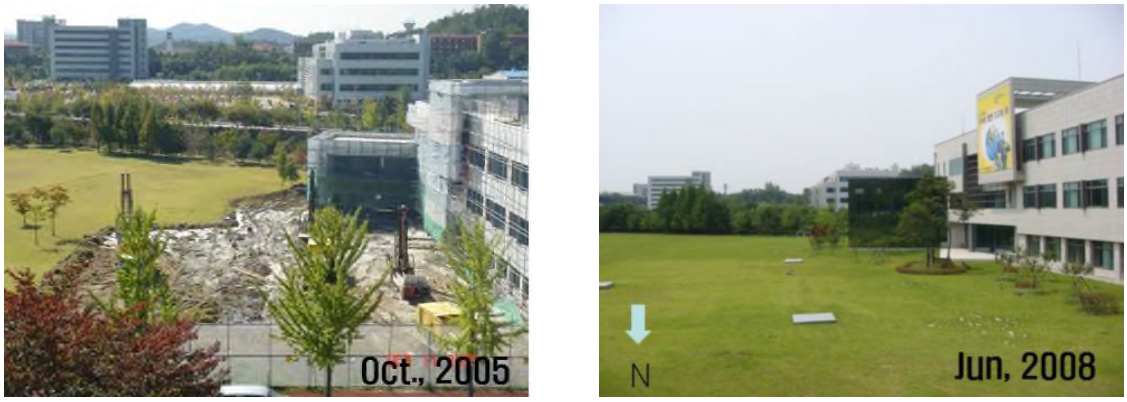
drilling of borehole for BHE

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

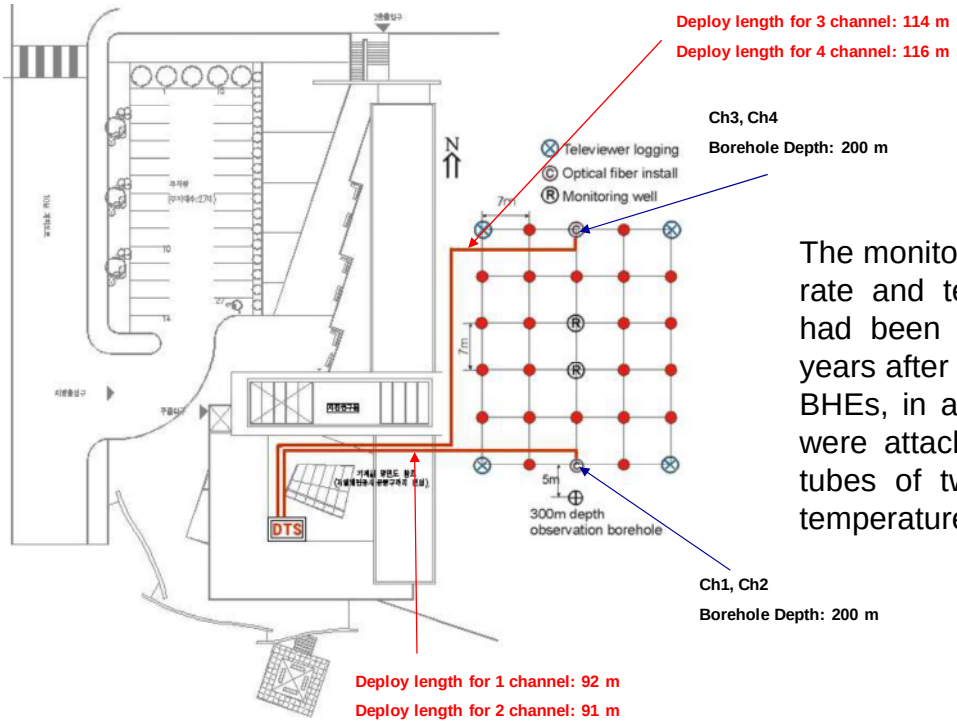
- A long-term monitoring case of ground temperature variation according to GSHP operation can be found at the Earthquake Research Center (ERC) building in KIGAM.
- The building is three storeys high with an area of 700–900 m^2 each, 2,435.4 m^2 in total, constructed in 2005.
- The heating and cooling 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)

AIST Korea: Importance of monitoring and its data analysis

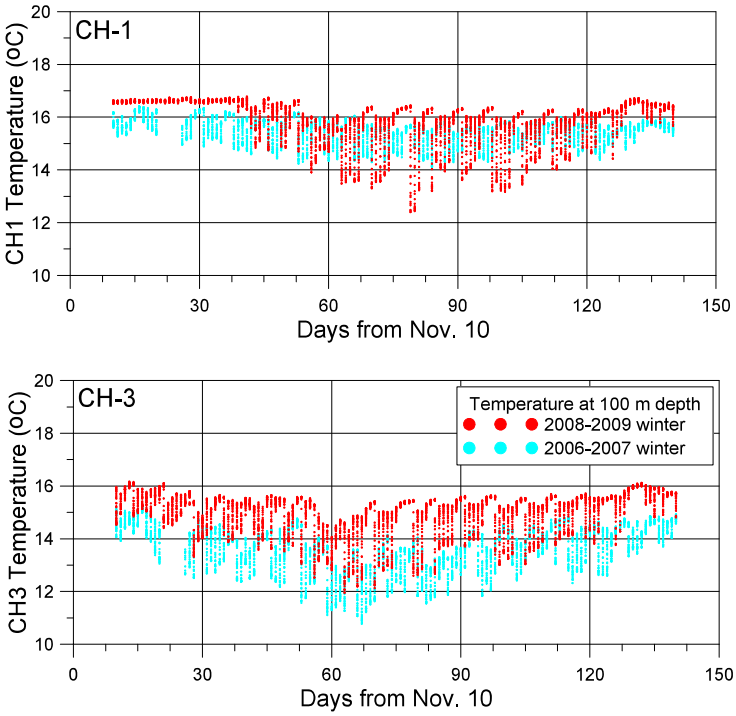
Long-term temperature monitoring in Earthquake Research Center, KIGAM



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**

AIST Korea: Importance of monitoring and its data analysis

Problem

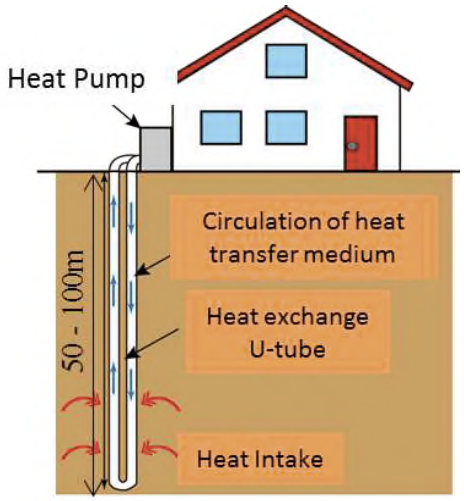
In South Korea, by law, all GSHP systems are subject to be monitored in terms of inlet and outlet temperature and flow rates during operation. All these data are collected by the authorised ministry. However, no analysis has been made for these data so that the actual coefficient of performance (COP) 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.

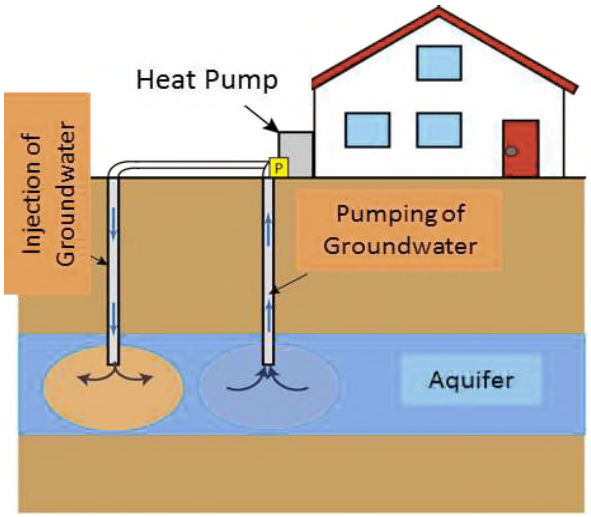
AIST Japan: Suitability mapping for both closed & open systems

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)



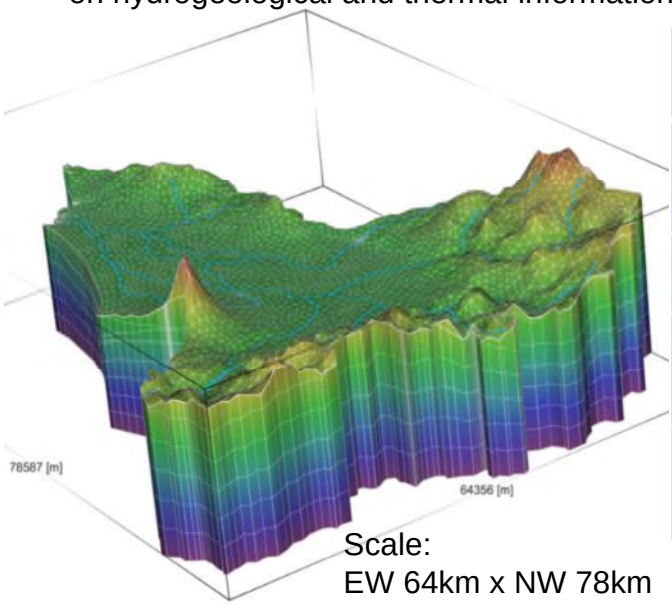
Suitability index parameters for open loop system:

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

AIST Japan: Suitability mapping for both closed & open systems

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.



Scale:
EW 64km x NW 78km

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

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

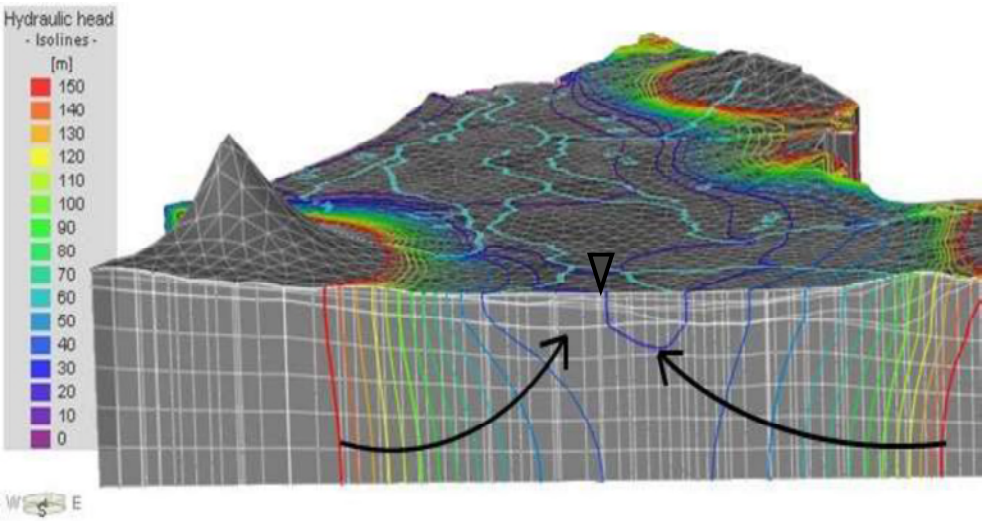
Geological Survey of Japan NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST Japan: Suitability mapping for both closed & open systems

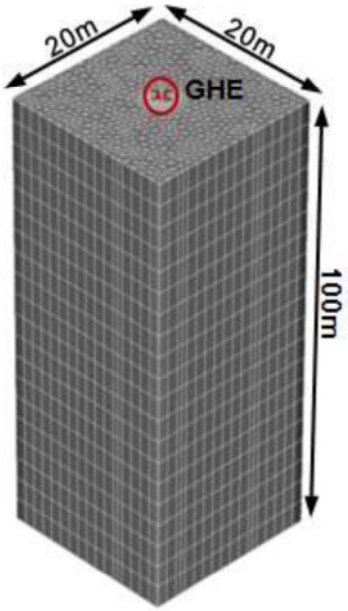
Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain

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).

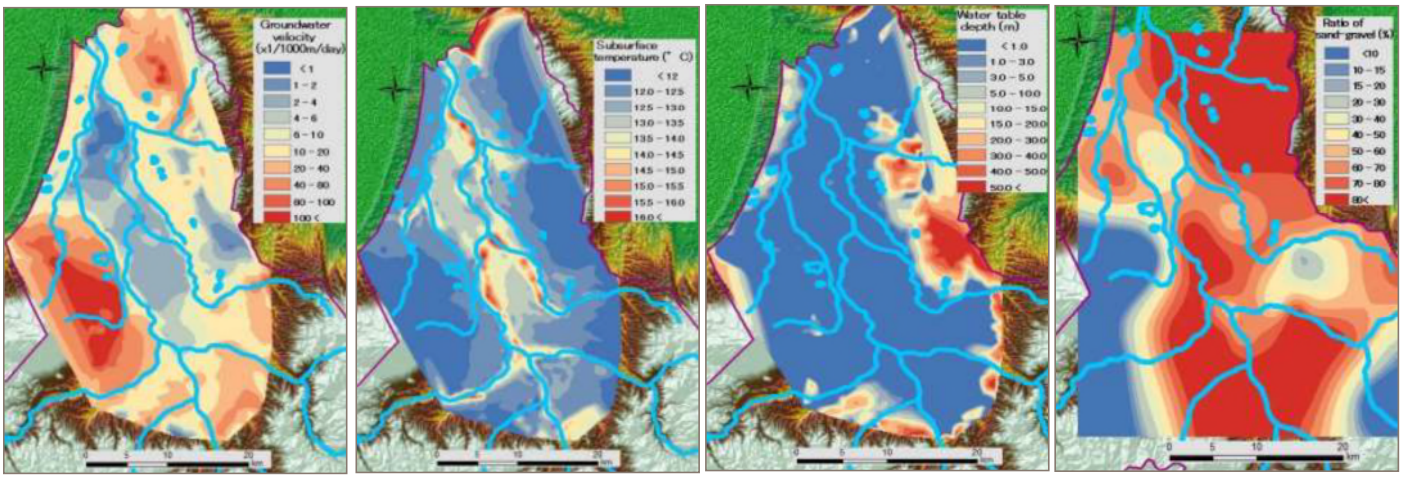


Single Ground Heat Exchanger Model

AIST Japan: Suitability mapping for both closed & open systems

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).

AIST Japan: Suitability mapping for both closed & open systems

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.

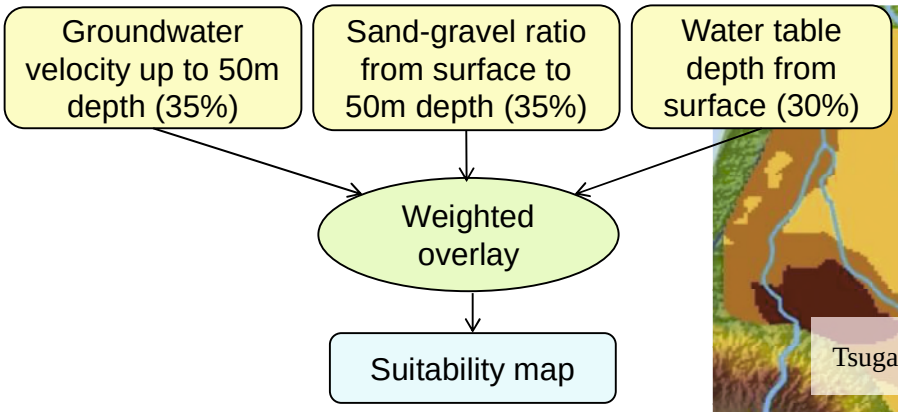
Groundwater velocity Index class ($x10^{-3}$m/day)	Sand-gravel ratio Index class (%)	Water table depth from surface Index class (m)	Grade
< 1	<10	50 <	1
1 – 2	10 – 15	40 - 50	2
2 – 4	15 – 20	30 - 40	3
4 – 6	20 – 30	20 - 30	4
6 – 10	30 – 40	15 - 20	5
10 – 20	40 – 50	10 - 15	6
20 – 40	50 – 60	5 - 10	7
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).

AIST Japan: Suitability mapping for both closed & open systems

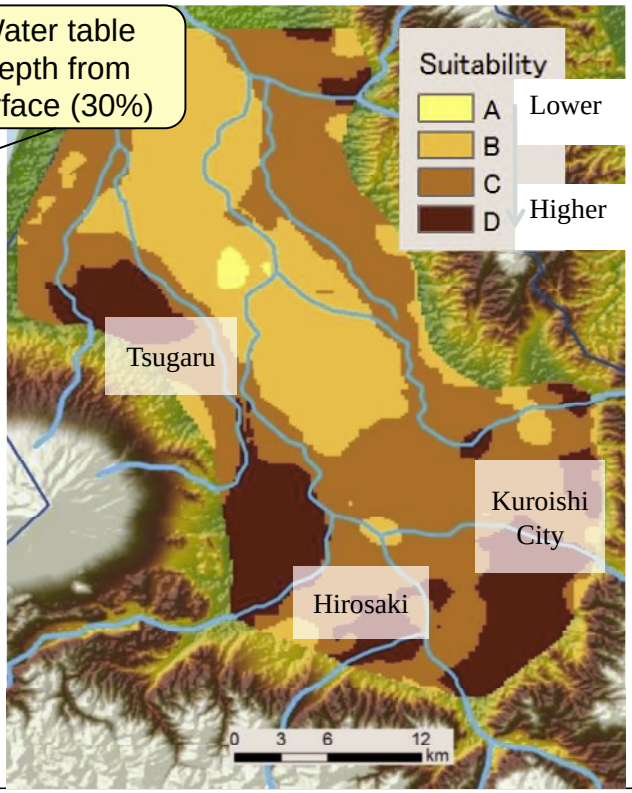
Suitability map for closed-loop GSHP system; development of suitability map for installation of GSHP system in the Tsugaru Plain

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)

AIST Japan: Suitability mapping for both closed & open systems

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.

AIST Japan: Suitability mapping for both closed & open systems

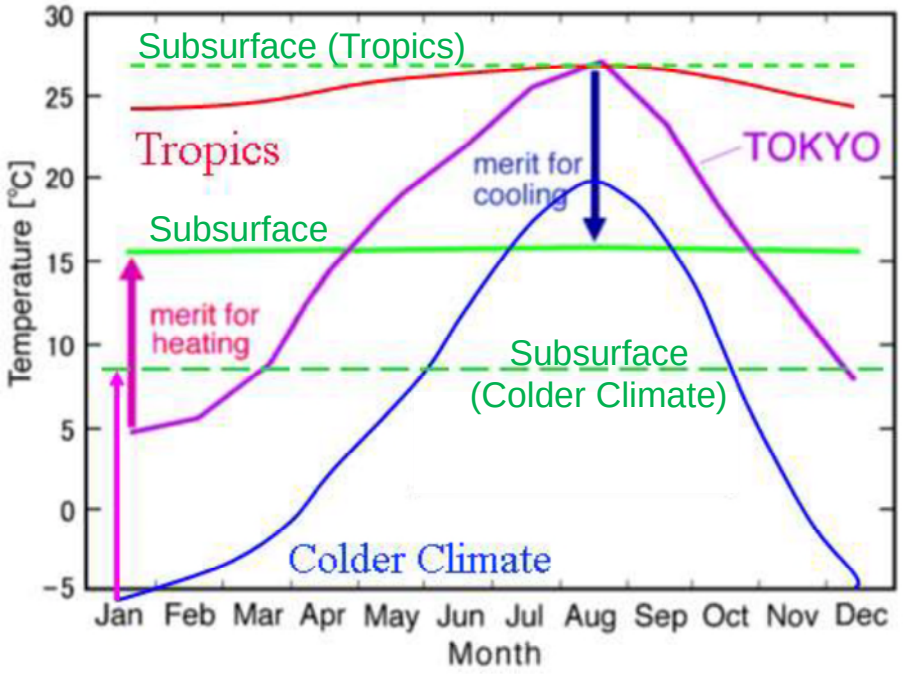
Lessons learned (continued)

- 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)

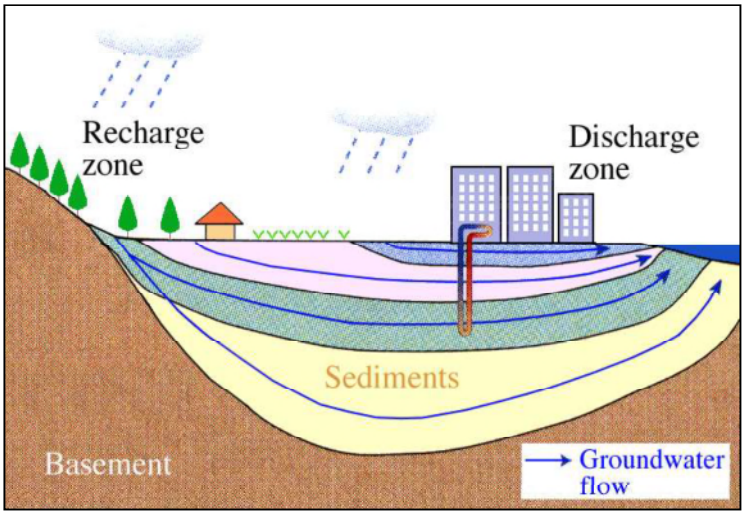
AIST Thailand: Comparison of groundwater and atmosphere

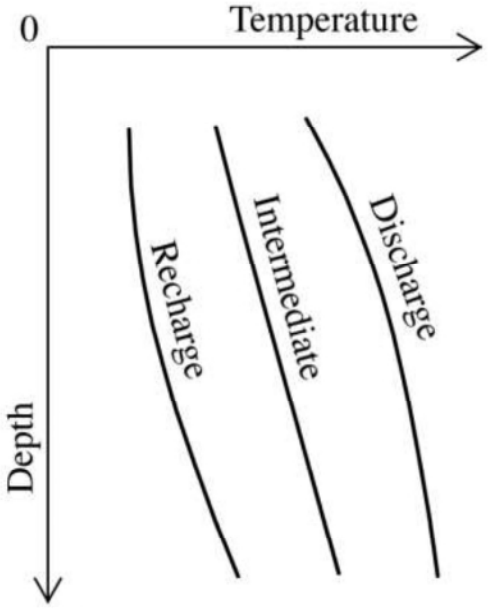
Can we use GSHP System in tropics?

- 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

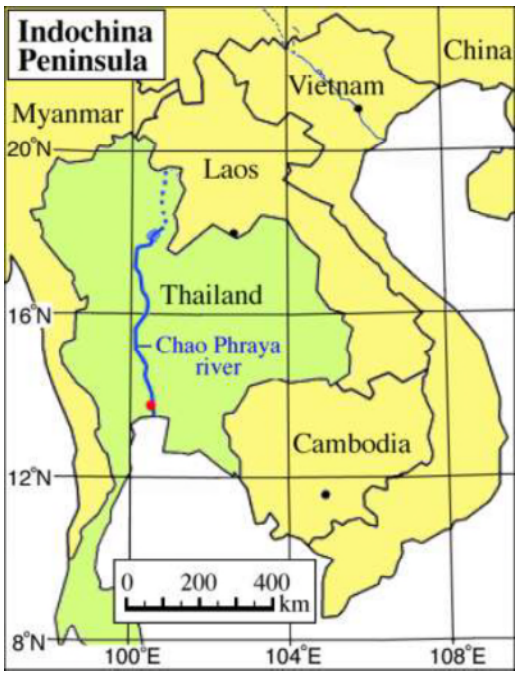


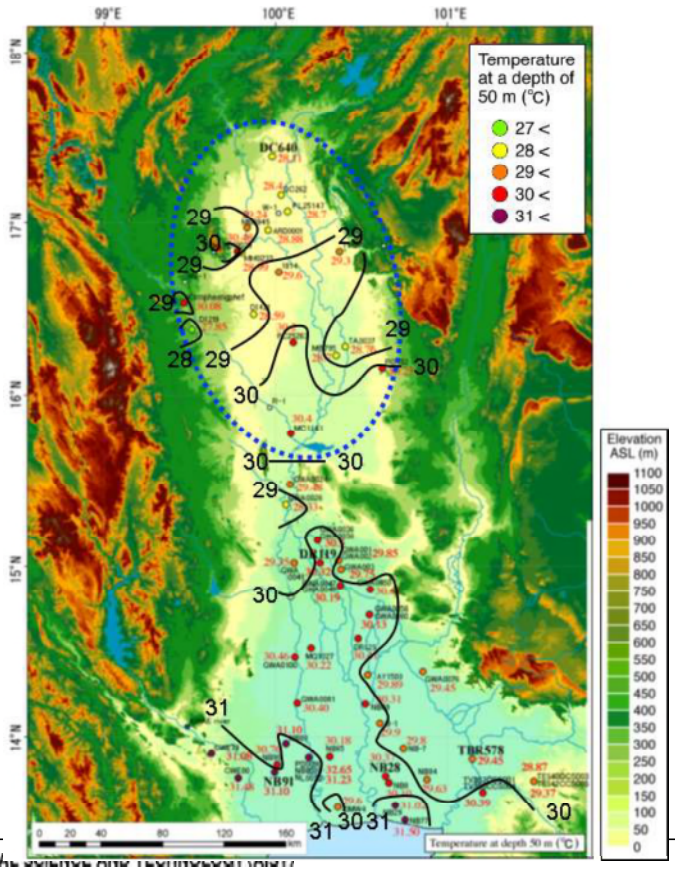


Subsurface temperature profile with groundwater flow

AIST Thailand: Comparison of groundwater and atmosphere

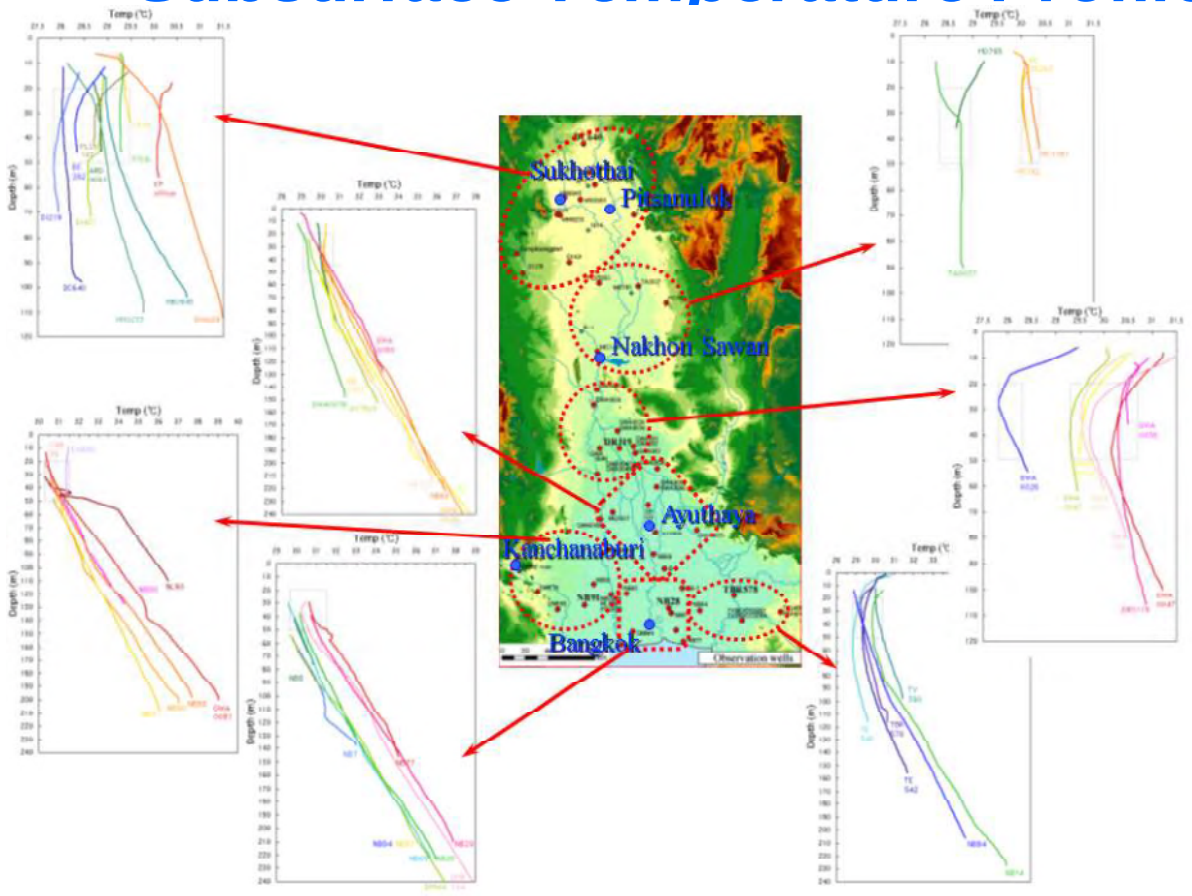
Temperature measurements in Thailand





DGR: Department of Groundwater Resources of Thailand

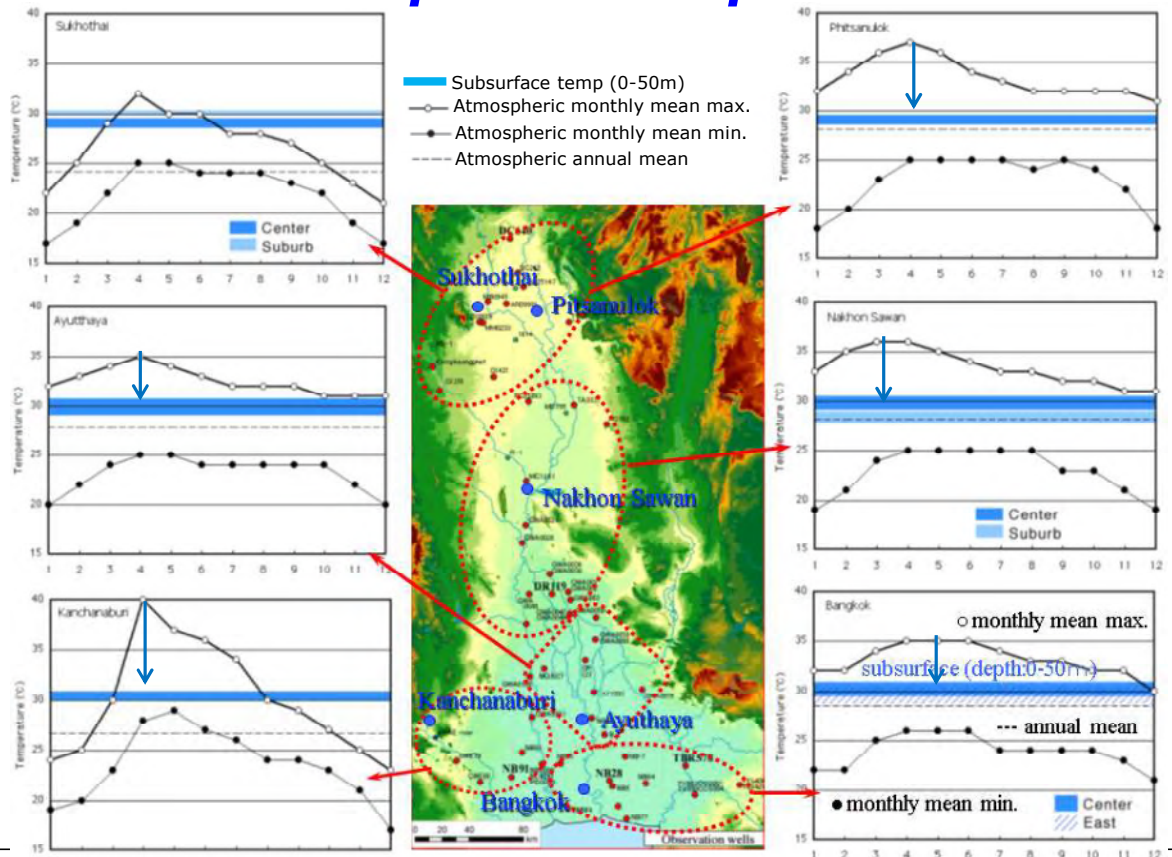
Subsurface Temperature Profiles



(Yasukawa et al., 2009)

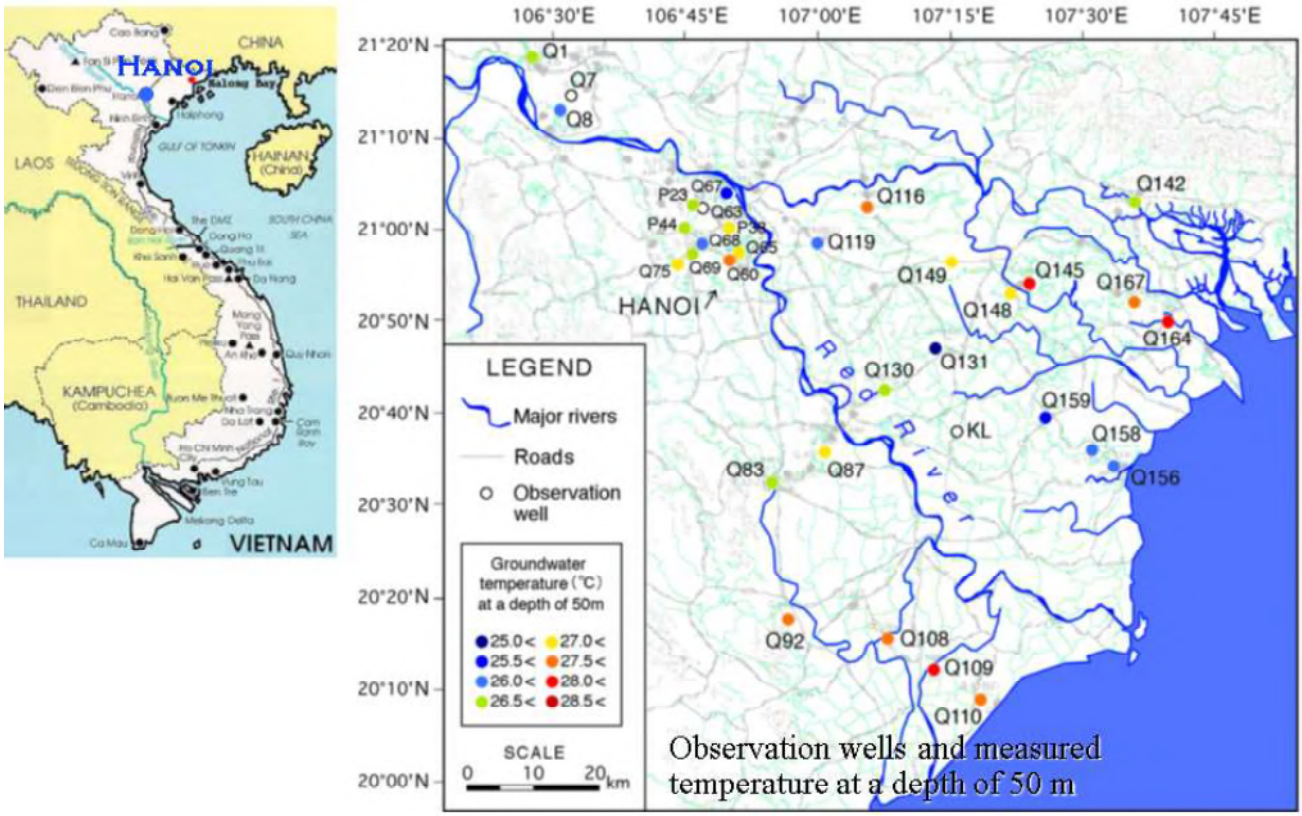
AIST Thailand: Comparison of groundwater and atmosphere

Comparison between subsurface and atmospheric temperature



(Yasukawa et al., 2009)

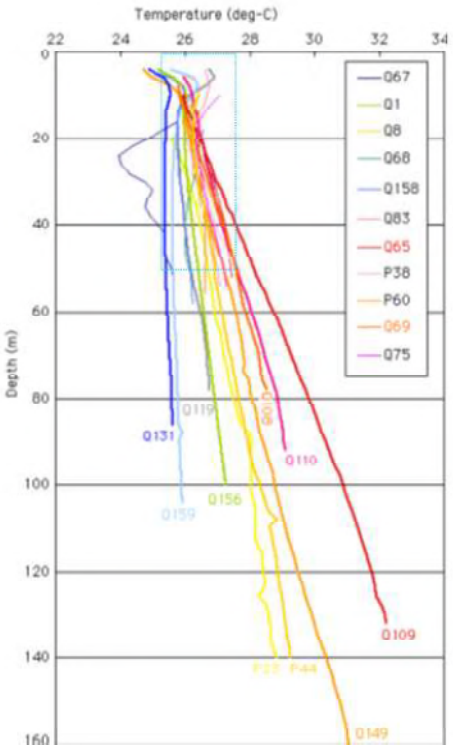
Temperature measurements in the Red River Plain (Hanoi region)

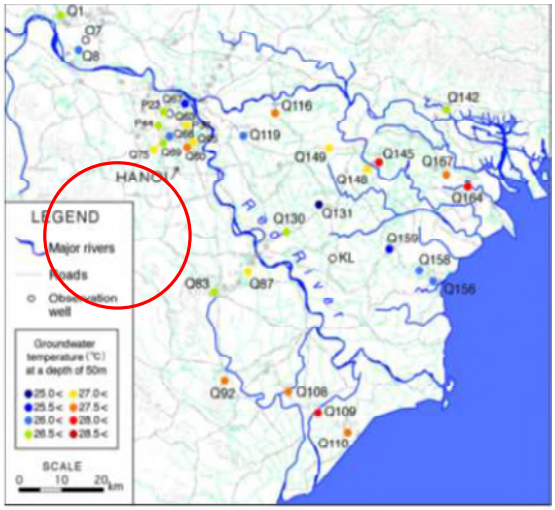


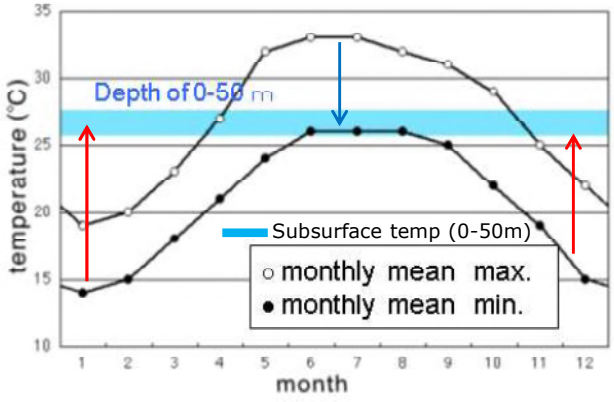
(Yasukawa et al., 2009)

AIST Vietnam: Comparison of groundwater and atmosphere

Comparison between subsurface and atmospheric temperature in Hanoi

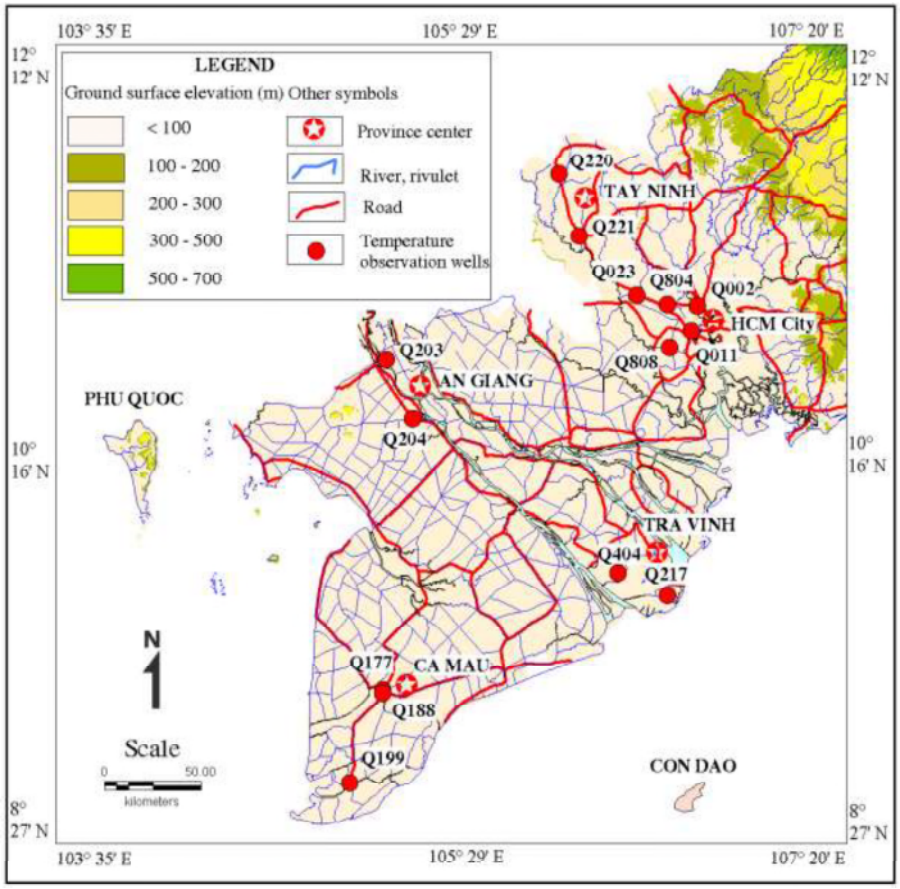






(Yasukawa et al., 2009)

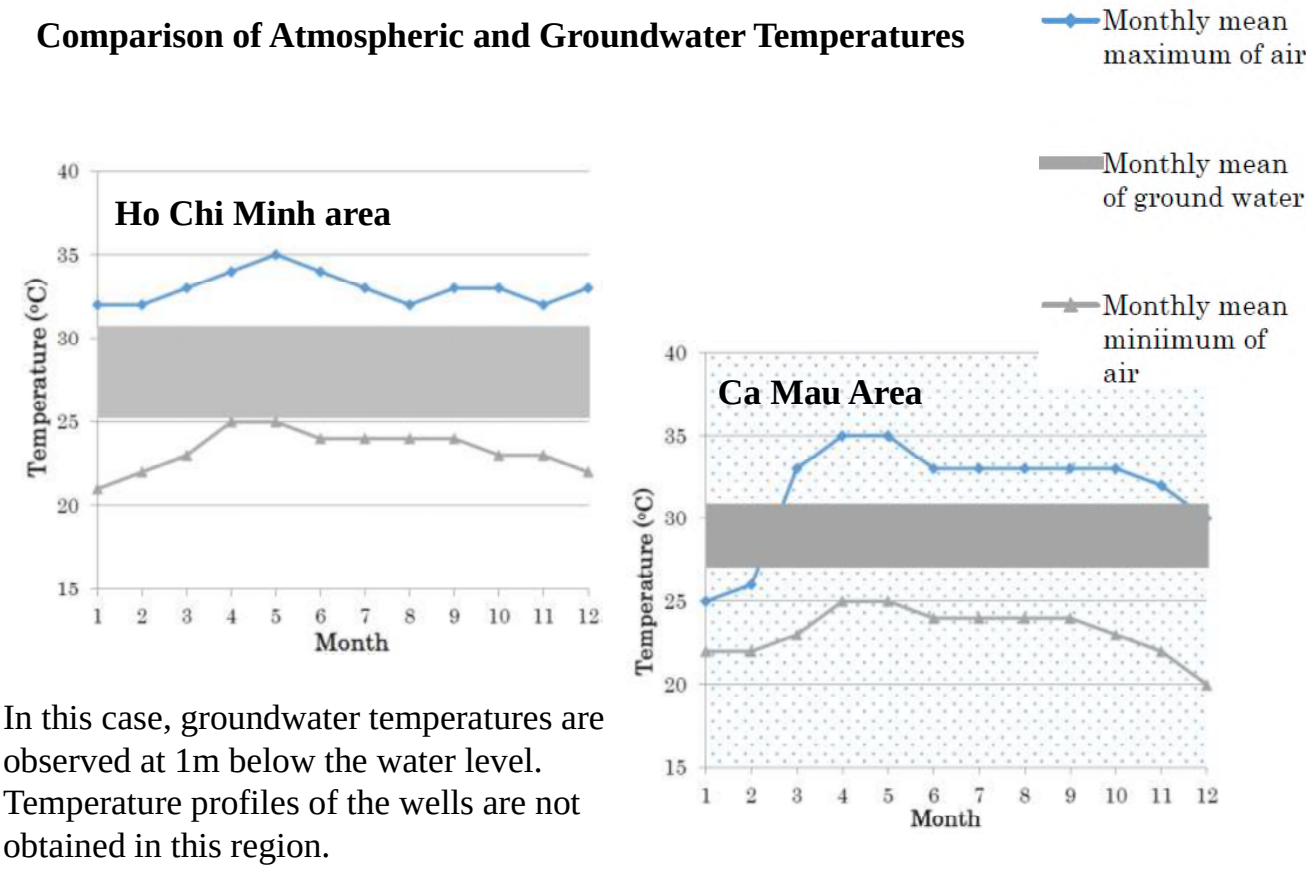
Temperature measurements in the South Plain (Ho Chi Minh region)



NDWRPI (2011).

AIST Vietnam: Comparison of groundwater and atmosphere

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 ↑

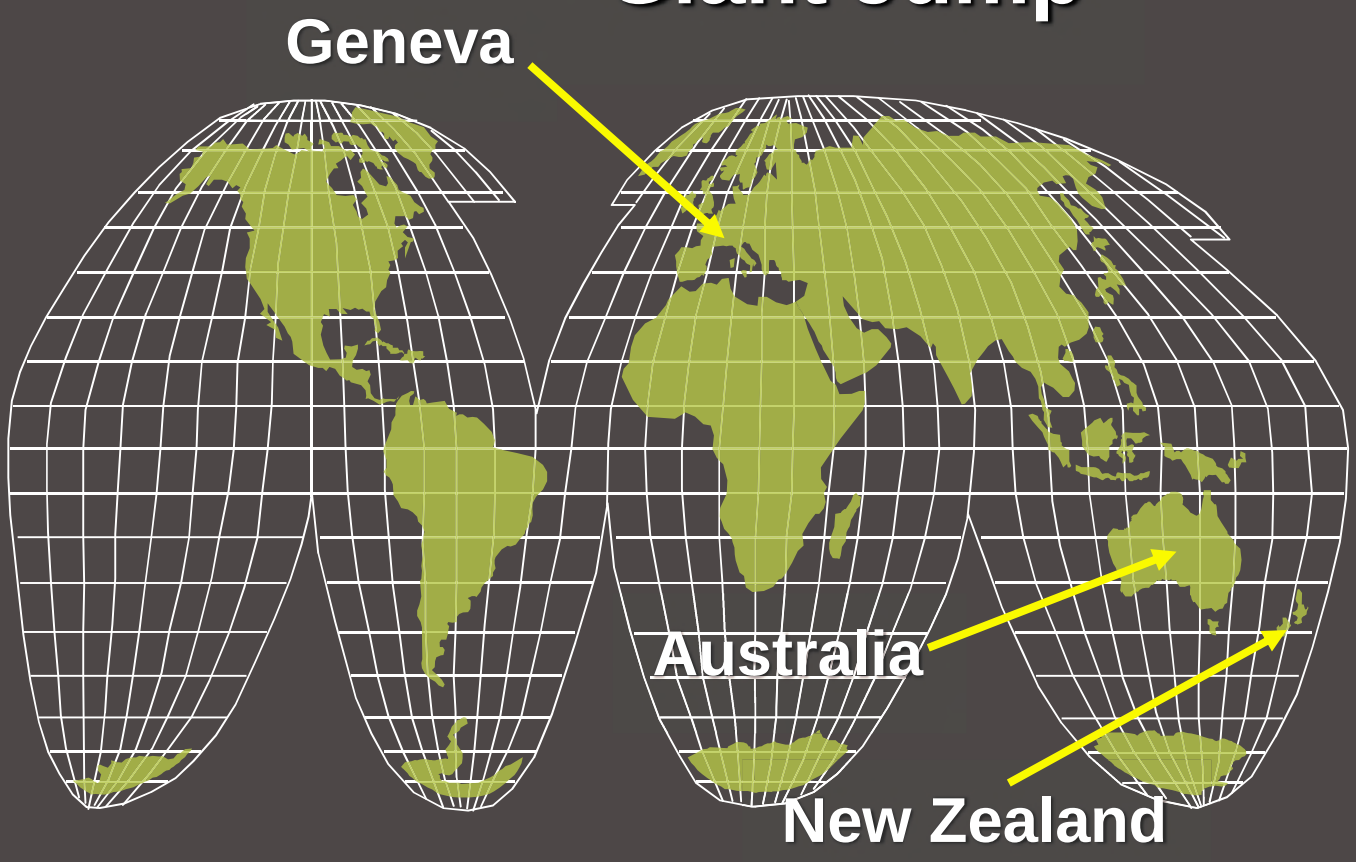
New Zealand and Australia

Brian Carey
New Concepts Workshop
Penthes Geneva
30th October 2015

Where are Australia and New Zealand ?

- **Giant Jump**

Giant Jump



Quite Different

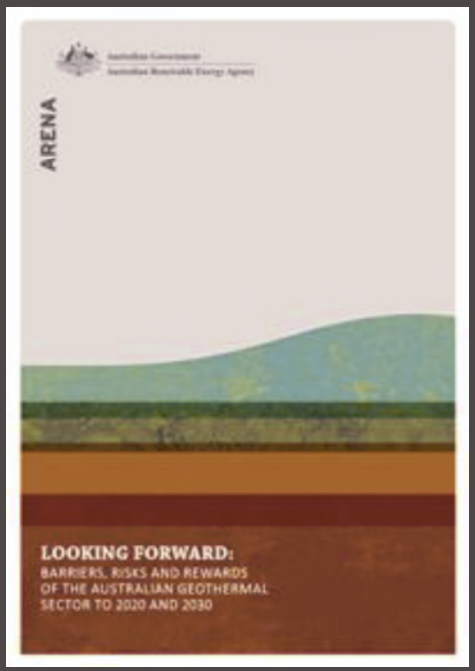
- **New Zealand**
  - High temperature geothermal resources
  - Amongst the world leaders
  - Much more opportunity
    - Direct Use
    - Lower temperature use
- **Australia**
  - Create higher temperature reservoirs
  - Sedimentary aquifers
  - Using lower temperature
  - More can be done

Australia

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

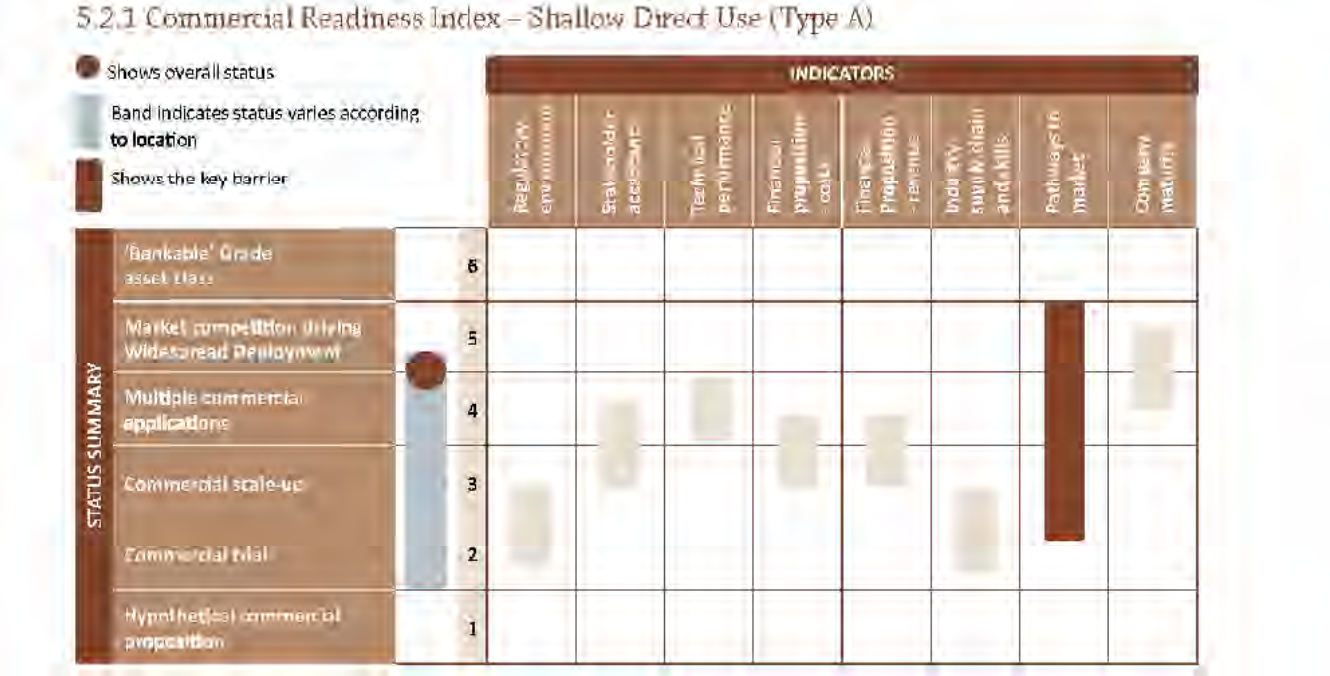
Expert Report

- **Structured approach**



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

Readiness Matrix

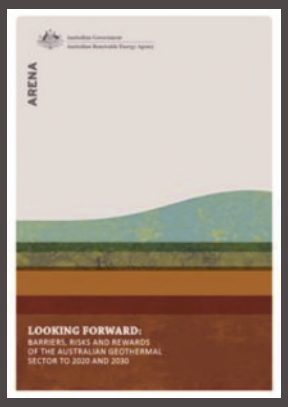


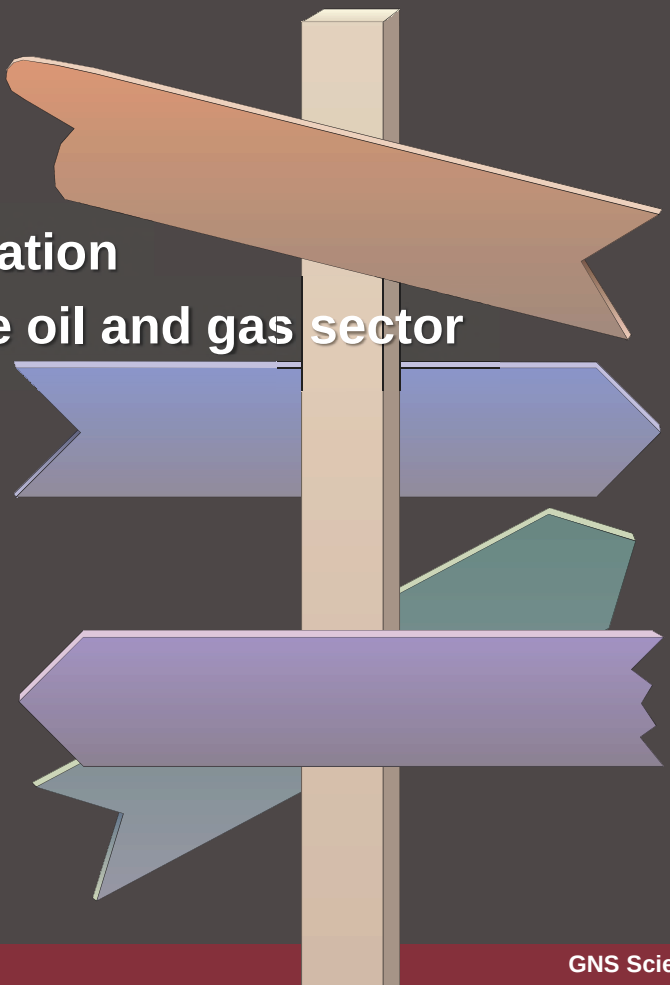
Report

- **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



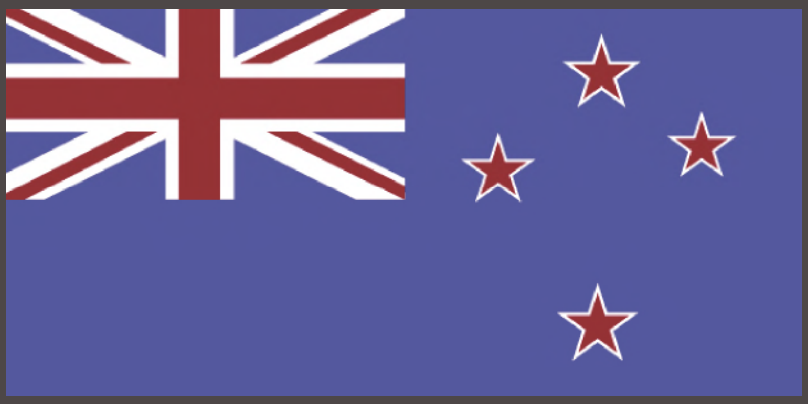


Australian Innovation

- 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

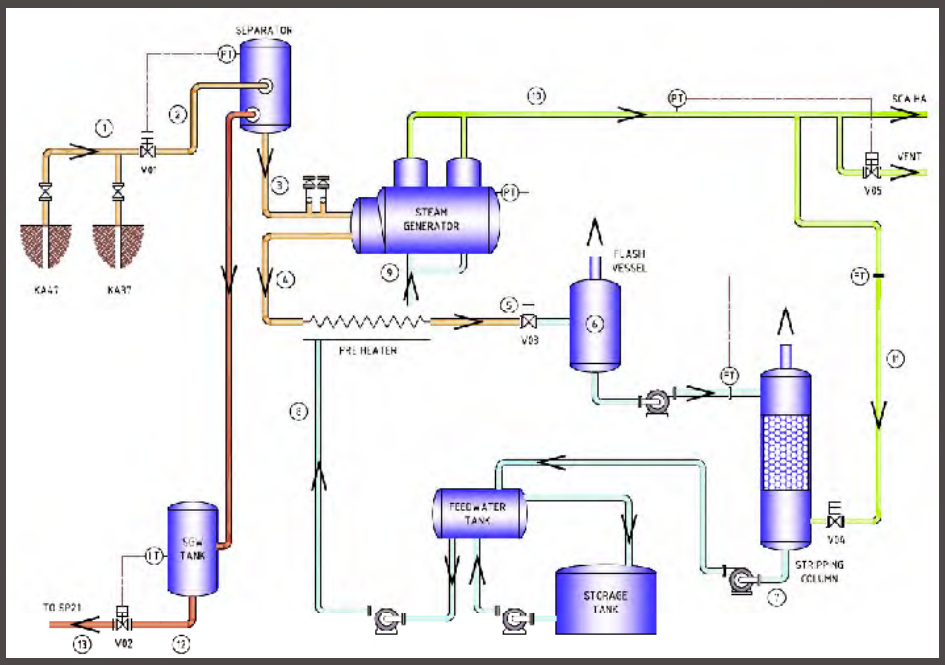


Kawerau

- 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

Geothermal Heat Pumps

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

GHANZ
GEOTHERMAL HEAT-PUMP ASSOCIATION OF NEW ZEALAND

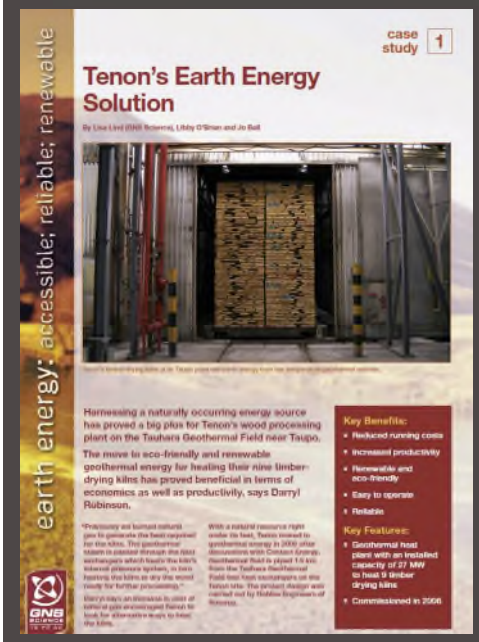
Geothermal Heat Pumps in Christchurch

- Post 2011 earthquake
- City energy nodes being established

Christchurch Central City GHP Locations

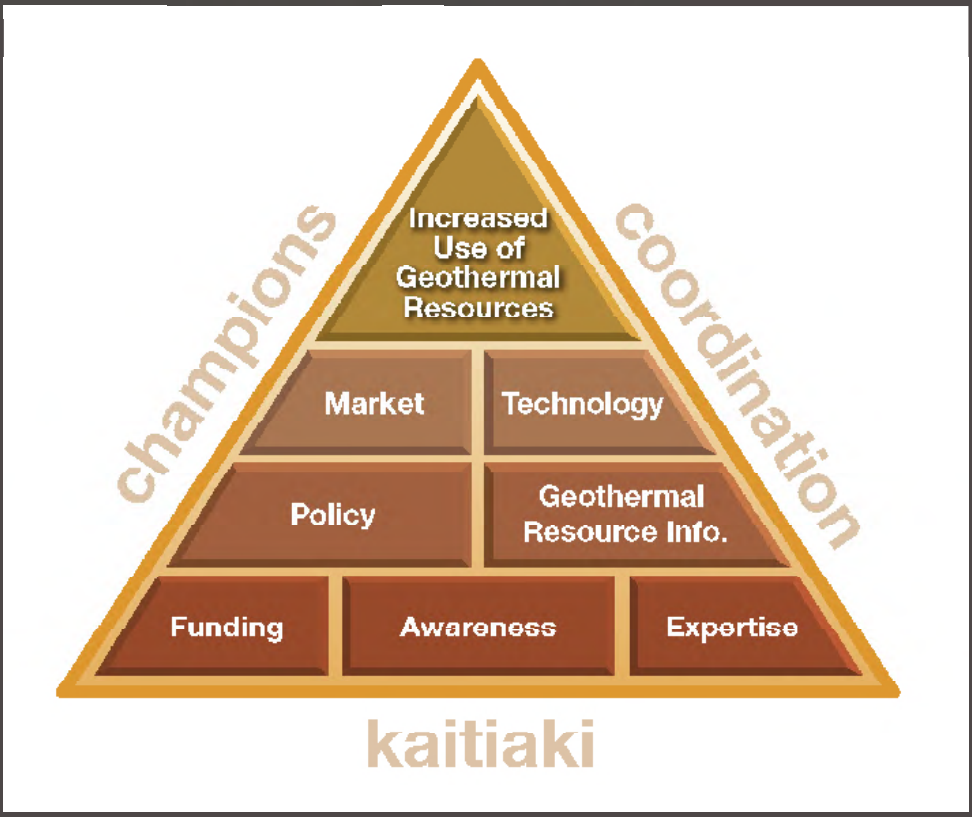
At least 10 systems

Direct Geothermal Case studies



www.gns.cri.nz/Home/Learning/Science-Topics/Earth-Energy/Case-Studies

Direct Use - GeoHeat Strategy



Direct Use Strategy

- **Sponor - 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

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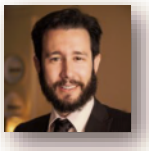
Geothermal / GSHP systems for heating and cooling in Victoria

Ian Johnston & Guillermo Narsilio



Melbourne - State of Victoria

Melbourne:

~4 M inhabitants

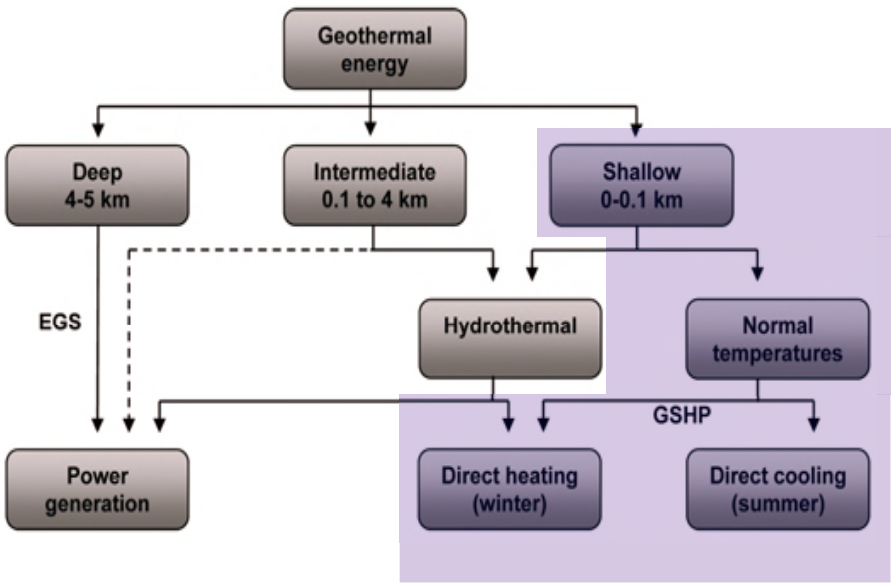
Latitude 37 South

Temperate

Summary – Geothermal Heat Pumps

- 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

Heating and cooling buildings



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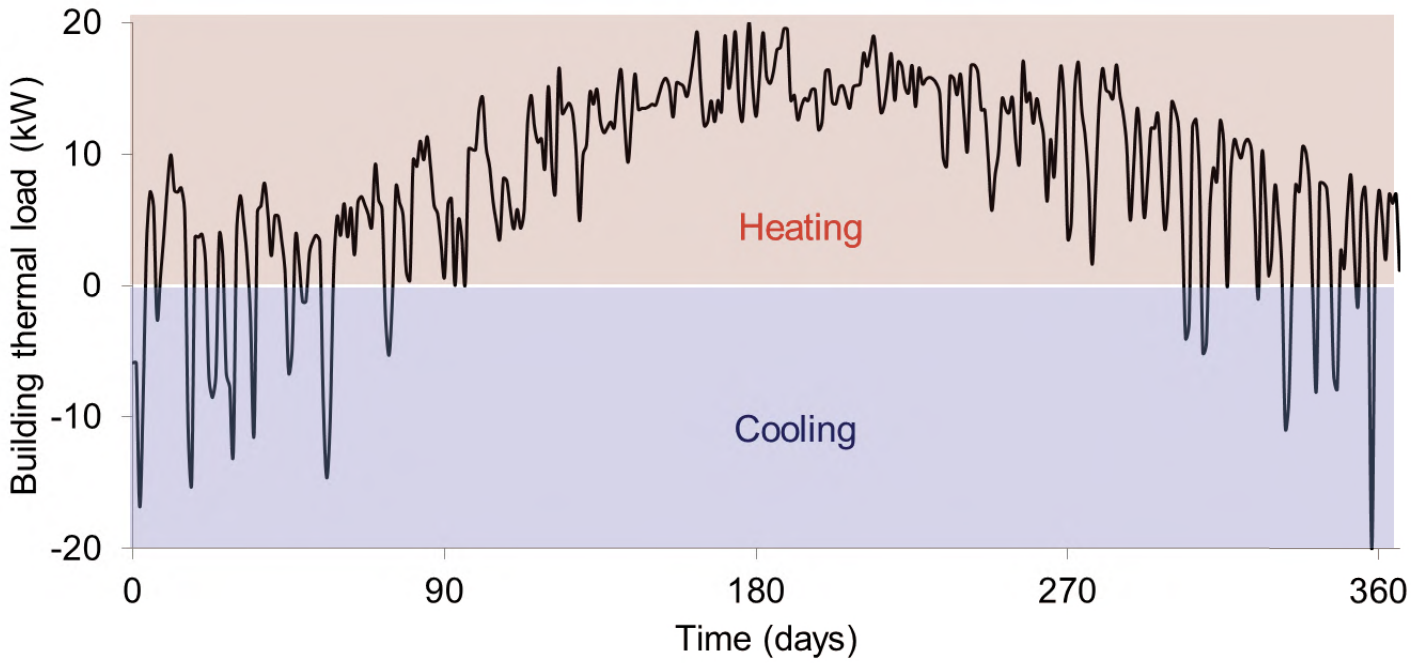
Heating and Cooling



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Work

Full Scale Pilot Projects

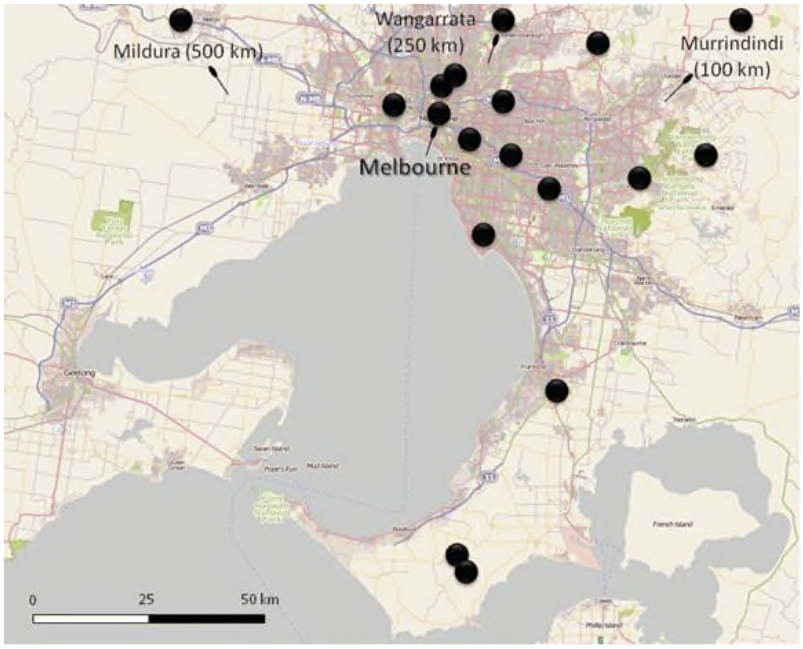
- Borehole heat exchangers at University and elsewhere
- Horizontal heat exchangers – other locations in Victoria

Energy Pilot Demonstration Program – Government support

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

Detailed 3D Numerical Models

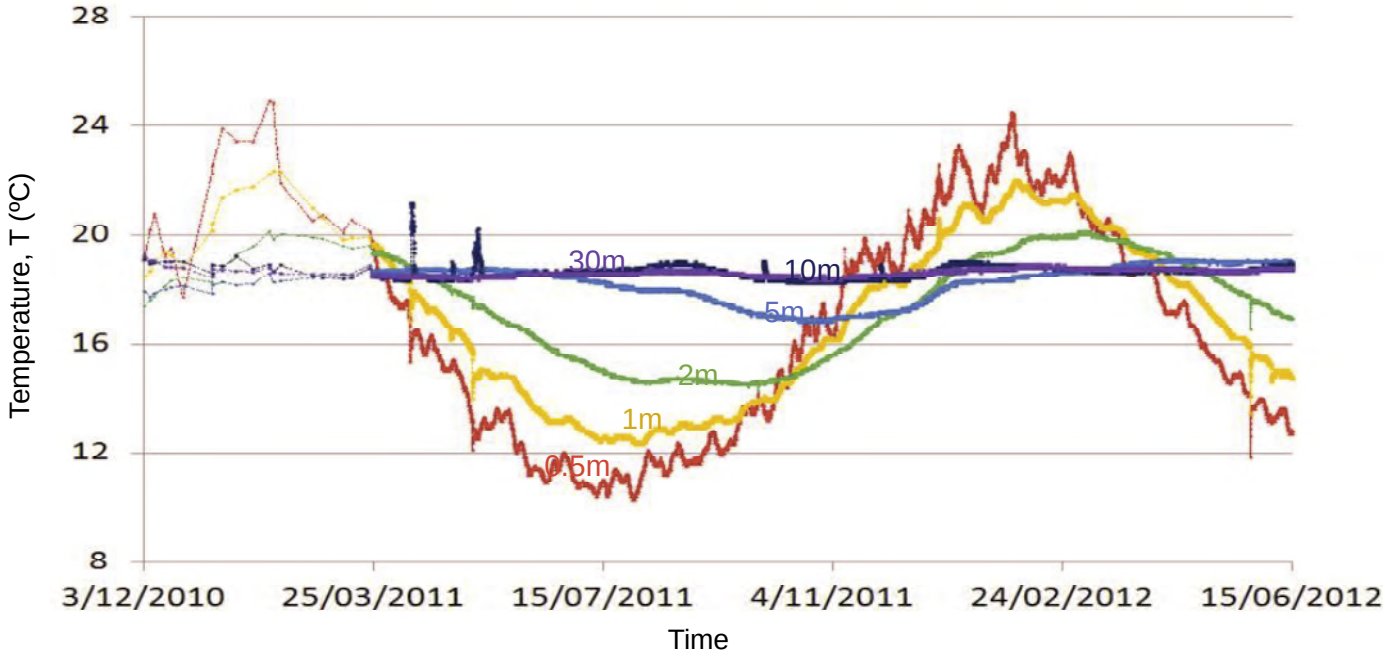
Instrumented Geothermal Heat Pump Systems



Around Melbourne ≈ 25 systems in place

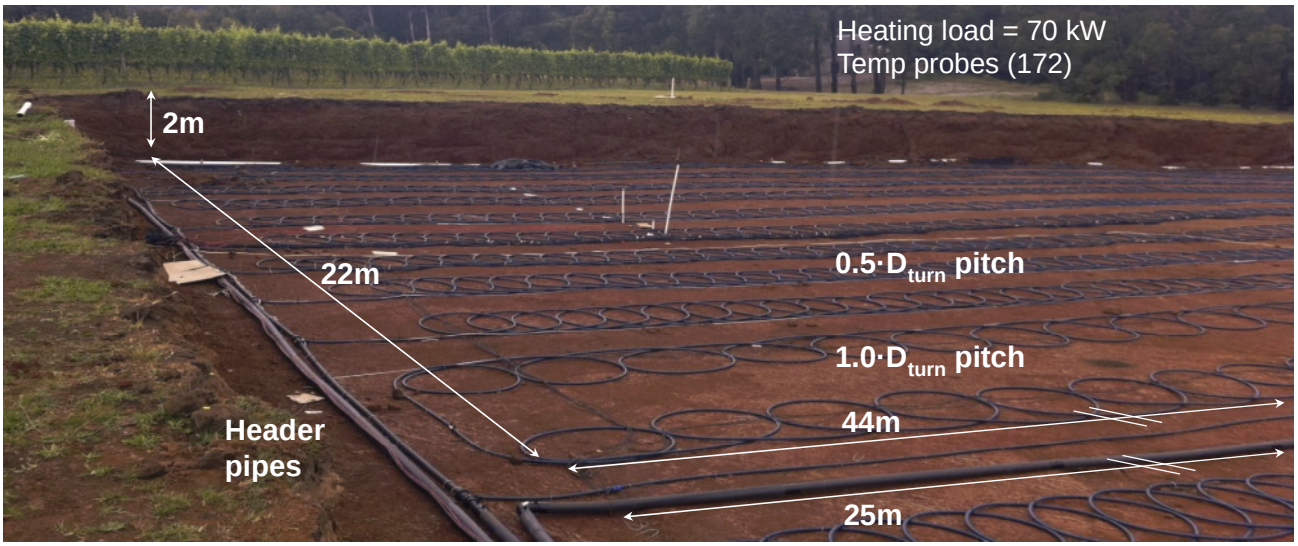
Ground temperature below 10 m typically 18 C

Far field temperature with depth at UoM



Walter Boaz Building – UoM – 50m Vertical

Main Ridge – Mornington Peninsula

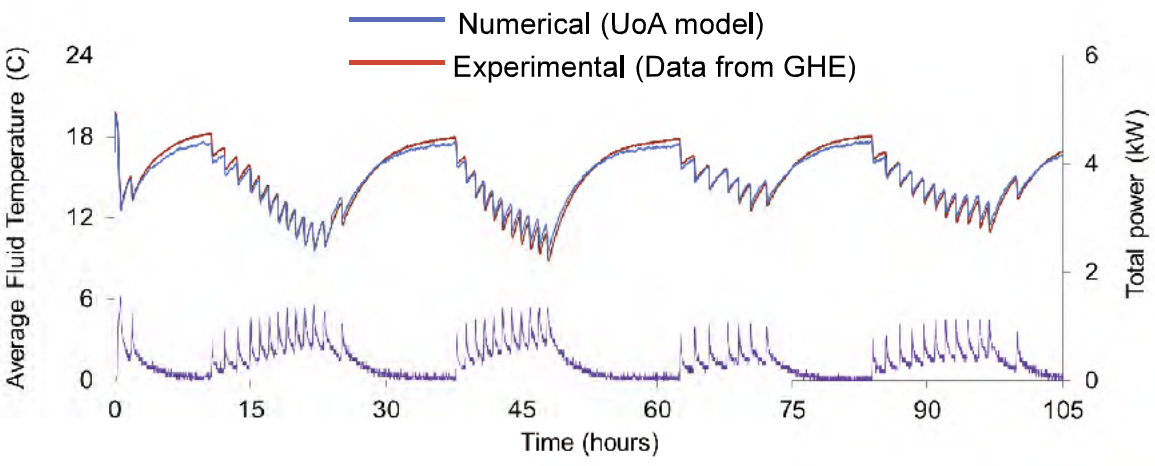


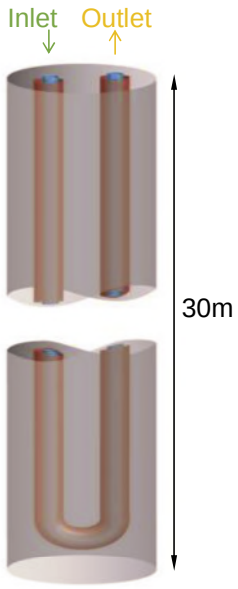
Energy Piles - Beaurepaire Sports Centre Facility

30m Energy Piles

Numerical Model Validation

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

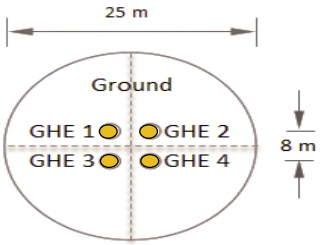


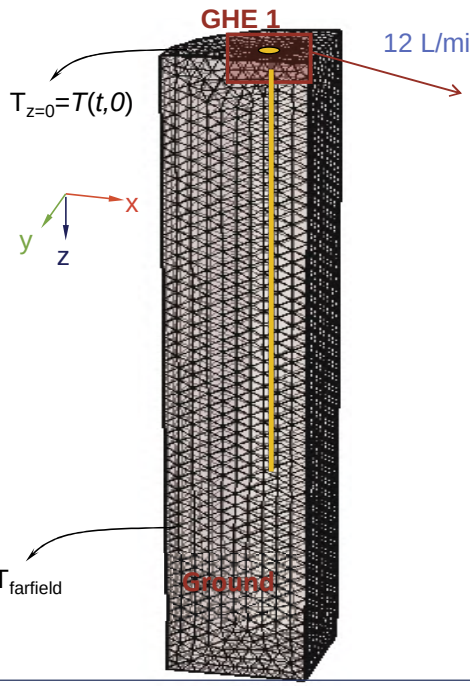


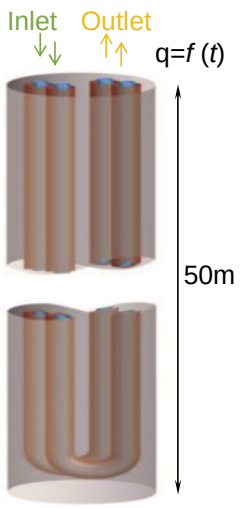
GHE, 125 mm Ø
Pipe, 20 mm Ø

Numerical Models

Borefield with 4 GHEs x 50m





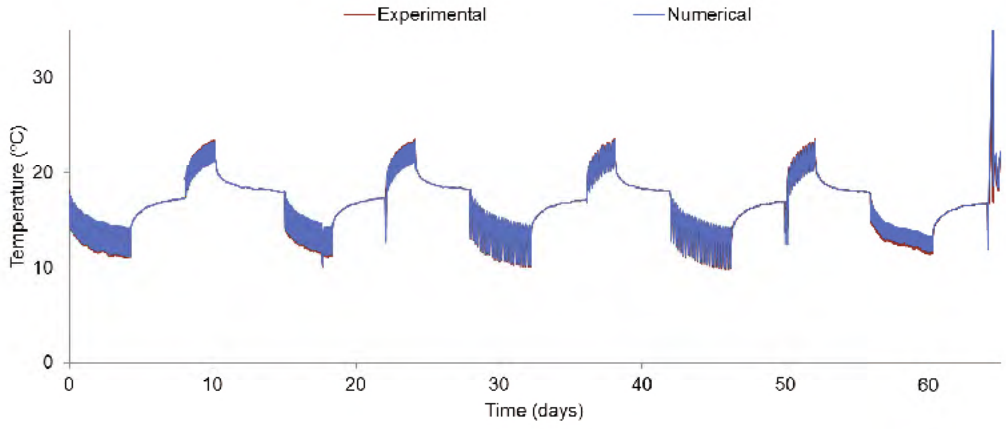


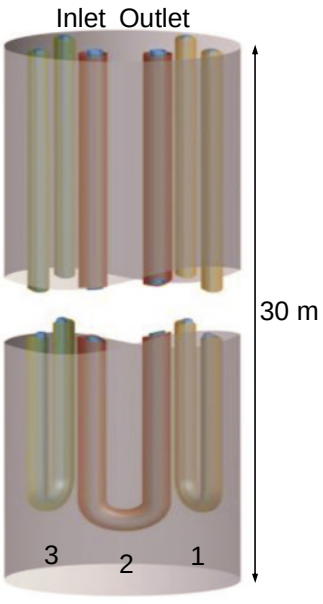
GHE, 300 mm Ø
Pipe, 25 mm Ø

Numerical Model Validation – 30m Pile Cage

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

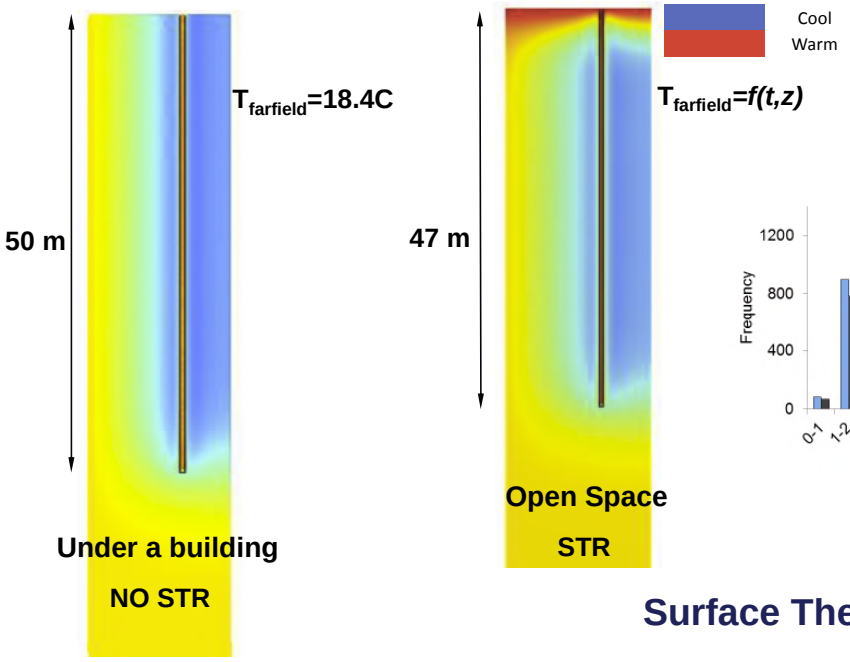
Material	k_m W/(mK)	$C_{p,m}$ J/(kgK)	ρ_m kg/m³	Diameter m	Spacing m	Wall thickness mm
Soil	2.7	850	2,350	-	-	-
Pile (3 loops)	2.5	1,190	2,100	0.6	-	-
Pipe	0.4			0.02 (d_o)	0.105-0.23	1.84
Carrier fluid	0.582	4,180	1,000	-	-	-

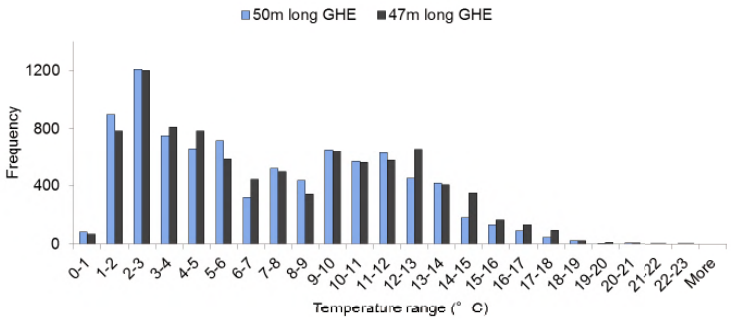




GHE, 600 mm Ø

Quantifying Surface Thermal Recharge





Surface Thermal Recharge = GHE cost savings

Keep a watch on the UoM work

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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MELBOURNE

Visionary Panel Discussion, Conclusions and Next Steps

Iceland, Startup Energy Reykjavik - Alicja Wiktoria Stoklosa (GEORG)

Title: Business Success Story?

Presenter: Alicja Wiktoria 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 Wiktoria Stoklosa

Outline

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

Startup Energy
Reykjavik

How the idea began?

- Research Institution
- Financial Institution
- University
- Power Company
- Public authority
- Innovation Center

Idea

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

Idea

How we make it happen?

Creating

The holding company
Startup Energy Reykjavik

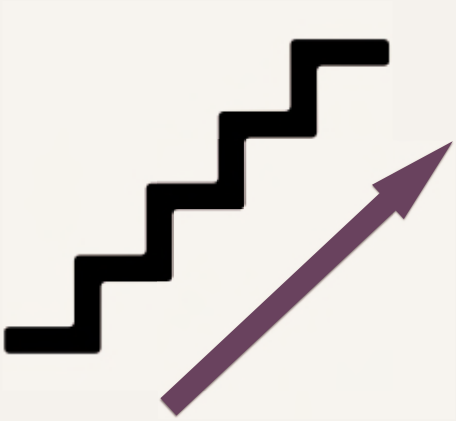
Investing

In new innovative ideas

Proceeding

With mentorship and funding

Stages



FORMING COMPANY

PROTOTYPE

RESEARCH PROJECT

IDEA

Concept

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**

Month 1

1. Open for applications

Month 2

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

Month 3

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

Month 5

1. Investor Day

Program

How we make it happen?

The program gives opportunity:

Mentor meetings

Management meetings

Feedback

Company presentation

Networking and meet- up

Investments

Guest lectures

Pitch practice

Geo Tech Companies

Startup Energy Companies

gerosion

Landsvarmi

GEO DRONE

Eta-nýtni

Loki Geothermal

XRGpower

KEYnatura

Startups

Startup Energy Companies

7

2014

2015

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
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
2. **XRG Power-** Electricity generator from non- boiling geothermal water
   www.xrg.com
3. **Keynatura-** Production of food, neutraceutical & pharmaceutical products from algae using Icelandic energy.
   www.keynatura.is

What do we look for

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

Startup Energy Reykjavík
Batch 2014

Startup Energy Reykjavík
Batch 2015

Contact

Startup Energy
Reykjavik

Visit the website for information

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Arion banki Landsvirkjun GEORG Innovation Center Iceland Iceland Geothermal Cluster Initiative innovit klak

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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

Back to the program ↑

Geothermal ERA-NET / IEA Geothermal

"New Concepts –
New and Innovative Applications of Geothermal Energy"

Geothermal ERA-NET / IEA Geothermal

"New Concepts –
New and Innovative Applications of Geothermal Energy"

Geothermal ERA-NET / IEA Geothermal

"New Concepts –
New and Innovative Applications of Geothermal Energy"

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, CO2 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

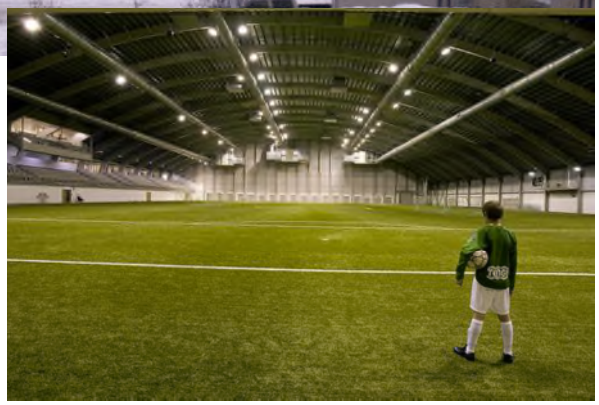
Iceland vs the Netherlands

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 Þorgeirsdottir, 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.

László 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 "ECOGI – 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 CO2 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 Münich and Stadtwerke Münich, for "Münich 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 Eijdems 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 Wiktoria Stoklosa kicked of 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.

Back to the program ↑

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