

ATES Workshop Hoorn, NL 2023  
20 & 21.04.2023

# Workshop Proceedings



**Disclaimer:**

IEA Geothermal and GEOTHERMICA do not warrant the validity of any information or views and findings expressed by the authors in this report. IEA Geothermal (IEA-GIA), IEA, GEOTHERMICA, or the Netherlands Enterprise Agency (RVO) shall not be held liable, in any way, for use of, or reliance on, any information contained in this report.

**Title (suggested citation):**

IEA Geothermal & GEOTHERMICA ATEs Workshop Hoorn, NL 2023, 20 & 21.04.2023, Workshop proceedings. May 30<sup>th</sup>, 2023.

**Authors:**

Stephan Bolay, IEA Geothermal, Robin Horsmans and Paul Ramsak RVO/GEOTHERMICA.

**Cover Photo:** Albert Stam photography

**Acknowledgements:**

Many thanks to ECW Energy for hosting the field trip.

This work has been supported by the Swiss Federal Office for Energy (swissenergy) and the Netherlands Enterprise Agency (RVO).

**What if?...**

*“What if we could store the heat of summer to keep us warm on a cold winter's day?  
If we could do that, we wouldn't need to burn fossil fuels to keep us warm. “*

*“But wait, we want to turn renewable and stop burning fossil fuels... Does that mean...we **need** to store the summer heat?”*

*“Yep!”*

*“... and where???”*

*“Under our feet!”*

*“Under our feet?”*

*“Yes, under our feet, in these UTES or ATES or BTES or MTES or whatever they call it...”*

*“Can we then start with A?”*

*“Sure, let's start with A-TES...”*

*“...but where?”*

*“In Hoorn”*

*“Hoorn?”*

*“Yeah, Hoorn, you know, where these guys were from, that rounded Cape Horn first...”*

## Content

1. Preface .....	5
2. Workshop Organisation .....	6
3. Agenda .....	6
4. Participants .....	8
5. ATES Questionnaire Findings .....	9
6. Discussion session .....	12
7. Results & Outlook .....	13
7.1. IEA Geothermal review study on ATES .....	13
7.2. UTES collaboration.....	14
7.3. Pilot & Demonstration projects .....	14
7.4. Developing the UTES network .....	14
7.5. Upcoming events .....	14
8. Appendix .....	15

## 1. Preface

Storing the heat of summer, not to be cold in winter, and vice-versa. It may sound magical and wonderful at the same time, but it will become crucial. If we want the transition from fossil to intermittent renewables to succeed, we will need to find large scale storage solutions.

One of the most promising places is where most people never look: under our feet! UTES or Underground Thermal Energy Storage might become a crucial part of the Energy Transition any time soon. However, it will take joint effort and action to bring this forward.

Therefore, we're very happy that IEA Geothermal and GEOTHERMICA have found together and joined forces to take on this important topic and to organise a first strategic workshop on ATES or Aquifer Thermal Energy Storage in the beautiful town of Hoorn, The Netherlands.

We thank all participants from whichever time-zone, that have taken the effort to join us in Heaven.

It was a great start... Now, let's continue the excitement...

Paul Ramsak  
GEOTHERMICA



Christian Minnig  
IEA Geothermal



## 2. Workshop Organisation

Organisation:

Name	Country / Institution
Robin Horsmans	NL / RVO & GEOTHERMICA
Paul Ramsak	NL / RVO & GEOTHERMICA
Stephan Bolay	CH / IEA TCP
Brian Carey	NZ / IEA TCP

Date & location:

20 + 21 April 2023, Netherlands, Hoorn

Thursday morning field trip: HT-ATES site Middenmeer

Thursday afternoon venue: Municipal Theatre Het Park, Westerdijk 4, 1621 LE Hoorn

Friday venue: <https://www.heavenshotelhoorn.com/> Grote Kerk 33, 1621 ET Hoorn

## 3. Agenda

**Field trip: Thursday 20.04.2023 9:00-15:00 CET**

Fieldtrip to ECW Energy HT-ATES site Middenmeer (GEOTHERMICA HEATSTORE Demo Project).



Figure 1: Workshop participants group picture at ECW Energy HT-ATES site in Middenmeer, Netherlands.

**Session 1: Thursday 20.04.2023 15:00-19:00 CET**

Start	End	Topic (speaker)	Duration
15:00	15:10	Welcome (IEA TCP and GEOTHERMICA)	00:10
15:10	15:40	"Current state and development of ATES in the Netherlands & country update" (Bas Godschalk, IF Technologies, NL)	00:30
15:40	16:00	"Project Forsthaus, Bern & Country update Switzerland" (Peter Meier GeoEnergy, CH + Christian Minnig, SFOE, CH)	00:20
16:00	16:20	"Project VESTA Germany " (Thorsten Hörbrand, SWM, DE)	00:20
16:20	16:30	Break	00:10
16:30	16:55	"ATES groundwater: Geochemistry & drinking water & project Push-It" (Daphne Wiggers - de Vries , KWR, NL)	00:25
16:55	17:15	"Clusterproject ATES Germany" (Sebastian Bauer, IFG / DE)	00:20
17:15	17:30	"Country update USA" (Alexis McKittrick, DOE, US)	00:15
17:30	17:45	"Country update Korea" (Yoonho Song, KIGAM, KR)	00:15
17:45	18:00	"Country update Slovenia" (Nina Rman, Geo-ZS, SI)	00:15
18:00	18:10	Break	00:10
18:10	18:40	"Critical Succes Factors + Heatstore Roadmap" (Peter Oerlemans, IF Technology, NL + Dorien Dinkelman, TNO, NL)	00:30
18:40	19:00	Open discussion: Global potential of ATES: importance and future, coupled sectors (moderation Paul Ramsak & Christian Minnig)	00:20

**Session 2: Friday 21.04.2023 09:00-13:00**

Start	End	Topic (speaker)	Duration
09:00	09:15	Welcome and recapitulation of Day 1, goals of workshop (IEA TCP and GEOTHERMICA)	00:15
09:15	10:40	ATES workshop part 1 LT ATES (all, moderation: IEA TCP Stephan Bolay)	01:25
10:40	11:00	Coffee break	00:20
11:00	12:20	ATES workshop part 2 HT ATES (all, moderation: GEOTHERMICA Stephan Schreiber & Paul Ramsak)	01:20
12:20	12:30	Break and time buffer	00:10
12:30	13:00	Wrap up, chapters for review study, list of cooperation ideas (IEA TCP and GEOTHERMICA, all)	00:30
13:00	14:00	Lunch	01:00

## 4. Participants

Nr	Name	Country / Institution
1	Peter Meier	CH / GeoEnergy / IEA TCP
2	Stephan Bolay	CH / GEOTEST / IEA TCP
3	Christian Minnig	CH / SFOE / IEA TCP
4	Andreas Koch	DE / FZJ / IEA TCP
5	Sebastian Bauer	DE / IFG / Research
6	Josef Weber	DE / LIAG / IEA TCP
7	Stephan Schreiber	DE / PTJ / GEOTHERMICA
8	Thorsten Hörbrand	DE / SWM GmbH
9	Virginie Schmidlé Bloch	FR / AFPG / IEA TCP
10	Christian Boissavy	FR / AFPG / IEA TCP
11	Hjalti Páll Ingólfsson	IS / GEOTHERMICA
12	Kasumi Yasukawa	JP / JOGMEC / IEA TCP
13	Tae Jong Lee	KR / KIGAM / IEA TCP
14	Yoonho Song	KR / KIGAM / IEA TCP
15	Bas Godschalk	NL / IF Technology
16	Peter Oerlemans	NL / IF Technology
17	Daphne Wiggers - de Vries	NL / KWR
18	Robin Horsmans	NL / RVO / GEOTHERMICA
19	Paul Ramsak	NL / RVO / GEOTHERMICA
20	Dorien Dinkelman	NL / TNO
21	Jiri Muller	NW / IET / IEA TCP
22	Samantha Alcaraz	NZ / GNS / IEA TCP
23	Nina Rman	SI / Geo-Zs / GEOTHERMICA
24	Alexis McKittrick	US / DOE
25	Lauren Boyd	US / DOE / IEA TCP / GEOTHERMICA
26	Ivo Vos	NL / TNO
27	Laurens Vlaar	NL / ECW



## 5. ATES Questionnaire Findings

The questionnaire contained three general and five detailed questions each with regard to LT- and HT-ATES. The following countries and attendees provided much appreciated answers to questionnaires:

- Korea                      Yoonho Song
- Japan                      Kasumi Yasukawa
- Slovenia                  Nina Rman
- Germany                  Thorsten Hörbrand, Stephan Schreiber & Sebastian Bauer
- Switzerland              Peter Meier & Christian Minnig
- France                      Christian Boissavy
- USA                          Lauren Boyd & Alexis McKittrick
- The Netherlands        Bas Godschalk

The main findings of the questionnaire can be summarized as:

- **The potential for ATES is available in most countries**
- **Most important are (full scale) demonstrations & success stories**
- Different barriers are observed in countries, but also similar challenges exist
- ATES can contribute to solving specific problems (i.e., sector coupling, demand ramping)
- New geological settings are under investigation
- High interest in international cooperation
- The examples from the Netherlands can play an important role for ATES development in other countries

A summary of the answers given by each country per question is presented below. The detailed answers that were given per country can be found in Appendix 8.1.

### G.1. What is the status of ATES in your country? Are ATES projects already realized or still in development? If implemented, how many ATES projects are operational?

- In most countries very few projects exist, but more are in planning phase
- Netherlands: Big business > 4000 LT-ATES projects and still growing. MT- and HT-ATES under development.

### G.2. Is there any policy on ATES in your country? Are there support/subsidy schemes?

Most countries:

- No dedicated policy known
- ATES fits strategic goals (sector coupling, renewable energy, cooling potential)

Some countries:

- Research incentives
- Restrictive policies

Netherlands:

- For LT-ATES a good legal framework exists and the systems are protected. No subsidies for LT-ATES anymore.
- Legal framework is in development for HT-ATES. Does not yet easily fit into subsidy schemes.

A country update of the Netherlands is provided by Bas Godschalk and can be found with the following citation:

- Godschalk, B., Provoost, M., & Schoof, F. (2020). Netherlands Country Update. In Proceedings World Geothermal Congress. Pag. 1.
- Bakema et al. (2019). Aquifer Thermal Energy Storage in the Netherlands, a research programme (2010-2012), Extended English summary of a report by the Dutch research programme MMB (Meer Met Bodemenergie). Pag. 1-77.

Europe:

Ivo Vos provided additional information following the workshop on existing European efforts in terms of the development of an overview of current / ongoing ATES projects in Europe:

- <https://www.geologicalservice.eu/areas-of-expertise/geoenergy-resources>  
WP3 - Geothermal energy & underground storage inventory  
<https://meetingorganizer.copernicus.org/EGU23/EGU23-15481.html>

### G.3. How do you see the future role of ATES in your country?

Most countries:

- Potential available: Favourable geological settings known
- Importance growing
- Increasing geothermal potential & efficiency
- Peak demand ramping, winter months

France:

- Small

Netherlands:

- Mature business for LT-ATES. Growing business for HT-ATES. Development from single solutions to more integrated solutions

### D.1. Is there an overview of all the ATES (or other UTES) projects in your country? If so, provide the link or add to mail

Most countries:

- No «official» overview
- Personal insights
- Germany: Fleuchhaus et al. 2021

Netherlands:

- Country report available (see G.2.)

### D.2. What is needed to scale up (the number) of ATES projects?

Most countries:

- Demonstration (potential studies, case studies, pilot projects, techno economic analysis)
- Sharing of success stories
- Changes to regulatory framework

Netherlands:

- More brains and hands

**D.3. Do you have an overview of relevant innovation or R&D projects in your country? If so, provide the link or add to mail. Are there any knowledge gaps? Are there any innovation opportunities?**

Most countries:

- No R&D

Existing R&D for Germany, Switzerland, Netherlands, USA:

- National and international projects
- Build confidence
- Range from analytical and/or numerical analyses to laboratory tests on the meter to decametre scales
- Switzerland: Fractured aquifers
- Netherlands: Interesting are the outcomes of the 2010-2012 'Meer met Bodemenergie' research programme. Large scale results to effects and options for ATES. There is an English summary available.

**D.4. What are the barriers (technical, economic, environmental, social) for ATES in your country? What are the opportunities for ATES in your country?**

Korea, Japan, Slovenia:

- Social (awareness, energy supply system, no district heating or only HT)
- Slovenia: Conservative authorities

Further points:

- Missing information in multiple disciplines such as subsurface or technical knowledge or energy supply system
- Complicated hydrogeological / geochemical conditions
- Environmental conflicts (drinking water)
- Regulatory framework not clear or very complicated
- Temperature limits
- Technical risk and scalability assessment missing
- Carbon avoidance
- Netherlands: Lack in capacity
- Funding of pilots & demonstrations is seen as big opportunity

**D.5. Is international collaboration relevant? If so, what kind and how? What could IEA Geothermal / GEOTHERMICA do?**

Mostly positive feedback:

- practise and examples can cross borders
- Information exchange and collaboration & good practices
- Methodology for evaluation of potential
- Comparison of similar geological settings / play types
- demonstration of economic viability
- adequate regulatory framework & practice
- environmental impacts
- technical competences.
- Networking for professional collaboration
- GEOTHERMICA: calls for heat storage projects

France:

- there is a lot to do with conventional geothermal deployment before highlighting ATES

Netherlands:

- We have a lot of experience in NL and are open to share this and to support other countries to develop this ATES market.

## 6. Discussion session

List of discussed points:

- Terminology matters, ATES might cause negative reaction due to groundwater concerns. Alternative terms can be RTES (reservoir thermal energy storage, used in the US) or UTES (underground thermal energy storage, general term).
- LT-ATES can be starting point for developing HT-ATES.
- Regulations can be based on absolute temperature or difference in temperature.
- Clear need for storage visible (winter/summer “bathtub”, base load problem for renewables, 50% of energy demand is heating in many countries), but demand and production side are disconnected.
- Where does the (free) energy to store come from? How will the sources change in the future? Is ATES renewable if it stores fossil energy? Green washing? → In the Netherlands a roadmap for energy storage is currently being developed where Electrical, Thermal and Chemical Energy Storage are addressed and supported by the Dutch minister. In this report the success of GEOTHERMICA's HEATSTORE HT-ATES demo and other UTES are highlighted, and points of action have been drawn up for a clear way forward.
- More country updates are needed to raise awareness and show successful projects.
- For moving towards a multi-source and multi-consumer energy mix, seasonal storage is needed. Investors tend to choose solutions with fewest risks and avoid underground solution due to unknown subsurface.
- UTES is hidden underground and therefore needs lobbying to get onto the agenda. Also, when talking about energy, the focus is often on electricity / gas / hydrogen and not about heat.
- Lack of awareness is a big issue for ATES and the development of new ATES. Also, missing district heating networks and focus on individual solutions slow down ATES developments.
- Most demand for cooling in industrial areas, which have already overused groundwater resources and sometimes caused subsidence problems.
- Regulators need to agree on pilot projects to learn from monitoring. Decision making based on results → pilot and demonstration projects are very necessary.
- For countries with specific concerns, it can be easier to contribute to Pilot and Demonstration projects in other countries (without those specific concerns). Concerns and fears are very different from country to country.
- National / individual surveys and studies should be linked → GEOTHERMICA Thermal Storage Platform/Initiative?
- Move away from very technical reports with focus mostly on risk but look also at financial and CO2 savings. Raise awareness, showcase successful projects. → IEA Geothermal role with summary reports for specific audiences (policy, regulations, investors)
- Top Down: Can we get a statement of IEA head Fatih Birol on the importance on storage and UTES? How do we engage with other TCPs (e.g., storage TCP → invite to Offenburg)
- Bottom up: Workshops for planners and industry, but regulatory framework is needed to be successful.
- A UTES specific (interactive) newsletter could be helpful to stay informed and share knowledge.
- ATES fact sheets to be added to IEA Geothermal website.

## 7. Results & Outlook

Many opportunities have been discussed on how to move ATES and UTES forward. Both IEA Geothermal TCP and GEOTHERMICA have suggested follow-up plans, individually as well as jointly. They are summarized in figure 2 here below.

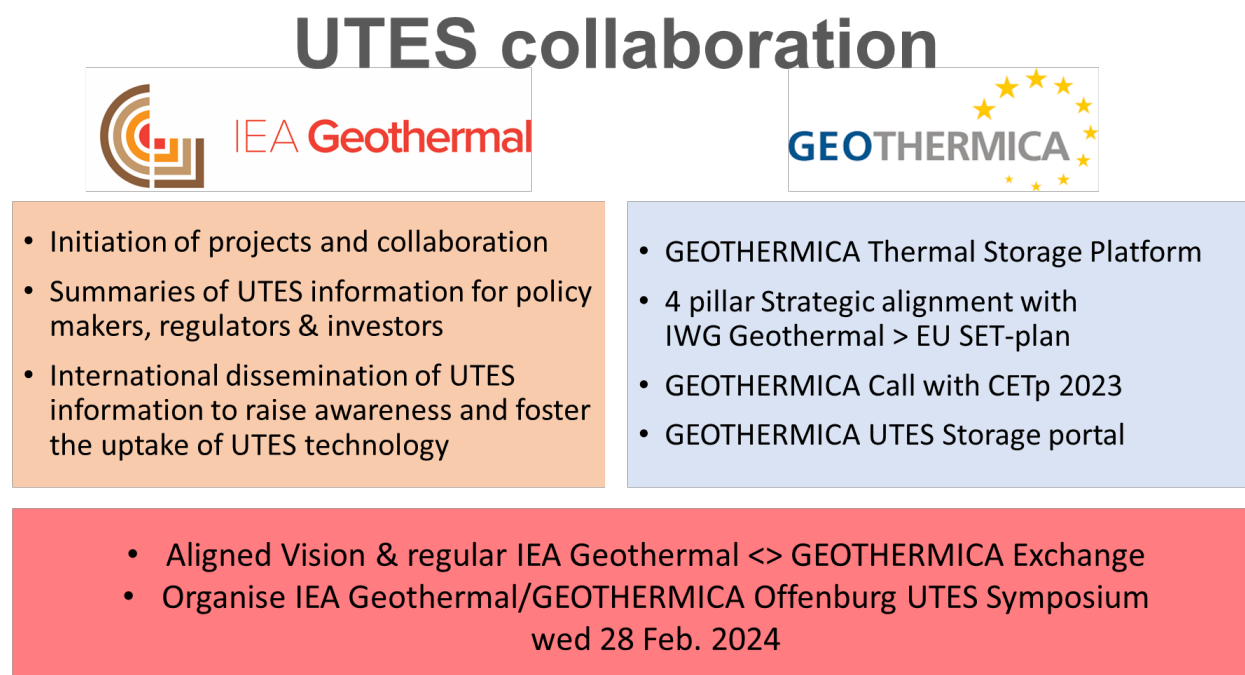


Figure 2: Suggested actions and future collaboration between IEA Geothermal and GEOTHERMICA on UTES.

### 7.1. IEA Geothermal review study on ATES

A proposal for a review study on ATES was submitted by IEA Geothermal WG14 Heating & Cooling. One of the goals of this workshop was to narrow down the relevant scope of the review study and to learn more about existing studies and ongoing work.

Many relevant studies were pointed out during the workshop:

- GEOTHERMICA HEATSTORE deliverables and road map, [Link](#)
- VESTA GAP analysis, not published
- WarmingUP draft legal framework for HT-ATES (in Dutch), [Voorlopig afwegingskader vergunningverlening HTO - okt 2021 \(warmingup.info\)](#)
- Fleuchhaus et al. 2021 (projects) [Link](#), Stemmler et al. 2022 (potential) [Link](#)
- Geologic Energy Storage, Buursink, M.L., Anderson, S.T., Brennan, S.T., Burns, E.R., Freeman, P.A., Gallotti, J.S., Lohr, C.D., Merrill, M. D., Morrissey, E.A., Plampin, M.R., and Warwick, P.D., 2023, Geologic energy storage: U.S. Geological Survey Fact Sheet 2022–3082, 4 p., <https://doi.org/10.3133/fs20223082> .

The goal of producing specific reports within the IEA Geothermal stays intact. The contents and potentially the format will be reviewed due to helpful feedback within this workshop. Focus will be on easy to read and relevant to the target audience. There might be several summary reports, e.g. on policy relevant actions, regulations and for investors. Ideally the Energy Storage TCPs perspective can be included. Potential contributing authors could be identified.

## 7.2. UTES collaboration

As a result of the workshop a new UTES collaboration between IEA Geothermal and GEOTHERMICA was initiated. Both groups agreed to organise a follow up symposium as a side event prior to the next GeoTherm on 28<sup>th</sup> of February 2023 in Offenburg Germany. We aim at also involving IEA Energy Storage in the UTES collaboration.

Christian Minnig (IEA Geothermal) and Paul Ramsak (GEOTHERMICA) will oversee establishing a strong liaison between IEA Geothermal and GEOTHERMICA. The collaboration will help avoiding working on the same problem (“what has been already done / is being worked on” → GEOTHERMICA Storage Platform/Initiative) and help to align vision and speak with one voice where possible.

## 7.3. Pilot & Demonstration projects

Pilot and demonstration projects have been identified by many countries as the most important way to move forward. The upcoming GEOTHERMICA/CETp 2023 call might offer funding opportunities for UTES pilot and demonstration projects.

## 7.4. Developing the UTES network

The workshop showed the strength of international collaboration and networking. To expand on this an application for the COST action programme could be filed. The Open Call 2023 is open until 25 October 2023 via <https://www.cost.eu/>. COST actions provide funding for interdisciplinary networking on a topic for 4 years.

## 7.5. Upcoming events

23.-24.05.2023	2nd European Underground Energy Storage Workshop, <a href="#">Link</a>
03.-07.09.2023	GeoBerlin 2023 – Geosciences Beyond Boundaries - Research, Society, Future. With dedicated ATES session. <a href="http://www.geoberlin2023.de">www.geoberlin2023.de</a>
15.-17.09.2023	World Geothermal Congress Beijing,
28.02.2023	IEA Geothermal & GEOTHERMICA UTES Symposium Offenburg, to be confirmed

## 8. Appendix

### 8.1. [Detailed Questionnaire Answers](#)

- 8.1.1. LT-ATES
- 8.1.2. HT-ATES

### 8.2. Presentations

8.2.1. <a href="#">Current State Netherlands ATES</a>	IF Technology	Bas Godschalk
8.2.2. <a href="#">Country Update Switzerland</a>	SFOE	Christian Minnig
8.2.3. <a href="#">Heat storage Forsthaus Bern</a>	GeoEnergy	Peter Meier
8.2.4. <a href="#">VESTA Project</a>	SWM	Thorsten Hörbrand
8.2.5. <a href="#">ATES Groundwater</a>	KWR	Daphne Wiegers - de Vries
8.2.6. <a href="#">Country update Germany</a>	IFG / DE	Sebastian Bauer
8.2.7. <a href="#">Country update USA</a>	DOE	Alexis McKittrick
8.2.8. <a href="#">Country update Korea</a>	KIGAM	Yoonho Song
8.2.9. <a href="#">Country update Slovenia</a>	Geo-ZS	Nina Rman
8.2.10. <a href="#">Critical Succes Factors</a>	IF Technology	Peter Oerlemans
8.2.11. <a href="#">Heatstore Roadmap</a>	TNO	Dorien Dinkelman
8.2.12. <a href="#">Field trip HT ATES Middenmeer</a>	ecw energy	ecw energy

### 8.3. Additional Information

- 8.3.1. Godschalk, Bas, Melanie Provoost, and Frank Schoof. "[Netherlands Country Update.](#)" Proceedings World Geothermal Congress. 2020.
- 8.3.2. Dutch research programme MMB (Meer Met Bodemenergie). "[Aquifer Thermal Energy Storage in the Netherlands a research programme \(2010-2012\). Extended English summary.](#)" 2012. English translation last edited 2019.
- 8.3.3. GSEU Presentation: WP 3 – "[Geothermal energy & underground storage inventory.](#)"



ATES Workshop Hoorn, NL 2023  
20 & 21.04.2023

# Workshop Proceedings

