ECES Annex 12

"High Temperature Underground Thermal Energy Storage"

7th report to the Executive Committee
17.-18.5.2001

Annex 12 of the ECES Implementing Agreement of IEA is a task-sharing annex. There are four countries participating in the annex, comprising the locations of most of the operational HT-UTES plants and the institutions where work towards HT-UTES is done:

- Belgium
- Canada
- Germany
- Sweden

A fifth country, the Netherlands, where the only other operational HT-UTES is located, is participating through some industry involvement and assistance to the work of the annex. Norway attended the experts meeting in spring 2001 as an observer.
Funding for the work is fully available in Belgium and Germany, and currently limited in Canada and Sweden. In the Netherlands, a study on optimum storage temperatures for UTES is funded (not officially part of the annex).

One experts meeting has been conducted since the last ExCom meeting:
XM 7, Nijmegen, NL, April 2001
The minutes of this meeting are given as Appendix A.

Work on monitoring and on the site test methods for aquifer chemistry and ground thermal parameters is continuing. Currently monitored are:

- Neckarsulm, BTES (D)
- Rostock, ATES (D)
- Berlin, ATES (D)
- Hooge Burch, ATES (NL)

New HT-UTES projects are under construction or in planning, and will be monitored:

- Anneberg, BTES (S) start of operation spring 2001
- Attenkirchen, BTES (D) start of operation summer 2001
- Mol, BTES (B) start of operation summer 2002

With the current end of phase 2 in June 2002, data from Anneberg and Attenkirchen will be included; for Mol, only the experiences from the design and construction phase will be available by then.

The test equipment for aquifer chemistry and groundwater behaviour could be made operational in Stuttgart, Germany, in early 2001, and a first test run in Stuttgart was successful. After further completion of the rig in Lüneburg, the trailer was brought to Nijmegen to be demonstrated during the annex 12 and annex 13 experts meetings. IF Technology of Arnhem organised a suitable groundwater well site close to the meeting venue, and the experts could examine the equipment in operation. Heating from ca. 10 °C (natural groundwater temperature) up to ca. 85 °C was successfully done, and the heat exchange characteristics of a plate heat exchanger could be monitored and some scaling could be observed.

From the first test in Stuttgart, at a well with extremely high hardness, severe scaling could be found, and samples were shown; further examination of the type of precipitates is planned.

For borehole heat exchangers, many more thermal response tests have been done in the participating countries, mainly in Germany and Sweden. Norway, as an observer, supplied information on experiences with response test in crystalline rock.

An independent homepage for Annex 12 is under construction at Justus-Liebig-University, and will be linked to the ECES-homepage in Turkey (expected June 2001).

Report given by: Dr. Burkhard Sanner
Operating Agent Annex 12

Appendix A

Minutes of the 7th Expert´s Meeting in IEA ECES Annex 12 High Temperature UTES

24.-25.4.2001, Nijmegen, Netherlands

Participants:
Frank Cruickshanks, Environment Canada, CAD
Bert Gysen, VITO, Mol, B
Guido Knoche, ISWA, Univ. Stuttgart, D
Michael Klein, Univ. Lüneburg, D
Michael Koch, ISWA, Univ. Stuttgart, D
Fred Michel, Carlton Univ., CAD
Manfred Reuß, Landtechnik Weihenstephan, Freising, D
Wolfgang Ruck, Univ. Lüneburg, D
Burkhard Sanner, IAG, Univ. Gießen, D
Helge Skarphagen, NGU, N (Observer)
August Willemsen, IF Technology, NL

Begin 24.4.2001, 9:30

Item 1: Welcome, Participants, Status

The Operating Agent, Burkhard Sanner, and the host, Guus Willemsen, welcomed the participants to Nijmegen.

An introductory round identified the participants and the status of there countries towards the Annex.

Country status

Country	Status	Participant
Belgium	member	VITO
Canada	member	Environment Canada
Germany	member	FZ Juelich / Giessen University
Netherlands	"assistant"	IF Technology
Norway	observer	Geological Survey
Sweden	member	BFR? / TU Lund

Item 2: Round-Table with country update

Belgium

Bert Gysen

- TESSAS (Mol): Calculation, 144 BHE single-U polybutene
- Plan of temperature sensors
- Tendering documents early May
- Start of drilling planned August 2001
- start of operation planned spring 2002

Canada

Frank Cruickshanks

- Standard for UTES made with CSA (with German and IEA input)
- Textbook for UTES in cooperation with Luleå TH
- „Earth Energy Utility“ established in Canada, with German investment
- RET-Screen software for renewable energy screening continously updated, available free of charge
- TED is used as a „marketing tool“
- UTES in general: Project for BTES in a high school in Halifax
  Project for Agriculture Canada near Vancouver ongoing (ATES)
  NSAC Truro greenhouse project in planning stage (ATES)

Germany

Burkhard Sanner

- Guideline VDI 4640 part 3 (UTES) final version now ready (release May 2001)
  part 1 (environment etc.) final version publ. Dec. 2000
  part 2 (GSHP) final version due June/July 2001
  part 4 (mainly air ducts) draft due fall 2001
- TED in commercial use (2 rigs, UBeG in the West and Aetna in the East), further development and experience; one more rig for scientific work in Freising.
- Preparation of maps (GIS) with thermal parameters of the shallow underground. Leading is the Northrhine-Westfalen Geological Survey, see http://www.gla.nrw.de/gt_2.htm
  (map example on http://www.gla.nrw.de/gt_61.htm)
- HT-BTES in Neckarsulm enlarged (almost tripled in size), according to the advancement in ongoing building construction. ITW Stuttgart does the monitoring. One core drilling made, samples from core for thermal conductivity measurement for comparison to TED tests.
- A group working on generic cost of various STES concepts was established and presented a first draft in January 2001. The results will help to assess suitable storage technologies for different applications and site conditions. It has to be checked, if results from this group can be made public to the Annex.
- A project with using surplus heat from solar collectors (for DHW) for BHE thermal recharge is under construction in Hessisch-Oldendorf (Lower Saxony).

Manfred Reuss

- In Munich a project called "Ackermannbogen" will be designed with different storage options, and the best alternative selected.
- A project „Solar City Munich“ was launched and will probably include storage.

Netherlands

Guus Willemsen

- Utrecht is definitely stopped for good.
- Hooge Burch running (some problems with heat retrieval and water treatment
- Haarlem, project with solar loading, originally planned at 70 °C, now because of expected buoyancy flow in the aquifer reduced to 30 °C and HP.
- Study for heat storage optimum temperature for NOVEM by IF until end of 2001, dealing with economics and energy.
- Eindhoven airport project (use of heat from airport runway, stored in ATES, for runway snow-melting and house heating via HP.
- many applications now are heating dominated, but on low temperature and HP.

Norway

Helge Skarphagen

- TED tests are now done routinely in many boreholes for the Geological Survey
- Lab measurement on thermal conductivity in phyllite showed extremely high anisotropy:
  parallel ca. 4 W/m/K
  perpendicular ca. 1 W/m/K
- At this site, drilling was in phyllite with lamina tilting ca. 45°; this resulted in 140 m borehole depth, 90 m deviation towards perpendicular to the lamina.

Sweden

Göran Hellström

- Anneberg, HT-BTES solar heated
- possible HT-ATES in Malmö, see below
- Luleå Kallax airport, runway heating BTES, pre-study finished
- 3 big projects lost in study phase because of utility competition (rate lowering or equipment financial support)
- 14000 GSHP in 2000, around 100’000 in total by end of 2000
- Problems increasing with licenses for BHE or horizontal loops
- Leaks in pipes in 5 BHE 140 m deep for a TV-station, with 40 °C and groundwater level at 140 m below ground: Other material used than specified (rated for lower pressure and temperature range).
- Project with using surplus heat from solar collectors for BHE thermal recharge

Item 3: Presentations

A number of presentation concerning HT-UTES aspects had been prepared and was delivered at this time.

(Slides, Papers etc. will be sent around as an appendix after all is received here in Giessen; MTE: Mobile Test Equipment for ATES)

1) Michael Klein: Chemical monitoring of the Reichstag ATES

2) Guido Knoche: MTE, construction and first test (in Stuttgart)

3) Michael Klein: MTE, mass flow control, determination of the heat transfer coefficient

4) Wolfgang Ruck: MTE, ideas on sensor technology to directly measure scaling by frequency changes; application for control of water treatment (e.g. acid dosage)

5) Manfred Reuss: Attenkirchen hybrid UTES project, status update

6) Guus Willemsen: Utrecht University ATES evaluation

- Storage at 90 °C
- planned 6000 MW_{th} per year
- 6 MW_{th} power at 100 m^3/h
- started operation 1991
- abandoned 1999
- Energy 27 % thermal storage efficiency
  stored 12.500 GJ/y average
  discharged 3.400 GJ/y
  main cause was too high return temperature
- Financial investment 25 % higher than predicted
  Exploitation positive due to electricity generation
- In 1999, when leakage in the warm well occurred, the decision was made not to drill a new well, and cogeneration was resumed with dry coolers in 2000.
- Design problems cost money
- Operation
  Water treatment too labour intensive
  Water treatment failed in 1994
  Warm well clogged gradually from 1993-1999, reached 4,4 bar
  Cause of leak not exactly known
- Positive Experience
  Thermal behaviour almost as expected
  wells performed well (clogging is thought to be in aquifer)
  no corrosion
- Environmental impact caused no problems:
  Thermal influence as expected (i.e. negligible at top of the confining layer)
  Water quality showed small variations due to temperature and water treatment
  Small area above store had increase in elevation of <5 mm
- Conclusions:
  Temperature level in building must be low enough
  No suitable commercially available water treatment method (research needed)
  Cause of leak in warm well and cause of clogging has to be investigated

7) Göran Hellström Project for a HT-ATES in Malmö

- Storage 50 Gwh with 50 Mwh power
- Loading at 85 °C, unloading at 55 °C
- Several alternatives studied
  water tank / pit, ca. 250 mio SEK
  CTES, 2000000 m^3, 300 mio SEK
  BTES with 900 BHE 200 m deep 50 mio SEK
  ATES with shallow aquifer 2 x 35 wells 60-70 m deep, 20 mio SEK
  ATES with deep aquifer 2 x 7 wells 1350 m deep, 20 mio SEK

Item 4 Subtasks:

Monitoring

Germany: Reichstag, Rostock, and NSU active; Attenkirchen from summer 2001 on
Sweden: In Anneberg, houses are still under construction, begin of operation maybe in 2001
Belgium: TESSAS Mol operational in spring 2002 (project develops as planned)
Netherlands: In Hooge Burch (Gouda) a basic monitoring is done.

ATES-MTE

The equipment is operational and was tested in Stuttgart and Lüneburg; Nijmegen is the first field test.

HT-TED

It was decided to push forward to get a printed documentation of the Mol event from October 2000. The test data are open to the group. This also was discussed later in Annex 13.

Borehole Heat Exchangers

Göran Hellström suggests a look at the Annex 13 BHE report from a HT angle, and write relevant report

Economy

It is to be checked if the IEA group can use data from the German cost group
For Rostock and Neckarsulm, cost data should be available from ITW

Item 5 next meeting, AOB, closing

Next meeting scheduled on Nov. 8-9, 2001, in Atlantic Canada
(no joint meeting with Annex 13 this time)

Adjournment ca. 18:00

25.4.2001
Technical Tour

- Visit to the ATES-MTE site, ca. 300 m north of the meeting hotel.
  The equipment is operating at a groundwater well. Layout and operation are demonstrated.

- Visit to Gelredome stadium (ATES) in Arnhem

- Visit to IKEA (ATES) in Duiven

Thanks to IF Technology and Guus Willemsen and Guido Bakema in particular for the organisation!

8.5.2001
Burkhard Sanner
Giessen, Germany