

**OECD/IEA
COMMITTEE ON ENERGY RESEARCH AND TECHNOLOGY
END-USE WORKING PARTY**

Implementing Agreement on
Energy Conservation Through Energy Storage

Annual Report 2002



April 2003

CONTENTS

CHAIRMAN'S REPORT	3
ENERGY CONSERVATION THROUGH ENERGY STORAGE IMPLEMENTING AGREEMENT.....	5
ACTIVITIES	7
ON-GOING ANNEXES.....	9
ANNEX 12. HIGH TEMPERATURE UNDERGROUND THERMAL ENERGY STORAGE.....	9
ANNEX 13. DESIGN, CONSTRUCTION AND MAINTENANCE OF UTES WELLS AND BOREHOLES	12
ANNEX 14. COOLING IN ALL CLIMATES WITH THERMAL ENERGY STORAGE.....	14
ANNEX 17. ADVANCED THERMAL ENERGY STORAGE TECHNIQUES FEASIBILITY STUDIES AND DEMONSTRATION PROJECTS	18
PROPOSED ANNEXES	23
ANNEX 15. ELECTRICAL ENERGY STORAGE AND THE INTEGRATION OF RENEWABLES	23
ANNEX 16. ENGINEERING TEXTBOOK ON THERMAL ENERGY STORAGE AND RENEWABLE ENERGY.....	25
NEW ACTIVITIES.....	27
MARKETING UNDERGROUND THERMAL ENERGY STORAGE (UTES)	27
HIGH TEMPERATURE ENERGY STORAGE.....	27
TRANSPORTATION OF THERMAL ENERGY UTILIZING THERMAL ENERGY STORAGE TECHNIQUES	27
APPENDICES	29
APPENDIX 1 - PARTICIPANTS OF ECES IA	29
APPENDIX 2 -LIST OF PUBLICATIONS	30
APPENDIX 3 - LIST OF ANNEXES	31

CHAIRMAN'S REPORT

Volkmar Lottner
Forschungszentrum Jülich, Germany

The year 2002 was a year of transition. After a careful review of 25 years of international cooperation in the IEA the Committee on Research and Technology (CERT) has developed a new strategy for the future collaboration in the **IEA framework**. The concept has been discussed with all Implementing Agreements. The new IEA framework was adopted by CERT at its spring meeting 2003. The new framework will probably have a great impact on the Implementing Agreement: “Energy Conservation Through Energy Storage (IA-ECES)”. We all hope that participation of new contractors/sponsors will be facilitated in particular from the legal point of view.

Political Mandate

Energy conservation and utilization of renewable energies have still a high priority on the political agenda. It has become general consensus that the steadily increase of CO₂ and other greenhouse gas emissions into the atmosphere will lead to a dramatic change of the world climate with severe environmental consequences already in the 21st century. The **Global Summit on Sustainable Development** in August/September 2002 in **Johannesburg**, South Africa confirmed the commitment and action plans of many nations to meet specific targets of the reduction of fossil fuels in the medium to long term. The goal can only be achieved by a further increase of the energy efficiency and the wider utilization of Renewable Energies. Energy Storage Systems as part of efficient energy systems can play hereby an important role. More and more governments support R&D and the implementation of renewable energies and rational utilization. On the other hand the severe economic situation in many countries leads to shrinking budgets for R&D. This also restricts the possibilities of launching new activities and projects. On the other hand international cooperation e. g. within the IEA can help to use national financial resources more effectively by pooling together the expertise and knowledge of experts around the world.

Technology Transfer and Information Dissemination

The IA-ECES made another very good progress to enhance the international collaboration. The technology transfer from the experts to the business people in industry is a pre-requisite for the wider deployment of new innovative energy technologies. This was implemented in all ongoing Annexes 12, 13, 14 and 17 e. g. by organizing workshops with the industry. A new glossy ECES brochure was printed to show the public audience the results of IA-ECES. Complete information about the IA-ECES is also presented in the internet ECES-homepage. With the move of the ECES-Secretariat from the Cukurova University to the Bavarian Centre for Applied Research Munich (ZAE-Bayern) the homepage got a new outfit.

Collaboration

To be effective a close cooperation is necessary not only between the participants and experts of the IA-ECES, but also with the ExCo's and experts of other IA's. This holds in particular for all seven Building Related Implementing Agreements (BRIA'S). The Building Coordination Group (BCG) was established by the End Use Working Party (EUWP) of CERT to facilitate the information exchange within BRIA'S. The ECES ExCo is very actively

engaged in BCG. In addition joint meetings with other Executive Committees are organized to discuss in detail the topics of common interest and the opportunities of cooperation. A joint meeting of both ExCo's ECES Solar Heating and Cooling (SHC) took place in Brussels in November just before the regular ExCo meeting. A close cooperation was agreed in particular in the first phase of the new Task 32: "Advanced Solar Storage Systems" in the IA-SHC.

Programme

Annex 12 and Annex 13 will be accomplished in 2003 with the publication of several state of the art reports and final Task Reports. The reports will provide results and technical expertise from R&D, D to assist designers, builders and operators of Underground Thermal Energy Storage (UTES) Systems.

The ExCo also considered new possible activities in the IA. Several suggestions were submitted and discussed including: market deployment, high temperature thermal energy storage for industrial applications and transportation of waste heat by transportable TES.

The topic electrical energy storage (previously proposed Annex 15) is again being reviewed. This review will show whether there is enough interest to launch the previously proposed Annex 15.

Participation

Several changes occurred in 2002. Unfortunately NOVEM has withdrawn from the IA-ECES by July 1, 2002. On the other hand The Research Council of Norway has signed the IA in April 2002. The ExCo approved the application of IF-Technology to join the IA as sponsor. According to the new IEA framework the sponsorship has still to be confirmed by CERT. Poland is continuing its efforts to become a signatory member of the IA ECES.

EA-Technology has been replaced as Contracting Party by The Ministry of Trade and Industry (DTI), UK.

Administration

At the 52nd ExCo meeting in Potsdam, Germany April 20-22, 2002 Halime Paksoy and Hunay Evliya, Cukurova University Adana Turkey have retired as Chair and Secretary of the Committee. I have been elected as Chairman, Halime Paksoy and Franck Cruickshanks as Vice-Chairs. Andreas Hauer, ZAE-Bayern was appointed at the 53rd ExCo meeting as ECES-Secretary.

On behalf of the Committee I would like to thank Halime Paksoy and Hunay Evliya for their excellent work for several years. Their efforts resulted in great progress and achievements in the IA-ECES. I would also like to thank Madeline Woodruff, the former desk officer of IEA-Secretariat Paris and responsible for the IA-ECES for her continuous support of the ExCo. Phil Harrington succeeded Madeline Woodruff as desk officer of the IEA Secretariat Paris.

The ExCo appreciates also very much the previous long term engagement and successful efforts of the Dutch representative Gijs van Mourik, NOVEM who served as Chairman of the ExCo for several years.

ENERGY CONSERVATION THROUGH ENERGY STORAGE IMPLEMENTING AGREEMENT

The Implementing Agreement (IA) started in 1978. A 5 years extension until December 2005 was recently approved by CERT. At present there are 15 participating countries: Belgium, Canada, CEC, Denmark, Finland, Germany, Italy, Japan, The Netherlands¹, Norway², Spain, Sweden, Turkey, United Kingdom, USA. The Executive Committee is working intensively to attract more countries to join the activities and to sign the Implementing Agreement. Australia, Bulgaria, China, France, India, Israel, Korea, Malaysia, Poland, South Africa and Switzerland have expressed interest to participate in the activities of the Implementing Agreement. Experts from several countries do already participate in the Annex work as observers.

According to the present Strategy Plan (1998 – 2003) the objectives for the IA are as follows:

“The overall objective of the IA on ECES is to develop and demonstrate various energy storage technologies for applications within a variety of energy systems and to encourage their use as a standard design option. Energy storage technologies can improve the utilisation of renewable energies, in particular solar and wind and the greater utilisation of waste heat energy storage technologies should be implemented in all countries with significant energy storage market potential”

The Executive Committee co-ordinates and leads the collaborative work in the Annexes and the Committee also takes an active part in various information activities such as workshops, seminars and conferences.

Executive Committee Meetings

The Executive Committee had two meetings during the year 2002 and a joint meeting with the Executive Committee Solar Heating and Cooling. The 52nd XC meeting was held in Potsdam, Germany on April 25-26 and 53rd XC meeting in Turnhout, Belgium on November 21-22. The joint meeting was held in Brussels on November 20 prior to the Executive Committee meeting in Turnhout.

The most important items and decisions of the ExCo meetings in 2002 are outlined below.

The Potsdam Meeting, April 25-26, 2002

- Halime Paksoy and Hunay Evlya retired as Chair and Secretary
- Volkmar Lottner was unanimously elected as new Chairman, Halime Paksoy and Franck Cruickshanks as Vice Chair.
- A new ECES secretary will be proposed by Volkmar Lottner, in the interim Hunay Evlya will prepare the minutes of the Potsdam meeting and will assist the Chair
- Minutes of XC 51 were adopted
- Annual Report 2001 was approved

1 Withdrawn July 1 2002

2 Signed the IA in April 2002

- Financial statement of the secretariat for the period July,1 2001 until June 30, 2002 was approved
- Approval of the ECES brochure and printing costs
- Approval of all progress reports of ongoing Annexes (12, 13,14,17)
- Extension of Annexes 12, 13 and 14 were approved
- Further evaluation of new Annex proposals

The Turnhout Meeting, November 21-22, 2002

- Approval of the minutes of the XC 52
- Approval of Andreas Hauer, ZAE Bayern, Germany, as the new secretary
- Approval of the submitted budget October 1, 2002 until September 30, 2003
- Establishment of a new ECES-homepage at ZAE-Bayern
- Approval of the application and terms of condition of IF Technology to join the IA as sponsor.
- Approval of all Annex progress reports (12,13,14, 17) and the extension of Annex 12 and 13 until June 2003-04-14
- New Updated Strategy Plan. Working Group established. Chair: Franck Cruickshanks, members Björn Sellberg, Halime Paksoy, Phil Baker and Roman Domanski
- General interest on the new Annex Proposal: Marketing Energy Storage Systems. Aart Snijders was asked to submit a concept paper before the next ExCo meeting.
- Fredrick Setterwall and Andreas Hauer were asked to explore the interest for a new Task: High Temperature Thermal Energy Storage and Transportation of Thermal Energy by TES.
- Phil Baker was asked to review the status of the EU funded project on electrical energy storage.
- Support the preparation of Futurestock'2003 and encourage national experts to participate and submit papers

ACTIVITIES

Executive Committee Meetings

- 52nd XC meeting, Potsdam, Germany on April 25-26
- 53rd XC meeting in Turnhout, Belgium on November 21-22.
- The joint meeting of both ExCo's ECES and Solar Heating and Cooling was held in Brussels on November 20 prior to the Executive Committee meeting in Turnhout.

Expert Meetings and Workshops 2002

Annex 12: High Temperature Underground Thermal Energy Storage"

- 9th Expert Meeting: April 15-16, 2002, Malmö, Sweden

Annex 13: Design, Construction and maintenance of UTES Wells and Boreholes

- 9th Expert Meeting: April 17-19, 2002, Malmö, Sweden
- 10th Expert Meeting October 9-11, 2002 Amsterdam, The Netherlands

Annex 14: Cooling in All Climates With Thermal Energy Storage

- 8th Expert Meeting October 23-24, 2002, Pomona, NJ USA
- 5th Workshop: October 25, 2002, Pomona, NJ USA

Annex 17: Advanced Thermal Energy Storage Through Application of Phase Change Materials and Chemical Reactions-Feasibility Studies and Demonstration Projects

- 2nd Expert Meeting, April 3, 2002, Ljubljana, Slovenia
- Workshop: April 4-5 2002, Ljubljana, Slovenia
- 3rd Expert Meeting, September 30, 2002, Tokyo, Japan
- Workshop, October 1-2, 2002. Tokyo, Japan

Participation in the meetings of the Building Coordination Group (BCG)

- January, 2002, Frascati, Italy, ECES-delegate: Halime Paksoy
- September 26, 2002, Oslo: ECES-delegate Volkmar Lottner

Participation in IEA-Workshops

- MOST-IEA Workshop on Energy Technology Collaboration
Beijing, People's Republic of China, 17 May 2002, ECES-representative: Burkhard Sanner
- EUWP-Workshop: "How to assess and communicate the added value of IA-work"
Interlaken, 30 September 2002, ECES-representative: Mari Westin (nee Gustafsson)
- Workshop: "BRIAS meet Norwegian Industry"
Oslo, September, 26, 2002, ECES-representative: Volkmar Lottner

Conferences 2003

- **Conference on Thermal Energy Storage Technologies (in conjunction with Annex 17 meeting), March 21-24, 2003, Indore, India**
- **Futurestock'2003: 9th International Conference on Thermal Energy Storage in Warsaw, Poland, September 1-4, 2003**

ON-GOING ANNEXES

Annex 12. High Temperature Underground Thermal Energy Storage

Operating Agent; Burkhard Sanner, Giessen University, Germany

Introduction

The Annex 12 "High Temperature Underground Thermal Energy Storage (HT UTES)" was approved at XC43, December 1997.

Participating Countries: Belgium, Canada, Germany, Netherlands, Sweden

Based upon the results from previous IEA activities and ongoing R&D, the objectives of Annex 12 are to demonstrate that HT-UTES can be attractive to achieve more efficient economical and environmentally benign energy systems, and to disclose requirements and find problem solutions for reliable long-term operation. The type of UTES-system concerned is confined to Aquifer Storage (ATES) and Duct/Borehole Storage (BTES). High temperature in this annex refers to a minimum storage loading temperature in the order of 50 °C.

Workplan

To achieve the objectives, several activities will be carried out in two Phases:

The work is divided into two phases:

- | | |
|---------|---|
| Phase 1 | Review of the state-of-the-art, investigations into system opportunities and further R&D-need; completed with report end of 1999 |
| Phase 2 | Monitoring of existing plants (demo projects), design tools, improvement in water treatment and development of test equipment, choice of materials suited for high temperatures, economic analysis, design guidelines.
Phase 2 was approved at XM 47, November 1999; ongoing |

The work is done on a task-sharing basis, with experts meetings twice a year.

Results

The state-of-the-art report within phase 1 was published as:

SANNER, B. (ed.) (1999): High Temperature Underground Thermal Energy Storage, State-of-the-art and Prospects. - Giessener Geologische Schriften 67, 158 p., Giessen

There is a small number of HT-UTES plants in operation, where monitoring programs allow to evaluate system performance, reliability, operational experiences, etc. within Phase 2. Monitoring is done within national programmes, and the results should be shared and compared within Annex 12:

Amorbach	Neckarsulm, D	BTES, residential area with solar heat (meanwhile enlarged to >500 BHE)
Anneberg	Solna, S	BTES, residential area with solar heat

Brinckmannshöhe	Rostock, D	ATES, apartment houses with solar heat
Hooge Burch	near Gouda, NL	ATES with heat from heat-and-power-cogeneration
Reichstag building	Berlin, D	ATES with heat from heat-and-power-cogeneration

Two other projects became operational during 2002, and first operational results could be obtained:

Attenkirchen	near Freising, D	BTES with water tank, residential area with solar heat	spring 2002
TESSAS	Mol, B	BTES, test plant	summer 2002

In Neckarsulm, the work for enlargement of the total system had an impact of the operation of the existing store and on the monitoring. For Annex 12, only the existing part as of late 2000 is considered. The full extent of the Reichstag ATES in Berlin has been reached in the year 2002, with the finalization of the surrounding building and the connections of the heating and cooling network. The full thermal capacity of the co-generation plants was available for loading of the store for the first time.

Some other HT-UTES projects have been discussed or planned in 2002:

Malmö, S	Huge system for 50 MW thermal output and about 100 °C, 2x19 wells 450-500 m deep, for the district heating system
Mahone Bay, NS, CAN	Hawthorn Village, HT-BTES with ca. 80 houses, medical centre, etc., with solar thermal for loading; total system should have at least 50 % solar fraction
Halifax, NS, CAN	Quinpool Towers, residential complex, flats/apartments; 1100 m ³ pilot store, 4 holes, 3 m distance 120 m depth, storage operated at 50 °C. Planned to be enlarged to ca. 32 boreholes. Solar collectors and/or waste heat as heat source

Test methods for both BTES and ATES have been successfully demonstrated:

- Thermal Response Test (TRT), used in mobile equipment since ca. 1995, was used for design of the Attenkirchen BTES and also for the enlargement of Neckarsulm BTES. This technology meanwhile can be considered commercial for the low-temperature applications (mainly ground source heat pumps), and proved to be well adapted also for the higher temperature range. Because TRT does not determine the thermal conductivity of the solid ground only, but gives a value for apparent thermal conductivity comprising also other components like convection, the results are temperature-dependent and measurements have to be done at the desired operational temperature of the BTES.
- Test equipment for ATES to investigate groundwater behaviour in situ (scaling, corrosion, etc.) has been improved and tested at several locations in 2002. A standard procedure to assess the suitable temperature range for ATES was developed, using step-wise increase of loading temperature with given flow and test duration. Tests at sites with different groundwater chemistry allowed to study the different behaviour, however, more tests are required to understand the processes better and to allow for the comparison with results obtained from computer models of groundwater chemical behaviour.

In 2002, only one experts meeting has been held:

- Malmö, Sweden, April 15/16, 2002

The OA of Annex 12 presented the ECES IA at a joint meeting of IEA with the Chinese Ministry of Science and Technology in Beijing, China, on May 17, 2002, and the work of Annex 12 at the joint meeting of the SHC IA and ECES IA in Brussels, Belgium, on Nov. 20, 2002. Presentations on the possibilities and advantages of UTES were done on Sep, 2, 2002 in

Thessaloniki (GR) and on Sep. 11, 2002, at a German-Turkish Seminar on Renewable Energies in Istanbul (TR); both papers by Sanner & Paksoy, see: <http://www.uni-giessen.de/~gg1068/pdf-Dateien/Geothermie/Literatur/Gth-days02/igd-greece-2002-utes.pdf>

An overview over BTES was given by Annex 12 members at a conference in Waren, Germany, see: <http://www.geothermie.de/oberflaechennahe/waren-btes.pdf>

Annex 13. Design, Construction and Maintenance of UTES Wells and Boreholes

Operating Agent: Olof Andersson, Lund Institute of Technology, Sweden

Scope and objectives

Annex 13 cover aspects of testdrilling, well and borehole design, construction and maintenance of wells and boreholes for UTES applications especially concerning ATES and BTES systems.

The final goal of the Annex is to work out a set of guidelines covering the following subtasks.

- How to gain information of the underground properties by testdrilling (Subtask A)
- How to design well or borehole systems properly (Subtask B)
- How to construct wells or boreholes cost effective, safe and properly (Subtask C)
- How to keep the storage systems functional during operation (Subtask D)

A second goal is to identify items or areas that need further research and development.

Workplan

The Annex was planned during 1997 and eventually approved by the 43rd EXCO Meeting in Paris 4-5 of December 1997.

The workplan takes into consideration that a number of participating countries will contribute to the further development of the Annex following the task shearing principle. The target is set to close the Annex in June 2003.

The participating countries during the year 2002 have been:

- | | |
|---------------|----------|
| • Belgium | Formal |
| • Canada | Formal |
| • Germany | Formal |
| • Japan | Formal |
| • Netherlands | Formal |
| • Norway | Observer |
| • Switzerland | Observer |
| • Sweden | Formal |
| • Turkey | Formal |
| • USA | Formal |

Activities in 2002

During the year 2002 there has been two organised activities. These are:

The 9th Expert Meeting, that took place in Malmö, Sweden, April 17-19, 2002. At the meeting all formally participating countries except Belgium and Japan were represented, Norway now as a formal member of the Annex. Switzerland was participating as an invited observer. The major part of the time was spent on group work related to four sections in the guidelines. It was agreed that the subtask reports should be made available at the homepage of ECES prior to the next EXCO meeting. It was also concluded that the guidelines had to be worked on more at an extra meeting. The target was set to have a draft version ready prior to the 53rd EXCO meeting.

The 10th Expert Meeting was held in Amsterdam, The Netherlands, October 9-11, 2002. At the meeting only the authors of reports were participating with the aim to co-ordinate and make final adjustments of the subtask reports. It was confirmed to finalise the reports within the next coming months with the target to have them reviewed and approved by the ExCo Meeting in May 2003.

Workplan for 2003

For the coming year 2003, no more Expert Meetings are planned. The Annex is expected to be finalised by submitting six subtask reports and a final report with guidelines within the first half year.

Contacts

Country co-ordinators are

- Belgium, Bert Gysen (gysenb@vito.be)
- Canada, Frank Cruickshanks (frank.cruickshanks@ec.gc.ca)
- Germany, Burkhard Sanner (burkhard.sanner@geo-uni-giessen.de)
- Japan, Xiaomei Li (li@host2.hptej-unet.ocn.ne.jp)
- Netherlands, Guido Bakema (office@if-tech.nl)
- Norway, Helge Skarphagen (helge.skarphagen@ngu.no)
- Sweden, Olof Andersson (olof.andersson@sweco.se)
- Switzerland, Walter Eugster (wjeugster@swissonline.ch)
- Turkey, Halime Paksoy (hopaksoy@mail.cu.edu.tr)
- USA, Jeff Spitler (spitler@osuunx.ucc.okstate.edu)

Annex 14. Cooling in All Climates with Thermal Energy Storage.

Operating Agent: Halime Paksoy, Çukurova University, Adana, Turkey.

Introduction

Annex 14 has started operation after being approved by the Executive Committee at the 46th Executive Committee Meeting of ECES IA in Lulea, Sweden on June 14-16, 1999. Cukurova University Center for Environmental Research Adana, Turkey acts as the Operating Agent.

The scope of the work is to improve the efficiency of energy usage (energy conservation) which is valuable for the global environment and economies in both developed and developing countries. Moreover, Thermal Energy Storage (TES), which provides the matching of energy supply and demand, has been shown to contribute significantly in improving energy efficiency when compared to conventional energy systems. Such systems can also increase the potential of utilizing renewable energy sources such as ambient cold air or waste heat.

The overall objective of Annex 14 is to employ research, development and feasibility studies to advance the prospects of cooling with TES of technologies for applications within a variety of energy systems and climate conditions and to encourage their use as a standard design option. The Annex will rely heavily on the activities and results of Annexes 6, 7, 8, 10 and 13 to encourage energy efficiency and increased sustainability of the global energy resources by stimulating the expanded use of TES in innovative, energy efficient and cost-effective projects in participating countries.

Subtasks

Phase I

- Subtask 1. Conduct a general review of existing and emerging cooling with TES applications in different climates
- Subtask 2. Evaluation of Feasible Boundary Conditions and System Configurations for Cooling with TES
- Subtask 3. Design and Analysis User-friendly Tools
- Subtask 4. Determining potential cooling with TES applications in different climates

Phase II

- Subtask 5. Feasibility study and design of practical demonstration of viable TES in representative cooling applications
- Subtask 6. Construction of practical demonstration of viable TES in representative cooling applications

Duration of Phase I

July 1999 – June 2003

Participating Countries

Canada, Japan, Sweden and Turkey are the participating countries from the beginning of the Annex. USA joined the Annex in 2002. Germany, China, Malaysia and Korea have participated in a number of Annex 14 workshops. Information exchange between experts from these countries is also established.

Collaboration with other Cooling Activities in IEA

- Presentation at Joint ExCo meeting of ECES and SHC in Brussels on November 20, 2002
- Information exchange with IEA ECBCS Annex 37 “Low Exergy Systems for Heating and Cooling in Buildings”

Status of Subtasks in 2002

Subtask 1

- ◆ Final country-specific state-of-the-art reports - completed except for Canada.
- ◆ General state-of-the-art report - on-going,
- ◆ Annex 14 brochure with a CD-ROM including final reports- on going

Subtask 2

- ◆ List of boundary conditions – on-going
- ◆ Cold sources – on going
- ◆ System configurations – on going

Subtask 3

- ◆ Ice storage early decision tool program translated from Japanese to English - completed
- ◆ Survey on existing models and tools – completed except for UTES models from Sweden
- ◆ Database for environmental calculations – on going

Subtask 4

- ◆ *General description of system configurations – on going*
- ◆ Classification and characterization – on going
- ◆ Feasibility study of the most promising choices – on going
- ◆ Proposal for demo plants (Phase II) – on going

Activities in 2002

- Seventh Experts’ Meeting of Annex 14 was held in Kuala Lumpur, Malaysia on May 6-8, 2002 hosted by Tenaga SPL Company. Experts from Canada, Japan, Malaysia, Sweden and Turkey participated at the meeting.
- Eighth Experts’ Meeting and Fifth Workshop were held on October 23-25, 2002 in Pomona, NJ USA, hosted by Richard Stockton College. There were 75 participants joining the workshop from Canada, Japan, Sweden, USA and Turkey. Table 1 shows

the papers presented and contribution to Annex work. Proceedings of the workshop is prepared on CD ROM.

Table 1. Input from Annex 14 Fifth Workshop

Presentations	Subtask 1	Subtask 2	Subtask 3	Subtask 4
IEA ECES Annex 14 “Cooling in all climates with thermal energy storage”-Overview by Halime Paksoy, Turkey	*			
Borehole Thermal Energy Storage (BTES) Modeling by Jeffrey Spitler, USA			*	*
Aquifer Thermal Energy Storage (ATES): recent developments in The Netherlands by Aart Snijders, The Netherlands	*	*		*
Aquifer Thermal Energy Storage (ATES):Application at Richard Stockton College by Lynn Stiles, USA	*			*
Japanese situation of short term storage technologies for comfort cooling by Motoi Yamaha, Japan	*	*		*
Cooling with UTES in Sweden - Market development and some exapmle of applications by Olof Andersson, Sweden	*	*		*
Diurnal TES in USA by Mark MacCracken by USA	*			
Electrical Energy Storage: The Other Option by Imre Gyuk, USA				
American Hebrew Academy: Closed Loop Geothermal Heat Pump Project (BTES) by Howard Alderson, USA	*	*		*

Publications in 2002

- Draft Annex 14 brochure
- Fifth Workshop Proceedings, Stockton, NJ, USA October 25, 2002 (CD-ROM)

Upcoming Meetings

9th Experts’ Meeting and 6th workshop will be held on April 8-11, 2003, Leida, Spain

National Contacts

Sweden

Bo Nordell, Bo.Nordell@sb.luth.se
Kjell Skogsberg, Kjell.Skogsberg@sb.luth.se
Fredrik Setterwall, setter@chemeng.kth.se
Olof Andersson, OLOF.ANDERSSON@sweco.se
Bo He, bohe@ket.kth.se
Göran Hellström, neo.energy@swipnet.se

Japan

Motoi Yamaha, yamaha@isc.chubu.ac.jp
Tadahiko Ibamoto, ibamoto@env.a.dendai.ac.jp

Canada

Frank Cruickshanks , Frank.Cruickshanks@ec.gc.ca
Edward Morofsky, MOROFSKE@PWGSC.GC.CA

Turkey

Bekir Turgut, annex14@mail.cu.edu.tr
Derya Dikici, ddikici@mail.cu.edu.tr
Halime Paksoy, hopaksoy@mail.cu.edu.tr
Hunay Evliya, hevliya@mail.cu.edu.tr

USA

Lynn Stiles, Lynn.Stiles@stockton.edu

Annex 17. Advanced Thermal Energy Storage Techniques Feasibility Studies and Demonstration Projects

Operating Agent: Professor (emeritus) Fredrik Setterwall, Fredrik Setterwall Konsult AB, Bäckvägen 7c, SE 192 54 Sollentuna, Sweden

Annex 17 “Advanced Thermal Energy Storage through Application of Phase Change Materials and Chemical Reactions – Feasibility Studies and Demonstration Projects” was approved at the meeting of the Executive Committee of the Implementing Agreement on Energy Conservation through Energy Storage in Hull, Canada, 2001-05-16—18.

The scope of the Annex is to overcome technical and market barriers for phase change materials and chemical reactions as a mean for thermal energy storage, especially in the building, industrial and food technology sectors. This will be achieved by performing feasibility studies and demonstration projects in the area. The results of the projects are to be presented at work shops arranged twice a year in connection with the annex experts meeting.

The Annex has three official members: Germany, Japan and Sweden. During the year observers from the following countries have participated in the work of the annex:

China, India, Slovenia, Spain, Switzerland and Turkey

During year 2002 two work shops and experts meetings have been arranged. One meeting was held in Ljubljana, Slovenia on the 3rd to 5th of April. The second meeting was held in Tokyo, Japan on the 30th of September to 2nd of October. In total 50 persons from 9 different countries have participated in the work shops. 27 papers were presented during these work shops.

Project progress

The work in the annex is divided into three different subtasks: Heating and Cooling of Buildings, Handling of Temperature Sensitive Materials and Waste Heat Utilization. Several projects in each area are being discussed within the annex. In the field of heating and cooling of buildings the incorporation of thermal energy storage materials in the building material itself is addressed in several projects. The poor heat conductivity of phase change materials is improved by different matrixes for improvement of heat conductivity or by microencapsulation of the material thereby decreasing the length of the heat resistance.

Utilization of cold nights for cooling during daytime has been demonstrated in a couple of projects.

Protection of temperature sensitive materials during transport is mainly a question of finding the correct material for heat insulation. It is a balance between high temperature constancy and high weight of the container.

Waste heat utilization is realized both by district heating/cooling applications and utilization of industrial waste heat from high temperature processes

- Heating and cooling of buildings (Germany and Japan)

- “Energy storage in the CREA building (Lleida)”
 - The architects are working on the building
 - “PCM module to improve stratified water tanks”
 - Reported in the 1st Work Shop in Benediktbeuern in Germany. The technique is now commercially available in Japan
 - Building materials:(Germany)
 - A report was given during the 3rd Work Shop in Tokyo, Japan. In short it is reported about a new PCM with a melting range of 20 – 24 °C, PCM in building materials and on PCM in windows and shadings
 - “PCM wallboard containing PCM penetrated with cross-linked polyethylene”
 - “Encapsulated PCM in building technology”
 - Reported during the 2nd Work Shop in Ljubljana, Slovenia
 - “Mixture of wood, PCM and concrete”
 - Reported during the 2nd Work Shop in Ljubljana, Slovenia
 - “PCM wallboards”
 - Sorption systems: (Germany)
 - “ Heating and Cooling with Zeolites”
 - The project was presented at the 3rd Work Shop in Tokyo, Japan
 - “ Air conditioning and cold storage in open sorption systems ”
 - This is a new project dealing with liquid desiccants (like a LiCl solution) for cooling and solid desiccants Like Zeolite) for dehumidification.
 - “Silica gel in a Closed System”
 - This is a commercial project run by the company Sortech. Demonstration plants will be erected in the Netherlands, Austria and in Germany .Andreas Hauer will visit the demonstration plant in Austria and report during the next Expert Meeting
 - Peak shaving: (Japan)
 - “HVAC with PCM storage in it”
 - A report was given during the 2nd Work Shop in Ljubljana, Slovenia.
Presentation of different applications of PCM for air conditioning has been given at the 3rd Work Shop in Tokyo, Japan. This includes ventilation systems for energy savings, thermal storage in ceiling systems, floor supply air conditioning systems
 - “Simulation of PCM storage system”
 - “Cityhall with PCM heater”
 - Stevenage Borough Council’s offices
 - Passive cooling utilizing cold night time air for comfort cooling. A joint English/Swedish project to be reported during the next Work Shop
- Temperature sensitive materials :(Spain, Luisa Cabeza)

- Report on the state-of-the art on PCM for temperature sensitive materials given during the 2nd Work Shop in Ljubljana, Slovenia.
A project was reported on transportation of fine art performed at ZAE-Bayern in cooperation with the German company Va-Q-Tec
 - “Blood transportation”
 - This is a project of Rubitherm GmbH. Results will be given at the end of the year 2002.
- Waste heat utilization: (Sweden, Viktoria Martin)
 - “Absorption chillers and energy storage”
 - A first report was given during the 2^{ne} Work Shop in Ljubljana, Slovenia. Now work is performed on a system study and on erecting experimental equipment.
 - “Cold transportation in liquid dessicants”
 - This case study will be finished by the end of 2002.
 - "Industrial waste heat utilization by transportation of PCM tanks"
 - A system utilizing sodium acetate tri hydrate for increasing the energy density in transportation of heat has been introduced by the company TransHeat. More information could be found on www.eurecaag.de/Trans/index.htm
 - “PCM applications in industry”
 - A report on this project is available, but only in the german language.
 - “Thermal management of solid oxide fuel cell systems”
 - This project is finished and a report will be given later
 - “PCM slurry systems”
 - A system utilizing tertiary ammonium salts forming a slurry with high energy density was presented during the 5th Work Shop of Annex 10 in Sue, Japan. A demonstration of this system was shown during the technical visit following the 3rd Work Shop of Annex 17 in Tokyo, Japan.
- Other projects
 - Introduction of thermal energy storage in a district cooling net in existing built environment
 - Usually in built environment space is as much a restriction as is money and technology. A feasibility study on introduction of thermal energy storage for increase of the capacity of an existing cooling net work is performed in Sweden with a case in Gothenburg

Cooperation with other organizations

It has been discussed to increase cooperation with other organizations namely

Solar and heating Program within the International Energy Agency (SHC)

Working Party on Ice-Slurries within the International Institute of Refrigeration (IIR)

Energy Storage and Transportation Network (ESTNET) proposed to the 6th Frame Work Program of the European Commission

This cooperation will be in the form of joint projects or tasks (SHC), invitation to meetings (IIR) and reporting of activities (ESTNET). Members of Annex 17 are among the initiators and are members of the governing board of ESTNET.

SHC have put forward a suggestion for a new task (Task 32) within SHC where experts from Annex 17 are anticipated to participate. The Operating Agent of Annex 17 will be in contact with J.C.Hadhorn, the Operating Agent of Task 32

ESTNET will have a meeting in January 2003 to discuss the content and organization of a Network of Excellence or an Integrated project within the 6th Framework Programme.

Budget

The cost of the research and development foreseen to be presented within Annex 17 exceeds 10 million Euro whereas the cost for the actual work in the annex (25% of the expert time plus traveling cost) in total is less than 400 000€. The budget will be updated and presented as an argument for countries to join the international cooperation in IEA.

Timeframe

Due to the fact that many projects that are a part of the Annex will not be finalized during the originally stated time frame it was decided to ask the Executive Committee for an extension of Annex 17 until 30th of June 2005, e.g. one year extension.

Homepage

A home page for the Annex could be found on www.fskab.com/Annex17. The website is sponsored by TEAPPCM (Australia), Rubitherm GmbH (Germany) and Climator AB (Sweden). The website is active. More than 40 countries and approximately 300 unique visitors visited the website during the month of December 2002.

In order to attract new countries the experts meetings and work shop will be located to countries that either have difficulties to attract enough attention on thermal energy storage within the country or are not members of IEA. In this way the cooperation and collection of information will be spread outside the members of the annex.

Upcoming meetings

- Indore, India, 2003-03-21--24.
- Warsaw, Poland, fall 2003, in connection with Futurestock Conference.
- Sweden, spring 2004.
- Beijing, China, fall 2004
- Turkey, spring 2005

National contacts

Germany: Andreas Hauer hauer@muc.zae-bayern.de

Japan: Motoi Yamaha yamaha@isc.chubu.ac.jp
Spain: Luisa Cabeza lcabeza@diei.udl.es
Sweden: Fredrik Setterwall fredrik.setterwall@telia.com
Viktoria Martin viktoria@ket.kth.se

PROPOSED ANNEXES

Annex 15. Electrical Energy Storage and the Integration of Renewables

Operating Agent: Alan Collinson, EA Technology, UK

Introduction

Electrical energy storage is widely recognised as a key emerging technology, likely to find widespread use within electricity generation, transmission, distribution and supply networks as well as other major industrial and commercial end user applications. The benefits of bulk energy storage applied to the increasing levels of embedded generation, especially from new and renewable sources, are being increasingly recognised. The Annex 15 proposal is focusing specifically on the issues of electrical energy storage and how it can be used to assist in the successful conservation of energy by the integration of new and renewable energy sources into existing electrical networks.

Key issues which will be addressed by Annex 15 include:

- the need for storage from a renewables perspective
- modelling of network/renewables/storage interaction
- implementation strategies for storage-based solutions
- the costs of storage
- the benefits of storage
- alternatives to storage

Annex 15 is seen as a key enabling mechanism in moving the application of energy storage to the integration of new and renewable energy sources significantly closer to market realisation. Key elements of this strategy include the modelling of the interaction between the electricity network and the energy source as well as producing targeted educational and promotional material to increase awareness of the growing potential of energy storage-based solutions.

Discussions at the ECES Executive Committee

The first proposal of Annex 15 as a follow on of Annex 9 was submitted by EA-Technology to the ExCo at the meeting XC47, November 1999, Berlin.

Several issues had to be clarified including:

- Interest of participation: the suggested workshop and kickoff meeting to identify the topics and interest of possible participants never took place.
- Requested common budget for the Operating Agent: cost sharing was hardly to finance.
- Overlap with other new activities: The Commission of EU established a network with research institutes and companies for the preparation of a joint European Programme on Electrical Energy Storage. Information was presented by the Lead person Philippe Malbranche, CEA, France

- At the Turnhout ExCo meeting some member countries like UK and Finland pointed out that their main interest on participation in the IA is the topic Electrical Energy Storage. It was decided that Phil Baker reviews the present status of interest and possible overlap with the EU-Programme before the next XC meeting and submit a proposal how to proceed for the next ExCo meeting in Norway, May 2003

Dr Alan Collinson, at

EA Technology,
Capenhurst Technology Park,
Chester,
UK,
CH1 6ES.

Tel: +44 (0)151 347 2396

Fax: +44 (0)151 347 2135

email: alan.collinson@eatechnology.com

www.eatechnology.com

or subscribe to the Annex 15 egroup at:

<http://groups.yahoo.com/group/electricalenergystorage>

Annex 16. Engineering textbook on thermal energy storage and renewable energy

Operating Agent: B. Nordell, Luleå University of Technology, Sweden

1. General information

One of the conclusions of Annex 8, **Implementing** Underground Thermal Energy Storage Systems (UTES) of ECES IA, was that an engineering textbook was needed for the wide spread utilization of UTES system. This textbook on Thermal Energy Storage (TES) would be used for technology transfer to engineers and consulting companies but also for teaching at engineering educations. The project should preferably be carried out within the framework of IEA.

The overall objective of the Annex is to write and disseminate an engineering textbook on Thermal Energy Storage and Renewable Energy. The target group should be engineering students and consulting engineers. The vision for a second stage of this annex is to develop an Internet course based on the textbook. One suggestion is to present the course in three levels of education: 1/ General. 2/ Engineering. 3/ Scientific.

The idea is to start from an existing Swedish textbook, which has been used at Luleå University of Technology for more than 15 years. The textbook was preliminary translated into English in 1998 as a subject of discussion for the Annex 8 experts. Environment Canada made additions and changes to the text while brushing up the language in 2001.

Bo Nordell (BN) presented a draft annex proposal at XC47 in Berlin, Nov 1999. The plan was to write the TES textbook during a three-year period to collect available data and knowledge from experts in participating countries.

The Executive Committee showed interest but the project was not approved because of different opinions in the funding of the Annex. Since then Annex 16 has been brought up at several XC meeting.

2. Activities for 2001

At XC51 in Paris, Oct 2001, the Executive Committee suggested that BN should take leadership, contact EU and look for the possibilities and deadlines etc. Some EU contacts had already been taken by some of the XC delegates, indicating that this project should have a good chance to get funding. One advantage was that Energy Storage was now defined in the EU program as target action K.

3. Next step

During the first half of 2002 a project proposal will be submitted to the Swedish Energy Agency. It will cover 12 – 15 man-months per year for the Swedish part of the UTES textbook project. The proposal will include possible IEA collaboration with ECES participants and other countries. This three-year project is planned to start in Jan 2003.

At the Turnhout ExCo meeting a recent publication of a book was mentioned which seems to represent already the planned textbook. Bo Nordell/Bjorn Sellberg were asked to figure out the situation and whether the proposal should be skipped.

New Activities

Marketing Underground Thermal Energy Storage (UTES)

In order to accelerate the deployment of the underground thermal energy storage technologies developed in the framework of this Implementing Agreement, the preparation of a new Annex on the marketing of these technologies is underway.

The objectives of this Annex are:

- to assess the most perspective applications (market segments) for UTES.
- to develop marketing strategies for these market segments.

The development of appropriate marketing tools might be part of this Annex, the marketing itself is considered the responsibility of private companies.

For more information contact office@ifinternational.com.

High Temperature Energy Storage

A new Annex on high temperature energy storage materials and techniques is planned. During the last Annex 17 workshop at least two applications for high temperature energy storage were discussed.

- One application was utilization of intermittent waste heat emissions from process industries (the example came from the steel industry). Encapsulated copper was used as storage media for this application.
- The second application was concentrated solar applications where several phase change materials for temperatures above 250 °C.
- High temperature applications for fuel cells have been discussed at previous meetings both in the executive committee and in the experts meetings of Annex 17

There will be a meeting on February the 17th in Munich about this planned annex. For more information contact hauer@muc.zae-bayern.de or fredrik.setterwall@telia.com.

Transportation of Thermal Energy Utilizing Thermal Energy Storage Techniques

In many cases the utilization of waste heat is not possible, because the potential consumer is not at the same location. Under certain boundary conditions the use of a thermal energy storage device or medium to transport heat from the source to the consumer can be economically interesting. Two examples were discussed at the last Annex 17 workshop:

- A German company, TransHeat, have developed a system whereby thermal energy is transported on trucks by utilizing sodium acetate as a way to increase the thermal density of the transported liquid.
- The company NKK Corporation Engineering Research Center presented during the fifth work shop of annex 10 in Tsu, Japan on the 12th-14th of April 2000 a pumpable

PCM-slurry based on a tertiary ammonium salt clathrate. The melting point of the slurry could vary between 0 and 12 °C depending on the concentration of the salt. The system was demonstrated during the workshop this year in the Yokohama-Hanasaki Building

For more information contact hauer@muc.zae-bayern.de or fredrik.setterwall@telia.com .

Appendices

APPENDIX 1 - PARTICIPANTS OF ECES IA

COUNTRY	CONTRACTING PARTY
Belgium	Ministry of Economical Affairs
Canada	Public Works Canada
CEC	Commission of the European Communities
Denmark	The Ministry of Energy
Finland	TEKES, Technology Development Centre of Finland
Germany	Forschungszentrum Jülich GmbH
Italy	ENEA , Governmental Energy Research Agency
Japan	The Heat Pump and Thermal Storage Centre of Japan
Spain	IBERDROLA, Madrid (Feb 1999)
Sweden	FORMAS
The Netherlands	NOVEM ³
Norway	The Research Council of Norway
Turkey	Cukurova University
UK	Department of Trade and Industry (DTI)
USA	US Department of Energy
Poland	Present status: Observer
IF Technology	Application for Sponsor Status, approved by the ExCo

IEA-Secretariat:

Responsible desk officer in CERT:

Until May 2002: Madeline Woodruff, afterwards Phil Harrington

³ withdrawn July 1, 2002

APPENDIX 2 -LIST OF PUBLICATIONS

Annex 12

SANNER, B. (ed.) (1999): High Temperature Underground Thermal Energy Storage, State-of-the-art and Prospects. - Giessener Geologische Schriften 67, 158 S., Giessen

Presentations on the possibilities and advantages of UTES were done on Sep. 2, 2002 in Thessaloniki (GR) and on Sep. 11, 2002, at a German-Turkish Seminar on Renewable Energies in Istanbul (TR); both papers by Sanner & Paksoy, see:

<http://www.uni-giessen.de/~gg1068/pdf-Dateien/Geothermie/Literatur/Gth-days02/igd-greece-2002-utes.pdf>

An overview over BTES was given by Annex 12 members at a conference in Waren, Germany, see: <http://www.geothermie.de/oberflaechnahe/waren-btes.pdf>

Final Report and State of the Art Reports Annex 12 and Annex 13: in preparation, will be published 2003

Annex 14

Proceedings of Workshops available on CD-ROM

- Richard Stockton College, Pomona NJ, USA October 25, 2002

Contact Prof. Halime Paksoy, Cukurova University Adana, Turkey: hopaksoy@mail.cu.edu.tr

Draft state-of-the-art report for Canada

Final state-of-the-art report for Japan

Final state-of-the-art report for Sweden

Final state-of-the-art report for Turkey

CD-ROM's containing papers presented at the First, Second, Third and Fourth Workshops

Internet site: <http://cevre.cu.edu.tr/annex14/>

Annex 17:

Proceedings of Workshops presented in internet of Annex 17 homepage:

www.fskab.com/Annex17

- Ljubljana, Slovenia: April 3-5, 2002
- Tokyo, September 30-October 2, 2002

APPENDIX 3 - LIST OF ANNEXES

Annex No.	Annex Name
	Closed Annexes
1	Large Scale Thermal Storage Systems Evaluation
2	Lake Storage Demonstration Plant in Mannheim
3	Aquifer Storage Demonstration Plant in Lausanne-Dorigny
4	Short-term Water Heat Storage Systems
5	Full-scale Latent Heat Storage Installations
6	Environmental and Chemical aspects of Thermal Energy Storage in Aquifers and Research and Development of Water Treatment Methods
7	Innovative and Cost-effective Seasonal Cold Storage Applications
8	Implementing Underground Energy Storage Systems
9	Electrical Energy Storage Technologies for Utility Network Optimisation
	Ongoing Annexes
12	High Temperature UTES
13	Design, Construction and Maintenance of UTES Wells and Boreholes
14	Cooling in All Climates with Thermal Energy Storage
17	Advanced Thermal Energy Storage Techniques Feasibility Studies and Demonstration Projects
	Proposed Annexes
15	Electrical Energy Storage and the Integration of Renewables
16	Engineering textbook on thermal energy storage and renewable energy
	New Activities
	Marketing of Energy Storage Systems
	High Temperature Thermal Energy Storage
	Transportation of Thermal Energy Storage

Previous Annexes

Annex 1. Large Scale Thermal Storage Systems Evaluation

Annex 1 was a technical and economic evaluation of various storage concepts presented by the participating countries. The results of this work formed the basis for subsequent Annexes. The final report was published in October 1981. The Annex was formally closed at the Executive Committee Meeting in April 1983. Participating countries: Switzerland (OpA), Belgium, CEC, Denmark, Germany, Sweden, USA.

Annex 2. Lake Storage Demonstration Plant in Mannheim

Annex 2 had the objective of developing a seasonal lake storage and to demonstrate the feasibility by the construction of a large-scale pilot plant in Mannheim, Germany. Construction of the plant was cancelled after failing to achieve an economic design.

Annex 3. Aquifer Storage Demonstration Plant in Lausanne-Dorigny

Annex 3 involved the design, construction and operation of a high-temperature aquifer storage in Lausanne-Dorigny. The storage consisted of a vertical well with horizontal drains. The project was commonly called SPEOS. Waste heat from a municipal facility was stored in summer and used for space heating and domestic hot water of a gymnasium. Collaboration involved seven countries and terminated in 1989. Participating countries: Switzerland (OpA), Denmark, USA, Sweden.

Annex 4. Short-term Water Heat Storage Systems

Annex 4 reviewed the theory, techniques and application of hot water storage systems and

produced a state-of-the-art report. It focused on various measures to maintain thermal stratification. The Annex was closed in 1988. Participating countries: The Netherlands (OpA), Germany, Sweden, USA

Annex 5. Full-scale Latent Heat Storage Installations

Annex 5 involved the installation and monitoring of latent energy storage installations with the objective of evaluating their technical and economic feasibility. The Executive Committee recommended reviewing the state-of-the-art of latent heat stores and a workshop was held in 1984 sponsored by the German Ministry for Research and Technology. As a result of the workshop recommendation to concentrate on monitoring pilot and demonstration plants to provide reliable performance data, an Annex on Full Scale Latent Heat Storage Installations was initiated in 1988. Germany has provided the Operating Agent. The Annex was terminated in 1992. Participating countries: Germany (Op. A), Sweden, USA.

Annex 6. Environmental and Chemical aspects of Thermal Energy Storage in Aquifers and Research and Development of Water Treatment Methods

Annex 6 dealt with the chemical and environmental aspects of thermal energy storage in aquifers. A major potential problem of aquifer energy storage is the scaling and clogging of wells and heat exchangers. To avoid these problems reliable and ecologically sound methods of water treatment are required. The development and testing of the chemical, microbiological and environmental effects of ground-water treatment methods were the objectives of Annex 6. The work was initiated in 1987 and extended through twelve experts meetings into 1993. The Netherlands provided the Operating Agent and nine countries participated. The Annex was formally closed by the Executive Committee in 1996. Participating countries: The Netherlands (Op. A), Canada, Denmark, Finland, Germany, Sweden, Switzerland, USA.

Annex 7. Innovative and Cost-effective Seasonal Cold Storage Applications

Annex 7 aimed to demonstrate innovative, energy efficient and cost-effective cold storage design for a variety of building types and industrial applications to encourage the adoption of cold storage as a standard design option. More specifically, it evaluated effective storage control and operating strategies; evaluated combined hot and cold storage for increased energy efficiency and cost-effectiveness; and conducted national market studies for the developed technologies. A planning workshop in Sweden initiated the work in January 1989 and the activities extended through eight experts meeting into 1993. The Annex was formally closed by the Executive Committee in 1996. Participating countries: Canada (Op. A), Germany, Netherlands, Sweden.

Annex 8. Implementing Underground Thermal Energy Storage Systems

Annex 8 aims to speed the introduction of Underground Thermal Energy Storage in the building, industrial and agricultural sectors. It will encourage the adoption of energy storage in standard project designs by developing procedures and tools based upon documented applications in different energy efficient systems. Screening and decision tools will be provided to ensure ecologically sensitive applications. The first experts' meeting was held May 1994 in Sweden. Participating countries: Sweden (Op. A), Belgium, Canada, Germany, Netherlands, Turkey, USA, Japan. Final report can be reached at [<http://www.sb.luth.se/~bon/bon/IEA/ax8report.html>]

Annex 9. Electrical Energy Storage Technologies for Utility Network Optimisation

Annex 9 will examine the potential role of electrical storage technologies in optimising

electricity supply and utilisation. It will identify and overcome barriers to widespread adoption of electrical energy storage technologies through successful demonstration projects. Annex 9 was proposed by EA Technology Limited of the UK as a result of the recommendations of the Energy Storage Strategy Workshop held in Montreal during January 1995. The annex started in June 1996. Participating countries: Canada, Germany, Netherlands, Sweden, UK (OpA), and USA.

Annex 10. PCM and Chemical Reactions for Thermal Energy Storage.

Annex 10 will examine the role and accelerate the introduction of phase change materials into energy systems in residential, commercial, industrial and agricultural sectors. It has been proposed by the Concordia University, Centre of Building Studies in Montreal as a result of the recommendations of the Energy Storage Strategy Workshop held in Montreal during January 1995. The Annex was approved by XC43 on December 1997. Participating countries: Bulgaria, Canada, Finland, Germany, Japan, Poland, Sweden (OpA) and Turkey. China is preparing its participation and Australia, France, India, Italy, the Netherlands, United Kingdom, and USA have shown interest in participation.

Ongoing Annexes

Annex 12. High Temperature UTES

Germany initially suggested Annex 12. Phase 1 of the annex was approved by XC43. This stage starts with a State-of-the-art review of HT UTES applications. It will be followed by a study in which the most promising applications and system concepts for HT-UTES are evaluated. The results will allow assessing the expected benefit of HT-UTES and justify a decision on phase II. Participating countries are not yet clear but Canada, Germany (OpA), Belgium, Sweden and the Netherlands have shown interest in the annex.

Annex 13. Design, Construction and Maintenance of UTES Wells and Boreholes.

Annex 13 is a result of the Energy Storage Strategy Workshop held in Montreal during January 1995. The annex was approved by XC43, December 1997. The objectives are to: Describe UTES drilling and exchange experiences of different technologies. Identify related problems in order to establish areas for further R&D. Work out guidelines connected to test drilling, well design and construction. Investigate the occurrences and arts of operational failures related to the well or borehole system and to work out preventive guidelines for monitoring, maintenance and rehabilitation measures. The following countries have shown interest in participation: Australia, Belgium, Canada, Germany, Italy, the Netherlands, Sweden, Switzerland, Turkey, and the U.S.

Annex 14. Cooling in All Climates with TES

This annex has been approved by the ExCo at 46th meeting in Lulea, Sweden in June 1999. Participants are Canada, Japan, Sweden and Turkey. The overall objective of Annex 14 is to employ research, development and feasibility studies to advance the prospects of cooling with TES technologies for applications within a variety of energy systems and climate conditions and to encourage their use as a standard design option. The Operating Agent is Cukurova University, Center for Environmental Research from Turkey. Phase I of the annex is planned to end in June 2001.

Annex 17. Advanced Thermal Energy Storage Techniques Feasibility Studies and Demonstration Projects

The objectives of this Task are to overcome technical and market barriers for introduction of long- (seasonal) or short-term phase change and chemical reaction thermal energy storage for energy savings and for reduction of peak demand of energy in buildings, agricultural and industrial applications. Specifically this will be achieved by the demonstration of thermal energy storage with phase change materials or chemical reactions in building materials, for cold and heat storage for comfort purposes, for long and short term storage in the food sector including the transportation of food and other temperature sensitive goods, for applications in industrial processes.

Proposed Annexes

Annex 15. Electrical Energy Storage and Integration of Renewables

This annex has been proposed to the ExCo at the 48th meeting in Berlin in November, 1999. It is a stated objective of this work to move storage systems towards commercial market implementation, via the mechanism of technology and applications demonstrators. Whilst it is beyond the scope of Annex 15 to implement an actual demonstration project, it is fully intended that much of the necessary groundwork will be covered within the project to make a demonstration project the next logical step in electrical energy storage system market development. Such a move towards market uptake will represent a significant advance in the application of storage systems, permitting their very real benefits in terms of improved integration of renewables to be realised. A Programme Definition Workshop will be held in Spring 2000 which will provide the platform for pulling together the Annex 15 participants.

Annex 16. Engineering Textbook on Thermal Energy Storage and Renewable Energy

This annex has been proposed to the ExCo at the 48th meeting in Berlin in November, 1999. The overall objective of the annex is to write and disseminate an engineering textbook on Thermal Energy Storage and Renewable Energy. The target group should be engineering students and consulting engineers. The vision for a second stage of this annex is to develop an Internet course based on the textbook. One suggestion is to present the course in three levels of education: 1/ General. 2/ Engineering. 3/ Scientific.