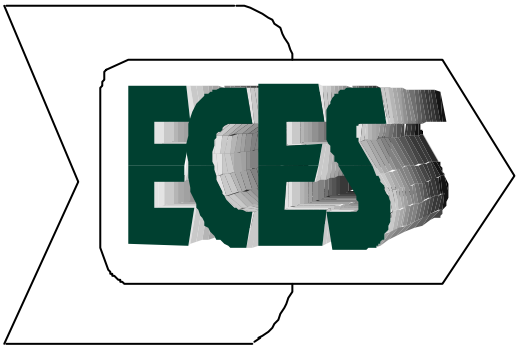
OECD/IEA
COMMITTEE ON ENERGY RESEARCH AND TECHNOLOGY
END-USE WORKING PARTY

Implementing Agreement on
Energy Conservation through Energy Storage

Annual Report 1999



May 2000

Prepared by:

Halime Paksoy & Hunay Evliya

Çukurova University
Center for Environmental Research
01330 Adana, Turkey
Tel/Fax: +90 322 338 6361
e-mail : cesam@cevre.cu.edu.tr

TABLE OF CONTENTS

INTERNATIONAL ENERGY AGENCY
ENERGY CONSERVATION THROUGH ENERGY STORAGE

Implementing Agreement

The Implementing Agreement (IA) started in 1978 and in the latest Executive Committee Meeting in Berlin it was decided to ask for an extension for another five years starting December 2000. It has now (1999) 14 members: Belgium, Canada, CEC, Denmark, Finland, Germany, Italy, Japan, The Netherlands, Spain, Sweden, Turkey, United Kingdom, USA. During the past year the Executive Committee has worked intensively to attract more countries to join the activities and to sign the Implementing Agreement. As a consequence Spain is the new member of the year and Australia, Bulgaria, China, France, India, Israel, Korea, Poland and South Africa have expressed interest to participate in the activities of the Implementing Agreement.

The Executive Committee has finished the work on preparation of the Strategy Plan for the period 1998 - 2003, which mainly will be an update of the present Strategy Plan (1994-1997).

According to the Strategy Plan the objectives for the IA are:

"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.

The Executive Committee had two meetings during the year. The first meeting was held in Lulea, Sweden in June and in Berlin, Germany, in November.

<u>The Lulea Meeting, June 1999</u>

The most important items and decisions of the Lulea meeting are outlined below.

- New chairman,vice chairmen and secretary were elected unanimously
- Approval of annual report 1998
- Approval of the secretariat cost based on three different levels
- Approval of the extension for the final report of Annex 8.
- Approval of all progress reports of ongoing Annexes (8, 9, 10, 12, 13)
- Approval of the start of the new Annex 14 (Cooling in all climates) Op.A. Turkey
- Encouragement to submit papers to Terrastock 2000
- Approval of the ECES Strategy Plan 1999-2003

- A group was formed to work on the homepage policy
- Brochure must be ready by November 1999

The Berlin Meeting, November 1999

The most important discussions and decisions are outlined below.

- The approval of the revised ECES IA
- New countries of interest, Poland was an observer at this meeting.
- Unanimously decided to ask for an extension for five years
- Approval of budget for fiscal year July 1,1999-June 30, 2000
- Decision on task definition phase for two annexes: Annex 15. Electrical energy storage and integration of renewables, Annex 16. Engineering textbook on thermal energy storage and renewable energy
- Approval of all annex reports and the extension of Annex 8
- Decision to have a joint ExCo meeting with IEA ECBCS IA on November 8, 2000 in Tokyo
- Final form of the marketing brochure of ECES will be ready for TERRASTOCK'2000 Conference
- Cukurova University Center for Environmental Research will be the web master for ECES homepage
- A committee is formed to make a proposal about the information policy of ECES.

CHAIRMAN'S REPORT

Halime Paksoy
Çukurova University, Turkey

Overview

The Implementing Agreement on (ECES) Energy Conservation Through Energy Storage started the new millenium with a very well organized Executive Committee Meeting in Berlin in November, 1999. A technical tour to the Reichstag Aquifer Thermal Energy Storage (ATES) Project was realized in conjunction with this meeting. The delegates of the Implementing Agreement were very proud to see that the efforts of German experts from ECES Annexes to introduce ATES concept to Germany have led to this magnificient project. I congratulate all the project team and Germany for pioneering an example project for the world. The executive committee in Berlin concluded on-going annexes and set a new definition and proposal for new annexes, introducing new information policy of ECES and decisions on request for extension of the Implementing Agreement term for another five years, as of December 2000. The meeting gave promises for a very active year with stronger collaboration.

The new millenium brought about some changes: A new chairman, a new secretary, as well as a revised Implementing Agreement with a common fund for the Implementing Agreement's Secretariat's extra cost.

Two successful annexes: Annex 8 "Implementing Underground Thermal Energy Storage Systems" and Annex 9 "Electrical Energy Storage" are coming to an end in 1999. Annex 8 was the source of the on-going Annexes 12,13 and 14. At the Future of Annex 8 Workshop many new ideas for annexes were brought up. One of these ideas Annex 16 "Engineering Textbook On Thermal Energy Storage and Renewable Energy" were proposed at the 47th Executive Committee Meeting in Berlin. Annex 9 is a first on electrical storage and broadens the scope of the Implementing Agreement. The new Annex 15 is proposed as a result of Annex 9. The final reports of Annex 8 and 9 will be submitted in the next Executive Committee Meeting.

Annex 12 "High temperature underground thermal energy storage" has concluded its Phase I and started Phase II. The new Annex 14"Cooling in all climates with thermal energy storage" initiated in 1999, carries a global perspective that aims to spread the area of thermal energy storage for cooling applications in the world.

Our Executive Committee has formed a committee, lead by Sweden to propose new information policy of the Implementing Agreement. This work may lead to a new online information platform.

A marketing brochure to increase the visibility of the Agreement is being prepared by The Netherlands with input fromdelegates and operating agents.

The number of countries who signed the Implementing Agreement reached 14 when Spain joined. We welcome Spain in our activities. The Executive Committee will continue its efforts to increase the number of participants.

New Activities

- Electrical energy storage and integration of renewables (United Kingdom)
- An online communication and information platform (Germany, Sweden, Turkey and United Kingdom)
- Engineering textbook on thermal energy storage and renewable energy (Sweden)
- Database formation and computer design (Sweden)

Internet Site

Updating of the internet site continues and new pages are added as needed. A calender for events in 2000 is the latest addition. In addition to the sections available to public, a password secured site for use of Executive Committee was added. The new address for the site is: http://cevre.cesam.cu.edu.tr/eces/

Coordination with Other Implementing Agreements

A joint ExCo meeting with ECBCS is going to be held in Tokyo, Japan on November 8, 2000. Annex 14 have also contacted other IEA activities about cooling and at the latest ExCo meeting a presentation about ECBCS and SHC activities about cooling were given. A workshop in collaboration with Solar Heating and Cooling Implementing Agreement is also being organized during TERRASTOCK'2000.

Conferences and Workshops

- Annex 14, Cooling in All Climates with Thermal Energy Storage, June, 1999,
- Antalya, Turkey
- Annex 8, Future of Annex 8, June 1999, Lulea, Sweden
- Annex 10, PCM and Chemical Reactions for Thermal Energy Storage, May 1999, Helsinki, Finland, October 1999, Benedictbauern, Germany
- Annex 13, Design, Construction and Maintenance of UTES Wells and Boreholes
- October, 1999, Westerville, Ohio
- 6th International Batteries for Utility Energy Storage Conference, Gelsenkirschen, Germany, September 1999
- TERRASTOCK'2000 8th International Conference on Thermal Energy Storage, 28 Aug - 1 Sept, 2000, Stuttgart, Germany
- IEA-Workshop Advanced Solar Storage Technologies for Low Energy Buildings, 30-31st August 2000, University of Stuttgart, Germany
- EESAT 2000 Electrical Energy Storage Systems Applications and Technologies, September, 2000, Florida, USA

Acknowledgement

I would like to thank Bjorn Sellberg, our former chairman and Bo Nordell, our former secretary for their very successful service and efforts that lead to revitalizing of ECES IA with new activities and countries. I would like to give special thanks to operating agents who have contributed to the preparation of this report.

ACTIVITIES

Workshops and Conferences

Workshops 1999

Annex 8, Future of Annex 8, June 1999, Lulea, Sweden

Annex 10, PCM and Chemical Reactions for Thermal Energy Storage, May 1999, Helsinki, Finland, October 1999, Benedictbauern, Germany

Annex 13, Design, Construction and Maintenance of UTES Wells and Boreholes
October, 1999, Westerville, Ohio

Annex 14, Cooling in All Climates with Thermal Energy Storage, June, 1999,
Antalya, Turkey

Conferences 1999

6th International Batteries for Utility Energy Storage Conference, Gelsenkirschen, Germany, September 1999

Planned Conferences and Workshops

TERRASTOCK'2000, 8TH Conference on Thermal Energy Storage, 28 Aug-Sept 1, 2000 Stuttgart, Germany

IEA-Workshop Advanced Solar Storage Technologies for Low Energy Buildings, 30-31st August 2000, University of Stuttgart, Germany

EESAT 2000, Electrical Energy Storage Systems Applications and Technologies, September 2000, Florida, USA

Annex 14, Cooling in All Climates with Thermal Energy Storage, November, 2000, Tokyo, Japan

Annex 10, PCM and Chemical Reactions for Thermal Energy Storage, November, 2000, Stockholm, Sweden

Annex 15 Electrical energy storage and integration of renewables, 25-27 October, 2000.

ON-GOING ANNEXES

Annex 8: Implementing Underground Thermal Energy Storage
Operating Agent: B. Nordell, Luleå University of Technology, Sweden

1. Introduction

Objectives
The general objective of Annex 8 is to conserve energy and improve the environment by speeding the introduction of Underground Thermal Energy Storage Systems (UTES) into the building, industrial, agricultural and aqua-culture sectors.

At the start the annex had four participants Canada, Germany, Netherlands and Sweden. Later on Belgium, Turkey, USA and Japan joined. Several more countries have shown interest by attending the experts meetings as observers (Australia, Denmark, Finland, Poland, Spain, and UK).

Subtasks
Originally the annex consisted of five sub-tasks:

1 Evaluation of Feasible UTESS Boundary Conditions (The Netherlands)
2 Environmental Screening and Community-Based Development (Canada)
3 Demonstration Projects (Germany)
4 Design and Analysis Tools (Sweden)
5 Technology Transfer to Appropriate Groups (Sweden)

Participants that joined the annex after the start in May 1994 participated in the original sub-tasks but were also given their own specific tasks. New participants with little experience of UTES (Turkey, Belgium, Japan) performed national potential of UTES (economy, geology etc.) of their countries:

6 UTES Potential in Turkey
7 UTES Potential in Belgium
8 UTES Potential in Japan

The USA contributed considerably to the subtask Technology Transfer by sharing experience from the Geothermal Heat Pump Consortium (GHPC) work.

Duration
Initially Annex 8 was planned for five years (from May 1994). Later this schedule was changed to three years to follow the time schedule of ECES IA. When the IA was extended in Annex 8 went back to its original time schedule.

2. Activities in 1999

During 1999 the final annex 8 meeting was held on 10-11 June at Storforsen, Sweden. During the following day a workshop was held on the future of Annex 8 where different scenarios for a continued Annex 8 were discussed and also new annex ideas emanating from discussions within the experts' group.

Annex 6 – 7 resulted in Annex 8, which was a great network for information exchange. It was group for fruitful discussions on new applications and systems. This network was helpful for new countries in starting up new projects. The Annex group collaborated with other annexes within ECES IA but also with other IAs. Annex 8 initiated three new annexes:

- Annex 12, High Temperature UTES (HT UTES)
- Annex 13, Design, Construction and Maintenance of UTES Wells and Boreholes
- Annex 14, Cooling in All Climates with TES

Indirectly Annex 9 on Electrical Energy Storage and Annex 10 on Phase Change Materials were started because of Annex 8.

It was concluded that the Annex 8:
- Made UTES known
- Helped in implementation
- Disseminated information
- Collected and evaluated models, systems etc.

It was also found that this work had been successful and important in speeding the UTES development in participating countries.

Several suggestions were discussed to organise continued work. A new UTES centre "Thermal Energy Storage Documentation and Information Network" was seen as the natural continuation of Annex 8. Other names were also suggested: "TES for Agenda 21" and "TES Information and Outreach Program". Part of the work should include:
- Education
- Technology Transfer
- Workshops on Specific Topics
- Subtask to find sources for funds

For the continued work five different areas were defined. It was also suggested that some of the experts would write annex proposals in these areas for future discussions within ECES IA. These areas and experts were:
- UTES Textbook (B Nordell): The idea was to write a comprehensive textbook on UTES. The target group was engineering students and consulting engineers. This textbook would be based on a Swedish textbook that has been used at Luleå University of Technology during the last fifteen years.
- Database and Computer Design (G Hellström). Continued work on evaluation and testing of available models. Databases for important UTES data should be made available via Internet or CD.

- Marketing Activities and Industrial Collaboration (G Bakema).
- Technical Innovation and New Development (M Reuss).
- Legal & Environmental Aspects (O Andersson).

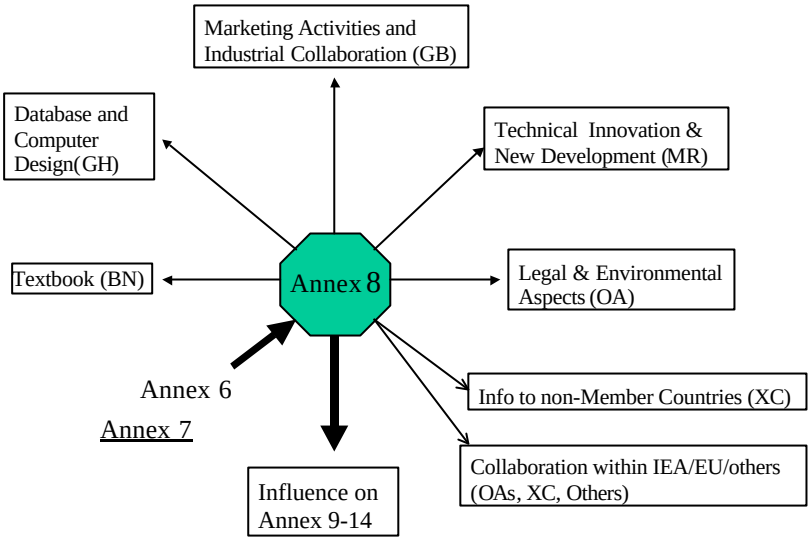


Figure. Annex 8 – influences and outcome.

Some of these annex proposals were presented at the ECES Executive Committee Meeting in Berlin . The outcome of the discussion was summarised in graphic form as shown by Fig. 1.

After the final Annex 8 meeting the final report to the ECES IA Executive Committee was still to be completed. This report would summarise the history and result of the annex was not completed during 1999. Some of the material necessary to finish the work was not delivered.

3. Work planned for 2000

The plan for 2000 means that final Annex 8 report to the Executive Committee will be presented at the autmn meeting in Tokyo, Nov 2000.

The work on the future annex proposals that were initiated att the Future Annex 8 workshop will continue but outside of the Annex 8 organisation. Since this work is performed by the Annex 8 experts there will still be some collaboration.

4. Publications in 2000

The final Annex 8 report is the only planned publication during 2000. Then of course a large number of UTES papers will be presented in August at Terratstock´2000.

5. 1994-1999 Experts Meeting

There was one Experts' Meeting during 1999, the final meeting in Sweden. All meeting are listed in the Table 1.

Table 1. Annex 8 Expert's Meetings

XM	*Location*	*Date*	*No. Experts*	*Participating countries*
1.	Uppsala, Swe	4-6 May 94	13	Swe,Ger,Can,NL + Fin,Bel
2.	Arnhem, NL	7-9 Nov 94	11	Swe,Ger,Can,NL + UK,Bel

3.	Freising, Ger	25-27 Apr 95	10	Swe,Ger,Can,NL + Bel,Tur
4.	Adana,Tur	13-15 Nov 95	10	Swe,Ger,Can,NL,Bel,Tur + USA
5.	Halifax, Can	10-11 Jun 96	12	Swe,Ger,Can,NL,Bel,Tur,USA + Jap
6.	Leuven, Bel	27-29 Nov 96	15	Swe,Ger,Can,NL,Bel,Tur,USA + Jap,Fin
7.	Sapporo, Jap	13-14 Jun 97	18	Swe,Ger,Can,NL,Bel,Tur,USA,Jap,A + Pol
8.	Pomona, NJ, USA	23-24 Mar 98	13	Swe,Ger,Can,NL,Bel,Tur,USA,Jap + Pol
9.	Warsaw, Pol	17-19 Nov 98	14	Swe,Ger,Can,NL,Bel,Tur,USA,Jap + Pol,Den
10.	Luleå, Sweden	10-12 Jun 99		Swe,Ger,Can,Nl, Bel,Tur,Jap + Spa

6.National Contacts

The national contacts persons are listed below.

Bo Nordell, Operating Agent Water Resources Engineering Luleå University of Technology SE-97187 Luleå, SWEDEN	tel: +46-920-91000 (or 91646) fax: +46-920-91697 Bo.Nordell@sb.luth.se http://www.sb.luth.se/^bon
Göran Hellström, Secretary Department of Mathematical Physics Lund University of Technology P.O. Box 118 SE-22100 Lund, SWEDEN	tel: +46-46-222-9091 fax: +46-46-222-4416 Goran.Hellstrom@shogun.matfys.lth.se "Göran Hellström" <neo.energy@swipnet.se>
Olof Andersson VBB VIAK AB Geijersgatan 8 S-21618 Malmö, SWEDEN	tel: +46-40-167-214 fax:+46-40-154-347 Olof.Andersson@sweco.se
Burkhard Sanner Inst. f. Applied Geosciences University of Giessen Diezstrasse 15 D-35390 Giessen, GERMANY	tel:+49-641-99-36124 or -36100 fax:+49-641-99-36109 Burkhard.Sanner@geolo.uni-giessen.de
Manfred Reuss Technische Universität München Bayerische Landesanstalt für Landtechnik Vöttingerstr. 36 D-85354 Freising, GERMANY	tel: +49-816-171-3462 fax:+49-816-171-4048 reuss@tec.agrar.tu-muenchen.de
Dorota Chwieduk KAPE, National Energy Conservation Agency 35/41 Nowogrodzka Str, XII floor 00-651 Warsaw, POLAND	tel: +48-22-622-2797 fax:+48-22-622-4392 Dorota Chwieduk <kape3@poczta.pol.pl>
Frank Cruickshanks Environment Canada Environmental Conservation Branch 45 Alderney Drive Dartmouth, Nova Scotia B2Y 2N6, CANADA	tel: +1-902-426-6885 fax: +1-902-426-4457 Frank.Cruickshanks@ec.gc.ca

Guido Bakema IF Technology b.v. Frombergstraat 1 P.O. Box 605 6800 EA Arnhem, NETHERLANDS	tel: +31-26-4431-541 fax:+31-26-4460-153 office@IF-tech.nl http:WWW.xxlink.NL/IF-tech
Halime Paksoy Çukurova University Faculty of Arts and Sciences Chemistry Department 01330 Adana, TURKEY	tel:+90-322-338-6081 fax:+90-322-338-6070 hopaksoy@mail.cu.edu.tr
Hunay Evliya Çukurova University Centre for Environmental Research Chemistry Department 01330 Adana, TURKEY	tel: +90-322-338-6361 fax: +90-322-338-6361 evliya@mail.cu.edu.tr
Katsunori Nagano Dept. Environmental Engineering Faculty of Engineering Hokkaido University N13-W8, Kita-ku, Sapporo, 060 JAPAN	Tel: +81-11-706-6285 fax: +81-11-706-6285 nagano@eng.hokudai.ac.jp
Kiyoshi Ochifuji, delegate Division of Urban Environmental Engineering Graduate School of Engineering Hokkaido University N13-W8, Kita-ku Sapporo, 060-8628 JAPAN	Tel:+81-11-706-6280 fax:+81-11-706-7890 ochifuji@eng.hokudai.ac.jp
Lynn F. Stiles Richard Stockton College of New Jersey Natural Sciences and Mathematics Route 575, Pomona New Jersey 08240, USA	tel: +1-609-652-4677, fax:+1-609-652-4972 or 748-5515 LYNN.STILES@STOCKTON.edu
Paul Dirven Vlaamse Instelling voor Technologisch Onderzoek, VITO Boeretang 200 B-2400 Mol, BELGIUM	tel: +32 14 335 913 (5511) fax:+32-14-321-185 dirvenp@vito.be

ON-GOING ANNEXES

Annex 9: Electrical Energy Storage Technologies for Utility Network Optimization (Phase 2)

Operating Agent: J.N.Baker, EA Technology, United Kingdom

1. Introduction

The follow on, Phase 2, work programme for Annex IX was unanimously voted into force at the 43rd Executive Committee meeting, held at IEA Headquarters, Paris, France, 4th-5th December 1997. The work programme itself had previously been worked up in a process of detailed consultation with the previous (Phase 1) participants, during the latter half of calendar year 1997.

The original (Phase 1) work programme was concluded, December 1997, and the original planning called for a smooth transition to Phase 2, with immediate effect, from January 1998 on. However, in practice, many of the original participant set quite correctly wished to appraise the outputs from the first phase of the work, prior to committing to the follow on programme. This therefore led to the actual start of Phase 2 being re-scheduled until March 1998 and, even then, with it being undertaken on a part risk basis, in the absence of formal contractual commitments, from the full participant set. Once started, however, this seemed to encourage further participation and eventually contractual arrangements were concluded with the organisations as described in 2 below. At this stage further organisations would still be welcome to join.

2. Participation

Countries joining with EA Technology and the UK as participants are:-

Canada	Hydro Quebec
Germany	EUS GmbH
Netherlands	Kema T&D, Novem
Sweden	Elforsk
Finland	Helsinki University of Technology
Spain	Iberdrola
USA	Dep. of Energy (Sandia National Laboratories), ILZRO

3. Work Programme

The main activities to date have concentrated on conducting the essential preparatory groundwork, associated with the retrospective applications case studies, the forward looking project definitions, the collation/dissemination of information and the identification/initiation of complementary R&D

programme activities. The first participating agents' meeting was held at Chester in June preceding the EESAT '98 conference. The second was held on 5th October 1998, co-incident with the Energy Storage Association's Fall meeting in Atlanta Georgia, USA and the American Superconductor Power Quality Workshop on the 8 October.

There has been some difficulty in obtaining some of the information for subtask 1 and 2, which has led to a small adjustment in the timescales for completing these tasks. This has been discussed with, and agreed by the Annex participants and is not expected to affect the complete programme timescale.

A plan to improve communications between the operating agent and participants involving better use of electronic mail and telephone conferencing is to be put into operation

ON-GOING ANNEXES

Annex 10. Phase Change Materials and Chemical Reactions for Thermal Energy Storage. Operating Agent: F. Setterwall, Royal Institute of Technology, Stockholm, Sweden.

1. Introduction

Annex 10 was approved during the Executive Committee meeting in Paris 4-5 of December 1997. It was decided that the Department of Chemical Engineering and Technology at the Royal Institute of Technology in Stockholm, Sweden should act as Operating Agent. The Annex will be in operation for at least 3 years.

The general objective of Annex 10 is to solve technical and market problems for a better market opportunity for thermal energy storage systems utilising Phase Change Materials (PCM) or chemical reactions in the building, the agricultural and the industrial sector. The aim is to broaden the knowledgebase and disseminate information. The Annex 10 work will result in accomplished/initiated case studies and demonstration projects related to potential fields of application. This will be accomplished in close co-operation with manufacturers, utilities, users and governmental organisations involved in dissemination of energy technologies.

Participants in the annex are Canada, Finland, Germany, Japan, Sweden and Turkey. Several other countries have shown interest in Annex 10, mainly Bulgaria, China, India, Poland, United Kingdom and USA.

2. Activities during 1999

During the year two experts meetings have been held combined with technical workshops. The first meeting was held in Helsinki, Finland on the 26th to 28th of May. The workshop was combined with a technical visit to the laboratory of the Finnish expert at the Helsinki Technical University showing the test facilities for indoor climate utilizing Phase Change Materials for energy savings and peak shifting. The 20 participants were from Canada, Finland, Germany, Japan, Sweden and Turkey. During the workshop was presented results from ongoing research in the participating countries of the annex. In total 7 presentations were made. The authors were from Finland (1), Germany (2), Japan (1) and Sweden (1)

The second meeting was held in Benedictinerbeuer outside Munich, Germany on the 27th to 29th of October. The 30 participants came from Canada (1), Finland (1), Germany (18), Japan (3), the Netherlands (1), Spain (1), Sweden (3) and Turkey (2). 10 presentations were made with 7 from Germany, 2 from Japan and 1 from the Netherlands.

The State-of-the-art reports over activities in the participating countries have been updated. The reports include information about and description of active research groups and companies that are producing or using thermal energy storage. It also gives contact information to the research groups and companies as well as their recent publications.

An Internet site has been produced. There will be a link to a special page labelled "Companies dealing with PCM and chemical reactions for thermal energy storage". On this page you can find links to homepages of the companies. The same will apply to universities and research institutes. All companies or other organisations that wants to be linked to the Annex 10 homepage will be allowed to join in return they will be asked to have a link to the Annex 10 homepage on their internet site. There will also be links to other Implementing Agreements or annexes related to annex 10, e.g. Heat Pumping Technologies, Solar Energy, Buildings. The homepage can be found at http://www.ket.kth.se/Avdelningar/ts/annex10/

Databases on materials properties and on literature references have been made as well as fact sheets on demonstration projects and on case studies performed within the annex.

A marketing brochure has been published in the beginning of 1999. It contains a description of Thermal Energy Storage by Phase Change Materials and by Chemical Reactions as well as information on the scope and work of the annex and some general information on IEA and on the Implementing Agreement on Energy Conservation through Energy Storage.

3. 2000 Experts meeting

During the year 2000 experts meetings and workshops are planned for Japan in April and for Stockholm in November

4. National contacts

Canada	Prof. Dimitri Procos, Dalhouise University, Box 1000, Halifax, NS, B3J2X4 Canada
Finland	Kai Siren, Helsinki Technical University, Box 4400, 02015 HUT, Finland
Germany	Andreas Hauer, ZAE Bayern, Dept 4, Box 440254, D – 80751 Munich, Germany
Japan	Prof. Kazunobu Sagara, Mie University, Kamihama-Cho 1515, TSU 514, Japan
Sweden	Fredrik Setterwall, Royal Institute of Technology, S – 10044 Stockholm, Sweden
Turkey	Halime Paksoy,Cukurova University, 01330 Adana, Turkey

ON-GOING ANNEXES

Annex 12. High Temperature Underground Thermal Energy Storage
Operating Agent; Burkhard Sanner, Giessen University, Germany

1. Introduction

The new annex on " High Temperature Underground Thermal Energy Storage (HT UTES)" Phase 1, was approved at XC43, December 1997.

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-systems concerned shall be confined to Aquifer Storage (ATES) and Duct/Borehole Storage (DTES).

High Temperature in this annex refers to minimum storage loading temperatures on the order of 50 °C. Storage may be from short term (diurnal) to long term (seasonal), whereas "seasonal" requires the store to yield energy recovery at least three month after end of the loading period.

2. Workplan

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

Phase I (1.1.1998 - 30.6.1998)
State-of-the-art-review, system opportunities (from energy system side).

Phase II (1.1.1999 - 31.12.2000)
Long-term perspective and scenarios, environmental impact/benefits, development of design tools, improvement in water treatment, choice of material suited for high temperatures, and development of test equipment, HT demo projects, design guidelines.

The results shall be:

Phase I:
Evaluation and summary report of previous activities (state-of-the-art-report) and a report on R&D needs and opportunities and recommendations for Phase II

Phase II:
Ecobalance, annual reports, workshops, test equipment, design guide-lines / tools

Participating Countries are Belgium, Canada, Germany, Netherlands, Sweden, Turkey (not all yet confirmed); Operating Agent is Germany.

The work started in January 1998, a first Expert's Meeting was held in Giessen, Germany, on June 17, 1998; a workshop and the second expert's meeting is scheduled for October 14-16, 1998, in Lund, Sweden. Report to XC45 in USA, December 1998

ON-GOING ANNEXES

Annex 13. Design, Construction and Maintenance of UTES Wells and Boreholes
Operating Agent: Olof Andersson, Lund Institute of Technology, Sweden

1. Introduction

Most UTES (Underground Thermal Energy Storage) concepts incorporate drilling one way another. Furthermore some concepts are highly dependent on a proper well or borehole efficiency to have an optimal operational performance. Based on these statements, the main objective with the Annex is to make UTES technically safer and more cost effective.

This annex will cover aspects of testdrilling, well and borehole design, construction and monitoring and maintenance of UTES applications. The main target is set upon aquifer and borehole systems (in some countries refereed to as ”open” and ”closed or duct” systems).

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

- How to gain accurate 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)

Except the guidelines, the final result will also contain a report that describes identified areas or subjects that need further research and development.

The Annex is planned to be finalised at the end of year 2001.

2. Activities 1999

The annex was planned during 1997 and eventually approved by the 43rd EXCO Meeting in Paris 4-5 of December 1997. During 1997 the following events have been executed

- The 3rd Expert Meeting in Appenzell, Switzerland, March 17-19
- The 4th Expert Meeting in Westerville, Ohio, USA, October 6-8

3. Achievements

All together ten countries have been represented in the Annex during the year 1999. These are Belgium, Canada, Denmark, Germany, Japan, Netherlands, Sweden, Switzerland, Turkey and USA.

During the expert meetings, state-of-the-art information has been presented covering all subtasks.

In general the organisation and co-ordination of the work has suffered from an unbalanced input of information. The reason for this is that several countries have had difficulties to obtain financial

support for the work. As a result, the work with the state of the art has progressed slower than planned. However, the quantity and quality of information input has been accurate to fulfil the Annex goal.

The publications from the Annex are restricted to Minutes from the Expert Meetings. These contain documentation from 35 presentations.

4. Workplan for 2000

The Annex will continue to work with the state of the art reports and the evaluation of material.

Two new Expert Meetings are planned where the state of the art and the evaluation stages shall be finalised and the work with guidelines and R and D issues be started. The first final state of the art reports are expected to be ready at the very end of the year.

The Annex work will also be presented on several conferences related to the drilling industry and at Terrastock 2000 in Stuttgart.

5. Contact persons

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)
- Sweden, Olof Andersson (olof.andersson@sweco.se)
- Turkey, Halime Paksoy (hopaksoy@mail.cu.edu.tr)
- USA, Jeff Spitler (spitler@osuunx.ucc.okstate.edu)

Two more countries are involved as observers. Contact persons for these are

- Denmark, Stig Sørensen (emcon@post10.tele.dk)
- Switzerland, Stefan Berli (foralith@foralith.ch)

ON-GOING ANNEXES

Annex 14. Cooling in All Climates with Thermal Energy Storage.
Operating Agent: Halime Paksoy, Çukurova University, Adana, Turkey.

1. Introduction

Annex 14 "**Cooling in all Climates with Thermal Energy Storage"** has started operation within the International Energy Agency (IEA), Implementing Agreement on Energy Conservation through Energy Storage (ECES IA) after being approved by the Executive Committee at the last (46th) Executive Committee Meeting of ECES IA in Lulea, Sweden on June 14-16, 1999. Cukurova University Centre 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 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 resource by stimulating the expanded use of TES in innovative, energy efficient and cost-effective projects in participating countries.

Subtasks

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

Duration

July 1999 – December 2000

2. Activities in 1999

Annex 14 First Workshop was held in Antalya, Turkey on the 4-5 June, 1999. The workshop was sponsored and organized by Çukurova University Center for Environmental Research and Turkish Scientific Research Organization (TÜBÝTAK). There were 18 participants from Canada, Germany, Israel, Japan, Sweden and Turkey. 8 papers were presented in two sessions on June 4th from Universities and Companies. The proceedings of the workshop has been produced on a CD ROM by Çukurova University Center for Environmental Research and distributed to the participants.

Annex 14 text was prepared based on the results from the panel discussion that was held on June 5th during the workshop.

First Experts Meeting was held on 5-6 November 1999 in Sundsvall, Sweden hosted by Lulea University of Technology. A technical tour to the Hospital Snow Storage Project, which is the first project of its kind in the world at Sundsvall was also organized. This project can be a demonstration project for Annex 14.

Op. A prepared a webpage for Annex 14 with address http://cevre.cu.edu.tr/annex14/.

A discussion group for Annex 14 participants on the internet is also started by the Operaring Agent. The purpose of this group is to enhance the communication in between the Experts' Meetings.

3. Workplan for 2000

December 1999 – June 2000

- Develop and evaluate criteria for the determination of the boundary conditions of technically and financially feasible cooling with TES applications
- Evaluate possible sources of cold to determine which sources of cold are most applicable to cooling with TES in different climates
- Evaluate and modify existing planning and engineering tools for the analysis, modelling and verification of cooling with TES
- Draft state-of-the-art-report

June 2000 – December 2000

- Final state-of-the-art-report

4. Publications in 1999

- Draft state-of-the-art report for Canada
- Draft state-of-the-art report for Japan
- Draft state-of-the-art report for Sweden
- Draft state-of-the-art report for Turkey
- Annex 14 First Workshop, June 4-5, 1999, Antalya, Turkey, CD-ROM containing papers presented at the workshop

5. 1999 Experts' Meeting

- November 5-6, 1999 in Sundsvall, Sweden hosted by Lulea University of Technology and Sweco

6. 2000 Experts' Meetings

- April 6-7, 2000 in Halifax, Canada
- August 2000 in Stuttgart, Germany
- November 9-10 in Tokyo, Japan

7. National Contacts

Sweden

Bo Nordell
Water Resources Engineering
Luleå University of Technology
SE-97187 Luleå, SWEDEN
Tel: +46-920-91646
Fax: +46-920-91697
Bo.Nordell@sb.luth.se

Kjell Skogsberg
Water Resources Engineering
Luleå University of Technology
SE-97187 Luleå, SWEDEN
Tel: +46-920-91496
Fax: +46-920-91697
Kjell.Skogsberg@sb.luth.se

Fredrik Setterwall
Dept. of Chemical Engineering
and Technology
DIV. of Transport Phenomea
Royal Institute of Technology
100 44 Stockholm, Sweden
Fax: +46 8 10 52 28
setter@chemeng.kth.se

Olof Andersson
VBB VIAK AB
Geijersgatan 8
S-21618 Malmö, SWEDEN
tel: +46-40-167-214
fax: +46-40-154-347
OLOF.ANDERSSON@sweco.se

Bo He
Transport Phenomena
Dep. of Chemical Engineering and Technology
Royal Institute of Technology
Stockholm, SwedenTel. +46 8 7909480
Fax. +46 8 105228
bohe@ket.kth.se

Göran Hellström
Department of Mathematical Physics
Lund University of Technology
P.O. Box 118
SE-22100 Lund, SWEDEN
Tel: +46-46-222-9091 (alt 188-660)
Fax: +46-46-222-4416
"G.Hellström" neo.energy@swipnet.se

Japan

Motoi Yamaha
Associate Professor, Dr. Eng.
Department of Architecture,
College of Engineering
Chubu University
1200 Matumotocho-cho, Kasugai,
Aichi 487-8501, Japan
Phone : 81 568 51 1111 ext. 2464
Fax : 81 568 52 0134
yamaha@isc.chubu.ac.jp

Tadahiko Ibamoto
Professor, Dr. Eng.
Tokyo Denki University
2-2 Kanda-nishiki-chou, Chiyoda-ku,
Tokyo 101-8457, Japan
Phone : 81 3 5280 3429
Fax : 81 3 3294 3264
ibamoto@env.a.dendai.ac.jp

Canada

Frank Cruickshanks
Environment Canada
Environmental Conservation Branch
45 Alderney Drive Dartmouth
Nova Scotia B2Y 2N6, CANADA
tel:+1-902-426-6885
fax:+1-902-426-4457
Frank.Cruickhanks@ec.gc.ca

Edward Morofsky
PWGSC, A&ES Technology
Manager RDD
Place du Portage
Phase III, 8B1
Hull, Quebec K1A 0S5, CANADA
tel: +1-819-956-3419
fax: +1-819-956-3400
MOROFSKE@PWGSC.GC.CA
RDDI@TECH-ENV.COM

Turkey

Derya Dikici
Çukurova University
Faculty of Arts and Sciences
Chemistry Department
01330 Adana, Turkey
Tel: +90-322-338-6418
Fax: +90-322-338-6070
ddikici@mail.cu.edu.tr

Hunay Evliya
Çukurova University
Faculty of Arts and Sciences
Chemistry Department
01330 Adana, Turkey
Tel: +90-322-338-6418
Fax: +90-322-338-6070
evliya@pamuk.cc.cu.edu.tr

Halime Paksoy
Çukurova University
Faculty of Arts and Sciences
Chemistry Department
01330 Adana, Turkey
Tel: +90-322-338-6418
Fax: +90-322-338-6070
hopaksoy@mail.cu.edu.tr

Bekir Turgut
Çukurova Üniversity Centre for Environmental
Research 01330 Adana, Turkey
Tel:90 322 3386084-2998
Fax: 90 322 3386361
annex14@mail.cu.edu.tr

PROPOSED ANNEXES

Annex 15. Electrical Energy Storage and the Integration of Renewables

Alan Collinson, EA Technology, UK

1. 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. In 1996, the developing interest in electrical energy storage resulted in the establishment of a collaborative work programme under the auspices of the International Energy Agency (IEA) Implementing Agreement on Energy Conservation through Energy Storage (ECES). Identified as Annex 9 of that agreement, it involved the participation of Governmental and non-Governmental organisations in the UK, US, Canada, Germany, Netherlands, Sweden, Finland and Spain.

The benefits of bulk energy storage applied to the increasing levels of embedded generation, especially from new and renewable sources, are being increasingly recognised. Annex 15 is a natural development borne out of the previous Annex 9 work programme, 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.

Aims & Objectives

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.

Work Programme Definition Workshop

A Programme Definition Workshop will be held in Spring 2000 which will provide the platform for pulling together the Annex 15 participants. The workshop will also provide prospective participants with a direct opportunity to shape the detail of the Annex 15 work programme. Whilst the detail of the work programme will be defined at the workshop, 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

Timescales:

Workshop: *"Electrical Energy Storage and the Integration of Renewables"* To take place April/May 2000, venue: major European City

Annex 15: Work Programme to be presented at 48th Executive Committee meeting, with a view to commencing the project in July 2000.

Benefits

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.

For further information, contact the project manager, Dr Alan Collinson, at

EA Technology, Capenhurst, Chester, UK, CH1 6ES.
Tel: +44 (0)151 347 2396
Fax: +44 (0)151 347 2135
email: abc@eatl.co.uk
www.eatechnology.com

More information on this initiative will also soon be available on the ECES Website at:-

http://cevre.cu.edu.tr/eces/

PROPOSED ANNEXES

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

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

Background

Thermal energy storage has, during the last few decades, grown from small-scale pilot tests to an important technology for the future. It is benign to the economy and the environment and it is the key technology for the large-scale utilisation of renewable energy sources. A number of countries are collaborating within the framework of IEA, in the Energy Storage Implementing Agreement (ECES IA), to develop and to speed-up the introduction of these technologies.

The status of the energy storage technologies varies in different countries. In most countries it is never considered but in some countries it is a natural option for space heating and space cooling. There are many reasons for this difference but one conclusion drawn by the experts of Annex 8 (ECES IA) was that lacking engineering education is one explanation.

Even in countries where energy storage technologies are commonly used only a few experts know how to design the systems. To speed-up the extended use of energy storage technologies the design procedures must be included in engineering education. There is a demand of a good textbook to disseminate the knowledge now concentrated at a few institutes and companies. We have only found one textbook – in Swedish and at Luleå University of Technology for 15 years now. The intention of this annex is to use this existing text as a basis for a new improved and extended textbook in English for engineering students and consulting engineers. As a second stage of this annex we have the vision to develop an Internet based course on energy storage.

Objectives

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.

Means and Activities

The new textbook will be written in English. It will be based on an already existing textbook[1] originally written in Swedish and used at Luleå University of Technology (LTU) The LTU course has been given during the final (5th) year in civil engineering for almost 15 years.

The Swedish textbook was translated into English during the spring of 1999. This was made to enable international collaboration in rewriting and updating the current book to meet requirements in different countries. Consequently, given examples must picture the situation in different countries and climates. Environmental benefits of the technology must be included.

In the new textbook different technologies should be described as part of a system. Simple design rules, detailed design calculations and modelling should be treated.

Definition of the potential reader groups
As a first step the potential readers must be defined. Should the content be divided into different levels of information? General, Engineering and Scientific information?

Detailed list of contents
During the second step the content or the scope of the textbook will be defined. What kind of renewable energy sources should be included? Thermal or/and other types of renewable energy?

At this stage we also have to decide which types of storage systems that should be treated. Seasonal storage and short-term storage? Thermal storage and PCM? Underground storage? Geothermal energy? ATES, BTES, CTES? Snow Storage?

Review of current literature
So far we have not found any other textbook covering our field of interest but there are of course many textbooks and papers with vital information for the annex, e.g. environmental aspects must be considered. For this we have to define keywords for a literature search, perform the search and also collect information from the participating group of experts.

Layout
The layout of the textbook should be decided before the actual work of writing starts. It is of great importance that everybody engaged has a vision of the final work.

Writing and Proof-reading
Most of the available project time will be spent on writing and proof reading. Here we should also find good pictures of current projects to be included in the text. This part requires electronic communication to speed-up the process.

During this stage of the annex we must make good design problems to be solved by the reader. These problems must be relevant in different countries and climates.

[1]/ Nordell B, Söderlund M (1998). Natural Energy Sources and Energy Storage. 2nd revised edition. Department of Environmental Engineering, Luleå University of Technology. Sweden. pp. 132.

At the end of this task we also have to consider next stage of the annex, the development of an Internet course based on the textbook.

Project Management and Reporting

It is proposed that the work of the Annex is carried out on a task-share basis. The proposed organisation structure is shown in Figure 1. The Operating Agent will have a stronger position than what is normally the case in most other annexes. This is because of the very special project.

A good textbook requires an all-pervading style. Nevertheless the experts are of utmost importance for the result of the annex.

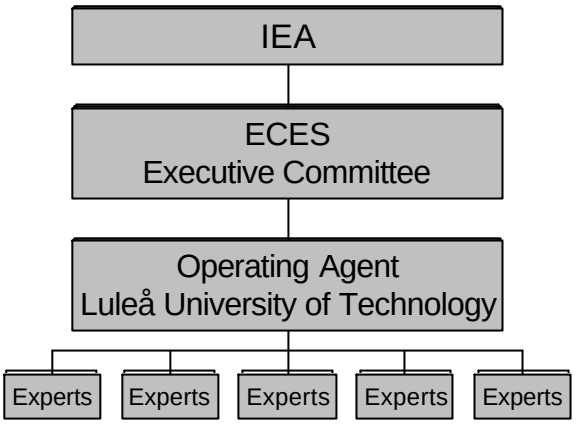


Figure 1. Proposed Organisation Structure.

Operating Agent

Luleå University as Operating Agent will supervise and co-ordinate the activities of the Annex. They will be responsible for the progress of work in order to fulfil the objectives within the time scales of the Annex.

The Operating Agent will report to the Executive Committee twice a year at the Committee meetings on the progress and results of the work performed.

On completion of the Annex, all participating experts will disseminate the textbook through suitable national activities (i.e. seminars, promotion, marketing etc)

Luleå University of Technology is familiar with IEA procedures and is therefore well suited to undertake the role of Operating Agent. Luleå University of Technology is also experienced in teaching the content of the textbook.

Participants

Each Participant shall contribute to the completion of task shared activities in terms of collaborative effort.

Each Participant shall make its best efforts to provide the Operating Agent with any information and data requested to fulfil the objectives of the Annex.

It is estimated that the level of collaborative effort required to complete the work of the Annex will be a total of 24 man months of which half is estimated for the Operating Agent.

Results

The deliverables of the Annex are:

- Engineering Textbook on Thermal Energy Storage and Renewable Energy.
- National activities for dissemination.
- A new annex proposal to establish an Internet based education on thermal energy storage.

Time Schedules

This Annex shall run for two years (June 2000 – June 2002). The Internet will be used for most of the information exchange but at some occasions there must be some time in Experts' Meetings, for round-table discussions and presentations of ideas.

	Meetings	Date
1	Kick-off Meeting Potential readers and scope	Jun 2000
2	1st Experts' Meeting Current literature, Layout	Dec 2000
3	2nd Experts' Meeting Writing and Proof-reading	Jun 2001
4	3rd Experts' Meeting Writing and Proof-reading	Dec 2001
5	4th Experts' Meeting Final Writing and Proof-reading National activities to promote the textbook 2nd Stage: Internetbased course	June 2002

Level of Effort

The level of collaborative effort required from the Participants to complete the task activities of the Annex is estimated to a total of about 24 man months. The major work must be in the hand one person, the Operating Agent. For that reason the Operating Agent is assumed to need 6 man months per year while the other experts are assumed to contribute with 1-2 man months per year.

Participants

During the Workshop on the future of Annex 8 (June 1999) several of the participants plus Spain showed great interest in the writing of this textbook. As a result of these discussions the experts of the following countries should to be interested: Belgium, Canada, Germany, Netherlands, Spain, Sweden, Turkey, and Japan. USA was not attending the meeting.

Information and Intellectual Property

It is of vital importance to have a mutual understanding and agreement upon the strategy for rights to intellectual property of the textbook

STRATEGIC PLAN 1999 - 2003

Preface

This strategic plan of the Executive Committee outlines the scope and goals of the IEA-Energy Storage Programme for the next 5 years (1999-2003). The paper has been compiled after intensive discussions at two workshops arranged in conjunction with the regular Executive Committee Meetings in 1998. The final document was approved by the Executive Committee in Spring 1999.

The strategy plan will serve as the basic working document to guide the future work of the Executive Committee and will also provide a comprehensive summary for other Committees of the IEA and for the IEA-secretariat. More detailed information on the Storage Programme, especially for a public audience is published in Conference Proceedings /1/, annual reports and Annex status reports of the Executive Committee, Annex brochures and on the Internet-Website of the IEA-Energy Storage Programme /2/.

Structure

1. Introduction

Energy storage technologies are a strategic and necessary component for the efficient utilization of renewable energy sources and energy conservation. There is a great technical potential to substitute for burning fossil fuels by using stored heat that would otherwise be wasted and by using renewable generation resources. These energy sources can be used more effectively through the addition of short and long term energy storage. Thermal and electrical energy storage systems enable greater and more efficient use of these fluctuating energy sources by matching the energy supply with demand. Thermal energy storage can also be used for cooling to reduce or eliminate the demand for electricity, including the most expensive electrical energy that is generated during periods of peak power demand.

The Implementing Agreement on Energy Conservation through Energy Storage was established in 1978 with the objective to facilitate international cooperation on research, development and demonstration (RD&D) of new, innovative energy storage technologies. Energy storage technologies are relevant in many IEAImplementing Agreements, especially in the building and transport sectors related to the Working Parties Renewable Energies and End Use Energy. Cooperation with these IEA Executive Committees is becoming more and more important in order to achieve the system integration and implementation of storage technologies.

2. Motivation

In 1973, after the first oil crisis, highest priority was given to improving the **energy security** of highly industrialized countries. At that time, many countries were completely dependent on imported oil. Today the situation has changed. The dependence on imported oil continues, but the rate of growth of petroleum products is slowing, and cheap fossil fuels are currently available. However, the further unlimited use of fossil fuels is causing a steady increase of energy-related CO_2-emissions into the earth`s atmosphere. This may lead to changes in the world climate in the medium and long term. Additionally, the use of conventional mechanical cooling utilizing ozone depleting substances (ODS), such as CFC and HCFC refrigerants, is also a major concern.

In December 1997, the Parties to the UN Framework **Convention on Climate Change** agreed to the terms of the **Kyoto Protocol**. This historic agreement sets legally-binding greenhouse gas emission objectives over the period 2008-2012 for industrialized countries. The energy sector, from supply to end use, is responsible for the majority of greenhouse gas emissions in the developed world, through the combustion of fossil fuels and the emissions of CO_2, N_2O and CH_4, three of the six gases covered by the Protocol.

Many governments have committed to reduce CO_2 emissions into the atmosphere. They have decided to strengthen their national efforts to increase the deployment of energy conservation technologies and utilization of renewable energy sources. So far in most industrialized countries, renewable energy sources contribute only marginally to satisfy energy demand. This is due to several reasons, in particular because new energy systems are not yet economically competitive with the combustion of fossil fuels, long term reliability is not yet proven, and there are still some regulatory and market barriers which have to be overcome. Therefore, further attempts have to be made to resolve these issues. This is especially true for many new energy storage technologies and concepts that have not yet been implemented on a large scale in the market.

The Executive Committee on Energy Storage has the following mission and vision for the Programme:

3. Mission

To research, develop, implement, and integrate energy storage technologies to optimize energy utilization by improving overall energy efficiency and economic growth while benefiting the local and global environments.

4. Vision

Energy storage technologies are able to contribute significantly to energy efficiency, the global environment, and economic growth. Therefore it is envisioned that over the next decade the IEAProgramme on Energy Storage will continually broaden the scope of its activities by undertaking research and technology development, technology transfer activities and the prototyping and deployment of near-market ready and market ready technologies. Moreover, the effective matching of energy supply with energy demand through systems integration will be emphasized, as will the expansion of collaborative actions with all interested countries and other Implementing Agreements.

5. Objectives and Strategies of the Programme

The Energy Storage Programme is technology, environment and market oriented. The main objectives are:

TECHNOLOGY: Advance the development of thermal energy storage technologies utilizing waste, renewable or ambient energy sources to supply space heating, space cooling and process cooling to achieve significantly improved energy efficiency and cost-effectiveness. Research and develop electrical energy storage technologies and systems that integrate batteries, flywheels, and other storage media with power electronics and controls to enhance energy security and facilitate increased use of renewable energy sources. We will provide a forum to facilitate the international exchange of information and experience on energy storage research, development, project applications, field trials and products. We will advocate that adequate design information on innovative energy storage technologies is made available to interested groups in industry, government, and academia.

ENVIRONMENT: Evaluate and document the many environmental benefits of energy storage and ensure that potential environmental problems are directly addressed and avoided by sound technical analysis and design techniques. We will involve national and regional environmental agencies in our work to ensure that energy storage meets the present and future requirements of these agencies. We will raise the level of awareness and understanding of energy storage technologies, especially their

environmental benefits, and advocate that impartial technical information is made available to all stakeholders involved in the implementation of energy storage.

MARKET: Encourage the required steps be taken to achieve the proper application of proven energy storage technologies world-wide in the commercial, industrial and agricultural sectors. We will focus our communications efforts on the world market players including design engineers, architects, building owners, developers, governments, regulatory agencies, electric utilities, and community leaders. We will encourage the use of renewable energy sources to cool non-residential buildings in a post-CFC world; develop methods to integrate energy storage technologies into community-based systems; and develop effective residential cold storage techniques that avoid the use of conventional chillers in moderate climates. Heating and cooling applications are part of the market, but economic and technical limitations indicate that cooling is the first priority, followed by combined cooling and heating, and lastly heating. We will develop and encourage deployment of electrical storage with renewable generation technologies where market conditions favor off-grid implementation (many developing countries and remote locations world-wide). Short-term electrical storage will be investigated to improve power quality and reliability in all types of commercial endeavors. Longer duration electrical storage will be considered for peak shaving, system stability, and improved asset utilization in utility networks.

In general, we will establish and strengthen new and existing internal and external international networks that may result in increased implementation world-wide of many energy storage technologies.

6. Market Opportunities and Barriers to Deployment

As with many other renewable energy and energy saving technologies, energy storage technologies offer great market potential in the long term, but the present implementation is impeded by significant barriers.

The most important factors have been identified by the Executive Committee:

Market Opportunities

- Great energy saving and fossil fuel substitution potential.
- Opportunity to assist in meeting CO_2 emissions targets.
- Market deployment will create new jobs.
- Enhanced energy security through the use of storage technologies.

Threats and Challenges

- Energy storage technologies are not always cost-effective based on energy savings.
- High initial costs.
- Availability of cheap fossil fuels.
- National regulations of groundwater protection often impede the implementation of aquifer thermal energy storage.
- Perceived high technical and financial risks for the owner.
- Lack of knowledge and the need for education.

Strengths and Weaknesses

The most important factors are:

Strengths
- Direct and immediate technology transfer between the participating countries.
- Increased research capacity by combining research efforts.
- International network of experts.

Weaknesses
- Lack of sufficient funding for RD&D of thermal and electrical energy storage systems.
- Early demonstration plants had overly optimistic expectations and were not highly reliable.
- Cooperation is mainly research-oriented, there has been poor or insufficient involvement of industry.

7. Collaboration with other Executive Committees

Closer cooperation among the relevant Executive Committees is essential, especially for the Storage Programme. Storage technologies have to be integrated with the total system and have to meet the specific technical and economic requirements of the application. Integrated system concepts that include storage technologies have to be developed to achieve an optimal cost-effectiveness and energy saving potential. Therefore the Executive Committee will intensify the cooperation with other Executive Committees in the future. One way this will be done is by joint workshops to identify new cooperative joint activities. Close collaborations will be established in the Residential and Commercial Sectors especially with the following Programmes:
- Solar Heating and Cooling
- Energy Conservation in Buildings and Community Systems
- Heat Pumping Technologies
- District Heating and Cooling
- Demand Side Management (DSM)
- Photovoltaic Power Systems
- Superconductivity

8. Achievements of the Programme

So far, great progress has been made by the Programme to achieve its objectives. The main results are:

- A reliable data and information base on various energy storage technologies and concepts has been established by international reviews of the state of the art, assessment and market studies, and construction and monitoring of pilot and demonstration plants.
- The technical as well economic risks to implement new energy storage technologies have been reduced.

- National and international guidelines have been developed for the implementation of ground and aquifer storage systems to avoid environmental risks and to facilitate installation by local water authorities.
- Design tools and computer models have been developed and are being used now by engineers for the planning and design of new energy systems that include energy storage technologies.
- Technology transfer and information dissemination have continued with the sponsorship of workshops and international conferences, including the series of International Thermal Energy Storage Conferences (Enerstock'85, Jigastock´88, Thermastock´91, Calorstock´94, Megastock´97) and the Electrical Energy Storage Conference (EESAT´98).
- Deployment of low temperature aquifer storage facilities for heating and cooling on a large scale in various countries, e. g., Belgium, the Netherlands, Sweden, the United States of America, Switzerland and Germany.
- Close cooperation with other Implementing Agreements (e. g., Solar Heating and Cooling, Buildings and Community Systems, Heat Pumping Technologies) has been established to avoid duplication of effort and to align the Energy Storage Programme with the interest of other IEAProgrammes. Cooperation within the Future Building Forum has been initiated.
- Internet homepages of the IEA-Energy Storage Programme and various Tasks has been set up.
- New member countries (Japan, Spain, Turkey, UK) have been attracted. Other countries (Bulgaria, Poland, Switzerland) are interested in participating in the Programme.

9. Scope and Workplan

The Executive Committee constitutes a forum of Senior National Programme Managers and Experts. It fulfills the following tasks:

- Task Management (Appendix)
- Coordination of national activities among participating countries
- Information dissemination by electronic Journals and Internet Websites
- Organization of International Conferences and workshops
- Evaluation of the State-of-the-Art technologies.

Until recently, the Storage Programme was mainly focused on thermal energy storage technologies for the heating and cooling of buildings because this sector offers the largest energy saving and substitution potential in northern countries. However, electrical energy storage systems are also important for the stabilization and optimization of electrical energy systems as well as for the utilization of renewable energy sources, in particular in photovoltaic and wind energy systems. Therefore, the End Use Working Party recommended that the scope of the programme be broadened to include electrical and other energy storage technologies.

In January 1995 an IEAWorkshop on Energy Storage was held in Montreal to examine the opportunities and interest of cooperation in storage technologies that the IA had not previously covered in the Programme. As a result of the workshop, two new Annexes were initiated:
- Annex 9: Electrical Energy Storage Systems and Network Optimization.
- Annex 10: Phase Change Materials and Thermochemical Storage.

In 1998, the IA was extended by the Energy End-Use Working Party for 3 years until the end of the year 2000. So far twelve Annexes have been carried out, and seven of them have already been completed successfully (Appendix 1).
Special R&D activities on energy storage systems have been carried out in the context of other IEA programmes, e. g.,
- Solar PACES: (High temperature thermal storage systems for solar thermal power plants).

- Solar Heating and Cooling: Task 16 - Photovoltaics in Buildings (Survey: Battery Storage Systems), Task 14 and Task 26: Advanced Solar Heating Systems (hot water storage).
- Photovoltaic Power Systems.
- Heat Pumping Technologies.
- District Heating and Cooling.

10. Proposed Future Activities

The proposed future activities are largely extensions of the previous and present work of the Programme. Various topics and activities will be continued in order to achieve successful implementation of storage technologies. The following list includes the activities that will be examined by the Executive Committee.

- Follow-on to Annex 8: Implementation of underground thermal energy storage.
- Follow-on to Annex 9: Pilot and demonstration electrical storage plants. Develop consortia and explore funding mechanisms to realise demonstration schemes within a reasonable time scale.
- Evaluation of electrical storage systems for use with renewable resources and demonstration of the environmental benefits of reduced greenhouse gas emissions.
- Research electrical energy storage for competitive electricity supply markets and determine the economic advantages of storage for peak shaving, capital equipment deferral and frequency regulation applications.
- Annex 14: Cooling in all climates with thermal energy storage systems (Task Definition Phase).
- Short term cold storage for DSM (demand side management)
- Comprehensive evaluation of the environmental and indoor consequences of energy storage by reviewing present national efforts and development of a validated methodology.
- Role of thermal energy storage in increasing the energy efficiency of building HVAC systems such as combined with closed-loop building heat pump systems and desiccant-based cooling systems. Cooperation with the IEA Building and Community Systems, Heat Pumping Technologies and Solar Heating and Cooling IAs will be useful.
- Evaluation of the benefits of hot and cold storage with heat pumps, especially the advanced generation of heat pumps, in collaboration with the Heat Pump IA.
- Study the potential for water remediation efforts using energy storage through community or aquifer-based planning of large-scale energy supply systems with the objective of assisting the implementation of energy storage in a systematic manner.
- Organisation of International Conferences, workshops and symposia:
    - TERRASTOCK-2000 (August 2000, Stuttgart, Germany)
    - EESAT 2000 (September 2000, Orlando, Florida, USA)
    - Workshop on Advanced Solar Thermal Energy Storage (October 1999, Freiburg, Germany) in collaboration with the Solar Heating and Cooling Programme.
- Publication of the electronic journal: Underground Thermal Storage and Utilization /2/.
- Publication of Programme and Annex brochures and reports on Internet /2/.
- Continuous evaluation and preparation of state-of-the-art reviews.
- Joint efforts should be initiated to implement new energy storage technologies in all countries with an interest in storage or with a significant energy storage market potential.

11. Participation

The following countries and corresponding organizations have signed the IEA Energy Storage Implementing Agreement:

Belgium, Ministry of Economical Affairs
Canada, Public Works Canada
Commission of the European Communities
Denmark, The Ministry of Energy
Finland, Technology Development Centre TEKES
Germany, Forschungszentrum Jülich GmbH
Italy, Ente per le Nuove Tecnologie l `Energia e l`Ambiente (ENEA)
Japan, Heat Pump &Thermal Storage Technology Center of Japan.
Spain, IBERDROLA
Sweden, The Swedish Council for Building Research
The Netherlands, The Netherlands Agency for Energy and the Environment (NOVEM)
Turkey, Çukurova University, Adana
United Kingdom, EA Technology
United States of America, Department of Energy.
Bulgaria, Poland and Switzerland presently participate in various Tasks and have sent representatives to the Executive Commitee meetings. These countries are expected to become signatory countries of the Implementing Agreement on Energy Storage.

12. References

/1/ CALORSTOCK`94: 6th International Conference on Thermal Energy Storage, August 22-25, 1994 Espoo, Finland, Proceedings pp. 303-339.

MEGASTOCK`97: 7th International Conference on Thermal Energy Storage, June 18-21, 1997, Sapporo, Japan, Proceedings pp. 1003-1026.

EESAT 98, Electrical Energy Storage Systems Applications & Technologies, June 16-18, 1998, Chester, UK, Proceedings.

/2/ Internet Website addresses:

http://www. sb.luth.se/vatten/projects/iea/ (general information, task and annual reports)
http://www.eatl.co.uk/annexIX/home.htm and http://www. eus.de/energy-storage/ (Annex9)
http://www.chemeng.kth.se/avdelningar/ts/annex10/index.htm (Annex10)
http://www.geo-journal.stockton.edu (electronic journal)
http://www.itw.uni-stuttgart/TERRASTOCK

Appendix: Current Annexes

Annex 8: Implementing Underground Thermal Energy Storage Systems.
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 various energy efficient systems. Screening and decision tools will be provided to ensure ecologically sensitive applications. Sweden is providing the Operating Agent. The Annex has been extended into 1999.
Duration: 1996-1999, Operating Agent: Sweden.

Annex 9: Electrical Energy Storage Systems and Network Optimization.

The overall objective of Annex 9 is to encourage the greater uptake of electric energy storage systems on utility and associated distribution networks, thereby allowing the full energy savings, operational efficiency and environmental benefits to be realised. The priority areas to be addressed in the short and medium terms include the application of electrical energy storage systems in the following areas:-

- integration with renewables and non-despatchable power sources
- power quality/quality of supply
- asset management
- deferment of capacity additions

The scope of work includes the following elements:-

- retro-spective case studies
- forward looking project definitions
- network applications modelling
- information collation and dissemination
- formation of strategic R&D partnerships

Duration: 1996-1999, Operating Agent: UK

Annex 10: Phase Change Materials and Thermochemical Reaction Systems

The objectives of Annex 10 are to solve technical and market problems for increased market opportunities for thermal energy storage systems utilising phase change materials (PCM) or chemical reactions and to broaden the knowledge base and disseminate technical information.

Research will be carried out to find solutions to the difficulties in using PCM or chemical reactions for thermal energy storage. In particular, research into system analysis will be pursued in order to eliminate market barriers for implementing the technology in residential, commercial, industrial and agricultural sectors. The action will be executed in close co-operation with manufacturers, utilities, users, governmental representatives and organisations involved in the development of energy technologies.

Annex 10 will result in completed case studies and demonstration projects related to potential applications. Furthermore, it should produce general recommendations for the energy industry and more application-oriented R & D activities with increased participation by industry, manufacturers, and other stakeholders

Duration: 1998-2000, Operating Agent: Sweden

Annex 12: High-Temperature Underground Thermal Energy Storage (HT-UTES)
In contrast to Annex 8, this Task deals with the storage of heat at temperatures above 50 °C. The stored heat can be used without a heat pump. HT-UTES still is not yet widely used, but might allow further applications e.g., in district heating, in waste heat recovery, in solar heating, etc. The type of UTES-systems concerned shall be confined to Aquifer Storage (ATES) and Duct / Borehole Storage (DTES). The Annex is being carried out in two Phases.

Phase I (1.1.1998 - 30.06.1999)
Based upon the results from previous IEA activities and ongoing R&D, the objectives of Annex 12 are to demonstrate that HT-UTES can achieve more efficient, economical and environmentally benign energy systems, and to disclose requirements and find solutions for reliable, long-term operation. A state-of-the-art-review has been completed along with the identification of system opportunities.

Phase II (1.10.1999 - 31.12.2002)
Based on the conclusions and recommendations of the Phase I review, the necessary R&D efforts will be initiated and demonstration plants erected, monitored and evaluated. Long-term scenarios will be investigated; environmental impacts and benefits will be examined; design tools and guidelines will be developed; water treatment methods implemented; and material suited for high temperatures tested.
Duration: 1998-2001, Operating Agent: Germany.

Annex 13: Design Construction and Maintenance of UTES Wells and Boreholes.
Most UTES (Underground Thermal Energy Storage) concepts incorporate drilling one way another. Furthermore some concepts are highly dependent on a proper well or borehole efficiency to have an optimal operational performance.

This Annex will cover aspects of test drilling, well and borehole design, construction and monitoring and maintenance of UTES applications. The main target is set upon aquifer and borehole systems (in some countries refereed to as ”open” and ”closed or duct” systems).

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

- How to gain information of the underground properties by test drilling (Subtask A)
- How to design well or borehole systems properly (Subtask B)
- How to construct wells or boreholes cost effectively, safely and properly (Subtask C)

- How to keep the storage systems functional during operation (Subtask D)

Duration: 1998-2000, Operating Agent: Sweden

Annex 14: Cooling in All Climates with Thermal Energy Storage (Task Definition Phase).

The overall objective of Annex 14 is to employ research, development and demonstrations to advance the prospects of thermal energy storage (TES) technologies for applications within a variety of energy systems in various climate zones and to encourage their use as a standard design option. The Annex will rely heavily on the activities and results of Annexes 6, 7 and 8, to encourage energy efficiency and increased sustainability of the global energy resource by stimulating the expanded use of TES in innovative, energy efficient and cost-effective projects in participating countries.

Duration: 1999 Start of the Task Definition Phase, Operating Agent: Turkey.

END-OF-TERM-REPORT (September 1997 – December 2000)

BACKGROUND AND SUMMARY

The Implementing Agreement (IA) started the activities in 1978. At the EUWP meeting in April 1995 the IA reported activities and plans for the future. In April 1997 the EUWP and also the CERT endorsed an extension of the IA to the end of the year 2000. Finally the Governing Board decided in this way in September 1997.

The Executive Committe of the ECES IA has produced annual reports since the start of the ECES IA. The Reports were printed since 1992. Strategic Plan for the period 1998 – 2003 has been also produced and approved by the Executive Committee in December 1998 (See attached document). Since the latest Executive Committee meeting, in November1999, the IA has the following annexes in operation:

- Annex 8: Implementing Underground Thermal Energy Storage. Started May 1994. Termination date May 2000. Operating Agent: Sweden
- Annex 9: Electrical Energy Storage for Utility Network Optimisation. started July 1996. Termination date May 2000. Operating Agent: United Kingdom.
- Annex 10: PCM and Chemical Reactions for Thermal Energy Storage. Started December 1997. Operating Agent: Sweden.
- Annex 12: High Temperature Thermal Energy Aquifer and Duct Storage. Phase 2 started December 1999. Operating Agent: Germany.
- Annex 13: Design, Construction and Maintenance of UTES Wells and Boreholes. Started December 1997. Operating Agent : Sweden.
- Annex 14: Cooling in All Climates with Thermal Energy Storage. Started June 1999. Operating Agent Turkey

Annexes (8-14) are to be completed by the end of 2000, except for Annex 12 Phase 2. Annexes under preparation are:

- Electrical energy storage and integration of renewables (United Kingdom)
- An online communication and information platform (Germany, Sweden, Turkey and United Kingdom)
- Engineering textbook on thermal energy storage and renewable energy (Sweden)
- Database formation and computer design (Sweden)

New annexes are important continuations of the work or/and new strategic projects coming up from current annexes.

The following countries are now active in the Implementing Agreement on Energy Conservation through Energy Storage: Belgium, Canada, CEC, Germany, Japan, The Netherlands, Spain, Sweden, Turkey, United Kingdom, USA. Finland has recently activated their membership. Denmark

and Italy have signed the IA but are passive at the moment. Australia, Bulgaria, China, France, India, Poland, South Africa and Switzerland have expressed interest to participate in the activities of the IA. Australia, Bulgaria, France and Poland have sent observers to recent Executive Committee meetings.

This end of term report shows the situation as of March 2000, plans for the rest of the year 2000 are also included.

A. NATURE AND OBJECTIVES

Tasks/Annexes

1. Currently active Tasks/Annexes, their starting dates and expected completion dates;

- Annex 8: Implementing Underground Thermal Energy Storage. Started May 1994. Termination date May 2000. Operating Agent: Sweden
- Annex 9: Electrical Energy Storage for Utility Network Optimisation. started July 1996. Termination date May 2000. Operating Agent: United Kingdom.
- Annex 10 - PCM and Chemical Reactions for Thermal Energy Storage. Started : December 1997; Completion : December 2000.
- Annex 12 - High Temperature Energy Storage. Phase 1, Started : December 1997; Completion : December 1999. Phase 2, Started : December 2000; Completion : June 2002
- Annex 13 - Design, Construction and Maintenance of UTES Wells and Boreholes. Started : December 1997; Completion : December 2000.
- Annex 14: Cooling in All Climates with Thermal Energy Storage. Phase 1, Started : June 1999; Completion : December 2000.

2. Tasks/Annexes completed in the period covered by the End-of-Term Report (September 1997 - December 2000):

- Annex 8: Implementing Underground Thermal Energy Storage. Started: May 1994; Completion: April 2000. Operating Agent: Sweden
- Annex 9: Electrical Energy Storage for Utility Network Optimisation. Started : July 1996; Completion : November 1999. Operating Agent: United Kingdom.
- Annex 10 - PCM and Chemical Reactions for Thermal Energy Storage. Started : December 1997; Completion : December 2000.
- Annex 12 - High Temperature Energy Storage. Phase 1, Started : December 1997; Completion : December 1999.
- Annex 13 - Design, Construction and Maintenance of UTES Wells and Boreholes. Started : December 1997; Completion : December 2000.
- Annex 14: Cooling in All Climates with Thermal Energy Storage. Phase 1, Started : June 1999; Completion : December 2000.

3. Tasks/Annexes currently being prepared.

- Electrical energy storage and integration of renewables. Planned starting date: July 2000; Planned completion date: June 2002 (United Kingdom)
- An online communication and information platform (Germany, Sweden, Turkey and United Kingdom)
- Engineering Textbook on Thermal Energy Storage and Renewable Energy (Sweden)
- Database formation and computer design (Sweden)

Nature of Work

4. Describe the nature of the IA's activities in relation to the following headings.
a) Information exchange about independent activities

Information exchange takes place in series of International Thermal Energy Conferences, organized every three years. At the Megastock '97, 7th International Conference on Thermal Energy Storage, there was a collaborative presentation between Germany and US on Borehole Thermal Energy Storage (BTES) applied on cold storage in Central Europe and the US. These were followed up by a computer workshop and a presentation at the 2nd Stockton Conference in March 1998. Formal information exchange also takes place during the series of Electrical Energy Storage Systems Applications and Technologies (EESAT) Conferences.

b) Informal co-ordination or initiation of activities by participants

IF Technology and the Netherlands have worked in helping US (especially the State of New Jersey) in designing Aquifer Thermal Energy Storage (ATES). In particular, New Jersey has strict environmental regulations not originally designed for this use of the aquifers. Experiences from the Netherlands are transferred to US on this issue. Another informal co-ordination activity was a seminar on Cooling in Telecommunication Stations that was given in Istanbul on May 6, 1999 by experts from Sweden and Turkey. Informal groupings of Annex 9 participants and others have been formed to develop proposals for the European 5th Framework Programme.

c) Formal co-ordination or initiation of activities in different countries, through shared tasks and information exchange, to achieve shared objectives

Most of the formal activities are performed through annexes, workshops etc. based on task-shared and task/cost-shared basis.

d) Formal co-ordination or initiation of activities based on sharing the costs of mutually agreed projects

The ExCo meetings have information exchange from each of the participating countries on the agenda at every meeting. Japan and Poland are carrying out a collaborative project on Phase Change Materials funded by their governments.

Which (one or more) of these is the most important?

All activities are important all together. The main element of the Program is the international co-operation within Annexes.

5. Indicate the main technology areas or issues currently being investigated within the Agreement.

Underground Thermal Energy for Heating and Cooling has been the dominant technology during the 1990's (before 1995). The main technology areas/issues addressed by annexes are for Annex 8: from US perspective; Marketing of GHP/UTES systems. Included in this sharing Marketing research and programs of the Geothermal Heat Pump Consortium (GHPC) and setting up an Electronic Journal. For Annex 9:

- application of electrical energy storage systems
- integration of renewables and non-despatchable power sources
- modelling
- cost/benefit ratios
- system technologies, including: battery storage, flywheels, capacitors, SMES, compressed air/hydro and fuel cell/electrolyse systems.

For Annex 12: Optimisation of heat supply to buildings and processes by storing heat at elevated temperature levels for longer time.

For Annex 13 :

- to improve the methods for test drilling and geodata collection
- to develop the procedures and define the criterias for well and borehole design
- to define and partly develop drilling and completion drilling methods for UTES applications
- to identify UTES operational problems and to develop preventive methods

For Annex 14: Cooling technologies with thermal energy storage in different climates.

6. Indicate additional technology areas or issues that are potentially within the scope of the IA.

Since the beginning of 1995 - the Montreal Workshop - the scope of work has extended to Electrical Storage (Annex 9), PCM and Chemical Storage (Annex 10), designing, construction and maintenance aspects (Annex 13) and Low Temperature Storage (Annex 14).

7. Are there plans to add any areas or issues to the actual work of the IA? If so, which ones?

Further applications of the studied technologies. Further project proposals are endorsed continuously by the ExCo. The added tasks are the establishment of an electronic journal, an online communication and information platform, writing a textbook on thermal energy storage and renewable energy. Another example is experimental work on subjects related to borehole heat exchangers and clogging processes of wells.

Objectives

8. What are the objectives set out in your Agreement?

"The overall objective of the Implementing Agreement on Energy Conservation through Energy Storage is to develop and demonstrate various advanced 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 utilization of renewable energies, in particular

solar and wind and the greater utilization of waste heat. Energy storage technologies should be implemented in all countries with a significant energy storage market potential".

9. Are the objectives that are actually being pursued different from those set out in the Agreement? If so, why and in what ways?

The work is consistent with the objectives set forth in the agreement.

10. Do you regard the objectives as currently appropriate?

Yes, in principle. According to the new Strategy Plan (1999-2003) the main objectives with respect to technology, environment and market are also given.

11. In this light, is the technology area covered by your Agreement adequately defined? Should it be more concentrated? Or broadened?

Before the Montreal-Workshop in January 1995, EUWP asked the IA to broaden the scope of work. Additional technology areas and issues can broaden the technology area covered by our Agreement. See also question 6.

B. PARTICIPATION

1. List the Countries and organisations participating in the Implementing Agreement and specify in which Annexes they participate. Categorise participants according to government, industry, academic or other.

Countries and organisations (Contracting Parties) participating in the Implementing Agreement on Energy Conservation through Energy Storage:

Belgium	Ministry of Economic Affairs. Governmental. Annex 8, 12, 13.
Bulgaria	Interest in Annex 10
Canada	Public Works. Governmental Agency. Annex 8, 9, 10, 12, 13, 14
CEC	DG XII. No participation at the moment, but will reactivate its participation
Denmark	Ministry of Energy . No annex participation at the moment.
Finland	TEKES. Governmental Agency. No annex participation at the moment. Interest in Annex 9, 10
Germany	Forschungzentrum Jülich, GmbH. Governmental Agency. Annex 8, 9, 10, 12, 13
Italy	ENEA, Governmental Energy Research Agency. Passive member. No annex participation
Japan	Heat Pump and Thermal Storage Technology Center of Japan. Industrial and Governmental Agency. Annex 8, 10, 13, 14
Poland	Interest in Annex 10
Spain	IBERDROLA Annex 9
Sweden	The Swedish Council for Building Research. Governmental Agency. Annex 8, 9, 10, 12, 13,14
Switzerland	Interest in Annex 13
The Netherlands	NOVEM, The Netherlands Agency for Energy and the Environment. Governmental Agency. Annex 8, 9, 10, 12, 13

Turkey	Çukurova University, Adana. ”Academic”. Annex 8, 10, 13, 14.
UK	Ea Technology. Consultancy Company. Annex 9
USA	US Department of Energy. Annex 8, 9, 13.

Within the Annexes research institutes, engineering and industrial companies (e.g. electric utilities, manufacturers) and government work together to develop and demonstrate new energy storage technologies.

Member Countries

2. Are there IEA Member countries with relevant activities that do not participate in the Agreement? In your view, what is the main reason why they do not participate (e.g., lack of funds, lack of interest, have not been approached, etc.)?

Australia, France, and Switzerland have expressed interest to participate in the activities of the IA. Australia and France have sent observers to recent Executive Committee meetings. We work with promotion activities but have not reached the ultimate goal yet. Switzerland, for example, is not participating in ECES IA yet, in spite of their long experience and many activities. The main reason for not participation for some of these countries is lack of funds.

3. Is there scope for intensifying the involvement of Member countries, so that the IA's objectives can be better met? If so, please provide suggestions on how the involvement could be strengthened.

Yes. The best thing to ”sell” the IA according to our opinion is to work with attractive annexes and information activities. Storage is important in today’s and tomorrow’s energy system.

Non-Member Countries

4. Which, if any, non-Member countries (NMCs) participate in the IA?

Poland, Bulgaria,China, India, South Africa, South Korea, Israel and New Zealand have shown interest in different annexes. Poland and Bulgaria have sent observers to recent Executive Committee meetings, but they have not signed the Implementing Agreement, yet.

5. *Has NMC involvement led to special experience and insights for the IA?*

Yes. Every country contributes with new experiences, especially developing countries have differing requirements and economics.

6. *In your view, is there scope for the IA and for IEA headquarters to further promote NMC participation in selected areas in which important technology transfer opportunities exist? If so, what should be done?*

Yes. Endorsement of promotion and open attitude from the IA's to NMC's. Contacts with NMC-countries are very helpful to "sharpen the eye" for special needs. Activities to promote participation of NMC by ECES IA can be summarized as:

- Generation and distribution of information through workshops, seminars, conferences. (Workshop in Bulgaria, Seminar in Poland, Participation in Conference in India by a group of delegates and experts from annexes).
- A Committee is formed within the ExCo to seek financial resouces from international funding organizations to involve developing countries in ECES activities
- In the last ExCo meeting a proposal on creating a pre-IEA network was done. The ExCo approved this proposal. The purpose of the network is to facilitate for NMC to participate in the work of the Implementing Agreement on Energy Conservation trough Energy Storage. The network will primarily be a network on Internet to exchange information on ongoing activities in different countries with regard to energy storage. The network will also serve as a mean to find partners for joint efforts in research, development and application of energy storage systems. The network will serve as a mean for technology transfer between countries advanced in the field of energy storage and those less advanced. It will also promote joint work and in that way increase the speed of development of the area. The network will consist of persons from universities, governemental bodies, industries and other interested partners.

Other Participants

7. Is industry involved in the IA's activities? If so, how does this occur? Please comment in relation to the following headings:

a) Participation in the Executive Committee and its Tasks/Annexes

Industry is involved especially in the Tasks/Annexes (Annex 9, but also in the other annexes). Different "rules" in different countries. See also question B1.

b) Attendance at technical meetings or seminars

Yes. Example: There has been a large involvement of Utilities, Manufacturers and Design Professionals at the conference at Stockton in March 1998 and over 180 from this segment participated at the first meeting.

c) Participation in activities as a partner (i.e., contributes to the choice of activities)

Yes. More or less a rule in Annex 9. The industry is directly involved in the various activities. National Team participants have been actively involved in the various activities of the Annex,

including the successful programme of Experts' meetings and in response to the various technical questionnaires etc.

e) Participation as supplier of equipment

Yes. Ground Source Heat Pump Consortium has supplied reports on Design Tools, Marketing and Education for Designers.

8. Are other types of users (other than government) involved in the IA? Please use the previous headings to comment

Yes. see question B1 and 7.

9. How is the involvement of industry and other non-governmental users developing? Are there any factors in the background that constrain industry's participation (e.g., competition in markets for equipment, changes in outlook of public sector corporations due to actual or expected privatisation, other aspects of government policy)?

Industry involvement is increasing in the annex work and also at workshops. Industrial involvement is sometimes difficult, in particular where rapid return of money is not expected. It varies according to technology and the market position of a certain technique in the countries. In annex 12, for example- according to the OA - it is expected to be easier in the Netherlands and Sweden and consulting companies from these countries are involved for some years. The monetary contribution from the companies, is however, not always a reciept of their involvement in the project work. In Canada, in particular, R&D on a more academic level has to be strengthened to offer promising prospects to the industry and thus to attract their participation.

10. Does the ExCo see scope for increased industry participation and are there plans for its development in the next term?

We believe so indeed. For instance, industry can be involved to a larger extent in demonstration projects.

C. ACTIVITIES

Meetings

1. Please indicate the numbers of meetings of various types (under the headings shown below) organised by the Agreement during the present term and the average numbers of people attending.

a) Executive Committee meetings

The Executive Committee meetings are normally held twice a year. Average attendence during last three meetings has been 25 people.

b) Technical meetings and workshops

Annex experts meetings 2-4 times a year, about the same with workshops. Annex meetings attendence is about 12 and associated workshops is 40 people.

For Annex 9 (Phase 1) Experts Meetings

• Batteries I Experts' Meeting	June 1996	>25 attended
• Fuel Cell/Electrolyser Experts' Meeting	November 1996	13 attended
• Flywheels Experts' Meeting	November 1996	9 attended
• Power Conversion/Capacitors Experts' Meeting	February 1997	12 attended
• Batteries II Experts' Meeting	March 1997	21 attended
• SMES Experts' Meeting	March 1997	16 attended
• Utility Requirements I Experts' Meeting	December 1996	>40 attended
• Utility Requirements II Experts' Meeting	March 1997	22 attended
• Modelling I Experts' Meeting	June 1997	9 attended
• Modelling II Experts' Meeting	September 1997	5 attended

Annex 9 (Phase 2) Experts Meetings

- June 1998 (Chester, UK)
- October 1998 (Atlanta, USA)
- June 1999 (Stockholm, Sweden)

For Annex 12, two experts meeting during 1998 are realized, with some 8 participants, and one workshop for up to 30 people. In addition national workshops will be organised to collect the information for the International State of the art review.

For Annex 13

- Preparatory Workshop, Paris	December 1997	15 attended
- Workshop Stockton, USA	March 1998	14 attended
- Expert Meeting, Giessen, Germany	June 1998	11 attended
- Expert Meeting, Malmö, Sweden	October 1998	26 attended
- Expert Meeting, Appenzell, Switz.	March 1999	12 attended
- Expert Meeting, Westerville, USA	October 1999	18 attended

For Annex 14 (Phase 1)

First Workshop	June 1999	16 attended
First Experts' Meeting	November 1999	17 attended
Second Workshop	April 2000	30 expected
Second Experts' Meeting	April 2000	15 expected

c) Seminars and conferences (open to non-participants as well as IA Participants)

One International Thermal Energy Conference is organized every three years. Usually about 100 papers and 200 attendees. The latest one MEGASTOCK '97 was in Sapporo in 1997 with about 400 delegates. The next one will be in TERRASTOCK'2000 in Stuttgart, Germany. Expected number of participants are about 200 and 133 abstracts have been presented so far. A workshop in collaboration with Solar Heating and Cooling Implementing Agreement is also being organized during TERRASTOCK'2000.

Stockton Conference in March 1998, c.f question B 7 b).

EESAT '98 Electrical Energy Storage Systems Applications and Technologies (Chester, UK, June 1998),140 delegates. EESAT 2000 (planned for Florida, USA, September 2000), target 100-200 delegates. 6th International Batteries for Utility Energy Storage Conference, Gelsenkirschen, Germany, September 1999, approximately 100 delegates. Seminars are organized 1 - 2 times a year (See question C 1 b).

Costs of Agreement

2. What are the annual costs of the ongoing collaboration? Please provide values for the most recent full budget year available. If you do not know exact amounts, please provide ranges. Specify your estimates in the three areas below.

a) Size of the IA common fund (cost-sharing of administration and jointly-funded activities)

A common fund is established to fund the secretriat function as of June 1998. The maximum annual budget for the Secretariat is set each year by the Executive Committee, acting by unanimity, based on a detailed proposal from the secretary. The most recent budget (1999-2000) is as follows:

	Cost (US$)
▪ Stafftime	20000
▪ Printing	500
▪ Postage	1000
▪ Telephone/Fax/Internet 1000	
▪ Data processing	2500
▪ Travel/Subsistence	4000
▪ Stationary/Copying	500
▪ Miscellaneous	500
Total	30000

The annual contributions of the Contracting Parties is set according to the following scale of contributions:

Country	**Cost**	**Fraction**
Canada, Germany, Japan, UK, USA	4000	8/60
The Netherlands, Sweden	2500	5/60
Belgium, Denmark, Finland, Spain, Turkey	1000	2/60

Annex 9 has been a combination of task share and cost share activity. The cost share activities for Annex 9 both Phase One and Phase Two required a budget of £150,000 each whilst the task share activities for both phases required an input of between one-third and three times the equivalent national contribution to the common fund from each of the Participating Agents/Participating Countries.

b) Size of in-kind contributions to co-ordinated projects (task sharing)

Most of the annexes are run on task-sharing or combined cost/task-sharing basis. Also difficult to calculate are the reports from the GHPC as well as the sum of the costs of travelling. Annex 12 (1998): One person month is required from each participating country for the international co-operation within the Annex.

c) Annual value of the work about which significant information is exchanged (i.e., how much activity is actually linked by this Agreement? For this item it will be useful to ask each ExCo Delegate to provide an estimate of the level of national activities in his/her country that are linked through the Implementing Agreement.)

Difficult to calculate. The International collaboration is, in many cases, integrated with national activities. Annual value of work for Sweden is expected to be $200,000 – 400,000 Per year.

Example from the Stockton Conferences: Total cost more than $ 200,000 to put on together. the monitoring results of the RSC UTES project - the total research funds for monitoring is in excess of $ 1.2 million. Above that there are a number of smaller projects connected to various activities.

Example: EESAT ‘98 is planned as the major open access dissemination event for the Annex 9 and is to be self supporting financially, open to both participants and non-participants.

For annex 12; relevant work linked to the annex in Germany approx. USD 100.000 .

Example: Additional value of the benefits of the information exchange is the collaborative projects and student and other personell exchange program. Examples from Turkey:

- Collaborative project for feasibility study of ATES to a Hospital was realised by task-sharing and financial support from National project resources.
- Student exchange is financed by international Scholarship programs: PhD student visiting the Technical University of Luleå, Sweden to study cold storage and one geological engineering student visiting VBB/VIAK, Malmö, Sweden, for training in pump tests in ATES and modelling at the Technical University of Lund, Sweden.

Dissemination of Results

3. How are results of the IA's work disseminated (e.g., conferences and meetings, reports, publications, direct participation of industry and users, other ways)? Please provide a list of publications of the IA during the term under review.

A list of publications is attached to each annual report during the period. Please, refer to these lists. Annex 9 published a report for most of the experts meetings, and each participating agent was free to distribute the report within their own country, according to their national agreements. Additionally, conference proceedings are available for EESAT 98 and the 6th International Battery conference and are generally available from the conference organisers. During Phase 2 of Annex 9, several task-specific reports were compiled, including an applications case study report , a project definition report and an energy storage modelling report. Two spreadsheet based models for electrical energy storage were developed during phase one and a stand-alone power quality-related model was developed during phase two of the work.

Proceedings from the Stockton Conference in 1998 formed the first issue of the Electronic Journal. The IA has a web site. A special Task of the Executive Committee Member is the national dissemination of the IEA activities and results.

Other means of dissemination are: Conference proceedings, Internet, Publications, Workshop Proceedings, State of the Art reports

4. Do you have vehicles for increasing the visibility of the Agreement (e.g., marketing brochures, publications, newsletters, World Wide Web pages)? If so, please describe them.

The ExCo and annex 8, 9, 10 and 14 have home pages. An "Annex 9" web site was pioneered during phase one of the project, and a more elaborate web site was established during phase 2, which contained both publicly accessable pages and restricted access pages. However, the web site is not a replacement for brochures and publications, it is complementary. The annex 9 has arranged an International Conference in June 1998 (see above) to introduce a forum for information and discussion of the results and activities. Discussions are underway for an online communication and information platform. Annex 10 has published an information brochure. A brochure for marketing the IA is also being prepared.

5. Have there been significant developments in this area in the current term? Are there plans for development in the next term? If so, please describe them.

During the period of this report 5 new countries have joined the IA and the annexes 9 - 14 have started. The Strategic Plan (1999-2003) covers the future plans of the IA.

Co-ordination with Other Bodies

6. Specify to what extent there is a need to co-ordinate your activities with other IAs. If so, which Agreements and on which issues?

Energy storage is a technology which is important in an energy system. A storage plant does not, however, work only by itself. It is one component of an energy system. In systems with solar, heat pumps and district heating and cooling for example storage systems are essential for the utilization of renewables or waste heat. The system efficiency will increase. It is therefore natural to collaborate with the IAs representing these technologies, including the Energy Conservation in Buildings and Community Systems (ECBCS) IA., Demand Side Management (DSM), Solar Heating and Cooling (SHC), District Heating and Cooling (DHC), and Heat Pumping Technologies (HPT). We have also collaboration with the EETIC IA for co-ordinating information activities, etc. For electrical storage, collaboration with Photovoltaic Power Systems and Superconductivity are realized.

Some of the members of our ExCo are also members of other ExCos and consequently, information exchange and strategic collaboration can easily be discussed with other relevant IAs. Examples: The Swedish delegate is also a member of the Heat Pumping ExCo and the German delegate of the Solar Heating and Cooling ExCo.

7. What arrangements for co-ordination with other IAs are in place?

A joint ExCo meeting with ECBCS is going to be held in Tokyo, Japan on November 8, 2000. Annex 14 have also contacted other IEA activities about cooling and at the latest ExCo meeting a presentation about ECBCS and SHC activities about cooling were given. Annex 14 experts are also invited to the corresponding tasks to give information about their activities.

8. Are there other international co-operative programmes working on issues similar to those dealt with by the IA? If so, describe any arrangements you may have for co-ordinating with them.

Coordination could start with the European Union with the new delegate in the Committee.
We are interested in the report from the collaborative IEA-EU meeting and the actions from the organisations that came out from that meeting.

Internal Assessment and Planning

9. Does your IA have a built-in review mechanism? If so, please describe it briefly.

We use the Executive Committee and their National network of experts for built - in review.

10. Does your IA have an up-to-date Strategic Plan? (Please attach.)

Strategic plan for 1999-2003 is attached.

11. What procedures are used in developing the Strategic Plan? How often is it updated?

We have designated a group at the ExCo meeting in December 1997 to work with the new Strategic Plan for the period 1999-2003. This group reviewed the previous Strategic Plan, update and make it valid for 1999-2003. Two workshops have been arranged in conjunction with the ExCo meetings in 1998 for this purpose. The final Strategic Plan was approved by the ExCo in Spring 1999. The previous Strategic Plan was for the period 1994-1997.

12. In what ways is the current Strategic Plan influencing the work of the IA (e.g., tasks or annexes pursued; operation of activities; end-products; IA management)?

We have pursued the objectives of our plan and have successfully achieved most of them. We also work with the current reality and situation. The reality leads the way we run the IA and the Strategic Plan is our way to predict it. Workshop in Montreal in January 1995 and the meeting with the EEUWP in April 1995 gave the ExCo clear instructions.

D. ACHIEVEMENTS AND BENEFITS OF CO-OPERATION

Technology Development

1. How has the Agreement contributed to technology development?

Previous annexes have substantially contributed to ***technology development*** and have been crucial for the continuous development. Annex 8 and 9 are also important for the development. Annex 9 has provided a very effective bridge between the work being carried out in North America and Europe. The Annex has had a very strong "applications" focus and has therefore helped steer the direction of researchers and developers in the field of "utility scale" electrical energy storage. The other new annexes 10-14 that started after December 1997 have not contributed yet.

2. Please provide success stories you may have concerning the development of new technologies or techniques (e.g., new knowledge, technology adaptation, development of codes, measurement protocols, etc.).

Annex 8 with further implementation of aquifer and borehole storage technology. Cold storage is a real technical and economical success, not only in Sweden but also in the Netherlands. Aquifer Thermal Energy Storage has a great success in Belgium. Several plants with direct cooling have been built in Germany. Particularly, underground cold storage in combination with the newly developed "Energy Piles" is rather successful and now grows without further help from governmental financing. Some examples for Germany:

- GSHP with direct cooling for the Neantertal Museum, Mettman, Germany (1996)
- Aquifer cold storage for the Reichtag Building, Berlin, Germany
- Energy Piles with cold storage for the Main Tower of the Helaba - bank. Frankfurt, Germany.
- a number of smaller plants with GSHP and direct cooling for office buildings at various places in Germany.

Annex 9 has identified as one of its final conclusions the synergy between electrical energy storage and the integration of large amounts of energy from renewable energy sources (such as wind and photovoltaics).

3. Have important publications resulted from collaboration through this IA? If so, please provide examples.

See publication lists in the annual reports. Examples:
The Stockton project (A large borehole storage plant) and its videotapes have influenced many large projects including some in the US (California, Virginia, etc.) as well as in Sweden and Germany.
There is an article in Swedish Building Research, 1997. US found out about a Swiss roadway deicing project and Energy Piles from the Conference information. There are now one of each of those projects in the US. (Even though the data was never asked for , the ideas and success was transmitted to the US.)

Annex 8: workshops in Adana, Turkey (1995), Halifax, Canada, (1996), Leuven, Belgium, (1997), Stockton, USA (March 1998).

Technology Deployment

4. How has the Agreement contributed to technology deployment?

Through the annex works; in particular annexes 8-14. This occurs through demonstrations in each country. Cooperation in Annex 8 has led to a large scale implementation program in Belgium.

5. Please provide success stories you may have concerning the development of new technologies or techniques (e.g., Has it assisted in the creation of agreed performance measures for new technologies? In the development or harmonisation of standards?).

Annex 8: Implementation of an extensive program on demonstration plants in the Netherlands.
Annex 9: The production of the software assessment packages and the increased understanding of the systems applicability have already focused thoughts on a number of possible applications, demonstration schemes to be addressed in the second phase of the annex 9.
See also question D2.

6. Has the Agreement engaged in information dissemination activities associated with market deployment of technologies? If so, what are the target audiences? How is this information used by the audience?

Various publications about Low Temperature Thermal Energy Storage in Ducts and Aquifers by CADDET (Sanner, Hellström, Nordell)
Assisting the Geothermal Consortium in the USA with modelling, etc.

Networking

7. How has the agreement contributed to International networking, including networking between researchers and end users in universities, governments and industry?

Example: We have contributed to the Heat Pumping Newsletter with information about the activities of the IA.

8. How has the networking contributed to the flow of information and improvement of research and demonstration programmes in participating countries?

Each of the active persons contribute to the dissemination of information in the country. There are national networks, often in the form of National Teams.

9. What are the particular strengths and weaknesses of the network compared with alternative networks in the field (for example, university links, bilateral links between countries, international research or trade associations)?

The strengths are the network with people that know each other well and have short ways of communication and they represent different positions in the society. Example: The Lund University SBM model was an important tool in designing the Stockton UTES system and Göran Hellström, project manager, was instrumental in giving access to software.

Policy Relevance

10. Does the Agreement help participating governmental agencies evaluate the status of particular energy technologies? Are there examples in which this has contributed to effective energy and environmental policy making?

Internationally, yes. Hopefully, yes, in most of the countries. Example from the US. The New Jersey Board of Public Utilities and the US DoE are funding a project to re-write environmental regulations to reduce first cost barriers while ensuring the integrity of the ground water for drinking. Work from the Netherlands and other participating countries will help in this analysis.

11. Has the Agreement contributed to the transfer of technology to non-OECD-Member countries?

To some extent, yes. Non-member countries have expressed interest to participate in annexes and the IA.

Environment

12. Has the Agreement made any contributions to dealing with environmental issues that are worthy of note because of their large impact or because they relate directly to mitigating environmental damage (as distinct from contributing indirectly by helping to reduce energy consumption)?

The Environment issues are important and go through all the activities. See also question 10.

More efficient Use of Resources

13.How has the Agreement enabled participants to share costs and pool technical resources? Give concrete examples?

In the annexes activities are task or task/cost shared. Technical workshops are arranged to discuss results and technical matters.
Examples:
Annex 8: Shared activities in dissemination (e.g. Workshops), software list etc. Shared efforts in state of the art reports.

14.Are there examples of information transfer, either in research or technology demonstration, that have enabled participants to avoid duplication or mistakes?

For all activities : Avoid earlier mistakes. State of the art reports are essential.
Example from the start-up process of annex 12:
A first discussion on contiuing co-operative R&D within the IEA framework took place at a HT-UTES workshop in June, 1996, during the IEA ECES Annex 8 expert's meeting in Halifax, Canada. In April 1997, a dedicated workshop on HT-UTES within IEA ECES was performed in Berlin, Germany with international attendence. This workshop was a platform for a first review of the state of the art and the future opportunities, and resulted in the recommendation to proceed in establishing a relevant annex. In December 1997 just before the ExCo-mmeting, a final preparatory meeting took place in Paris, France, and the annex was accepted by the ExCo at the December 1997 meeting. The preparatory activities helped to shape the objectives and workplan and allowed to begin with information exchange at an early stage. The objectives of this annex are to demonstrate that the 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-systems concerned shall be confined to Aquifer storage (ATES) and Borehole/Duct storage (DTES).

Various benefits will be achieved with HT-UTES (Annex 12):

- Energy conservation (as stated in the tile of the IA). HT-UTES will allow to use renewable energies like solar thermal energy, which otherwise has bad characteristics in matching time of heat load and supply and to make use of waste heat in times where no heat load exists. In consequence, other (fossil) primary energy can be saved. Using HT-UTES, also the energy necessary for recovering the heat can be minimised.
- Environmental benefits (reduction of emissions). In unison with energy conservation the emission of carbondioxide and noxious gases will be reduced substantially. If waste heat can be used for storage, then thermal pollution caused by dumping this heat into the environment can also be mitigated. HT-UTES might here play a double role in reducing flue gas emissions and decreasing thermal emissions simultaneously.
- Economic benefits and improved reliability. It is expected to achieve eventually a good economic basis for HT-UTES, at least in plants making use of otherwise wasted thermal energy. Reliability can be very high, provided the relevant techniques (e.g. water treatment) will successfully be demonstrated.

15. Has the Agreement strengthened national R&D capabilities for any of the participants through improved access to personnel exchanges, training, information, technology or equipment?

For most of the countries - yes. Examples can be found at various places in this document.

Overall Significance of Agreement

16. What are the main achievements of the Agreement during the present term? Does any one stand out as especially important?

Initiation of several new Annexes with new topics (e.g. electrical energy storage in Annex 9). Reaching out to new communities of storage technologies such as fuel cells, batteries, flywheels, SMES, renewables and making their work relevant to electrical utility planning.

17. If there are other international collaboration organisations in the area, what are the main strengths and weaknesses of the IEA agreement in comparison to them? How would you say that the IEA collaboration is rated, compared to these other organisations, by participants and by non-participants?

A comparison among other international organizations in the area is not available, but our IA may be regarded as strong with over 20 participating countries and a long history of collaboration. See attached Strategic Plan for strengths and weaknesses of our program. The IEA collaboration is more effective in the experts' level co-operation.

18. In your view, are there any important actions that would improve the Agreement and its activities?

Broadening the scope of work, starting new annexes will certainly attract new countries. The driving force of the IA is, no doubt, the ongoing annexes.

Other activities

Collaborative Groups, Workshops and Meetings

IEA-Workshop Advanced Solar Storage Technologies for Low Energy Buildings, 30-31st August 2000, University of Stuttgart, Germany

Joint Executive Committee Meeting with ECBCS IA planned for November 6, 2000, Tokyo, Japan

Participation in Future Buildings Forum, Building Coordination Group and Building Related Implementing Agreements

APPENDICES

APPENDIX 1 - IEA GENERAL INFORMATION

Framework of the International Energy Agency (IEA)
Established in 1974 with headquarters in Paris, the IEA is the energy forum for 24 industrial countries - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Union also participates in the work.

The IEA, based in Paris, is an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD). The IEA's main decision-making body is the Governing Board, composed of senior energy officials from each Member country. Under normal circumstances, the Governing Board holds regular meetings several times a year. Meetings at Ministerial level are held every two years.

The Governing Board directs the activities and makes the major policy decisions of the IEA. It regularly reviews the world energy situation as well as domestic energy policies to assess future energy supply and demand patterns and to determine policies to meet changing energy and economic conditions.

A Secretariat, with a staff of energy experts drawn from Member Countries, supports the work of the Governing Board, the Standing Groups and Committees. The IEA Secretariat collects and analyses energy data, assesses Member countries' domestic energy policies and programmes, makes projections based on differing scenarios and prepares studies and recommendations on specialised energy topics. An Executive Director appointed by the Governing Board heads the IEA Secretariat.

The countries participate in the IEA to safeguard the members' collective energy security, and thereby reduce the economic risks, associated with energy shortages. Steps to safeguarding from economic risks has included reducing dependency on oil imports, the sharing of oil supplies in emergencies, the promotion of more stable world oil markets and the initiation of collaborative research on new and efficient energy technologies.

The future promises fundamental changes in the global energy balance. Higher economic growth rates will result in non-industrialised nations accounting for more than 60% of the world energy demand by the end of the century. The growing concern for environmental issues also having a strong influence on the nature of national and global energy priorities. IT appears that the need for international collaboration in energy strategy continuing to increase in importance.

Objectives

- To maintain and improve systems for coping with oil supply disruptions;
- To promote rational energy policies in a global context through co-operative relations with

non-member countries, industry and international organisations;
- To operate a permanent information system on the international oil market;
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- To assist in the integration of environmental and energy policies.

Shared Goals

The 24 Member countries of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments.

IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

- Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydropower, make a substantial contribution to the energy supply diversity of IEA countries as a group.
- Energy systems should have the ability to respond promptly and flexibly to energy emergencies. In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.
- The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.
- More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.
- Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by Governments and all energy users are needed to realise these opportunities.
- Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.
- Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary

and practicable, the environmental costs of energy production and use should be reflected in prices.
- Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.
- Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

The IEA Ministers adopted the "Shared Goals" at their 4 June 1993 meeting in Paris.

Committee on Energy Research and Technology (CERT)
Fostering energy technology innovation is a central aspect of the IEA's work. Development of safer, more efficient technologies is imperative for energy security, environmental protection and economic growth. Equally essential is the widespread deployment of these more economical, environmentally benign technologies. But progress in energy technology research, development, demonstration and deployment implies investment. Two decades of IEA experience have shown that international collaboration on these activities avoids duplication of effort, cuts costs and speeds progress.

The IEA's Energy Technology Collaboration Programme operates under the guidance of the Agency's Committee on Energy Research and Technology (CERT) and its subsidiary bodies dealing with technologies for fossil fuels, renewable energy, efficient energy end-use and fusion power, as well as its expert groups on electric power technologies and technology assessment methodologies. The Programme enables experts from different countries to work collectively and share results, which are usually published. The Programme's objectives are
- improved energy efficiency and technology reliability;
- enhanced access to up-to-date assessments of energy technology performance;
- reduced environmental impact of energy-sector activities;
- Co-operation with non-member countries.

Practical elements of the Programme include:
- policy analysis through reviews of energy technology and R&D programmes in Member and selected non-member countries, thereby encouraging common approaches;
- sharing of practical experience and exchange of information through joint studies, conferences and workshops that monitor technological advances in key areas and enhance visibility for leading-edge techniques; and
- collaborative research projects. IEA Implementing Agreements offer the framework for these collaborative research projects.

The projects aim to:
- expand basic understanding of existing technical processes and reduce their costs;
- remove barriers to market deployment;
- foster sharing of operating experience and expand general awareness of technological capabilities.

The Implementing Agreements provide the legal mechanism for establishing participants' commitments and the project's management structure, and for ensuring distribution of benefits from

the co-operative work while protecting participants' intellectual property. Activities are managed jointly by experts from IEA Member and non-member countries (representing government bodies, industry, academia and other international organisations). Resources come from participants. Benefits include not only pooled resources and shared costs, but also harmonisation of standards and hedging of technical risks. The IEA programme places emphasis on expanding co-operation with industry.

More than 30 countries are involved in Europe, America, Asia, Australia and Africa. Flexible and dynamic, the programme is expanding steadily as the advantages of international collaboration secure wider recognition. Some forty Agreements operate currently, involving a total of some US$100 million. They cover the full range of technologies used in the production, transformation, distribution and end-use of energy. Among the many areas covered by Agreements are bio-energy, solar heating and cooling, wind turbine systems, advanced fuel cells and electric vehicles. Energy technology information centres have also been set up under the programme. Concern for the protection of the environment is reflected strongly in the mandates of both long-standing and more recent Implementing Agreements.

Working Parties

The four Working Parties are the Working Party on **Energy end-Use Technologies**, the Working Party on **Fossil Fuels**, the Working Party on **Renewable Energy Technologies** and the **Fusion Power Co-ordinating Committee**. Working parties are composed of government officials from member countries who have a broad knowledge of their countries' activities in those particular areas. They help focus research and development initiatives and review the status of technology development and deployment. Working Parties identify areas of mutual interest among countries and, if warranted, initiate Implementing Agreements, which they then review and guide on a regular basis. Working Parties also exchange information on the status of national programs and on the development of technologies.

Working Party on Energy End Use Technologies

Infrastructure energy systems, buildings, industry, agriculture and food, electricity end-uses and crosscutting technologies are the current thrust areas of this Working Party. The following lists the active Implementing Agreements of the IEA which are guided by the Working Party on Energy End-Use Technologies.

Implementing Agreements

- Advanced Fuel Cells
- Alternative Motor Fuels
- Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET)
- District Heating and Cooling
- Electric Vehicle Technologies and Programs
- Energy Conservation and Emissions Reduction in Combustion
- Energy Conservation in Buildings and Community Systems
- Energy Conservation through Energy Storage
- Energy Technology Data Exchange (EITDE)
- Impacts of High-Temperature Superconductivity in the Electric Power
- Program of Energy Technology Systems Analysis (ETSAP)

- Pulp and Paper

An **Implementing Agreement**: is a framework, which facilitates the initiation, implementation monitoring and review of international collaborative efforts. Implementing Agreements can encompass any phase of the technology cycle research and development demonstration, validation of technical environmental and economic performance: market deployment or information: exchange: Member countries choose to participate in those-Implementing Agreements which best meet their needs.

Implementing Agreements are flexible and are set up to meet the requirements of those countries that wish to take part. Participants can be member country government organisations, semi-private entities (including universities) and private organisations when formally designated by the national government. Non-member countries may also join a given Implementing Agreement under a mechanism termed **Associate Participation**, provided **they obtain prior consent** from the IEA Governing Board. Private organisations not formally designated by their government, and non-intergovernmental international entities may also join the Implementing Agreement under a special designation termed **Sponsor Participation** provided they obtain prior approval from the Committee on Energy Research and Technology.

The initiative for an Implementing Agreement is usually taken by interested countries, which work with the IEA Secretariat and the Working Parties to draft a program of work. The proposed Implementing Agreement is first considered by CERT and then by the IEA Governing Board. Once approved, an **Executive Committee**, made up of one representative from each country, which joins the Agreement, develops a strategy for carrying out the research and development. If an implementing Agreement involves sizeable or varied work, it may be broken down into Annexes. Interested countries may choose to join all the Annexes, or only those which fulfil their requirements. An **Operating Agent** is elected for each Annex to act as project manager;

The IEA has no central funds to finance the Implementing Agreements, thus all resources are supplied by the participating countries. Two methods exist for financing an Implementing Agreement:

1. Cost-sharing: the participating countries contributing monetary resources to a common fund for equipment purchase or the operation of test facilities or information processing centres, and

2. Task-sharing: each participating country undertakes to devote specific resources and personnel to carry out part of a common work program.

Implementing Agreements are legal documents signed at a senior level such as the ambassador to the OECD.

APPENDIX 2 - 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
	Ongoing Annexes
8	Implementing Underground Energy Storage Systems
9	Electrical Energy Storage Technologies for Utility Network Optimisation
10	Phase Change Materials and Chemical Reactions for Thermal Energy Storage
12	High Temperature UTES
13	Design, Construction and Maintenance of UTES Wells and Boreholes
14	Cooling in All Climates with Thermal Energy Storage
	Planned Annexes
15	Electrical Energy Storage and the Integration of Renewables
16	Engineering textbook on thermal energy storage and renewable energy

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 an 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, micro-biological 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.

Ongoing Annexes

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.

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.

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 at 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 December 2000.

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.

APPENDIX 3 - 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	The Swedish Council for Building Research
The Netherlands	NOVEM, The Netherlands Agency for Energy and the Environment
Turkey	Cukurova University
UK	EA Technology
USA	US Department of Energy

APPENDIX 4- LIST OF PUBLICATIONS

Strategy Plan 1999-2003

Annex 9

Collinson, A., Stones, J.C.& Tyson, A. "Electrical Energy Storage:Network Application Case studies" EATL Report No. 4829, April 1999.
Collinson, A., Stones, J.C.& Tyson, A. "Electrical Energy Storage:Costed project definitions for selected applications" EATL Report No. 4825, May1999.
Collinson, A., Stones, J.C.& Tyson, A."Applications Modelling of energy storage", EATL Report No. 5029, November1999.
Stones, J.C. "Power Quality Applications model" Software model, September 1999.
Collinson, A., Stones, J.C.& Tyson, A. "Annex IX Phase 2 (Electrical Energy Storage) Final Report" EATL Report No. 4073, November1999.

Annex 10

Marketing brochure
Country state-of-the-art reports
Materials database
Fact sheets for case studies and demonstration projects

Annex 14

Draft state-of-the-art report for Canada
Draft state-of-the-art report for Japan
Draft state-of-the-art report for Sweden
Draft state-of-the-art report for Turkey
Annex 14 First Workshop, June 4-5, 1999, Antalya, Turkey, CD-ROM containing papers presented at the workshop