ANNUAL REPORT

2013

International Energy Agency

Energy Conservation Through Energy Storage Programme

Contents

Preface

ENERGY CONSERVATION THROUGH ENERGY STORAGE IMPLEMENTING AGREEMENT

The Implementing Agreement (IA) started in 1978. Its present term ends by February 2016. At present Contracting Parties from the following countries have signed the Implementing Agreement: Belgium, Canada, China, Denmark, Finland, France, Germany, Italy, Japan, Korea, The Netherlands , Norway, Slovenia, Sweden, Turkey, USA and the Institute of Heat Engineering (ITC) of the University of Technology, Warsaw, Poland and University of Lleida from Spain as sponsors. The Executive Committee is working intensively to attract more countries to not only join the activities but also sign the Implementing Agreement. Ireland, New Zealand, Australia, India and Chile are interested. Experts from several countries do already participate in the Annex work as observers.

According to the new Strategy Plan (2011 – 2015) approved in 2010 the strategic objectives for the IA remain as follows:

Technology: Maintain and develop international technical R&D collaborations that further the environmental and market objectives.

Environment: Quantify and publicise the environmental and energy efficiency benefits of integrated energy storage systems.

Market and Deployment: Develop and deliver information to support appropriate market deployment and provide effective collaboration and information to stakeholders.

The Executive Committee coordinates 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.

Introduction

We need energy - electrical or thermal - but in most cases not where or when it is available. Enjoying the sound of music while you are jogging, you can not stand beside the socket: electrical energy storages - batteries – make you mobile. The energy you need is stored for a short while and over the distance you like to run. Having a cold beer on a summers evening was possible even before cooling machines were invented. At that time people were cutting ice from the lakes in winter, transported the ice to the brewery and stored it in deep cellars. The cold was stored or the winter to the summer: An example for long term thermal energy storage and the utilization of renewable energies. In cold climates surplus solar heat from summer can be used in winter for heating of buildings by seasonal storage. Waste heat from industrial processes, steam from solar thermal power plants or electricity from photovoltaic panels are examples for energy sources, which can not be used more extensively without energy storages.

A huge potential of energy sources substituting fossil fuels can only be exploited by energy storage systems, utilizing renewables like solar thermal, PV and wind energy. Thermal and electrical energy storage systems enable greater and more efficient use of these fluctuating energy sources by matching the energy supply with the demand. This can finally lead to a substantial energy conservation and reduction of CO_2 emissions. The growing peak demand of today’s energy consumption, essentially caused by electrical air conditioning, leads more often to blackouts all over the world. Such a problem - the shifting of a peak demand for only a few hours or minutes - can be solved by cold storage technologies. In this context energy storages can be the best solution not only from the technical point of view, but also for economical reasons. The energy to be stored can be either electrical or thermal. Both energies require completely different storage technologies. However, in the actual application both technologies can meet: The peak demand of electricity for example is in most cases caused by air conditioning, which is a thermal task. The cooling demand can be covered by a cold store (ice or chilled water) which is charged at off-peak hours by electric chillers. Energy storages can be described by their storage capacity (stored energy per mass or volume), power (energy output per time), storage period (how long the energy should be stored) and size. All these parameters can vary over a huge scale: From latent heat storage to prevent laptops from getting too hot (stored energy in the range of a few Wh) to the heat and cold thermal underground storage system underneath the German Reichstag in Berlin (stored energy in the range of some 2 GWh).

Many governments have committed themselves to reduce CO_2 emissions into the atmosphere. They have decided to strengthen their national efforts and the international cooperation for research and development (R&D) in the International Energy Agency (IEA) and 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. Energy storage technologies can help to solve problems caused by the intermittent energy supply of these sources. There is a huge potential for the application of energy storage systems. The fact that energy storage systems are not as widely used as they could is due to several reasons. In particular because most new storage systems are not yet economically competitive with fossil fuels and their long term reliability and performance is not yet proven. There are still some regulatory and market barriers which have to be overcome. Therefore further attempts are being made to resolve these issues. The IEA Implementing Agreement on Energy Conservation through Energy Storage provides the platform for international cooperation (www.iea.org) in R&D. After almost three decades of R&D the emphasis of the cooperative R&D efforts has shifted towards the implementation and optimal integration of new storage technologies for an efficient use of energy and renewable energy sources. In the future more application oriented topics like thermal energy storage for cooling and industrial processes or mobile thermal storage systems for the utilization of waste heat will be investigated. The issue of implementation and deployment of new energy storage technologies has become a higher priority as the R&D phase is concluding

Chairman's Report

The following disadvantageous developments of the year 2013 indicate that world decision makers do not yet understand the risks of climate change:

- Fracking shale gas deposits in USA
- Summer heat waves setting electric demand records in the UK
- Severe air pollution seen in major cities of China

Efforts to alleviate the climate change through especially more solar and wind capacities bring new challenges. There are problems with integrating renewable energies into the grid and distributed generations in countries such as Germany.

Energy storage is the key element of low carbon energy technologies that posess integrated renewable energies. Thermal and electrical energy storage systems can be used separately or in complementary to each other to make systems more energy efficient and cost effective. Two important facts have to be taken into consideration in structuring future energy systems: Total cost of ownership of thermal storages in USD/kW is less than in the order of 4-10 times compared to different electrical storages and the demand for heating and cooling in final energy consumption in most countires is more than 40%. These numbers show that 100%"electrification" cannot be the sole answer to the energy problem of today.

2013 has been another very active and productive year for ECES. We are addressing different aspects of current challenges though our Annexes and collaborations with IEA and/or non-IEA bodies.

On our Annex level, we have completed Annex 24 – Compact Thermal Energy Storage: Material Development for System Integration, started Annex 29 – Material Research & Development for Improved TES Systems, in continuation and as a joint annex with IEA Solar Heating and Cooling Programme. Furthermore, a new annex looking at the issues of distributed energy storages, Annex 28 – Distributed Energy Storage for Integration of Renewable Energies has been approved. Under preparation are three other new Annexes: Annex 27 – Quality Management in Design Construction and Operation of Borehole System Annex 30 – TES for cost-effective energy management and CO_2 mitigation and Annex 31 – Energy storage with Net Zero Energy Buildings and Districts: Optimization and Automation.

One of the highlights of 2013 was our contribution to IEA Energy Storage Technology Roadmap. This has been a motivating and eye-opening experience for us. We tried to coordinate with IEA's energy storage team in this mission. I hereby wish to thank IEA team for their cooperation and all our delegates and experts who have contributed to the preparation of this document. Our current experiences show that energy storage as a whole is still misunderstood. More data and modeling tools are needed to indicate the role of energy storage technologies clearer in the complete energy picture.

We continue our co-operation with other IEA bodies. Prof. Luisa Cabeza from the University of Lleida has represented us in the IEA EUWP Energy Efficiency in Industry Workshop in Brussels, 20 March 2013 and I gave a presentation at IEA Future Buildings Forum Workshop on "Transforming the Built Environment by 2035" in Soesterberg, 11-12 April 2013.

Reaching out to new members and re-activating some existing (yet inactive) members continued in 2013. The Netherlands has completed its formal procedures and signed the Implementing Agreement. We had observers from both Ireland and Chile showing interest in joining us.

The preparations for our next tri-annual conference are under way. Greenstock - 13th International Conference on Energy Storage will be organized by China in Beijing in May 2015.

I would like to thank our delegate Josefine Wejerstrand from Sweden who will be leaving our group. I hereby give a very warm welcome to our new delegates who have joined us in 2013: Lex Bosselaar, delegate and Teun Bokhoven, alternate delegate from Netherlands, Paul Sra, our delegate from Canada,, Jennica Broman delegate from Sweden, Hyun-Choon Cho delegate from Korea and Yuriko Terao alternate delegate from Japan. IF Technology from Netherlands has withdrawn from being our sponsor member, when Netherlands joined us as a full member. I would like to thank IF Technology for their contributions to ECES over the years.

Last but not least, I wish to thank all the members of our Executive Committee, our Operating Agents, the experts of Annexes, our secretary Hunay Evliya, our webmanager Yeliz Konuklu, and the IEA desk officer John Dulac each, for their excellent contributions to the collaborative work and success of ECES.

Halime Paksoy, Chairman ECES

Ongoing Activities

In 2013 five Annexes were performed by the "Energy Conservation through Energy Storage" Implementing Agreement.

Annex-No.	Title	Time Schedule	Operating Agent
21	Thermal Response Test	2007-2010	ZAE Bayern/Germany
23	Applying Energy Storage in Buildings of the Future	2009-2013	Concordia University/Canada
25	Surplus Heat Management using Advanced Thermal Energy Storage Technology	2010-2013	University of Leida / Spain
26	Electric Energy Storage: Future Energy Storage Demand	2010-2013	Fraunhofer Umsicht/ Germany
29	Material Research and Development for Improved TES Systems	2013- 2015	ZAE Bayern/ Germany

Annex 23 : Applying Energy Storage in buildings of the Future

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Duration of Annex:
October 2009 - December 2013.

Overview of scope

Sustainable buildings need to be energy efficient well beyond current levels of energy use. They need to take advantage of renewable and waste energy to approach ultra-low energy buildings. Such buildings need to apply thermal and electrical energy storage techniques customized for smaller loads, more distributed electrical sources and community based thermal sources.

The general objective of this Annex was to ensure that energy storage techniques are properly applied in ultra-low energy buildings and communities. Applications of these designs are foreseen in recent years where total carbon dioxide reduction is required. Proper application of energy storage is expected to increase the likelihood of sustainable building technologies and may well be necessary for the wide scale adoption of sustainable buildings.

ANNEX 23 was initiated with the aim of answering the following question “How heat storage technologies can be best integrated into future ultra-low energy buildings?” So, to answer the above question, five subtasks were formulated:
Specific objectives of Annex 23 include:

- Assess the potential of harnessing natural energy sources to supply building heating and cooling through energy storage;
- Assess the use of energy storage to optimize the efficiency of distributed generation;
- Develop and evaluate energy storage conceptual designs suitable for specific applications; and
- Develop guidelines and procedures to estimate the environmental performance of energy storages when applied in ultra-low energy buildings and communities

Contracting Parties or Sponsors participating and representing institutes:

Country	Research Group
Canada	Concordia University Public Works Government Services Canada Laboratoire des Technologies de l'énergie d'Hydro-Québec
China	Tsinghua University
Denmark	Technical University of Denmark
France	CETHIL, INSA de LYON La Rochelle University École Nationale des Travaux Publics de l'État University of Savoie
India	Anna University
Norway	Norwegian University of Science and Technology (NTNU)
New Zealand	University of Auckland
Spain	University of Lleida University of Zaragoza
Sweden	Chalmers University of Technology Dalarna University
Turkey	Dokuz Eylül University
UK	University of Ulster

Activities / achievements:

Subtask A carried out a survey which included seventeen projects: six from Canada, four from France, three from China, three from Sweden and one from Spain. These projects covered a wide spectrum of applications and were based on various storage materials.

The review performed within subtask B reported only a qualitative analysis could be made because case studies differ widely or data are not sufficiently detailed. Concerning thermal energy storage materials, both sensible and latent storage materials are reported in the projects of subtask A. For sensible materials, it is water, brick and concrete which are well described in the review of subtask B. It is the same for latent storage materials (PCMs and ice) except for snow. In addition, subtask A projects contain both passive and active thermal storage systems. The passive systems are PCMs embedded in structure buildings for cooling whereas active systems cover a wide range of technologies and applications. Thus, storage tanks (water, ice and snow) are the most used while ventilated concrete slabs and borehole storage in rock are used both for heating and cooling. Four projects use solar energy as renewable energy. The storage temperature of the projects ranges from low to high, 0°C to 900°C. Lastly, only three projects are long term (seasonal) storage systems. Except for the snow stored in a shallow pond, all these systems are described in detail within the review of subtask B. Indeed, subtask A projects cover a wide range of applications but neither of them is a thermo-chemical or electrical energy storage system.

In conclusion, a general agreement was observed between the survey of the real applications (subtask A) and the literature review (subtask B). It was also concluded that it is very difficult to extract general design rules or even simple practical results from the scientific literature. This problem arises from the fact that there is almost no inter-comparison between various designs. In most studies, the optimization of a single particular configuration is studied. Even for models, each group tends to use its own in-house solution without systematic comparisons with others. In addition, performances of energy storage systems are strongly related to local climatic conditions, which add to the difficulty of the reutilization of previously published results in subsequent research as a comparison basis.

Subtask C dealt with the modeling of new sustainable TES (Thermal Energy Storage) or improvement of promising existing systems that have potentials to be successfully integrated with a variety of ultra-low energy buildings. Therefore several kinds of TES models have been analyzed even if this subtask is mainly focused on PCM. The subtask carried out intermodal comparison of the existing models. A number of numerical benchmarking were developed and proposed to participants. Figure 1 represents the surface temperature evolution for a wall integrating a PCM.

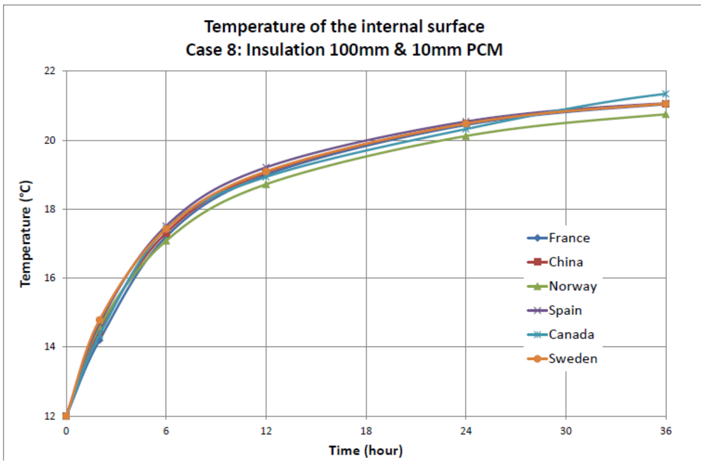

Figure 1: Evolution of the internal temperatures. Case 8

A number of simulation models were developed to simulate the performance of building with integrated PCM within building envelope, with the mechanical ventilation system (air handling unit), and with the domestic hot water tank. The developed simulation tools were validated with the experimental data which were collected within Task D and from literature.

Figure 2 shows the prediction of a validated 3-D transient numerical model of a centralized latent heat thermal energy storage (LHTES) system filled with paraffin RT20. The centralized LHTES system is integrated into a mechanical ventilation system of a building. The thermal performance of LHTES system is assessed using hourly inlet air data obtained from the national climate data and information archive, Canada for summer months. The dashed area epresents the amount of cooling load that was removed using the control strategy by switching to the LHTES system. This results in a reduction of 63% in the total required cooling load for June 1st.

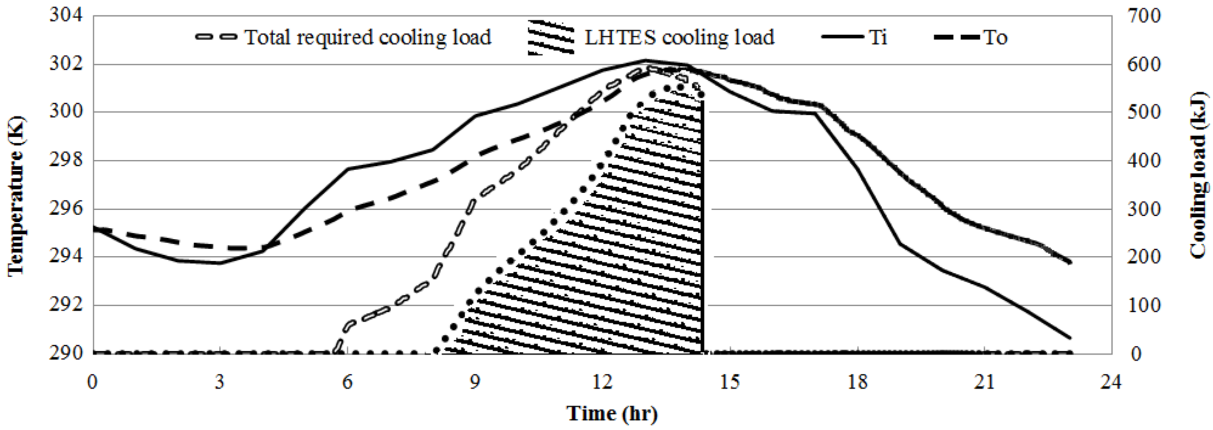

Figure 2. Hourly variations of the measured ambient air and LHTES system's outlet air-temperatures for June 1st and the cooling load of the LHTES

In Task D of Annex 23 one of the main goals was to simplify the selection and design process. This issue is addressed by investigating different technologies under development, its potential benefits and the current status. This will allow architects and engineers to select the correct technology for a specific problem based on the expected benefits that have been determined by detailed measurements and analysis in experimental set-ups. This study also offers detailed information of each analysed system in order to provide the designers an insight to the previous experiences.

The activities in the Task E are limited to thermal storage in building elements and components, and mainly PCM. PCM based components can be used in different parts of the building envelope such as internal/external walls, floor and ceiling, thus the orientation of the component has also influence on thermal behavior of the building. It was reported that PCM must be well encapsulated before it can be used in any application, especially when is used in building envelope. The available microencapsulated/ macro encapsulated products vary in quality with regards to leakage. PCM application in building requires perfect encapsulation to avoid leakage through evaporation/ sublimation, which will have two following negative impacts;

(1) Environmental issues since the leaked vapour will go to the interior of the building,

(2) Evaporation leads to change in the melting range. The PCM melts at higher temperatures compared to the original one and hence a PCM, which work well, may not work well later. For examples paraffin waxes may lose the more volatile component while ester does not lose weight at all but rather gain weight due to moisture absorption.

However, PCM should never be used in all rooms or locations in the building, otherwise the payback period will be more than 15 years. Its use must be optimised very carefully in order to reduce the payback period to 5 years

Finally, the designers need guidelines and simplified design tools for calculation of the energy saving, payoff time and life cycle assessment. As long as the standards, guidelines and calculation tools are not available, it will be very difficult to introduce latent heat based building products to the construction market.

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Annex 25: Surplus Heat Management using Advanced TES for CO2 Mitigation

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Duration of the Annex: 2010-2013

Overview of scope

The general objective of this Annex is to identify and demonstrate cost-effective strategies for waste heat management using advanced TES. New knowledge will be generated with regards to:

- The potential for advanced TES to minimize process waste heat through better process integration, enabling the use of waste heat for internal heating demands or cooling demands (via heat driven cooling).
- The potential for advanced TES to cost-effectively increase waste heat driven power generation in industrial applications.
- The potential for advanced TES to enable external use of heat from industrial-scale processes through effective thermal energy distribution.
- The potential for advanced TES to increase the utilization of waste heat in vehicles like on-board cooling and minimization of cold-start.
- The potential for advanced TES to increase the use of waste cooling (e.g., the large cooling potential associated with LNG regasification) and free cooling for comfort cooling applications.

Thus, a sub-goal of this proposed annex is to really dig into the waste heat utilization issue from a very broad perspective and show the great potential for using advanced TES towards reaching a resource efficient energy system where waste heat (and cold) is minimized. This has a good potential for attracting a large number of participants from a variety of disciplines and levels of R&D (basic research to commercial systems).

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Activities / achievements

Workshops:

6th Experts meeting and workshop

5-8 March 2013

Munich, Germany

8 participants from 5 countries

7th Experts meeting and workshop

7-8 October 2013

Adana, Turkey

20 participants from 4 countries

1 observer

Parallel workshop with Annex 23

Findings:

- Discussion on how to estimate the waste heat potential in countries started, and a methodology was agreed.
- The round robin test was commented and it was decided to also include in the final report a description of the apparatus available in the different labs for materials testing. The round robin test will continue after the Annex is finished.
- The importance of the energy mix and CO_2 factor were evaluated, and it was decided to include these topics in the final report.
- Waste heat potential accounting has been carried out by the ZAE Bayern and the University of Lleida and will be published and included in the final report.
- CO_2 assessment is divided between into embedded CO2 in the storage materials and the operational CO_2 reduction achieved by TES technologies. This will be reflected in the final report.
- The energy mix and CO2 factor have been assessed and will be included in the final report.
- There is interest to publish a common paper with the CO_2 findings of the Annex. Luisa F. Cabeza is in charge to follow this objective.
- There is a clear interest of the participants to start a new Annex in January 2014.

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Researchers exchange

Researcher	**Origin institution**	**Host institution**	**Topic**	**Dates**
Laia Miró	University of Lleida, Spain	ZAE Bayern, Germany	T-history high temperature analysis of PCMs	June-Sept 2013

Annex 26: Electric Energy Storage: Future Energy Storage Demand

Contact information for the operating agent:

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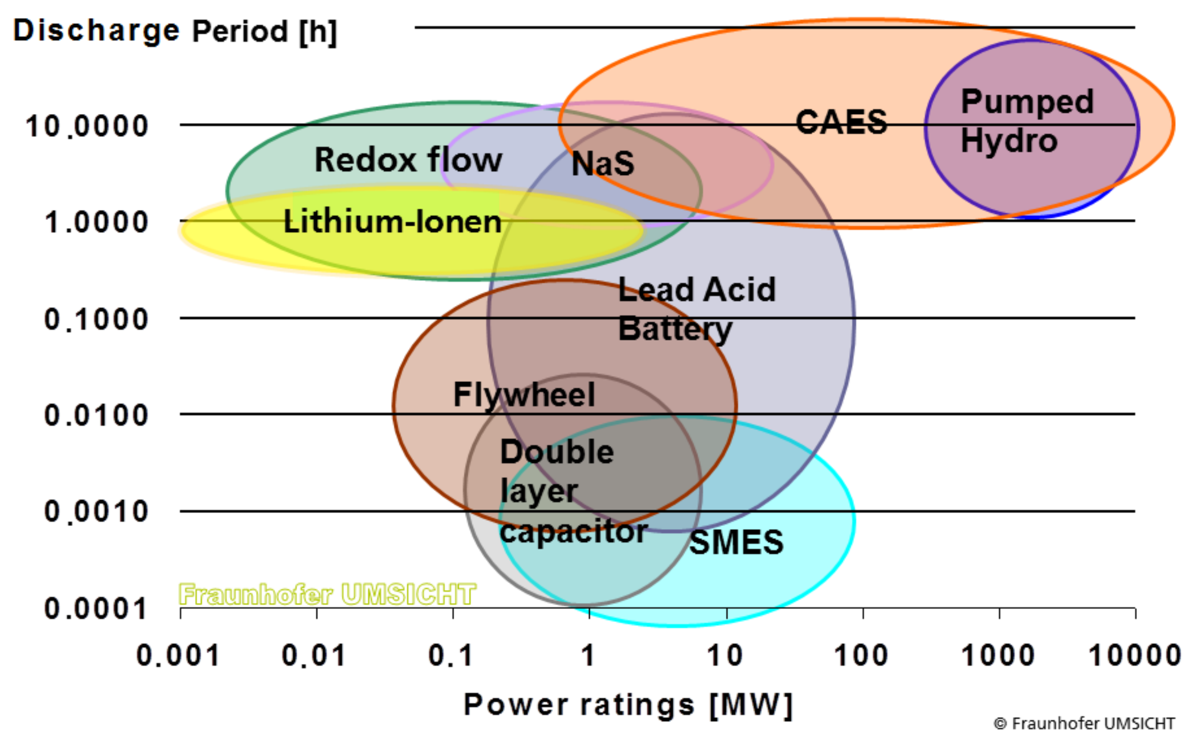
Duration of Annex:

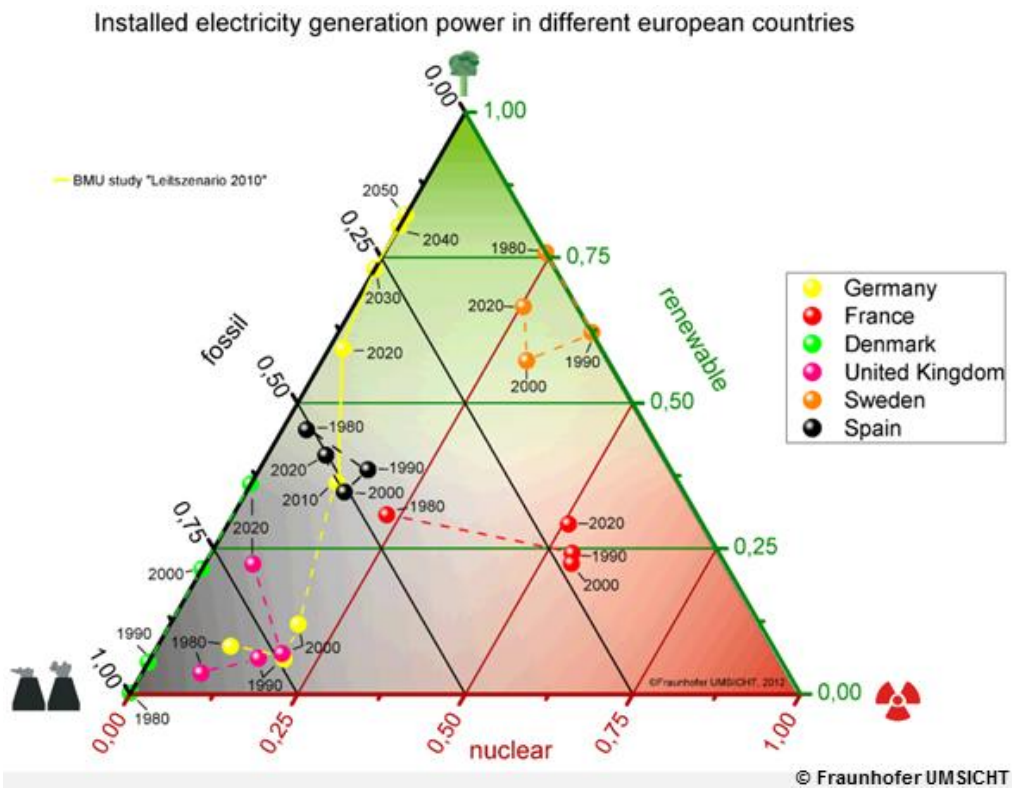
2010 until March 2014

Overview of Scope

The future of electricity network involves a massive penetration of unpredictable renewable energies. For insuring network stability as well as for maximizing the energy efficiency of such networks, storage is a key issue. Up to now, the integration of renewable energies did not take into account the demand side and was performed in a "fit and forget" way. The optimum evolution in an economic perspective is in the future to have an integration that is respecting the needs. One solution – beneath demand side management and grid extension – is the use of energy storages. The main purpose of adding energy storage systems in the electricity grid is to collect and store overproduced, unused energy and be able to reuse it during times when it is actually needed. Essentially the system will balance the disparity between energy supply and energy demand. Worldwide between 2% and 7% of the installed power plants are backed up by energy storage systems (99% pumped hydro systems). The future demand of energy storage devices is actually unknown. Only the main influence factors on this demand are known.



Survey about different storage technologies (>100 kW) realized in the world



Survey about power plant fleet in some European countries and the development

The main objective of this task is to develop a method or approach to calculate the regional energy balancing demand and to derive regional storage demand rasterizing the area and taking into account that there are competitive technical solutions.

Additionally there are two important aspects. On the one hand an overview about the different technical and economical and legal framework requirements in the different countries.

Case Studies: Running projects, planned projects and future projects of stationary energy storage systems.

And on the other hand typical operation modes for energy storages and derived from this typical charge/discharge curves, needed for future standardizations.

To reach these objectives, the annex is structured in four main work packages

I.	**Technical and economic framework conditions for electric energy storage systems** The aim is to give an assessment and a comparison about general technical and economic conditions in the different countries. Therefore a survey about realized storage systems, national technical key figures with their future development and economic framework conditions have to be examined. 1.1 Survey about type, number, power, capacity and efficiency of energy storage systems 1.2 Different alternative technologies for grid balancing 1.3 Survey about technical key figures of different countries (power plant fleet, grid structure, future scenarios and forecasts) 1.4 Survey about estimations about the future energy storage demand 1.5 Survey about economic framework for energy storage systems (e.g. special tariffs or laws) 1.6 Assessment and comparison of technical and economical general conditions Leader work package 1: Dr. Bert Droste-Franke, European Academy, Germany
II.	**Calculation method to determine spatial demand for electric energy storage** In this core work package a new, spatial mathematical method has to be developed and applied to derive the grid balancing demand and the energy storage demand as a part of it. 2.1 Survey of different methods to estimate the demand for grid balancing 2.2 Development of a detailed method to estimate regional demand for grid balancing 2.3 Development of a simplified method to estimate regional demand for energy balancing Leader work package 2: Dr. Yvonne Scholz, DLR, Germany
III.	**Applications of electric energy storage systems** In this work package general and realized / planned applications of electric energy storage will be described and examined to derive probable business cases. Last but not least other grid balancing options, which are competing solutions, are taken into account. 3.1 Survey about different general applications of energy storages 3.2 Special realized applications 3.3 Competing solutions Leader work package 3 (interim): Dr. Grietus Mulder, VITO, Belgium
IV.	**Requirements for test procedures** The aim of this work package is to develop guidelines – derived from applications – for testing energy storage systems. 4.1 Overview about considered storage technologies for test procedures 4.2 Definition of operation modes of typical energy storage applications 4.3 Deriving typical charging / discharging cycles 4.4 Guidelines for testing energy storage systems Leader work package 4: Dr. Marion Perrin, INES-CEA - France

Research participants

Company / Country	Name(s)
Fraunhofer UMSICHT / DE	Christian Doetsch Patrick Wrobel Annedore Kanngießer
Fraunhofer IOSB-AST / DE	Peter Bretschneider Steffen Nicolai Daniel Beyer
DLR / DE /	Yvonne Scholz Hans-Christian Gils Felix Cebulla
INES-CEA / FR	Marion Perrin Elisabeth Lemaire
Europaeische Akademie / DE	Bert Droste-Franke
VITO / BE	Grietus Mulder
RWTH ISEA / DE	Matthias Leuthold Christian Bußar
FFE /DE	Christoph Pellinger Tobias Schmid
VTT / FI	Raili Alanen
EON / DE	Christian Folke Gerbert van der Weijde

Meetings and workshops

- Kick-off Meeting, Germany, Oberhausen, 2010-Apr-08
- 2nd Meeting, Spain, Barcelona, 2010-Oct-25
- 3rd Meeting, France, Le-Bourget-du-Lac, 2011-Oct-19/20
- 4th Meeting Spain, Lleida, 2012-May-14/15
- 5th Meeting Belgium, Mol, 2012-November-07
- 6th Meeting Germany, Stuttgart, 2013-July-09
- 7th Meeting Germany, Berlin, 2013-Nov-20
- Final meeting: 8th Meeting, France, Paris, 2014-March-18

Impression of the 7th Meeting in Germany, Berlin.

Publications

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Christian Doetsch, Jens Burfeind, Batterietechnologien - jenseits von Lithium und Blei, Leopoldina-Symposium „Energiespeicher - Der Fehlende Baustein der Energiewende", Halle, Germany, 2014 Feb. 6th

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Annex 29: Material Research and Development for Improved TES Systems

Dr. Andreas Hauer,
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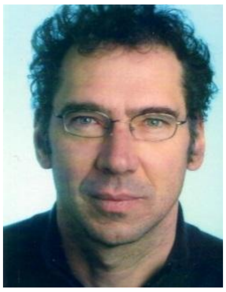
hauer@muc.zae-bayern.de



Start: January 2013
End: December 2015

At the Executive Committee Meeting in Auckland, New Zealand, November 2012, this Annex was approved. The objective of this joint Task with the IEA Solar Heating & Cooling Implementing Agreement is to continue the activities started in Annex 24 "Compact Thermal Energy Storage: Material Development for System Integration".

From the experience of the experts in the first period of the Task, it was concluded that one strong point elaborated is the interaction between the materials experts and the application experts, and the facilitation of this interaction by the division of the work into two subtasks: materials and applications.

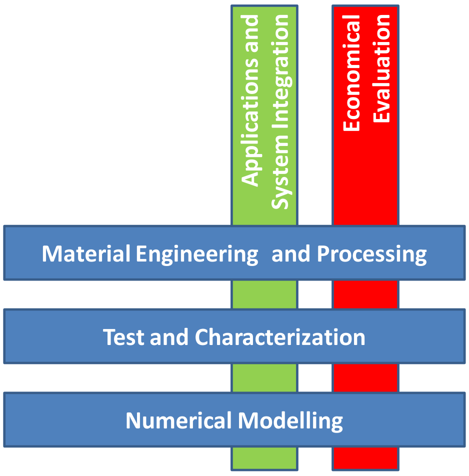


Figure 1: Structure of the working groups within Annex 29

The experiences of Annex 24 lead to the following new structure of the new Annex, depicted in **Hata! Başvuru kaynağı bulunamadı.**. The matrix-like structure is maintained, with three materials working groups (in blue), one subtask for applications (in green) and one working group on economical evaluation (in red).

The economical evaluation will be performed by a bottom-up approach (while in Annex 24 a top-down approach was used). A questionnaire was send out to predict the expected cost of each storage system, including material and other components.

The working group on applications and system integration starts to work on the identification of operation conditions for relevant applications. The applications properties (energy source, storage, demand) were listed. The storage requirements were described (high capacity or high power demand, short or long term storage).

Within the material working groups new material developments were highlighted. As an example figure 2 shows the coating of Metal-Organic-Frameworks (MOFs) on heat exchanger surfaces by the Fraunhofer Institute on Solar Energy, ISE, Freiburg, Germany.

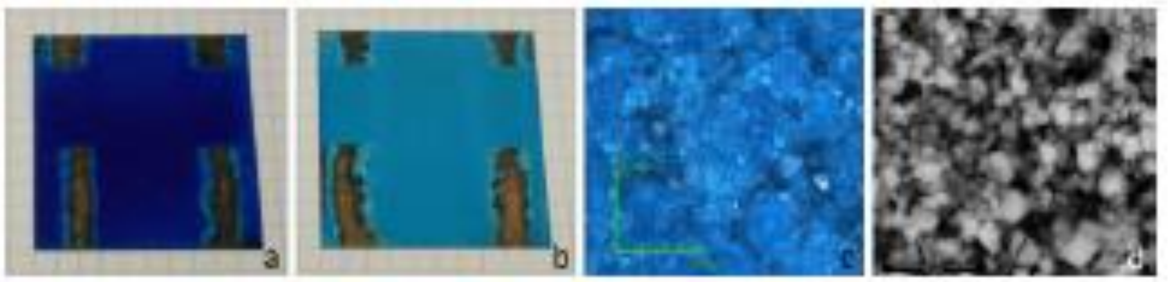


Figure 2: Optical image of the obtained coated sheets

As the working group on Test and Characterization continued its standardization efforts, the working group on numerical modelling followed its multi-scale simulation activities. The modelling of the reaction kinetics of salt hydrate grains is shown as an example in figure 3. The nucleation and growth of crystals was modeled. The validation with experiments leads to good agreements.

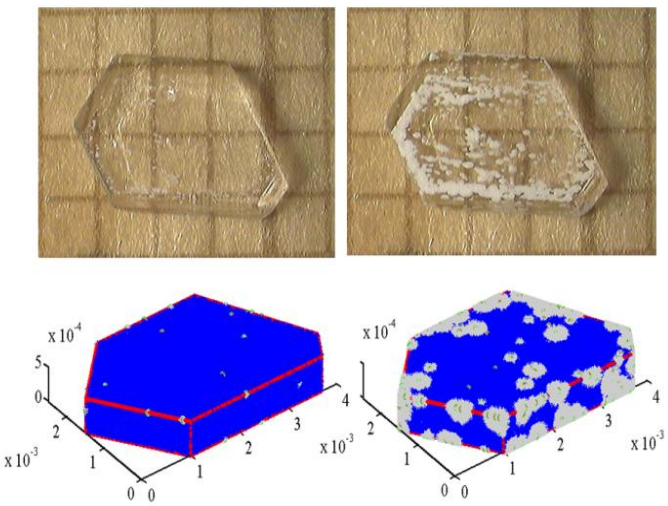


Figure 3: modelling of the reaction kinetics

The following Countries expressed their interest in participating in this new ECES activity:

Contracting Party	Representing Institutes
Germany	ZAE Bayern
Germany	Fraunhofer ISE
France	University of Bordeaux
Japan	Chubu University
Slovenia	National Institute of Chemistry
Spain	Universoty of Lleida
Sweden	Royal Institute of Technology
Turkey	Cukurova University

The first Experts Meeting was held in Freiburg, Germany, on April 15-17 2013, the second in Ljubljana, Slovenia, on October 2-4.2013.

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- Lazaro A., Peñalosa C., Solé A., Diarce G., Haussmann T., Fois M., Zalba B., Gshwander S., Cabeza L. F., Intercomparative tests on phase change materials characterisation with differential scanning calorimeter. Applied Energy 2012;
- Mónica Delgado, Ana Lázaro, Conchita Peñalosa, Javier Mazo, Belén Zalba, Analysis of the physical stability of PCM slurries. Accepted for publication in International Journal of Refrigeration.
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- R. Cadoret, E. Palomo del Barrio, J. Cadoret, "Fast estimation of the phase diagram of binary systems using infrared thermography", Sustainable Energy Storage in Building Conference, 19-21 June 2013, Dublin, Ireland.
- J. Catania, J.L. Dauvergne, E. Palomo del Barrio, "A simple experimental technique for fast estimation of the energy density of phase change materials", Sustainable Energy Storage in Building Conference, 19-21 June 2013, Dublin, Ireland.
- Celzard, E. Palomo del Barrio, "Vers des MCP biosoucés pour le stockage thermique saisonnier", Green News Techno n°84, p.5, 2012.
- Ristić, S. Henninger, V. Kaučič, Water sorption of composite CaCl2-FeKIL-2 for solar thermal energy storage, 5th Croatian-Slovenian-Serbian Symposium on Zeolites, 30.5.-2.6. 2013, Zlatibor, Serbia

NEW ANNEXES

Annex 27 Quality Management in Design Constrution and Operation of Borehole Systems

The quality assurance issues included in the strategic plan of ECES is going to be addressed for borehole thermal energy storage systems in this annex.
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Annex 28: Distributed Energy Storage for Integration of Renewable Energies

The contribution of renewable energy to overall global energy production is expected to grow worldwide. Most renewable energy sources, like wind, PV, and solar-thermal are fluctuating resources. Significant storage capacity is needed to smooth out these fluctuations for reliable future energy systems. At the moment the focus is on large, central energy storage technologies like pumped hydro or the conversion of surplus electricity into fuels such as hydrogen or methane. The potential for small, distributed energy storage technologies remains mostly unexplored.

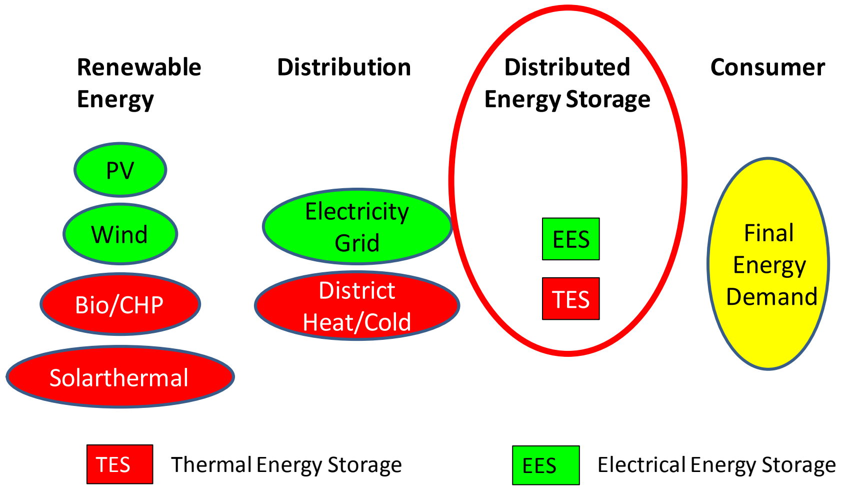

Figure 4: Definition of "distributed energy storages" by their position within an energy system.

The Implementing Agreement "Energy Conservation through Energy Storage" (ECES) approved at the Executive Committee Meeting in 2-3 December 2013 in Ljubljana, Slovenia, the new Annex on the "Integration of Renewable Energies by distributed Energy Storage Systems". This Annex should focus on the overall storage properties and their impact on the integration of renewable energy rather than the specific challenges of each energy storage technology. Collaboration with other Implementing Agreements (IA) within the IEA Technology Network and other institutions active in the field of distributed energy storage is crucial for this Annex.

The overall goal of Annex 28 is to foster the role of DES and to better evaluate the potential storage capacities for the integration of renewables at an economical competitive level. To reach this goal, distributed energy storage technologies and their properties will be examined, storage properties requirements depending on the different renewable energy sources will be reviewed and possible control and operation strategies for DES and technologies by smart grids will be studied. Finally the potential of DES systems for the integration of renewable energies based on the actual final energy demand shall be quantified and guidelines for choosing the most suitable DES technology for the actual application will be developed. Best practice and success stories examples will be given.

The scope of this Annex includes all energy storage technologies suitable on the consumer side. Three main fields of application – households, trade and commerce and industry – will be investigated. The Figure 2 shows these fields and the typical electric power range.

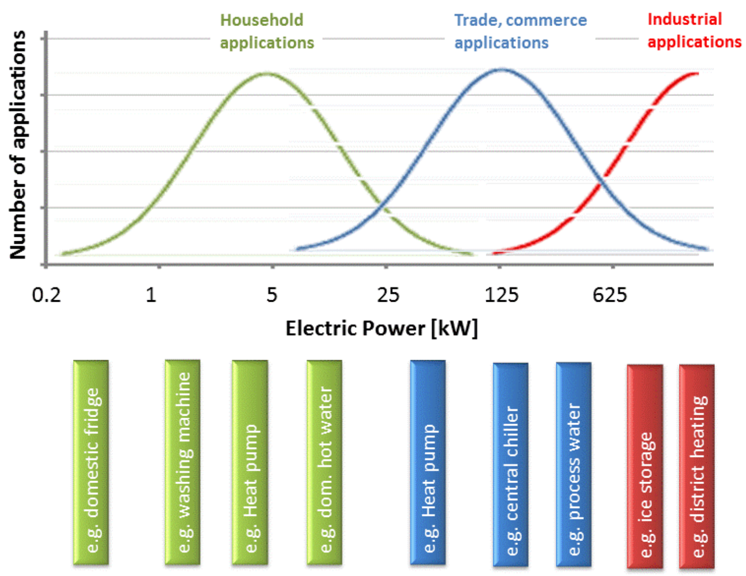

Figure 5: Application fields and the typical electric power range.

The Annex will cover the Assessment of all storage technologies which show a technical and economic potential for distributed applications, as well as the investigation of system concepts with the temporal mismatch between fluctuating, renewable energy sources (wind, PV, solar-thermal, …) and the corresponding energy demand. Finally an evaluation of national energy scenarios of the participating countries with focus on the development of renewable energies will be performed.

The kick-off workshop and experts meeting will take place in Munich. Germany on April 9-11 2014.

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Annex 31 Energy storage with Net Zero Energy Buildings and Districts: Optimization and Automation

The general objective of this Annex is to address the integration, control and automation of energy storage with NZEBs, districts, and/or local utilities. The focus will be on the development of design methods, optimization and control tools related to predicting, operating, and evaluating the performance of NZEBs and districts when energy storage is available. Task definition workshop was organized on December 5, 2013 in Ljubljana, Slovenia.
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Further Activities

CONFERENCES

GreenStock 2015
The next tri-annual conference, 13th International Conference on Energy Storage will be organized by China in Beijing. ECES delegates will participate in the International Scientific Committee.

EXECUTIVE COMMITEE MEETINGS

The Executive Committee had two regular meetings during the year 2013. The 75th XC was in Paris on April 25-26 and the 76th XC was in Ljubljana, Slovenia on December 2-3. The 2014 XC meetings will be as follows.

- Spring 2014: XC77 May 7-9, 2014 Amersfoort, The Netherlands
- Fall 2014: XC78 November 5-7, 2014 Dublin, Ireland

Co-ordination and Co-operation with Other IAs and Institutions

- Taking part in Building Coordination Group (BCG)
- Contributed to the preparation of this IEA Energy Storage Technology Roadmap
- Presented at the IEA EUWP Energy Efficiency in Industry Workshop in Brussels, 20 March 2013
- Presented at IEA Future Buildings Forum Workshop on "Transforming the Built Environment by 2035" in Soesterberg, 11-12 April 2013
- Joint annex with SHC IA: Task 42/Annex 29 Material Research & Development for Improved TES Systems
- Contributing to Storage Group within EC European Renewable Heating and Cooling Technology Platform – RHCTP
- Fraunhofer Institute represented by the Operating Agent of Annex 26 has become a member of EASE

.

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International Energy Agency
Energy Conservation Through Energy Storage Programme

ECES

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