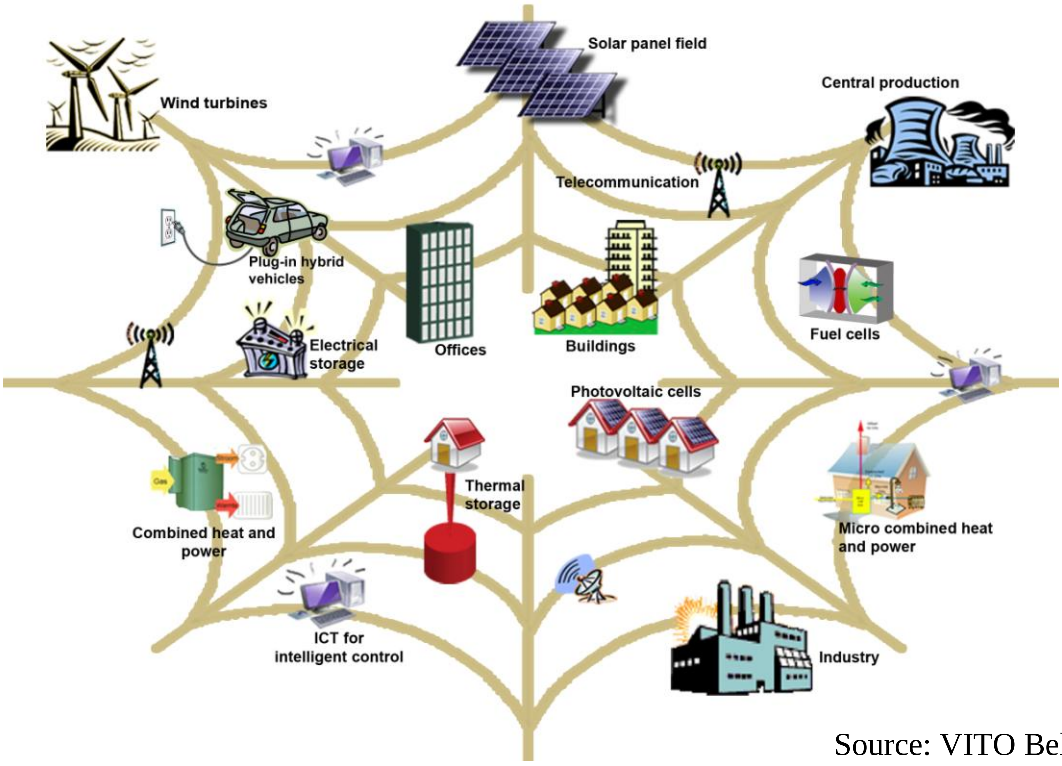
IEA - Implementing Agreement
Energy Conservation through Energy Storage

Strategic Plan
2011 – 2015



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Preface

The strategic plan of the Executive Committee of the Implementing Agreement Energy Conservation through Energy Storage (ECES) outlines the scope and goals of the IEA-Energy Storage Programme for the next term 2011 - 2015. It is an update of the previous strategic plan that was approved by the Energy End-Use Working Party in 2006 for the extension of the Energy Storage Implementing Agreement until December, 2009.

The strategic 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 IEA Storage Programme itself and links to various publications are available on the Internet-Website (http://www.iea-eces.org/) of the IEA-Energy Storage Programme.

Introduction

Despite many ambitious approaches from scientists, policy makers and industry global CO_2-emissions and oil demand continue to increase significantly. Developing countries aim for the same living standards as those in developed countries. Their economies are growing rapidly - Energy Technology Perspectives 2008 (ETP 2008), projects a four-fold GDP growth world-wide and ten-fold for developing countries between now and 2050.

It would be unsophisticated to believe that this trend can be stopped. Developing countries are not accepting any lower living standard if they are able to reach a higher level – even if this leads to an irreparable damage to their environment. Similarly, developed countries themselves will not accept decreasing living standards and no policy maker will make such decisions. Accepting these boundary conditions, one can draw at least the following conclusions with regard to the administrative and the technical level:

Facing the imbalance of the current standard of living in the world, global climate protection needs independent representatives developing roadmaps and targets on a technical level. The IEA is able to fulfill this role and each Implementing Agreement contributes with its international networks of experts. Concerning the technical level, energy efficiency measures become most important, as the increasing use of the renewables alone will not be able to solve the energy problem of the future.

The global financial crisis has not stopped this development at all. Maybe the growth is decelerated. In fact, the crisis is tightening the situation: Short-term economic benefit is preferred instead of sustainability.

This underlines again that economic aspects should be treated in parallel with energy questions. It is not enough to vigorously optimize energy systems, the economic benefit with respect to the payback time has to be calculated as well. Both the “green-image” and the monetary benefit are the arguments for any kind of climate protection to convince policy makers, industrial actors and the customers.

Energy storage technologies are a central component in every energy efficient system and they are necessary for the increasing use of renewables as well. It is the challenge for the ECES Implementing Agreement to accentuate this central message, namely to make the energy systems of the future as efficient as possible and to convince the above mentioned target groups of the energy and economic benefit of this solution. Furthermore, a strong focus is necessary on the dissemination beyond scientific and economic results. Each solution needs a positive image if we want it to be accepted by the user. We have the opportunity to prove that sustainability is not a step backwards and our Implementing Agreement has to play an important role within this process.

The meaning of Energy Storage

Thermal as well as electrical energy storage technologies can overcome the temporal mismatch between energy supply and demand. Furthermore they enable the use of energy to be dispersed and used at other places thereby improving the overall efficiency of the energy system. This leads to an increase of the total efficiency, as even waste heat can be used.

From the technical point of view, energy production means a transformation of the energy form (electrical, thermal, and chemical). To decrease losses between supply source and end-user such transformations should be kept to an absolute minimum. These requirements are also true for storage, meaning the charging and discharging process. But as mentioned before, economic boundary conditions are often the decisive factor. Therefore, the chosen storage solution depends on the total efficiency. As already pointed out, energy storage is suitable for increasing the efficiency in both the power sector and the end-use sector including industry, transport and the buildings. To define the mission and the next steps for the ECES Implementing Agreement, the meaning and the potential of different energy storage technologies are discussed.

The power sector will be subject to basic changes in future. The percentage of renewable energies is expected to increase, primarily wind power, solar energy and suitably driven µ-CHP. This means challenges and also new functions for the grids. The amount of fluctuating energy leads to a requirement of more flexibility and storage capacity. In addition, the demand itself may vary extremely. For example, though the Scandinavian countries favour a strong international transmission grid and the electrification of the transport and the building sector, these measures will not fulfill the balancing demand in the future. Furthermore, the net expansion is not the most efficient solution – from the energetic and economic point of view. Besides, it may not be possible for other parts of the world.

Currently, many electric storage technologies are available to fulfill the balancing demand. Pumped-hydro plants, CAES and even different electrochemical storages are considered. Further research and development activities will increase the efficiency of e.g. redox flow cells and NaS-batteries and decrease the specific costs. But the most efficient solution is strongly connected to the system boundaries. This means that energy supply and demand can not be judged separately – but not only in the mentioned electrification of the end use sectors. Generally speaking, all types of storages have to be taken into account to find the optimum in a given supply and demand situation. This means that even thermal energy storages are suitable for balancing the net. One example is the use of cold storages for decreasing the installed cooling capacity in buildings in summer. This helps to avoid black-outs as the electricity peak demand decreases. But even transforming surplus electrical energy and storing it e.g. in decentralized latent storages for refrigeration applications in a way that they have no electricity demand when the total demand exceeds the supply, may be energetically and economically efficient solutions.

As these examples show, storage technologies are the joining element between the supply and the demand side and in some aspects even to the distribution. The storage demand and the best storage technology are strongly connected to the system boundaries which should include the energy supply and the end user side.

But even in the narrower sense, energy storage has to play an important role for the necessary CO_2-reduction in future. Within the BLUE-map scenario in the ETP 2008, ambitious goals for the CO_2-reduction up to 2050 are described. In order to reach this, the contribution of measures to increase the energy efficiency in the end use sector is calculated to be 36%, while the percentage of the increasing use of renewable energy is 21%.

The use of waste heat in the industrial sector illustrates the possible contribution of energy storage to increase the energy efficiency. This can also be deduced from the fact that the percentage of the industrial heat demand is 70% of the total final energy consumption, whereas on the other hand a large amount of waste heat exists.

There is a big variety of energy efficiency measures in the building sector. First of all, passive measures should reduce the heating and cooling demand. After that, seasonal storage may provide an efficient energy supply, especially in combination with district heating and cooling systems. But also on a technical level, the efficiency of e.g. heating systems is strongly connected to energy storages. Within the building sector, energy storage bridges the gap between efficiency measures on the one hand and increasing use of renewables. Solar assisted heating and cooling systems, heat pumps or µ-CHP in combination with storage are very promising solutions for the future.

To sum up, energy storage technologies are necessary to increase the efficiency of energy systems in future. The amount and the storage system itself is a function of the system boundaries which may include both the supply and the demand side. Furthermore, the increasing use of renewable energies requires storage to balance the difference between energy supply and demand. Even if the technologies themselves are completely different, this storage demand is independent from the energy form.

The big variety of potential storage use – from the use of waste heat in industrial processes up to the heating and cooling demand in the building stock – requires many different technical storage based solutions. This enables an energetic and economic optimum to be reached and leads to the mission of the ECES Implementing Agreement.

Mission

To facilitate an integral research, development, implementation and integration of energy storage technologies to optimize energy efficiency of every kind of energy system and to enable the increasing use of Renewable Energy instead of Fossil Fuels.

Strategic Plan

Storage technologies are one central component in energy efficient systems. On the one hand it is a technical challenge to find the best system. However, on the other hand the whole system has to be taken into account, including its market deployment and the acceptance by the costumers. As Energy Storage is a cross cutting issue, the knowledge from experts from many disciplines (energy supply and all end-use sectors as well as distribution) has to be taken into account. To use this widespread experience efficiently and draw a benefit from the resulting synergies, high-level coordination is necessary to develop suitable working plans and research goals. ECES is predestined to fulfil this important task.

The strategic plan of ECES has to reflect both aspects. Therefore, ECES has to fill out its neutral and leading position in energy storage in a coordinative and cooperative way. The collaboration with experts on the demand and distribution side has to be strengthened significantly.

Taking into account all these aspects, the strategy can be divided as follows:

1. **Research Activities**
   a. Strategies for scientific research and development
   b. Strategies for dissemination
   c. Strategies for market and deployment

2. **Coordination Activities**
   a. Aims
   b. Adminstrative Matters

1. Research Activities

a. Strategies for scientific research and development

In order to make any energy system as efficient as possible, the whole environment has to be taken into account – including both supply and demand. This requires detailed information about the limitations and advantages of the different storage systems concerning thermal and electrical energy storages. Furthermore, a detailed roadmap should be developed including the state of the art, short and long term perspectives of each storage system. This means also a discussion of the physical and economical limits of each system and the storage materials themselves.

In addition, a detailed analysis of the energy saving potential within the different end-use sectors is necessary. This has to be carried out by experts in their countries to identify possible synergies. These examinations are the basis for the further steps: Demonstration projects as the result of material research, system engineering and case studies. To realize these projects, the dialogue with national funding organisations is very important and should be considered by the involved experts.

b. Strategies for dissemination

In order to bring storage based solutions to the market and to increase the efficiency of existing and future energy systems, scientific results has to be translated into the language of the different audiences. This requires a detailed analysis of the target groups. However, any simplified message has to be based on fundamental scientific results developed as described before. The most successful way to convince policy makers, end-consumers and the industry is to show success-stories and demonstration projects, accompanied by figures concerning e.g. the energy saving potential or the pay-back time.

To increase the visibility of the scientific results and the success stories, information platforms in each country and within the IEA have to be identified. This may include for example publications, scientific journals, roadmaps or conferences.

The introduction and the just mentioned strategies clearly show that even the scientific results can not be reached by experts from one discipline only. The collaboration of many disciplines in a very well-structured and headed process leads to the described success. Particular attention has to be paid to the intersections of educational programmes and relevant institutions. The future experts have to be involved in this interdisciplinary as early as possible.

c. Strategies for market and deployment

Demonstration projects address many different target groups. Presented in a suitable way they are best positioned to start collaborations with the relevant companies. Demonstration projects have to be the beginning of a fruitful cooperation between science and industry until and even after the components have reached their break-even point. To shorten up this process, within the international cooperation of the experts, standardisation questions have to play an important role. This enables the national industries to enter foreign markets. Well-planned and therefore successful demonstration plants have to trigger a chain reaction: Each realisation is the successful acquisition of the next cooperation project between industry and science.

But even successful demonstration projects and well-funded numbers may not suffer to bring storage solutions to the market. Also soft factors have to be taken into account, not only if end-consumers are addressed, even the dialogue with companies may effort the knowledge of their way of thinking and their aims.

2. Coordination Activities

a. Aims

Within the IEA-Framework, about 20 Implementing Agreements are related to energy storage questions. Any kind of future energy system needs energy storage to maximize the overall energy efficiency in an economic way. The big variety concerning the scientific and technical background of the involved experts in the Implementing Agreements dealing with energy storage aspects offer a great potential resulting in proposing solutions for future energy systems. However, it is quite impossible on expert level to cooperate with all relevant storage experts to find the optimum solution as there are too many players. In addition, joint research activities in the meaning of joint Annexes are not always the most efficient way of collaboration if more than three different Implementing Agreements have to be involved. In fact, coordinated working plans and a coordinated exchange of results delivered from parallel Annexes in a number of Implementing Agreements may be the best solution in such a case.

The development and heading of work plans and its delegation to the experts requires less detailed knowledge about specific aspects – e.g. energy-supply-, end-use technologies or distribution. Rather a more general approach is necessary. ECES is experienced in this role as identifying an optimal storage solution always requires to take the whole energy system into account.

b. Administrative Matters

ECES has already started this process leading to more cooperation in the field of energy storage. As pointed out before, a coordination platform above the different Implementing Agreements is necessary. Furthermore, energy storage is not limited to one Working Party: Even though the Renewable Energy and the End-Use Working Party are both involved a close contact to the Expert Group on Science for Energy (EGSE) is still necessary.

Representatives from all these groups have to be addressed by the storage coordination group to develop working plans, pointing out research goals, exchanging information between the different players and finally draw the conclusions from the work.

These results as an outcome of well-coordinated activities increase the visibility of the storage-based solutions significantly. They may influence both roadmaps and reports (like the Energy Technology Report) within the IEA as well as programmes and decisions of national policy makers and stakeholders.

To add weight to the idea of a storage coordination platform, ECES organized a first workshop in Bad Tölz, Germany from Sept. 30 to Oct. 2 in 2009. The outcome was an agreement of the participating Implementing Agreement to continue in this way of installing a kind of coordination group. Therefore, ECES has organized a second workshop in July 2010, to develop a number of research goals and the suitable way of cooperation for each case: Experts Workshops, Joint Annexes but also as an exchange platform coordinating the different activities and develop further steps and aims. ECES will continue this process and present the results within the IEA to the relevant groups.

After presenting the objectives for the future, the barriers and drivers within the processes mentioned in section 1 and 2 have to be reflected upon.

Barriers

The consciousness of energy efficiency beyond technical aspects is hard to teach, therefore engaged pioneers and a strong connection to universities and education centre in general are essential. We have already started this process, but increased efforts are still necessary.

This general statement is also true for energy storage itself as storage experts have to be on a par with system experts and material experts in the ideal case, having also the economic benefits in mind. But in the case of storages, additional difficulties occur. Storages are in most cases not visible within an energy system, they have to be regarded as a passive component. Solar thermal systems in the building sector are a good example: End-consumers discuss the advantages of vacuum tubes against flat plate collectors as active components, but they disregard the meaning of the storage, the gains of the collector array can be counted in kWh from the control unit, the effect of a better storage is hardly observable for them, least of all not in numbers. This is also a central topic for the funding of, for example, solar systems in the building sector. In most cases, requirements for the collector performance exist (based on standardised tests), but there is no pendant for the storage.

As in the strategies mentioned, state of the art reports do not currently exist. Many demonstration projects have been realized which do not reach the proposed aims. In many cases, mistakes concerning the future demand or general planning mistakes are responsible. These negative examples have unfortunately increased the reservation against similar ideas. In recent times the financial crisis has also reduced the financial possibilities of many smaller companies.

Drivers

On the one hand, the global financial crisis has impacted many companies, but on the other hand it has also increased the pressure for innovation to sustain market position. Even if energy prices have decreased in the last year, the prior developments have drawn attention to the limitation of fossil fuels. Energy efficiency measures are more and more accepted and the pay-back has already been reduced in comparison to the situation a few years ago.

Driven by ambitious climate protection goals throughout the world, in many parts of the world electro-mobility has become a new keyword, which is obviously strongly connected to electrical storages, namely Li-ion-batteries. Another very popular topic is the increasing use of renewable energies. This discussion has also highlighted the need for energy storages. Though most people have only electrical storage in mind, these circumstances offer the chance to extend the view on energy storage technologies in general.

The funding situation at least for electrical approaches is quite good, so many experts are attracted. To sum up, the actual situation offers a high potential to broaden the view to the meaning of energy storage in general. This is also a very good starting point for the described activities concerning the coordination activities.

Strength and Limitations of ECES

Limitations
As pointed out before, there are many positive signals at the moment and even difficult circumstances may offer new opportunities and lead to a change toward more energy efficiency in future.

ECES has to redefine its role within this rapidly changing world. In the last several years, ECES has had a strong focus on thermal storages. Electrical storages have not played any role at all. Furthermore, ECES has not fully developed the necessary general approach to find the best storage solution and to increase the overall energy efficiency as much as possible.

These points are not structural problems. In fact the market deployment is more difficult to reach as too few industries are sponsors. Further approach is necessary to start at least collaboration in different areas. In order to influence the economical development in developing countries, more of them have to be attracted to join the ECES. This is also a very important topic for the coming years.

Strength
Within the ECES-ExCo scientist of many disciplines, representatives from funding organisations and even companies are active. Therefore interdisciplinary research and development activities in the described way can be initiated. ECES has established a well-accepted network for R&D on thermal energy storages and is able to extend it to system analyses, respectively potential studies, and even to electrical storages. ECES has the expertise or at least the contact to experts to publish the results in scientific journals and to produce more visible messages for policy makers and other consumers on a national basis.

The already started coordination activities will have a positive effect. Increasing the visibility and the meaning of energy storage in general, enables ECES to attract more experts for the R&D-activities. In addition, this leads to a broader awareness of ECES within the other Implementing Agreements, therefore it will also facilitate the implementation of joint research activities.

Collaborations

Even before ECES started the process of a coordination platform on energy storage issues in general, there has been a close cooperation concerning building related activities.
Therefore the Executive Committee has intensified cooperation with other
Building Related Implementing Agreements (BRIA´S):

- Solar Heating and Cooling
- District Heating and Cooling
- Energy Conservation in Buildings and Community Systems
- Heat Pumps
- Photovoltaic Power Systems
- Demand Side Management (DSM)

Joint workshops and an annual 2-day meeting of the Building Coordination Group (BCG) are employed to share information, to transfer knowledge for implementation of new concepts and technologies and to identify new cooperative activities.
Beyond this, ECES is in contact with other Implementing Agreements, which will be described later on (section ***Achievements in 2009***).

In addition to the building related activities, ECES also participates in the Electricity Coordination Group.
Furthermore ECES was involved for the first time in the scientific organisation of the Eurosun 2010, the European conference on solar thermal energy of ISES and the IEA-Solar Heating and Cooling Programme. A similar participation is planned for the ISES Solar World Congress 2011.

Planned activities 2011-2015

The main aims for the new period can be described as follows:

1. Strenghtening of the collaboration in energy storage between all relevant players within the IEA Framework
2. Intensifying the research activities on both thermal and electrical storages
3. Starting cooperative research activities with developing and transition countries
4. Increasing the visibility of the meaning of energy storage for CO_2-reduction

1. Strenghtening of the collaboration in energy storage between all relevant players within the IEA Framework

ECES aims to establish a kind of coordination platform in the field of energy storage until the end of 2012. On the basis of the outcome of the workshop "Energy Storage – Matching the supply and the demand in future" in July 2010, further biannual or annual expert workshops on special aspects will follow. In addition, an annual coordination meeting is favorised.
These activities will lead to different ways of cooperation. On the one hand, joint Annexes may be a suitable way of collaboration if only a small number of Implementing Agreements are involved. On the other hand, the coordination group might develop a working plan, resulting in separate Annexes within different Implementing Agreements. The coordination group would establish the scientific exchange between the related Implementing Agreements and would develop new research and demonstration aims if necessary. Furthermore, the coordination group would be responsible for publishing the results in IEA-reports, in scientific magazines as well as on conferences. They would also be responsible for reporting the progress to e.g. CERT or other parties within the IEA.

2. Intensifying the research activities on both thermal and electrical storages

A further outcome of the above mentioned workshops is also the update of the R&D-goals in the field of energy storages. Depending on the practical needs, further research activities on new storage materials (incl. batteries) respectively their optimisation regarding lifetime, cycle-stability and costs will be started.
Special focus will be placed on standardisation and evaluation of test procedures for batteries for stationary and mobile applications. Even if there are no concrete Annexes in preparation, there are already several discussions on this topic which will lead to Annex activities in the medium term.

3. Starting cooperative research activities with developing and transition countries

As energy storage is the linchpin for the increasing use of renewable energies and for an increasing energy efficiency in all energy systems, a special focus will be on cooperative research activities with developing countries. The aim is to analyze different applications and to calculate the economic feasibility of using energy storages. One starting point might be the analysis of the cooling demand in the building stock. Following the results from the potential analysis, demonstration projects are useful to show best-practice examples of storage based cooling systems.

4. Increasing the visibility of the meaning of energy storage for CO_2-reduction

ECES is also going to increase the visibility of the results from 1. and 2. in addition to the publications mentioned in 1 by further collaborations. Cooperation with ETSAP is planned. ECES will review their technology briefs and will ask the storage experts to contribute to technology briefs on different energy storage technologies. Furthermore, a contribution to the Energy Technologies Perspectives from the IEA is planned. This kind of cooperation has already started in 2009.

To increase the practical relevance of R&D-results, demonstration projects are also very important to prepare a market entrance for storage technologies. Therefore, a close contact to industrial players is very important. ECES has already started to intensify contact with relevant industries in different countries and will continue this exchange.

The attendance of conferences on national and international level will also be important to increase the visibility.

In addition special attention will be drawn to the education of young scientists. Therefore, summer schools offer a large potential to broaden the view related to the meaning of energy storage in energy systems, as this is in general not done at university. Furthermore, summer schools are also very helpful to create networks. Especially joint summer schools with other Implementing Agreements are aimed for.

Therefore, the overall planned activities from ECES can be summarized as follows:

- Establishing a Storage Coordination Group within the IEA
- Carrying out research activities in joint Annexes with other Implementing Agreements
- Organizing summer schools, also together with other Implementing Agreements
- Attending Conferences like e.g. the Eurosun, the Solar World Congress and continue organizing storage conferences (“Stock”-Conferences)
- Contribute to IEA-publications, reports and roadmaps as well as to workshops to attract developing and threshold countries in particular
- Participating at further IEA-coordination groups (building and electricity coordination groups)
- Publishing own R&D-results in own brochures as well as in scientific journals
- Intensifying the contact to relevant industries and policy makers

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