

The Role of Storage in Energy System Flexibility

German Federal Ministry of Economic Affairs and Energy
Scharnhorststr, 34-37
10115 Berlin

22-23 October 2014



THE ROLE OF STORAGE IN ENERGY SYSTEM FLEXIBILITY

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Hosted by the German Ministry of Economic Affairs and Energy, Berlin

Rationale

The utilisation of electric power from renewable energy sources worldwide is growing steadily year to year. This presents opportunities and challenges for institutions responsible for both realising associated benefits and maintaining a reliable and affordable power supply system.

In contrast to traditional sources of electricity generation based on fossil fuels or nuclear power, renewable sources have compelling advantages: (1) they do not rely on scarce, imported, and/or potentially vulnerable (e.g., natural gas from Russia) resources and, hence, afford a degree of national or regional energy independence; and (2) they are not encumbered by other concerns, such as air quality, emissions of greenhouse gases, nuclear waste issues, or other risk factors.

However, the inclusion of a non-marginal amount of renewable energy from intermittent and/or variable sources into national energy production systems comes with challenges, many of which had not earlier been important management factors for grid system quality, stability or reliability. For example, traditional electricity systems based on adjustable (fossil or nuclear) power plants were typically operated in a way where changes in energy supply follow system changes in power demand. With renewable energy sources, this is not always possible. Wind strengths and variations in available sunlight are, in many respects, unpredictable. Importantly for system-wide they do not typically follow social patterns of demand for electricity. In some cases, bioenergy and geothermal sources of electricity can be used to compensate for fluctuations in more volatile energy sources, but many of these are available only locally or with limited supply.

Accordingly, any energy system envisioning the utilisation of a large amount of renewable energy power must eventually develop solutions to address these issues. Large capacity energy storage, in conjunction with other system components, affords a means to manage variability and potentially decouple short-term variations of supply from demand. Of course, this includes traditional pumped-hydro storage power stations, which play important roles in mountainous regions such as, in Europe, Austria, Switzerland and Norway. However, not every country's geography allows for pumped storage. Possible alternative technologies include among others chemical and/or thermal energy storage, conversion of electricity to hydrogen via electrolysis, as well as coupling of electricity generation with district heating grids. Many of these are costly or not well adapted to local circumstances. There is growing awareness that novel paths need to be explored.

Additionally, the electricity grids themselves are facing infrastructure challenges, aggravated by the large-scale advent of energy production from renewable energy sources. Renewable electricity is not necessarily produced in close proximity to the centers of consumption. This requires build-out of long distance power transmission lines. Regional production varies significantly with regional weather conditions, suggesting balancing by out-of region sources. Possible technologies include among others demand side management, high voltage DC techniques, smart grids and IT solutions, power-to-gas, the coupling of electricity and district heating grids and developments in the domain of power electronics.

As electricity grids are often interconnected, especially in Europe, these challenges cannot be examined from an exclusively national perspective. However, this interconnectivity can also be considered an advantage, since both fluctuations in renewable electricity production and power demand side statistically flattened out in large interconnected grids spanning a meteorologically more diverse region.

How to overcome these difficulties and how to guarantee an environmentally friendly electricity supply that is stable and cost-efficient at the same time will be among the more important questions for the energy and power sectors in the near future. These issues invite creative thinking across a broad range of activities, from foundational research to the successful demonstration and commercialisation of new technologies. They require a multitude of RD&D efforts, stimulated by public policy attention, governmental RD&D, and private investment.

Current Activities

There are many activities addressing these concerns ongoing throughout the world, including in the United States, Japan, Korea, China, India, Europe, and elsewhere. The IEA recently released an Energy Technology Roadmap¹ on Energy Storage which looks at the role of energy storage technologies within our future energy systems. The roadmap looks at how energy storage technologies can help to better integrate our electricity and heat systems and the role of the technology in energy system decarbonisation. It identifies the most important actions required in the short and long term to successfully accelerate the development and deployment of energy storage technologies. In Europe, the German approach, outlined below, perhaps, epitomises the level of interest and national priority now being given to such matters.

In Germany the Federal government is pursuing a strategy to increase the use of energy from renewable sources for generating electricity to 80 percent by 2050. In conjunction with another goal to reduce national electric power consumption by 25 percent, this is expected to reduce Germany's carbon dioxide emissions by 80 percent by 2050. This represents a re-organisation of the German energy system. One of the central pillars of the plan to reach this goal is the national RD&D program established to make existing technologies more effective and to trigger new innovations that will eventually provide acceptable solutions to the many-fold challenges associated with such a widespread transformation. Two initiatives have been launched:

1. Energy storage (published in 2011). This RD&D initiative is 185 M€. Nearly 80 different projects are being pursued, with a focus on battery applications in electrical grids, power-to-gas, thermal energy storage and adiabatically compressed air storage facilities; and
2. Electricity grids and transmission (published in 2012). This RD&D initiative is comparable in funding. It includes new developments in power semiconductor devices and operating equipment, decentralised automation concepts, IT solutions for smart grids, mathematical optimisation procedures, and simulation and new sustainable infrastructures.

¹ <http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapEnergyStorage.pdf>

Meeting Scope

The IEA's Experts Group on Energy R&D and Priority Setting will host a workshop on 22–23 October 2014 in Berlin, Germany, hosted by the Ministry of Economic Affairs and Energy. This workshop will focus on the evolving nature of the grid, with the goal of identifying novel approaches, RD&D needs, other areas not well covered but needing attention, and innovative case studies related to electricity storage in a flexible electricity grid of the future. The workshop will address a broad range of topics concerned with innovation and R&D strategies for energy storage and electricity grid enhancement with a focus on how best to welcome the inclusion of variable energy sources.

With input from speakers representing various actors, sectors, and regions, the workshop will result in a summary report, posted publicly, that identifies challenges concerning energy storage and energy grids, highlights a broad sampling of activities underway in various countries and technology sectors, identifies priorities and gaps in current programs for RD&D planners, and suggests a number of areas in the innovation arena needing public policy attention.

Questions

Questions to be addressed by the participating technology experts include:

- *How are governments and power-managing institutions innovating to address the grid reliability concerns associated with the advent of significant renewable power supply?*
- *Which electricity storage technologies are currently used, others emerging as leading innovations for the near-term, and others most promising for the longer-term?*
- *What is the current status of battery technology in a grid-context?*
- *What are the ways in which such devices be integrated into the energy market?*
- *What are high-priority grid storage RD&D needs, gaps, and opportunities?*
- *What other technical needs (e.g., safety) are not being well addressed today?*
- *What policy innovations are most effective in mobilising energy storage innovation?*
- *Does the regulatory framework need adjustment for a better stimulation and integration of energy storage technologies?*
- *Can the grid be treated separately or do mutual interdependencies between electricity-, gas- and heat markets lead to technical advantages and/or economic benefits?*
- *Which primary technological limitations and barriers need to be overcome to make energy storage more beneficial to power utilities?*
- *Does the IEA-framework of Implementing Agreements need adjustments to tackle all aspects of necessary co-operation?*

Target Audience

In addition to EGRD national experts, we are seeking input from RD&D decision-makers, strategic planners, and program managers from industry concerned with energy storage systems technologies related to electrical grids. Participation is by invitation only.

DAY 1 – Wednesday, 22 October 2014

Session 1: Introduction

The Session provides background and context for the Workshop. It reminds participants of the purposed, interactive nature of presentations, dialogue and social interactions, and the expected outcomes, and post-meeting activities and communications.

- *Previous work of the group*
- *Rationale of the workshop*
- *Expected outcome of the workshop*
- *Flexible energy systems and the increasing need for energy storage*
- *The IEA energy storage roadmap*
- *The German Energy storage RD&D initiative*

Introduction			
<i>Chair: Rob Kool</i>			
08:30	Registration		
9.00 - 10:30	Welcome		German Federal Ministry of Economic Affairs and Energy
	Introduction		Rob Kool, Chair EGRD, Netherlands Enterprise Agency
	1	The IEA Energy Storage Roadmap	Luis Munuera, Energy Demand Technology Unit, IEA
	2	The German Energy storage RD&D initiative	Arne Höll, German Federal Ministry of Economic Affairs and Energy
10:30	Coffee break		

Session 2: Energy Systems and Demand for Storage

This session analyses the current and projected future energy system of different IEA member countries / regions with respect to the need for energy storage solutions.

- *How can renewable energy sources be integrated into the market while ensuring sustainability and security of supply?*
- *Which measures can be taken to stabilise the grid against fluctuations coming from renewable energy sources?*
- *How is electricity storage handled in different countries?*
- *Which experiences do exists in different countries concerning the need for large scale electricity storage?*

<i>Chair: Birte Holst Jørgensen</i>			
11:00	3	Worldwide need for energy storage	Christian Doetsch, Fraunhofer UMSICHT
11:30	4	Energy storage in a grid with fluctuating sources: the German perspective	Ulrich Fahl, IER Stuttgart
12:00	5	The DOE Global Energy Storage Database	Georgianne Huff, Sandia National Laboratories, USA
12:30	Lunch		
13:30	6	A TSO's Perspective on Energy Storage	Norela Constantinescu, ENTSO-E
14:00	Discussion		

Session 3: Flexibility Options as Alternatives to Storage

This Session discusses whether the problem of energy storage can be effectively mitigated, or avoided entirely, through implementation of alternative technologies, such as demand side management in a grid context, power-to-heat and power-to-gas technologies, or intelligent trans-border coupling of national electricity grids.

- *Can the problem of energy storage be solved on a national basis or is an international perspective mandatory? Which benefits can be identified by adopting a transnational perspective?*
- *How can power, voltage and frequency be kept stable in an electricity grid where the supply side does not instantly follow the demand side?*
- *Can the electricity sector be treated separately or do mutual interdependencies between electricity-, gas- and heat markets lead to technical advantages and/or economic benefits?*
- *How can demand side management help to minimise the need for storage?*

Flexibility Options as Alternatives to Storage			
<i>Chair: Johannes Tambornino</i>			
14:30	7	Convergence of electricity and gas grids	Peter Markewitz, Forschungszentrum Jülich
15:00	8	Japanese perspectives on storage alternatives	Atsushi Kurosawa, The Institute of Applied Energy
15:30	Coffee break		
16:00	9	Energy system flexibility, security, standards	Jillis Raadschelders, DNV-GL
16:30	10	Demand Side Management	Matthias Stifter, Austrian Institute of Technology

17:00	11	The Future Energy System - with focus on flexibility by system interactions	Poul Erik Morthorst, Danmarks Tekniske Universitet
17:30	Discussion		
18:00	Close Day 1		
19:30	Group Dinner		

DAY 2 - Thursday, 23 October 2014

Session 4: Energy Storage Technologies

During this session different energy storage technologies which are currently used and/or researched on are presented.

- *Which energy storage technologies are currently used?*
- *What is the current status of battery technology and can these batteries be used as large-scale electricity storage facilities in the foreseeable future?*
- *Which primary technological limitations and barriers need to be overcome to make Energy Storage more beneficial to power utilities?*

Energy Storage Technologies			
<i>Chair: Robert Marlay</i>			
09:00	12	Battery storage for grid stabilisation	Matthias Leuthold, RWTH Aachen
09:30	13	Flow Batteries	Gary Yang, UniEnergy Technologies
10:00	14	DOE Energy Storage RD&D Program	Imre Gyuk, Head, Energy Storage R&D Program, U.S. DOE
10:30	Coffee break		
11:00	15	Technological opportunities and barriers for utility scale energy storage	Estathios Peteves, EU-JRC
11:30	16	Smart Heat Storage for solar heating systems	Simon Furbo, Danmarks Tekniske Universitet
12:00	Discussion		
12:30	Lunch		

Session 5: Energy Storage Markets and Business Models

This session discusses possibilities how the regulatory framework can be adapted to accommodate for energy storage markets and presents selected business examples.

- *Does the regulatory framework need adjustment for a better integration of energy storage technologies?*
- *Is the energy-only market sufficient to ensure security of supply or do we need a complementary capacity market?*
- *Best Practice examples: a business in energy storage*

Energy Storage Markets and Business Models			
<i>Chair: Herbert Greisberger</i>			
13:30	17	Battery Systems for Grid Stability	Alfons Westgeest, EUROBAT Association
14:00	18	California Utility Storage Experience	Chris Edgette, California Energy Storage Alliance
14:30	19	Economics of Energy Storage	Dominik Möst, TU Dresden
15:00	Coffee Break		
15:30	20	Perspectives on Grid Transformation and the Market for Storage	Landis Kannberg, Pacific Northwest National Laboratories
16:00	Discussion		
16:30	Wrap Up of the Workshop, Panel Discussion, and Participants Round Table		
17:30	Close Day 2		

Meeting Location:

The workshop will be hosted by and located at the:

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