Electricity Storage Insight

Delving into the key issues

2016

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KPMG's Energy & Utilities Advisory practice (one of KPMG's global Power & Utilities Centers of Excellence) provides business advisory services to company owners and leaders in the electricity, natural gas, district heating sectors and water industries, as well as for regulators, government institutions, investment companies, banks and other stakeholders. The practice based in Budapest provides advisory support on strategy, mergers & acquisitions, corporate finance, restructuring, cost optimization, energy trading, risk management and regulatory matters to all elements of the value chain.

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Gain insight from this industry-shaping white paper on electricity storage.

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List of abbreviations

Alternating current	AC
Central and Eastern Europe	CEE
Combined Cycle Gas Turbine	CCGT
Compressed Air Energy Storage	CAES
Concentrated Solar Power	CSP
Cryogenic Energy Storage	CES
Distribution System Operator	DSO
Electrical Energy Storage	EES
Electro-chemical Storage	ECS
Electro-mechanical Storage	EMS
European Union	EU
Hydrogen Energy Storage	HES
Photovoltaic	PV
Project of Common Interest	PCI
Pumped Heat Electrical Storage	PHES
Pumped Hydroelectric Storage	PHS
Small and Medium-sized Enterprises	SME
South-East Europe	SEE
Ten-Year Network Development Plan	TYNDP
Thermal Energy Storage	TES
Transmission and Distribution	T&D
Transmission System Operator	TSO

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1. Executive summary

1 The widespread and rapid implementation of intermittent renewable energy sources, namely solar photovoltaic (PV) and wind, is **catalyzing efforts to modernize electricity systems around the world.**

2 **There is a range of technologies which are either already deployed or currently under development.** These include Pumped Hydroelectric Storage, Thermal Energy Storage, Electro-chemical Storage, Electro-mechanical Storage, Cryogenic Energy Storage and Hydrogen Energy Storage.

3 Electrical Energy Storage (EES) is one of the key technologies to have been developed, exhibiting a **high growth rate and high level of importance in the last few years.**

4 **There are three main categories for installation of EES across the value chain: generation support, grid support (T&D) and consumer support.**

EES technologies help to provide reliable and stable system operation of transmission and distribution (T&D) systems, can meet frequency control requirements and can provide a "black start" capacity in case of total or partial shutdown of a transmission system. Some of EES can also provide service continuity during generation facility maintenance of energy generators, and provide balancing support for mitigating the imbalances of power generation and consumption.

5 **The lack of appropriate regulatory framework is one of the main barriers for the development of EES within the EU.** Creating an appropriate regulatory framework that would support EES development has now become crucial. Since the EU is in the middle of the process of creating the new European electricity market design, it is now the right time to address the regulatory issues relating to electricity storage. However, the technology progresses fast and if the EU legislator acts slowly, then other global economies will take the lead in storage project developments.

6 In the absence yet of an appropriate EU level regulatory framework, countries in Central & Eastern and South-east (CEE / SEE) Europe could seize the opportunity to create their own national regulations which may not only comply with the applicable EU rules, but at the same time will facilitate electricity storage project development in these countries. **A well-designed regulatory framework supporting the development of EES projects could be viewed as a competitive advantage, rendering a given country attractive for investors.** Key issues to be considered in the context of any new regulatory framework design include defining the role of storage in the electricity value chain, supporting storage projects without creating undue distortions on the energy markets, and handling challenges resulting from the mass deployment of storage facilities.

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2. Market status and technology outlook

2.1 Introduction

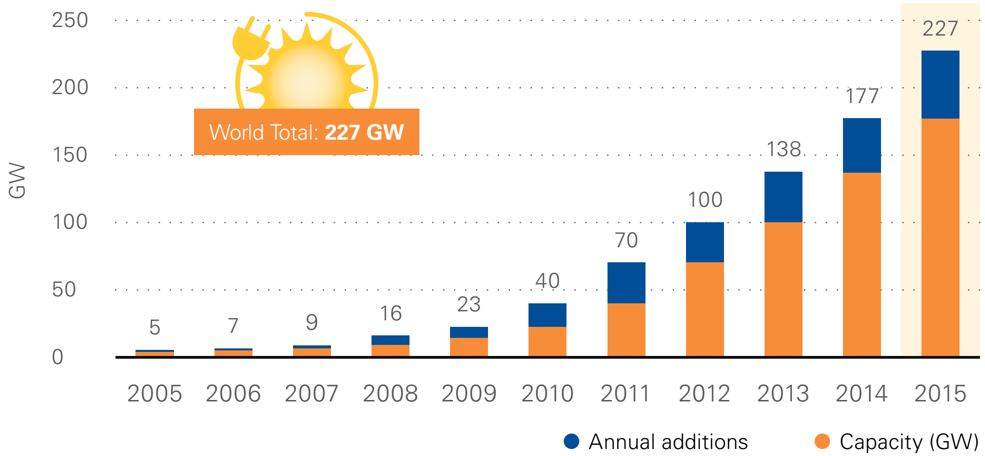
The power sector experienced its largest annual increase in capacity ever, with significant growth worldwide. Wind and solar PV had record increases in installed capacity for the second consecutive year, accounting for about 77% of new generation. Around the world, technical, economic and market transformation of the electric power sector continued to accelerate, and many countries have begun to respond to the challenge of grid integration.

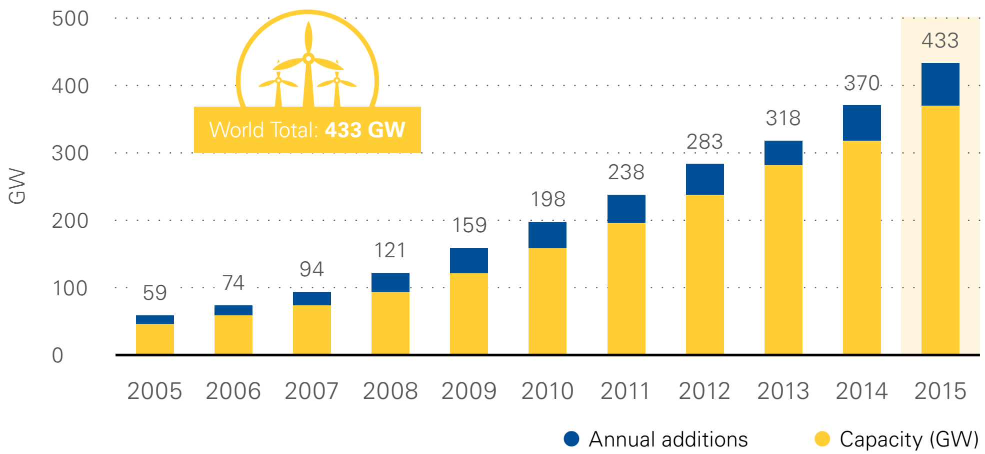
With the importance of renewable energy sources on the power sector increasing, solutions and appropriate measures are needed to balance the supply and demand of energy. In addition, the need to manage reserves of EES has been increasing incrementally.

For over a century, electricity storage in the power sector has been dominated by one technology, called pumped hydroelectric storage (PHS). Massive deployment of renewable electricity sources and the promotion of policies to modernize electricity production and consumption are spurring the development of electricity storage, including increased electro-chemical storage. Small-scale electricity storage has been available in consumer electronics markets, in the form of rechargeable batteries. More recently, their use has spread to the transport sector in batteries for electric and hybrid vehicles. Now, falling costs and innovation mean that electricity storage technologies are starting to emerge at larger scales and, can be used over a much wider range of applications and locations than PHS.

At present, there is a range of storage technologies which are either already deployed or currently under development. These include (among others) various types of batteries, flywheels and compressed air storage. Today, these technologies provide storage solutions at all scales, from household systems through to grid-size solutions.

Solar PV and wind power global capacity and annual additions, 2005-2015





Source: Renewables 2016 Global Status Report

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2.2 Technology overview

Description

Pumped Hydroelectric Storage (PHS)

PHS works by storing energy in the form of water in the higher of two reservoirs, to where it is pumped from the lower reservoir.

When the electricity demand is high, power is generated by releasing the water from the upper reservoir through turbines. When demand and electricity prices are low the upper reservoir is replenished by using electricity to pump water back into the higher reservoir. Pumped hydro storage has typical efficiencies ranging from 70% to in excess of 85% for state of the art turbines.

Thermal Energy Storage (TES)

Pumped Heat Electrical Storage (PHES) uses gas under pressure / liquid to heat up a thermal storage medium (crushed rock, molten salt), and the system stores energy in the form of heat. It uses a heat pump to transfer heat from the "hot store" and the "cold store". To recover the energy, the heat pump is reversed to become a heat engine. Round-trip efficiency for PHES is around 80-90%.

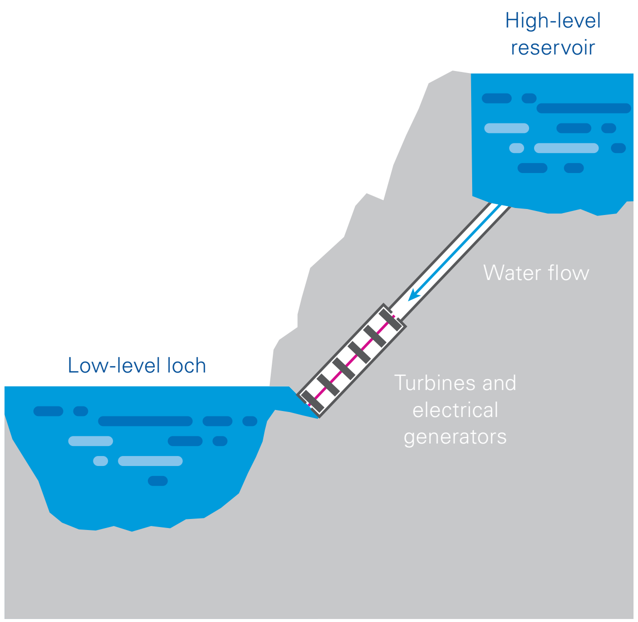
Concentrated Solar Power (CSP) can be used to heat up molten salt to store energy in insulated containers. When energy is required, it can be extracted as the molten salt is transferred to a "cold salt" tank. Due to heat losses, round-trip efficiency for CSP is around 65-80%.

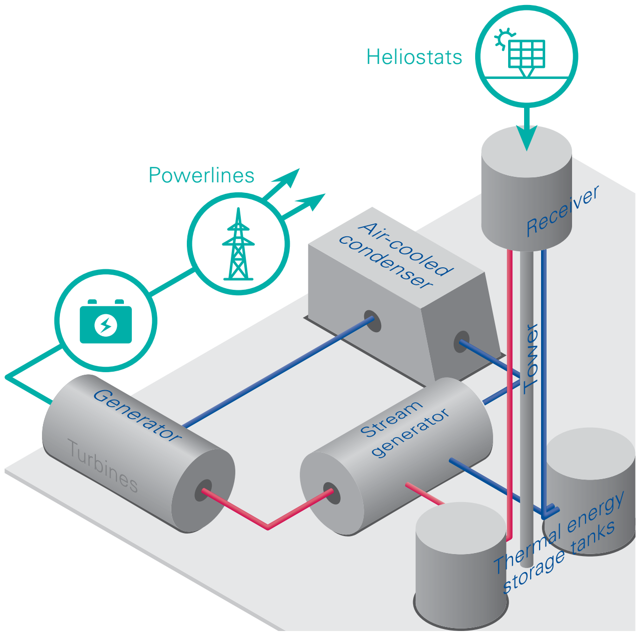
Electro-chemical Storage (ECS)

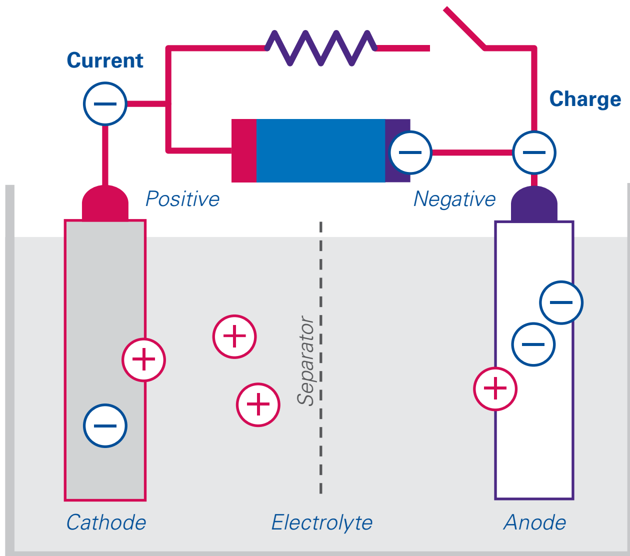
Electrochemical batteries are a rapidly growing segment of the energy market. Batteries come in a wide array of sizes, and are specific for numerous applications. With costs falling as scale ramps up, the applications of these batteries should see rapid growth. Their round-trip efficiency is around 60-98%.

- Lead Acid Battery (Ni-Cd, Ni-Mh)
- Lithium-ion Battery (Li)
- Sodium Sulfur Battery (NaS)
- Flow Batteries (redox, hybrid, membraneless)

Illustration







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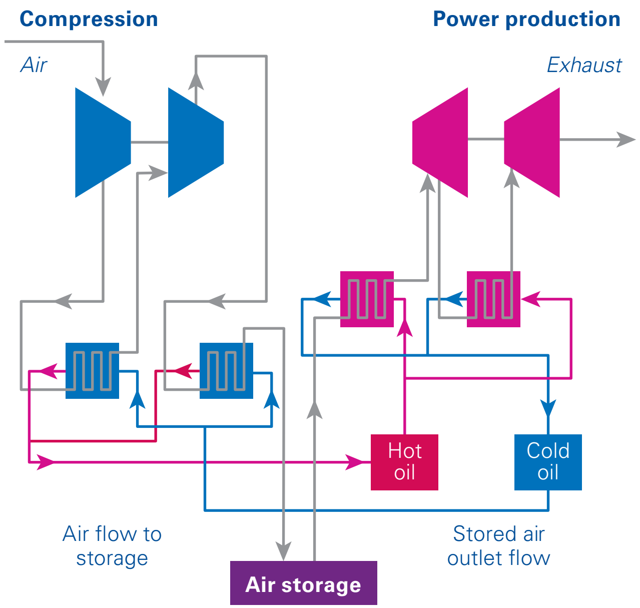
Electro-mechanical Storage (EMS)

Flywheels use electricity generated when prices / demand are low to accelerate a flywheel to a high speed, i.e., energy is stored in mechanical form. Stored energy is converted by slowing the flywheel down by generating power through a generator. Round-trip efficiency for flywheels is around 70-95%.

In a **Compressed Air Energy Storage** (CAES) plant, air is stored under pressure during periods of low demand/electricity prices. The storage unit is typically an underground cavern. When there is high demand for electricity and/or high prices, the compressed air is released, and decompresses in a turbine driving a power generator. CAES works best at utility scale of 10 MW to 100 MW with an AC / AC efficiency of 40-75% (low efficiency is due to additional cooling / heating during charge / discharge.)



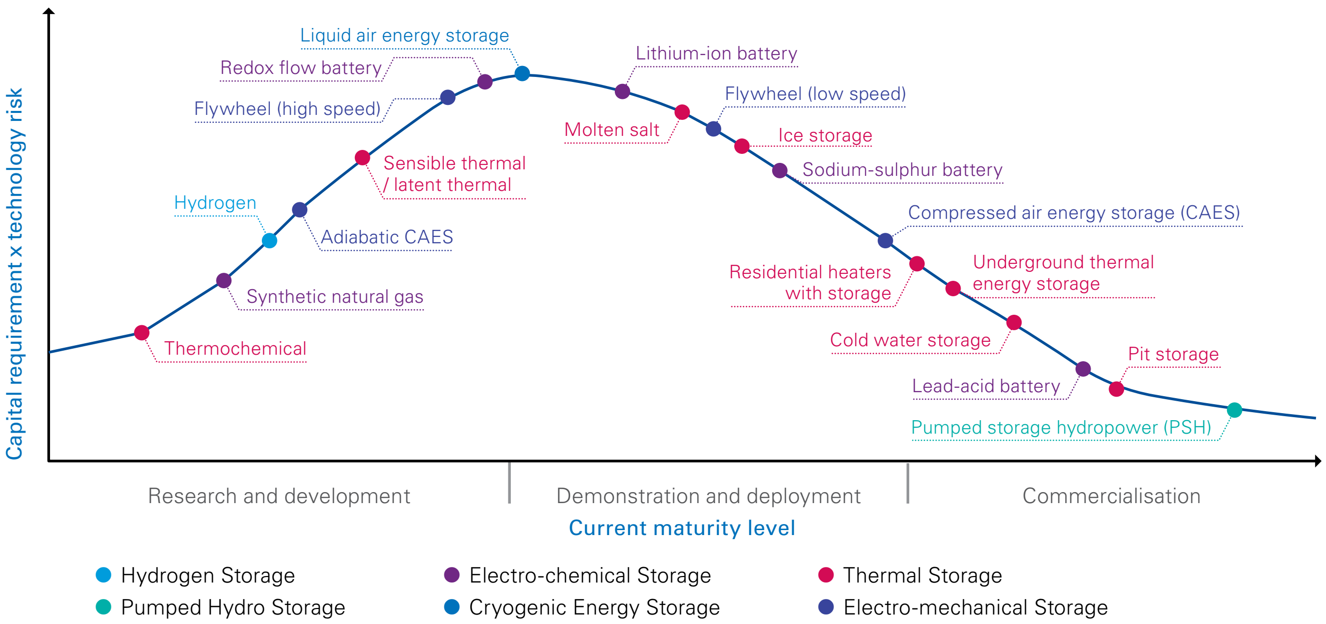
Cryogenic Energy Storage (CES)

CES stores liquefied air or liquid nitrogen at atmospheric pressure. Charging takes place when demand / prices are low as electricity is used to drive an air liquefier. The gas is then cleaned, compressed and cooled until it is converted to liquid. It is stored in an insulated tank at low pressure. When demand / prices are high, the liquid is pumped to high pressure, and then heat is applied, transforming the liquid to a high-pressure gas used to drive a turbine generator. The technology's round-trip efficiency is expected to reach 60%.

Hydrogen Energy Storage (HES)

HES works by using electrolysis to convert electricity at times of low prices/demand into hydrogen. Electrolyzers can range in size from small, appliance-size equipment that is well-suited for small-scale distributed hydrogen production to large-scale, central production facilities that could be tied directly to renewable or other non-greenhouse-gas-emitting forms of electricity production. The hydrogen can then be converted to electricity using fuel cells, burned in CCGT power stations or can be converted into methane. The round-trip efficiency for fuel cells is around 25-45%.

Maturity of energy storage technologies



Sources: World Energy Council • IEA: Technology Roadmap (Energy storage)

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2.2.1 Comparison of characteristics of EES

Storage applications are broadly classified according to their power rating and discharge time requirements:

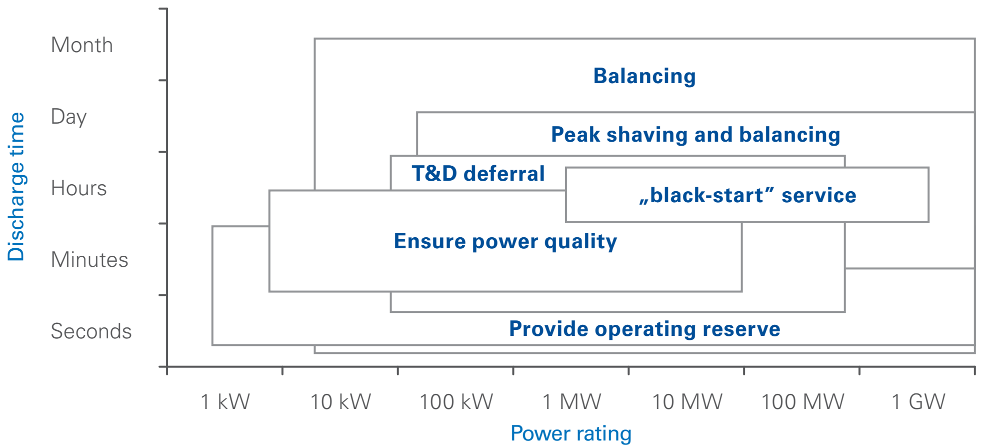
- *Power rating* rates the storage device's instantaneous ability to withdraw / inject energy from / into the grid.
- *The discharge time* indicates the time needed to provide this energy. It corresponds to the energy capacity of the storage divided by the power rating.

The power-to-energy ratio is an essential factor in meeting the requirements of different applications. Some applications require long duration of output power, while others short injection of high power.

Main technical features of the main storage technologies

	Power rating (MW)	Storage duration (h)	Cycling or lifetime	Self discharge[2]	Energy density (Wh/l)	Power density (W/l)	Efficiency[3] (%)	Response time
PHS	100 – 1,000	4 – 12	30 – 60 years	~ 0	0.2 – 2	0.1 – 0.2	70 – 85	Sec – Min
CAES	10 – 1,000	2 – 30	20 – 40 years	~ 0	2 – 6	0.2 – 0.6	40 – 75	Sec – Min
Flywheels	0.001 – 1	Sec – hour	20,000 – 100,000	1.3 – 100%	20 – 80	5,000	70 – 95	< sec
NaS battery	10 – 100	1min – 8h	2,500 – 4,500	0.05 – 20%	150 – 300	120 – 160	70 – 90	< sec
Li-ion battery	0.1 – 40	1min – 8h	1,000 – 10,000	0.1 – 0.3%	200 – 400	1,300 – 10,000	85 – 98	< sec
Flow battery[1]	0.1 – 100	1 – 10h	12,000 – 14,000	0.2%	20 – 70	0.5 – 2	60 – 85	< sec
Molten salt	1 – 150	Hours	30 years	heat loss	70 – 210	n/a	80 – 90	Min
Hydrogen	0.01 – 1,000	Min – weeks	5 – 30 years	0 – 4%	600 (200 bar)	0.2 – 20	25 – 45	Sec – Min

Source: KPMG editing; Electricity Storage – SBC Energy Institute, September 2013
1 Data for vanadium redox flow battery
2 Percentage of energy lost per day
3 Depends on utilization and other factors



All applications have specific technical requirements that will have to be matched with the characteristics of storage technologies

Sources: KPMG editing; Electricity Storage – SBC Energy Institute, September 2013

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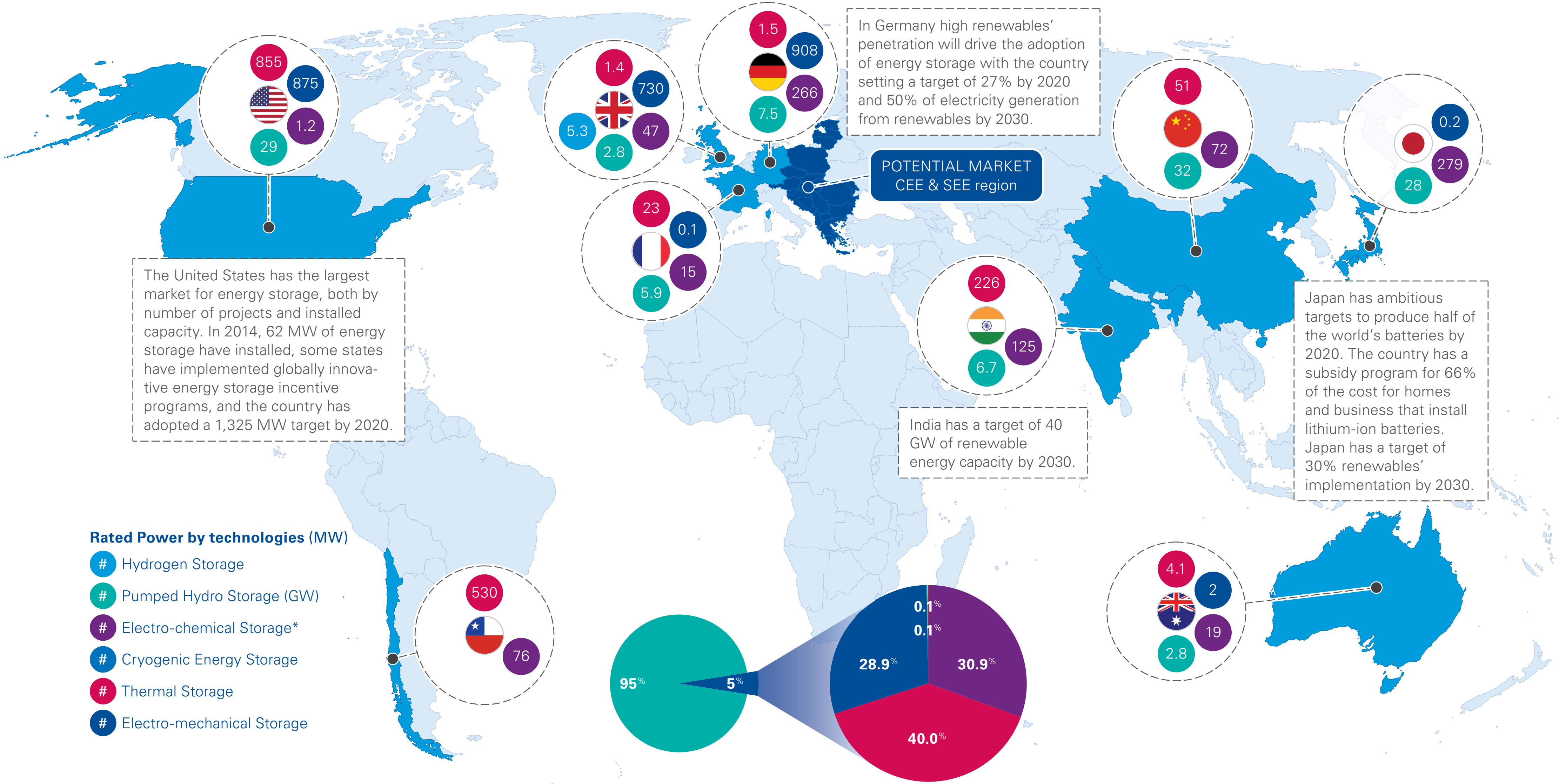
2.3 Global Energy Storage World map

Aggregated rated power in MW of leading projects



Globally installed capacity: **192 868 MW**

Source: DOE Global Energy Storage Database (2016)
** USA (GW)*

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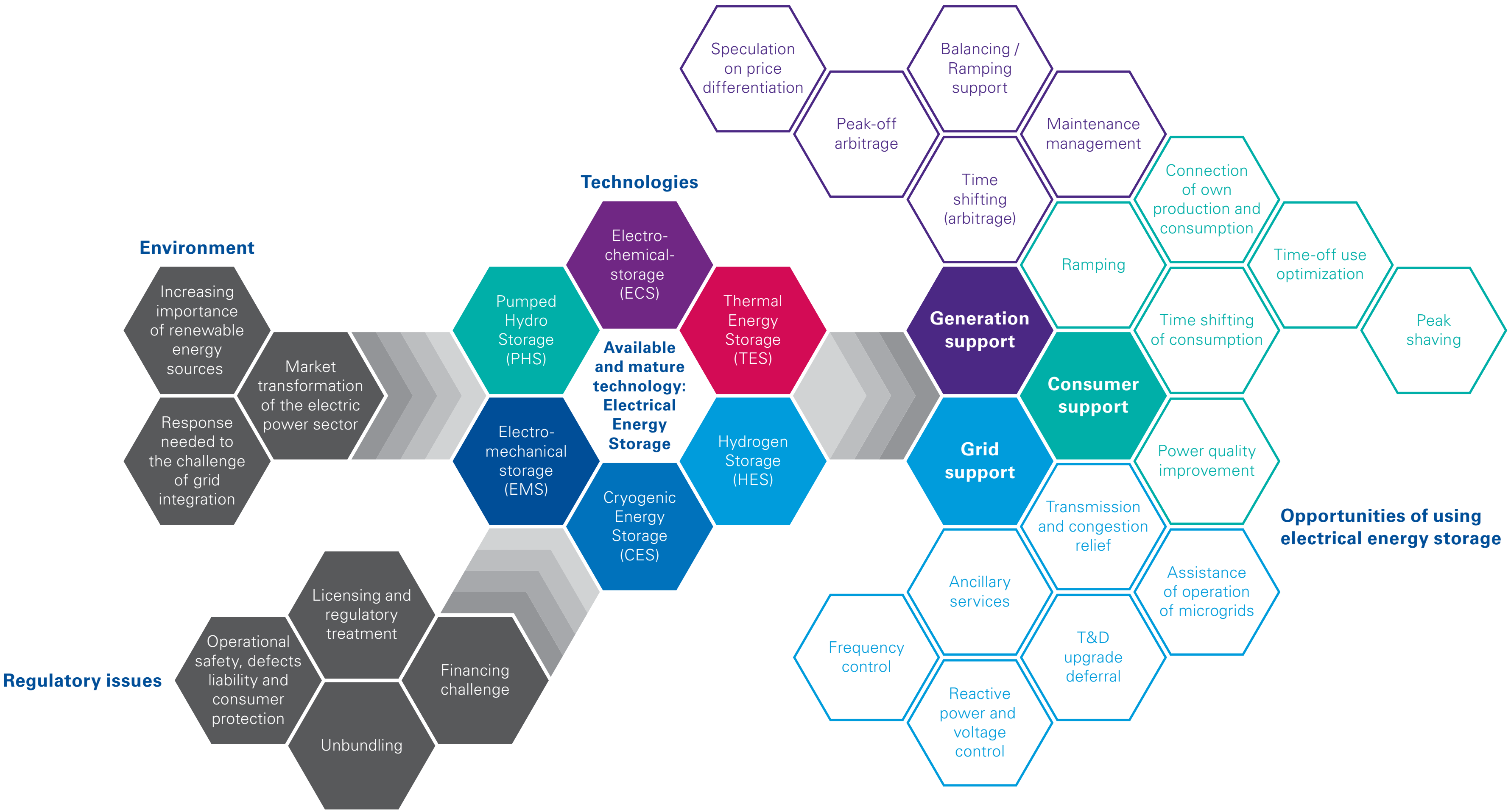
3. Challenges and opportunities of using electrical energy storage across the value chain



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3.1 Generation support

	Time shifting		Balancing / ramping support	Maintenance management
	Peak-off arbitrage	Speculation on price differentiation		
Description	Time shifting the electricity generated by a power plant for technological or commercial purpose		Obligation of keeping a generation schedule for power plants with the aim of maintaining a balance in an electricity system	Providing service during maintenance of energy generation units
Challenge	Too much electricity generated during off-peak periods, putting pressure on the system	Selling the generated electricity on the best available price	Compensation for the generator's deferral from the planned schedule	Service continuity during refurbishments / maintenance
Solution offered by storage	Produced power stored during off peak periods and sold during peak periods	Storage charges during off-peak times, when prices are low, and discharges during peak times when demand and prices are high	Depending on the direction of the generator's deferral from the planned schedule the EES charges or discharges	Substitution for the loss of power plant capacity due to generation unit maintenance
Result	This kind of behavior should be rewarded by the system operator	The difference between the off peak and peak price as an income	Avoidance of penalties due to the deferral (savings)	Avoidance of income loss
Technology	Size depends, charge/discharge time: >hours PHS TES ECS EMS CES HES		Size depends, charge/discharge time: >hours ECS EMS	Size depends on the substituted technology PHS ECS EMS

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3.2 Grid support

	Ancillary services			Transmission and congestion relief	T&D upgrade deferral	Operational assistance for microgrids
	Frequency control	Reactive power and voltage control	„Black start"			
Description	Ancillary services are energy products which are necessary to maintain safe and reliable operation of the (T&D) systems. The growing need for ancillary services also drives the demand for electricity storage systems			There is insufficient transmission capacity to simultaneously accommodate all requests for transmission service within a zone	The capacity of certain elements of the T&D network can become inadequate, which can be handled with network upgrade	Decentralized energy generation including microgrids will bear increasing importance in the near future
Challenge	Maintaining balance between production and consumption in order to maintain system frequency around the optimal level is a mandatory	It is necessary to inject or absorb reactive power to maintain voltage in the T&D system under normal conditions	Recover from a total or partial shutdown of the transmission system	In Europe an increasing number of transmission system is becoming congested due to renewables production and distributed generation	Rising electricity consumption and changed electricity flows	Maintaining reliable and continuous electricity flows in microgrids
Solution offered by storage	EES can meet the requirements of frequency control and can be utilized for spinning and supplemental reserve	EESs can provide reactive power control to adjust the power factor	Grid-scale battery storage system can provide "black start" capability for larger turbines	To reduce transmission congestion, the utilization of ESS reduces the amount of demand that must be served by the transmission system	EES can replace T&D capacity with peak shaving, which can defer or eliminate the need for T&D capacity upgrades	EES can supplement decentralized / distributed energy generators, such as renewables
Result	Income from the frequency control	Income from the voltage control	Income from "black start" capacity	This kind of behavior should be rewarded by the TSO	Savings from unrealized investments	Income from the service provided
Technology	Primary (<min) and secondary (<h) control: EMS ECS Tertiary (>h) control: PHS EMS	Size depends, charge/ discharge time: <hours ECS	Connected to power plant: ECS Connected to grid: PHS TES	Size depends, charge/discharge time: >hours PHS TES ECS EMS CES HES		

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3.3 Consumer support

	Time shifting		Power quality improvement	Connection of own production and consumption	Ramping
	Peak shaving	Time-off use optimization			
Description	Time-shifting of the energy consumed by a consumer for the purposes of cost saving		Maintaining good power quality for consumers is indispensable	For offices / production companies and households with renewable energy generators, power supply may occur during periods when the demand is low	Large industrial consumers are obliged to report their consumption for the system operator
Challenge	A large volume of electricity is needed during peak times, which results in exorbitantly high system usage fees	Too much electricity consumed during peak periods	Power quality is not adequate at the point of consumption	The demand for electricity does not necessarily occur when supply from the system is available	If the volume of electricity consumed differs from the declared amount, the company has to pay a penalty
Solution offered by storage	At peak consumption periods, electricity is supplied by EES	Electricity bought during off-peak periods in change for a significantly lower price stored and discharged by the storage when the need for electricity occurs	Fast correction of voltage turbulences by providing frequency regulation and voltage improvement by EES. Functions as back-up power source in case of blackouts	By storing the power surplus generated by renewable sources, the so-called "prosumer" gets a chance to consume that electricity when there is actual demand for it	A storage smooths out the differences between estimated and actual electricity consumption
Result	Savings on system usage fees	Savings on a company's electricity bill	Savings realized on avoiding production losses or waste due to the malfunction of power quality-sensitive assets	Depends on the implemented governmental support scheme for the usage of renewables	Savings on penalty fees
Technology	Size depends on the amount of electricity needed during a peak period, charge/discharge time: >hours TES ECS EMS CES HES		Fast reaction: ECS EMS Backup: TES ECS	Size depending on renewable generation, charge/discharge time: >hours ECS HES	Size depends, charge/discharge time: >hours ECS EMS HES

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4. Legal aspects of EES projects

Current status of regulation

The pillars of the current EU electricity regulatory framework, including in particular the Third Electricity Directive, were created at a time when EES only played a marginal role. This was primarily due to the dominance of fossil fuel based generation and the lack of commercially mature storage technologies (other than PHS). Consequently, in contrast to the EU natural gas regulatory framework, where gas storage is an established regulatory concept, the current EU electricity regulatory framework fails to address the EES issue. Whilst there are references to EES in some legislative acts and policy documents, there is no specific regulatory framework for its support and operation. However EES is increasingly viewed as an important element in future electricity systems. Through its ability to modulate demand and act as a flexible generation source, EES can contribute to energy security, the completion of the internal market and emission reductions, all being key objectives of the Energy Union in Europe. In addition, EES can play an important role in the further deployment of renewable energy generation. However, aside from pumped hydro, only limited EES exists present in the EU energy markets.

Where to go from here?

The lack of an appropriate regulatory framework is one of the main barriers for the development of future EES technologies within the EU. Accordingly, creation of such a framework has become crucial for the future development of this area. Since the EU is now in the process of creating a new European electricity market design, which will also likely lead to the adoption of a new electricity directive, it now appears to be the right time to address EES regulatory issues at the EU level.

As past experience shows, the adoption of an EU regulatory framework takes a considerable amount of time, during which technology progresses and where a risk is entailed that other global economies may take the lead. Therefore, the lack of EU level harmonization also provides an opportunity for member states, including the CEE countries, to create a national regulatory framework which complies with the applicable EU regulations, but at the same time facilitates storage project development. A well-designed regulatory framework could be viewed as a model for future EU regulation, and as a competitive advantage rendering the given country or countries attractive for investors.

Key issues which need to be considered from the perspective of regulatory design are summarised in the following slides and include:

- Defining EES, including its role and status, within electricity market design
- Creating a regulatory framework which would render the development and operation of EES economically viable
- Handling the challenges resulting from the mass deployment of EES

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4.1 Defining electricity storage, its role and status

Lack of definition and categorization

Currently there is no official definition of EES in EU energy legislation. In June 2016, in a policy paper, the European Commission proposed the following definition: "the act of deferring an amount of the energy that was generated to the moment of use, either as final energy or converted into another energy carrier," but this definition has not yet been transposed into EU energy legislation.

The lack of definition has also resulted in ambiguity as to the categorization (placement) of EES within electricity market design, which currently divides the electricity value chain into the traditional main categories: generation, transmission, distribution and supply. It is yet undecided whether EES should be regarded as network assets, generation assets or should an entirely new category be established? The regulatory categorization of EES has a number of practical and legal implications as to their ownership and operation, including the application of the unbundling rules to EES, grid tariff calculation issues and licensing requirements.

Unbundling

The unbundling rules restrict the network operators' (TSOs and DSOs) ability to engage in activities other than the operation of the network. Such restrictions apply in particular to the control of electricity generation asset.

The applicability of the unbundling rules to EES is currently unclear and will depend on how the storage is defined and categorized. This needs to be decided primarily at the European level to ensure its uniform application in all member states. Until such clarification is made regulatory uncertainty will remain.

If EES were considered as a generation asset, this would make it more difficult for a network operator to have control over a storage project. At present, differing views exist as to the necessity of applying the unbundling regime to EES. Given that network operators could be an important stakeholder group in EES project development and that EES may contribute to resolving balancing issues in a cost efficient way, one could argue that the regulatory framework should allow the participation of network operators in EES activities, with the inclusion of appropriate regulatory safeguards so as to avoid undue distortions in competition resulting from the monopolistic position of network operators.

Grid tariff application and licensing issues

As a result of current uncertainty around the definition of EES, there is a risk that the operator of the EES has to face the grid usage fee payment obligation twice (i.e. as a generator and as a final customer). This issue has already arisen in countries such as Austria, Belgium and Greece. However, some other member states have already implemented mechanisms to avoid the double usage fee payment. For example, in Germany EES facilities are exempted from certain levies, if the stored electricity is exclusively fed back into the grid from which it is originally drawn. Similar issues arise with respect to the payment of the grid connection fee.

From the perspective of creating a storage friendly regulatory environment, further to the elimination of double payment issues, network fees should be calculated on the basis of the real impact of the EES on the grid, taking also into account the possible contribution of storage to grid balancing and congestion problems.

The lack of binding definition of EES also causes problems and raises questions about the licensing of EES. It is a question of interpretation, whether operation of EES should be viewed as an activity which requires the obtainment of a license, and if yes, what licensing requirements should be fulfilled by the prospective applicants.

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4.2 Addressing the economic viability challenge

Role of regulation in financing

In the past, the business model for larger scale EES projects was primarily based on the spread between off-peak and peak prices of electricity. Under such a business model, EES projects participated on the wholesale electricity markets. However, due to a decrease of the spreads, new business models needed to be developed for EES which ensure return on the EES investment. Thanks to the development of EES technology, EES can now provide other services to the market. For example, now it is technically capable of participating in the balancing market and the market for ancillary services (e.g. frequency control, back-up capacity, reactive power compensation).

Storage can also play an important role in supporting the mass deployment of intermittent renewable energy generation. However, as opposed to the "traditional," non-regulated wholesale energy markets, in the aforementioned market segments regulation plays an important role. Regulation may also come into play when providing EU or member state funding for the development of EES projects. At the member state level, beyond direct financial support, other forms of support (e.g. tax incentives, long term contracting) could also be considered, provided that EU state aid rules must in any case be observed.

Participation in the balancing market and the market for ancillary services

Participation in the balancing markets and other ancillary services markets could constitute an important revenue stream for EES projects. According to the Electricity Directive, rules adopted by transmission system operators for balancing the electricity system shall be objective, transparent and non-discriminatory. Effective transposition of this general requirement into national laws is of particular importance from the perspective of EES. Transparent and technology-neutral rules are needed, allowing the participation of EES in the provision of such services under the same conditions as for other market participants.

At the EU level, cross border balancing markets will be harmonized by the Balancing Network Code, which emphasize that one of its main objectives is to facilitate the achievement of the "participation of Demand Side Response including aggregation facilities and energy storage". A further significant aspect of using EES for balancing purposes could be its use for further integration of intermittent renewable sources. The inclusion of EES projects into targeted renewable energy support mechanisms could be considered in this respect.

EU and member state funding services

From an EU perspective, the EU Infrastructure Package could help in developing EES projects, especially until the potential markets for EES (e.g. balancing and ancillary services) become more developed and more accessible for EES projects.

The recently published draft of the electricity Ten-Year Network Development Plan 2016 ("TYNDP") refers several times to the importance of financing EES projects. The TYNDP foresees "around 150 billion euros of investments in grid infrastructure supporting 200 projects in transmission and storage". Several EES projects are now included in the list of Projects of Common Interest ("PCI"), the latest version of which was published in January 2016. Being identified as a PCI project has several advantages such as accelerated planning and permit granting and increased visibility to investors and potentially access to financial support through the Connecting Europe Facility.

The latest Energy and Environmental State Aid Guidelines (Guidelines), which were published in 2014, list EES as an energy infrastructure category, that is eligible to receive state aid subject to the fulfilment of the conditions set out in the Guidelines. As a result, member states are allowed to provide direct financial support for the development of EES projects. Interestingly, the Guidelines contain a definition of electricity storage, which is positive, notwithstanding the fact that it is different from the definition proposed by the EU Commission in its position paper referred to above.

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4.3 Challenges resulting from potential mass deployment

Prospects for household EES deployment

Recent business trends show that EES facilities will probably become common household appliances in the near future. The combination of solar power systems with batteries or thermal storage options is becoming increasingly available option on the market for households and SMEs.

As an indication, the selling of small scale electricity storage systems has already begun in Germany. This newly-developed product package consists of a PV system, a storage device and an application, which taken together can meet the electricity needs of a small family during the evening and the night hours with a storage capacity of 4.4 KWh.

As a consequence of the emergence of new business models, regulators now need to find ways to adjust legislation to the technical features and challenges of the EES equipment allowing its development and mass deployment.

Operational safety, defects liability and consumer protection

Domestic deployment of EES solutions raises the importance of operational safety regulations applicable for such appliances. Differences in national regulatory requirements may constitute a real obstacle for the development of the EES market segment, thus the application of uniform safety standards at the European level may become inevitable.

The increase in the popularity of EES products will likely trigger an increase in product liability, defects and consumer protection-related claims. Consumer information and certification will also play a vital role in this respect. Whether the relevant European regulatory framework (e.g. Energy Labelling Directive, Ecodesign Directive and further regulatory framework on product quality, performance, efficiency, and liability) could appropriately address such issues, or there is a need to adapt such EU framework to the needs of EES, or complement the applicable national regulatory framework to this effect, needs to be evaluated.

Challenges posed by the prosumers

The rapid development of decentralized renewable electricity generation current with that of EES technologies, may result in a large number of end-user customers becoming "prosumers", i.e. customers not only consuming but also generating electricity which they then feed into the grid.

This new role for the customer presents flexibility challenges for the grid, in particular due to unpredictability of the volume of the generated electricity. Furthermore, there is a risk that the prosumer phenomenon could result in substantial load defection (i.e. a significant decrease in electricity demand) or even grid defection (i.e. a significant drop in grid use).

Since the current business operating model of network operators is based on a forecasted volume of network use, through which both fixed and variable costs of network operation and maintenance are distributed among the network users, a fundamental change in customers' relationship use of the grid will challenge the economic viability of the current business model. Such a challenge could constitute a risk to security of supply and, as such, would need to be tackled by regulatory means.

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Resources

- Battery storage for renewables: Market status and technology outlook; IRENA (International Renewable Energy Agency); January 2015
- Development of decentralized energy and storage systems in the UK: A report for the Renewable Energy Association; KPMG; 2016
- DG ENER Working Paper: The future role and challenges of Energy Storage, European Commission, 2012
- DOE Global Energy Storage Database: Office of Electricity Delivery & Energy Reliability (www.energystorageexchange.org)
- Electricity Storage in GB, PÖYRY
- Energy Storage Opportunities and Challenges, ECOFYS, 2014
- Energy Storage: Which Market Designs and Regulatory Incentives are Needed, European Parliament, 2015
- E-storage: Shifting from cost to value: Wind and solar applications, World Energy Resources; World Energy Council; 2016
- European Regulatory and Market Framework for Electricity Storage Infrastructure, stoRE, 2013
- Global Energy Storage Market Overview & Regional Summary Report; Steve Blume, President Energy Storage Council; 2015
- Leading the Energy Transition FactBook: Electricity Storage; SBC Energy Institute; September 2013
- Overview of the Energy Storage Possibilities to Support the Electrical Power System, Research Paper to assist the ERRA Licensing and Competition Committee
- Renewables 2016: Global Status Report; REN21 (Renewable Energy Policy Network for the 21st Century; 2016
- Renewables and Electricity Storage: A technology roadmap for Remap 2030; IRENA; June 2015
- Technology Roadmap: Energy storage; IEA (International Energy Agency); 2014

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