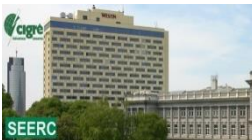


SOUTH EASTERN EUROPEAN REGION OF CIGRÉ SEERC

AUT - BIH - GRC - HRV - HUN - ITA - MKD - MNE - ROU - SRB - SVN - TUR - UKR - CZE

1st KICK-OFF-MEETING FOR REGIONAL WG 04 Location : Zagreb, Croatia



**SEERC RWG 04
Zagreb, 23. 09. 2016.**

Composition of the RWG 4

Participants of the KICK-OFF-MEETING FOR REGIONAL WG 04

Country	Name
NC Italia	Stefano Bellabona
NC Croatia	Marijo Šundrica Branko Horvat Tomislav Plavšić Vedran Jurić Nenad Švarc Božidar Filipović-Grčić Mladen Zeljko



SEERC RWG 04
Zagreb, 23. 09. 2016.

Composition of the RWG 4

Participants of the KICK-OFF-MEETING FOR REGIONAL WG 04

Country	Name
NC Ukraine	Yuriy Bondarenko
	Nikolai Hlopuk
	Sergii Osadchyi
	Oleksandr Shlepak
	Iaroslav Bondarenko
NC Slovenia:	Bojan Kastelan
NC Serbia:	Dragan Balkoski

Terms of reference RWG 4

“Technical and economical features of Hydro Pumped storage power plants (HPSPPs) in power systems”

SEERC RWG - 04	Name of Convenor: Yuriy Bondarenko (Ukraine) E-mail address: ynb@ukr.net, cigre@ukr.net
Technical Issues: The development and installation of energy storage systems and its impact on the power system development and operation	Strategic Directions: Making the best use of the existing system
The WG applies to field of system distributed generation and real-time system operation activities (SC C6)	

Terms of reference RWG 4

Scope, deliverables and proposed time schedule of the Group :

Background :

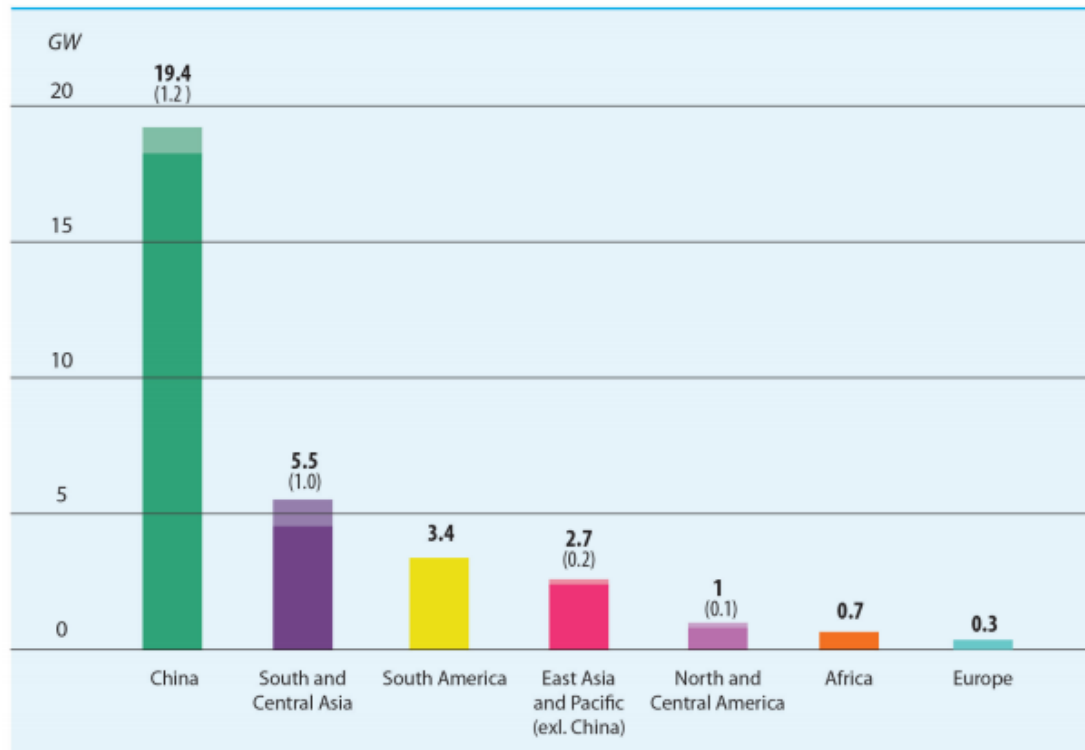
Hydroelectric pumped storage power plant uses in its work either set of generators and pumps or reversible hydro power generating sets, which are able to work not only in the generator mode but also in the pumping mode. Experience of the usage of the HPSPP for purposes to regulation electrical modes shows that they are not only generate source, but also the source of the rendering ancillary services, which contribute as to optimization of the daily load curve and reliability growth and supply quality. The capability of the HPSPP to expend extra energy at night and return it to electric energy system at the time of the largest consumption makes them an efficient tool for aligning the electricity grid capacity.

The changing of the structure of the generation capacities takes place in power system, beyond traditional: nuclear, thermal and hydro; solar and wind generation increases, which requires the new sources of the regulation power.

General information

Total capacity added in 2015 by region:

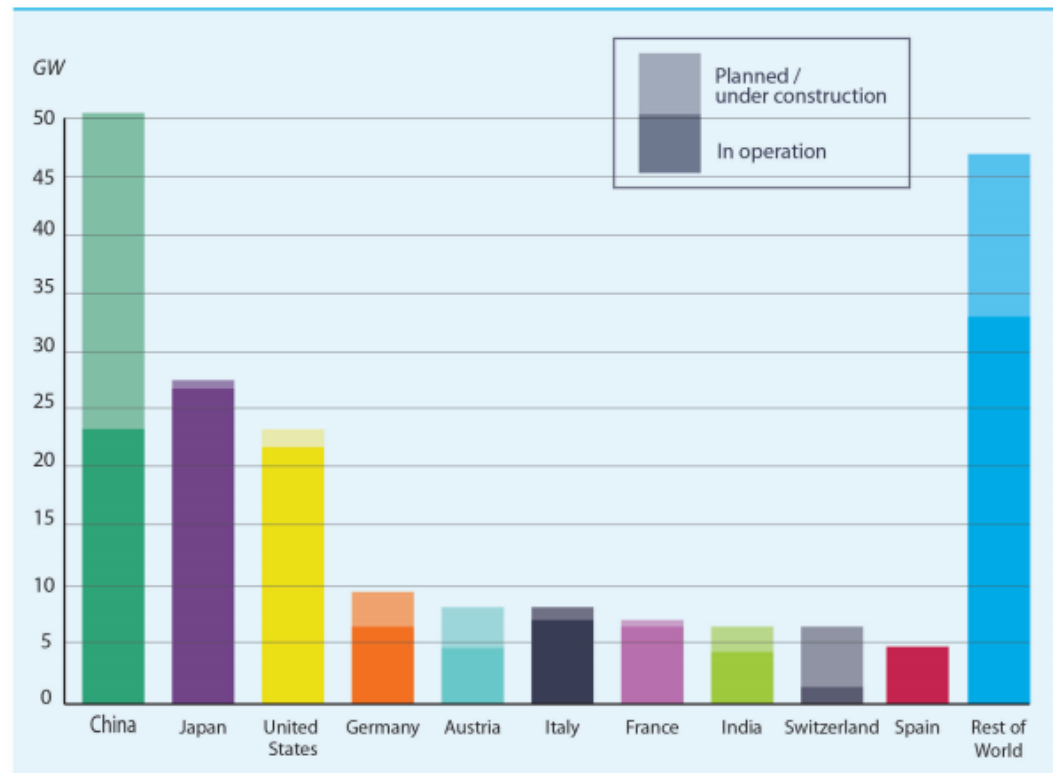
33 GW hydropower capacity (including 2.5 GW pumped storage)



Estimated distribution of new hydropower capacity added by region (pumped storage shown in brackets)

General information

Worldwide distribution of pumped storage capacity (GW) at the end of 2015



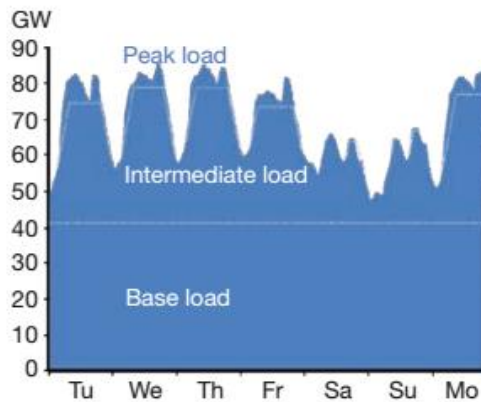
Pumped storage hydropower capacity(GW) in operation or planned and under construction

General information

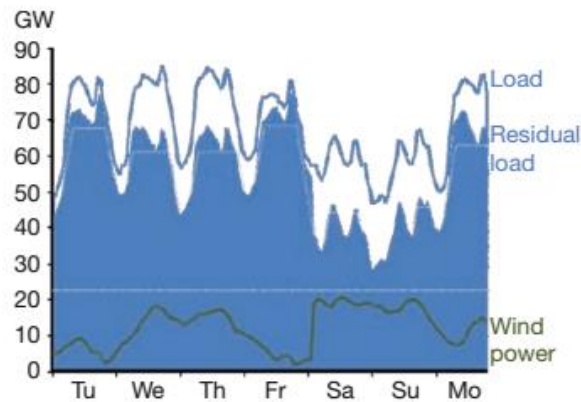


Operational PSP power in 27 EU member countries plus Norway and Switzerland (2008 EUROSTAT data).

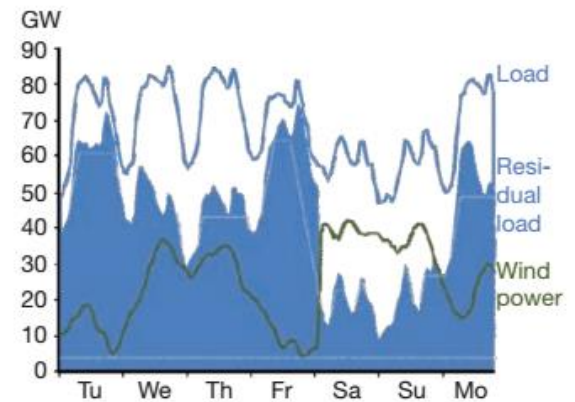
General information



100 % dispatchable portfolio



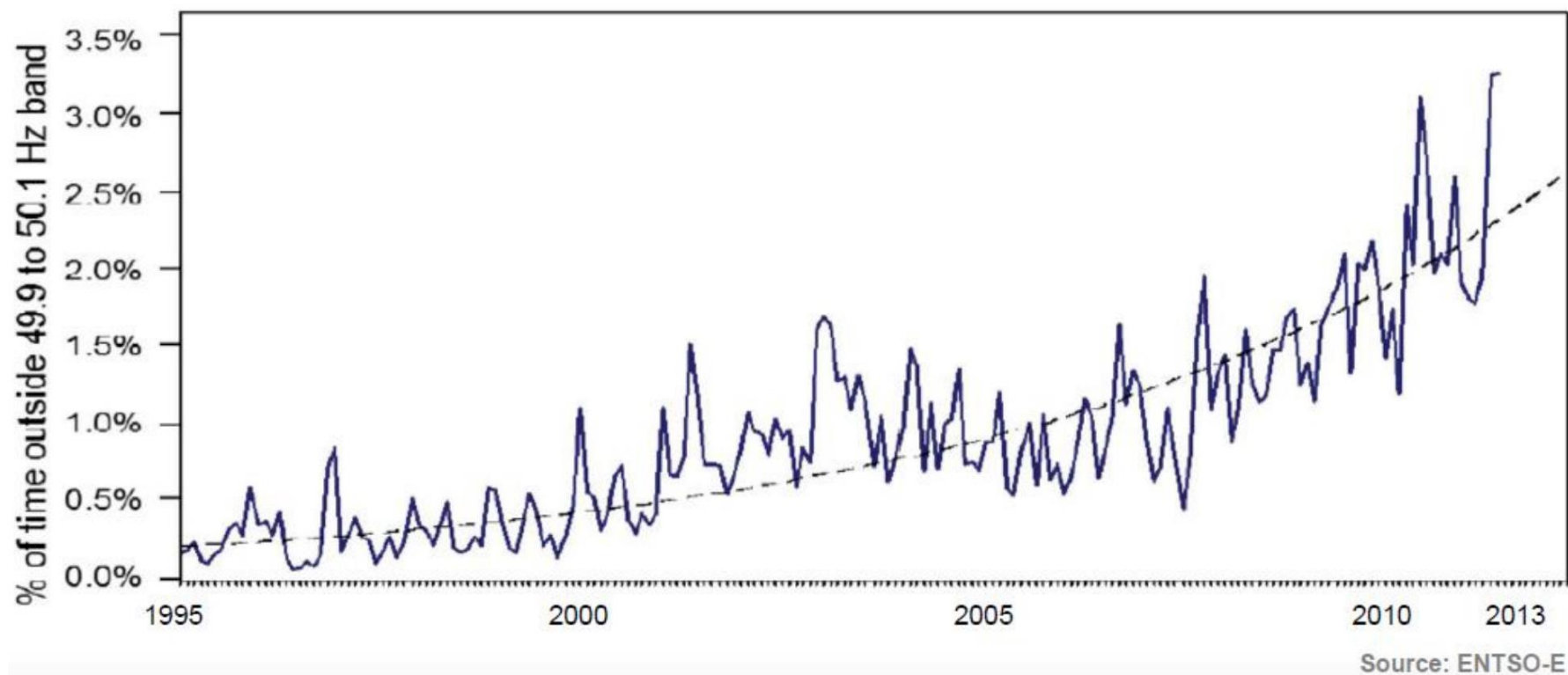
Generation mix in 2009



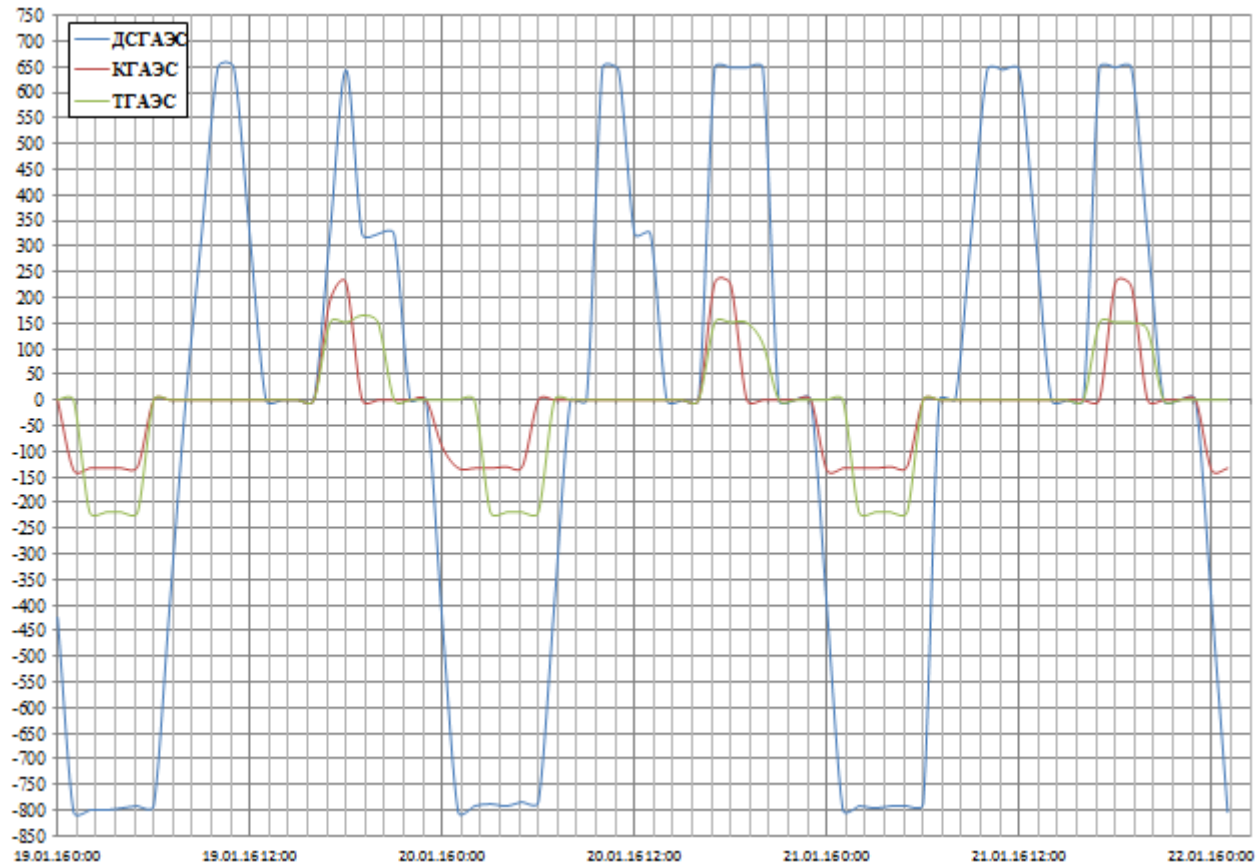
2009 mix scaled to 2020

Load curve example

Frequency deviations in a European Interconnected Power System



General information



General information

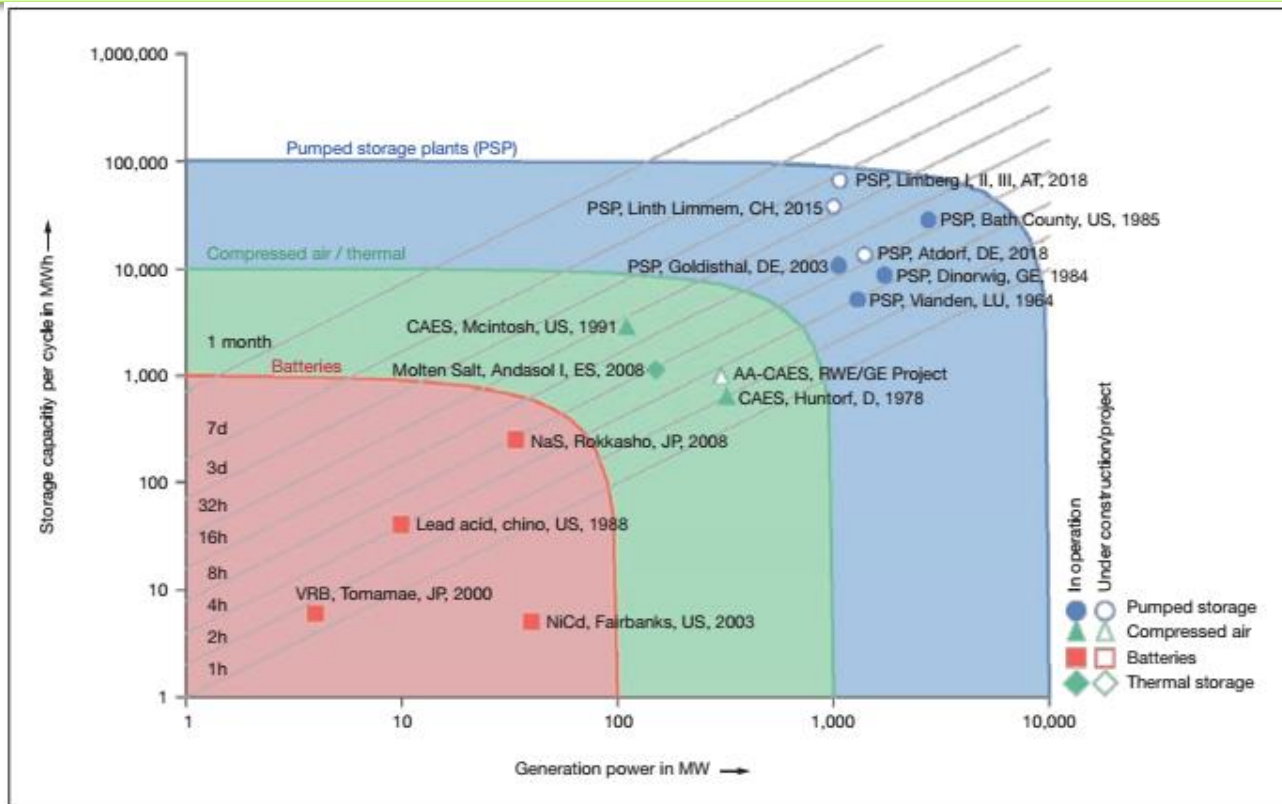
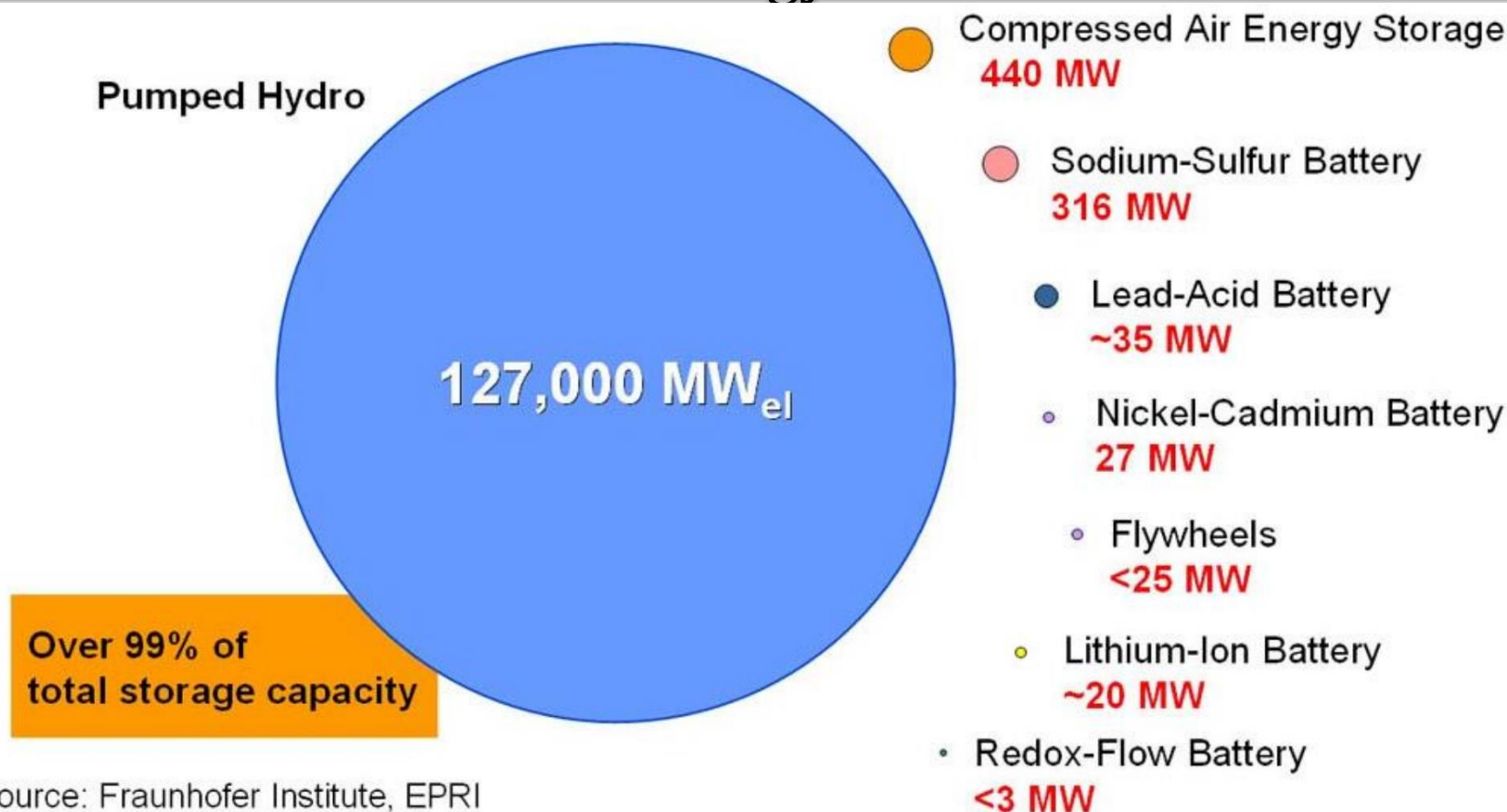


Figure 1. Selected storage sites and projects that represent the state of the art in terms of power and storage capacity (AA-CAES – Advanced Adiabatic CAES, CAES – Compressed Air Energy Storage, NaS – Sodium Sulphur Battery, NiCd – Nickel Cadmium Battery, VRB – Vanadium Redox Flow Battery). The turbine power of the CAES in Huntorf and McIntosh include gas combustion [19, 20]. Big PSP are one order of magnitude larger than CAES and thermal storages, that in turn are one order of magnitude larger than major battery sites.

Worldwide installed storage capacities for electrical energy



Energy Storage Systems Comparison

Technology	Power	Efficiency (%)	Lifetime	Total capital cost (USD/kW)
Pumped Hydro	250 MW > 1 GW	87	30 years	2700 - 3300
CAES – Compressed Air Energy Storage	15 – 400 MW	54 - 88	35 years	600 - 750
Ultra capacitors	10 MW	90	> 50000 cycles	1500 - 2500
SMES - Superconducting Magnetic Energy Storage	1 – 3 MW	90	> 30000 cycles	380 - 490
NaS Batteries	35 MW	80 - 85	15 years	1850 - 2150
Li Ion Batteries	5 MW	90	15 years	4000 - 5000
Fe/Cr Flow Batteries	< 10 MW	50 - 65	20 years	2000 - 2500

Source: Prospects for Large-Scale Energy Storage in Decarbonised Power Grids, OECD/IEA 2009



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Plan of future work

- Proposals for WG4 main experts
- Questionnaire preparation and its distribution to National Committees
- Additional information on Pump Storages in operation and perspective Pump Storages in region
- Analysis of Questionnaire results
- Next meeting of WG4 in May 2017 in Kyiv
- Report in September 2017
- May 2018 – Conference in Kyiv, Ukraine



Thank you