IHS ENERGY

Presentation

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Lawrence Makovich, Vice President and Chief Strategist, North American Power

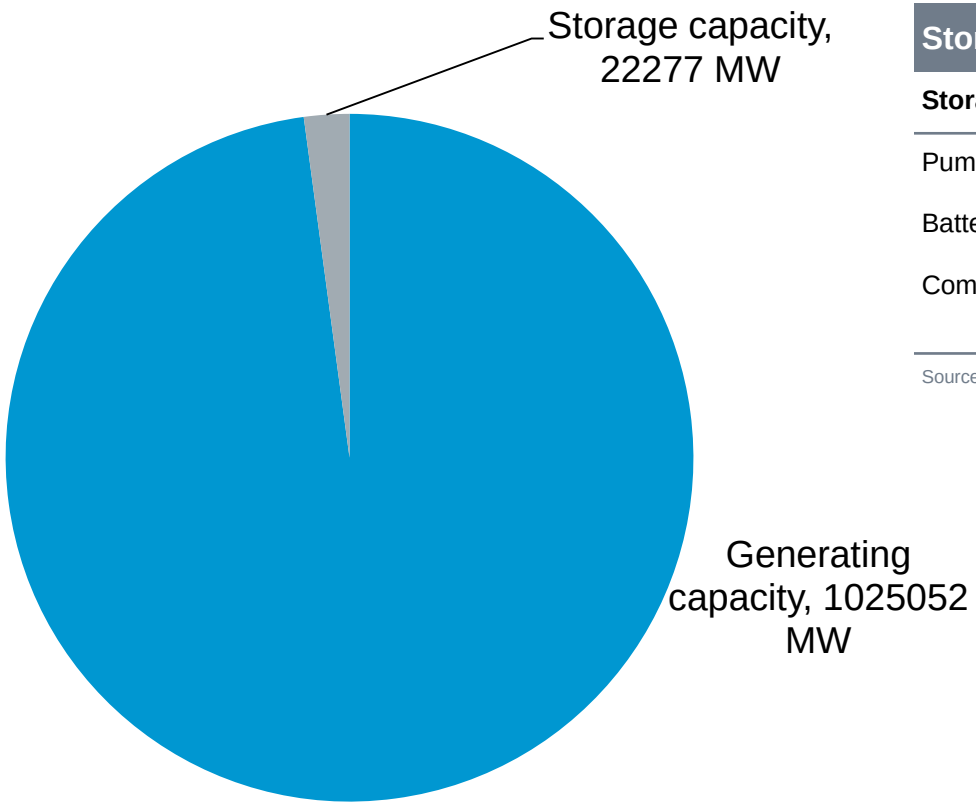
+1 617 866 5372, lawrence.makovich@ihs.com

Grid-scale energy storage overview

- The most promising applications of the current state of storage technologies are in the grid rather than the distributed generation end of the power business.
- Current cost and performance of power storage technologies are not close to posing a disruptive technology threat to grid connected central power stations. Instead, the threat will come from the policy side--mandating and subsidizing storage applications for distributed solar PV installations.
- If a technological breakthrough occurs that lowers the cost and increases the performance of electric storage enough to make it an economic option in power supply, then expect technology adoption to economically disadvantage wind and solar generation technologies compared to coal-fired and nuclear power generating technologies.

Energy storage in the US

US electric capacity: 1.05 TW



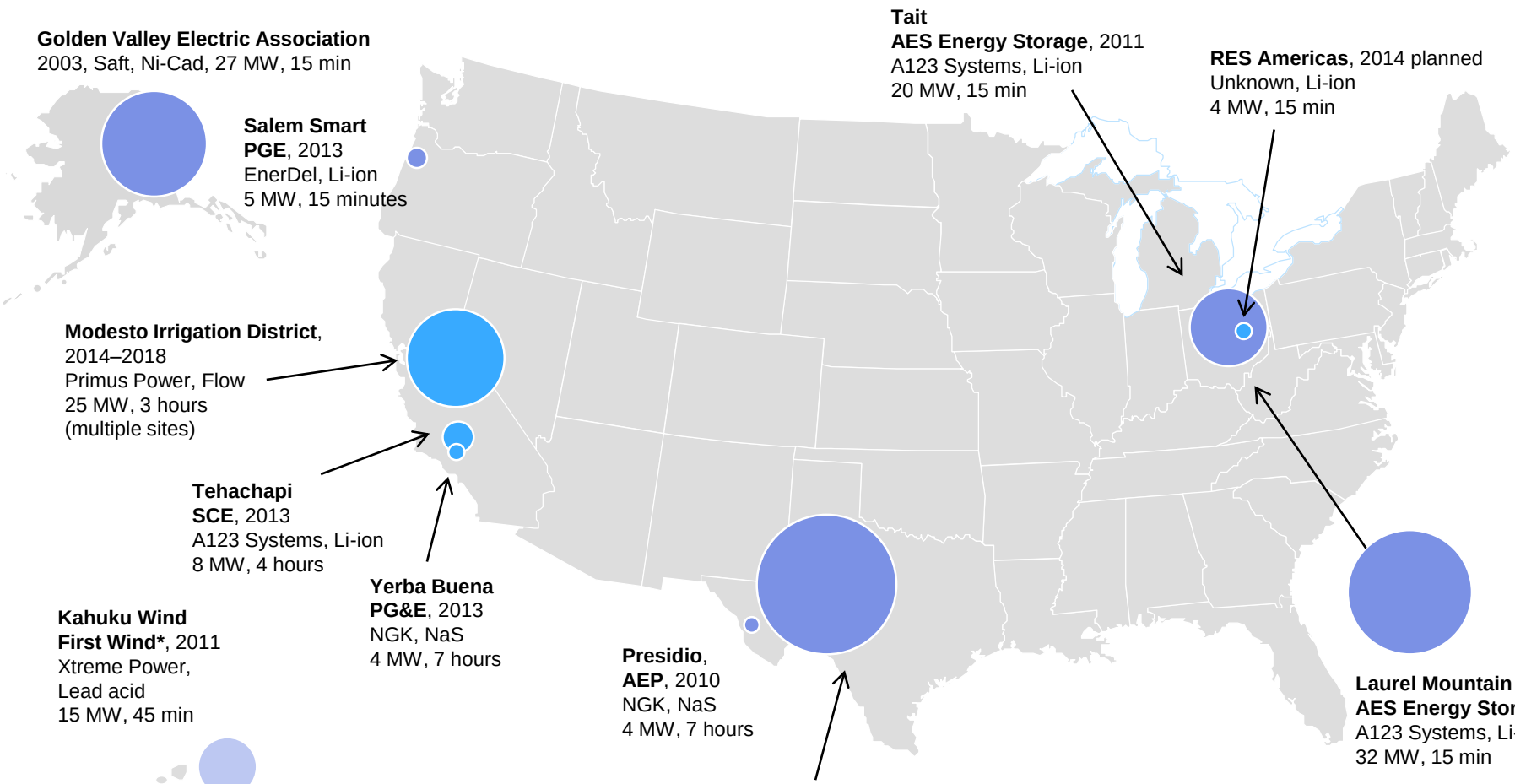
Storage types

Storage type	Capacity
Pumped storage	21,602 MW
Battery storage	565 MW
Compressed air storage	110 MW

Source: IHS

Source: IHS

Grid-connected battery projects in the US -- >4 MW



Golden Valley Electric Association
2003, Saft, Ni-Cad, 27 MW, 15 min

Salem Smart PGE, 2013
EnerDel, Li-ion
5 MW, 15 minutes

Modesto Irrigation District, 2014–2018
Primus Power, Flow
25 MW, 3 hours
(multiple sites)

Tehachapi
SCE, 2013
A123 Systems, Li-ion
8 MW, 4 hours

Yerba Buena
PG&E, 2013
NGK, NaS
4 MW, 7 hours

Kahuku Wind
First Wind*, 2011
Xtreme Power,
Lead acid
15 MW, 45 min

Auwahi Wind
Sempra, 2012
A123 Systems,
Li-ion, 11 MW, 24 min

Kaheawa Wind
First Wind, 2011
Xtreme Power, Lead acid
10 MW, 2 hours

Presidio, **AEP**, 2010
NGK, NaS
4 MW, 7 hours

Notrees Wind
Duke, 2013
Xtreme Power,
Lead acid
36 MW, 40 min

Tait
AES Energy Storage, 2011
A123 Systems, Li-ion
20 MW, 15 min

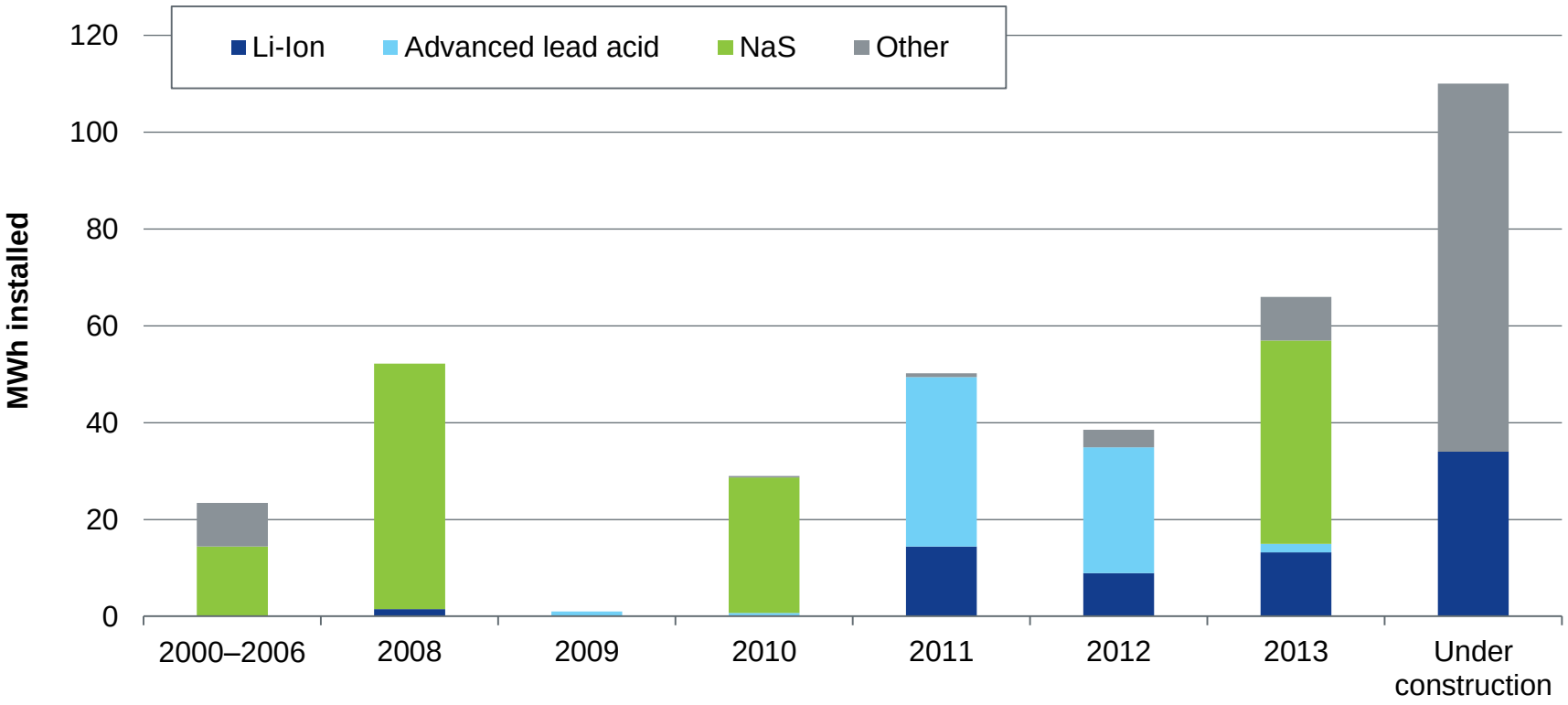
RES Americas, 2014 planned
Unknown, Li-ion
4 MW, 15 min

Laurel Mountain
AES Energy Storage, 2011
A123 Systems, Li-ion
32 MW, 15 min

Note: *The Kahuku wind farm was destroyed in a fire in 2012.

Historical battery installations by technology

Historical US grid-connected battery installations by technology (MWh)

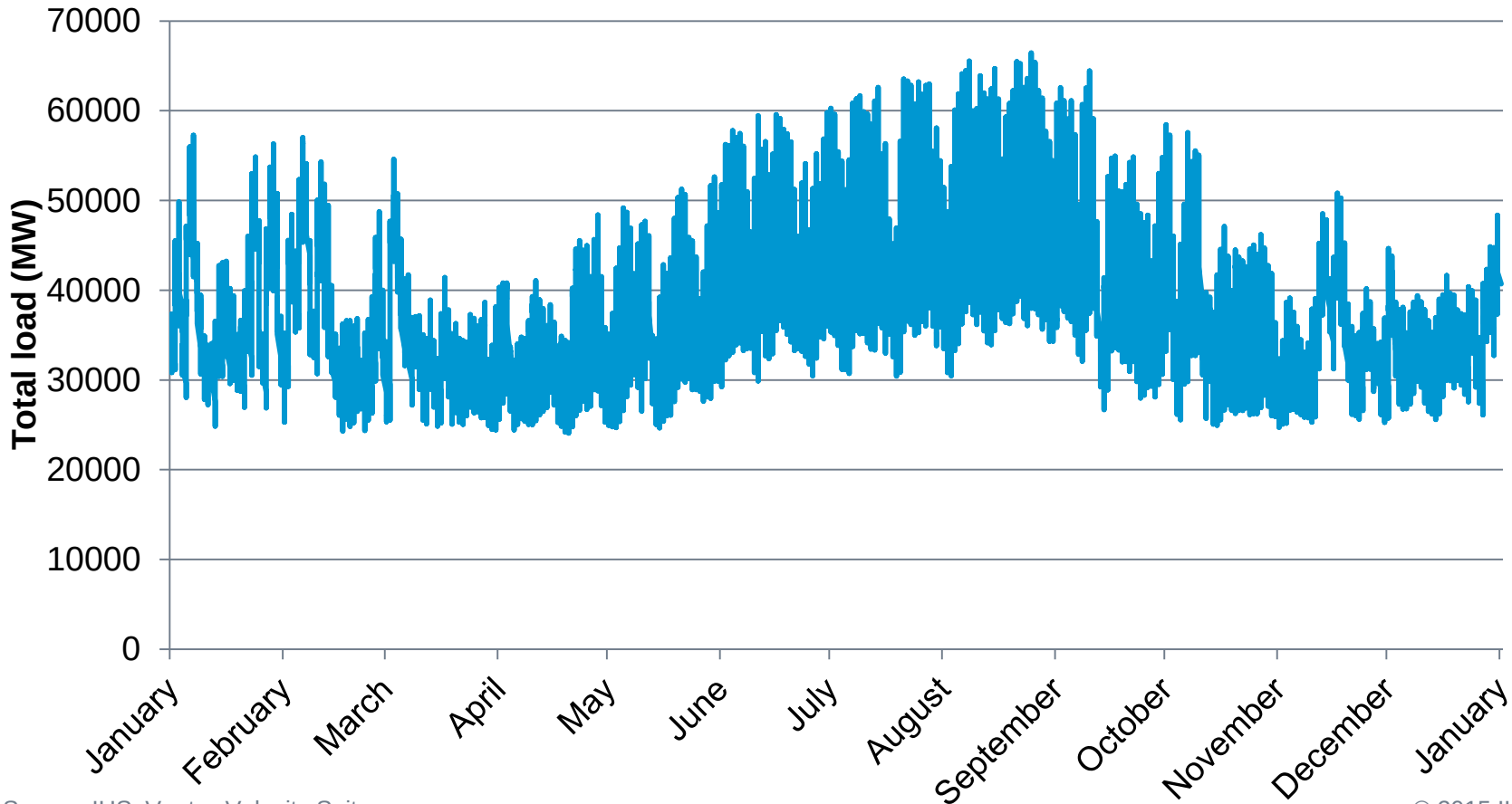


"Other" includes several early-stage battery technologies, with flow batteries making up the majority of projects in this category.

Source: IHS

Power system hourly load - ERCOT

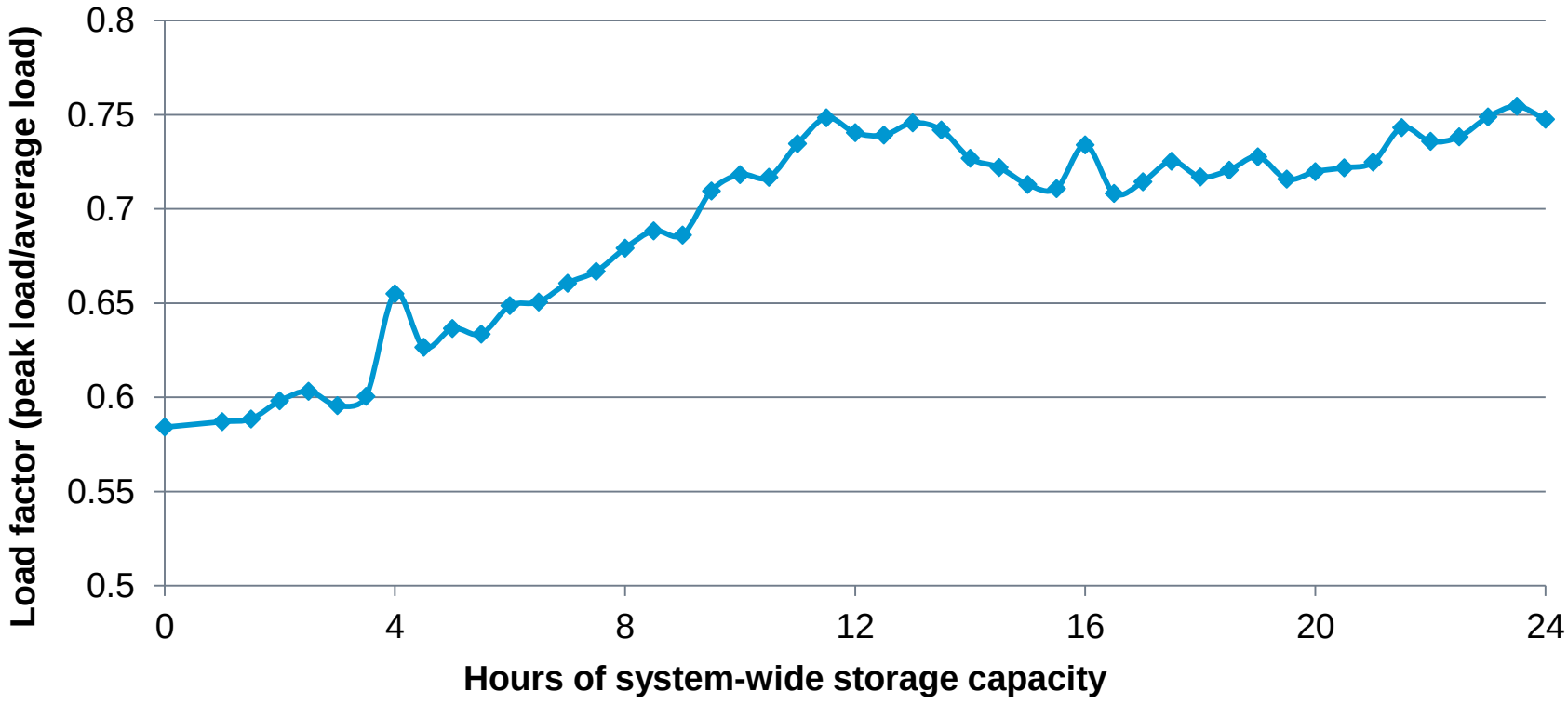
ERCOT hourly load, 2014



Source: IHS, Ventyx Velocity Suite

Impact of large storage additions on the ERCOT power system

Impact of system-wide electricity storage on the ERCOT load factor, 2014



Source: IHS, Ventyx Velocity Suite

Notes: Based on analysis of storage load-smoothing on ERCOT power system. Average transfer capacity required 21,000 MW.

Spectrum of electricity storage applications

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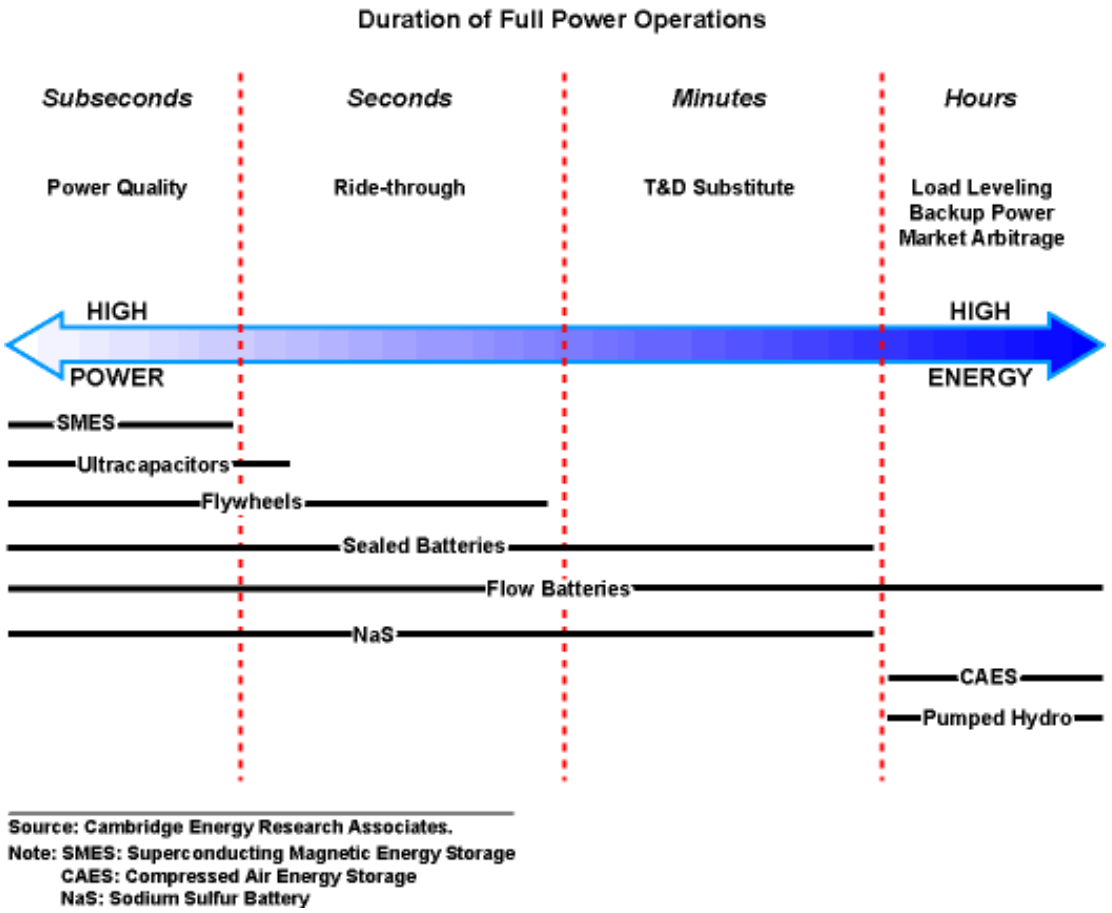
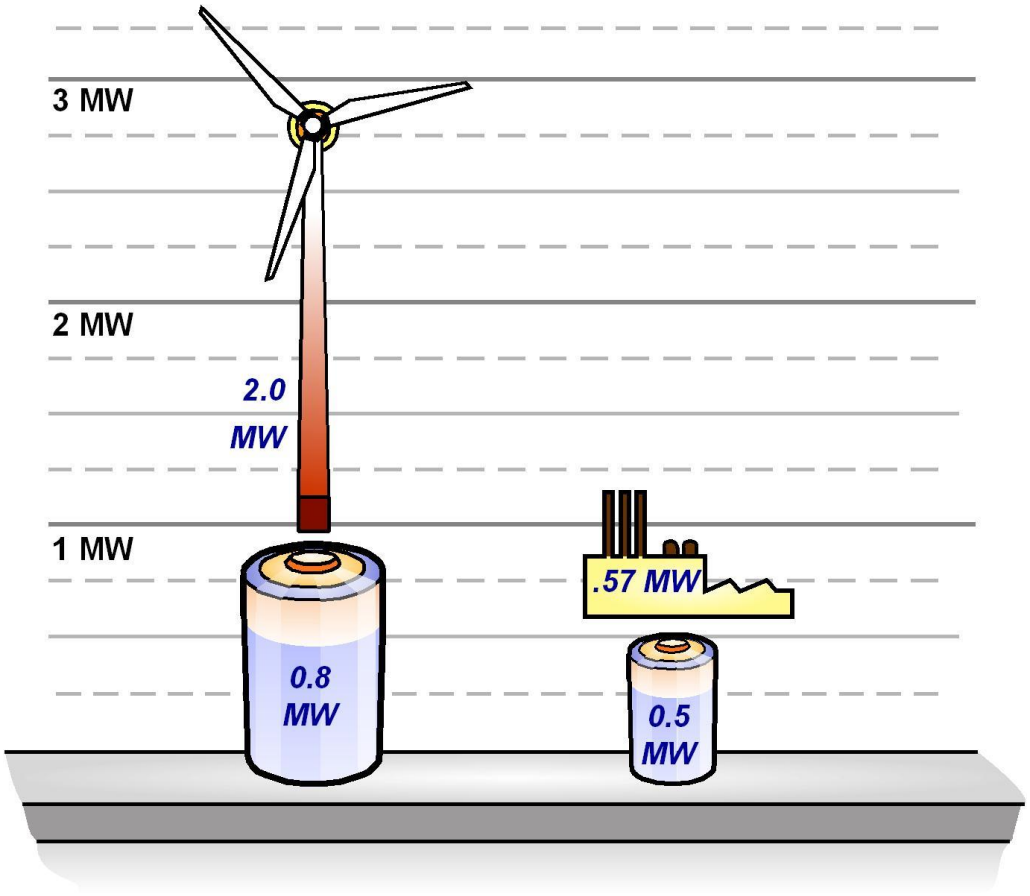


Source: Cambridge Energy Research Associates.
Note: SMES: Superconducting Magnetic Energy Storage
CAES: Compressed Air Energy Storage
NaS: Sodium Sulfur Battery

The line-up for meeting incremental power use

Energy storage: 1 MW of demand with 5,000 MWh of energy



Source: IHS.
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