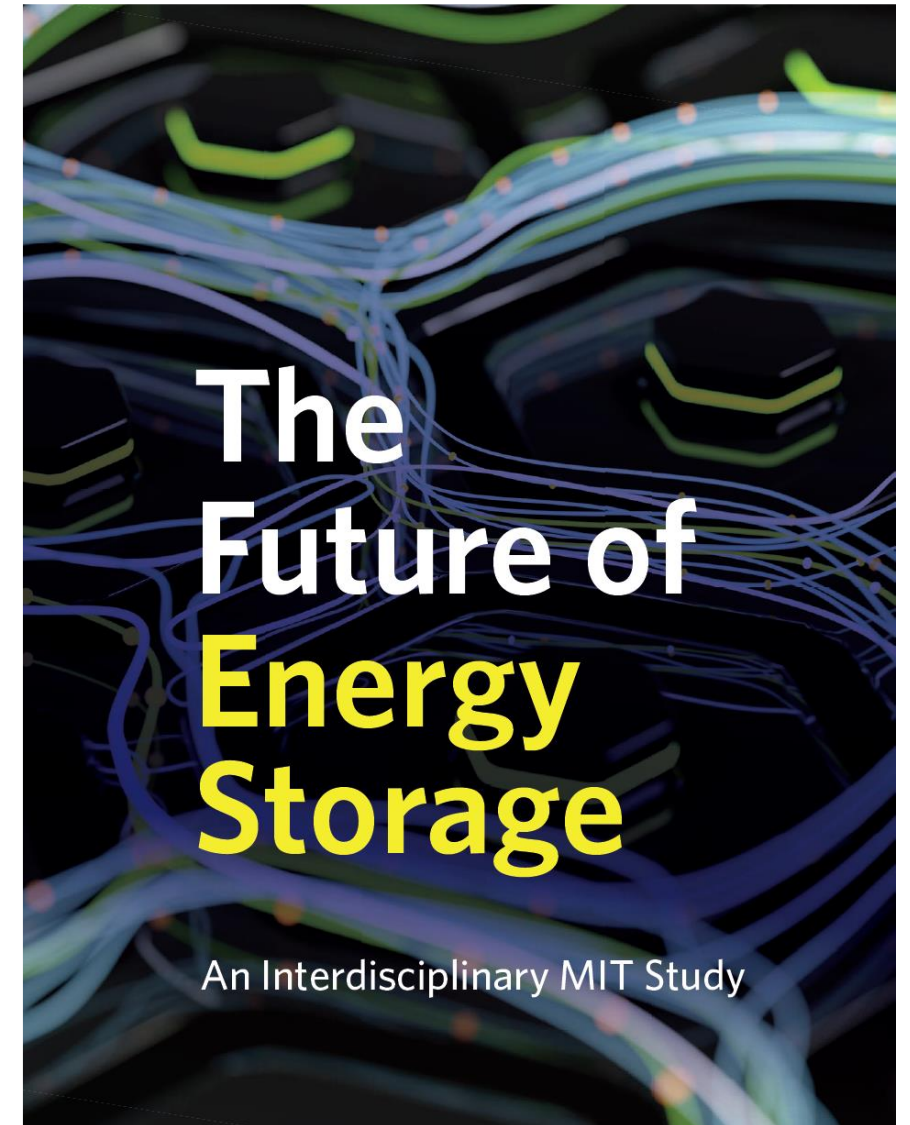
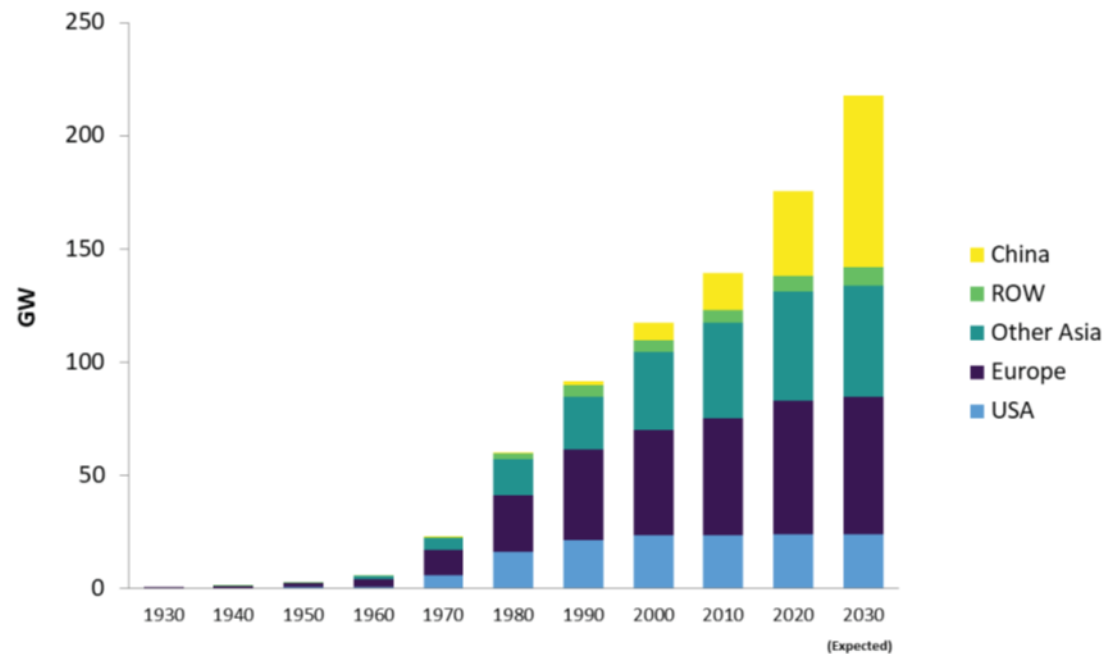


Pumped Storage Hydropower Storage: Insights from the Future of Energy Storage Study

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Pumped storage hydro (PSH) is a mature and widely-deployed long-duration (10+ hours) storage technology. The U.S., Europe, and Japan built significant PSH capacity over 1960-2000. Since 2000, China has dominated PSH growth



- In 2020, PSH was over 99% of the energy capacity and over 90% of power capacity of the world's total electricity storage -- (for the U.S. only, over 98% and over 87% respectively)
- The PSH share of total electricity storage is falling more rapidly for power capacity than for energy capacity
- The economic value of PSH and other forms of storage has generally decreased over the last 20 years as the increasing role of natural gas generation has reduced the gap between day and night generation costs
- Electricity market restructuring, both in the U.S. and globally, has also made it much more difficult to finance PSH projects

Pumped hydro storage costs: power capacity (MW) is costly, energy capacity cost (\$/MWh) varies widely by project (\$5/kWh to \$70/kWh or higher)

- PSH attributes
 - + 80% RTE (high relative to other LDES)
 - + long service life
 - long build time
 - many site-specific elements
 - value of/demand for PSH services uncertain
 - very hard to finance
 - environmental impacts/ siting process for open-loop PHS; (+) closed loop PSH is easier
- + potential synergies between seawater PSH and desalination
- Conventional hydro can also store VRE energy by avoiding use of stored water when VRE is available to enable increased generation when it is not

Cost of power and energy capacity for PSH projects since 1995

