ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Storage™

Technology Strategy Assessment

Findings from Storage Innovations 2030

Thermal Energy Storage

July 2023

- **Design for assembly, maintenance, and operation:** The design of the integration of a new energy source in the form of a TES unit with an existing process needs to utilize existing technologies and supply chains as much as possible. In order to better leverage the capabilities of the existing technologies, it is important to identify and use such tools for integrating a TES unit.
- **Simplification of process integration:** The integration of the new process with the existing process must be simplified to minimize change to the existing infrastructure and subsequently the infrastructure upgrade costs.

Non-Technical Areas of Need

- **Supply chains for high-temperature components:** Since the COVID-19 pandemic, supply chains for high-temperature materials and components needed for high-temperature TES systems have been disrupted. The improved availability of these materials and components are needed for cost-effective deployment of TES systems for industrial process heat decarbonization.
- **The use of locally available materials and existing supply chains:** Using locally available natural resources, in most cases, leads to solutions that maximize cost effectiveness and are not too dependent upon external (potentially volatile) supply chains. Supply chains that are supporting the existing energy industry and providing the equipment, materials, and technology solutions should be incorporated in the new technology integration to reduce the time to commercial deployment.

R&D Opportunities – Buildings

Thermal energy storage in buildings can be used to adjust the timing of electricity demand to better match intermittent supply and to satisfy distribution constraints. TES for building heating and cooling applications predominantly utilizes sensible and latent heat technologies at low temperatures (i.e., near room temperature). Most building applications are electricity-to-heat form of storage.

Next-generation TES materials, new integration strategies, improved system design and operation, and advancements in codes and standards for behind-the-meter storage can foster sustainable, scalable, affordable, and equitable solutions to meet building sector energy and climate goals. In the long term, TES is expected to have lower total installed costs compared with electricity-to-electricity storage, particularly in applications where ambient temperatures allow for larger heat-pump coefficient of performance ratios between charging and discharging periods.

The U.S. DOE Building Technologies Office is developing a roadmap for thermal storage in buildings to support U.S. decarbonization efforts. Methods for evaluating the benefit in terms of cost per kWh_e have been developed [31] and thermal storage in buildings represents a promising pathway to achieving less than $0.05/$kWh_e$.

Highest Impact Opportunities

The U.S. building stock is comprised of 126 million commercial and residential buildings, totaling 329 billion square feet of floorspace [35]. About 74% of U.S. total electricity is consumed in buildings [36] and more than 50% of the consumed electricity is for meeting thermal demands in the building, such as space heating, space cooling, water heating, and refrigeration [37]. Thus, applying TES in buildings could address a major portion of the national storage requirements. TES could directly help reduce the need for electric grid reinforcement resulting from electrification of space heating, especially in cold climates. TES also can reduce summer peak demand while meeting the increasing cooling demand. By integrating TES in buildings, the behind-the-meter demands of electricity in buildings can be flexible, which could increase the utilization of renewable generation and shift

Table D.2. Descriptive statistics for individual innovations

Innovation_cat	Innovation	rte_low	rte_high	rte_mean	rte_std	bpc_low	bpc_high	bpc_mean	bpc_std	fom_low	fom_high	fom_mean	fom_std	vom_low	vom_high	vom_mean	vom_std
Supply chain	Domestication of supply chains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	-0.03	0.04	-0.05	0.00	-0.03	0.04
Technology components	Heat-to-electricity conversion improvements	0.05	0.10	0.08	0.03	-0.20	-0.05	-0.13	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Electricity-to-heat conversion improvements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Component standardization	0.00	0.00	0.00	0.00	-0.20	-0.05	-0.12	0.08	-0.20	-0.05	-0.12	0.08	-0.20	-0.05	-0.12	0.08
	Single-tank storage	-0.03	0.10	0.02	0.03	0.00	0.00	0.00	0.00	-0.90	0.00	-0.40	0.46	-1.00	0.00	-0.43	0.51
Advanced materials development	Mass production and automation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	-0.02	0.03	-0.05	0.00	-0.02	0.03
Deployment	Deployment policies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Large-scale demonstration	0.00	0.03	0.02	0.02	-0.10	-0.05	-0.08	0.04	-0.90	-0.15	-0.53	0.53	-1.00	0.00	-0.50	0.71
	Small-scale demonstration	0.00	0.03	0.02	0.02	-0.05	0.00	-0.03	0.04	-0.90	-0.15	-0.53	0.53	-1.00	0.00	-0.50	0.71
	Deployment efficiency	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
End of life	Salt recycling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

rte = round-trip efficiency, bpc = balance of plant cost, fom = fixed operations and maintenance (O&M), vom = variable O&M

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