



Thermal Energy Storage Developments for Grid and Industrial Process Heat Decarbonization

Dr. Jeffrey Gifford
National Renewable Energy Laboratory
ASES SOLAR 2023 | August 10th, 2023



1. Introduction

2. Particle Thermal Energy Storage

3. Current Work

4. Conclusions

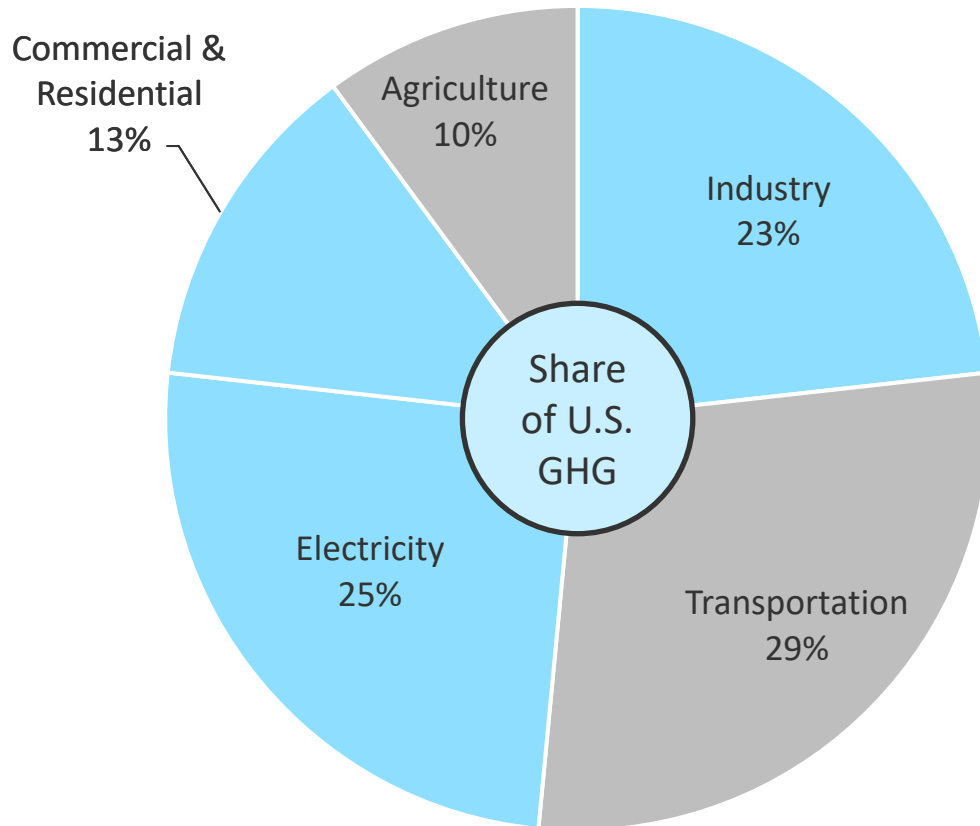
1. Introduction

2. Particle Thermal Energy Storage

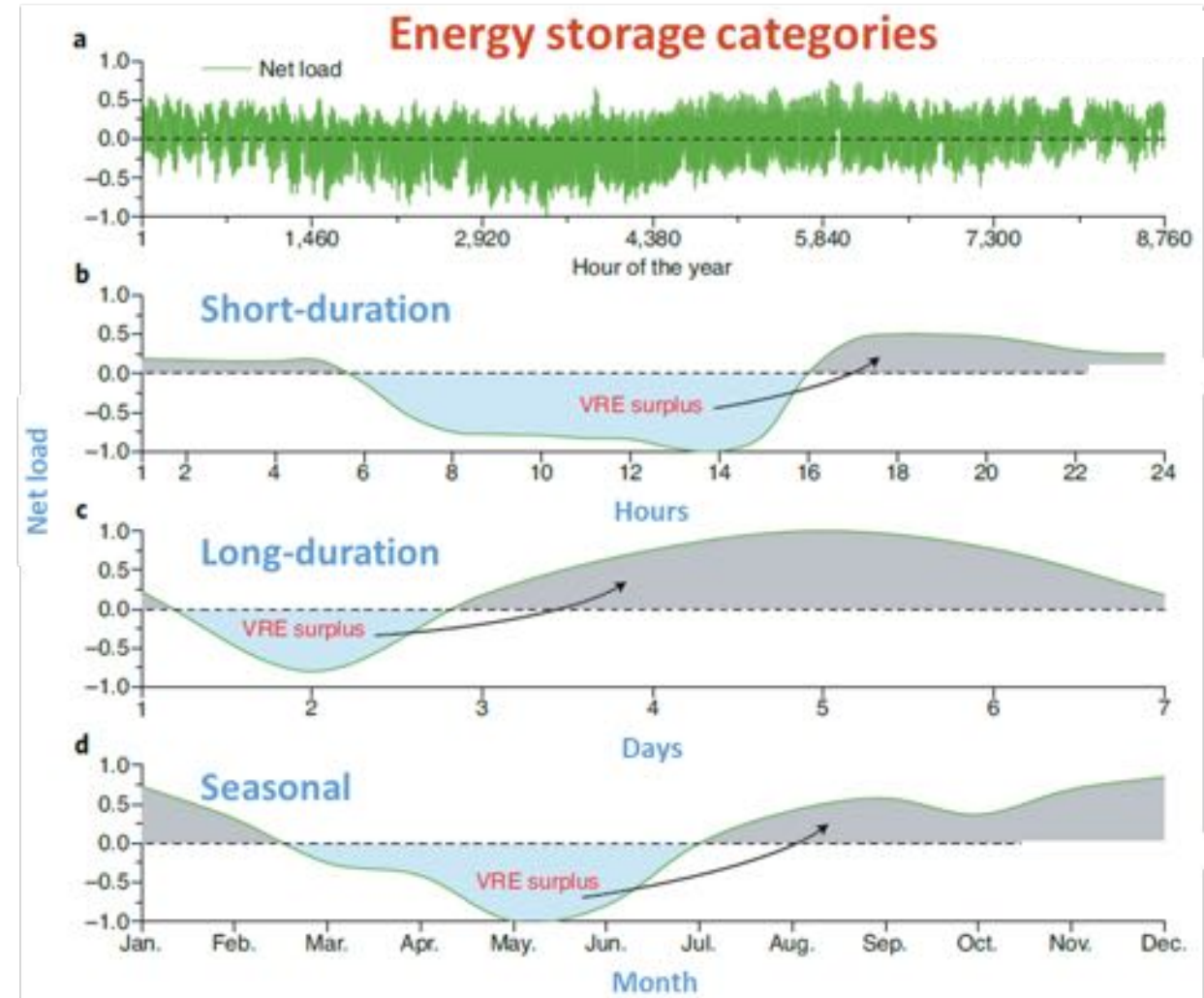
3. Current Work

4. Conclusions

Many energy sectors need to be decarbonized; long-duration energy storage is a solution to these needs.

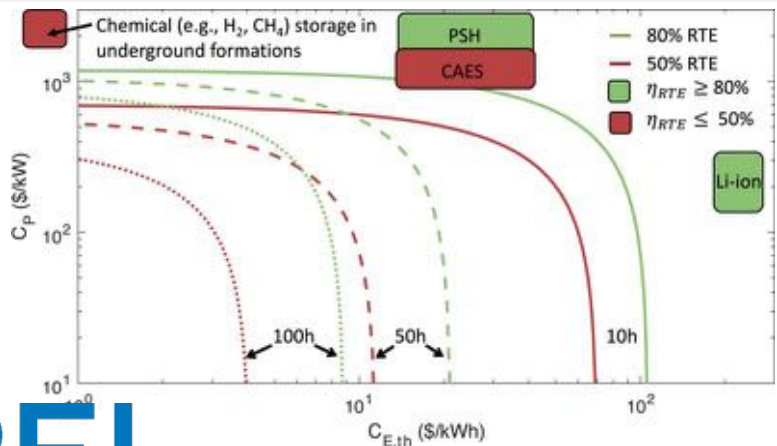
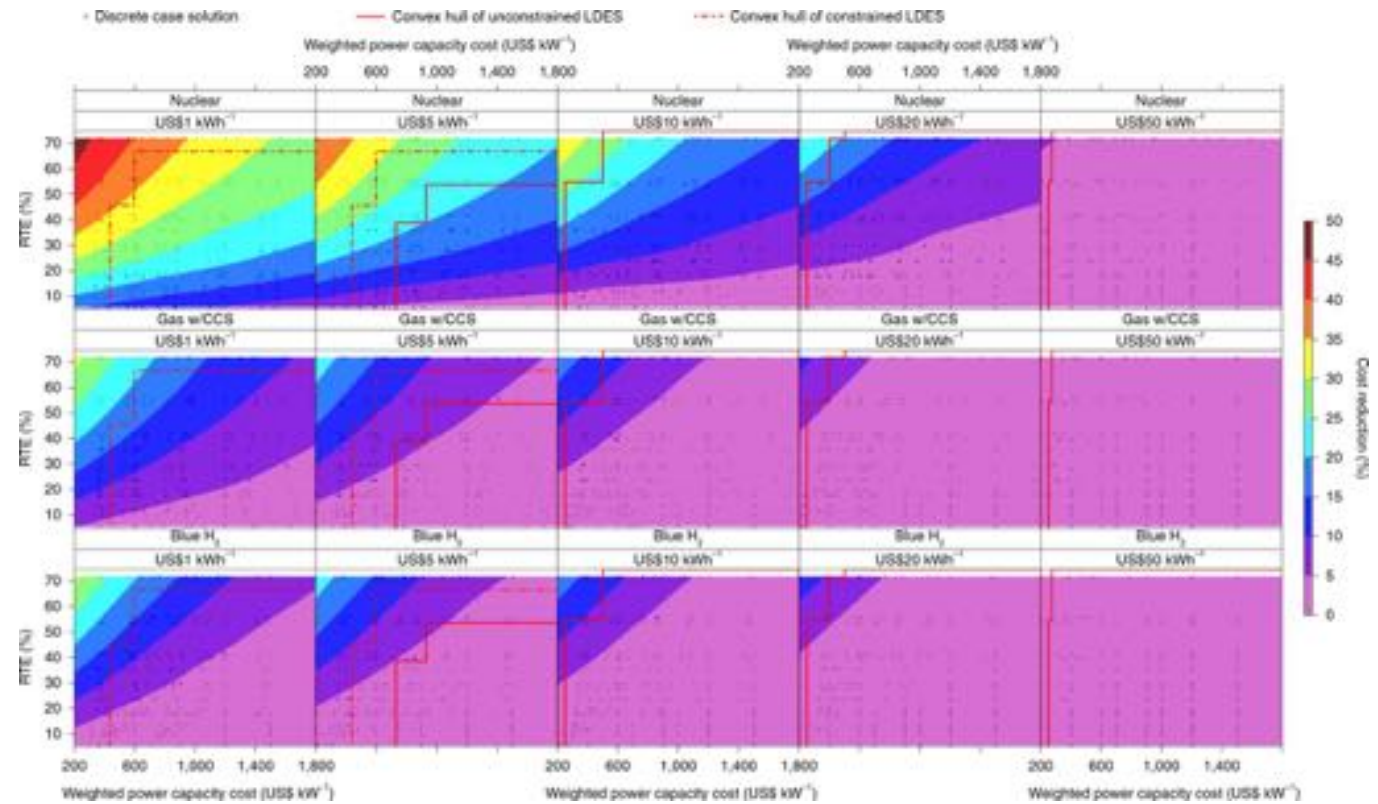
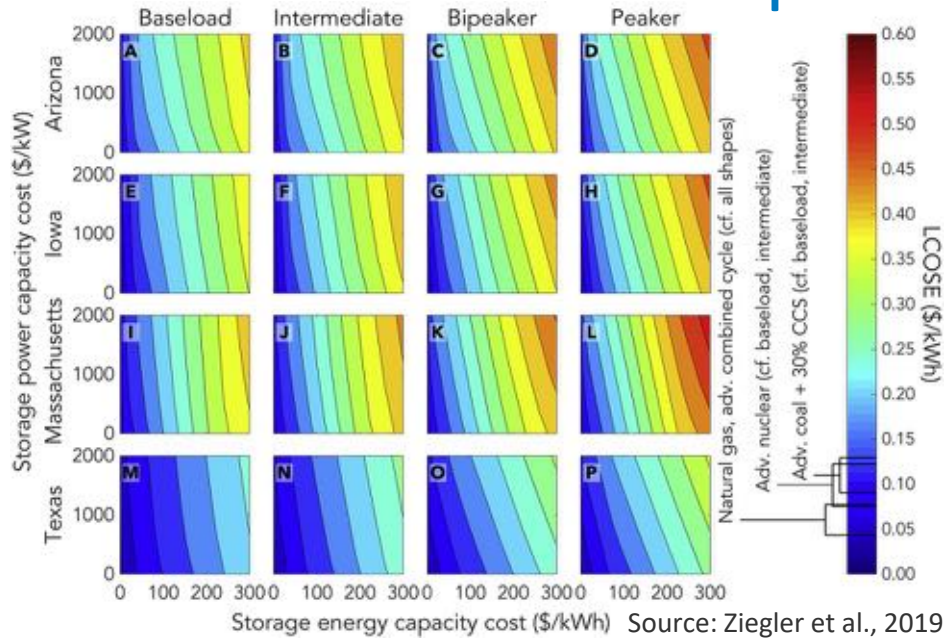


Source: [Inventory of U.S. Greenhouse Gas Emissions and Sinks](#)



Source: Guerra 2021

However, long-duration energy storage must meet specific cost, performance targets.



Source: Albertus et al., 2020

Source: Sepulveda et al., 2021



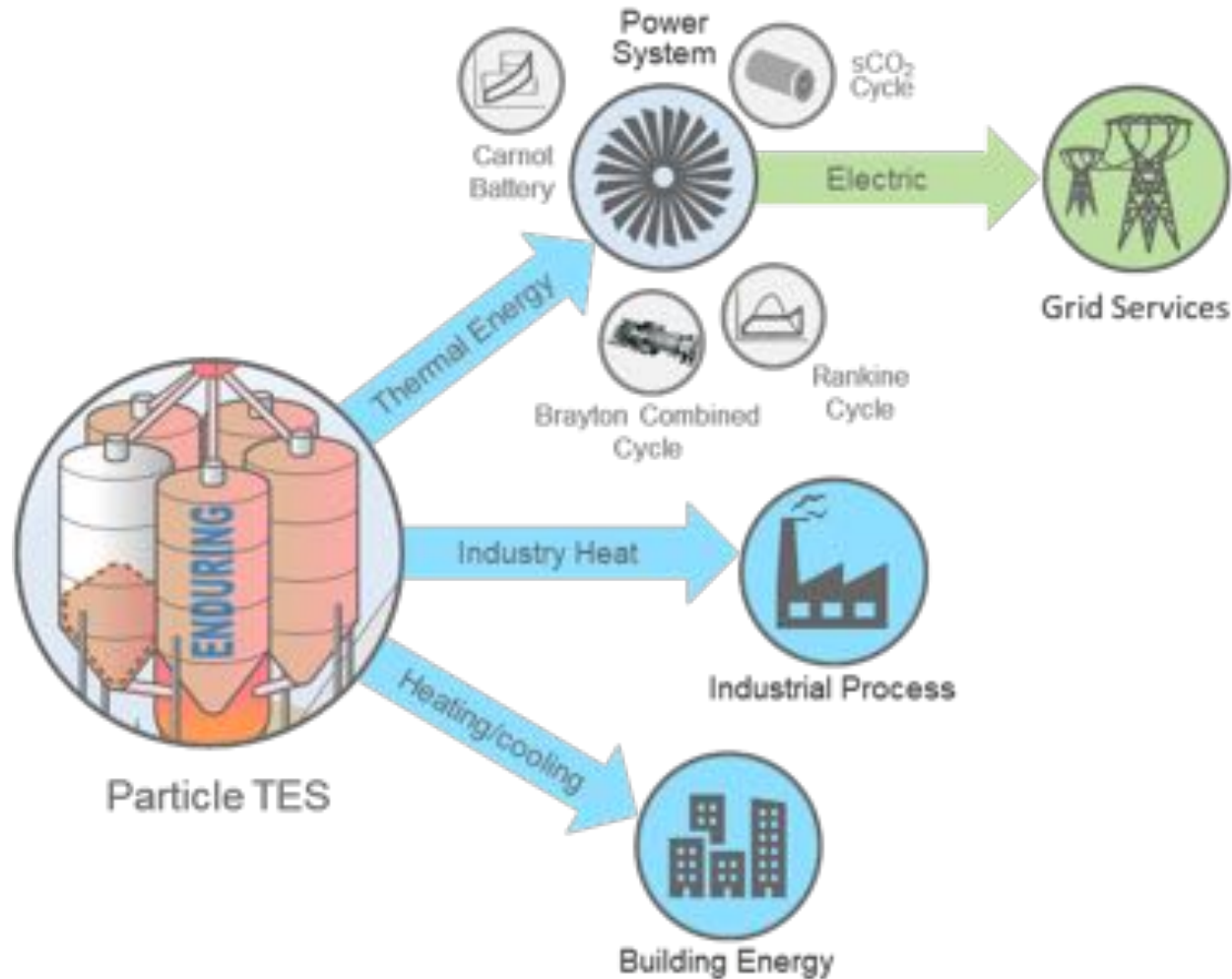
1. Introduction

2. Particle Thermal Energy Storage

3. Current Work

4. Conclusions

Particle thermal energy storage can integrate with a range of applications, meet performance and cost targets.



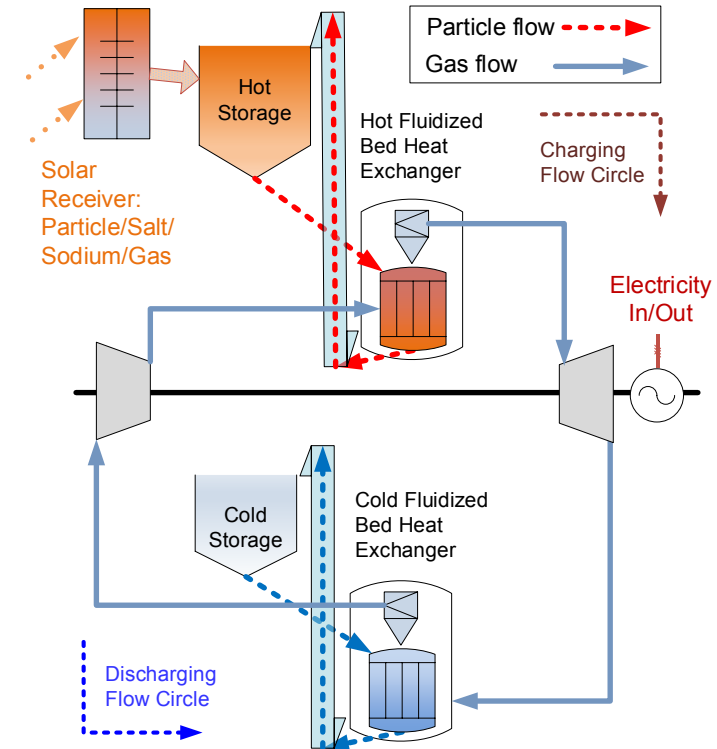
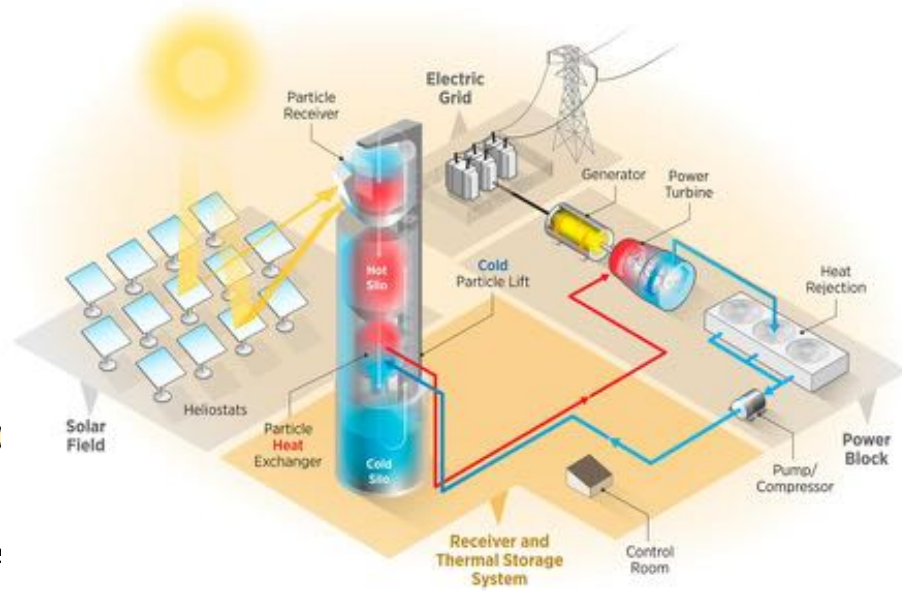
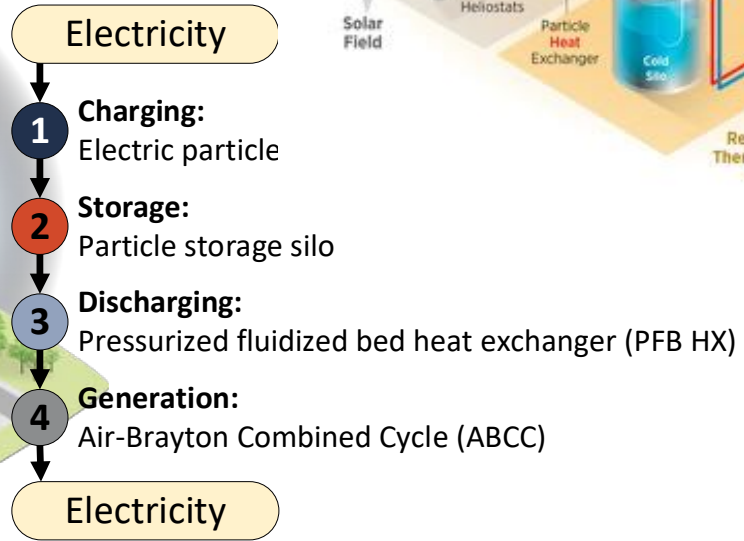
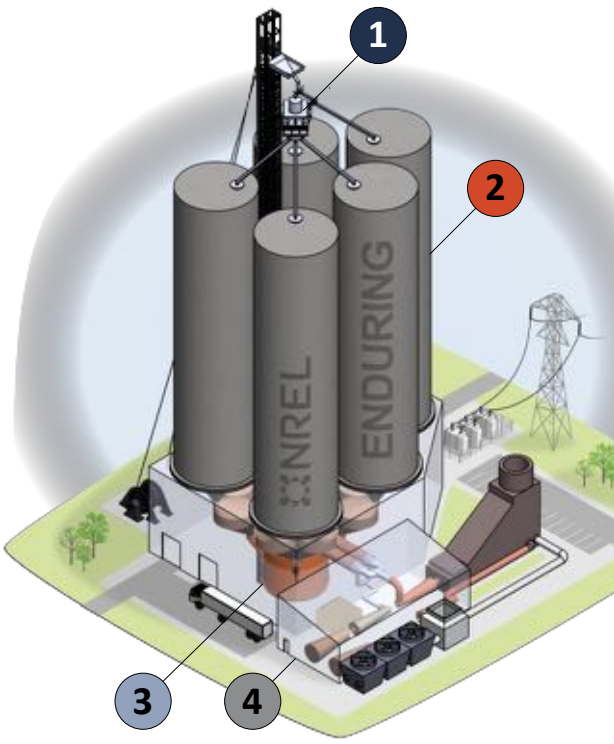
Large temperature range

Low cost

Non-toxic

Abundant

Particle thermal energy storage can integrate with a range of applications, meet performance and cost targets.





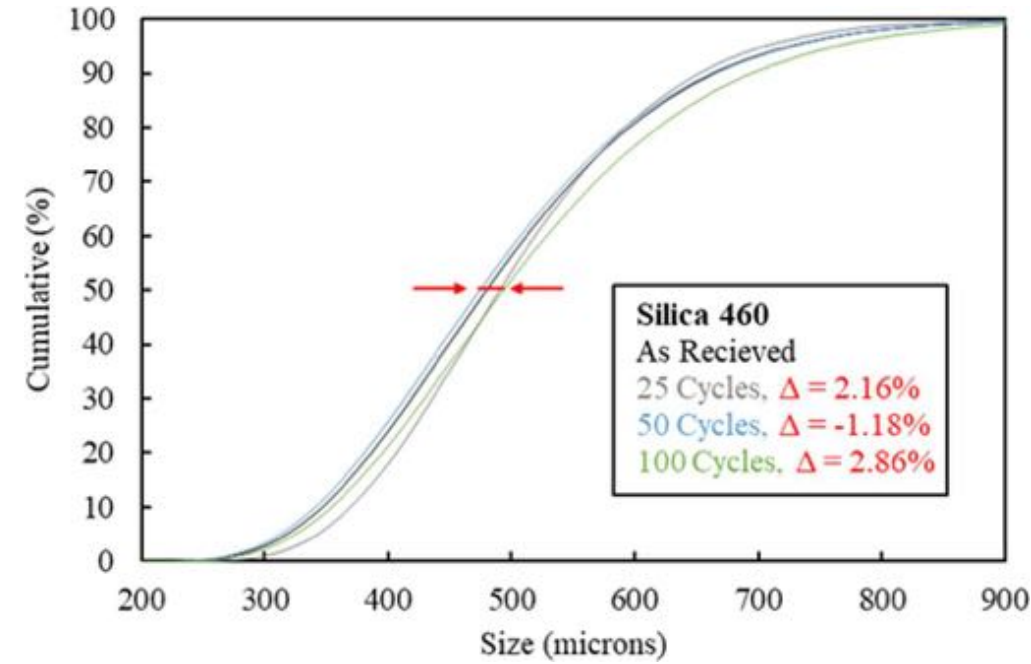
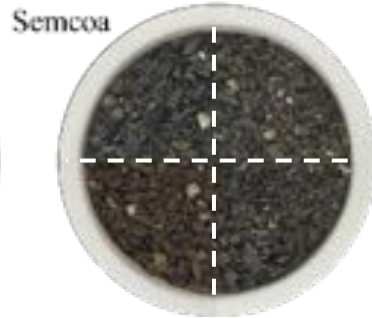
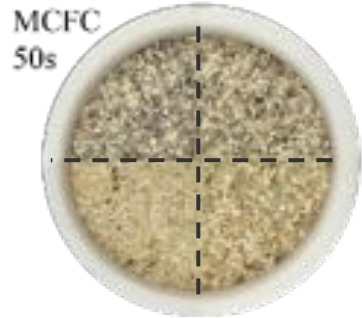
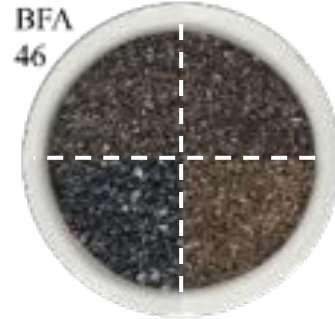
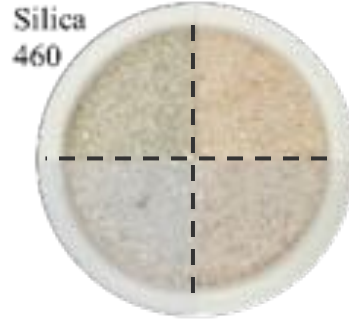
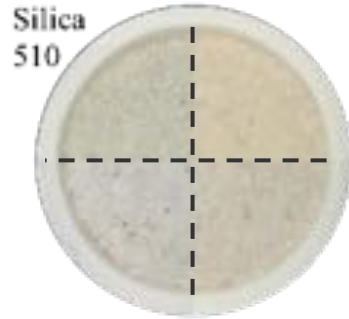
1. Introduction

2. Particle Thermal Energy Storage

3. Current Work

4. Conclusions

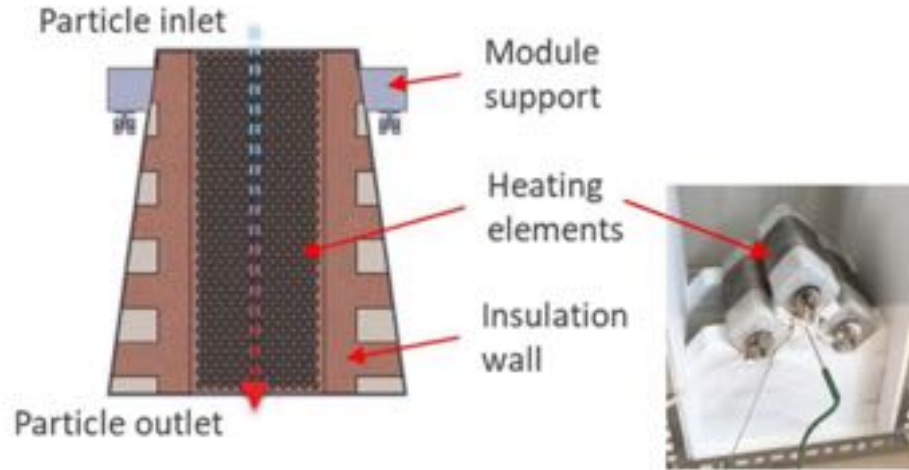
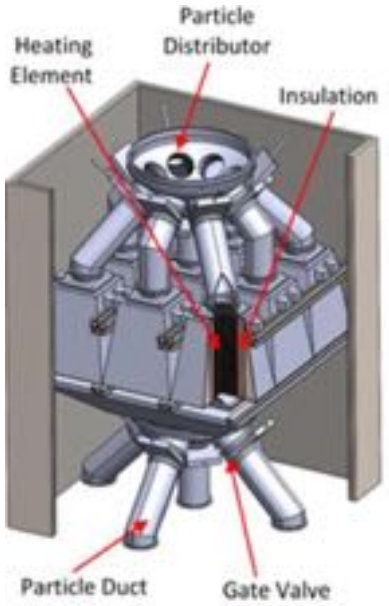
Particle testing and characterization are used to examine cycling stability.



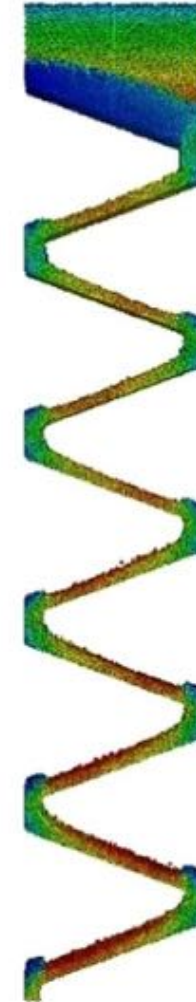
Component research & development focuses on design, performance, and costing.

Commercial design

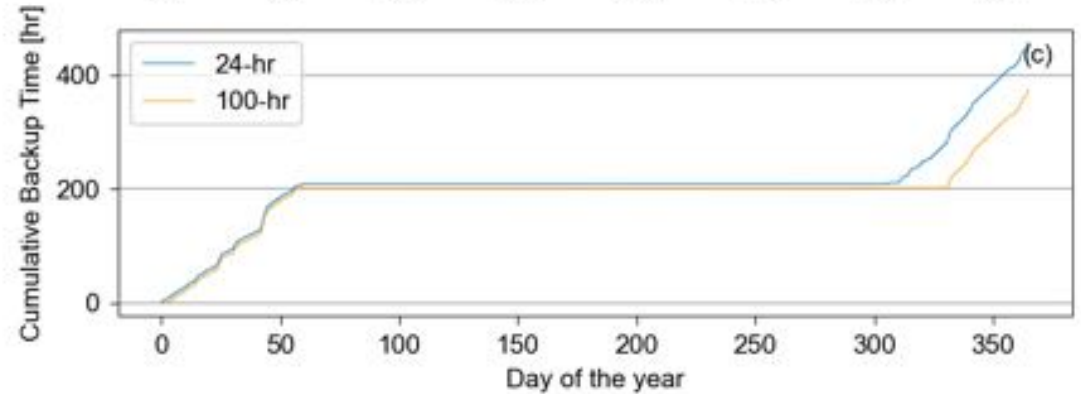
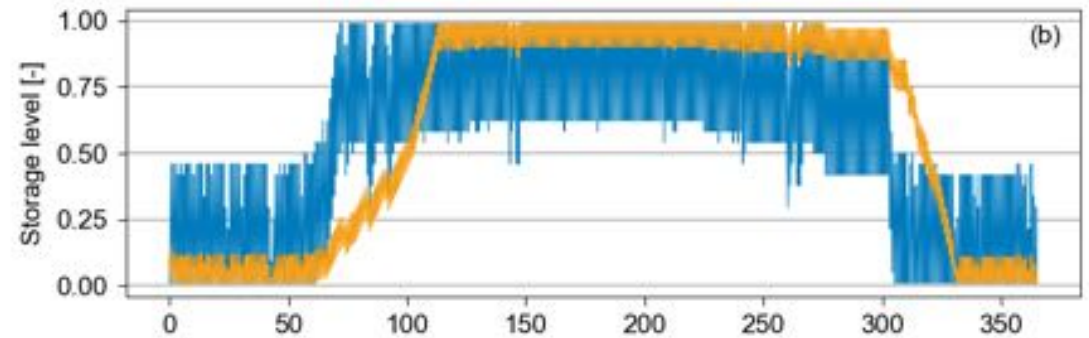
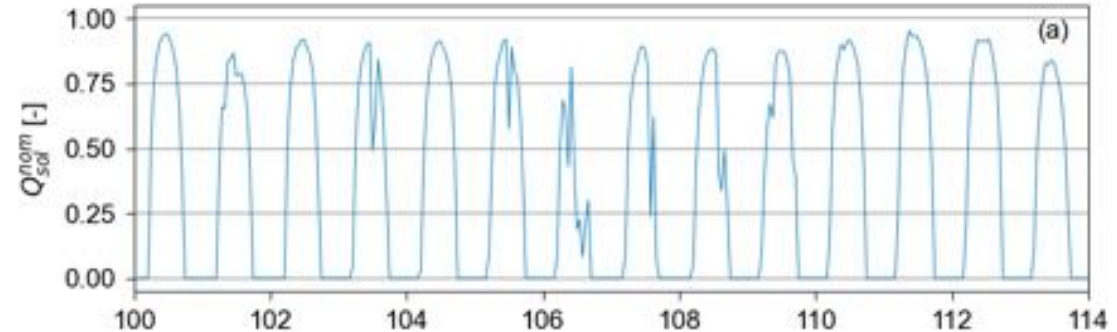
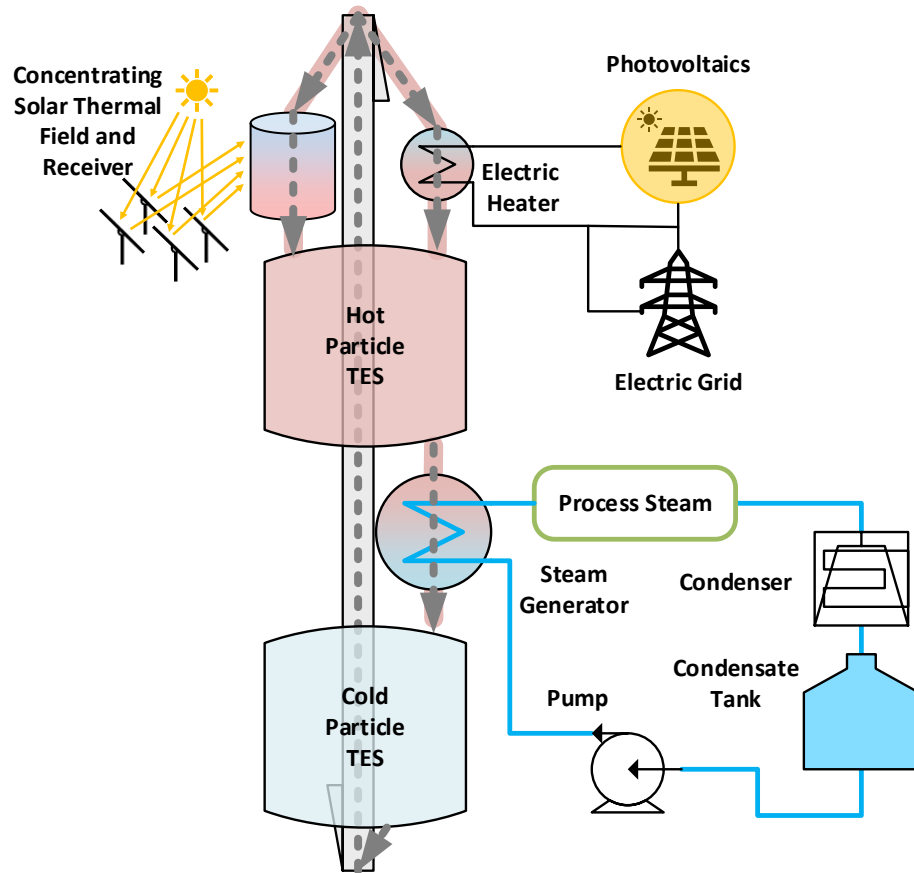
Model development



Experimental testing



System analysis answers questions about overall performance, design sensitivity, and techno-economics.





1. Introduction

2. Particle Thermal Energy Storage

3. Current Work

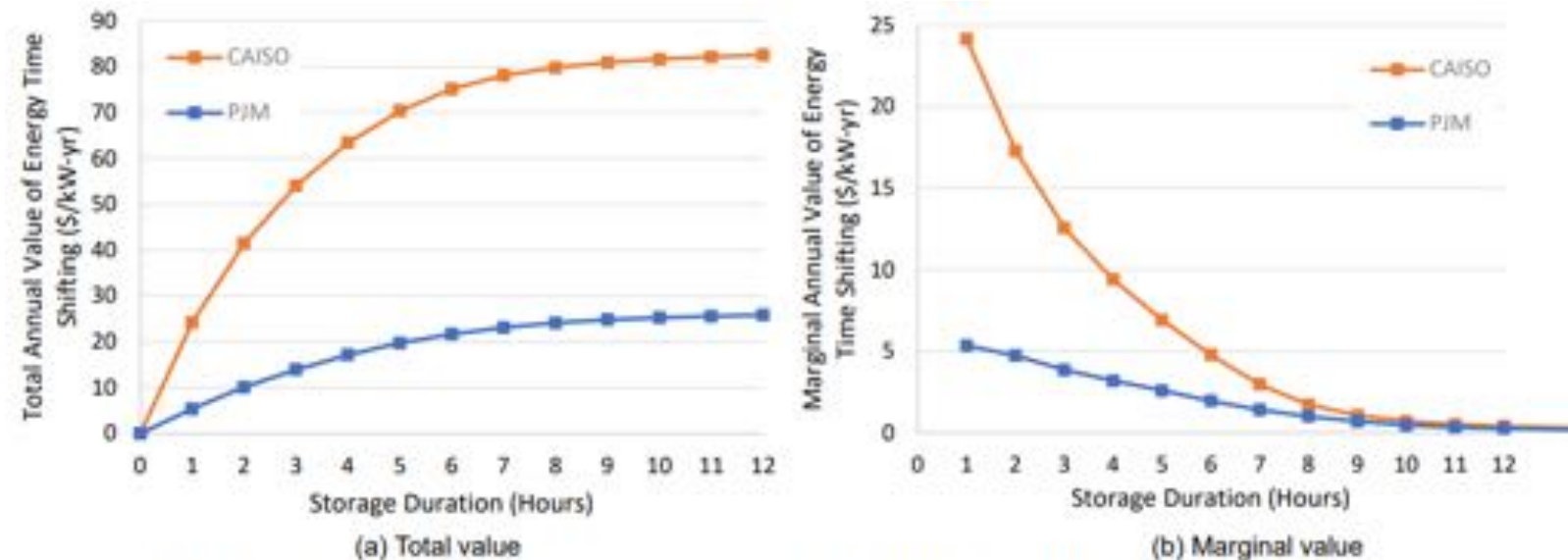
4. Conclusions

While much more is known, significant development work of particle TES and questions about long-duration energy storage remain.

Scale-up & Integration

Transients & Cycling

Life-cycle assessments



Example of the total and marginal value of energy time-shifting using 2019 energy market values

Source: [NREL Energy Storage Futures Study](#)



Thank you! Questions?

Jeffrey.Gifford@nrel.gov