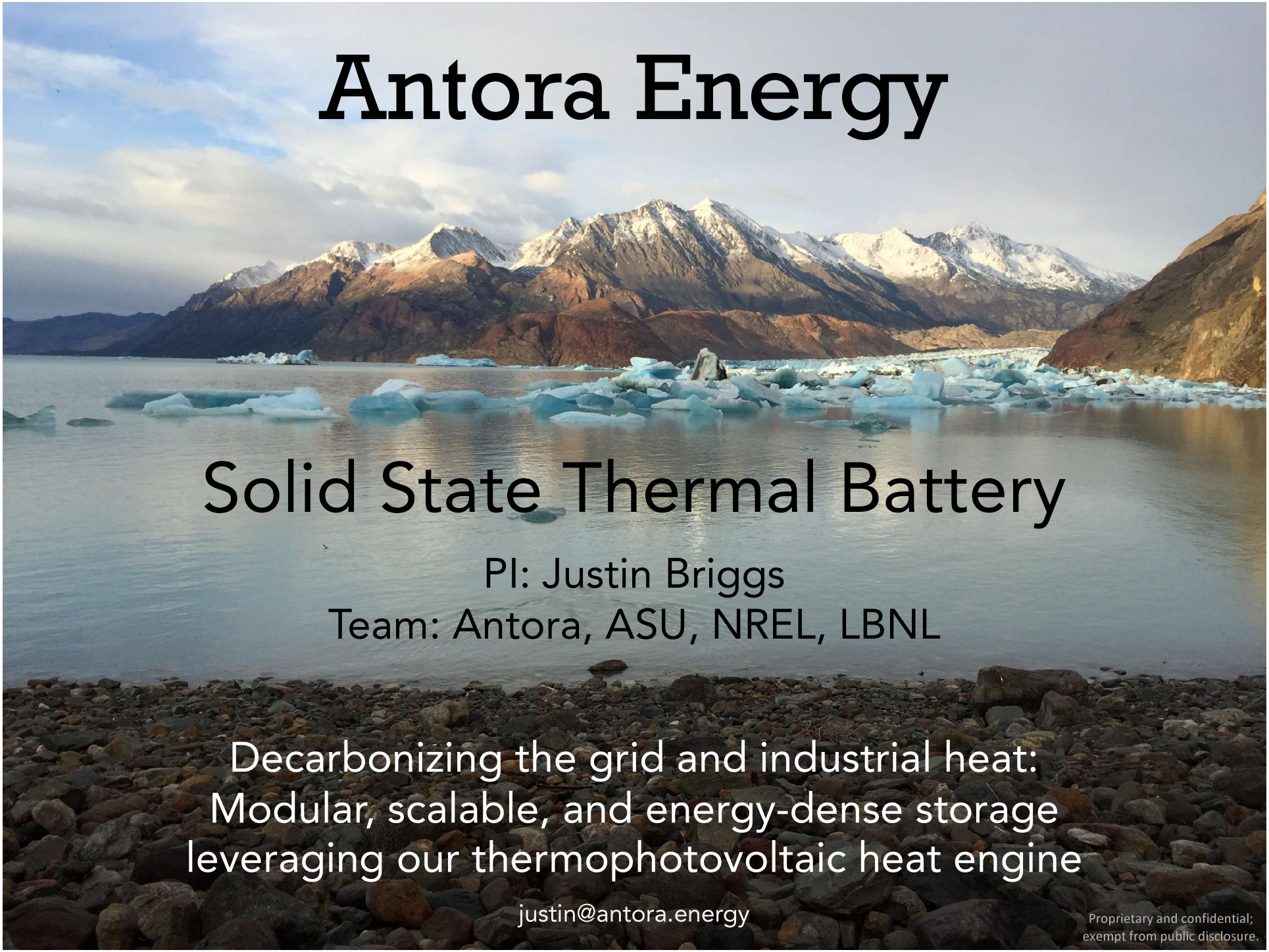


Antora Energy

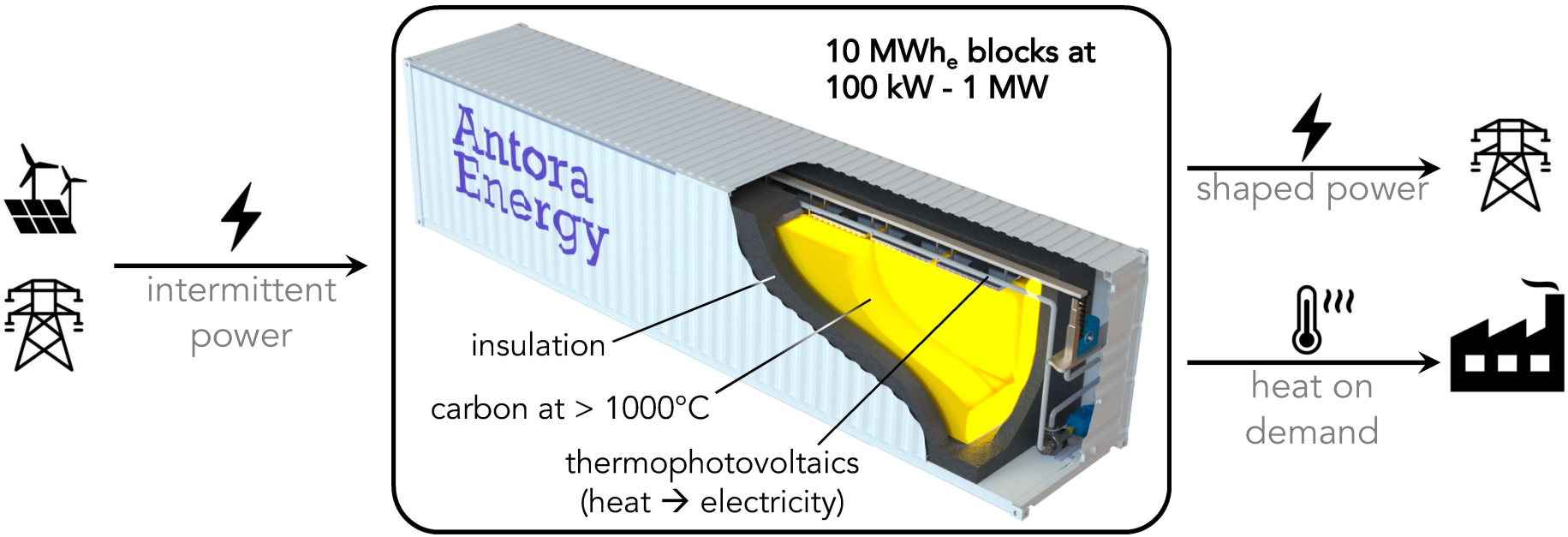
Solid State Thermal Battery

PI: Justin Briggs
Team: Antora, ASU, NREL, LBNL

Decarbonizing the grid and industrial heat:
Modular, scalable, and energy-dense storage
leveraging our thermophotovoltaic heat engine

justin@antora.energy

Antora's solid state thermal battery



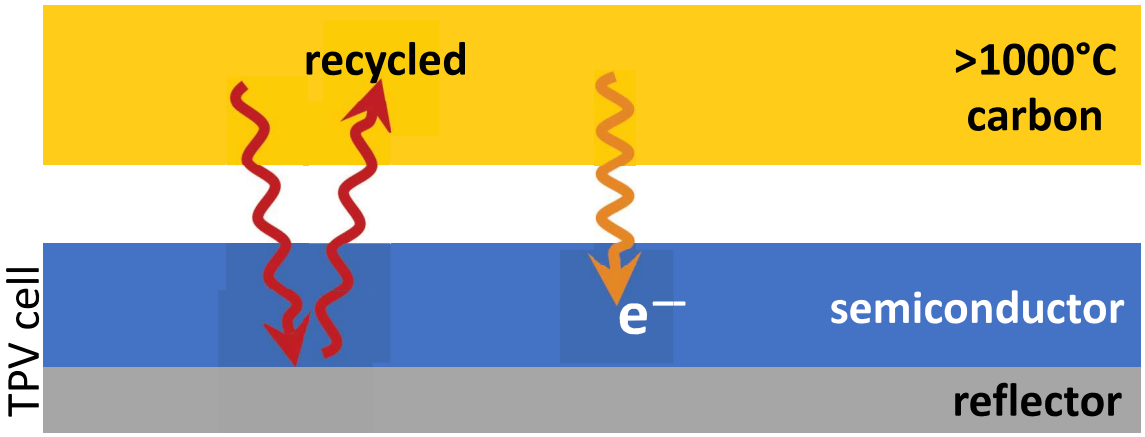
energy capacity:
solid carbon
(373 MMt/year)

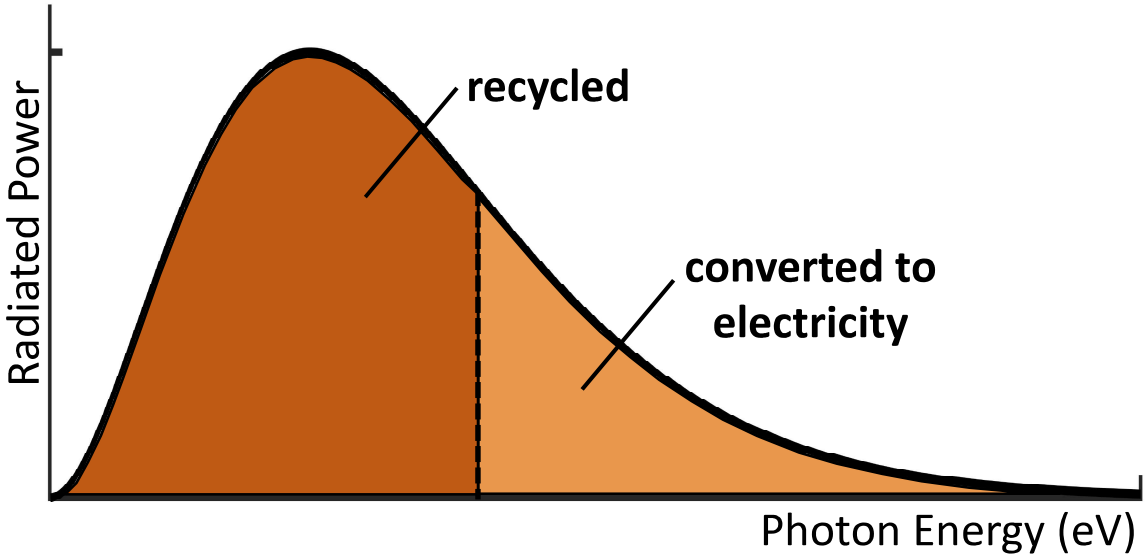
power capacity:
photovoltaics
(20 GW/year)

Key Features

- **Affordable:** <$10/kWh$_e$
- **Scalable:** mature supply chains
- **Safe:** no thermal runaway
- **Robust:** no cycling degradation
- **Site-able:** no geographic constraints

thermophotovoltaics (TPV): heat → electricity conversion

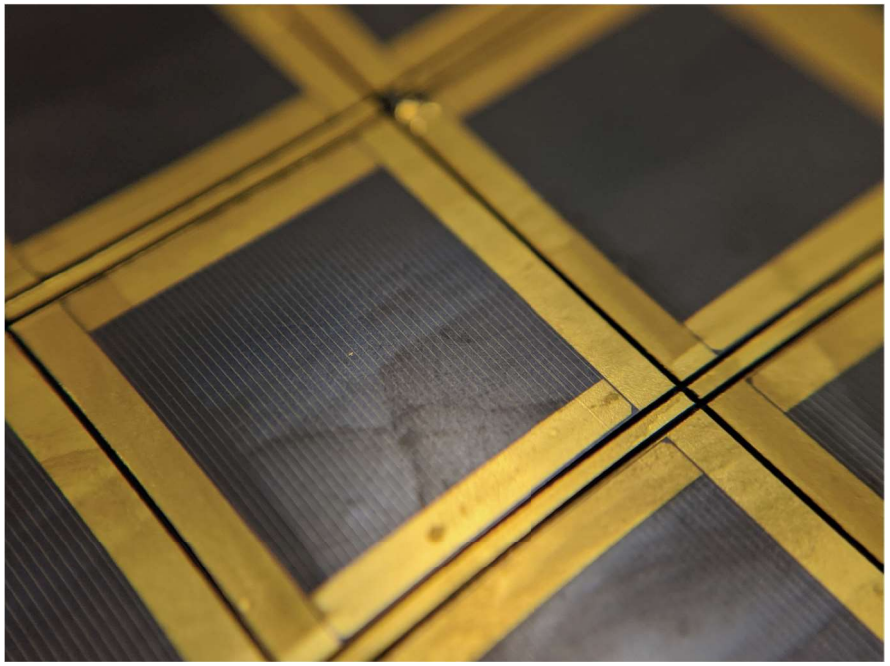




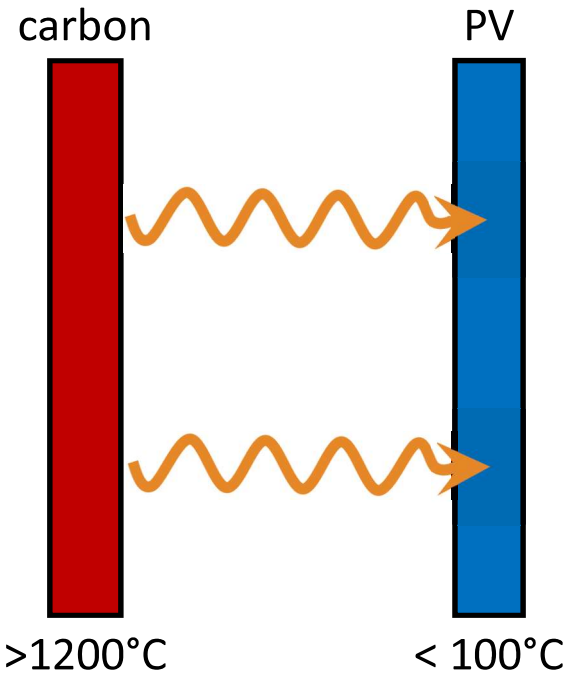
- Recycling low-energy photons enables **much higher efficiencies than solar PV**
- Antora has demonstrated **world record 40% conversion efficiency**, with a credible path to >50%
- Scalable and modular: performance does not change when scaled up or down
- Leverages semiconductor scaling and existing PV manufacturing
- Compact and extremely power-dense: 10-200 kW_e/m^2

ARPA-E DAYS project objectives

Objective 1: Develop a TPV module with >50% efficiency.

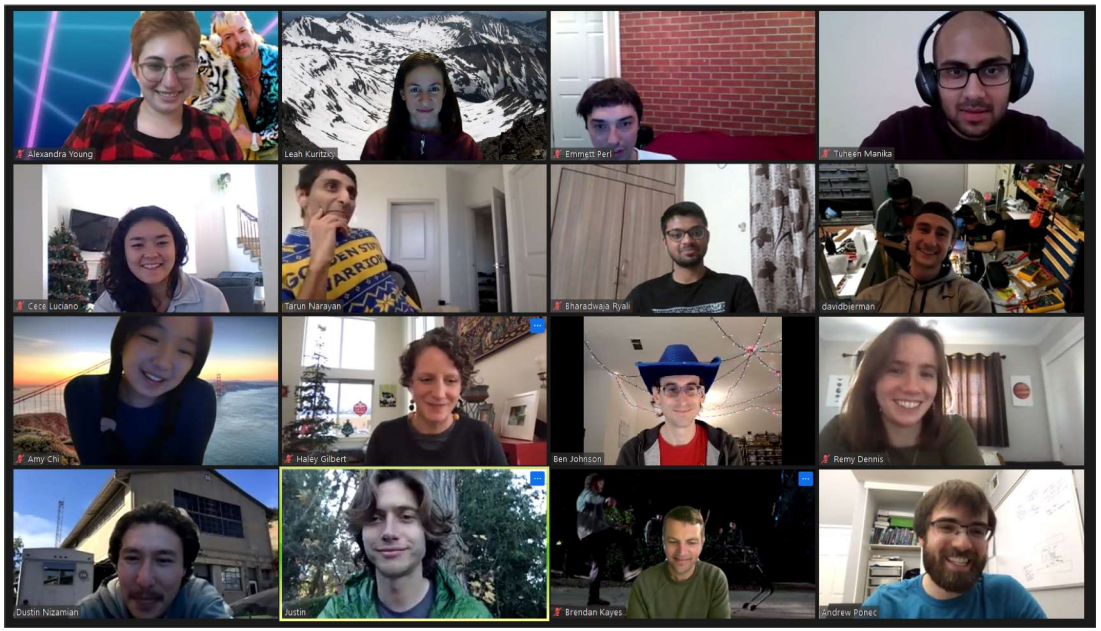


Objective 2: Prove that TPV system can operate stably over time



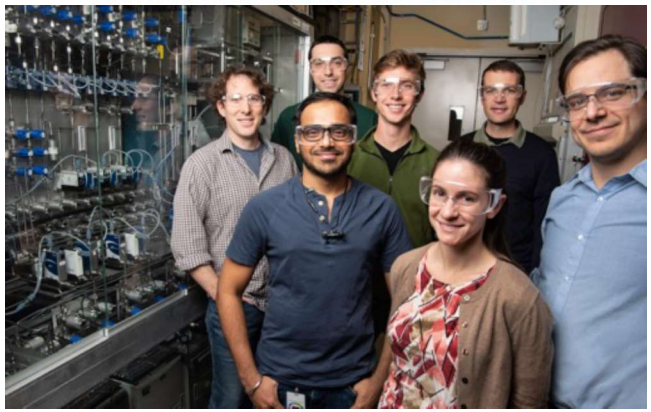
team

Antora Energy



TPV design/fab/testing, thermal storage integration, commercialization

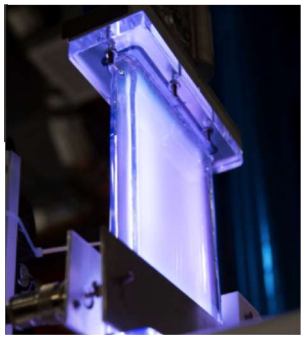
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

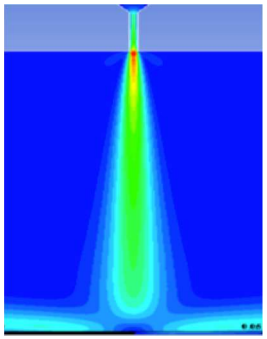


TPV cell fabrication

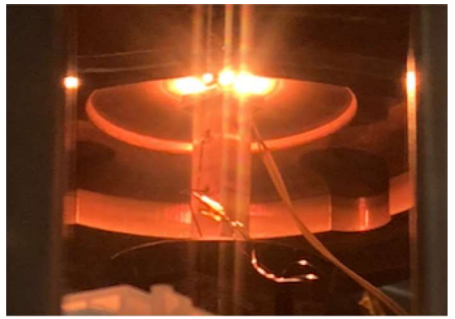
ASU

designer optical materials





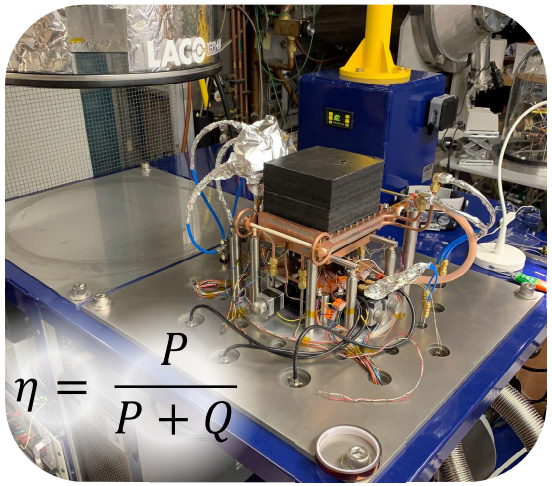
BERKELEY LAB



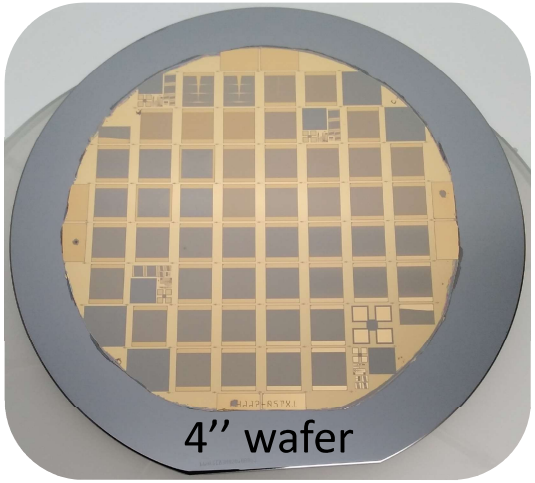
high-temperature materials

results

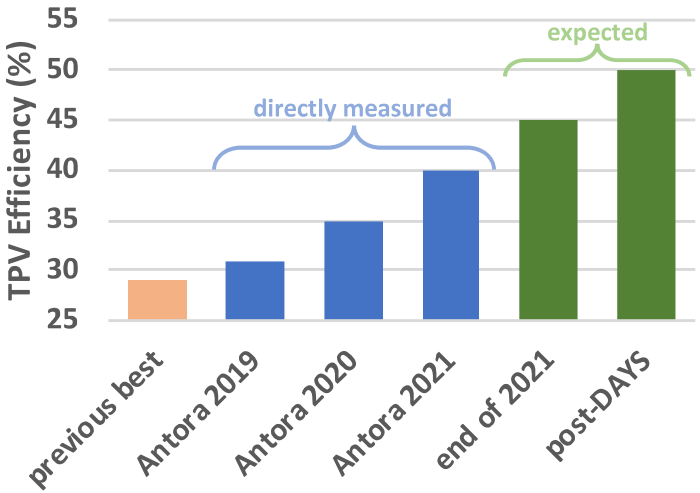
built critical high-accuracy TPV efficiency measurement platform



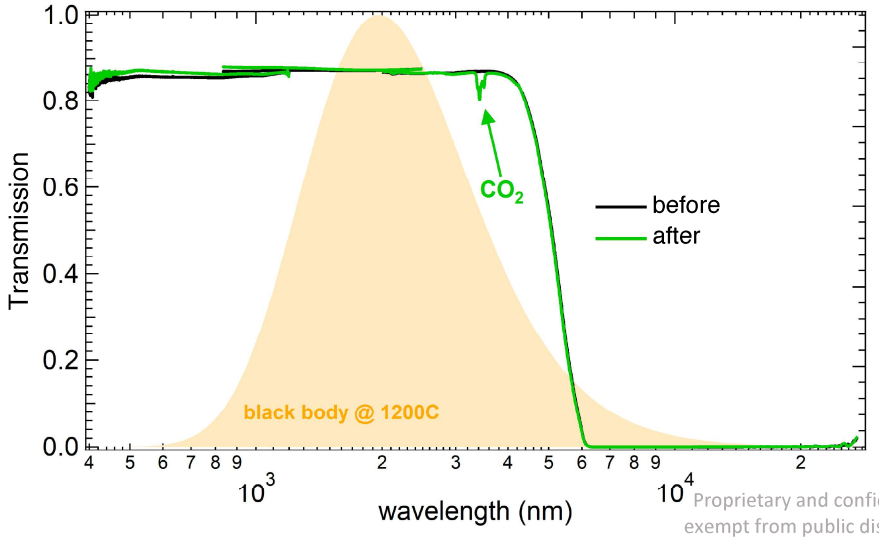
proved out large-scale TPV fabrication in commercial manufacturing environment



routinely making world's most efficient TPV devices (40% measured)

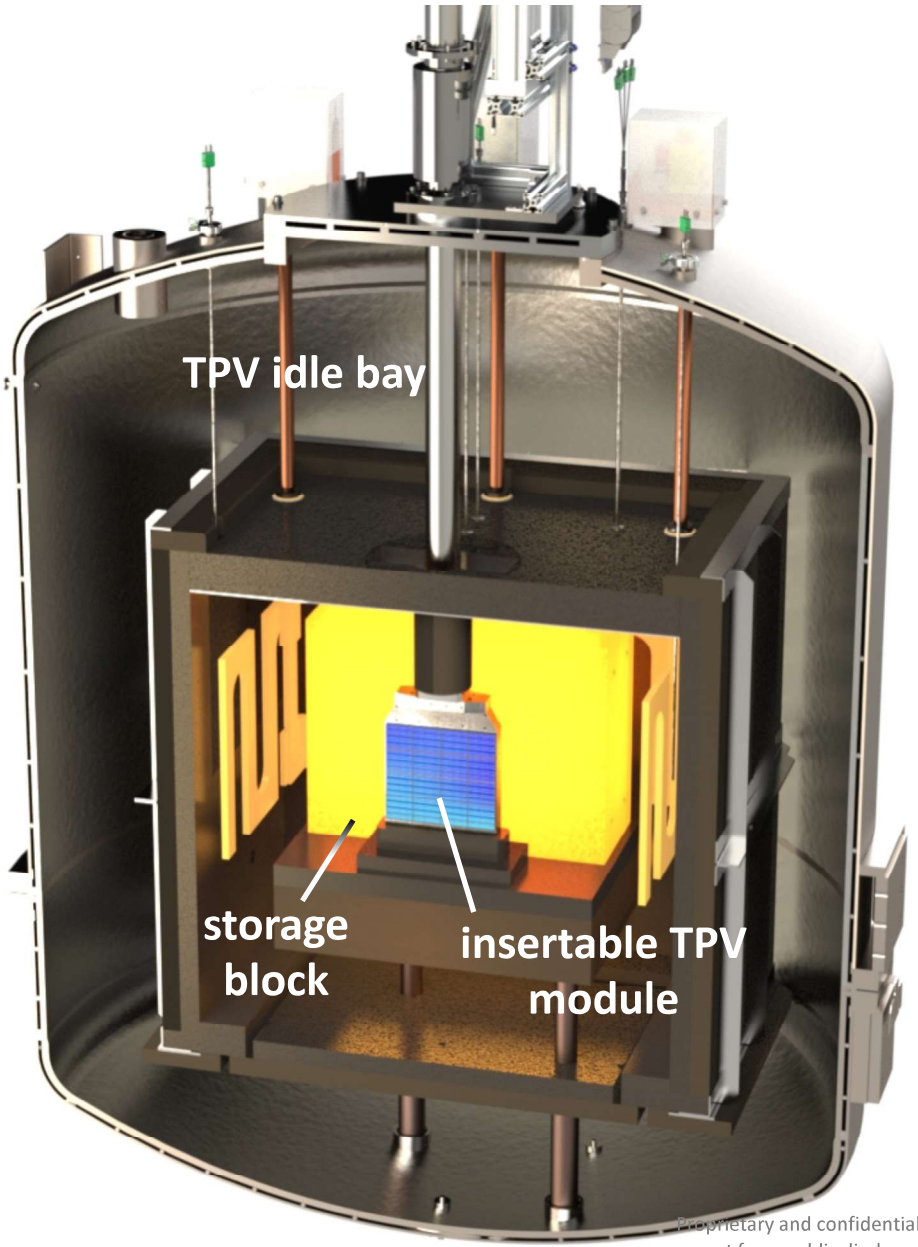


demonstrated stable operation for >100 hours



results

100 kWh system prototype



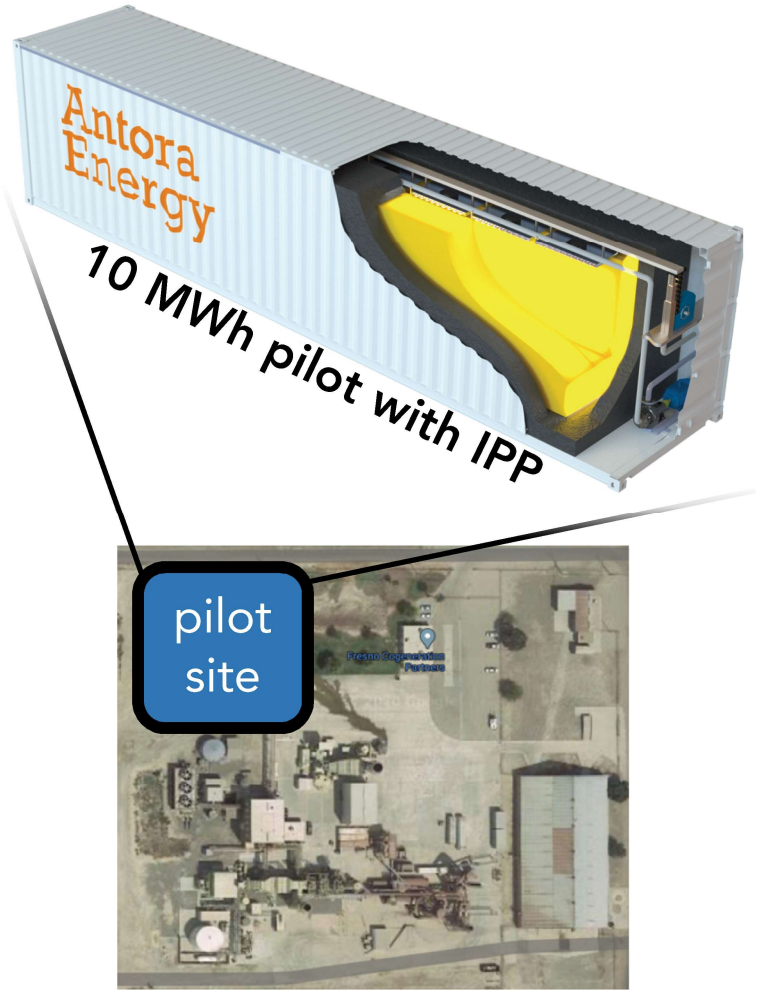
potential partnerships

- pre-commercial and commercial pilot customers
- early partnerships with EPCs
- heavy industrial carbon supply chain (e.g. steel and aluminum)
- electricity grid modeling with sophisticated dispatch model and high spatial & temporal resolution
- techno-economics of long-duration storage, including value stacking from all possible energy and power services

technology-to-market

<u>customers want 3 things</u>:

1. **dispatchable heat**
   - hard & expensive to decarbonize heat
2. **capacity**
   - demand charge reduction
   - resource adequacy (RA)
   - resiliency
3. **small & safe solutions**
   - very consistent customer feedback



- **secured customer LOIs for 100s of MWs of storage products**
- **completed first sales of TPV cells, plus ~$500k in pending orders**

project risks and opportunities

- major project risks:
  - long-duration storage markets are not well established
  - utilities are appropriately conservative
  - regulatory/permitting processes are slow

- mitigation strategies:
  - partner with progressive utilities, developers, and IPPs to tee up future projects
  - **leverage high energy density to gain access to new customer classes (e.g. C&I)**
  - **monetize heat**

thermal storage is a lower-cost pathway than H_2 for clean heat