# AESTUS™ Energy Storage

Earth Abundant High Temperature Thermally Pumped Energy Storage (EARTH TPES)

# System Overview and Status

August 3-4, 2022

### System Design | Robust Cost-Effective Subsystems / Efficient Closed Loop System

#### System configured to compress/expand inert gas by electric drive

- Generated heat is stored in solid abundant earth ceramic
  - Working temperature up to 1200C
- Released heat expanded to drive a generator
- Closed loop allows excess discharge heat use in charge
- Inert environment, low pressure yields low maintenance and long life

#### **CREARE Third Party System Design Evaluation**

- Thermodynamic cycles are accurate
- Compressor and expander operating conditions are reasonable
- Completion of detailed design optimization is needed
- The planned use of cold and hot heat sinks is well thought-out
  - Flow distribution must be managed in the heat sinks Cost model for primary and sub-systems is reasonable and supported by initial quotation and estimates
- Prototyping essential to commercialization







# Aestus Thermal Storage | Heat Sink Design

#### Sub-Scale Build and Test of Heat Sink to Validate Design Model

- Cordierite material obtain from IPS Ceramics
  - Cross-section build is 647mm (25in)
- Open face area of cordierite is 30%
- Ramboll Refractories is building the test vessel and will perform testing
- Alfred University is collaborating to define instrumentation and perform data acquisition
- Aestus/Alfred evaluating use of recycled glass to produce cordierite
- Lucideon Materials 3<sup>rd</sup> Party Evaluation
  - Material choices are robust and cost effective
  - Design model validation needed by sub-scale test needed for full scale design confidence

#### Full Scale Heat Sink for 20MWh at 2MW Rating (Gen 1)

- 2m Diameter Heat Sink
  - Working temperature up to 1150C
- Conventional Refractor Insulation
- Carbon Steel Pressure Vessel
- Flat bed shipping within standard truck envelop
- Rubber tire crane positioning and assembly on site







# Aestus | Energy Storage: Serving a \$1T market



Renewables



**Grid Support- Demand Response** 







# **Key Markets to Enter**

- Storage becoming integral part of all global generation systems
- Growth curve forecast to be like renewables i.e. outstanding....
- Reliability, safety, cost essential to enter



**Disaster Relief** 



#### **Commercial and Industrial**





# **Product Differentiation | Techno-Economic Analysis**



- Collaborating with CSU to estimate value proposition with TEA
- Looked at 7 Power markets,
  >34K nodes at 5-min resolution
- Compared Gen 4 systems to projected 2030 Li-ion battery
- Representative CAISO results
  - Benefits from increase variability in the grid
  - Aestus ES system has positive NPV in >50% of nodes
  - Li-ion loses money because high CAPEX, replacement
  - The Proposed system can be profitable today

