



Developing Large-scale Pumped Heat Energy Storage

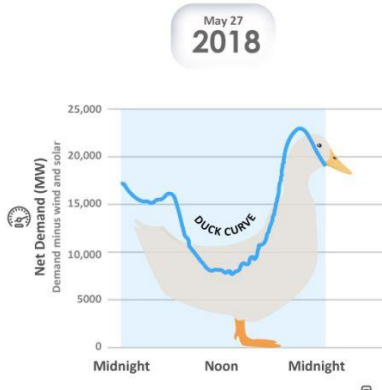
Malta Inc.



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Overview of Malta Pumped Heat Energy Storage (PHES)

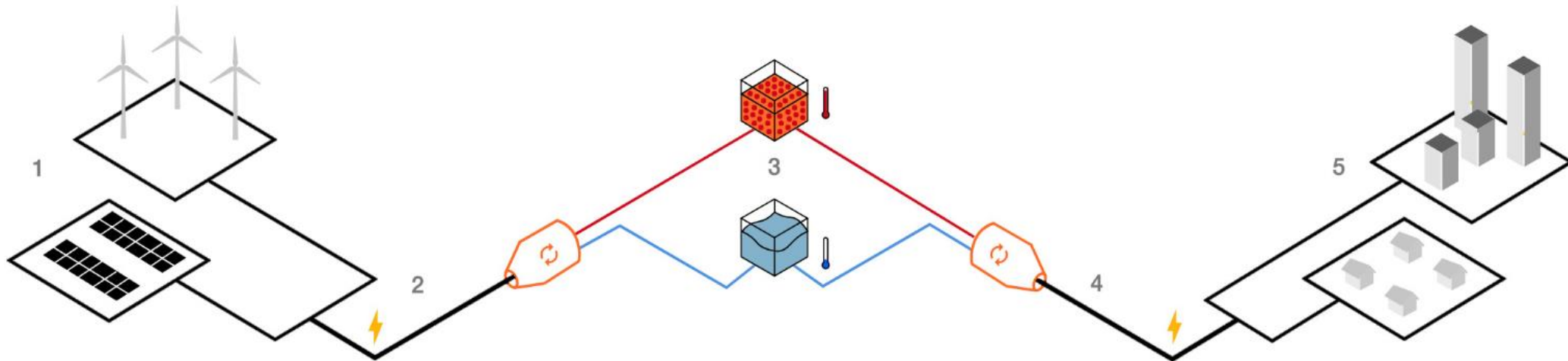
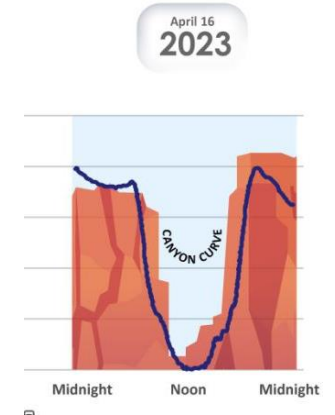


Electricity-in, electricity-out *grid-synchronous* PHES

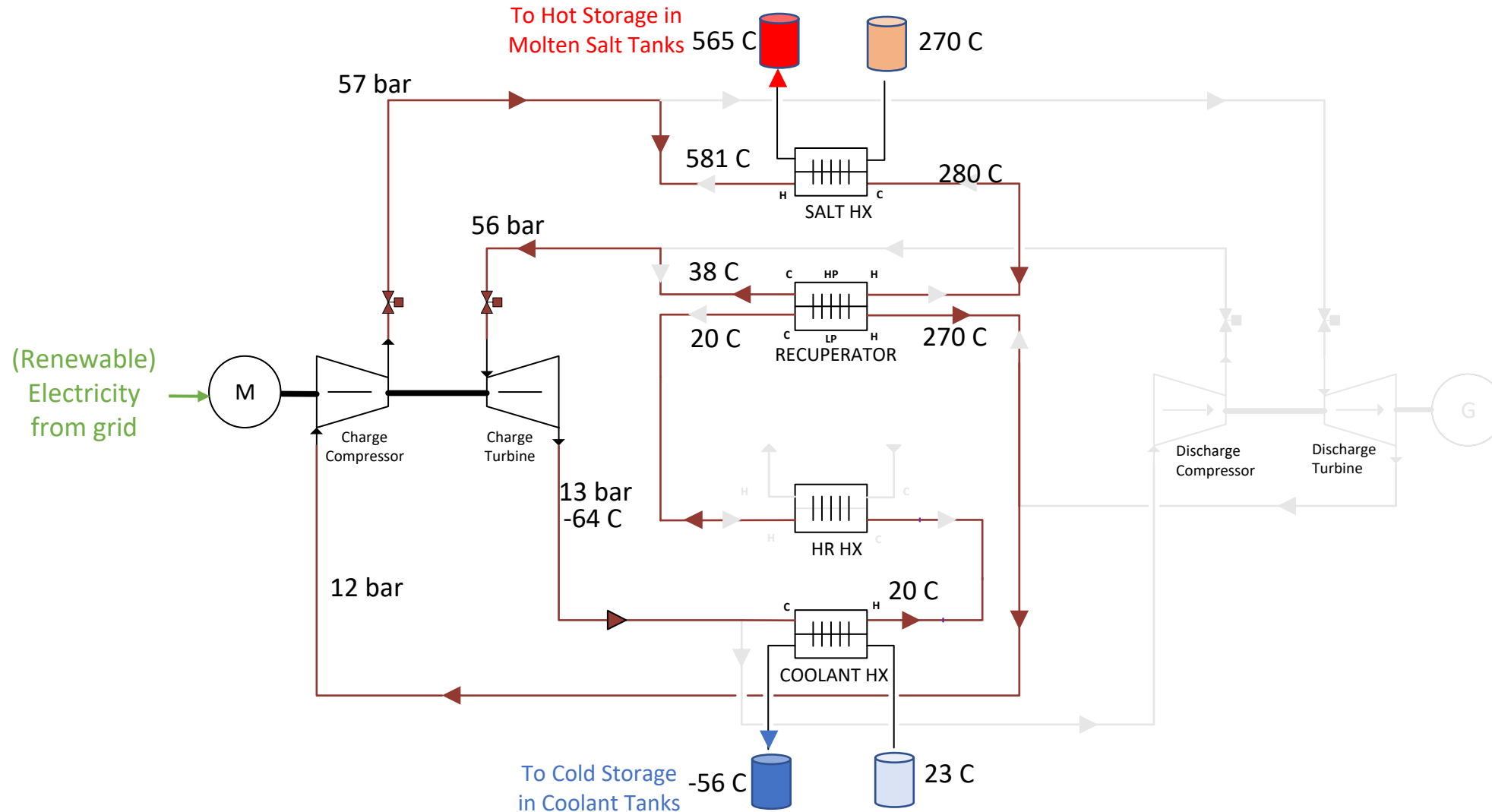
Grid scale (100+ MW) Molten Salt

Duration: 10 – 20 hour sweet spot

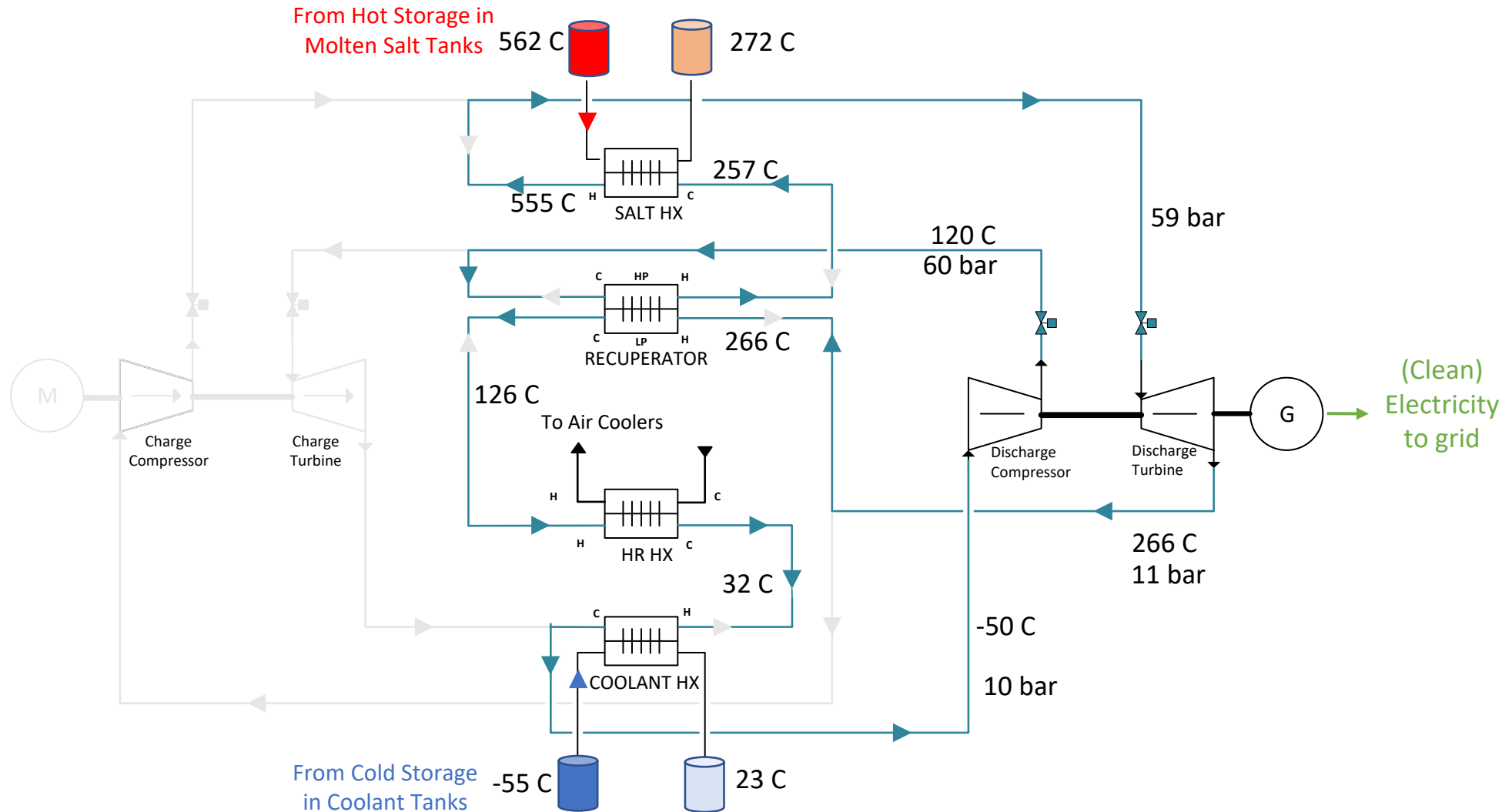
Optional industrial process heat output



Malta power cycle – charge: reverse-Brayton heat pump



Malta power cycle – discharge: Brayton-cycle heat engine



Synchronous Inertia prevents Rolling Blackouts

- Grid synchronous inertia → RoCoF
- RoCoF → how low frequency drops given the fastest responding assets (FFR and synthetic inertia)
- Excessive frequency drop → load shedding (blackouts)

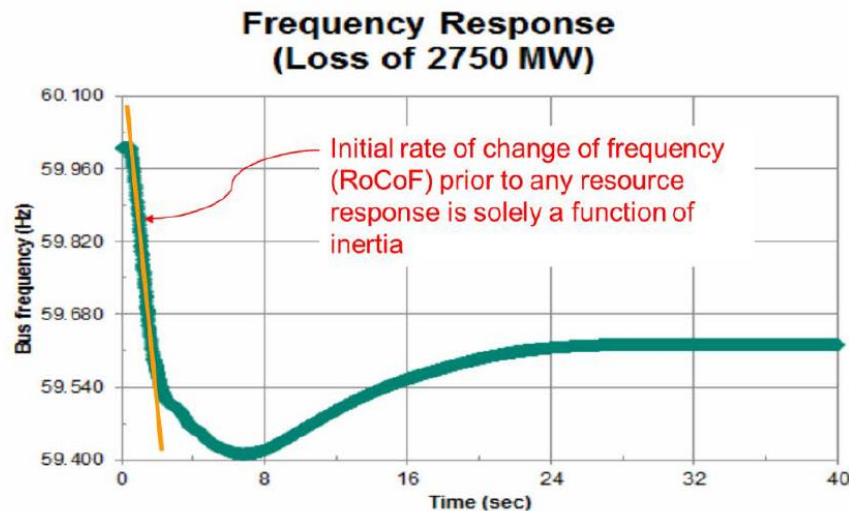


Figure 1: Frequency trace after loss of 2,750 MW and initial RoCoF after the event

ERCOT (2018). *Inertia: Basic Concepts and Impacts on the ERCOT Grid*.
https://www.ercot.com/files/docs/2018/04/04/Inertia_Basic_Concepts_Impacts_On_ERCOT_v0.pdf

Short-Circuit Current prevents Brownouts

- Neighbor drops a large load onto the grid
 - Not enough short-circuit current capability nearby
 - Insufficient wires to bring current in from elsewhere
- Voltage sag (Brownout)

Long-Duration Energy Storage
with 3600 rpm (60 Hz) synchronous
powertrains
provides synchronous condenser
functionality.

Store2REPower

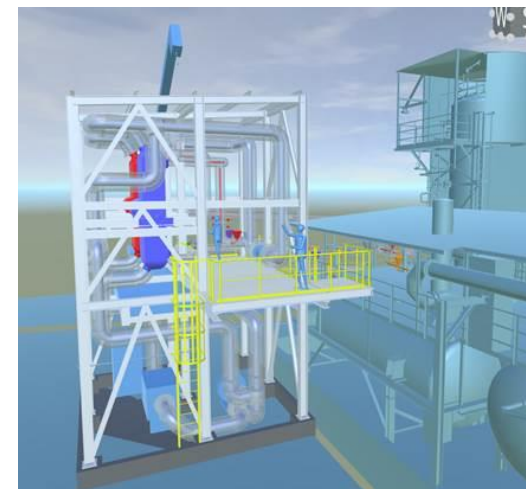
High Temperature Pumped Heat Energy Storage as a Decarbonized Flexibility Replacement for Fossil Power Plants

Project Targets:

- Investigation of critical design aspects and qualification of the air/salt heat exchangers of the Malta High Temperature Pumped Heat Energy Storage System
- Market study on the application potential of Malta energy storage systems with electricity/heat extraction in Germany
- Development of a demonstration plant concept in a selected target application

Key Tasks:

- Expansion of the DLR Test Facility for Thermal Energy Storage in Molten Salts (TESIS) and development of the methodology and instrumentation for heat exchanger tests
- Measuring the performance and proving the durability of the Alfa Laval 5 MW air/salt heat exchangers
- Modeling and techno-economic optimization and evaluation of the Malta energy storage system in end use cases



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Project Partners: Malta Hochttemperatur Wärmepumpen Stromspeicher GmbH, Deutsches Zentrum für Luft- und Raumfahrt, Alfa Laval Mid Europe GmbH, Siemens Energy Global GmbH & Co. KG



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Thank you!

