COMMENTS ON COMPRESSED AIR ENERGY STORAGE

CAES

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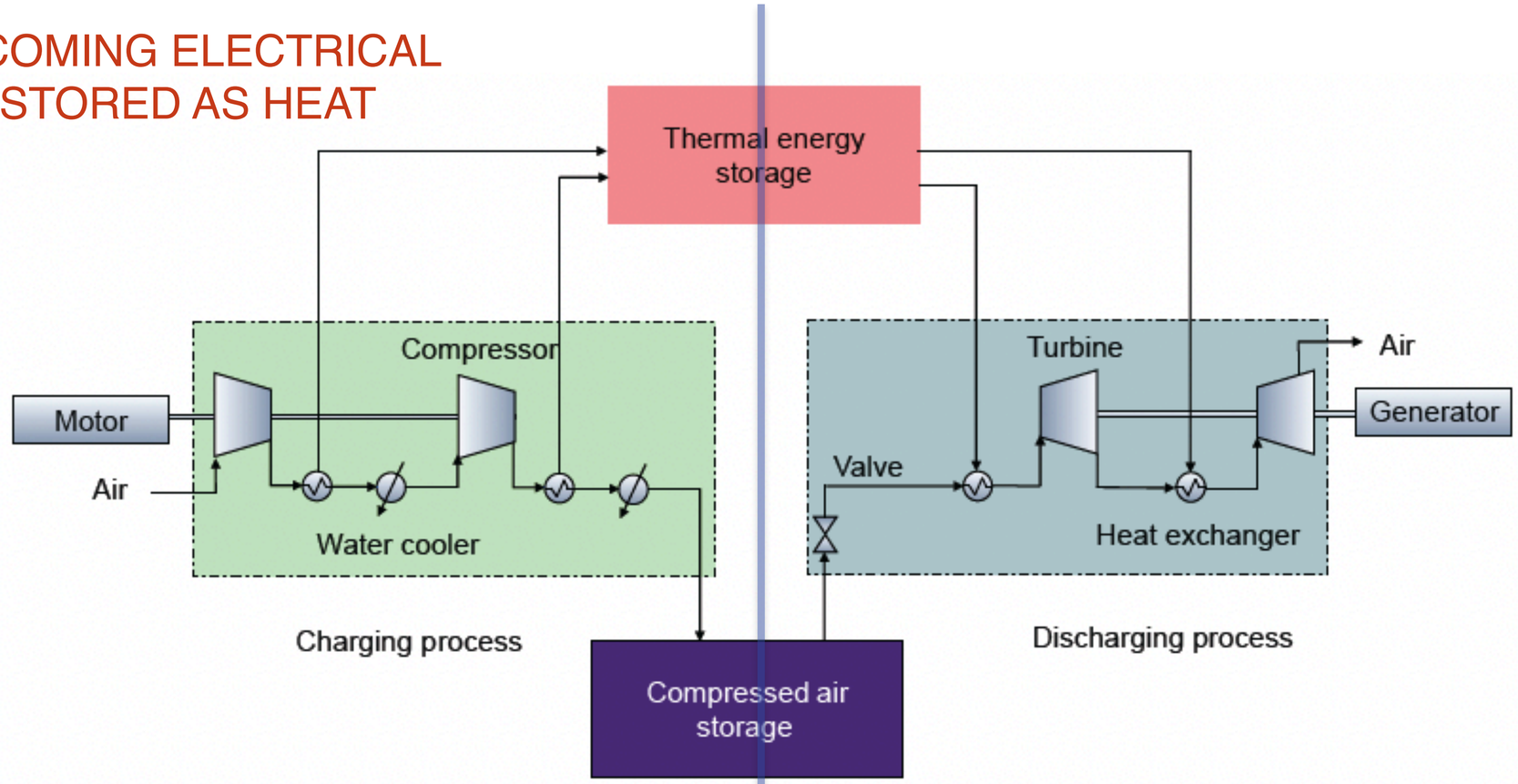
Mechanical energy storage:

- low energy density compared to thermal and electrochemical, hence
- large footprint
- geographical constraints
- not modular

WHAT IS CAES?

ALL THE INCOMING ELECTRICAL ENERGY IS STORED AS HEAT

ELECTRICAL ENERGY IN



ELECTRICAL ENERGY OUT

ENERGY STORAGE

MOST (~NEARLY ALL) THE OUTPUT WORK IS STORED IN THE COMPRESSED GAS

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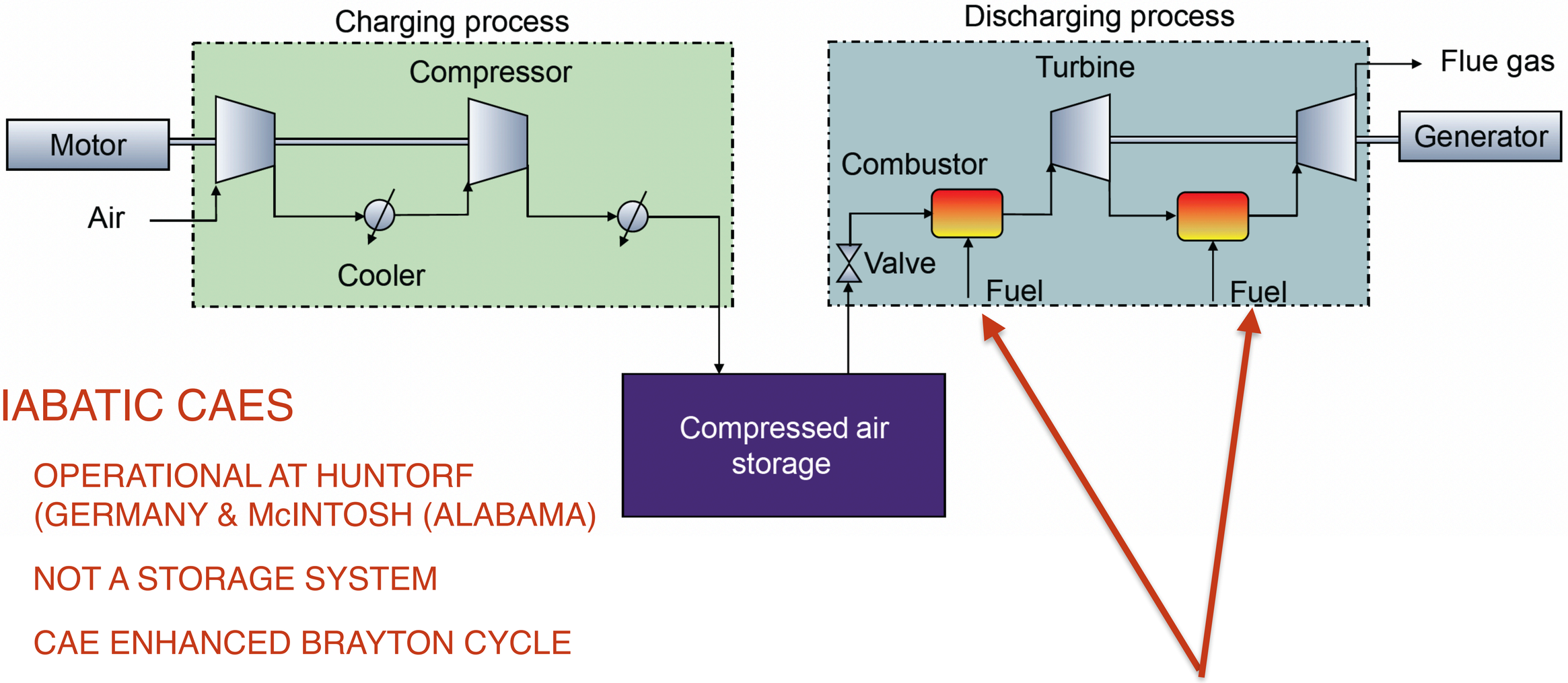
NOT DIABATIC CAES



DIABATIC CAES

- OPERATIONAL AT HUNTORF (GERMANY & McINTOSH (ALABAMA)
- NOT A STORAGE SYSTEM
- CAE ENHANCED BRAYTON CYCLE

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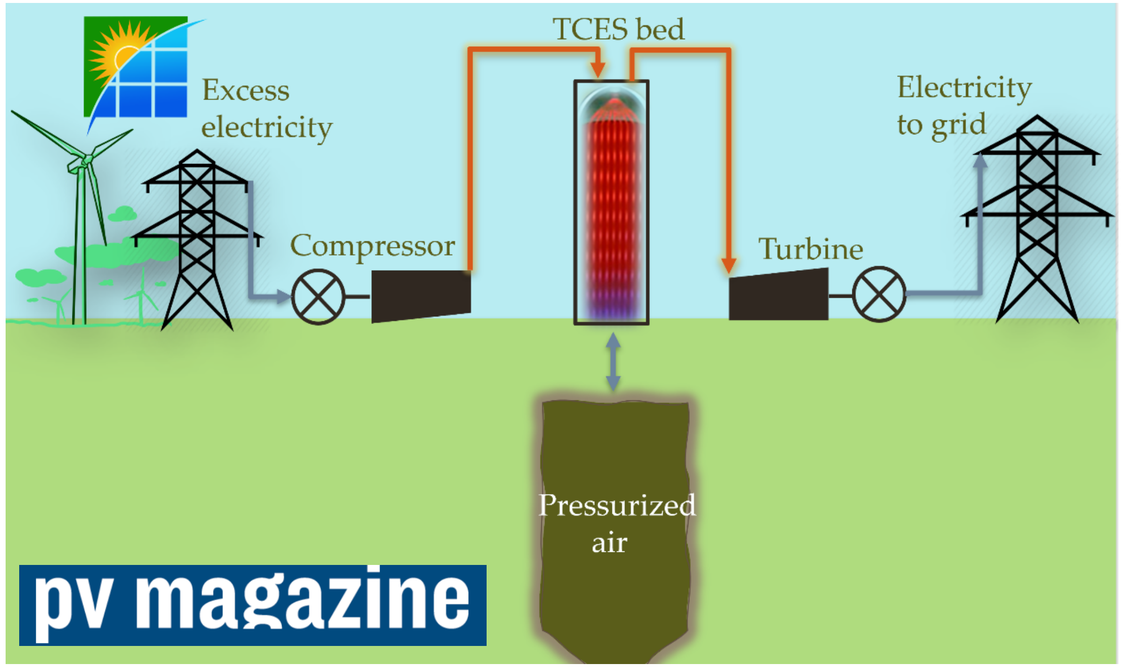
A-CAES THERMAL ENERGY STORAGE



CAES requires TES facility comparable to conventional thermal energy storage systems

100 GWH crushed rock thermal energy storage facility

https://www.pv-magazine.com/2022/01/11/improving-compressed-air-energy-storage-efficiency-via-chemical-reactions/

https://helioscsp.com/100-gigawatt-hour-crushed-rock-heat-storage-for-concentrated-solar-power-and-nuclear/

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ISSUES/COMMENTS:

- TRL IS LOW: NO SUCCESSFUL DEMONSTRATION AT RELEVANT SCALE IN REALISTIC ENVIRONMENT.
- REQUIRES SYSTEM FOR STORING THERMAL ENERGY COMPARABLE TO DEDICATED TES STORAGE FACILITY.
- REQUIRES UNDERGROUND AIR STORAGE IN GEOLOGICAL FORMATION WITH CAPABLE OF SUSTAINING HIGH (~100 BAR) PRESSURE WITH HIGH PERMEABILITY $\Longrightarrow$ SALT CAVERNS,…
- MULTIPLE STAGES OF COMPRESSION/EXPANSION ARE MECHANICALLY ADVANTAGEOUS BUT THERMODYNAMICALLY PROBLEMATIC.
- THERMO: – ISOCHORIC, + ISOBARIC
  CIVIL ENGINEERING: + ISOCHORIC, – ISOBARIC.

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TAKEAWAYS:

- In principle, CAES could store compressed air above or below ground. Because of inherent problems with aboveground air storage, grid-scale deployment of CAES depends on the availability of suitable, large-scale, underground air storage, which is geologically limited and competes with H_2 and NG.
- Regional analyses of potential underground air storage sites has often been done at the macro scale, but technical and economic feasibility must be assessed at specific locations.
- Ultimately, adiabatic CAES with underground air storage seems viable, and in some regions with favorable geological resources it may play a non-trivial role in the future. However, geological constraints and limited cost reduction potential seem likely to make CAES less competitive over time as other long-duration storage technologies (eg. thermal, electrochemical, hydrogen) mature.

+ Liquid air (above ground) energy storage offers siting flexibility, relatively mature (liquification/heat exchange) technologies. Key questions center on cost and flexibility.

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