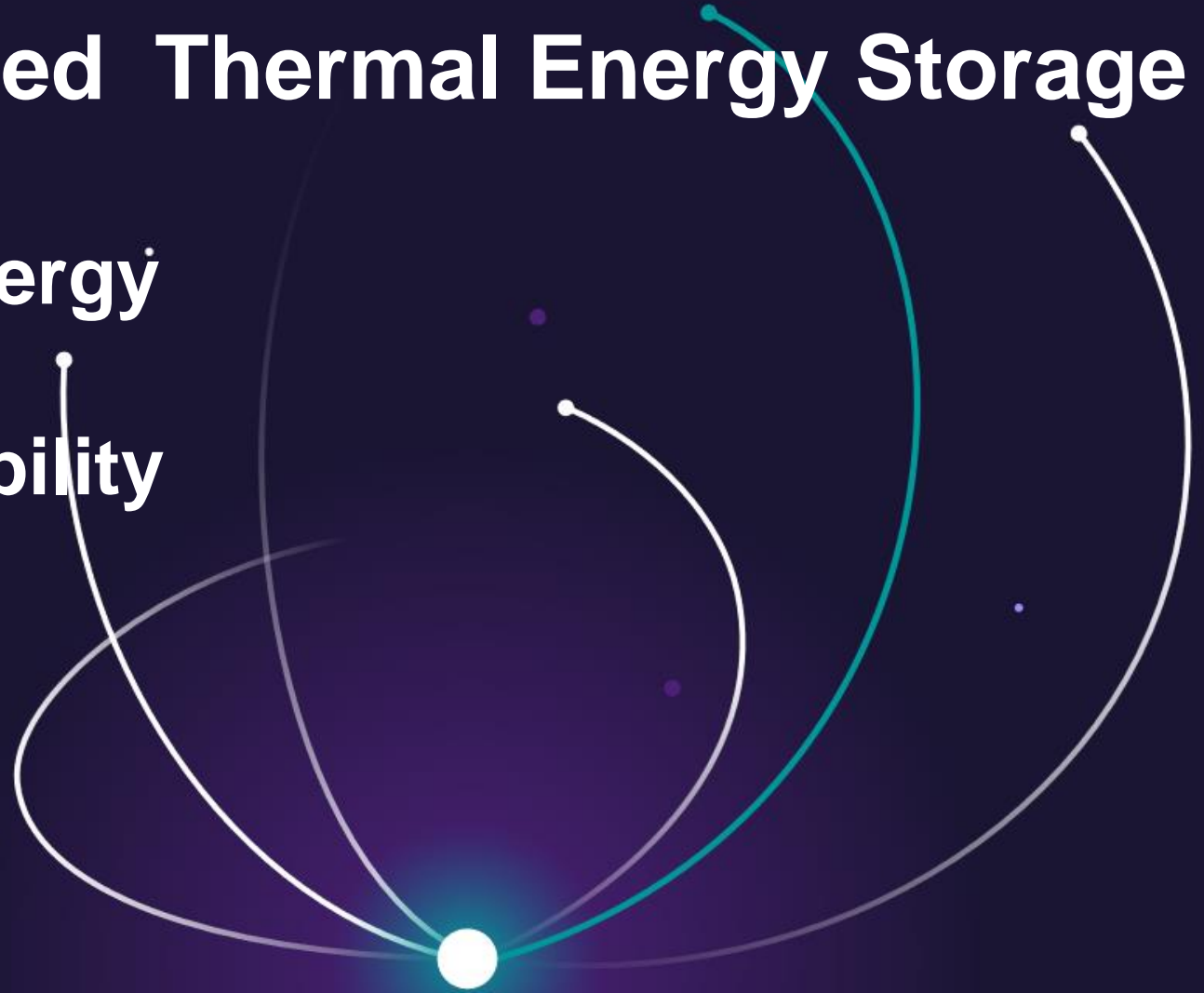


Combined Cycle integrated Thermal Energy Storage

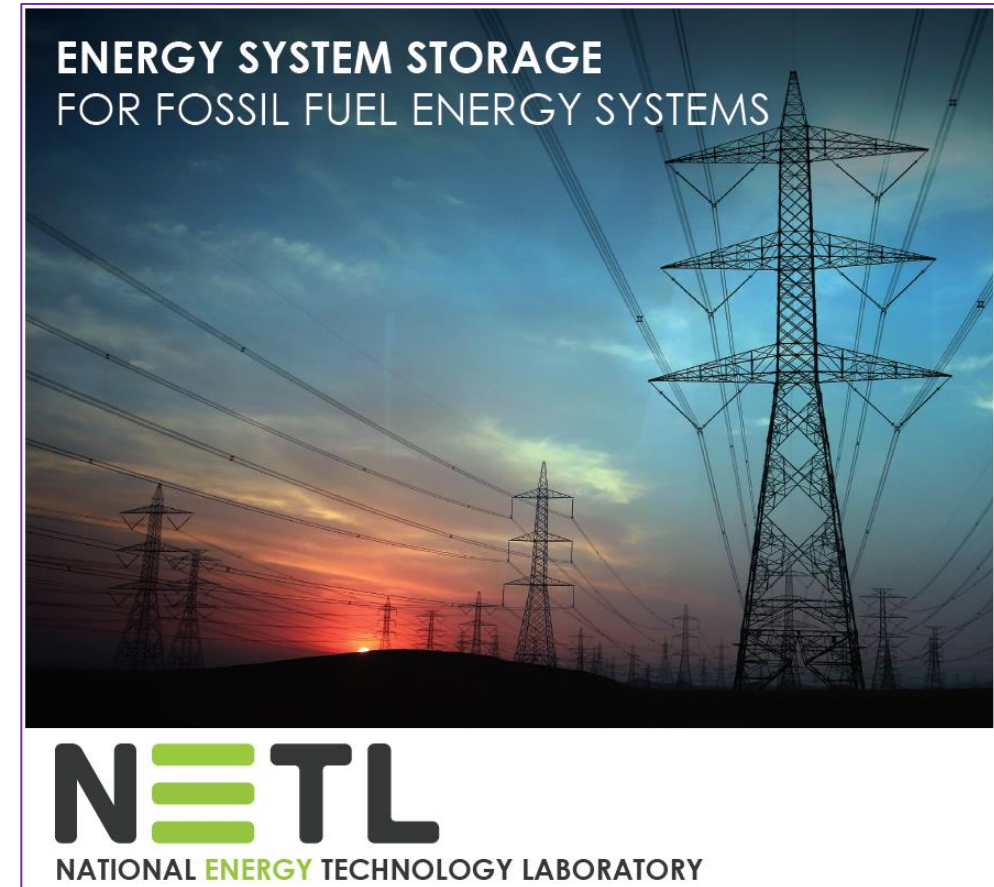
using surplus renewable energy
&
improving power plant flexibility

Thorsten Wolf
Siemens Energy Inc.
Orlando, Florida
April 6th, 2021



Combined Cycle integrated Thermal Energy Storage CiTES DoE Project DE-FE0032029

- Prime Recipient: Siemens Energy Inc.
- PI: Thorsten Wolf tnwolf@siemens-energy.com
- Partner:
 - Exelon Corporations: Host (plant, market data)
 - Siemens Gamesa Renewable Energy: Technology
- Location:
 - for Engineering work: Orlando, FL
 - Plant: modern, utility-sized Combined Cycle (t.b.d.)
 - Market: ISOs in the United States (several)
- Feasibility Study:
 - Conceptual design of integrated Thermal Storage
 - Cost Estimation on turnkey level
 - Techno-economic simulation of annual (one full year) performance in different markets
- Budget: \$200,000 DoE; \$50,000 Siemens Energy

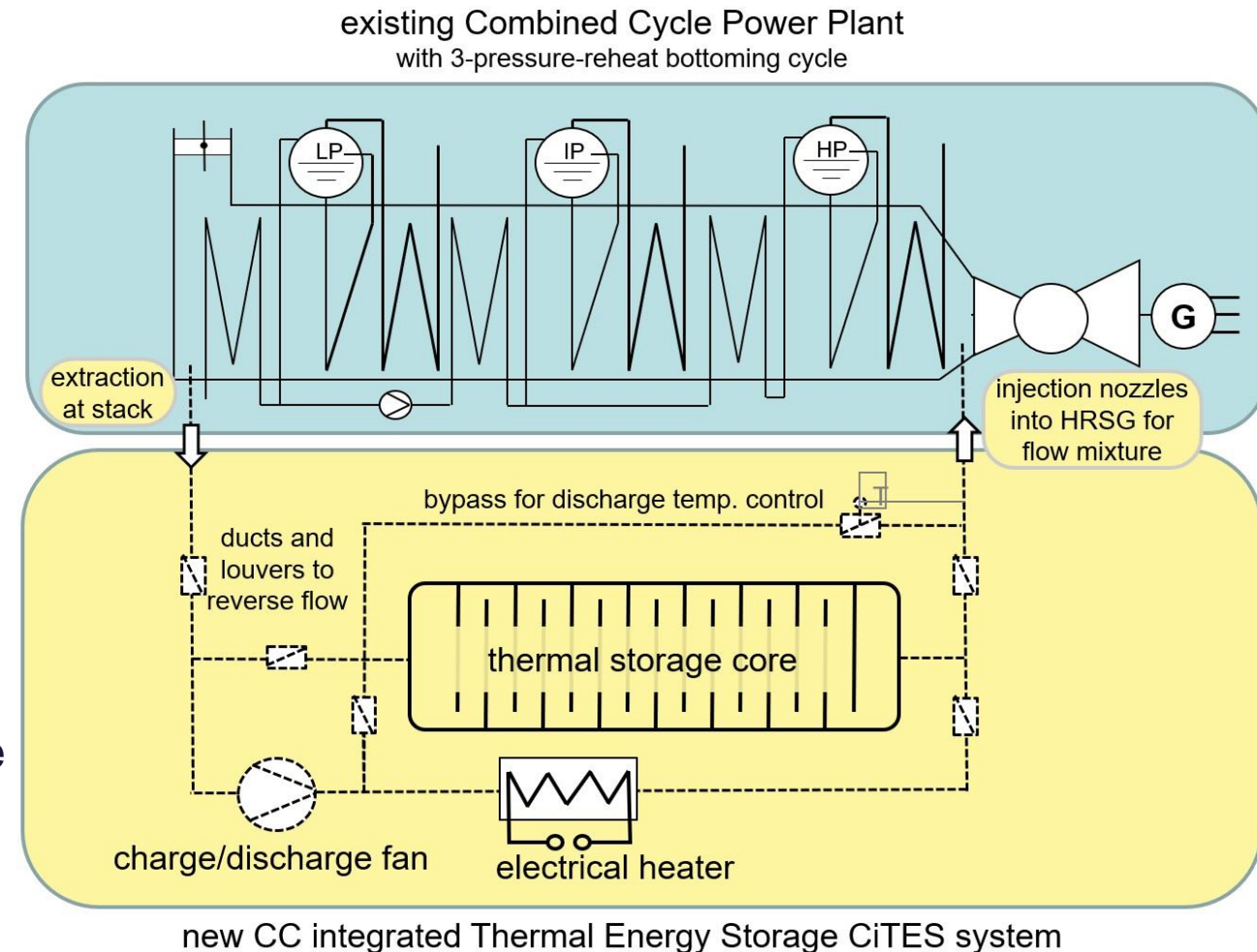


CiTES supports fossil generation by: storing and using surplus renewable energy and makes fossil assets more flexible for the changing operational profile

Combined Cycle integrated Thermal Energy Storage CiTES

The Concept

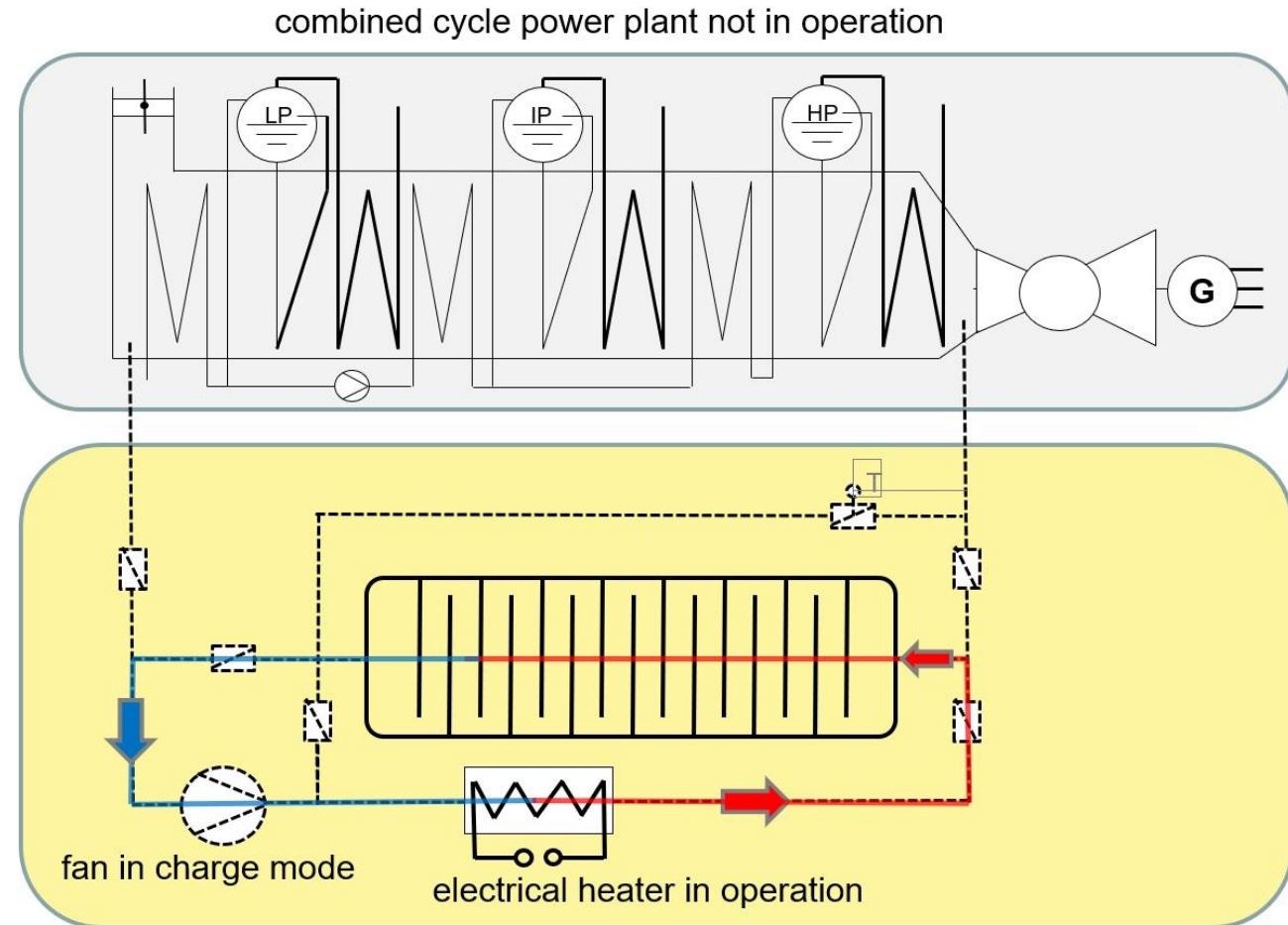
- Take an **existing** combined cycle plant
- A thermal storage system using solid thermal storage material stores heat is added
- **Charging = plant is in shutdown**
 - An electric heater is using surplus renewable energy to heat up the storage
 - An electric blower push the air through the thermal storage core
- **Discharging = plant is in operation:**
 - Cold gas is extracted at stack
 - Fans push the gas through the storage
 - Hot gas is injected into the HRSG
- The bottoming cycle of the plant is converting the thermal energy into electricity
- **Flexibility Improvement:**
 - hot air taken from storage keeps HRSG warm
 - Converts every cold start in a hot-restart



Combined Cycle integrated Thermal Energy Storage CiTES

The Concept

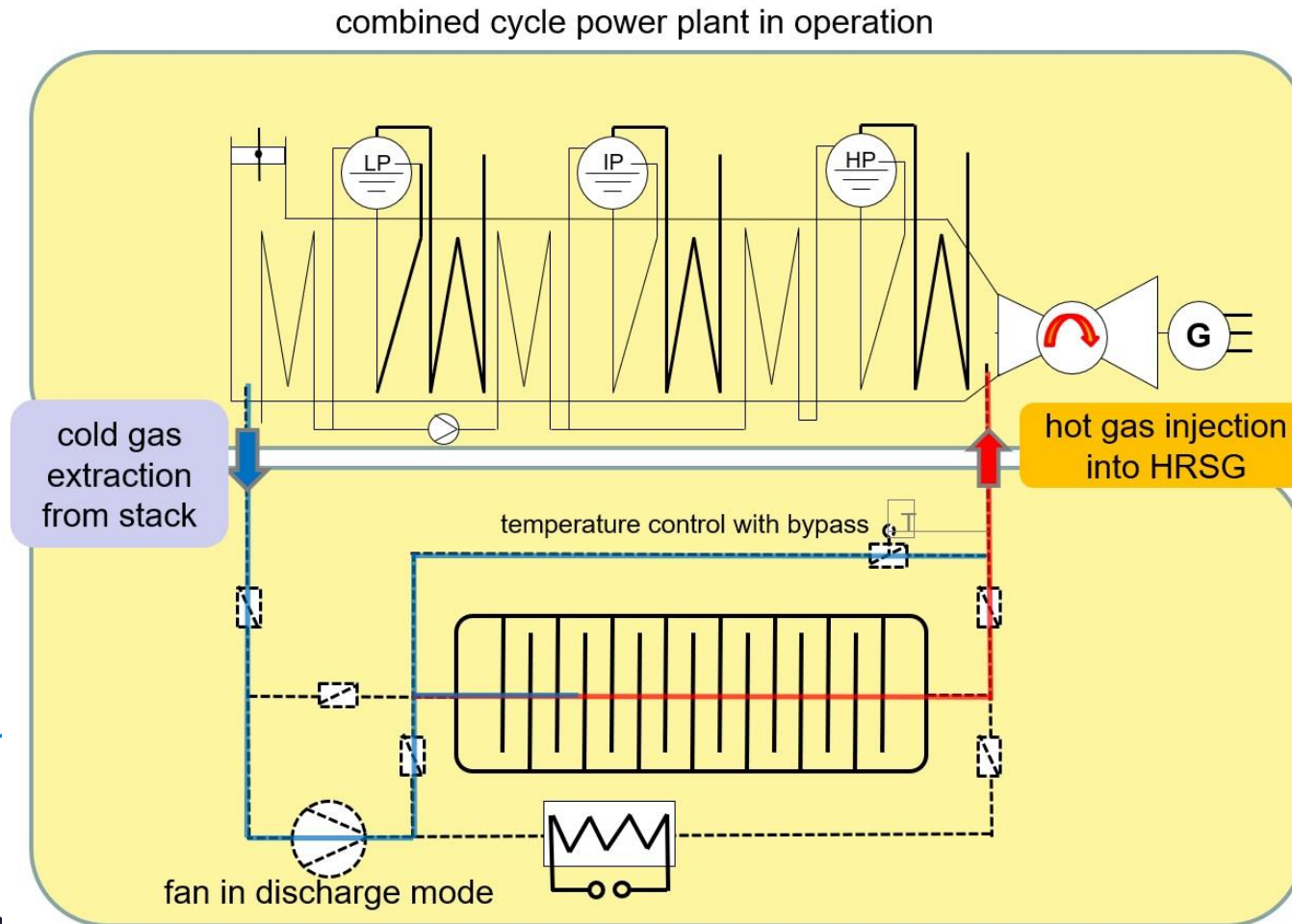
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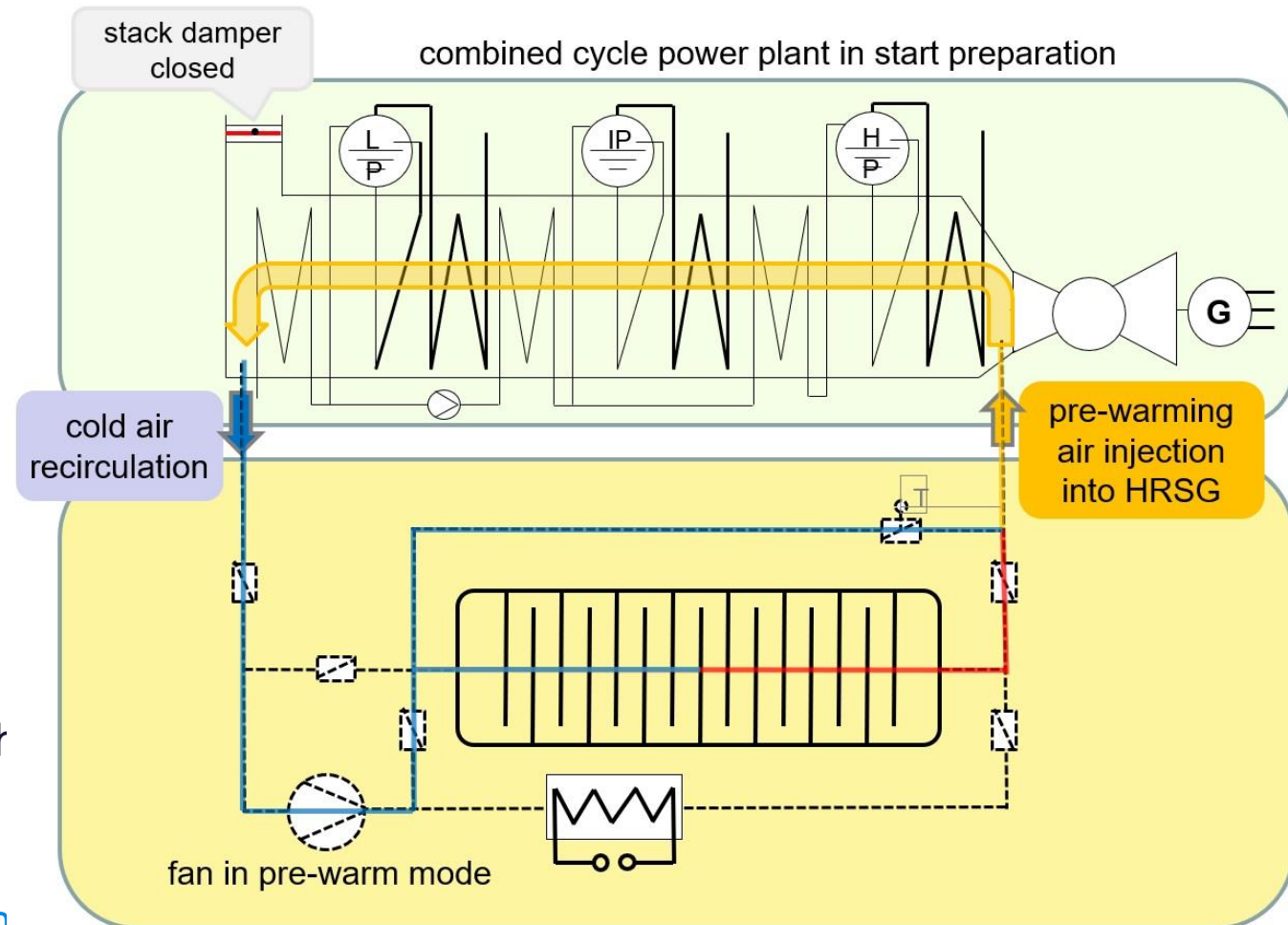
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Combined Cycle integrated Thermal Energy Storage CiTES Our Partners

Technology for Thermal Storage

- Siemens Gamesa Renewable Energy
- Thermal storage technology based on volcanic rocks
- 10+ years experience in thermal storage
- Testing facility and 130MWh_{th} (440MMBTU) pilot plant in Hamburg, Germany

Operational Experience and Market Knowledge

- Exelon Corporation
- One of the cleanest electric power producers in the US
- Present in all major competitive power markets
- Generation assets including nuclear, fossil and renewables
- Contributes the “host” Combined Cycle Plant
 - Technology: realistic plant performance under commercial operation conditions
 - Market data and expertise of all major US ISOs

130 MWh pilot plant in Hamburg, Germany, 2019

Supported by:



Federal Ministry
for Economic Affairs
and Energy

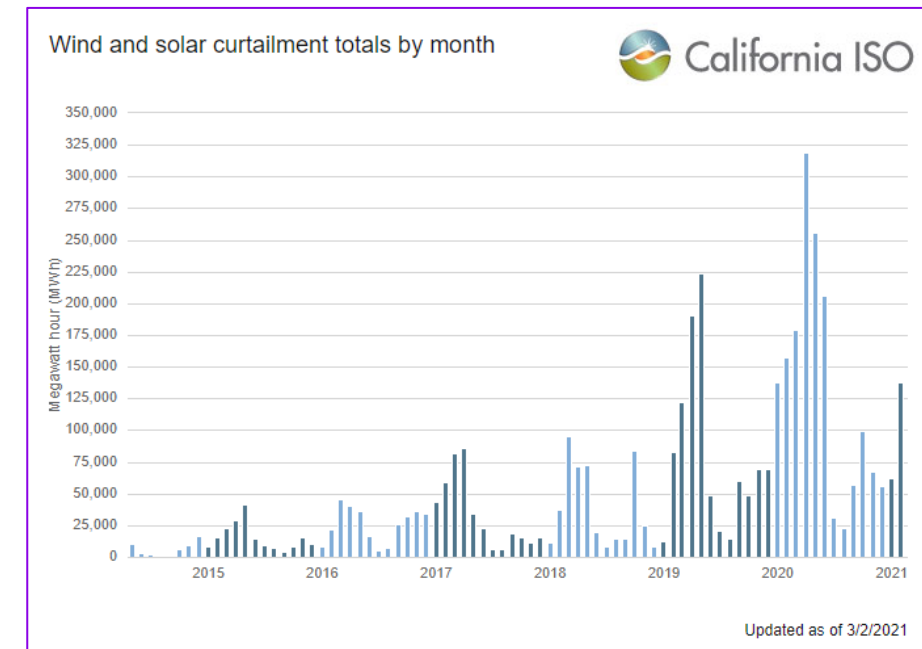
on the basis of a decision
by the German Bundestag



Combined Cycle integrated Thermal Energy Storage CiTES

The Objectives

- With renewable generation increasing, losses of due to curtailment become painful, see CAISO chart
- The California duck curve teaches us that gas-base generation is needed to back-up the grid (may be Hydrogen plus natural gas).
- Batteries integrated in PV are acceptable for 4 – 6hrs
 - but don't help the fossil fleet
 - don't provide rotating inertia like a power plant
- Thermal Energy Storage material is cheap, it has the potential to become an economic viable solution for mid-term storage: 10 – 20 hours as target range
- Cost Target: Released energy from thermal storage for the same costs as generated with natural gas.
- Hurdles:
 - who gets the renewable credits? Surplus generation or storage?
 - is surplus renewable energy for free?
- **Contact:** Thorsten Wolf, tnwolf@siemens-energy.com



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