Small-scale Compressed Air Energy Storage (CAES) systems coupled with Micro Gas Turbines

Session 4 - Microgrids

Speaker: Martina Raggio, PhD student
martina.raggio@edu.unige.it

THERMOCHEMICAL POWER GROUP
UNIVERSITY OF GENOA (ITALY)
tpg.unige.it

Introduction

- The **NextMGT** is a European Horizon 2020 research project with the aim to improve the understanding of the fundamental design and operational aspects of **Micro Gas Turbine (MGT)** technology

- There is of focus on increasing the share of **Renewable Energy Sources** because of climate concerns and the increase of power demand
- **Distributed Energy Resources** are gaining interest due to the possibility to maximize local power production and reduce transmission losses
- **Energy storage Systems** can balance heat/power production

- **Small-scale Compressed Air Energy Storage (CAES):**
  - ✓ No charge/discharge degradation
  - ✓ No need of protection for working at high temperatures
  - ✓ Suitable for cogeneration/trigeneration
  - ✓ Smaller volumes compared to large size CAES

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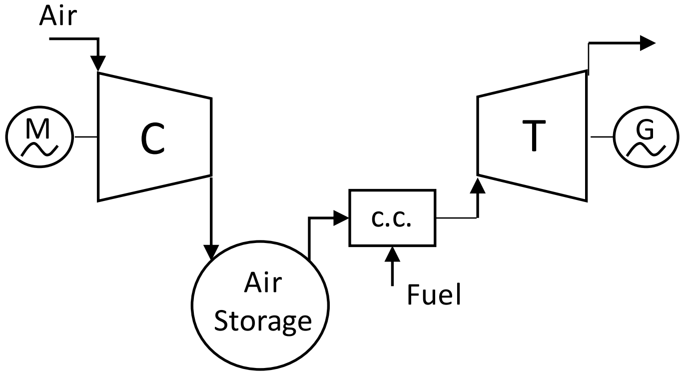
CAES main strategies overview

1) Conventional CAES

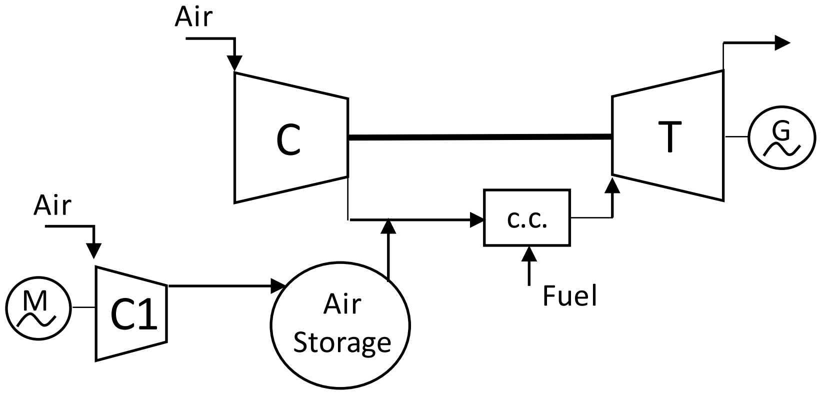


- Off-peak periods: air is compressed with excess electricity and stored
- Peak periods: air is heated and expanded to produce electricity
- Dissipation of thermal energy (need of combustion chamber)

2) **Adiabatic CAES :** Thermal Energy Storage (TES) to absorb heat during compression and reuse it during discharge

3) **Isothermal CAES :** perform near isothermal compression/expansion (ex. introduction of small liquid drops in air)

4) Second generation CAES



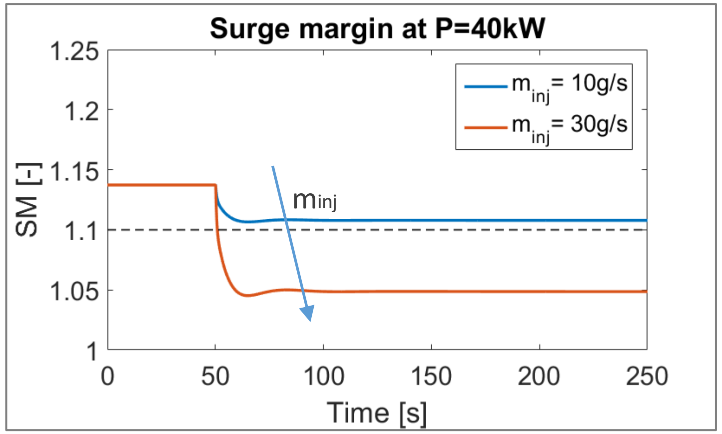
- Use of a commercially available MGT + air compressor and storage
- Lower investment costs
- Improved reliability and flexibility of the plant

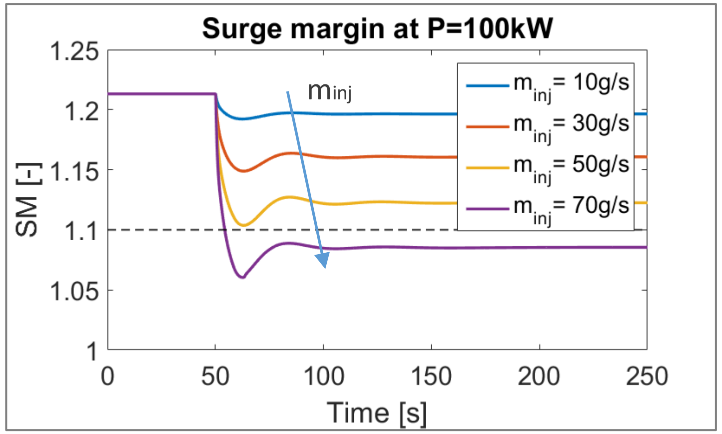
Preliminary study: CAES coupled with a T100 micro gas turbine

- **Augmented gas mass flow** rate at the expander can lead to compressor instabilities
- Main aim: use a **transient model** to determine the maximum achievable GT mass flow injection ensuring safe operation

- Surge Margin:

$$SM = \frac{\dot{m}\,\dot{\beta}_{s.l.}}{\dot{m}_{s.l.}\dot{\beta}} \geq 1.1$$





- At higher power settings higher mass flow rates can be injected
- Transient analysis can be used to estimate the maximum mass flow allowed for the discharging phase at different conditions
- Higher fuel savings when air is injected at higher power settings

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