Challenges in the Development of Micro Gas Turbines for Concentrated Solar Power Systems

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Outline

- Concentrated Solar Power (CSP)
- Micro Gas Turbines (MGTs) and their Application in CSP (Pure Solar Systems)
- The Technical challenges with MGTs in CSP systems
- Control Strategies for CSP Based MGTs
- Alternative MGT-CSP Systems
- Conclusion
Concentrated Solar Power (CSP)

Main components are:

- the **Concentrator** (dish)

■ **Solar Receiver**
Micro Gas Turbines (MGTs)

- Power range below 250 kW?

- Different applications:
  - Turbochargers
  - Distributed Power
  - Range extenders
  - UAV
  - Renewable Energy Harvesting
Micro Gas Turbines (MGTs)
CSP-based Micro Gas Turbines

Diagram showing a CSP-based micro gas turbine system:
- A: Solar Concentrator (dish)
- B: Receiver and MGT

Symbols:
- Blue arrow: Air flow
- Red arrow: Sunlight
- Orange arrow: Sunlight
The Technical challenges with MGTs in CSP systems

- Cost Considerations
- Rotordynamics and Dynamic Stability
- MGT Turbomachinery Design For Solar Application
Cost Consideration

- the biggest share is the **dish**

*including all electrical components from the generator to the grid*
Rotordynamics and Dynamic Stability

- Wide range of operation in term of speed
- How to avoid the critical speeds
- Different shaft assembly (each has advantage and disadvantages)
MGT Turbomachinery Design For Solar Application

- The main technical challenges would be design and manufacturing of high-efficiency turbomachinery components that are able to perform in near peak efficiency for a quite wide range of operation.
Control Strategies for CSP Based MGTs

- Main challenge is that there we don’t have control over the solar irradiation!

- **Power Electronics** is the main mean of the control available; The control system needs proper integration with the power electronic system, as practically power electronics would be the only way of controlling the micro gas turbine in absence of conventional fuels.

- PEs for high frequencies in the range of power is still immature
Alternative MGT-CSP Systems

- CSP-MGT with Thermal Storage (24/7)
  - still is in the research level; high temperature is required for efficient MGT

- Hybrid Systems (with conventional or biofuels)
  - the main technical issue is the stability of the combustor in wide range of A/F ratios
Conclusion

- The advantages of MGTs as prime mover in the CSP system
- The main technical challenges are related to design and manufacturing of high-efficiency turbomachinery components
- The control system needs proper integration with the power electronic system
- For continues power generation the thermal storage should be coupled with the MGT in excess of 800°

- A preliminary study showed that generator-in-middle arrangement has more potential to operate in wider range of speed, which is the case for the solar application.
Thank you