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Integration of MGT with Solar based technologies

Professor Abdulnaser Sayma

Micro Gas Turbine (MGT) Meeting

MGT in the European Energy Scenario

18 March 2016

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Topics

- **Distributed solar thermal technology options and status**
  - **Parabolic dish-Sterling**
  - **Parabolic dish-Micro Gas Turbine**
  - **CSP – Organic Rankine Cycles (ORCs)**

- **OMSoP project**
  - **Technology challenges to integrate Solar with MGT**

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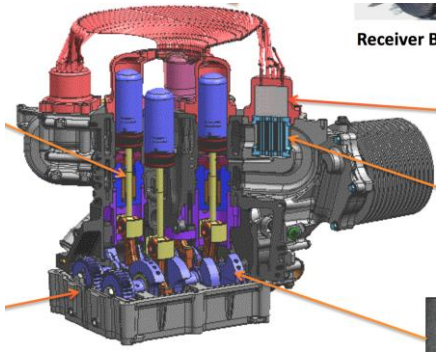
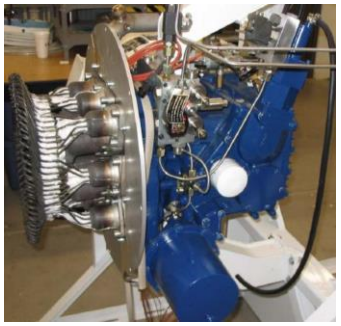
Parabolic dish Sterling





Characteristics:

- High design point efficiency
- Low rotational speed – off the shelf generators – bulky
- Poor reliability
- Dispatchability may be difficult (Hybridisation with fuels and thermal storage)

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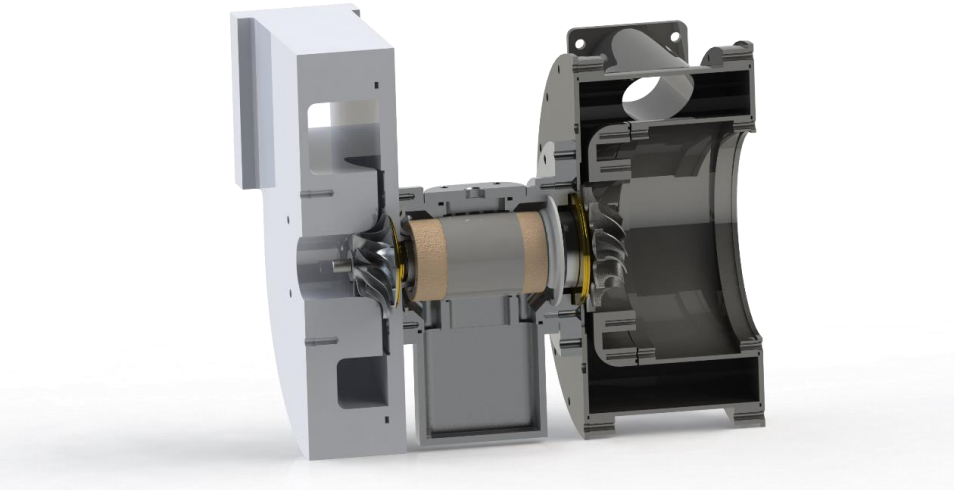
Parabolic dish MGT



- Promising Technology – under development
- Currently, lower design point efficiency than Sterling
- Potential for higher reliability
- Better potential for dispatchability through hybridisation with fuels and thermal storage

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CSP – Organic Rankin Cycle (ORC)

- Operate at much lower temperatures ~ 300 ^{o}C
- Intermediate fluid: Easy to hybridise
- Can be used for CHP
- Despite continued R&D, no commercially available systems below 50kWe
- Bulky – Large Heat exchangers
- Low design point efficiency

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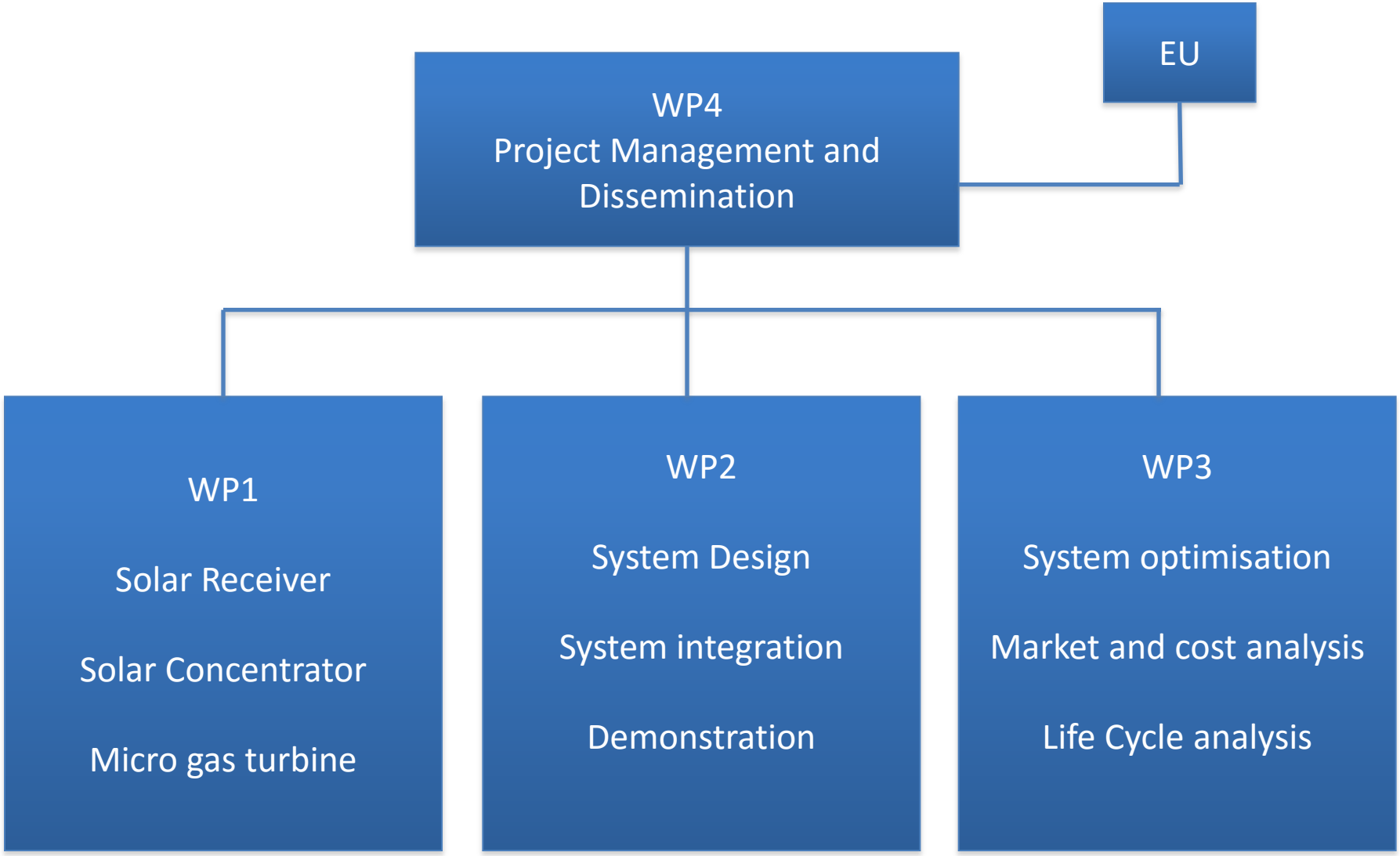
Overall Objectives

- The demonstration of concentrated solar power technology using a parabolic dish system powering a micro-gas turbine – 3-10 kWe
- Techno-economic system optimisation
- Market and cost analysis - Worldwide

Technical objectives

- Alternative to sterling engines (reliability issues)
- Better solar dish: reflective materials, weight, control …..
- High temperature receiver > 900^{o}C
- Competitive cost of electricity

Project Structure



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Micro-gas turbine

- Demonstration Unit
  1. Improved MGT starting from a conventional design
  2. Optimised turbine and compressor designs
  3. Alternative shaft and bearing arrangement for rotor dynamic stability
  4. Ability to withstand harsh conditions, with a unit moving in 3D with the dish orientation
- Optimised MGT for future systems
  - Produce an optimised design for a unit close to market.

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Parabolic dish MGT

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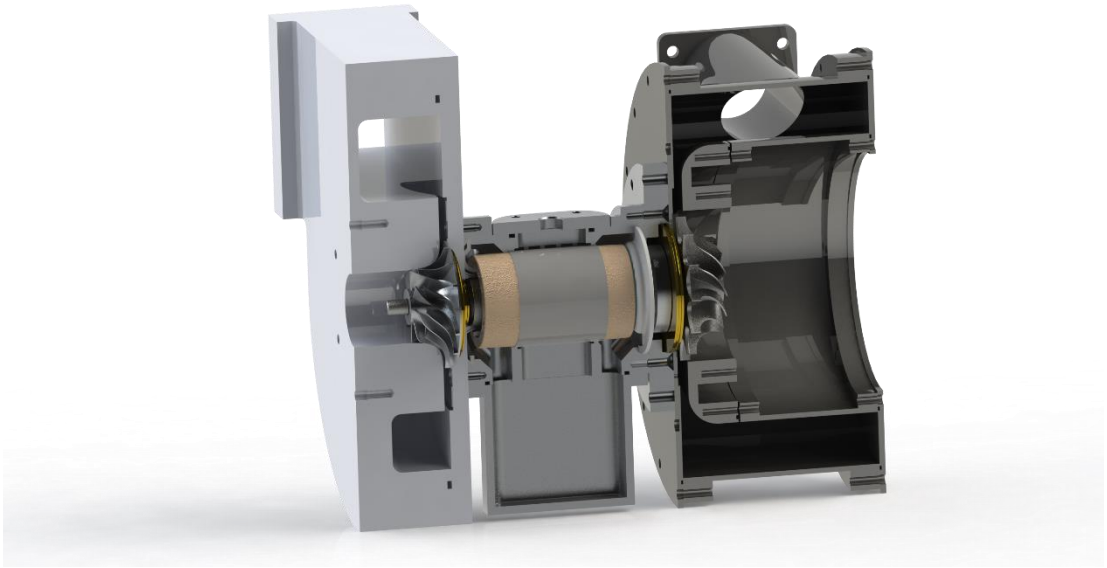

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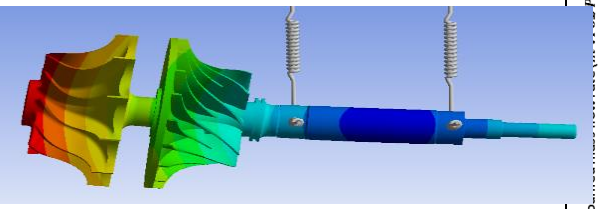
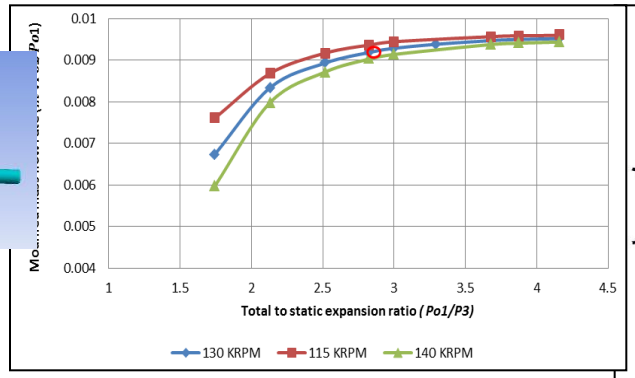
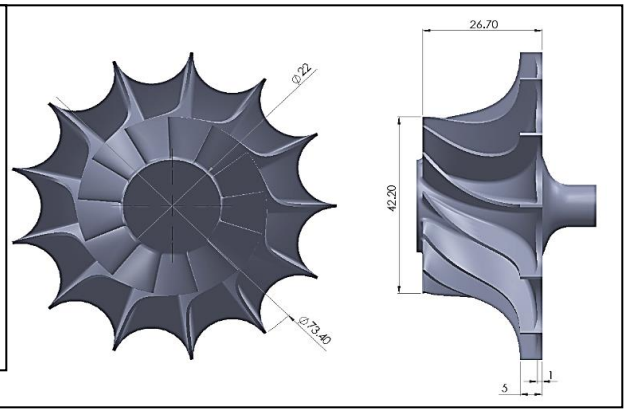
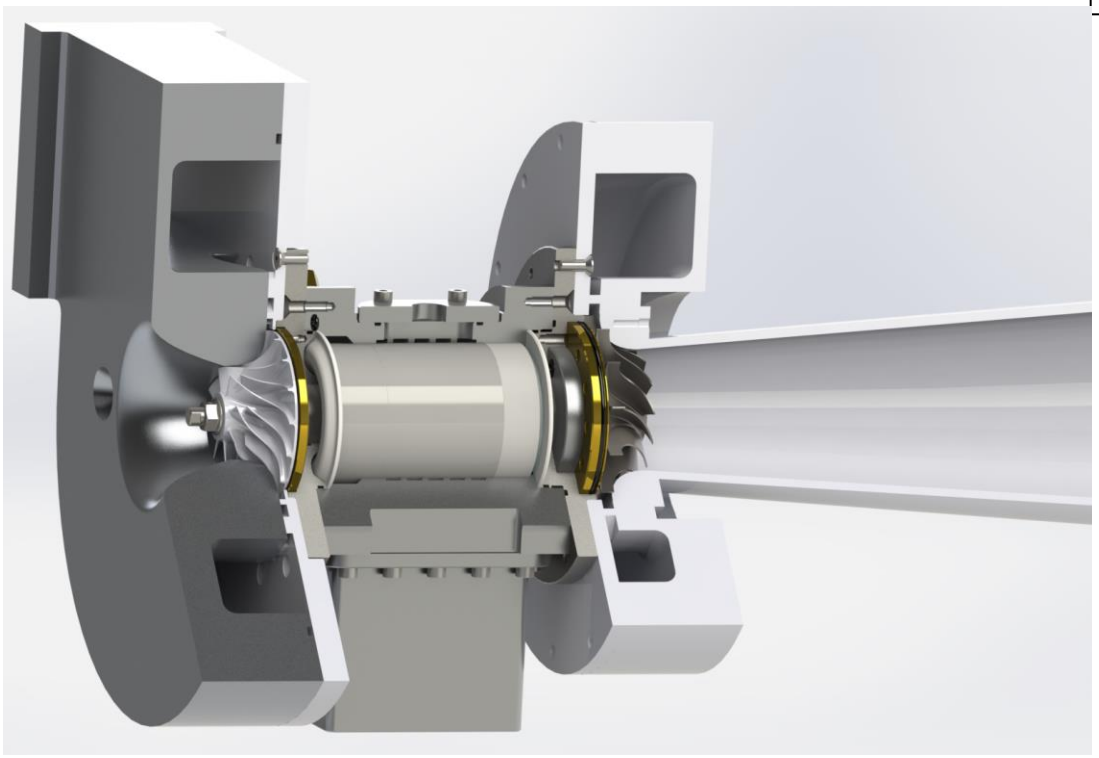
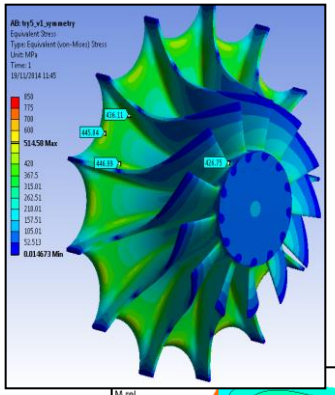
Micro turbine design, construction and testing at City

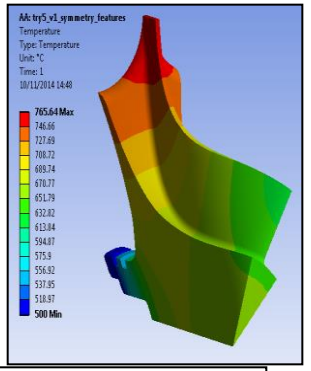


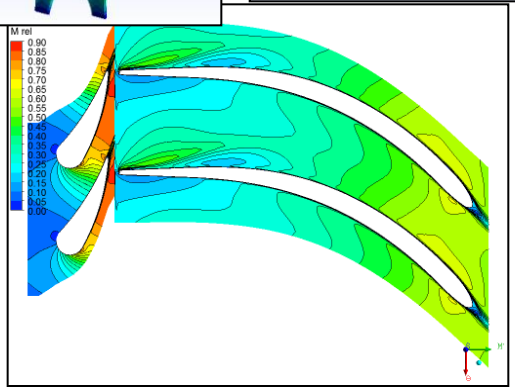












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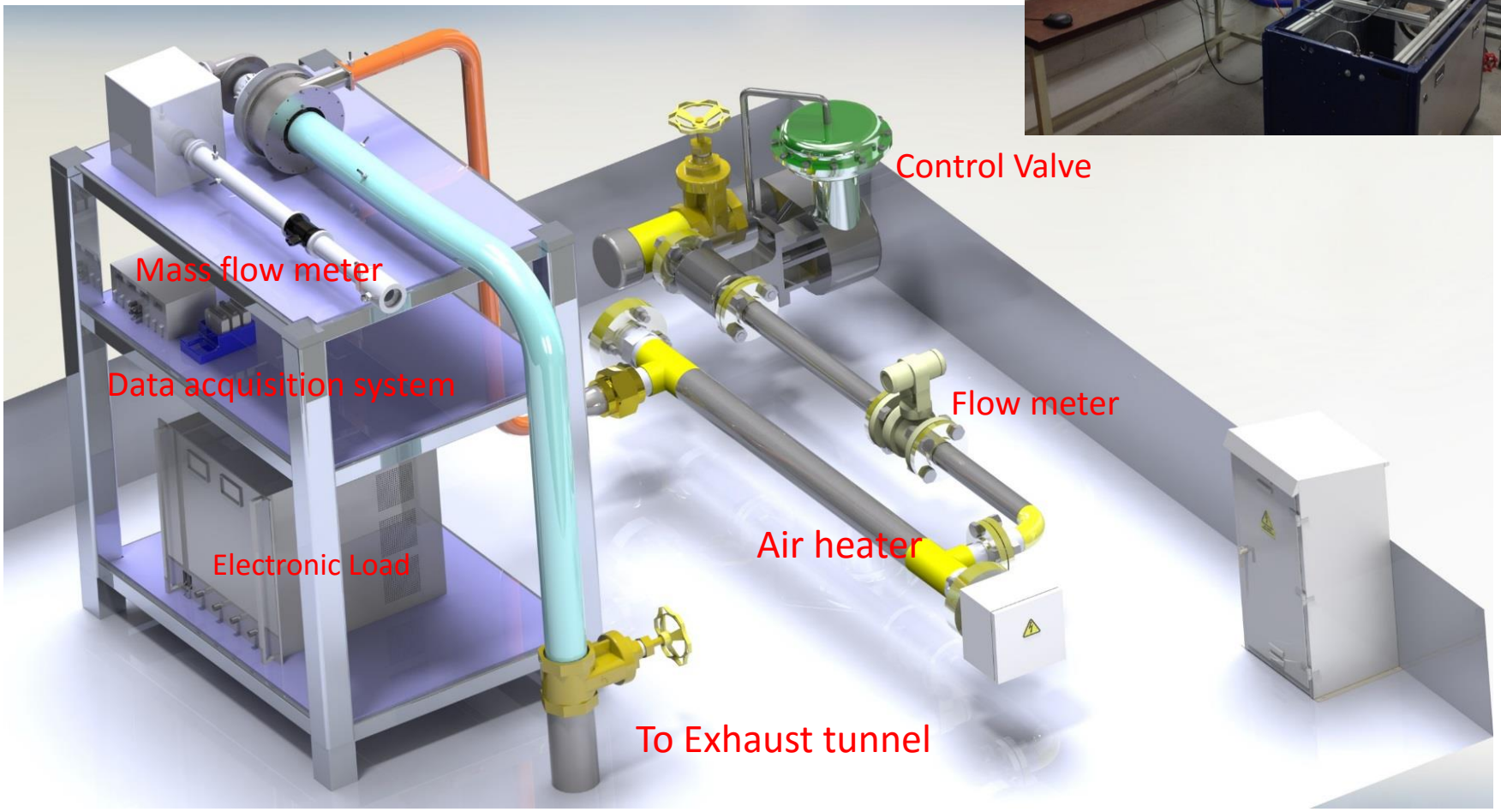
The Test Facilities – reconfiguration



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System performance

- What is the trade-off between high MGT and the overall CSP system capital cost → cost of electricity
- What are the most cost effective dispatchable CSP-MGT system:
  - With thermal Storage?
  - With Electrical Storage?
  - With Flywheel
  - Hybrid with other fuels
- What are the technological advances required to bring these systems to market?

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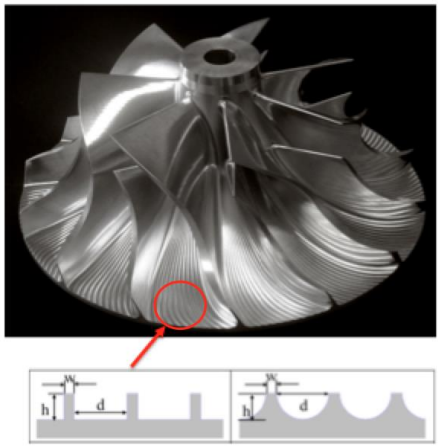
System layout

- MGT on top of the dish

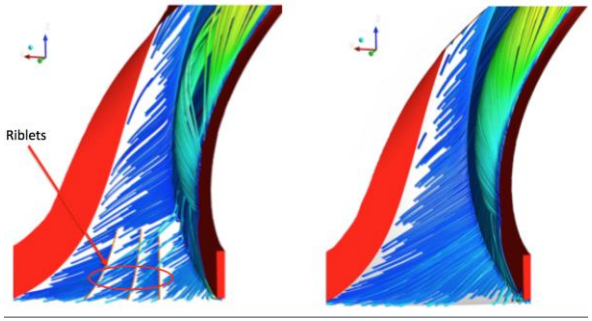
- Secondary receiver with MGT on the ground

Challenges - I

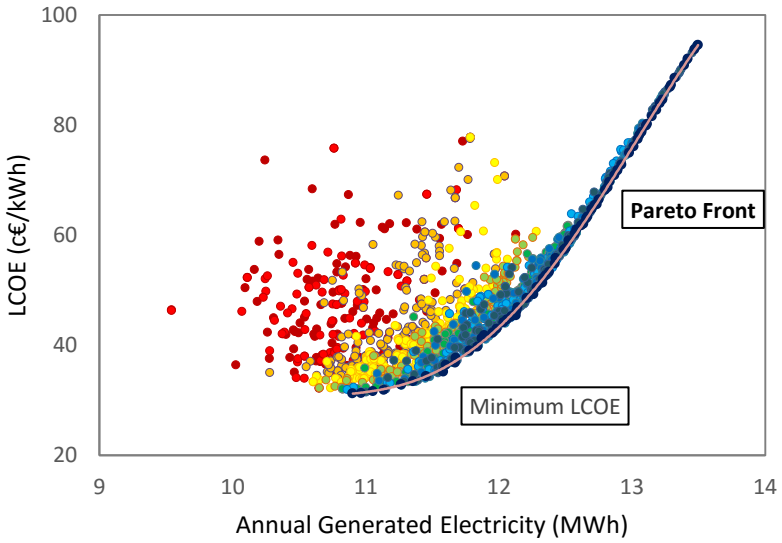
- High efficiency at a wide range of operating conditions and/or high annual generated power



Innovative component designs

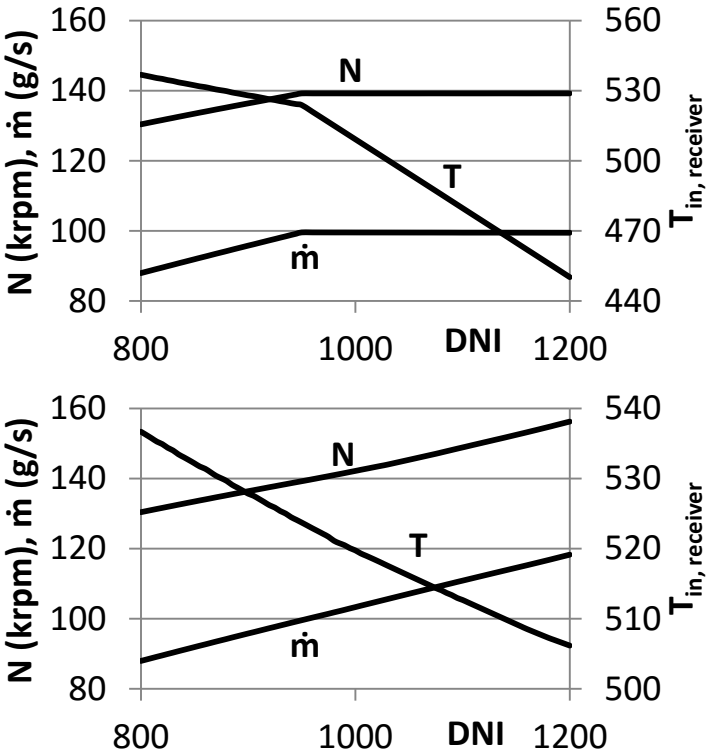


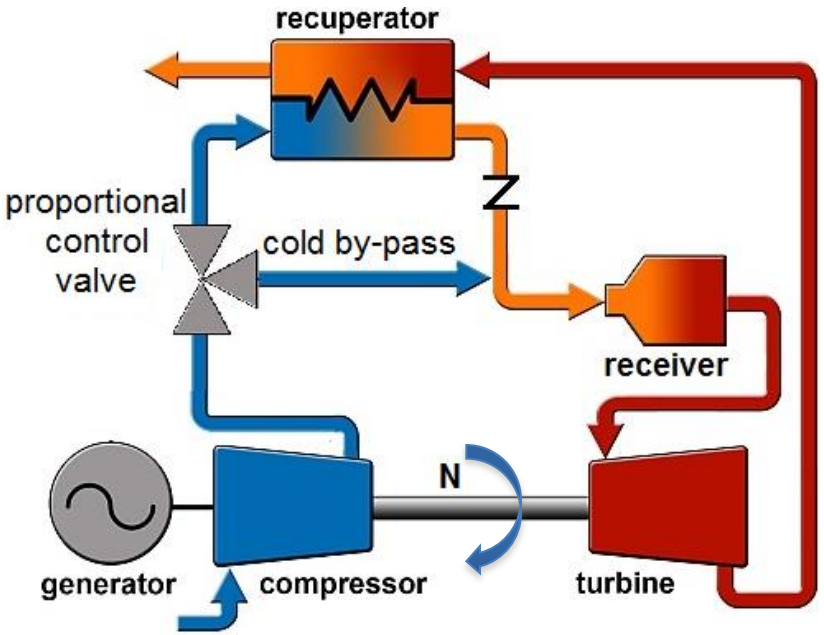
Cycle innovations for optimum techno-economics



Control (performance and reliability)

- A practical and feasible control strategy is required to:
  1. Achieve maximum power at any DNI
  2. Protect the system from extreme conditions





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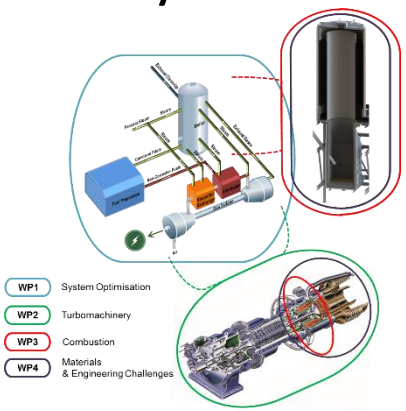
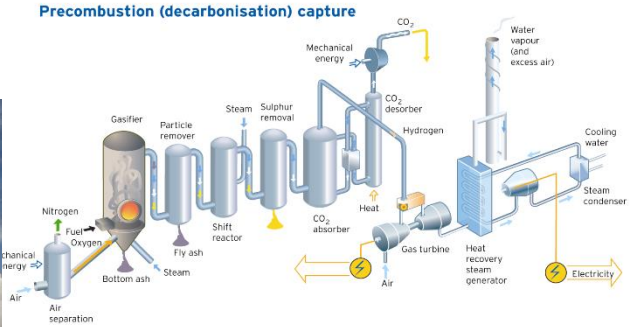
Thank you

PolyBioGT



OMSoP



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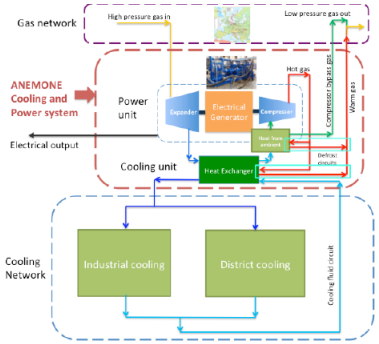
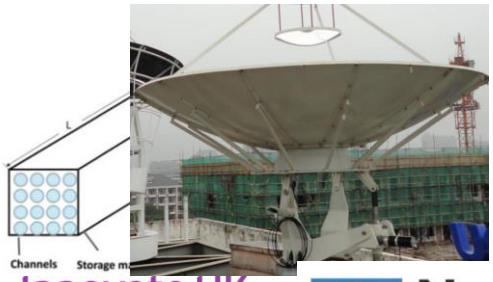


SolGATs



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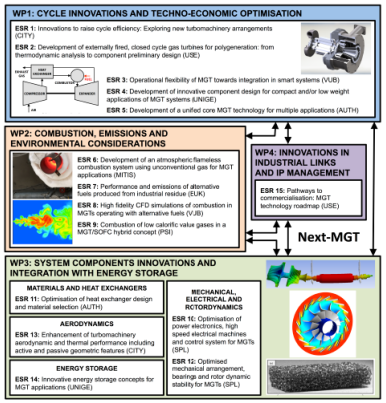

NextMGT