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Towards, Competitive, Reliable, Safe and Sustainable Concentrated Solar Power (CSP) Plants

Midterm meeting REA, 18-19 April 2024

DC10 - Full economic and environmental analysis of CSP plants

PhD candidate: Mª Asunción Palmero González

Hosted by: Universidad Carlos III de Madrid (UC3M)
Supervisors: Esperanza Batuecas & Carolina Marugán Cruz

- Academic & professional background
  - Bachelor's Degree in Energy Engineering – Universidad Carlos III de Madrid
  - Master's Degree in Industrial Engineering – Universidad Carlos III de Madrid
    - From 2021 – 2023: Electricity transport and distribution sector as a Project engineer (Iberdrola i-DE)
- In **TOPCSP**
  - September 2023 – February 2024: Hosted by John Cockerill (Solar Energy department).
  - March 2024 – present: Hosted by Universidad Carlos III de Madrid (Thermal & Fluid eng. Department)

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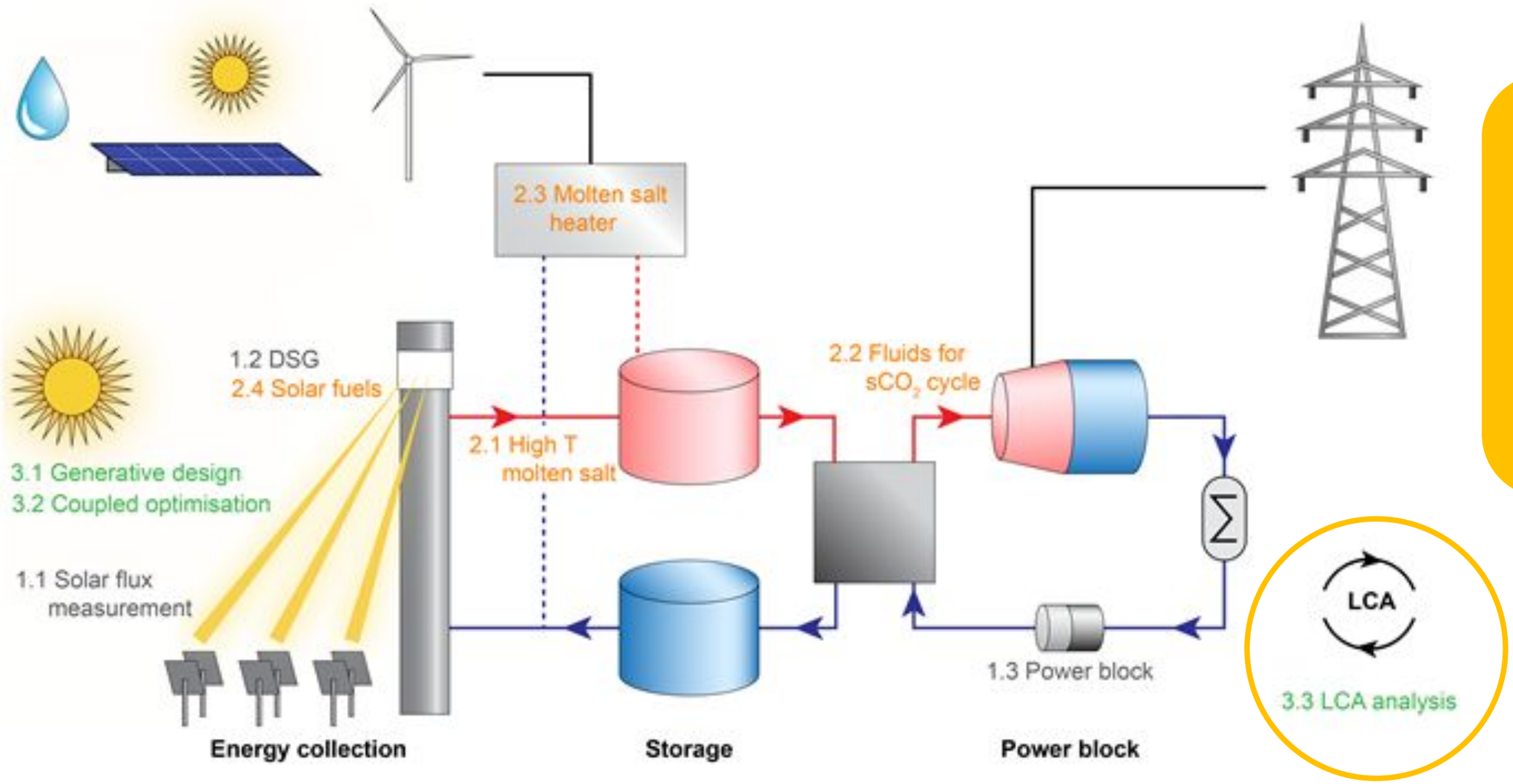

TASK 3.3

Life Cycle Analysis and economic analysis of a state-of-the-art CSP plant and comparison of the results with other renewable energy generation technologies.

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- INDEX
  - Literature review
    - Main outcomes
  - Current status
    - Impact of the refrigeration system in a central tower CSP plant

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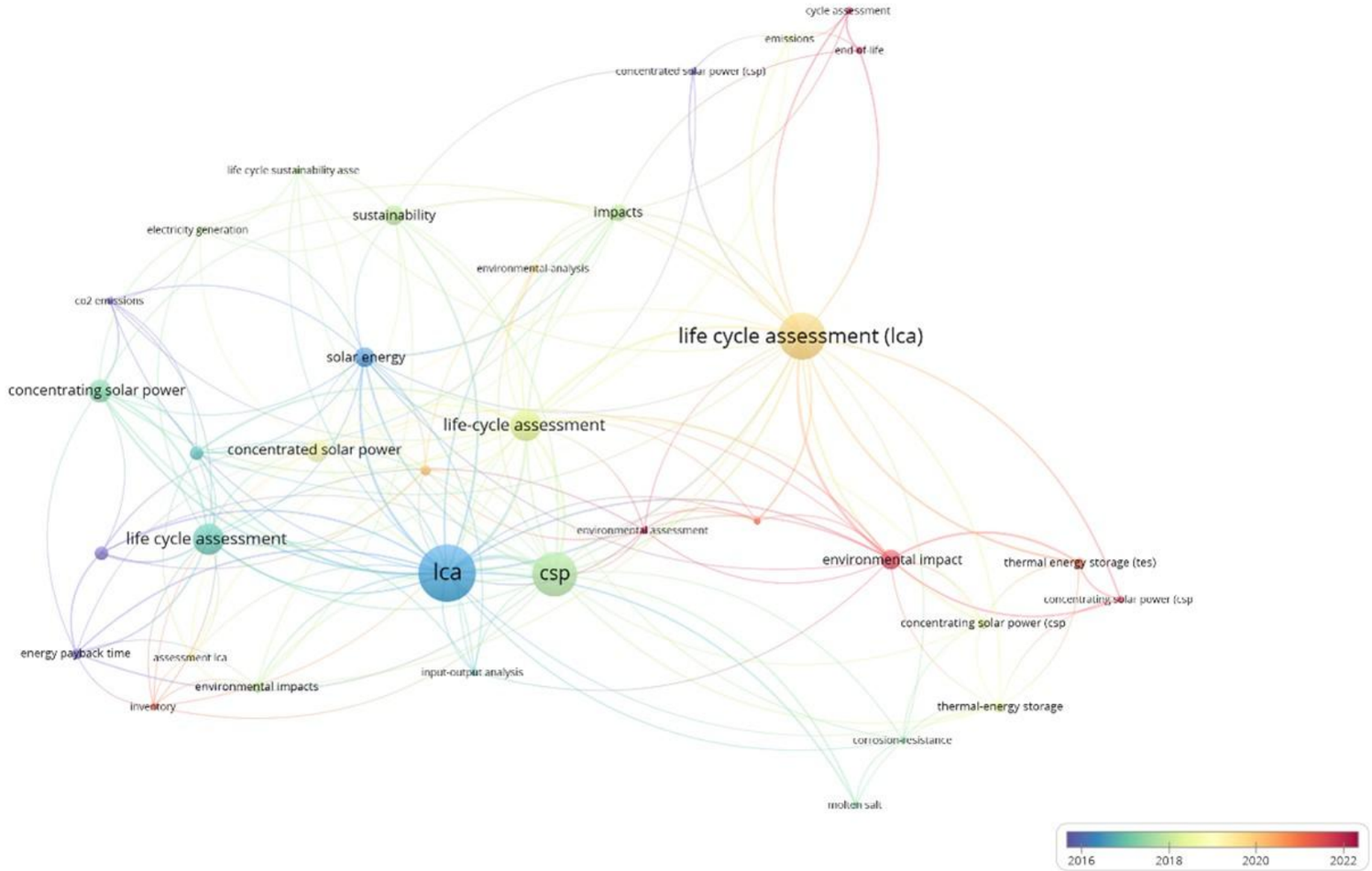
•LITERATURE REVIEW

- What has been done until now?
- What are the main results?
- What knowledge gaps are we facing?



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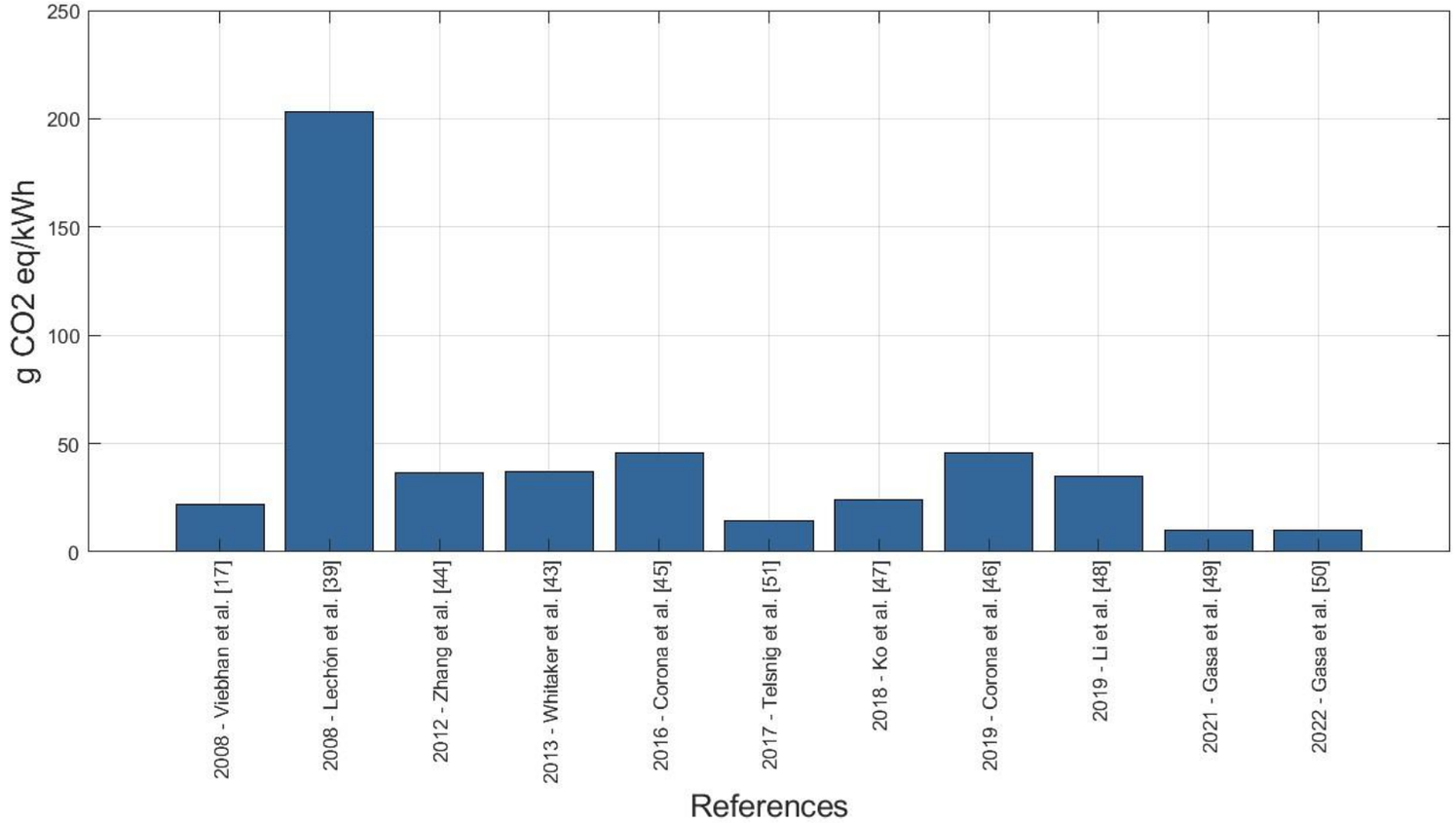
Main outcomes

- **Environmental impact estimations & materials within CSP plants exhibit inconsistencies**
- **Scarcity of accurate Life Cycle Inventory data**
- Limited information on decommissioning & disposal phases
- Many studies predominantly concentrate on PTC
- Few studies regarding environmental impact of CSP subsystems



- Average CO_2 emissions for CSP plants < 50 g $CO_{2,eq}$/kWh
- Material transportation, intensive use of critical materials, and the influence of molten salts and HTFs

Renewable and Sustainable Energy Reviews Journal - **Life Cycle Assessment studies of Concentrated Solar Power technology: a literature review**

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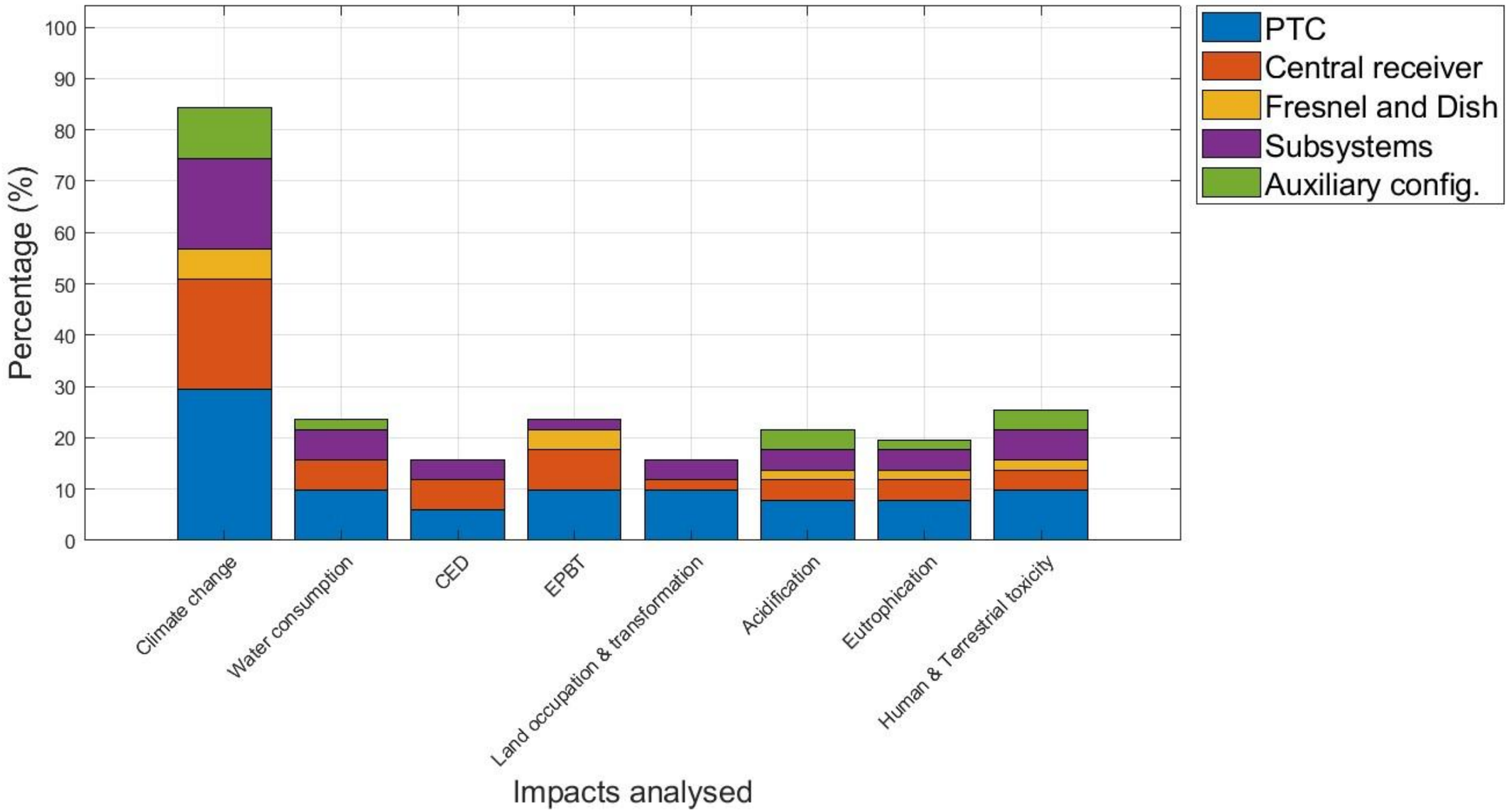
- Main outcomes



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Current status @ UC3M:

- ENVIRONMENTAL IMPACTS OF THE REFRIGERATION SYSTEM IN A CENTRAL TOWER CSP PLANT

  - Plant configuration, P_{elec}, P_{water} – Most suitable refrigeration system and the overall environmental impact of the complete central tower CSP plant

  - REDSTONE, 100 MWe – 12 h TES (South Africa)

  - Plant modelling: SolarPILOT
  - Plant performance: MATLAB
  - Refrigeration system: MATLAB
  - Inventory collection
  - Environmental impact assessment: SimaPro

Source: https://www.saisc.co.za/listing/redstone-csp-project-mw-tower/

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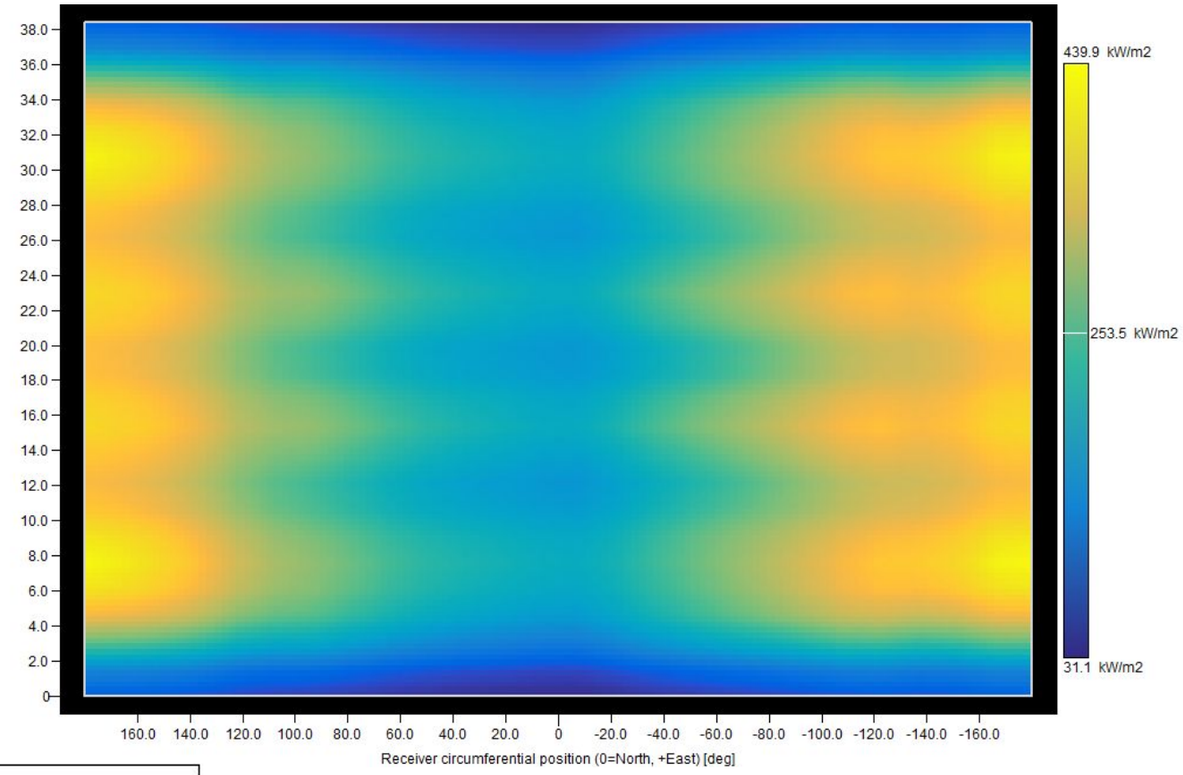
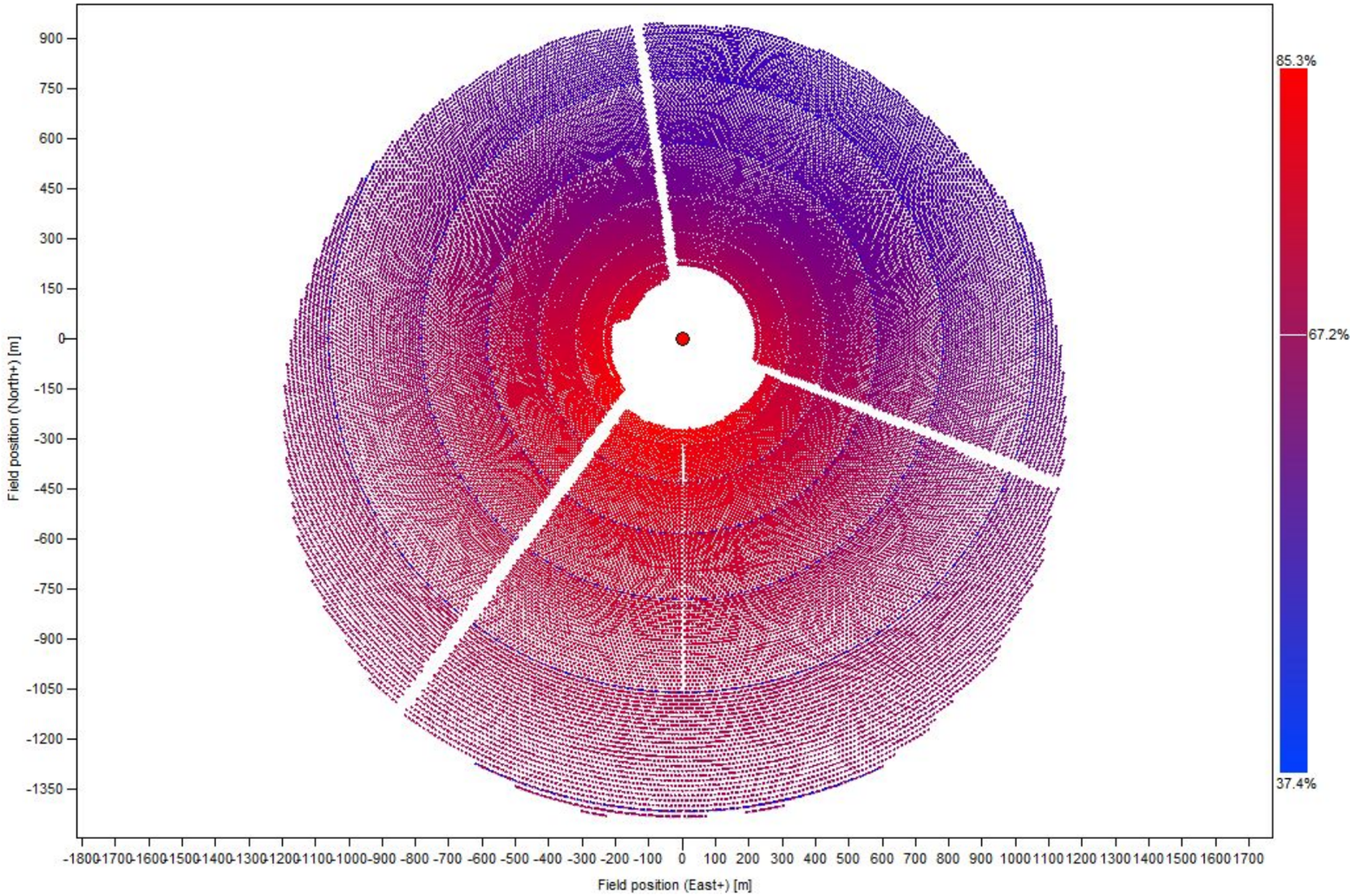
Source: GoogleEarth





Design point – Spring Equinox	Value
Simulated heliostat area [m2]	1008247
Simulated heliostat count [-]	40762
Power incident on field [kW]	1008247
Power absorbed by the receiver [kW]	632344
Absorption efficiency [%]	94,00
Solar field efficiency [%]	**66,72**
Incident flux [kW/m2]	253,47

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Thank you!

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