Optimisation of solar thermal system under material constraints

Primary supervisor and chair: John Pye

Advisors: Ali Shirazi, Joe Coventry

A scholarship is available for a full-time student, either domestic or international, to undertake studies in the topic of concentrating solar thermal (CST/CSP) system modelling and optimisation.

As CSP works to reduce its overall cost, systems are sought that capture and store energy at increased temperatures using more challenging materials and more challenging processes, and these systems will have to push even harder against the various constraints imposed by materials, optics, heat transfer and thermodynamics. In this project, it is proposed to implement system-level models of CSP systems in a way that explicitly evaluates these constraints, and allows us to use high-performance computing to optimise system designs within those constraints, with the full range of annual variations in system behaviour included in the model. The highly dynamic nature of CSP systems with cloudy conditions and the day/night cycle and the challenges of modelling the entire system through such conditions, mean that accurately calculating the impact of materials constraints on the optimal design is something has not yet been well studied. Filling that gap is the intention of this project.

A student working on this topic will get broad exposure to all aspects of CSP system design, from components to operating strategy to optimisation to material issues such as fatigue and creep. It is expected that the main focus of the project will relate to CSP for the production of electricity. ANU participates in a major Australian program on CSP research, titled ASTRI (Australian Solar Thermal Research Initiative). This project is paid for from that ASTRI program, and it will be expected that work undertaken in this project will maintain a strong relevance to that program. ASTRI is considering systems incorporating PCM storage, sCO2 power cycles and both particle receivers and liquid sodium receivers, and will be working towards development of a demonstration plant design over the period of this project.

REQUIREMENTS

The position suits a candidate from a chemical engineering, systems engineering or mechanical engineering background. Desired skills include: thermodynamics, heat transfer, computational mechanics, numerical methods, computer programming in common languages (e.g. Python, C, C++; experience with Modelica beneficial but not essential), software engineering, and the ability to analyse complex mathematical problems. Essential are strong analytical, interpretive and problem-solving skills, the ability to exercise sound independent judgement with a high level of self-motivation, and proficiency in technical (written and oral) English.

General information for applicants can be found at http://students.anu.edu.au/applications.

A three-year scholarship (starting from $26,682 per year) with tuition fee waiver will be offered. Apply at https://cecs.anu.edu.au/study/graduate-research preferably by **30 Sept 2017** to be eligible for an early 2018 commencement. Please **additionally** notify the Higher Degree Research team in CECS Student Services (research.cecs@anu.edu.au) when you have completed the online application.

Inquiries about this position should be sent to **Dr John Pye**.

REFERENCES

Some selected background reading is given below:

W Logie, J Pye and J Coventry, 2016. Thermal Elastic Stress in Sodium Receiver Tubes. In: *Proceedings of the Asia Pacific Solar Research Conference 2016*, Canberra, Dec.

P Scott, A de la Calle, J Hinkley and J Pye, 2016. SolarTherm: A Flexible Modelica-based Simulator for CSP Systems. *AIP Conference Proceedings* **1850**(1), Oct, from SolarPACES 2016.

C Asselineau et al, 2017. *Tracer: a Monte-Carlo Ray Tracing code in Python.* http://guthub.com/casselineau.

C Ho and B Iverson, 2014. Review of high-temperature central receiver designs for concentrating solar power. *Renewable and Sustainable Energy Reviews* **29**, pp835–846, Jan.

B Xu, P Li and C Chen, 2015. Application of phase change materials for thermal energy storage in concentrated solar thermal power plants: A review to recent developments. *Applied Energy* **160**, pp286–307, Dec.