The ETH's Professorship of Renewable Energy Carriers conducts research aimed at the advancement of the thermal and chemical engineering sciences applied to renewable energy technologies. The research focus comprises high-temperature heat/mass transfer phenomena and multi-phase reacting flows, with applications in solar power, fuels, and materials production, decarbonisation and metallurgical processes, CO_2 capture and recycling, energy storage and sustainable energy systems. PREC has pioneered the development of solar thermochemical reactor technologies for producing clean transportation fuels using concentrated solar energy. The infrastructure is equipped with a high flux solar simulator for testing reactors and receivers used in CST technologies, as well as supporting characterisation techniques such as flux measurements and *in-situ* gas analysis. Additionally, there is a materials chemistry laboratory (PREC-CHEM), with state-of-the-art facilities for characterizing materials, and the thermodynamics and kinetics of multi-phase reactions.

- HFSS - The high flux solar simulator is used for testing of CST components that are designed to be irradiated, such as reactors, steam generators, and solar receivers in general. The lab is also equipped with a suite of support and monitoring equipment, including gas analysis (gas chromatography, mass spectroscopy, infrared gas analysis), temperature measurement (pyrometers, thermocouples), cooling systems etc. which can be utilized subject to availability. This allows for flexibility in accommodating a broad range of test campaign wants, and offers a suitably advanced range of measurements to characterise the performance of the tested components under steady state and/or varying high intensity illumination.
- CHEM - The chemistry laboratory offers a unique suite of instruments, well suited for thermodynamic and morphological characterisation of materials for use in CST applications. The instrumentation is as follows, (1) two thermogravimetric analysis systems (TGAs, from Netzsch and Setarum), with gas analysis instrumentation (gas chromatography, mass spectrometry) and differential scanning calorimetry (DSC) capabilities, (2) a Netzsch laser flash system for measuring thermal diffusivity (conductivity/heat capacity) of materials, (3) a MicroMetrics Brunauer-Emmett-Teller (BET) a surface area analysis system, (4) a Horiba laser scattering particle size distribution analyser, (5) a Hitaschi scanning electron microscope (SEM) and (6) facilities for wet chemical synthesis. It is used to prepare and characterize materials, in terms of their thermodynamic properties such as heat capacity, thermal conductivity, phase changes, as well as other physical characteristics such as morphology, high temperature stability, etc. The thermogravimetric analysis (TGA) systems available in the lab also allow reaction systems such as redox cycles to be characterised, allowing for enthalpies of reactions to be determined. The systems are also suited to performing relaxation kinetics for many such reaction systems.

<u>Services currently offered by the infrastructure:</u>

The HFSS and CHEM labs, together with the PREC personal have been central to the success of the Professorship of Renewal Energy Carriers (PREC) infrastructure at ETHZ. The HFSS has been used to test prototype solar fuel reactors, and make a number of ground breaking first time demonstrations of CST solar fuel technologies. This includes solar gasification, methane reforming, thermochemical redox cycles and membrane reactors. The group has collaborated with international researchers, utilizing the HFSS lab to demonstrate the cerium redox cycle with was published in science back in 2010 [Chueh *et. al. Science,* 2010].

The CHEM lab has been used for screening and testing of materials at the laboratory scale for application in heat storage, thermochemical redox cycles, gasification, catalysis, with a focus on solar chemistry. In addition, it has been used more generally to test the suitability of materials for high temperature operation and cyclability, in terms of structure and durability. It offers a broad range of techniques, which allowed PREC to develop an excellent reputation in materials research for CST applications.

The infrastructure has been broadly publicised at conferences and in peer reviewed journals, and continues to receive positive recognition from the international CST community. Opening the available installations for the first time to non-partner international users, is an exciting development for the PREC group and we anticipate considerable interest in the facilities.