The IMDEA Energy's infrastructure provides support to the users for the design, simulation, optimization, testing and control of concentrating solar thermal technologies as well as other complex systems related to thermal processes. It gathers dedicated computational tools and experimental installations covering technology readiness levels from 1 up to 6. The infrastructure has unique facilities able to achieve very high concentrations in a wide range of total power (from 1 kW up to 250 kW), which are of special interest in materials development and high-temperature applications.
Areas of research comprise advanced optical engineering; computational fluid dynamics and mechanics for solar receivers, reactors and energy storage systems; numerical integration analysis of solar thermal systems and components in industrial and thermal processes and supervisory control and data treatment and acquisition by means of computational tools; materials synthesis and characterisation under high irradiances; testing of solar absorber materials; testing solar reactor components under very-high irradiances.
IMDEA Energy offers four (4) installations for the TA in this project:

- The **Computational Design Lab for High Temperature Processes (HTPU-CDL)** offers specific hardware and software tools for characterising, designing and modelling solar thermochemical and high temperature processes.
- The **High Temperature Processes Laboratory (HTPU-LAB)** provides support For characterization of tested materials: a bench-top Scanning Electron Microscope Model Hitachi TM-1000 that includes an Energy Dispersive X-Ray analyser from Oxford Instruments; XRD diffractometers X'Pert Por MPD and BrukerD8 Advanced; ICP-OES (Chemical Measurements) Perkin Elmer OPTIMA 7300DV with autosampler; Thermo-Gravimetric Analyser (TGA/DSC) for measurements at high temperature and under reactive atmosphere (water vapour) Netzsch Jupiter F3 449. Laboratory-scale high-flux 7kWe-solar simulator. Sintering furnaces, Flux measurement systems with CCD cameras and high-flux calorimeters; temperature measurement by IR cameras and pyrometer.
- The **42kWe High Flux Solar Simulator (KIRAN42)** comprises the IMDEA Energy's 42 kW high flux solar simulator (HFSS) and various test rigs and measurement techniques specifically designed for exhaustive thermal, optical and chemical characterisation of solar receivers, solar reactors, thermal shielding and other components subjected to defined high irradiance distribution. Independent testing room fully equipped (gases, mono- three-phase electricity supply, computer data sockets). 42kWe Xe-arc high flux solar simulator. Beam attenuator and radiation homogenisers. Computer-controlled 3-axis positioning system (250 kg. load capacity). Test rig for aerothermal characterisation of components for high-temperature process heat applications. Test rig for chemical characterisation of materials and components of solar reactors for high-temperature process heat applications. Thermographic cameras, radiometers, bi-chromatic pyrometer. H_2, O_2, CO, CO_2, CH_4 gas analysers for continuous gas composition monitoring and micro-gas chromatograph.
- The **Very High Concentration Solar Tower (VHCST)** is a unique infrastructure for testing components and devices under very high solar fluxes. The VHCST has a customized heliostat field that makes use of the most recent developments on small size heliostats and a tower with reduced optical height (15 m) to minimize visual impact. The heliostat field of 250 kWth (500 m^2 reflective surface) has been built adjacent to IMDEA Energy premises at the Technology Park of Móstoles, Spain, and consists of 169 small size heliostats (1.9 m x 1.6 m). In spite of the small size and compactness of the field, when all heliostats are aligned, it is possible to fulfil the specified flux above 2500 kW/m^2 for at least 50 kW and an aperture of 16 cm, with a peak flux higher than 3000 kW/m^2.

The VHCST installation will be available in SFERA-III from Sept. 2020 because of current testing commitments.

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

- **Services on reflectors and concentrators** (Characterization of optical properties of solar reflectors; outdoor exposure of solar reflectors; corrosion and materials protection studies under outdoor exposure, Measurement on material properties); Available services on concentrator's experimental characteristics (optical and thermal characterisation of solar concentrators, small-heliostat performance qualification),

- **Experimental services on absorbers** (accelerated aging of absorbers and absorbing coatings, optical properties/characterization of absorbers & receivers and their coating),
- **Services on heat transfer fluids** (qualification HTF based on particles),
- **Services on thermal energy storage** (characterization of heat storage and components for TES, thermal & thermochemical properties evaluation for thermal storage materials, development and characterization of materials and components for TES, advanced solid concepts for thermal energy storage, simulation and modelling of thermal storage systems. Integration in STE plants or industrial heat processes),
- **Services on solar chemistry** (high temperature solar chemistry: high temperature thermochemical research units, thermal and thermodynamic characterization of prototype reactors for central receiver on tower technologies under real operating conditions, solar fuels and thermochemistry, qualification of solar driven processes under realistic conditions; solar hydrogen: solar hydrogen production process qualification, solar thermochemical hydrogen/syngas, water splitting thermochemical cycles), and
- **Services on material testing and qualification** (Surface materials treatment, Metallography. Micro-hardness analysis. Thermogravimetric analysis, Advanced materials analysis and characterization techniques, Material synthesis, Analytical Services -Other Materials-, Gas analysis, Thermal analysis).

Scientific achievements have been reached in the framework of research stays in other RD programmes funded by EU, national and regional entities. Currently approx. 4-5 international users use the IMDEA Energy's installations per year.
Examples of possible services and research activities are the analysis of thermal performance of materials for high-temperature heat processes by continuous monitoring of temperature and irradiance on the samples; use of a test rig for aerothermal characterisation of volumetric absorbers (which involves monitoring of pressure drop, temperature distribution along the sample, and thermal performance); and the use of a test rig for thermo-chemical characterisation of solar reactors at 10kW-scale (Continuous monitoring of temperature distribution and gas composition).