Minimized water consumption in CSP plants - EU project MinWaterCSP is making good progress

Press release
04-12-2017

In Concentrated Solar Power (CSP) plants, collectors are bundling the sunlight on an absorber in order to generate electricity. CSP plants are often installed in arid areas where solar irradiation is high and water resources are scarce. CSP plants making use of traditional wet-cooling systems consume a large amount of water because of both cooling system evaporation losses and mirror cleaning processes.
In the Horizon 2020 project MinWaterCSP, the consortium aims to reduce the annual water consumption of a CSP plant through a number of complementary measures while maintaining or even improving thermal efficiency and reducing capital costs. This is done through a holistic combination of next generation technologies in the fields of hybrid dry/wet cooling systems, axial flow fans, wire structure heat transfer surfaces, comprehensive water management plans, mirror cleaning techniques and optimized cleaning schedules. Eighteen months into the project, the MinWaterCSP project partners have already achieved excellent results.

For the hybrid dry/wet cooling system, the environmental impact leads to less strain on local water resources and increased water availability for human consumption.

The project consortium designed a novel hybrid dry/wet cooling system which reduces water evaporation losses by between 75% and 95%, compared to a solely wet cooling system. The net efficiency of the steam Rankine cycle will be increased by 2% compared to dry-cooling only, or alternatively the capital cost of an exclusively dry-cooling system reduced by 15% - while maintaining cycle efficiency.

With regard to the axial fan development, tests have shown a potential reduction in fan power consumption with a direct impact on the profitability of CSP plant operation and its' life-cycle.

An axial flow fan was designed, manufactured and installed at the Eskom Matimba ACC site in South Africa by the SME partner NOTUS. The design approach followed the principle of duty point specific aerodynamic optimization. Tests showed that the new approach to fan design adheres to the performance and structural requirements for the typical air-cooled condenser installation.
Three prototype scale-model fans were designed and evaluated for a typical air-cooled condenser installation using Computational Fluid Dynamics (CFD). Fan noise levels were also evaluated. The performance tests were done by Stellenbosch University and the noise tests by Sapienza University of Rome. In addition, a number of improvement options to the cooling fan drive train efficiency are currently under development, i.e. a magnetic gearbox, a wound rotor motor and a written pole motor.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654443

The magnetic gearbox has the potential to reduce the required fan drive size, thereby positively impacting the capital cost requirements of CSP plants. It has also the potential to reduce maintenance costs of the mechanical equipment.

The novel wire surface heat exchanger concept offers - compared to conventional solutions - a potential saving of 10% of material and a reduction in life-cycle environmental impact, resulting in lower investment costs for cooling systems.

For the activities linked to the wire surface heat exchanger, a CFD comparison of the simulated performance of a wire structure heat exchanger with a reference air-cooled condenser of a CSP plant in Morocco shows a decrease in total mass of the heat exchanger of up to 10% at equal thermal and fluid dynamic performance. This can reduce investment costs for cooling systems used in CSP plants. The implementation of the manufacturing procedure of the textile wire structured heat exchanger by Fraunhofer ISE and ENEXIO is still ongoing.

For CSP plants, comprehensive water management plans in different locations are developed to assess the impact of the design improvements achieved, in a complete CSP system context.

Management strategies for water use and water treatment, developed by Waterleau and Fraunhofer ISE, are based on a literature study and discussions with CSP plant operators. Simulation models for overall CSP plant water consumption were developed and implemented into the system simulation software “ColSim” by Fraunhofer ISE.

Modular water treatment sub-systems have been defined as a solution for CSP-water treatment and management.

For the cleaning process, a reduction of 25% of the previous water consumption seems achievable with a positive impact on operation costs for contractors, which leads to a significant positive impact in arid areas.

The aim is to reduce the mirror cleaning water consumption by 25% by improving the mirror cleaning process. For solar collector cleaning, different cleaning prototypes have been designed and constructed - truck-based for parabolic troughs and heliostats and a new cleaning robot for Fresnel collector applications. The cleaning equipment was developed and tested by the SME partners ECILIMP and Soltigua. Furthermore, prototypes for collector reflectance monitoring have been installed by Fraunhofer ISE and the collection of data from the solar fields has started, which is used for measurement and mapping of soiling rates.

MinWaterCSP test rig and full-scale test facility

A test rig for cooling system fouling tests has been successfully commissioned by Kelvion Thermal Solutions and by the Moroccan partner IRESEN. Experiments with water compositions und representing typical operating conditions are presently being carried out by IRESEN.

In addition, the MinWaterCSP project partners Kelvion Thermal Solutions, ENEXIO and Stellenbosch University are currently building a novel full-scale test facility for the hybrid cooling system and the CSP cooling fan development in Stellenbosch, South Africa.

ColSim simulation software to act as a benchmark for CSP plants' life-cycle performance and water foot-print assessments.

Fraunhofer ISE has continued its development of their CSP plant simulation software 'ColSim' incorporating various improved modelling methodologies derived from the MinWaterCSP project. The models simulate water streams throughout the CSP plant enabling the quantification of water consumption, water quality, treatment processes and the required energy for treatment.

MinWaterCSP – achieving positive economic, environmental and societal impacts on the CSP Industry and beyond

The expected impact of the MinWaterCSP project is to reduce cooling system capital and operating costs. Net power output could be improved while saving water. As a result, locations with limited water supply can expect to benefit from CSP technology, reducing dependency on fossil fuels. Similarly, a reduction in the effects on the environment during the entire life-cycle of a CSP plant can be expected. Finally, the MinWaterCSP consortium aims to make CSP more attractive for investment purposes in order to drive growth in the CSP plant business as well as create new jobs.

About MinWaterCSP

MinWaterCSP is a research and development project which aims at reducing water consumption and improving thermal cycle efficiencies of Concentrated Solar Power (CSP) plants. It has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 654443.

The project started in January 2016 and will be completed in December 2018.

The MinWaterCSP project consortium consists of 13 partners from 6 different EU- and non-EU countries. It is coordinated by Kelvion Holding GmbH (Project Coordinator, Germany) and ENEXIO Management GmbH (Technical Coordinator, Germany). Further partners of the consortium are: Kelvion Thermal Solutions (Pty) Ltd. (South Africa), Fraunhofer ISE (Germany), Sapienza University of Rome (Italy), ECILIMP Termosolar SL (Spain), Stellenbosch University (South Africa), Notus Fan Engineering (South Africa), Laterizi Gambettola SRL – SOLTIGUA (Italy), ENEXIO Germany GmbH (Germany), Institut de Recherches en Energie Solaire et Energy Nouvelles - IRESEN (Morocco), Steinbeis 2i GmbH (Germany) and Waterleau Group NV (Belgium).

Further information on MinWaterCSP:
http://www.minwatercsp.eu
MinWaterCSP videos on euronews channel: Making green energy cheaper & What is wrong with solar power plants

Follow us:
Twitter: @MinWaterCSP
LinkedIN: MinWaterCSP

For more details please contact:
Kelvion Holding GmbH / ENEXIO Management GmbH
Project coordinator / Technical coordinator
Dr. Falk Mohasseb / Dr. Albert Zapke
contact@minwatercsp.eu

Press contact:
Steinbeis S2i GmbH
Charlotte Schlicke
secretariat@minwatercsp.eu

Pictures attached:

- Picture 1: Fan installation at Matimba (picture: Notus Fan Engineering)
- Picture 2: Fouling test rig, Green energy park in Morocco (picture: IRESEN/ENEXIO)
- Picture 3: Cleaning truck of partner ECILIMP Termosolar (picture: GEMASOLAR Plant, property of Torresol Energy©SENER, Cleaning Technology property of ECILIMP)