ECOSun
Economic COgeneration by Efficiently COncentrated SUNlight

Project duration: from 02.2020 to 01.2023
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Publishable Summary

Project ECOSun targeted a radical cost reduction of electricity and heat co-generation via a Concentrated Photovoltaic Thermal (CPV-T) system, by applying low-cost materials and advanced industrial manufacturing methods. In the ECOSun system, solar radiation is captured in a parabolic through collector, which incorporates a novel injection molded plastic support structure, and focused on a Co-Generation Absorber Module (CAM), where special c-Si-PV-cells are operated under concentrated sunlight. The heat dissipated through the cells is transferred into a heat transfer fluid (HTF) and - in combination with the generated electricity - can be used for various applications, such as solar cooling or heating, significantly increasing system efficiency.

A significant cost reduction was achieved by designing and optimizing the economically most relevant elements of the ECOSun system, which are:

- Mirror and Support Structure:

Since mirror, support structure and related assembly represent the biggest cost share in most concentrating solar power systems, a novel approach using components designed for high volume manufacturing technologies, such as injection molding and aluminum extrusion was taken. This will not only allow to reduce dependency from metal price fluctuations on the global market, but also enable easy assembly by untrained personnel, as well as a significant CO2 reduction of the transportation process due to light-weight, modular design. As a result, a patent regarding this innovative parabolic trough support structure was filed by the Austrian Industrial Partner IMK. A substantial reduction in weight and cost compared to IMK's previous collector version has been achieved, with the weight of support structure including mirrors at 16.5 kg/m² and the potential to reach production costs less than 100 €/m².

- CPV-Cell:

As a novelty, a low-cost solar cell based on crystalline silicon was designed, which can reach high efficiencies under 60 x concentration and perform well under elevated operating temperatures. Due to the concentration, much less active cell area is required, which reduces specific cost (€/Wp). (At high production volumes, mirrors can be acquired for 2~5 €/m2, while flat-plate PV panels range from 40~70 €/m2.) However, as long as the actually reached electrical efficiency lags behind the targeted > 22%, it might be more economic to incorporate silicon hetero-junction cells or multi-junction cells. This was another crucial finding of the study.

- Heat Sink and Thermal Management:

The heat rejection strategy and hardware for optimal cell cooling (i.e. a sweet spot between PV cell service life, efficiency and temperature level for heat use) was optimized with respect to low-cost industrial manufacturing, maximum service life and high system performance. These novel heat-sink designs were numerically studied and empirically validated.

One major milestone of the project was the manufacturing and testing of a fully functioning prototype, including all specifically developed components, that was submitted to real world testing. (Also see Figure 1 below.) To demonstrate the system's capabilities, a numerical model of the entire co-generation system was created and applied for the exemplary use case of "solar cooling for buildings", which relies on ab absorption chiller powered entirely by the ECOSun technology.

As indicated in the SET-Plan by the European Union, the only chance for Europe, as a high wage region, to regain leadership as CSP/CPV supplier is to substitute labor-intensive manual tasks with high-tech manufacturing know-how. This ambitious goal can be achieved by introducing highly automated and economically advanced manufacturing methods, like injection molding, as demonstrated in this project. Austria's manufacturing industry and related know-how must be considered a catalyst and ideal breeding ground for low-cost solar power components. Despite all the potential for design and engineering innovation, Austria needs research and business partners in southern Europe to realize new ideas in the CSP and CPV market. The ECOSun project was a door-opener for the desired international cooperation by integrating partners from Turkey and Spain. It is important to mention that the results of the ECOSun project have been published in top peer reviewed journals as well as conferences and general media, with dissemination activities and efforts to organize a follow-up project still ongoing.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Austria	2	675 953	562 553
Turkey	2	118 285	122 360
Spain	1	146 697	145 500
Total	***5***	**940 935**	**830 413**

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Austrian Research Promotion Agency (FFG)	Project number: 873785 eCall-number: 21722556 + 25112870
Türkiye Bilimsel ve Teknik Araştırma Kurumu (TÜBİTAK)	219M027 219M028
Agencia Española de Investigación (AEI) Ministerio de Ciencia e Inovación (MINECO)	Project reference: PCI2019-111922-2 Title: COGENERACION ECONOMICA MEDIANTE LUZ SOLAR EFICIENTEMENTE CONCENTRADA