# Assessment of the integration of a MED-TVC plant into a solar tower with Brayton cycle

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**ABSTRACT**

Seawater desalination is an energy-intensive process, and to mitigate freshwater scarcity in a planet threatened by climate change, the use of renewable energy sources to meet at least part of its power requirements is mandatory. Among the different renewable energy sources, concentrating solar power (CSP) plants is a dispatchable technology that provides heat and electricity simultaneously. It is therefore considered one of the most promising options to be combined with desalination. This is totally aligned to the EU's commitment to global climate action under the Glasgow climate conference (COP26) to be climate-neutral by 2050, an economy with net-zero greenhouse gas emissions. Among the different CSP technologies, those featuring a power block configuration based on a Brayton cycle rely on major advantages, making it the most promising CSP technology for its coupling to desalination systems in arid and semi-arid regions. Particularly, several advantages can be highlighted on this option: non-consumption of water by the power cycle, capacity to integrate high-temperature desalination systems (higher thermal efficiency) in the Brayton cycle with almost non-penalty on the power cycle efficiency, and the high modularity and capability of developing small power systems for remote areas with water scarcity. These advantages make Brayton CSP technology much more competitive than the Rankine CSP technology for its coupling with desalination systems. This work presents the assessment on the integration of a thermal seawater desalination system, based on Multi-Effect Distillation technology with Thermal Vapor Compression (MED-TVC), into a high-temperature power cycle (air Brayton cycle) and high-temperature CSP technology (central receiver solar tower). For such integration, the exhaust gases from the gas turbine are addressed to a recovery boiler where steam is generated to drive the MED-TVC unit. Models of the Central Receiver Solar Tower (heliostat field and receiver) together with the air Brayton cycle have been implemented Python. The heliostat field model was developed using SolarPILOT (Solar Power Tower Integrated Layout and Optimization Tool) from NREL, whereas the solar receiver and Brayton cycle were developed in Modelica. These models are based on the AORA solar power plant located at Plataforma Solar de Almería (PSA). Regarding the MED-TVC unit, a model that evaluates its thermodynamic performance by applying mass and energy balances has been firstly implemented in Engineering Equation Solver (EES). Then, to model the integration of the MED unit with the rest of the CSP plant in Python, a multi-variable polynomial regression has been developed from the results delivered by the EES model. Annual simulations have finally been performed to analyze the total fresh water and electricity produced as well as the efficiency of the power cycle considering a coastal location in the Middle East.

**KEYWORDS**

Power and Desalination integration, Multi-Effect Distillation with Thermal Vapour Compression, Central Receiver Solar Tower, Air Brayton Cycle