

Study the Possibility of Implementing a Solar Chimney Power Plant in Algeria

(Case study: Constantine)

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ABSTRACT

This work offers the opportunity to consider the possibility of realizing a solar chimney power plant in the region of Constantine (Algeria). This region is characterized by its important solar radiation resource and ambient temperature. Based on actual measurements of Constantine weather station for the period of April 2020, the performance analysis of a solar chimney which have three times the dimensions of the Manzaneres prototype (Spain) is carried out using of Fluent software. The obtained results show that when the dimensions of the solar chimney are large, the impact of small changes in solar irradiation is negligible. Also, the studied power plant with dimensions of; 584 m height, a diameter of 30 m and a collector diameter of 732 m is capable of producing a monthly average of 72 to 296 MW of electrical energy, this energy production would be sufficient to meet the needs of rural areas located in this region.

OBJECTIVES

The main objective of this work is to study the possibility of implementing a solar chimney power plant in the region of Constantine (Algeria), in which the solar potential is exceptional is investigated. Thus, our focus is to explore the performances and yield of such a facility in the aforementioned location.

PRICIPLE OF OPERATION OF A SOLAR CHIMNEY POWER PLANT

As presented in Figure 1, air is heated up by solar radiation under a low circular glass roof open at the periphery. Continuous 24 hours-operations are guaranteed by placing tight water-filled tubes under the roof. The water heats up during the daytime and emits its heat at night. These tubes are filled only once, then, no further water is needed. In the middle of the roof, there is a vertical chimney with large air inlets at its bottom. The joint between the roof and the chimney bottom is airtight. As hot air is lighter than cold air, it rises up the chimney. Suction from the chimney then draws in more hot air from the collector, and cold air comes in from the outer perimeter. Thus, solar radiation causes a constant up draught in the chimney. The energy contained in the hot air is converted into mechanical energy by pressure-staged wind turbines at the bottom of the chimney, and into electrical energy by conventional generators [1].

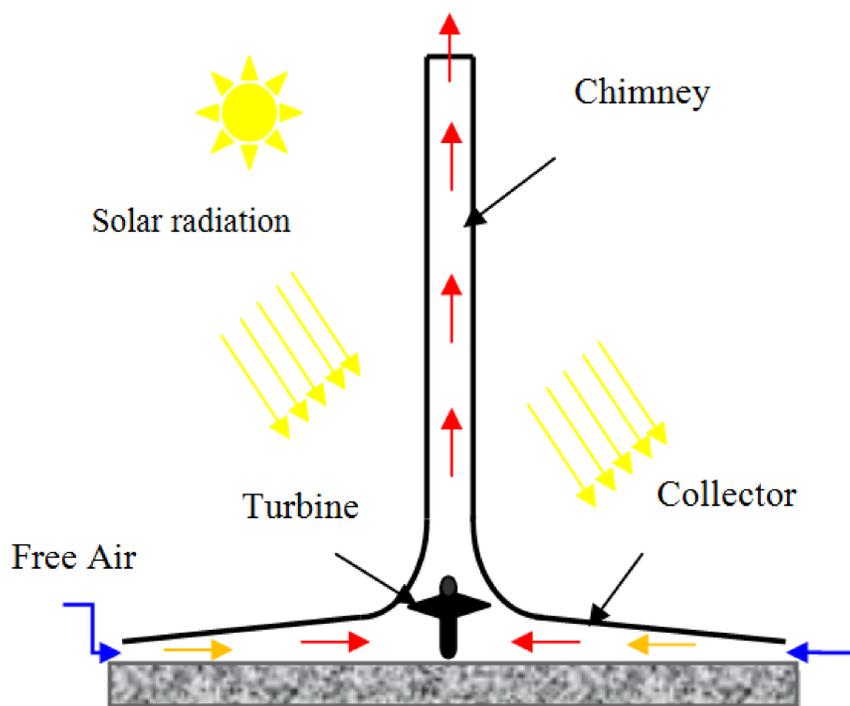


Figure 1 : Solar chimney power plant

RESULTS

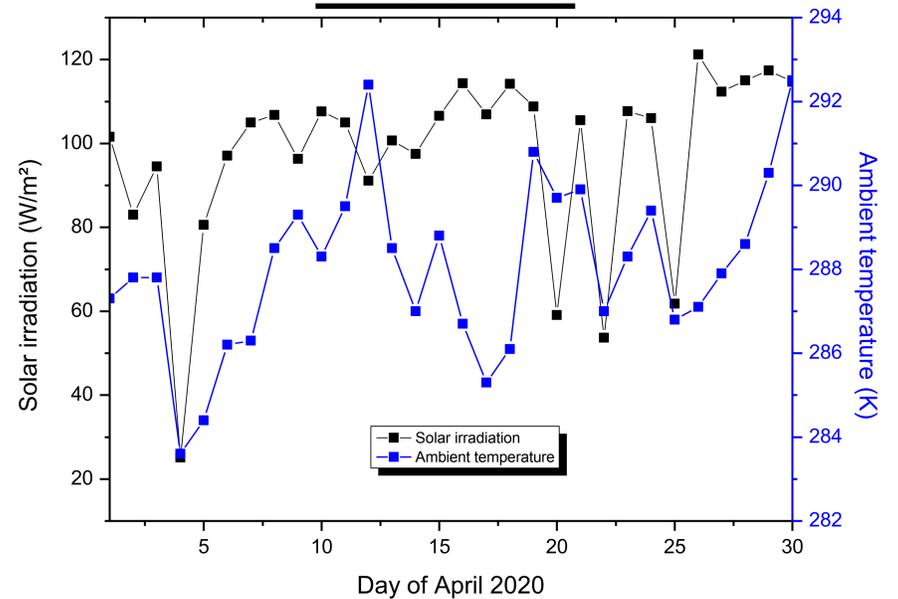


Figure 2 : Solar irradiation and ambient temperature during the month of April 2020 (Ain El Bey Constantine weather station)

The power production by the studied solar chimney power plant versus time for the nine chosen days; the curves have a similar appearance to that of the solar radiation. In addition, we can notice that this production varies during the whole month of April from 50 to 500 KW. It should be noted that for large size of solar chimney power plant, the impact of small variations in solar radiation on energy production is negligible.

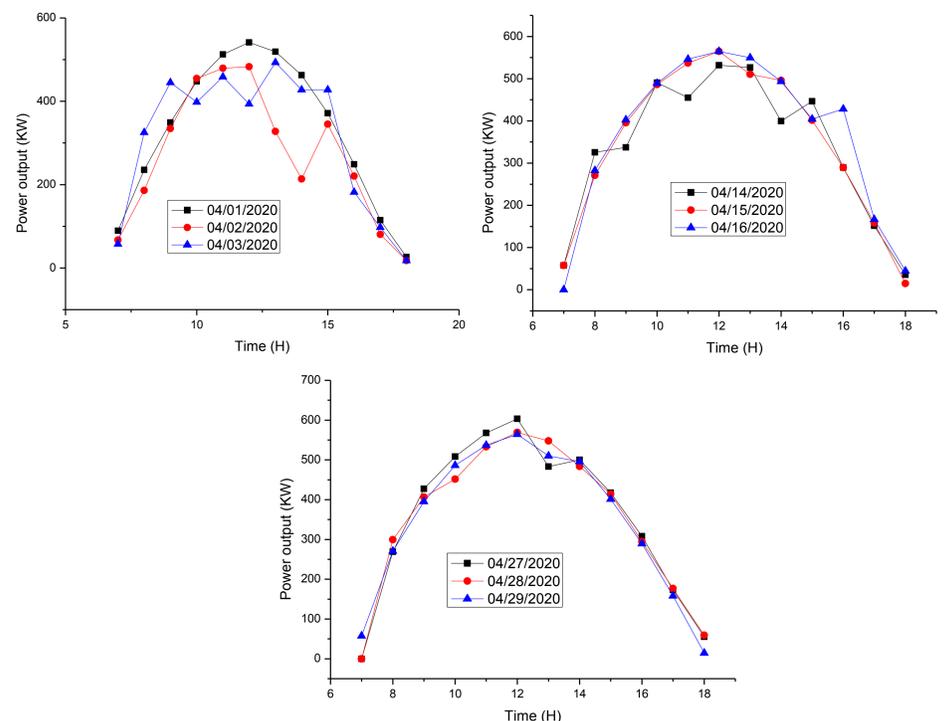


Figure 3 : Variation of generated power during the nine days of April

CONCLUSION

The influence of solar radiation and ambient temperature on the generated electrical energy of a solar chimney in the region of Constantine (Algeria) is studied. The results have led to the following notes:

- The production of electrical energy by the simulated power plant is perfectly related to solar radiation and ambient temperature evolutions. Nevertheless, the effect of the first parameter is much important than the second.
- The larger dimensions of the chimney plant, the less effect of changes of solar radiation
- The generated power of the installation in the region of Constantine (Algeria) with three times the dimensions of Manzaneres (Spain) prototype, could reach a high range of 270-395 kW. This configuration can enhance the dispatch capacities of such plants, and can reduce the levelized cost of electricity.