Chapter 31
Systems with Concentrating Solar Radiation

Saša R. Pavlović
University of Niš, Serbia

Velimir P. Stefanović
University of Niš, Serbia

ABSTRACT

In this chapter, description and working principles of the parabolic trough power plants, solar tower power plants, parabolic dish power plants, and power plants with Fresnel reflectors in the world and their potential use in Serbia are given. In addition, the examples and technical characteristics of some concetrating solar power plants in the world are given. The cases in which solar cells are used to generate electrical energy are very rare. Solar systems referred as mid temperature (100–400 ^{o}C) are considered suitable for integration with industrial processes, cooling, and polygeneration systems through use of concentrating solar collectors. The results of this research may be applied in the construction of small solar systems, but also in the design and construction of large polygeneration systems. Physical and mathematical model is presented, as well as numerical procedure for predicting thermal performances of the P2CC (Parabolic-and-Circular Collector) solar concentrator.

INTRODUCTION

Global increase in the number of population and this same increase in fortunes bring about increased consumption thus creating lack of resources especially sources of energy and drinking water. It is estimated that the consumption of electrical energy will double in the next 15-20 years. Irrespective of the ecological arguments increase of the production of electrical energy generated by renewable sources is necessary so that countries diminish their dependance on the import and the necessity to provide for new resources. Renewable sources are in the long run a valuable alternative. Many areas in the world abound in free solar energy while in some other areas wind and other types of renewable sources of energy impose themselves as a logical choice (Marković et al.,

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2011). Having in mind that fossil fuels on Earth are limited and that their usage ensues the emission of CO_2 that exerts negative influence on the environment, more and more renewable sources of energy are being used worldwide with the Sun as a primary source of energy. By means of the adequate equipment the energy of the sun irradiation can be converted into thermal and electrical energy. Depending on the degree of the heating of the working fluid we can differ between the low-temperature ($T<100^oC$), middle-temperature ($100^oC<T<400^oC$) and high-temperature conversion ($400^oC<T<4000^oC$). For low-temperature solar energy conversion one uses flat collectors with water and air, for middle-temperature conversion one uses vacuum colletors and collectors with concentrators, and for high-temperature one uses solar furnaces and CSP plants (Tomislav, 2007) and (Fernández-García et al., 2010). Concentrated Solar Power (CSP) plants denote plants that generate electrical energy by means of concentrated sun irradiation. CSP plants are composed of the solar concentrator, steam turbine and electricity generator. Solar concentrators can be parabolic troughs, heliostats, parabolic dishes and Fresnel reflectors (Robert, 2007). For the continuous functioning of the CSP plant during the night and in overcast days a thermal energy from the heat tank or gas as an additional source of energy is used (Sharma, 2011; Kaygusuz, 2011). The chapter goes on to give a description of the P2CC (Parabolic-and-Circular Collector) solar concentrator, solar energy potential in Serbia, current and future solar energy activities in Serbia. This chapter gives the analysis of the energy system simulation software, with an energy system defined as any system capable to satisfy one or more energy demands. The scope of this paper is to give brief descriptions about the energy system software, their similarities, differences, features, capabilities, limitations, and help modelers to choose a most suitable package for different tasks. The survey focuses and tries to provide data regarding most important features of the software such as:

- **Area/Purpose the Software was Designed For:** The criteria will make a classification of programs suitable for different modeling applications – energy system modeling, design, optimization, building energy efficiency, process integration.
- **Type of Simulation:** Static/dynamic
- **Solver Type:** Simultaneous/sequential
- **Included Tools and Features:** Design, integration tools, optimization tools, LCA, techno-economic analysis
- **Included Model Libraries of Available Technologies:** A classification based on the technologies covered in the ground file of the software (i.e. wind, solar, heat pump, cogeneration, gas turbine, oto/diesel engines…)
- **Flexibility:** Ability to combine technologies into a hybrid system, ability to make changes to the available component models
- **Decision Making:** Input/output options and results
- Program code open to changes and interaction
- **User Interface:** Graphical user interface (GUI) or command line

BACKGROUND

Review Stage

Numerous theoretical and experimental researches of solar collectors for the mid-temperature conversion of solar radiation into heat via a liquid as