A Parabolic Trough Solar Power Plant Simulation Model

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Concentrating Solar Power Technology Springer This report describes a component-based cost model developed for parabolic trough solar power plants. The cost model was developed by the National Renewable Energy Laboratory (NREL), assisted by WorleyParsons Group Inc., for use with NREL's Solar Advisor Model (SAM). This report includes an overview and explanation of the model, two summary contract reports from WorleyParsons, and an Excel spreadsheet for use with SAM. The cost study uses a reference plant with a 100-MWe capacity and six hours of thermal energy storage. Wet-cooling and dry-cooling configurations are considered. The spreadsheet includes capital and operating cost by component to allow users to estimate the impact of changes in component costs.

Intelligent Manufacturing and Energy Sustainability Springer Nature

A simulation for a solar thermal electric generating system with parabolic trough collectors in Basrah city is presented. This system consists of three parts: solar collector fields to heating the working fluid, a storage system to store the thermal energy, and power conversion system to convert the thermal energy to electrical. The simulation is presented for all parts. The energy conversion of solar radiation into thermal power along the absorber tube of the parabolic collector is studied. The coupling between the collector and the thermodynamic cycle is made up by heat exchangers, yielding the characteristic temperatures of the cycle. The conventional Rankine cycle is used as the thermodynamic cycle, whereby the electric power is calculated. The performance of a 30 MW power plant, composed of 50 rows with 16 collectors in series (total 800 collectors) was simulated. Finally, the output power of the plant is calculated for two cases: system with storage tank and with out it. A maximum of the overall cycle efficiency is

found at temperatures around 320 oC. All calculations are performed according to Basrah climate's conditions for 21st of each month in 2007.

Numerical Modelling of a Parabolic Trough Solar Collector Academic Press

This second edition of Concentrating Solar Power Technology edited by Keith Lovegrove and Wes Stein presents a fully updated comprehensive review of the latest technologies and knowledge, from the fundamental science to systems design, development, and applications. Part one introduces the fundamental principles of CSP systems, including site selection and feasibility analysis, alongside socio-economic and environmental assessments. Part two focuses on technologies including linear Fresnel reflector technology, parabolic-trough, central tower, and parabolic dish CSP systems, and concentrating photovoltaic systems. Thermal energy storage, hybridization with fossil fuel power plants, and the long-term market potential of CSP technology are also explored. Part three goes on to discuss optimization, improvements, and applications, such as absorber materials for solar thermal receivers, design optimization through integrated techno-economic modelling, and heliostat size optimization. With its distinguished editors and international team of expert contributors, Concentrating Solar Power Technology, 2nd Edition is an essential guide for all those involved or interested in the design, production, development, optimization, and application of CSP technology, including renewable energy engineers and consultants, environmental governmental departments, solar thermal equipment manufacturers, researchers, and academics. Provides a comprehensive review of concentrating solar power (CSP) technology, from the fundamental science to systems design, development and applications Reviews fundamental principles of CSP systems, including site selection and feasibility analysis and socio-economic and environmental assessments Includes an overview of the key technologies of parabolic-trough, central tower linear Fresnel reflector, and parabolic dish CSP systems, and concentrating photovoltaic systems

Simulation of Parabolic Trough Solar Power Plant in Basrah City DIANE Publishing

Solar Power Generation is a concise, up-to-date, and readable guide

providing an introduction to the leading renewable power generation technology. It includes detailed descriptions of solar photovoltaic and solar thermal generation systems, and demystifies the relevant solar energy technology functions in practice while also exploring economic and environmental risk factors. Engineers, managers, policymakers, and those involved in planning and delivering energy resources will find this reference a valuable guide to help establish a reliable power supply to address social and economic objectives. Focuses on the evolution and developments in solar energy generation Evaluates the economic and environmental viability of the systems with concise diagrams and accessible explanations Demystifies the relevant solar energy technology functions in practice Explores economic and environmental risk factors

Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts CRC Press

Subcontract report by Nexant, Inc., regarding analysis of plant size of solar parabolic trough plants.

Parabolic Trough Reference Plant for Cost Modeling with the Solar Advisor Model (SAM) DIANE Publishing

Climate change and water scarcity are important issues for today's power sector. To inform capacity expansion decisions, hybrid life cycle assessment is used to evaluate a reference design of a parabolic trough concentrating solar power (CSP) facility located in Daggett, California, along four sustainability metrics: life cycle greenhouse gas (GHG) emissions, water consumption, cumulative energy demand (CED), and energy payback time (EPBT). This wet-cooled, 103 MW plant utilizes mined nitrate salts in its two-tank, thermal energy storage (TES) system. Design alternatives of dry-cooling, a thermocline TES, and synthetically-derived nitrate salt are evaluated. During its life cycle, the reference CSP plant is estimated to emit 26 g CO2eq per kWh, consume 4.7 L/kWh of water, and demand 0.40 MJeq/kWh of energy, resulting in an EPBT of approximately 1 year. The dry-cooled alternative is estimated to reduce life cycle water consumption by 77% but increase life cycle GHG emissions and CED by 8%. Synthetic nitrate salts may increase life cycle GHG emissions by 52% compared to mined. Switching from two-tank to thermocline TES configuration reduces life cycle GHG emissions, most significantly for plants using synthetically-derived nitrate salts. CSP can significantly reduce GHG emissions compared to fossil-fueled generation; however, dry-cooling may be required in many locations to minimize water consumption.

Preprint Woodhead Publishing

Parabolic trough solar technology is the most proven and lowest cost large-scale solar power technology available today, primarily because of the nine large commercial-scale solar power plants that are operating in the California Mojave Desert. However, no new plants have been built during the past ten years because the cost of power from these plants is more expensive than power from conventional fossil fuel power plants. This paper reviews the current cost of energy and the potential for reducing the cost of energy from parabolic trough solar power plant technology based on the latest technological advancements and projected improvements from industry and sponsored R & D. The paper also

looks at the impact of project financing and incentives on the cost of energy.

Concentration Solar Power Springer

This report describes a component-based cost model developed for parabolic trough solar power plants. The cost model was developed by the National Renewable Energy Laboratory (NREL), assisted by WorleyParsons Group Inc., for use with NREL's Solar Advisor Model (SAM). This report includes an overview and explanation of the model, two summary contract reports from WorleyParsons, and an Excel spreadsheet for use with SAM. The cost study uses a reference plant with a 100-MWe capacity and six hours of thermal energy storage. Wet-cooling and dry-cooling configurations are considered. The spreadsheet includes capital and operating cost by component to allow users to estimate the impact of changes in component costs.

Simulation and Performance Evaluation of Parabolic Trough Solar Power Plants Springer Science & Business Media

ISES Solar World Congress is the most important conference in the solar energy field around the world. The subject of ISES SWC 2007 is Solar Energy and Human Settlement, it is the first time that it is held in China. This proceedings consist of 600 papers and 30 invited papers, whose authors are top scientists and experts in the world. ISES SWC 2007 covers all aspects of renewable energy, including PV, collector, solar thermal electricity, wind, and biomass energy.

Nexant Parabolic Trough Solar Power Plant Systems Analysis Emereo Publishing

Energy is one of the building blocks of modern society. The growth of the modern society has been fueled by cheap, abundant energy resources. Solar energy is a form of renewable energy which is available abundantly and collected unreservedly. In this research the application of solar energy using parabolic trough is analyzed. Parabolic trough technology is currently the most extended solar system for electricity production or steam generation for industrial processes. The prototype of the parabolic trough concentrating solar is collector manufactured using the available materials. The research work elaborates in detail the steps undertaken in the fabrication of the parabolic trough and other accessory parts used in the experimental setup. An experimental setup has been developed to investigate the performance of the parabolic trough. Measurements of total direct radiation on the plane of the collector, ambient temperature, wind speed, water flow rate, inlet and outlet temperatures of the water inside the absorber tube are collected and employed in studying the performance of the parabolic trough.

Advances in Green Energies and Materials Technology LAP Lambert Academic Publishing

This volume contains accepted papers presented at AECIA2014, the First International Afro-European Conference for Industrial

Advancement. The aim of AECIA was to bring together the foremost experts as well as excellent young researchers from Africa, Europe, and the rest of the world to disseminate latest results from various fields of engineering, information, and communication technologies. The first edition of AECIA was organized jointly by Addis Ababa Institute of Technology, Addis Ababa University, and VSB - Technical University of Ostrava, Czech Republic and took place in Ethiopia's capital, Addis Ababa.

Modeling of a Parabolic Trough Solar Field for Acceptance Testing

LAP Lambert Academic Publishing

As deployment of parabolic trough concentrating solar power (CSP) systems ramps up, the need for reliable and robust performance acceptance test guidelines for the solar field is also amplified. Project owners and/or EPC contractors often require extensive solar field performance testing as part of the plant commissioning process in order to ensure that actual solar field performance satisfies both technical specifications and performance guaranties between the involved parties. Performance test code work is currently underway at the National Renewable Energy Laboratory (NREL) in collaboration with the SolarPACES Task-I activity, and within the ASME PTC-52 committee. One important aspect of acceptance testing is the selection of a robust technology performance model. NREL1 has developed a detailed parabolic trough performance model within the SAM software tool. This model is capable of predicting solar field, sub-system, and component performance. It has further been modified for this work to support calculation at subhourly time steps. This paper presents the methodology and results of a case study comparing actual performance data for a parabolic trough solar field to the predicted results using the modified SAM trough model. Due to data limitations, the methodology is applied to a single collector loop, though it applies to larger subfields and entire solar fields. Special consideration is provided for the model formulation, improvements to the model formulation based on comparison with the collected data, and uncertainty associated with the measured data. Additionally, this paper identifies modeling considerations that are of particular importance in the solar field acceptance testing process and uses the model to provide preliminary recommendations regarding acceptable steady-state testing conditions at the single-loop level.

Design for Increasing Efficiency

Afro-European Conference for Industrial AdvancementProceedings of the First International Afro-European Conference for Industrial Advancement AECIA 2014

This fact sheet provides an overview of the potential for parabolic trough solar thermal

electric power plants, especially in the Southwestern U.S.

Experimental Investigation of Parabolic Trough Solar Collector

This book provides a technical overview of low-cost parabolic trough collector (PTCs) prototypes for low-temperature heat demand. It begins with a comprehensive but concise summary of the state-of-the-art in PTCs, and presents a detailed mathematical model of such systems. Subsequent chapters describe the construction and materials used in the manufacture of PTC prototypes, and offers technical solutions to overcome design problems. Finally, it provides an accessible guide to the standards used to test and evaluate the performance of PTCs. Offering a valuable resource to engineering researchers and practitioners, it is also suitable for students of solar thermal systems, renewable energy and applied physics.

Proceedings of ISES World Congress 2007 (Vol.1-Vol.5)

Parabolic troughs are used as a method of heating water by concentration of solar energy. Their success and usefulness have been proven in a number of countries around the world, especially in the field of power generation whereby the concentrator is able to heat up water to temperatures of 400 ° C. Parabolic troughs will position itself as an unstoppable cost effective solution in this desperate time of high demand for electricity. This positioning will be achieved by focusing on parabolic troughs competitive edge which is a "better, more affordable solar power for everyone" and will use clever and advanced methods of achieving better efficiency favorable in the South African market. The investigation at hand is comparing the practicality of parabolic dish and parabolic trough, by mounting either of them to the science and technology train. When destination is reached the mechanism needs to be set up and sun tracking can start to generate electricity by supplying a sterling motor with the necessary heat energy.

A Case Study

This fact sheet provides an overview of the potential for parabolic trough solar thermal electric power plants, especially in the Southwestern U.S.

Multiple plants at a common location, January 20, 2005 - December 31, 2005. Task 3

Concentrated Solar Power (CSP) technologies are gaining increasing interest in electricity generation due to the good potential for scaling up renewable energy at the utility level. Parabolic trough solar collector (PTC) is economically the most proven and advanced of the various CSP technologies. The modelling of these devices is a key aspect in the improvement of their design and performances which can represent a considerable increase of the overall efficiency of solar power plants. In the subject of modelling and improving the performances of PTCs and their heat collector elements (HCEs), the thermal, optical and aerodynamic study of the fluid flow and heat transfer is a powerful tool for optimising the solar field output and increase the solar plant performance. This thesis is focused on the implementation of a general methodology able to simulate the thermal, optical and aerodynamic behaviour of PTCs. The

methodology followed for the thermal modelling of a PTC, taking into account the realistic non-uniform solar heat flux in the azimuthal direction is presented. Although ab initio, the finite volume method (FVM) for solving the radiative transfer equation was considered, it has been later discarded among other reasons due to its high computational cost and the unsuitability of the method for treating the finite angular size of the Sun. To overcome these issues, a new optical model has been proposed. The new model, which is based on both the FVMand ray tracing techniques, uses a numerical-geometrical approach for considering the optic cone. The effect of different factors, such as: incident angle, geometric concentration and rim angle, on the solar heat flux distribution is addressed. The accuracy of the new model is verified and better results than the Monte Carlo Ray Tracing (MCRT) model for the conditions under study are shown. Furthermore, the thermal behaviour of the PTC taking into account the nonuniform distribution of solar flux in the azimuthal direction is analysed. A general performance model based on an energy balance about the HCE is developed. Heat losses and thermal performances are determined and validated with Sandia Laboratories tests. The similarity between the temperature profile of both absorber and glass envelope and the solar flux distribution is also shown. In addition, the convection heat losses to the ambient and the effect of wind flow on the aerodynamic forces acting on the PTC structure are considered. To do this, detailed numerical simulations based on Large Eddy simulations (LES) are carried out. Simulations are performed at two Reynolds numbers of ReW1 = 3.6 × 105 and ReW2 = 1 × 106. These values corresponds to working conditions similar to those encountered in solar power plants for an Eurotrough PTC. The study has also considered different pitch angles mimicking the actual conditions of the PTC tracking mechanism along the day. Aerodynamic loads, i.e. drag and lift coefficients, are calculated and validatedwith measurements performed in wind tunnels. The indepen-dence of the aerodynamic coefficients with Reynolds numbers in the studied range is shown. Regarding the convection heat transfer taking place around the receiver, averaged local Nusselt number for the different pitch angles and Reynolds numbers have been computed and the influence of the parabola in the heat losses has been analysed. Last but not the least, the detailed analysis of the unsteady forces acting on the PTC structure has been conducted by means of the power spectra of several probes. The analysis has led to detect an increase of instabilities when moving the PTC

to intermediate pitch angles. At these positions, the shear-layers formed at the sharp corners of the parabola interact shedding vortices with a high level of coherence. The coherent turbulence produces vibrations and stresses on the PTC structure which increase with the Reynolds number and eventually, might lead to structural failure under certain conditions.

Comparison of Wet and Dry Rankine Cycle Heat Rejection, 20 January 2005-31 December 2005

The results obtained for the proposed methodology were compared to another physical model (System Advisor Model, SAM) and a good agreement was achieved, thus showing that this methodology is suitable for any location.

Analysis of Dual Loop Parabolic Trough Concentrating Solar Power Plants

Subcontract report by Nexant, Inc., regarding a system analysis of multiple solar parabolic trough plants at a common location.

Nexant Parabolic Trough Solar Power Plant Systems Analysis

This paper describes the results of a validation of the FLAGSOL parabolic trough solar power plant performance model. The validation was accomplished by simulating an operating solar electric generating system (SEGS) parabolic trough solar thermal power plant and comparing the model output results with actual plant operating data. This comparison includes instantaneous, daily, and annual total solar thermal electric output, gross solar electric generation, and solar mode parasitic electric consumption. The results indicate that the FLAGSOL model adequately predicts the gross solar electric output of an operating plant, both on a daily and an annual basis.